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NORTHERN REGIONAL REVIEW OF ENVIRONMENTAL ARCHAEOLOGY
INVERTEBRATES IN ARCHAEOLOGY IN THE NORTH OF ENGLAND

ENVIRONMENTAL STUDIES REPORT

Harry Kenward

ARCHAEOLOGICAL SCIENCE

ENGLISH HERITAGE

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INVERTEBRATES IN ARCHAEOLOGY IN THE NORTH OF ENGLAND

Harry Kenward

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SUMMARY

Research and assessment undertaken on remains of invertebrates from archaeological sites in the northern counties of England is reviewed to provide a resource assessment. The quality and quantity of information available is considered and recommendations made for future research presented (a research agenda). This review includes a brief introduction to each of the invertebrate groups found or likely to be found in archaeological deposits, together with the techniques used to study these groups and the kinds of information they can provide. There follows a chronological review of the evidence, and then a consideration of a series of overarching themes such as evidence for climate change and the history of grain pests. The final sections cover techniques for studying invertebrate remains, problems and future development, and recommendations for future research.

ACKNOWLEDGEMENTS

Writing this review has been a remarkably mind-broadening experience for me and has already lead to a substantial number of 'spinoff' publications as well as providing clearer foci for future research. I am most grateful to English Heritage, and latterly the Department of Archaeology, for making it possible for me to devote a great deal of time to such an invigorating project.

I am also grateful to all of my past and present colleagues in the now defunct Environmental Archaeology Unit and the Department of Archaeology for tolerating my neglect of other matters while I worked on this review. I am especially in debt to Allan Hall for helping me in many ways, in particular for detailed comments on drafts, for managing the Environmental Archaeology Bibliography (EAB), for much discussion, and for help in clearing away unrelated tasks which threatened to interfere with the present one. Thanks are due to other EH post-holders (past and present) and staff both in the North and in other regions for spirited debate when the structure of the reviews was being established (I think time has shown that we were all right, up to a point...). Many people made information available: the *Palaeoecology Research Services* team (Shildon, Durham), notably John Carrott, deserve special thanks in this respect. Gill Campbell has been helpful, patient, understanding and supportive in the sometimes vexed last stages of writing, as well as offering numerous useful comments on the text. Dozens of archaeologists and environmental archaeologists alike have made unwitting contributions through discussion. Mark Robinson and Peter Murphy supplied drafts of their equivalent reviews, which helped to correct the direction of parts of this one and gave me standards to aim for, if not achieve. Terry O'Connor kindly provided references to assist my journey into archaeological molluscs, and helped in various other ways. Enid Allison, Paul Buckland, Nicki Whitehouse, Mark Robinson and David Smith are particularly thanked for various stimulating interactions and assorted assistance over the years. Finally, my wife, Kate, and sons, David and Christopher, have been supportive and patient while I worked on this review and a succession of other major projects simultaneously over a long period.

ARCHIVE LOCATION

Department of Archaeology, University of York

DATE OF RESEARCH

This review was written over a period of ten years and finalised in 2007

COVER

Psyllid nymph, *Trioza albiventris*, from Coppergate (H Kenward and E Allison)

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PREFACE

Using the review

Because this review is a compromise between needs of several principal user groups, and because it deals with a large number of invertebrate groups, time periods, geographical areas and historical themes, it is a large and rather complex document. It has been carefully structured, and cross-referenced, so the Contents combined with cross-referencing should provide a lead into desired information (searching the electronic version will of course be the best way to access minutiae), but a little more explanation may be helpful.

Part 1 includes various introductory and background elements. In Part 2, a brief introduction to each of the invertebrate groups found (or at all likely to be found) in British archaeological deposits is given, together with a short review of the practical methods and analytical techniques adopted for them. This is intended to provide information which will permit curators and archaeologists planning projects to make judgements about the likely value of work on particular groups, and to serve as a general introduction to students and non-specialists.

The first half of the core of the review (Part 3) consists of a chronological account of the evidence. The time periods employed are approximately those agreed at a meeting of the team producing the reviews, held over a decade ago.

The chronological account is followed in Part 4 by consideration of a series of themes. These range from the overarching (e.g. climate change) to minutiae (e.g. reviews of some individual species). Some are very 'invertebrate-orientated', but usually I have tried to take a broader view, even though it has, for brevity, usually been necessary to limit reference to other forms of evidence (notably the plant remains). There is sometimes repetition where themes draw on the same evidence, but generally I have tried to avoid this by cross-reference.

Within each section of the chronological and thematic accounts, attention is paid to topographic and political areas where there are special considerations or there are coherent bodies of evidence.

Following the thematic section, Part 5 considers some aspects of techniques of study, their problems and future development. Cases where opportunities to study various invertebrate groups have not been taken are dwelt on somewhat, in order to emphasise how poorly the remains have been treated at many sites. Part 6 considers how we may move forwards in studies of archaeological invertebrates, considering scientific, logistical and managerial aspects.

A series of recommendations are then brought together in what is designed to be a free-standing document. These recommendations are intended to feed into project designs, curatorial judgements, and future research proposals. They are obviously strongly biased by the author's experience and research interests, but an attempt has been made to be comprehensive.

Many of the review sections necessarily only refer to a single group (typically the insects), but as far as possible the invertebrates are treated in an integrated manner and all are considered under each of the major headings to the extent which is appropriate.

By definition, this review emphasises the contribution which invertebrates can make to the study of the human past, and considers questions which may be addressed particularly through them, giving an inevitable bias in the topics considered. However, there are probably few problems in human palaeoecology (i.e. archaeology in the widest sense) which invertebrates have absolutely no potential to address, at least when combined with other lines of evidence. Invertebrates have suffered neglect at many sites, and in an attempt to emphasise their value this review is long-winded at times. For this evangelism apology is made to the already converted.

Because rather little work has been carried out for most period/site type/geographical area combinations, it has (with rare exceptions) been impracticable to group sites for synthesis other than geographically in the chronological section; there is usually little to tie them together, so almost all have been considered individually under general headings. This sometimes makes for tedious summaries, for which further apology is offered. However, these summaries should be useful in desktop evaluations of nearby sites and in determining the general character of deposits in particular areas, and will often obviate the necessity to go to the original reports, which may be hard to obtain quickly.

It was originally intended to produce a brief review by curatorial area or topographic region, but it quickly became apparent that this would have little point. No area has been more than superficially studied for invertebrates. Although Roman Carlisle and Anglo-Scandinavian York might be argued to be well known, information for the former is restricted to the early centuries, and only a very small part of the latter (the area around Coppergate) is at all well studied (rather than having been subjected to numerous evaluations of limited academic value). Perhaps the next review of the region's archaeological invertebrates will have sufficient material for clearer patterns to emerge; for the present, care has been taken to flag regions within sections.

'Those who cannot remember the past are condemned to repeat it'

– G. Santayana, *Life of reason* (1905-6)

'Small is beautiful'

– E. F. Schumacher (Book title, 1973)

Introduction

The reviews of environmental archaeology

This review is a component of one of three sets of regional reviews originally commissioned by the former Ancient Monuments Laboratory (AML) of English Heritage (EH). The reviews cover northern England, the Midlands, and the South, these areas being based approximately on those adopted by EH for administrative purposes at the time of commissioning. It was intended that each regional review would be prepared in two stages: firstly the construction of 'material' reviews, dealing for example with plant or non-human vertebrate remains, and secondly the integration and condensation of the information in the material reviews to provide a synthesis. The structure adopted for each of the parts of the reviews varies and that of the present one, the 'material' review of invertebrates for the North of England, is a compromise which may please no-one.

The reviews have several purposes, but they are primarily intended to inform (a) those individuals and organisations who are responsible for the curation of the buried archaeological heritage and (b) archaeological units carrying out excavation. It is particularly hoped that they will provide a framework against which future policy decisions can be set, enabling the research value of projects to be maximised. It has been felt essential to include a substantial amount of introductory and background material in the present account, to make it more accessible to these readers, few of whom are likely to have much familiarity with either invertebrates or ecology.

The reviews have a third audience in mind, namely researchers and students. These people have been very consciously catered for during the preparation of the review of invertebrates, dealing as it does with the least well known yet most complex of the groups of biological remains encountered in archaeological deposits: the learning curve for students is particularly steep where invertebrates are concerned. That this text is not intended to be read cover-to-cover is perhaps self-evident from its sheer bulk, though it is hopes that the taxonomic and synthesis sections (as opposed to the accounts of sites) have sufficient flow to be readable.

There are reviews of invertebrates from other English regions: Murphy (CAR 68/2001) for East of England and the Midlands (mainly molluscs); and Robinson (CAR 39/2002; CAR 9/2003) for insects from the southern and midlands regions respectively. Readers wishing to improve their understanding of the value of invertebrates in archaeology will find much of interest in their reports.

Why study the past?

Archaeology is the study of the human past through material remains, usually buried. Its underlying motivation has always been largely honest curiosity and the magic of revealing what is hidden, perhaps just a re-direction of deep instincts ('mental modules', D. Jones 1999) to search out food and to acquire information, both activities of great survival value. However gratifying it may be, though, archaeology costs money, and that money must be got from somewhere. The problem of funding is infinitely worsened by the increasingly complex nature of archaeological investigation and, as we are all too often reminded, environmental archeology often contributes very substantially to the expense. Properly executed archaeology is science, and large-scale science is expensive. On the other hand, good science contributes directly or indirectly to the long-term good of humanity, and archaeology, particularly environmental archaeology, has a special place in this respect. Its value lies in its contribution to a better understanding of human-environment interactions and of the true nature and mechanisms of human behaviour. Archaeology records patterns of human behaviour and ecology in the past, and so can help us formulate ideas about what the future may hold for us and for the planet.

In a tailpiece to an article in the popular series *Science News*, Rhodes (1957) offered a series of reasons for studying palaeoecology, of which bioarchaeology is of course a part. Reasons offered were interpretation of the history of the earth, the study of evolutionary processes, and the location of mineral especially petroleum, reserves. These still stand, but it is quite remarkable that two reasons which would be seen as very important today are completely omitted. Firstly, the past is simply *interesting* to all of us - reason enough to study it. But most of all, *the past is the key to the future*, and this is the reason why governments are prepared to fund palaeoecology, and especially palaeoclimate research. The importance of Quaternary science in this respect is cogently argued by Oldfield (2004). Almost all good information about the world is obtained by looking 'sideways' at events which occur in the present, because we can carry out experiments in the present, but not in the past or future. However, most of the important factors affecting the biosphere - and thus humans - operate on long time scales (e.g. natural climatic cycles), or on a large scale (e.g. weather systems, ocean circulation), or are intermittent (e.g. droughts, cold periods, eruptions, cosmic impacts). They are thus not amenable to experimentation. Human societies, too, develop and change over very long time scales. We are thus thrown back on theoretical modelling or post-hoc deductions about how past events worked; for human societies, we tend to use subjective models dangerously biased by our socio-political stance. Occasionally we can find relevant real-time analogues, e.g. methane hydrate outgassing from the sea bed, volcanic dust clouds, disease outbreaks, or wars. However, it is very hard to mobilise researchers to observe these. (And, thinking on the biggest scale, we are presumably all quite keen not to observe the effects of massive bolide – asteroid or comet – impacts or supervolcano explosions first hand!)

In addition, although physical and biological (and social) mechanisms work according to simple rules, their interactions have enormously complex results. We are dealing with bogglingly complex systems. We do not have the *data* or *models* or *computing power* to build even medium-term predictions concerning many environmental and ecological processes, although substantial advances are being made. So the best way to understand these processes is by examining the record they have left in the past and look for parallels.

Archaeology is a *science* (Phillips 1986; Hart 1985), which should - as far as is possible for a human being - strive towards an *objective* view of the past. Thus the term 'scientific archaeology' should be a redundant tautology by now, but alas this is not so. Some 'conclusions' about the past, whether from cultural or scientific archaeologists, still appear to be as much influenced by preconceptions and dogmas as by observable data.

Scientific archaeology certainly started out as an 'add-on', a tool supplementing traditional approaches (reflected in the title of a British Association session on 'Technical aids for archaeology', reported by Jope in 1952); even at this early conference, however, papers were given which showed that bioarchaeology provided the essential framework for past human existence, not just decorative detail. Clarke (1972) wrote 'No archaeological study can be any better than the reliability of the observations upon which it is based and the assumptions that frame the development of its analysis and interpretation'. Barker (1977, 215-216) comments on this statement, adding that 'the reliability of evidence from settlement sites depends on quantity and the size of the sample, as well as on the accuracy of the observations made on the spot'. To this I would append the value of using *a wide range of different kinds of evidence*, which is where archaeological science is especially valuable, for the *predictions* (deductions) of one specialism can be used as hypotheses for *testing* by one or more others. (In this respect, the arguments of Gee (2001) regarding the impossibility of making objective deductions about the past should not be taken too literally: we can erect hypotheses and test them, but by using different sources of evidence rather than by artificially constructed experiments. However, the argument that hypotheses formulated before evidence is gathered, then tested, are superior to those constructed from collected evidence is valid – see, for example, Lipton 2005.) We archaeologists, whether 'science' or 'culture' based, should erect and test multiple working hypotheses, and not hang observations onto preconceptions or a single line of reasoning, however plausible.

Why do environmental archaeology?

Environmental archaeology is a huge interdisciplinary subject drawing on (or practised within) geology, geography, climatology, biology, archaeology, history, anthropology and even including tinges of sociology and politics. Its principal subject matter has been sediments, and the biological remains of all sizes down to molecules derived from their decay, contained in them. Environmental archaeology is an essential component of archaeology as a whole, providing many kinds of information about the past which are unobtainable in any other way. It is hoped that the *Regional Reviews* will serve to underline this fact. It has all too often been seen as a technique peripheral to 'mainstream' archaeology, together with physical dating methods or chemical analysis. This may have been a tenable view in the early 1970s, but the present author would argue strongly that environmental archaeology is now the shell within which the whole of what has been traditionally regarded as archaeology should exist, all human activity being, by definition, simply aspects of human ecology. Ecology as a discipline includes studies of resource-getting and exchange, energy flow, inter- and intra-specific interactions, and so on, so Samian ware or coins are still a real part of human ecology, as are all aspects of culture. This being so, environmental archaeology is best called by some other name, perhaps human palaeoecology, and this is reflected in the adoption of the name 'Centre for Human Palaeoecology' for the umbrella organisation bringing together research effort in this field at the University of York, and the full title '*Environmental Archaeology, the Journal of Human Palaeoecology*' for the journal of the Association for Environmental Archaeology.

Individuals need to be specialists in single areas in order to be effective researchers, and consequently the production of the regional reviews involves bringing together information concerning 'specialist' areas. However, is must be emphasised that the strength of environmental archaeology lies in the *integration* of results from a range of specialist areas, both within the subject and beyond; synthesis is its lifeblood. The ideal site report, for example, would not draw any distinction between evidence from coins and that from insects; all would be treated equally as sources of information about the human past. No archaeological project involving excavation can now be regarded as having been properly executed unless the full range of evidence has been properly examined - with consequent cost implications. But to destroy archaeological deposits by excavation without full investigation of all of the evidence locked up in them, and specifically that from environmental archaeology, is *not* preservation by record.

Why study archaeological invertebrates?

Most archaeological deposits include remains of some invertebrates, and many contain large numbers of them. The invertebrates are a vast and diverse group, probably outnumbering all other animals and plants by an order of magnitude in terms of numbers of species. They exploit just about every conceivable habitat, but many species are very restricted in the range of conditions which they can tolerate. Very few of them are deliberately cultured or collected by people. This might be thought to reduce their value in reconstructing the human past, but far from it. The invertebrates, by their very lack of perceived importance to humans, are almost perfect indicators of past ecological conditions, which include the activities of people and the conditions in which they lived. They are tied into human life in very many ways (e.g. Berenbaum 1995). One outstanding reason for studying invertebrates from archaeological sites is their sheer ecological diversity: marine, freshwater and terrestrial; plant-feeders, decomposers (animals involved in the breakdown of organic matter, from wood to milk, including members of most invertebrate groups); many adapted to life with humans; some needing high temperatures, some low; some used as food; others pests and parasites. Invertebrates therefore have huge potential to stand as evidence of past climate and ecology, and human activity, living conditions and diet. They can tell us about raw materials imported to sites, about ancient trade, about attitudes to hygiene, about rates of climatic change, about floods and the salinity of rivers, about disease, the permanence of settlements, and probably an almost infinite range of other things to do directly or indirectly with human beings. For biologists, archaeological invertebrates are posing questions about the origin and development of regional faunas, and a wide range of ecological issues related to this, and studies of archaeological and Pleistocene insects have revolutionised our ideas about rates of evolution and the morphological and ecological constancy of species, as well as climatic change. The remains of insects and other invertebrates buried deep in the ground are a crucial but often neglected part of studies of the human, and wider ecological and climatic, past.

Obviously, persuading archaeologists that it is worthwhile funding work on invertebrates is a motive for writing the review: for this reason, the wider uses of such remains is emphasised, in addition to summarising what has been done in the restricted geographical area under consideration.

Sources for the review

Published sources of information concerning invertebrates in archaeological deposits are numerous and diverse. They include detailed considerations of individual species, syntheses and research papers, a variety of invertebrate (mostly mollusc or insect) site reports, at least some partly integrated accounts of site-based 'environmental studies', and (very rarely) more fully integrated site reports, in the sense that 'environmental' and 'other' archaeological evidence have been closely tied together.

Unpublished work ('grey literature' and archives) is equally varied, and regrettably far more abundant. Some reports are very short and have little substance; others deal with biological remains which may or may not be of much interest, but lack dating or other vital information; many others give brief outlines of remains observed in evaluations and assessments and range from useful through tantalising to valueless, depending on the detail afforded. The last major category of unpublished work is the many essentially complete accounts of invertebrates (with or without other biota) which languish in archives and may or may not ever see full publication (Annetwell Street, Carlisle, perhaps being the most notable case relevant here). This class of reports requires at least selective publication as an urgent priority. It is hoped that this review will help to some extent in bringing such cases to general attention. Fairly few of the reports, however slight, which have been examined have had *absolutely* nothing to add to the review; sadly, many of the valueless examples which have been found are of recent date, symptomatic of the downside of PPG16-driven archaeology. The tradition of publication in environmental archaeology is very different from that in the natural sciences generally (Kenward 1997a). Rather than being presented in internationally-read peer-reviewed journals, as are the results of exploratory science in other research areas, most results in archaeology still appear in low-impact site reports. This means that important information and new ideas are often 'lost' in obscurity, and the rarity of high-profile publication, and the inadequate quality control over the way material is presented, has certainly damaged the image of discipline among scientists.

Returning to the present review, all published work which could be discovered concerning invertebrates from archaeological sites in the region has been consulted. For the major groups, publications dealing with insects from natural deposits of Hoxnian Interglacial or later date have been sought, and an attempt has been made to review at least the more significant regional work concerning all other groups of invertebrates from natural sites. Unpublished documents have been abstracted to the extent that they are easily available; all such reports produced in the former EAU have been examined. Note, however, that it has not been practical to refer back to the appropriate archaeological site reports for more than a few of the unpublished 'environmental' reports which contained inadequate background information; such research lay firmly outside the brief of this project (and indeed some reports do not even give the formal name of, or accession code for, the site from which the samples came!). Unpublished data inherited from the EAU have also been reviewed, including databases and archive hard copies. No attempt has been made to trawl the Sites and Monuments Records. While the review by definition has concentrated upon the north of England, the reviewer has looked more widely for published treatments of methods and general principles, and for examples of the use of invertebrates in archaeology in ways not yet well exemplified in our region.

The kind of information presented by these different sources obviously varies enormously. Evaluations and assessments almost by definition typically lack detail, but many published analytical reports only give (for perfectly good reasons) a list of the species recorded from a whole site, and sometimes (less justifiably) not even this. Many published data tables are difficult to use, however, especially when they are presented in fiche; electronic dissemination of data is essential and internet publication of data surely represents the best solution. It is certainly hard to justify volume print of *any* form of detailed data regarding archaeological excavations; this practise disappeared from most scientific literature several decades ago, and the best hope for the future of archaeology lies in making properly peer-reviewed accounts of the *implications* of its results as accessible as possible to colleagues and to the general public.

It is not always clear from a report that certain classes of remains were 'looked for but not found', especially where one specialist carried out all of the work on macrofossil or microfossil remains. There is a need to record explicitly the presence or absence of remains of all groups in both assessment and evaluation; it appears absurd if, for example, a botanist makes an evaluation of plants without even mentioning approximate numbers of the main groups of invertebrates present, even though they cannot be expected to identify them more closely or determine their ecological significance. However, such deficiencies highlight the need to bring together a team of experienced specialists in order to make meaningful evaluations or assessments. Rapid evaluation requires the highest level of specialist expertise to allow it to be useful without the accumulation of detailed data; inexperienced workers cannot possibly make a quick visual estimate of the representation of ecological groups, or notice the significant rarities, for example. Some recommendations concerning evaluations and other kinds of investigation are given on p. 448. The problem of evaluations and assessments which reveal potentially important invertebrate assemblages whose further study cannot be funded is a major one, frequently alluded to throughout the text.

Three main electronic sources were consulted for information concerning archaeological records of invertebrates: The EAB database (Hall and Tomlinson 1996), which covers the whole of British site-based environmental archaeology; the BugsCEP database (Buckland and Buckland, 2006; http://www.bugsscep.com); and the unpublished 'insect' databases of the former EAU, which usually include records of all macro-invertebrates (effectively a supplement to the records collected in BugsCEP, with almost no overlap). There is a pressing need to ensure that an integrated database for invertebrates in archaeology, which includes proper archaeological information (analogous the ABCD, Tomlinson 1993; EAU 1995/52; 1995; Tomlinson and Hall 1996), is created for future synthesis. These databases, and their future development, are discussed further on p. 474.

A major category of sources which has not been consulted systematically is the many historical and ethnographic documents which have some passing allusion to, implications concerning, or more specific mention of, invertebrates. This is a major void which ideally should be filled, especially in relation to economically important groups and materials (e.g. silk, bees, scale insects and their products, and shellfish) and disease causers (e.g. parasitic worms and blood-sucking insects). Documents concerning trade, both internal and overseas, conditions in ships and their cargoes, and storage and craft practices, will also be significant when considering the changing distribution of organisms in relation to human activity.

The tables accompanying this review are intended to list all the significant sources discovered, as well as those projects where insects and parasite eggs in particular were explicitly sought but not found, but inevitably many unpublished reports will have been omitted. Certain reports are not mentioned in the text, usually because they are of very minor significance, but rather too often because lack of dating or archaeological information (unfortunately, some early AML reports fall in this category, as well as some documents produced by the present author). Information is tabulated as follows: Table 3 insects and eggs of parasitic nematodes (combined as so often considered in the same report); and Table 4 the more significant sources concerning terrestrial molluscs. No attempt has been made to bring together records for earthworm egg capsules or soil nematodes cysts in a systematic way, as we usually cannot be sure if they date to the period of, or immediately after, deposit formation, or were much later intrusions. Reports dealing with crustaceans, testate amoebae and Foraminifera have not been tabulated but are mentioned in the text.

Some sections of this review were written in 1998, and could not be fully revised; as a consequence reference to some significant recent publications may have been omitted.

Invertebrates in archaeology

Introduction

Invertebrates have been recorded from archaeological sites for a century and more; from the north of England the records of beetles and land snails from Roman Manchester by Roeder (1899) and of beetles from Hatfield by Bayford (1903) must be amongst the earliest published (but note the mention of abundant oysters from Well, North Yorkshire, by Lethieullier 1735-6). However, almost all of the systematic studies of invertebrates directly associated with past human occupation have been made in the past thirty years, during which time huge strides have been made in understanding the value of such studies to archaeology, climatology and ecology.

Remains of the groups of backboneless animals considered here to be relevant to the reconstruction of the human past are mostly recovered as *microfossils* (i.e. require a transmission microscope to be recognised) or small *macrofossils* (i.e. on the scale of millimetres to tens of millimetres, mostly requiring a good binocular microscope for study). A few remains are larger, notably crabs and some molluscs. The remains of invertebrates themselves are normally the object of study, but some leave identifiable secondary traces in sediments or other biological remains - woodworm exit holes, silk, and earthworm burrows, for example - and these are also considered in the present account. It could, indeed, be argued that buried soils and many other sediments fall in this category, having been modified by the activity of organisms considered here.

Microfossils of all kinds might logically be expected to be considered together, but certain groups are reviewed elsewhere in this series (pollen, phytoliths, micro-charcoal), others not at all (notably the diatoms); in fact the ways these various kinds of remains are used are very different, and different specialists usually study them, so this separation is to a substantial extent justifiable. A similar argument may be applied to plant and invertebrate macrofossils, although it has been found desirable to study both major groups using the same sub-samples. But what is *really* important is to ensure information flow during parallel analyses, and then achieve proper *integration of results* by collaborating specialists in order to optimise the retrieval of archaeological information; this is considered more fully on p. 473.

Almost all sites have at least some deposits containing invertebrate remains preserved by one means or another, although where preservation is rare it may be necessary to review many samples to find them, and even then the interpretative potential may be negligible. However, experience has shown that there can be passably good preservation of material of archaeological value even in apparently unpromising deposits and that it is rarely entirely safe to rule out the need for sampling simply by inspection of deposits in the field. Fossils preserved by anoxic waterlogging may occur locally on 'dry' sites, snails on 'acid' ones. The fact that sometimes moderate to large numbers of samples are collected but produce little evidence (see Table 3) should not be seen as justification for not sampling other similar sites. Sampling is reasonably cheap and failing to sample may mean that crucial evidence is lost. This point has been made with respect to insects from the late and post-Roman periods and rare remains such as the horse parasite *Oxyurus equi* by Allison *et al.* (1991a, 68, 71), and is excellently illustrated by the site at North Bridge in Doncaster (Hall *et al.* 2003). The topic is considered in more detail on p. 440.

A recurring theme in this review is the regrettably large number of cases where opportunities to study invertebrate remains which would have been of value to archaeology (and biology) were lost completely, or where material was collected but funding was refused or inadequate, or where a research design has been produced but funding is undecided but improbable. One result is that, in addressing many issues, there is a good deal of subjective information available, but it is hard to offer supporting data which have been collected in a systematic way. This obviously suggests the need for a new approach to evaluation and assessment, in which a database of species records and approximate abundance is produced for each site, but the funds required to do this are unlikely to be made available in many cases unless a strong lead is taken by central legislators or planning departments.

The names of invertebrates used in this review

Most of the organisms discussed here have no 'common' name, or if they do it may be misleading, ambiguous or shared with a range of other, sometimes unrelated, species. Consequently, 'scientific' or Latin names are used. English names have been added where it is considered they would be helpful to the non-specialist. Some organisms have been given more than one Latin name, leading to confusion in the literature. To overcome this, I have usually given both the modern accepted name and that used in the original where they differ (e.g. '*Cepaea (Helix) hortensis*'). To avoid the use of authorities for Latin names in the text, where possible the nomenclature employed follows a (sometimes implicitly) named checklist or key work, a reference for which is given in the introductory section for each relevant group. For insects there are the Royal Entomological Society's checklists or revisions in later parts in the series of *Handbooks for the identification of British insects*, while for many other invertebrate groups there are Linnean Society *Synopses* which generally present the most up-to-date checklist.

It is worth mentioning at this point that there is no evidence for significant evolution or global extinctions of insects in the north temperate zone during at least the past million or so years (e.g. Coope 1995), and probably longer (supposed endemics in some stable refugial areas such as Iberia may represent an exception, Ribera and Vogler 2004, and we do not have adequate evidence to say this for other regions). The same is likely to be true for most or all for the groups discussed here. Quaternary insects described as extinct have almost all subsequently been show to be identical with living species (e.g. Ashworth 2004; it appears that such evolutionary and ecological stasis is not exceptional, DiMichele *et al.* 2004). This makes insects an excellent tool for climatic and ecological reconstruction. 'Evolution' in the broadest sense (i.e. minor genetic change; see Hewett 2000 for examples) has certainly occurred at the population level, sometimes producing subtly different morphology ('races' of some insects), but more often only detectable by molecular techniques (e.g. Arias and Sheppard 1996; Cornuet and Garnery 1991; Hewitt 1999; 2000; Reiss *et al.* 1999). However, it appears likely that these morphs are returned to the population melting pot, or wiped out, by each major climatic change (see, for example, Coope 1995).

Background material

This is a review of the remains of one part of the animal kingdom recovered from archaeological deposits in one small region of Britain. An attempt has been made to set the evidence in a wider context, but this has not always been practicable, in some cases because space is limited and in others because the author is unsure of its significance. As an interdisciplinary study (see, for example, Harris and Thomas 1991a) it is likely to have a broad audience, ranging from arts-based archaeologists to theoretical ecologists, far wider than can be catered for in detailed background information. Although a wide audience is anticipated, this review has been written primarily for archaeologists. It deals with animals which are little known to most people, even biologists, and in view of this, a short introductory account of each of the invertebrate groups of importance in archaeology is given in the taxonomic section. As far as possible, for each group, an indication of the potential of for reconstructing the past is provided, together with an outline of methods for recovery, identification sources, principles of interpretation, and some notable examples of their use in archaeology (and, where relevant, Quaternary palaeoecology). These pieces of background matter are intended to be illustrative and *not* full reviews!

General methods of recovery and study for invertebrates in archaeology

A short general introduction to sampling and extraction methods is necessary here since otherwise reference to site methods will be so dispersed as to be lost so far as an interested excavator or curator is concerned. Special methods for some groups are considered in the section dealing with them (Part 2, below). Potential future developments are discussed on p. 439. Sample storage is considered on p. 444.

The basic field method of environmental archaeology is the collection of sediment samples which we hope will represent the deposits from which they are taken. Dobney *et al.* (1992) outlined the range of sample types found useful during 20 years of bioarchaeological work based from York, and employed for most of the occupation sites reviewed here. They recommended the routine application of a sampling hierarchy, using the following: (a) General Biological Analysis samples (GBAs), typically about 10 kg of sediment in a plastic tub for laboratory analysis of various microfossil and macrofossil remains; (b) Bulk Samples (BSs), usually 30-50 kg, sometimes less or more, sieved on site or in the laboratory using 1 mm or 0.5 mm mesh, to recover larger remains of all kinds; Site Riddled samples (SRs), sieved on site using 8-11 mm mesh, for bones, finds, and coarse matrix components; and Spot samples (SPOTs), collected to represent peculiar or obvious remains observed during excavation (caches of seeds, fly puparia, shells etc). These remain appropriate, although 250 or 300 micron mesh is normally used for Bulk Sieving samples, at least for catching the light fraction, thus increasing the range of plant and invertebrate remains recovered. Hand-collecting of larger remains (principally mollusc shells so far as invertebrates are concerned) is an inevitable part of the routine of trowelling but does not produce very representative material for bioarchaeological analysis. Some additional sampling methods are employed for some kinds of microfossils and to represent the sediment matrix. Extraction methods affect the range and condition of recovered remains, of course (see Hosch and Zibulski 2003 and Wright 2005 for plant remains), and research into the effects of variations of technique is required for the insects and snails in particular. Different workers use different methods for sampling and extraction of remains; choice of mesh size is a particular area of variation and sometimes dispute. The English Heritage *Guidelines* offer useful advice regarding sampling and processing, but wisely avoid prescription in this area (English Heritage 2002).

Intensive sampling is strongly recommended, since it is easy to throw unwanted material away later, but there is no way of recovering it once excavated (each excavation, as so often stated but so rarely *really* appreciated, is an unique and unrepeatable experiment). It is very difficult to predict the full value of 'environmental' material before (and generally during) excavation: its potential usually only emerges during careful and full assessment (small-scale assessment will miss a great deal, see p. 446). Dobney *et al.*'s approach to sampling is a good routine for most excavations where there is little possibility of spending time thinking deeply about interpretative problems during the excavation process. Much more thoughtful approaches to sampling are desirable, however, in relation to achieving more meticulous excavation and on-site recording in general, to address real questions. One simple addition to the routine would be sampling at context interfaces, which will represent episodes rather than events. These matters are discussed in more detail on p. 440. Sampling issues in archaeology are considered in detail by Orton (2000). It is worth mentioning that there are rather few real-life cases where anything resembling true 'random sampling' will be appropriate to work on archaeological invertebrates. Careful and pragmatic direction of sampling effort is necessary when dealing with typical complex and heterogeneous occupation sites.

Various *extraction routines* are applied to invertebrates. Hand collecting is not a good method of recovering any biological remains (it has been discredited for bones for many years, see e.g. Jones 1982a, O'Connor AML 190/88; Payne 1975; AML 55/92), and is particularly inappropriate for invertebrates, most of which are far too small to be seen by excavators. Marine molluscs have traditionally been hand-collected with bones, but the material so recovered is a very biased sample, inevitably favouring large, entire, and 'interesting' shells at the expense of small species and taphonomically significant fragments. Hand-collected land snails are of very limited value in most cases. The bias introduced by hand collection of molluscs was considered briefly by Light (1995b). Hand-collected remains of invertebrates (shells, groups of remains such as puparia, and occasional large beetles, for example) are best seen as 'spot' finds, inherently unsuitable for systematic work but sometimes of use in reconstructing unusual events or in representing taxa not otherwise recovered.

Bulk-sieving (*sensu* Dobney *et al.* 1992; Kenward *et al.* 1980) represents a good general recovery and survey technique for the larger and tougher invertebrates, and marine mollusc (and crab, sea urchin, etc) material so recovered is suitable for quantitative study providing sufficient samples are processed. Assemblages of insects and other smaller remains recovered by bulk-sieving may be of value (e.g. in demonstrating a 'pitfall' effect in cut fills or recovering rare or irregularly-distributed species) but will not be fully representative if coarse mesh is used and may be contaminated even if fine mesh is employed.

One method serves for the extraction of many macro-invertebrates, but particularly insects: sieving of sediments to 0.3 mm (300 microns; smaller meshes are sometimes used but present difficulties with many deposits) followed by a 'washover' or paraffin floatation. The latter was first (and briefly) described in the context of palaeo-entomology by Coope and Osborne (1968); Kenward (1974) gave a fuller account and a detailed recipe is provided by Kenward *et al.* (1980: the only account of a routine which appears applicable to a wide range of deposit types). A quicker method for use in what are now called assessments and evaluations was outlined and justified by Kenward *et al.* (1986a). Buckland (1976b) described his methodology. Shortcomings of all these techniques are considered on p. 445, but it may be mentioned here that paraffin floatation sometimes fails, leaving an appreciable proportion of the remains in the residue.

Some groups, such as testate amoebae, ostracods and cladocerans, need special methods, and great care is needed to extract the shells of land and freshwater molluscs, which are often extremely fragile and not recovered by paraffin flotation (p. 47). For microfossils (particularly the eggs of parasitic nematodes) 'squashes' of sediment represent a good survey method (p. 29), but concentration techniques may be required to obtain large numbers of fossils for quantitative study.

Identification of all classes of biological remains relies on a solid working knowledge of the group involved, and good reference collections of modern material, together with accurate taxonomic works which include workable keys and clear illustrations. Whatever group is being considered, the level of certainty of identification must be made clear; specific identification is not always possible, but tentative identifications, or cases where remains can only be placed in higher taxonomic groups (genus or family), are often perfectly useful in interpretation. There is no shame attached to cautious identification, and over-confidence can lead to the publication of misleading records which may obscure patterns in future synthesis.

It was traditional to record invertebrate remains fully quantitatively, but this can be immensely time-consuming. Kenward *et al.* (1986a) suggested the use of rapid semi-quantitative rapid recording in certain applications in order to reduce the workload, especially when dealing with occupation sites. Kenward (1992) discussed this kind of recording in more depth, concluding that the reduction in cost and increased number of analyses more than compensated for the loss of detail for most routine purposes (although potentially significant data concerning the past distribution in time and space of rarer and less easily identified species would not be obtained).

Long-term storage of unprocessed sediment and of the material extracted is not a well-researched area. Cool, dark conditions are generally recommended for unprocessed sediment samples, but research is needed if we intend to retain an archive of such material for the future (p. 445). For extracted insect remains, the use of industrial methylated spirits (IMS) has kept fossils in reasonably good condition for a decade or so, although bleaching sometimes occurs. Currently in York the sorted remains are placed IMS in a small vial in the jar containing the paraffin flot. Storage of insect fossils dry on card slides makes them convenient to use but mounting is prohibitively slow and not especially reliable (*contra* Kenward 1974!); remains frequently fall apart when stored in this way. Dry storage of mollusc remains appears to be much the best method, and shells frequently soften in IMS. Development of convenient and cheap long-term storage methods is a priority for environmental archaeology in general; material must be kept since there is often a long time lag between sampling, processing, and analysis, and frequently a need for re-examination of remains for one reason or another many years after the initial analysis.

Earlier reviews of invertebrates in archaeology in the north of England

There has been no previous review dedicated to archaeological invertebrates in the region as a whole. The earliest reviews to include invertebrate fossils relevant to the period considered here appear to be those of Philips (1875, but with an edition dating to 1829), who gave various 'post Tertiary' records of molluscs from Bridlington, and of Drake and Sheppard (1910), who tabulated at least a few Quaternary records of insects, crustaceans, echinoderms, 'polyzoa', Foraminifera, and molluscs from East Yorkshire. However, none of these were from archaeological sites in the conventional sense. In the early 1980s the then Department of the Environment commissioned a general review of environmental archaeology for the northern part of the region by Donaldson and Rackham (1984). They employed a sub-regional structure, dividing their area into the following: the Lake District; the Eden Valley; the Pennine region; East Durham; Tynedale; and North Northumberland. None of these regions had at that time received much attention from environmental archaeologists other than in the reconstruction of vegetational history from pollen, and invertebrates were barely mentioned.

Environmental archaeology in York was briefly reviewed by Buckland (1974), studies in the Vale of York by Buckland (1973), and work on Anglo-Scandinavian York by Kenward *et al.* (1978). O'Connor *et al.* (1984) briefly reviewed the first decade of intensive environmental archaeology in York. Kenward *et al.* (1984), in a more systematic review commissioned by the Department of the Environment, outlined previous work in York, with a brief mention of the adjacent parts of Yorkshire, but the most useful part of their report was the substantial 'prospects for further work' section, in which research themes addressable through environmental archaeology were listed. Research priorities in York were reviewed by Kenward and O'Connor (1991), who incidentally flagged the dangers of indirect effects of development in damaging buried organic remains. Almost all of the research topics listed by these reviewers still remain as priorities for the future, although work since has generated many new questions. Stallibrass and Huntley (1996) examined the scant faunal and botanical data from the Neolithic of Northern England. Buckland (1984) reviewed evidence for conditions in north-west Lincolnshire early in the postglacial period. McCarthy (1995) summarised information concerning the impact of the Romans on vegetation near Carlisle, Cumbria, with a comment by Dumayne-Peaty and Barber (1997) and a reply by McCarthy (1997); the potential value of invertebrates, particularly insects, in reconstructing land use was emphasised. The bioarchaeological evidence from Roman York was reviewed by Dobney *et al.* (1999), that for Anglian Yorkshire by Dobney *et al.* (2000b), that for 8th-11th century York by O'Connor (1994), and for Anglo-Scandinavian York by Hall and Kenward (2004). Archaeology and landscape in the Vale of York is reviewed in an accessible and profusely illustrated booklet by Whyman and Howard (2005).

It is worth re-emphasising here that there is much of general relevance in the *Regional Reviews* of Murphy (CAR 68/2001: molluscs and other non-insect invertebrates from the West and East Midlands and the East of England), Robinson (CAR 39/2002: insects in the Southern region), and Robinson (CAR 9/2002: insects from the Midlands region). These reviews present some aspects of the study of invertebrates in archaeology in a more succinct, sometimes superior, way to the present one; the reader is particularly directed to the accounts of mollusc ecology and interpretation (Murphy *loc. cit.*), and to approaches to synthetic topics. The botanical review for Northern England (Hall and Huntley 2007) includes many topics to which work on invertebrates will be complementary.

PART 2: GROUPS OF INVERTEBRATES OF IMPORTANCE IN ARCHAEOLOGY

Introduction

Invertebrates are generally not well-known even to biologists, and many users of this review will have little familiarity with most of the groups, or be innocently subject to the many misconceptions concerning them. For this reason, a brief introduction to each of the groups of invertebrates of importance (or potentially of importance) in British archaeology is given here. An outline of specialised field, laboratory and interpretative methods for particular groups is given where appropriate, the level of detail varying according to the degree to which the organisms are employed and the extent to which practical and theoretical approaches to their interpretation have been developed (the author's personal bias will also be evident).

There is still no generally accepted scheme of classification for invertebrate animals and new schemes are presented from time to time, most recently based on DNA sequences. The order adopted here is fairly traditional. Fungi and bacteria, often considered to be plants, in fact have a way of life more like that of animals - they are heterotrophic, i.e. need complex molecules, and take a functional place alongside animals in decomposer communities. However, these groups are not considered here; archaeological records of macro-fungi from Northern England are reviewed by Hall and Huntley (2007).

Phylum Protozoa (Protista): single-celled organisms

The protozoa include a wide range of single-celled (but sometimes colonial) organisms, some of which have chlorophyll and are often treated as plants. Most are soft-bodied and do not preserve readily, and will certainly not be of importance in archaeology. However, some produce resistant resting stages, and others have tough skeletons. Some protozoon's cause diseases: Plasmodium causes malaria; Entamoeba amoebic dysentery; trypanosomes cause sleeping sickness and Chagas' disease; and some coccidians are pathogenic. Certain of these may have been important in Britain in the past and were certainly significant on a world scale. They may be detectable from archaeological material using biomolecular methods (some result have already been published) or from their effects on skeletons (p. 416).

A review, useful although now very old, of the remains of free-living protozoans in lake sediments is given by Frey (1964, 5-20). Diatoms are protists but for the purposes of these reviews are considered as plant microfossils. Their use as indicators of water quality, especially salinity, in archaeology is reviewed by Battarbee (1988; see also Murphy 2001). A further group of 'plant-like' protists of palaeoecological value not considered in these reviews is the Dinoflagellata (see for example Harland and Howe 1995; Thorsen *et al.* 1995); local examples are provided by the studies by Harland and Downie (1969) of interglacial material at Kirmington, Lincolnshire, and of Harland (1974) of Flandrian material from Stoneferry.

Rhizopoda: amoebae and their relatives

Amoebae are perhaps the most familiar protozoans to non-biologists, and two groups of them are of particular importance in palaeoecology.

Testate amoebae

Some aquatic and semi-terrestrial amoebae produce tests, either by secreting a gelatinous or membranous wall or by embedding mineral or other particles in a matrix of organic matter. Some of these tests are robust enough to preserve in ancient deposits. Charman *et al.* (2000) give a recent brief review of their use in palaeoecology. Many of the species are found in *Sphagnum* bogs (e.g. Corbet 1973), but there are open-water forms, noted by Harmsworth (1968) from lake sediments in Blelham Tarn, Cumbria for example, and others are found in soil (e.g. Clarke 2003). This group seems to have considerable interpretative significance within set limits and they are regarded as a significant source of information about hydrological changes in peatlands and lakes and even sea level change (e.g. Charman *et al.* 1998; Gehrels *et al.* 2001; Hendon and Charman 1997; Hendon *et al.* 1998; 2001; Roe *et al.* 2002); see Tolonen (1986) and Warner (1990a) for introductions to their study in Quaternary sediments, and Charman (1999) for a discussion of the problems of identification in this group, as well as references to studies of modern parallels). They have been little exploited in the strictly archaeological context (R. Chiverell, personal communication), although analyses of rhizopods from the peat associated with the Lindow II bog body are reported by Oldfield *et al.* (1986). A short introduction to the biology of the freshwater Rhizopoda is given by Fryer and Murphy (1991, 157-61), and Charman *et al.* (2000) summarise the habitats of the species found in Britain. Woodland *et al.* (1998), in a study of samples from Bolton Fell Moss, Cumbria, produced transfer functions from modern analogues for estimating water content of peatlands from testate amoebae.

These testate amoebae are occasionally recorded from 'squashes' (p. 29) and during other analyses for parasite eggs and other microfossils. Some samples from the Dominican Priory at Beverley yielded them (Allison *et al.* 1996c); while the assertion that 'these are common soil organisms of no further significance' may have been true for the Priory site, it is perhaps not generally applicable! They were present in appreciable numbers in a good proportion of a large group of samples from 12th-14th century deposits at Eastgate, Beverley, examined for parasite eggs by McKenna (1992). Amoeba tests identified as *Centropyxis* sp. were recorded in large numbers from a late 2nd century deposit at Tanner Row, York, and in small numbers from other deposits at the site (Hall and Kenward 1990, 357). Their archaeological significance was again regarded as unclear. Research into the way these tests become incorporated into deposits, and under what circumstances, might prove rewarding; their importation in peat or water may be archaeologically significant.

Recovery and identification: Extraction techniques for testate amoebae are considered by Charman *et al.* (2000), Hendon and Charman (1997) and Warner (1990a); the second of these report that tests are damaged by some reagents widely used in palaeoecology, particularly in pollen extraction, and provide a recommended 'recipe'. For entry into the literature of their identification see Corbet (1973). Ogden and Hedley (1980) and Warner (1990a); Charman *et al.* (2000) provide keys to species, Corbet (1973) gives a key to *Sphagnum* dwellers, and Clarke (2003) gives a guide to soil-dwelling forms.

Foraminifera ('forams')

An enormous amount of work has been done on fossil Foraminifera ('forams') of all ages, from hard rocks and from marine sediments. There has been little systematic work on fossil Foraminifera in direct association with archaeology, though they have occasionally been noted in archaeological deposits (e.g. Murphy 1982). They are probably often overlooked or not recorded even if seen. Bell (1981) mentions that foraminifera may be imported with seaweed.

The value of forams in documenting sea-level and estuarine change is well established (e.g. Bates *et al.* 2000; Boyd 1981; Evans *et al.* 2001; Haslett *et al.* 1997; 1998) and supported by modern studies directly related to palaeoecology and allowing quantification of reconstructions (e.g. Gehrels *et al.* 2001; Gehrels and Newman 2004; Horton 1999; Horton *et al.* 1999a; b). Foraminifera have particular value in reconstructing palaeotemperatures, a brief review being provided by Dodd and Stanton (1990) and a more recent account by Wilson *et al.* (2000). Bauch and Weinelt (1997) reported surface water changes in the North sea as indicated by isotopic studies of foraminifera; among other things they suggest that there was an event around 3000 BP which may be reflected in the fossil record in the North of England, by water-table and ecological changes in the Humberhead Levels, for example. In the palaeoclimatic context, foraminifera from Devensian deposits at Dimlington, East Yorkshire, are listed by Catt (1987b).

There are a few archaeological records from our region. At Sewer Lane and Mytongate, Hull (Kenward 1977; Miller *et al.* 1993), a foraminiferan which appeared to be an *Elphidium* (Polystomella) species was recovered from the fills of a late 13/early 14th watercourse and a 14th century pit respectively. Carrott *et al.* (PRS 2003/07) reported foraminiferans from post-medieval deposits at Tower Street, and a further layer from Hull, perhaps a make-up dump of 15th century date (or earlier) at Citadel Way, gave appreciable numbers (Hall *et al.* EAU 2001/37). Foraminifera were also recorded from the Roman signal station at Filey (Carrott *et al.* EAU 1994/07). Adams (1981) examined a limited fauna of foraminifera indicative of brackish conditions from deposits associated with the Brigg 'Raft'. A more systematic study of samples from an archaeological site in our area was that of Horton (2000), who examined deposits of uncertain date at sites in Whitby, North Yorkshire, finding two assemblages in ten samples analysed.

Methodology and identification: Murray (1971; 1979) provides a route into the identification of British nearshore forams, and illustrations are also provided by Haynes (1981). Methods are outlined in some of the site-based studies mentioned above.

Other protists

Radiolaria have a mineral skeleton and may be encountered as fossils (Hyman 1940, 138-143). Few **Ciliata** produce resistant parts, although a small number of species have cases composed of foreign particles (like some rhizopods), and have been recorded from lake deposits (Frey 1964, 18-19). Their interpretative significance appears small. Records of other 'animal' Protozoa from freshwater sediments are reviewed by Frey (1964); again these seem to have little potential.

Cysts of the parasitic flagellate *Giardia* have been recorded from archaeological material outside Britain: from desiccated faeces from a cave in Tennessee, for example (Faulkner *et al.* 1989; Faulkner 1991).

From various parts of the world, disease-causing protozoans have been identified – sometimes controversially – by the pathology they caused in mummies or skeletons, and from their DNA (see p. 416).

Phylum Porifera: sponges

Sponges are marine and freshwater organisms ranging from very small to very large. All live attached to solid objects such as rocks, shells and seaweeds and feed by filtering particles from a stream of water which they draw through the body. Although essentially gelatinous, most have either spicules (of calcite or silica), or horny spongin, or both, and these materials may survive in archaeological deposits. Sponges have a long history of exploitation, for medicine as well as for cleaning and mopping (e.g. Müller *et al.* 2004).

There are many marine species in northern Europe, and some with economic importance are likely to have been carried over great distances, either commercially or with personal belongings (especially perhaps by Roman soldiers). Thompson (1967) gives a record of sponge, probably from the Mediterranean, from medieval Novgorod, Russia, for example. Ancient 'hard rock' fossil sponges are occasionally found in archaeological deposits (e.g. at Bramdean, Hampshire, by Clutton-Brock 1982).

A few forms, all belonging to the class Demospongiae, live in freshwater, and their siliceous spicules and resistant propagules (gemmules) have frequently been noted in lake sediments (e.g. Frey 1964, 20-22; Harrison 1988; 1990), although, as Frey noted, specific identification, and thus ecological interpretation, is very difficult. Harrison (1988) reviewed the use of sponge remains in palaeolimnology, covering taxonomic and ecological aspects relevant to interpretation. Contamination by spicules etched from ancient rocks and redeposited in archaeological deposits is a possibility, considered by Buckland (1976a, 14). (*Spongia officinalis* is often called *Euspongia*, incorrectly according to De Laubenfels 1945.) On a world scale, a dozen or so species are exploited commercially.

Sponges are frequently used to clean and moisten exposed archaeological wood during excavation. Although plastic foam sponges are normally employed, 'real' sponge being far too expensive, the use of natural sponges too spoiled for bathing might lead to contamination and should be avoided. Fragments of plastic sponge have been recovered from samples on several occasions (e.g. in at least seven samples from Anglo-Scandinavian deposits at 16-22 Coppergate, York, Kenward unpublished database), and in one (fortunately unpublished) case were identified as ancient bath sponge despite being composed of perforated bubbles (rather than anastomosing fibres) and having a distinct pastel shade!

There are a few archaeological records of sponges for the region. Hunt *et al.* (1984) noted spicules of freshwater sponges in the lake deposits at Skipsea, East Yorkshire. Buckland (1976a, 14-15) noted sponge spicules from deposits in the Roman sewer at Church Street, York. Some were of the freshwater sponge

Spongilla (Euspongilla) lacustris, fairly common in clean water (Fryer and Murphy 1991, 168-70) and presumably brought with water flowing into the system through a yet untraced supply from beyond York. However, others appeared to be from a marine sponge, although they could not be closely identified and there was considerable doubt as to their origin. The argument concerning these spicules as evidence of the presence of faecal contamination ('Some support for the presence of excretory products...is provided by the abundant sponge spicules...') does not bear scrutiny; the most likely sponge to be employed, *Spongia*, having a skeleton composed of spongin fibres which give it the rough leathery texture (Hyman 1940, 352). Buckland also quotes entertaining Roman literary sources for the use of sponges, and there are written records back into ancient Greece (e.g. Cook 1959).

Small fragments of sponge, some at least closely resembling reference material of *Spongia*, were recovered from several 2nd-3rd century Roman deposits of various kinds at the General Accident site, Tanner Row, York (Hall and Kenward 1990, 331; Hall unpublished). There were two records of sponge from Anglo-Scandinavian levels at 16-22 Coppergate, York (Kenward and Hall 1995). One was of a small fragment of *Spongia* type from a surface-accumulated deposit pre-dating the first phase of identifiable buildings (ibid, 534); the other was a tiny (mm-scale) entire spherical fibrous sponge, which could not be identified further. The means by which all of these remains became incorporated into the samples is uncertain and it would be unwise to discount a residual origin or modern contamination.

Some marine sponges bore into calcareous rock and mollusc shells, or colonise the latter. An archaeological example from the north of England is provided by Carrott *et al.* (EAU 1995/34, table 1), who noted evidence of *Cliona celata* on oyster shells from the Old Manor House, Cottingham, Hull.

Recovery and identification: Small pieces of fibrous sponges are likely to be recovered from General Biological Analysis or Bulk Sieving samples using the methods employed to extract plant or invertebrate macrofossils. Larger pieces, should they ever occur, may be observed during excavation and should be collected as spot finds, together with samples of the surrounding matrix, so that any residues in them (e.g. concentrations of parasites eggs) can be investigated. Study of spicules requires special techniques, although if present in large numbers they would be noted during routine 'squashes' for parasite eggs and other microfossils (see p. 29). Harrison (1990) outlines the biology of and methods of study for freshwater sponges and discusses their potential in Quaternary palaeoecology, although with a North American emphasis. Identification is difficult, and requires access to an extensive reference collection of cleaned entire colonies and microscope mounts of prepared spicules. Spicules do appear to vary considerably between species (see for example the sketches given by Hayward *et al.* 1996, 35-43 and Harrison, *loc. cit.*), offering hope for identification *should* the great effort involved appear justifiable in a particular case.

Phylum Cnidaria: hydroids, corals, etc

The phylum Cnidaria includes hydras, sea anemones and jellyfish, none of which are likely to leave remains in archaeological deposits. Although hydras produce tough resting eggs, Frey (1964, 23) was unable to trace any examples of their recovery from freshwater deposits. Other members of this group (Classes Hydrozoa, the thecate hydroids and Zooantharia, corals) have horny tests or calcareous skeletons, and some others (the soft corals, Order Alcyonacea) produce spicules (Hayward *et al.* 1996, 62). Hydroids might be imported with shellfish or seaweed, or in fish guts, and thus be of archaeological significance (e.g. Buckland EAU 1997/47, 8). Buckland *et al.* (1983; 1993) mention abundant remains of the anthozoons *Dynamaena pumila* and *?Sertularia* in deposits at Norse farms in Greenland, perhaps arriving in the dung of livestock feeding on seaweed. It is rather easy to confuse these remains with those of calcareous algae such as *Corallina* (this latter genus was recorded at 16-22 Coppergate by Kenward and Hall (1995, 757), for example).

Corals may be massive and attractive and might have been brought to occupation sites as curiosities or to manufacture decorations including jewellery. Like some other 'collectable' groups (especially sea shells) they are likely candidates for recovery from post-medieval deposits following the expansion of overseas travel and trade and the rise in interest in natural history. Outside the British Isles there are records from coastal assemblages at various sites (e.g. Keegan *et al.* 2003).

Records of hydroids from sites in the north of England are fairly rare. A colonial hydroid resembling *Obelia* was recorded by Carrott *et al.* (EAU 1997/22) from the fill of the Citadel moat in Hull, while Carrott *et al.* (EAU 2001/12) noted an unidentified colonial hydroid from deposits dated to the first half of the 14th century at Blanket Row, also Hull, in an assemblage which included other halophiles. A. R. Hall (personal communication) has other, unpublished, records in his database, from the Newcastle Packet site, Scarborough, and the Magistrates' Courts site, Hull.

Recovery and identification: Recovery of these remains is likely to be a matter of chance; their concentration is rarely likely to be sufficient to justify separate study. If present, they will be recovered by bulk sieving and in General Biological Analysis samples. Keys to hydroids are provided by Cornelius (1995a, b), and may enable at least provisional identification of archaeological material. Various forms are illustrated by Hayward *et al.* (1996).

Phylum Platyhelminthes: flatworms, tapeworms and flukes

The most important platyhelminths from an archaeological point of view are the parasitic flukes and tapeworms. Early records of these and parasitic nematodes were reviewed by Pike (1967), but substantial advances have been made in the past decade or so in, increasing the range of parasites recognised and the confidence (and caution) with which they (together with nematodes, see below) are recognised. Eggs are rather often recovered from desiccated material, including coprolites and mummies, but also from conventional archaeological deposits (e.g. Bouchet 1995; Bouchet *et al.* 2003a; b; Dittmar and Teegan 2003; Gonçalves *et al.* 2003; Matsui *et al.* 2003; Reinhard 1990; 1992; Reinhard *et al.* 1987; Reinhard and Urban 2003). A few early studies of archaeological parasite eggs stand out, notably that of Jansen and Over (1962), but systematic investigations directed towards the problems of archaeological occupation sites did not really start until the late 1970s, principally in York.

Class Turbellaria: flatworms

Free-living flatworms are common in freshwater, and there are also marine forms. The freshwater species produce egg capsules or cocoons with walls of tanned protein (Nurse 1950), some of which are very resistant and have been recorded from Holocene freshwater deposits (and even from interglacial ones). They are discussed by Frey (1964, 23-25) and Warner (1990b), who provide some illustrations. It is likely that these structures have been overlooked in archaeological deposits. Their interpretative potential is uncertain. Harmsworth (1968) studied the egg capsules of neorhabdocoel turbellarians in the sediments of Blelham Tarn, Cumbria. The capsules could not be specifically identified, but were assigned to types, some of which were illustrated. Harmsworth suggested that these remains may have value as ecological indicators, but that much preliminary work will be required. This appears still to be the case - Reynoldson's (1978) key includes an inconclusive discussion of cocoons, and Warner (1990b) divides capsules into three types and concludes that 'it is difficult to assess the palaeoecological significance of the fossils'. The biology of the British freshwater species is outlined by Ball and Reynoldson (1981).

Class Trematoda: flukes

Structures tentatively identified as the eggs of flukes, *?Fasciola* sp., have been recorded from archaeological deposits in northern England by Jones (1982b) and Allison *et al.* (1991a). There are similar records from elsewhere in Britain (e.g. Boyer 1999). Nansen and Jørgensen (1977) reported eggs of *Fasciola hepatica* in numerous samples from Viking-age deposits at Ribe in Denmark, and Pike (1968) and Pike and Biddle (1966) reported *Dicrocoelium* from Owslebury, near Winchester. *Dicrocoelium dendriticum* was identified from eggs from a site in Winchester by Taylor (1955). *F. hepatica* is the liver fluke of sheep, while *D. dendriticum* infests the bilary tree of various herbivores (Markell and Voge 1976, 180-183).

Trematode eggs are described by Markell and Voge (1976, 169) as having a smooth hard shell, generally being of a conventional egg shape, with an operculum at one end, and varying in length from 30-175 microns according to species. They suggest (*loc. cit.*, 183) that *Fasciola* eggs cannot be readily distinguished from those of various other flukes on size or shape, leaving some concern as to how reliable the identifications mentioned above, and those published in the past decades from around the world, may be; the illustrations given by Burrows (1965) of eggs of a range of trematodes tend to re-enforce this view. Further work is clearly required,

Successful detection of fluke eggs in archaeological deposits may depend on the development of specialised concentration techniques. In addition to being very problematic in identification, the flukes have a wide range of mammals, including humans and domestic animals, as hosts and are consequently likely to be of limited interpretative potential unless recovered from the faeces of a known species.

Class Cestoda: tapeworms

Tapeworms are soft-bodied gut parasites of a wide range of animals, including humans, whose life-cycles are usually complicated, involving one or more intermediate hosts; they produce very large numbers of eggs which pass out in faeces and may preserve. For example, Nansen and Jorgensen (1977) reported *Taenia* from Viking Age Ribe, Denmark, and Bathurst (2005) identified eggs of the fish tapeworms *Diphyllobothrium* and *Nanophyetus* from a coastal shell midden in Canada; on a world scale there are now many archaeological records of tapeworm eggs.

Eggs determined as '?' or '*cf.*' *Hymenolepis* sp. have been recorded from some sites, notably from medieval pit fills at The Bedern and various deposits at 118-126 Walmgate, York, and in Hull (Hall *et al.* AML 56-58/93; Kenward and Hall EAU 2000/20; McKenna 1987) and, outside the area reviewed here, from the Deer Park Farms site, Northern Ireland (Allison *et al.* EAU 1999/08; 1999/10; Kenward *et al.* forthcoming b). It appears that doubt remains as to the identification of these remains (Hall *et al.* AML 56/93, 2), and further work is clearly required. *Hymenolepis* is the genus which includes the dwarf tapeworm of humans, *H. nana*, also found in rodents, so confirmation of the identity of these remains is of considerable importance. *H. nana* is cosmopolitan, and eggs are apparently able to infect the primary host directly or via an intermediate insect host (van der Hoeden 1964, 698-702). Although often asymptomatic in humans, infections may cause a variety of ailments including abdominal pain and epileptic fits.

Tapeworms are also are represented in the fossil record by calcified cysts which develop in an intermediate host; these are considered below as secondary evidence (p. 93) since they are produced by the host and are not part of the worm itself. The heads of cestodes bear hooks used to attach the animal to the gut wall of the host. These have apparently never been recorded as fossils, perhaps because they would have been very rare in the first place, and so are unlikely to be found by the standard methods of environmental archaeology. Alternatively, they may not preserve, or may be so like the wide range of claws and other appendages of arthropods present in 'waterlogged' layers that they would be overlooked. It is possible that mineral-replaced remains of adult worms voided with faeces may be recovered although they would probably be difficult to recognise and identify.

Recovery and identification: No special methods seem appropriate to the recovery of cestode remains; if present they should be found by specialists using standard sampling and analytical techniques for various other classes of remains. Identification will rely on consultation with specialist parasitologists. It has been suggested by Bouchet *et al.* (2003a) that some cestode eggs are very similar, but that shell microstructure, especially using SEM examination, of some groups can be helpful, while Ferreira *et al.* (1984) and Reinhard and Urban (2003) suggest that *Diphyllobothrium* eggs can be specifically identified. Taking the world literature as a whole, it appears that there is increasing confidence that these eggs can be determined with reasonable certainty, but caution should be exercised.

Phylum Nematoda: roundworms

Nematodes are mostly a millimetre to a few tens of centimetres in length, transparent or whitish in colour, and worm-like in form. They are remarkable for being composed of a very small number of cells (by comparison with most other macroscopic animals). They occupy an enormously wide range of habitats (e.g. Nicholas 1975, 135-162). Those recovered from archaeological deposits are terrestrial or parasitic. The former are almost exclusively recorded as cysts resembling those of the potato eelworm and its relatives (*Heterodera*), the latter as the eggs of a few species living in the guts of mammals.

Free-living roundworms

Among the terrestrial nematodes, *Heterodera* type cysts have been noted frequently and from a large number of sites. They are regarded as having some interpretative value as indicators of former active soils, although post-depositional intrusion is sometimes suspected. The cysts are found in a wide range of deposit types, however. Live cysts may be wind-transported (White 1953) or carried by water, and so occur in appreciable numbers out of context. An early archaeological record, from an Anglo-Saxon well at Elmham, Norfolk, was made by Webley (1974), who found numerous cysts, which could be specifically identified as *H. humuli*, together with at least four other species, and suggested that the host of *H. humuli* at least was nettle, *Urtica dioica L.*.

Records of *Heterodera*-like cysts in the Northern Region are exemplified by the following. Large numbers were present in a deposit interpreted as a dump of (probably industrial) ash at the York Minster Library site (Hall *et al.* EAU 1995/40). At North Cave, East Yorkshire (Allison *et al.* EAU 1997/37; forthcoming a) there were numerous cysts in fills of what had probably been a shallow well, together with earthworm egg capsules, suggesting soil inwash. *Heterodera* may suggest the transport of material by water or human activity when found in deposits in which the worms appear unlikely to have lived, in an 11-12th century putative soakaway at Flemingate, Beverley (Dobney *et al.* EAU 1995/48), for example.

Unfortunately these cysts probably often indicate penetration by recent organisms. At Waterton, North Lincolnshire (Carrott *et al.* EAU 1996/40), for example, they were abundant in fills of cut features with few or no other invertebrates, while Alldritt *et al.* (EAU 1991/02) recorded *Heterodera* in well drained deposits with clear evidence of earthworm activity and root penetration on high ground at The Mount, York, and Carrott *et al.* (EAU 1996/55) noted that they were almost the only remains in a probable Roman-British ditch fill at Kingswood, Hull. In some cases it may be unclear whether the cysts are ancient or modern especially where they were associated with modern rootlets (e.g. Carr Naze, Filey, Carrott *et al.* EAU 1994/7; at Burythorpe Church, Carrott *et al.* EAU 1995/50; and at Blanket Row, Hull, Carrott *et al.* EAU 2001/12). At the Lanes 2 sites in Carlisle there was no reason to doubt the antiquity of abundant ? *Heterodera* cysts, and they contributed to the evidence that cuts had been backfilled with surface soil (Kenward *et al.* EAU 1998/32).

There is a record of nematode worms preserved by copper corrosion products on a brooch from West Heslerton, North Yorkshire (Haughton and Powlesland 1999, 365). Elsewhere, in the USA, coprolites have provided a few free-living nematodes nematodes: Samuels (1965) reported remains from coprolites at Wetherill Mesa, and apparently ancient larvae of *Rhabditis* have been found in Lovelock Cave, Nevada (Heizer and Napton 1969).

Recovery and identification: Cysts are regularly recovered in General Biological Analysis samples being examined for plant or insect remains, appearing in both paraffin flots and residues. Mineral-replaced remains will only be found by chance. A systematic study of the cysts of *Heterodera* species has been made by Mulvey (1972), who also reviewed earlier literature, while simple illustrations are give by (for example) Jones and Jones (1974, 268). This work suggests that there are specific differences in shape, puncturation and patterning which might permit identification of fossils. Identification of mineral-replaced worms will generally by impossible since critical features will be lost.

Parasitic roundworms

The parasitic nematodes are of considerably more interest in archaeology than the free-living forms, and their eggs have been used extensively as indicators of the history of infection and of faecal contamination from very early in the history of modern environmental archaeology (e.g. Szidat 1944; Taylor 1955; Jansen and Over 1962; Pike and Biddle 1966; Pike 1967; 1968). Eggs of two genera occur very frequently: the whipworms, *Trichuris*, and the maw-worms, *Ascaris*. Both are parasites of a variety of mammals, including humans and domestic animals. *Trichuris* has a fossil record in Britain dating back to the late Mesolithic (Dark 2004). While many parasitic worms have complex life-cycles, that of *Trichuris* is very straightforward, favouring a high rate of infection. The adults live in the gut, and produce large numbers of eggs which pass out in the faeces. These eggs develop into new worms if they are swallowed. *Ascaris* has a life cycle which is almost as simple, except that the eggs, once swallowed by the host, hatch out into larvae which burrow through the gut wall, pass round the host's circulatory system, then re-enter the gut via the lungs and trachea before developing into the adult (see e.g. Markell and Voge 1976, 261). These worms may be debilitating when present in large numbers, sometimes producing extremely unpleasant symptoms including intestinal obstruction, prolapse of the rectum, weight loss and weakness (see for example Markel and Voge, *loc. cit.*), but Cooper *et al.* (1986) have suggested that even light infestations may contribute significantly to stunting of the growth of children.

A number of species of *Trichuris* are known, each primarily infecting a different host genus: *T. trichiura* in man, *T. suis* in pigs, *T. vulpis* in canids, *T. ovis* in caprovids, and so on. However, the worms may occur in more than the nominal host. *T. ovis* has been recorded from over 30 kinds of ruminants including goats, deer and bison, for example (Heuer *et al.* 1975; Knight 1984; McHugh 1972; Torina *et al.* 2004). In some cases these eggs may be identified to species by measurement (discussed below). Eggs are rarely measured in routine (and especially developer-funded) work because of the time required. However, *T. trichiura* has occasionally been confirmed by measurements: for example by Allison *et al.* (1991a, 70-1) for eggs from Roman Castle Street, Carlisle; by Jones (1983b) for Anglo-Scandinavian material from 6-8 Pavement, York; by Jones (1986, 137-8) for the Lindow II bog body; by Carrott (PRS 2002/17) for Brayford North, Lincoln, and by Large *et al.* (EAU 1994/11) for Roman eggs from Ribchester, Lancashire. The identification of *T. ovis* from the Deer Park Farms site in Northern Ireland seemed unequivocal on both size and general appearance (Allison *et al.* EAU 1999/08; 1999/10; Kenward *et al.* forthcoming b).

Eggs of *Trichuris* (especially) and *Ascaris* may be preserved in faecal concretions even where all or most of the other preservationally labile remains have decayed; such concretions are discussed more fully on p. 115.

It has been suggested by Taylor (1955) that a high ratio of *Ascaris*: *Trichuris* (rather than the predominance of *Trichuris* typical of human faeces) may be characteristic of pig faeces, though this does not appear to have been investigated systematically and there is a danger that this 'fact' will become part of the mythology of environmental archaeology.

Rarely, eggs of other nematode parasites have been noted in the region. The horse parasite *Oxyurus equi* has been recorded from archaeological deposits (p. 425), two eggs being found in an external blanketing soil deposit of early second century date at Castle Street, Carlisle (Allison *et al.* 1991a, 69-70; Jones *et al.* 1988) and one from Roman Tanner Row, York (Hall and Kenward 1990, 354). Jones *et al.* suggest that eggs of *Oxyurus* will be inherently rare because of its biology, but they were rather abundant at the Deer Park Farms site in Northern Ireland (Allison *et al.* EAU 1999/08; 1999/10; Kenward *et al.* forthcoming b). Eggs which appear to be of a *Capillaria* species, found in the guts of rodents, have been reported, for example as 'Capillaridae *sp.*' for Anglo-Scandinavian 16-22 Coppergate (Kenward and Hall 1995, 488). This kind of egg was also recorded from the Deer Park Farms site. Eggs of various other intestinal parasites may be too thin-walled often to preserve, or be of too generalised a form to be recognisable.

There appear to be no records of pinworm (*Enterobius*) from Northern England; the eggs of this creature can survive under some circumstances, as, for example, did those from 10,000 year old coprolites in cave deposits in Utah (Fry and Moore 1969 – one of the earliest record for any human parasite), from 6000 year old coprolites in Oregon (Hall 1977), from 2000 year old coprolites from Tennessee (Faulkner 1991), and from Roman-period Egypt recorded by Horne (2002); its DNA was recognised from American coprolites by Iñiguez *et al.* (2003b). Another nematode whose eggs might be encountered is *Toxocara*, with species parasitising dogs and cats which can perhaps infect humans (Burrows 1965, 188), and which has been recorded from a very old (300,000-500,000 years before present) site in France (Bouchet *et al.* 2003c).

Recovery. Although there was earlier work (by Pike 1968; Pike and Biddle 1966; Taylor 1955; Szidat 1944; Wilson and Rackham 1976), and the remains were sometimes recorded from pollen preparations (e.g. Dickson *et al.* 1979), techniques for the study of nematode eggs from archaeological deposits were given a new impetus by Jones and co-workers at York, who developed standard recovery and concentration methods, and used measurements for identification to specific level (Jones 1982b; 1983b; 1985, 1987b; 1992). The technique used was essentially the modified Stoll method, based on that recommended by the Ministry of Agriculture, Fisheries and Food (1977) for examination of modern faecal samples. Briefly, Jones' method is as follows: a sub-sample of 6 g is taken from each sample, and placed in 42 ml of sodium pyrophosphate ($Na_4P_2O_7$) solution, in which it is disaggregated by shaking. The mixture is left for two days before pouring through a freshly flamed 250µm sieve to remove coarse particles and adding a further 42 ml of water. A 0.15 ml aliquot of the resulting mixture is then placed on a 76x26 mm microscope slide and covered with a 22x50 mm cover slip. The mount is then scanned under a transmission microscope, at a magnification of x60-x80, and eggs counted and measured using an eyepiece graticule, calibrated to a stage micrometer at a magnification of x240. Approximate concentrations can be calculated by multiplying by 100, but the reviewer regards this practice as potentially misleading, compounding random variations and experimental errors, and it is more useful to discuss data using a semi-quantitative scale. Hall *et al.* (AML 56/93, 2) employed the following, taking account of inherent differences in egg production between the two main taxa: counts of 1-3 - 'trace'; 4-7 *Trichuris* and 4-5 *Ascaris* - 'few'; 8-15 *Trichuris* and 6-10 *Ascaris* - 'modest numbers'; more than 15 *Trichuris* or 10 *Ascaris* - 'significant numbers'; several tens of either - 'large numbers'.

Dainton (1992) tested and put on record a standardised method of rapid survey for parasite eggs using 'squashes', which had been employed informally in the former EAU for some time. Such an approach is very desirable, since multiple sub-samples need to be examined in view of the likely patchiness of egg distribution (e.g. Kenward and Hall 1995, 569). A small amount of sediment is collected from three separate points within the sampled material and homogenised in a little water. A drop of the resulting mixture is placed on a microscope slide and covered with a cover slip and the whole mount scanned rapidly under a transmission microscope, using a magnification of x60, the abundance of eggs being recorded semi-quantitatively using a five point scale: one; trace (estimated as 2-5); few (6-10); some (11-20); many (probably more than 20). This technique has subsequently been employed in York as a routine way of assessing the potential of a range of microfossils, including diatoms, phytoliths, testate amoebae and, where they are abundant, pollen grains (e.g. Carrott *et al.* EAU 1995/53; see also Hall and Huntley 2007).

The squash method was tested for its effectiveness by Dainton, who compared the results of 'squashes' and preparations made following Jones' method. Three groups of samples were used: six from which no eggs had been recorded in squashes, six in which small numbers had been noted and six in which they were more numerous. The results of this comparison suggested that the `squash' technique is a perfectly adequate one; in no case were significant numbers of eggs found by the modified Stoll method in samples in which they were undetected by the `squash'. Indeed, where numbers are small, it appeared that the former technique was barely more effective than the squash, as eggs might be missed by either. This was not considered surprising bearing in mind the likely patchy distribution of egg and it was suggested that examining a series of squashes may give statistically more valid results than the Stoll method as adapted by Jones and co-workers. Dainton discussed these observations in relation to the study of parasite remains from urban deposits (in particular) and concludes that the squash method provides results which are both more cost-effective and more simply interpretable than those from the modified Stoll technique. There is doubtless room for improvement in these techniques to widen the range of remains (e.g. phytoliths, diatoms, testate amoebae) recorded in a useful way. There is also scope for further development in methods for concentrating thinly dispersed eggs.

Identification: Burrows (1965) gives a key and illustrations for identification of eggs of nematode (and other) worms parasitic in humans, and this provides a useful starting point.

Trichuris can sometimes be identified to species with modest confidence using measurements of length and breadth where sufficient numbers of well-preserved eggs are recovered, though unfortunately the species primarily associated with pigs and man are very similar (Beer 1976; Jones 1982b), and the size of eggs is affected to some extent by sample treatment and mounting media (Hall *et al.* 1983a). Carrott, in a report which substantially clarifies the problem of identification of *Trichuris* in archaeology (PRS 2002/17) discussed the use of measurements separating eggs of *T. trichiura* and *T. suis*; he concluded that at a site at Brayford North, Lincoln, both were perhaps present. Analysis of egg size was taken further by Kenward and Carrott (EAU 2001/32), who applied cumulative frequency graphs to the problem of separating mixed populations, provided a range of statistical measures concerning variation within samples counts, and also gave a plot which emphasised just how much overlap there appears to be in egg size of different species. This discrimination requires further investigation, although the fact that cross-infection between man and pig can occur (see below) complicates the issue substantially. It also appears that aberrant eggs are occasionally produced (e.g. Burrows 1965: Jones and Nicholson AML 229/87 report likely archaeological examples), and presumably mixed infections may occur, too. *Capillaria* eggs strongly resemble those of Trichurus (e.g. Burrows 1965, Figure 52), and may easily be confused with them.

The species of *Ascaris* relevant to archaeology are *A. lumbricoides*, primarily in humans, and *A. suum*, primarily in pigs. The relationship of these two species is unclear; while they appear to have somewhat different life-cycles, this and nuclear DNA work suggesting that they are separate, mitochondrial DNA studies indicate thee major types found in both species, perhaps indicative of hybridisation (Loreille and Bouchet 2003; see also Criscione et al. 2007). *Ascaris* eggs are effectively impossible to identify to species (Loreille and Bouchet, *loc. cit.*), being similar and also variable (e.g. Burrows 1965), and identification has - rather dangerously - relied on association with *Trichuris* (e.g. Jones and Hutchinson 1991).

Some of the eggs of parasitic nematodes which have been recorded require further investigation to clarify their identity. This is true of the capillarids, and indeed more research is needed into the certainty with which the various *Trichuris* species may be separated. One potential approach may be the use of DNA residues (Martinez *et al.* 2003). It is possible that other species have been overlooked in archaeological deposits, and there is a need to obtain modern eggs of a wide range of species from numerous sources for reference purposes, to provide reference material so we can determine experimentally which are preservationally robust, and to establish what changes in size and appearance may occur in preservation and during laboratory treatment.

Checklists and key works for parasitic Nematoda relevant to environmental archaeology do not appear to exist, information being dispersed through the parasitology literature. Reviews such as that of Burrows (1965), Kassai (1999) and Smyth (1994) are the most useful general sources for the biology of these worms.

Interpretation of records of nematode eggs. While some *Trichuris* may be fairly host specific, it appears that *T. trichiura* and *T. suis* are able to exchange hosts (Beer 1976); similarly, *Ascaris lumbricoides* and *A. suum* may infest both humans and pigs (references given by Loreille and Bouchet 2003), *T. ovis* has a range of occasional hosts (see above) and T. vulpis may occur in humans, sometimes in mixed infections with *T. trichiura* (Burrows 1965, 174). This presents a serious problem when identification of the origin of faecal deposits is required; pig faeces on surfaces simply indicate that pigs were kept, useful enough information, but human faeces in the same situation might point to a very low standard of hygiene (providing redeposition of older cesspit deposits can be ruled out). This problem has generally been conveniently disregarded, and indeed for *most* features at *most* sites the presence of the eggs of these species is undoubtedly good evidence for the presence of human faecal matter, botanical remains frequently providing confirmation.

It is, however, important not to regard detection of a few eggs as evidence of a primary faecal deposit. Firstly, each host may carry large numbers of worms, which produce immense numbers of eggs, so the numbers of eggs in stools may be extremely large (Jones 1985). Secondly, eggs were probably moved about in space by various means (e.g. in trample, as dust, and perhaps by insects, Kenward and Large 1998b), and through time by redeposition of earlier cesspit fills, so that there is for any given site likely to be a non-significant 'background' level. Small egg counts may consequently be obtained from a large proportion of deposits on some intensive occupation sites. This has been recognised in the literature (e.g. Jones 1985, 112-3); concentrations of 300 eggs per gram have been regarded as certainly too low to be conclusive in the absence of other evidence (e.g. from plant remains likely to have been of faecal origin, and from insects associated with very foul conditions). Even high counts might result from bulk-redeposition of older layers (e.g. Kenward and Hall 1995, 600; see also Dobney *et al.* 1997), and so the stratigraphic and other biological evidence must always be given due regard. Low concentrations of eggs may be common at some sites (e.g. in medieval and post-medieval pits at The Bedern, York, Hall *et al.* AML 56-58/93), and in such cases it is necessary to turn to other evidence (principally botanical) to determine whether the deposits were only slightly contaminated by faeces, or whether they were faecal but the people concerned carried low parasite loads. Some deposits from which bran is recorded but for which parasite egg analyses prove negative may represent waste grain, faeces of livestock, flour or processed cereal products, rather than human faeces. The argument for low infection rates would be particularly convincing where other typical indicators of faeces, such as fruit pips and stones, are present.

Acanthocephala are a group of parasitic worms rather similar to nematodes. Eggs, probably of *Moniliformis clarki*, were present in palaeoindian coprolites in Oregon reported by Hall (1977), but no European records have been encountered during preparation of this review.

Phylum Rotifera: wheel animalcules

Rotifers appear to preserve poorly in sediments. There are exceptions, some adults and non-diagnostic eggs surviving and being discussed by Frey (1964, 26-28) and Warner (1990b), but the group appears to have little interpretative value. Their biology is usefully summarised by Fryer and Murphy (1991, 179-183).

Phylum Annelida: segmented worms, including earthworms and their relatives

Annelids are divided into three groups; the Oligochaeta (earthworms, pot worms and sludge-worms), Hirudinea (leeches), and Polychaeta (bristleworms, a very large and diverse, almost entirely marine, group). The first is common (as egg cases) in archaeological deposits; the other two may prove to be of some slight value.

Class Oligochaeta: earthworms and their relatives

Members of the class Oligochaeta, so called because they have unobtrusive chaetae on their segments, include the families Enchytraeidae (pot worms) and Tubificidae (sludge-worms), which are common at the present day, but appear not to preserve in archaeological deposits, although the former may apparently be recorded through their faeces on micromorphology slides (e.g. Macphail 1994). Earthworms (various families), on the other hand, are abundantly represented by their egg capsules, which vary substantially in different groups of earthworms.

The only specific identification of earthworm capsules from archaeological deposits encountered during this review is that of Hill (1993), who recorded *Eiseniella tetrahedra* from fen peats (probably of Roman date) at Thornton, East Yorkshire. This earthworm is associated with the roots of water plants and with soils near water, illustrating the potential of these remains for reconstructing depositional conditions. It is uncertain why there are no records of setae, abundant on both oligochaetes and polychaetes. Earthworms, for example, typically have eight per segment, and thus up to around 2000 per individual (Sims and Gerard 1985, 3-5). It might be expected that earthworm setae would occasionally be seen in 'squashes' for microfossils (p. 29) or in thin sections for soil micromorphology; the preparation of comparative material is desirable, as are tests of their resistance to decay. A mineral-replaced earthworm embryo in its cocoon was described from a site in Wiltshire by Pearce *et al.* (1990).

Some worms are primarily associated with well-drained soils, others are tolerant of more waterlogging, and others are favoured by accumulations of decaying organic matter, suggesting some interpretative value. There is, however, a major interpretative problem in that, of course, worms burrow. In fact, they penetrate very deeply. The common earthworm *Lumbricus terrestris* has been recorded at 3m below the surface, and some tropical forms go much deeper (Sims and Gerard 1985, 27). Even if the remains recovered are not modern they still may post-date the time at which a deposit was forming or was perhaps a living soil. Live worms are often found in archaeological deposits over a metre below the surface (a published example is Bradley 1958), so presumably egg capsules may be deposited at similar depths. In some cases the worms *may* have lived continuously in the deposit since its formation: this was argued for a population of *Eophila oculata* found alive 3-5 metres below the ground, deeply buried by various floor surfaces, at Verulamium (St Albans) by Dobson and Satchell (1956). Earthworm biology is reviewed by Edwards and Lofty (1977).

Where a convincingly well-sealed deposit has abundant egg capsules, and overlying deposits are relatively free of them, they may stand as evidence of a former active soil horizon; corroborative evidence would need to be sought, however. Worm egg capsules are sometimes present where other invertebrate remains seem to have decayed completely (e.g. in post 18th century deposits at Holmechurch Lane, Beverley, Carrott *et al.* EAU 1996/43). In such cases it is rarely possible to determine whether they have survived because they are especially resistant, or are intrusive, but the latter is suspected. Sometimes earthworm egg capsules may be indicators of soil inwash into cut features, as seems likely in the case of a shallow Iron Age well at the North Cave site, East Yorkshire (Allison *et al.* EAU 1997/37; forthcoming a), in this case the interpretation being supported by the presence of numerous *Heterodera* type soil nematode cysts.

Various earthworm species have been introduced to the British Isles by human activity (Sims and Gerard 1985): if these forms could be differentiated and securely provenanced, they would certainly be of interest. Such records might be useful in relation to the impact of the introduced forms on established fauna, though there may be a problem in differentiating direct competitive effects from those of changing land use (Stebbings 1962). Enckell and Rundgren (1988) used earthworms supposed to have been introduced by humans as indicators of abandoned settlements in the Faeroes. They argued that populations of the worms remain in enriched soils for a long time. Worm densities were higher in infields (both extant and abandoned) than in outfields, and densities were higher among abandoned house remains and in abandoned shielings. There was some relationship between species structure and the history of soils.

Earthworms and stratigraphy. As a result of their burrowing, worms move sediment upwards, carrying up fine particles and burying surface material. They also deliberately carry medium sized (mm-scale) particles downwards; their role in dispersing cow dung is discussed by Holter (1983), for example. For work on microfossils and some kinds of macrofossils they may therefore be a source of contamination. Their importance in disturbing and burying archaeological stratigraphy has often been referred to, from Darwin (1881) onwards, and reviewed by Stein (1983), while Armour-Chelu and Andrews (1991; 1994) discussed bioturbation and the movement of small bones, but the effect of worms in obscuring the stratigraphic record rarely seems to be adequately borne in mind when archaeological sites are being interpreted. Van Nest (2002) regarded earthworms as important in preserving Archaic archaeological sites in western Illinois, USA. Canti (2003; 2005) reviews the archaeological role of earthworms and relevant experimental literature in articles which are strongly recommended to all archaeologists.

Recovery and identification: Earthworm egg capsules are very frequently found using the standard methods employed for plant and invertebrate macrofossils. Those recorded have various sizes and shapes, reflecting those illustrated for modern capsules (e.g. by Evans and Guild 1947 and Sims and Gerard 1985), so they should be identifiable to some extent. Little effort has been made in this direction; while they appear to match illustrations, it has never seemed likely that the effort involved in confirming identifications using cultured reference material would be rewarded in terms of archaeological information obtained. This may be an unduly pessimistic view since some species have fairly constrained habitat ranges, following Sims and Gerard (1985). Superbly preserved mineral-replaced adult worms may prove to be identifiable using standard key characters; those fragments seen by the author have been too poorly preserved for there to be any reasonable hope that they could be named. Traces of earthworm burrows are considered on p. 93.

Class Hirudinea: Leeches

The potential for hard parts of leeches to preserve in archaeological deposits is not known. However, they produce robust cocoons which have been recorded from natural freshwater deposits (Frey 1964, 31-32), and numerous cocoons of *Erpobdella* sp. were recorded adhering to bones and shells at the Austin Friars site, Leicester, by Mellor (1981). They seem unlikely to be very important on archaeological sites, although any evidence of medicinal leeches (*Hirudo medicinalis*, which produces 'simple cocoons' according to Fryer and Murphy 1991, 208) *would* be of considerable interest! *H. medicinalis* produces very small numbers of eggs (around 10 per year in a single cocoon according to van der Hoeden 1964, 712), so their recovery from archaeological occupation deposits would be a matter of very good fortune, but highly suggestive of deliberate culture. It is not clear from the literature how closely leech cocoons from ancient deposits can be identified.

Class Polychaeta: bristleworms

Among the polychaetes, the tubeworms, families Serpulidae and Spirorbidae, are marine forms which secrete calcareous tubes attached to rocks, seaweed and shells, and which are occasionally seen on marine shells or loose in archaeological deposits, though probably they are often not published. There is a record of a '?spirorbid' from the Flixborough site, for example (Hall pers. comm.). These worms cause fouling of ship's bottoms and might be encountered in marine archaeology or on re-used timbers. Various forms found on the shores of northwest Europe are illustrated by Hayward *et al.* (1996, 112-4), and identification of tubes, which may be very robust, should not be too difficult. They may perhaps provide information concerning the origin of shellfish, on archaeological specimens of which they are sometimes observed. Other polychaetes bore into shells or calcareous rocks and may consequently be identified from archaeological material. *Polydora* species are moderately often recorded: *P. ciliata* and *P. hoplura* (Spionidae) were reported infesting oyster shells from the Old Manor House, Cottingham, Hull, by Carrott *et al.* (EAU 1995/34), for example. Outside out region, Boyd (1981, 279) gives a record of fragments of the jaws of free-living Nereis worms.

Recovery and identification: No special recovery techniques would be required for the cases or burrows of these worms, but access to a good reference collection would be desirable. Other polychaetes seem unlikely to be preserved in archaeological deposits, although the cases of Pectinariidae and Sabellariidae might survive under exceptional conditions.

Phylum Tardigrada: water bears

Although tardigrade eggs have been recovered from freshwater deposits (Frey 1964, 32), this group of delightful little animals seems very unlikely to have much significance in ecological reconstruction. Introductions to the group are provided by Fryer and Murphy (1991, 321-324) and Le Gros (1958; the latter illustrates some eggs, whose sculpture may allow some level of identification if preserved).

Phylum Crustacea: barnacles, shrimps, woodlice, crabs, lobsters etc

Generally speaking, crustaceans are not very important in occupation-site archaeology, except for the evidence for food and fisheries provided by crabs, and indications of aquatic deposition or the importation of water offered by water fleas. There has been a significant amount of work on cladoceran water fleas from natural aquatic sediments, and rather more on freshwater and estuarine ostracods. Both groups are often found in occupation deposits.

The status of the Crustacea as a separate phylum, or as a class within the Arthropoda, is a matter of argument.

Class Cirripedia: barnacles

The true barnacles (Order Thoracica) are common animals, attached to rocks, breakwaters, piers and ships and feeding by 'netting' small suspended particles. The goose barnacles (Lepadidae) have a soft stem which is attached to the substratum, or in the case of the buoy barnacle (*Dosima*) to a float secreted by the animal itself. The more familiar sessile barnacles are surrounded by hard plates and are represented by a considerable number of species belonging to three families. Barnacles are likely to be of limited interpretative significance, though Bell (1981) mentions their importation with seaweed. It has been shown that the rate of breakdown of the plates of barnacle species varies, so differential preservation seems likely; the common *Chthamalus stellatus* and *Balanus balanus* rot relatively quickly (Barnes 1956).

Barnacles have occasionally been noted in archaeological deposits. Their most likely origin on most sites is on shellfish valves. Small numbers of barnacle carapace fragments were recorded from Anglo-Scandinavian deposits at 16-22 Coppergate, York (Kenward and Hall 1995, 757). Those which could be identified were *Balanus crenatus*, commonly found on the shells of large bivalves and presumably introduced with shellfish (indeed, O'Connor AML 4297 observed that 'most specimens' at Coppergate were attached to *Mytilus* (mussel) valves). Berry and Spencer (1980) record *Balanus* (now *Semibalanus*) *balanoides* on oyster shells from Roman deposits at Skeldergate, York. Nicholson (1988; 1989a) found small quantities of barnacles (not identified further) at the Queen Street and Crown Court sites, Newcastle.

Recovery and identification: Typically barnacles will be recovered from Bulk Sieving samples or still be attached to hand-collected shells. Some progress with identification of the plates can be made using popular illustrated manuals such as Hayward *et al.* (1996, 122-5), and Bassindale (1964) provides keys, but confirmation requires reference material.

Class Notostraca: tadpole or fairy shrimps

The distinctive remains of *Lepidurus arcticus* have rather often been recorded from late-glacial and other cold stage deposits (e.g. Frey 1964, 34). Mitchell (1957) reports material from Neasham, SE of Darlington, Co. Durham, and gives a figure of the characteristic telson. Records of this species may complement other evidence for very low temperatures, but is very unlikely to be of importance in British archaeology. Thiéry *et al.* (1995) carried out a comparative analysis of cyst (resting egg) morphology of some European branchiopod crustaceans, including the Notostraca. They concluded that shape and shell surfaces are characteristic, often at the species level, so that fossil material, if found, may be identifiable. Remains are typically recovered by paraffin floatation.

Class Ostracoda: ostracods

The ostracods stand apart from other crustaceans in their body plan, having the body enclosed in a robust bivalved carapace. They are typically tiny, in the range around 0.5 to 2.5 mm in length as adults, although a few are as small as 0.3 mm and some as large as 30 mm. They live in the sea, in estuaries, and in freshwater, and numerous species have been recorded in northwest Europe.

Many ostracods have rather closely constrained habitats, making the group invaluable as indicators of aquatic conditions, including temperature and depth, and degree of oxygenation, salinity and pollution (Delorme 1990; Griffiths and Holmes 2000; Holmes 2001). Numerous studies of ostracods from natural deposits have been made in Britain, though rather few in the North of England as defined here. Frey (1964, 51-56) provides a review of earlier work on ostracods in freshwater deposits. The group is subject to active study in British freshwater deposits, and in many other parts of the world, but ostracods are still under-utilised.

Ostracods have been used to investigate palaeotemperatures using trace elements and isotope ratios (C-13/C-12; O-18/O-16; Sr/Ca; Mg/Ca) (Holmes 1996), and these techniques might usefully be applied in our region. Lister *et al.* (1991), for example, reconstructed a precipitation-evaporation budget for a Chinese lake, from which they determined regional changes in the strength of monsoons. Chivas *et al.* (1985) showed that Sr/Ca ratios in valves reflected lacustrine salinity. Palaeotemperature and salinity in Himalayan, Jamaican and Spanish lakes were investigated by Holmes *et al.* (1992; 1995) and Wansard (1996) respectively. Palaeosalinity (and hence aridity) was studied for the North American Great Plains by Fritz *et al.* (1994), using a range of techniques. Filippi *et al.* (1999) examined climatic and human influences on stable isotopes (oxygen) over the past two millennia in ostracods in a Swiss lake, comparing the record with that from bulk carbonates and concluding that there was a distinct but correctable offset in the values. Holmes (1992; 1996) reviews the use of ostracod shell chemistry as a palaeoenvironmental tool. Heaton *et al.* (1995) found that there was much variation in isotope ratios in ostracod shells in valves of the same species at single sites, as a result of temporal and spatial variations in water conditions and the fact that ostracods form their shells over a short period, suggesting the need for caution when using single valves for palaeoclimatic studies. Further problems were discussed by Holmes (1996), although ostracods were still regarded as of considerable potential importance in climatic reconstruction. The robust nature of the valves means that ostracods may survive throughout long sequences where more labile remains are only locally present: and example is provided by deep sediments in Lake Pamvotis, Greece, where species composition and stable isotopes in a sequence from the Last Interglacial to the Holocene were examined by Frogley *et al.* (2001). Remarkably, spermatozoa have been found in the remains of 5000 year-old ostracods in Britain and Germany (Matzke-Karasz *et al.* 2001).

Marine ostracoda have been used in environmental reconstruction, both on the basis of their biology and through isotope determination (e.g. Penney 1993 and references therein). Robinson (1980) discusses the marine ostracod record from the Lateglacial of Britain and North-West Europe. More relevant to the present review, they are also of value in the study of sea levels, marine incursions and land reclamation (Haslett *et al.* 1997; 2000).

Freshwater Ostracoda are normally considered as components of natural sediments, particularly lakes (e.g. Delorme 1990; Griffiths and Holmes 2000; Holmes 1992; 2001; Loffler 1986) and more rarely in fluvial deposits, some interglacial (e.g. Robinson 1990; Taylor *et al.* 1994). Ostracods were used in the USA to reconstruct agricultural activity from sediments in irrigation canals (Palacios-Fest 1997). In the North of England, Worsley *et al.* (1983) described ostracods from a cold stage (stadial) deposit at Chelford, Cheshire, and Holyoak and Preece (1985) gave analyses for a site on the fringe of the area considered here. Hill (1993) reported ostracods as present in later Bronze Age riverine deposits at St George's Field, York, and they were common, though again not closely identified, in natural river silts at the Adams Hydraulics I site, between the Foss/King's Pond and Peasholme Green, again in York (Alldritt *et al.* EAU 1990/01).

Ostracods have often been found in archaeological deposits *sensu stricto*, sometimes in abundance. In the area considered here, for example, they were numerous in a late Iron Age pit at North Cave, East Yorkshire (Allison *et al.* EAU 1997/37; forthcoming a), in a mid to late 4th century AD pit at Glebe Farm, Barton-upon-Humber (Carrott *et al.* EAU 1993/13), in a late medieval deposit, probably alluvial, at Carmelite Street, York Carrott *et al.* (EAU 91/15), in a post-medieval ditch fill at Waterton, North Lincolnshire (Carrott *et al.* EAU 1996/40), in a fill of what was apparently a covered culvert at 54-7 High Street, Hull (Jaques *et al.* PRS 2003/01), in a ground raising dump of 15th century date (or earlier) at Citadel Way, Hull (Hall *et al.* EAU 2001/37), in 15th century fills of a large pit at Morton Lane, Beverley (Kenward and Carrott PRS 2003/58), and in the fill of a 19th century wooden drain at 84 Piccadilly, York (Carrott *et al.* EAU 1991/16).

Meyrick (1976) recorded two species, *Candona parallela* and *C. candida*, from the fills of the Roman sewer at Church Street, York, the former being the more frequent and only the second British record at the time the report was published. The bottom-dwelling *Candona* are according to Meyrick often the only ones found in caves, and their good condition suggested that they lived in the sewer. Harding (1954) produced a bare species list for pre-Roman Iron Age ditch deposits at Stanwick, North Yorkshire. Material from archaeological sites in a strict sense has, however, rarely been subjected to detailed study (though there are examples from outside our area: see, for example Robinson, E. 1984). The loss of information from this failure to use a 'difficult' group is uncertain, but presumably at least some data concerning water quality would be recovered. However, even where it is not practicable to identify them closely, the abundant remains of ostracods found in some archaeological deposits are valuable indicators of aquatic deposition, or at least of the importation of water (see p. 321) and, if identified more closely, remains in well and ditch fills will be a source of ecological information (water quality, permanence, etc.).

Small numbers of ostracod valves are rather frequently found in deposits reasonably supposed to have formed on land (there were, for example, several cases at Anglo-Scandinavian 16-22 Coppergate, including three pit fills and two surface layers, Kenward, unpublished database, and some were found in a medieval floor at 54-7 High Street, Hull by Jaques *et al.* PRS 2003/01). When they are present in cess pits or other cut features, it may be that they invaded open water, and are thus of some value in reconstructing ecology, but they may also have been widely deposited by short-lived floods, by trample from waterside habitats, in faeces, and in buckets of water brought into areas of occupation. It is not clear to what extent ostracod populations may develop in small, temporary and polluted water bodies. Ostracods may be very abundant, and so small numbers may easily be found away from their natural habitats. One ostracod which may perhaps be found on occupation sites is the 'horse-trough ostracod' *Heterocypris incongruens*, a fairly large species living particularly in small artificial water bodies; its biology is reviewed at length by Fryer (1977). Ostracods have also been found in huge quantities in the guts of fish, suggesting another route into archaeological deposits (Henderson 1990, 1). It is uncertain whether they can pass through mammalian guts without being destroyed by stomach acids, but it is perhaps unlikely.

Extraction: Methods for the study of modern ostracods are outlined by Henderson (1990, 25-6), for Quaternary remains by Delorme (1990) and Löffler (1986), and for archaeological material by Griffiths *et al.* (1993). Henderson suggests that 250 micron mesh sieves are suitable for recovering modern adults, although Griffiths *et al.* recommend 125 micron mesh for fossils as they consider recovery of juveniles to be of potential value in determining the taphonomic history of ostracods, a full range of stages suggesting *in situ* preservation.

Identification and interpretation: The freshwater ostracod fauna of Britain is dealt with by Henderson (1990), who also provides a valuable introduction to the anatomy and biology of the group. Marine and brackish water species are keyed by Athersuch *et al.* (1989), and Angel (1993) deals with marine planktonic species, many of which have very characteristic sculpturing on the valves. The nomenclature used by these authors is presumably best adopted. Griffiths *et al.* (1993) provide a key to archaeological remains of most of the British genera as well as useful references. Neale (1983) gives a general introduction to the biology and palaeoecology of Quaternary (and Tertiary) ostracods. Ecological interpretation of ostracod remains has been discussed in many individual reports, but Delorme (1990) and Holmes (2001) give useful introductions, although for North American studies. Griffiths and Evans (1992) describe a system of succinct notation which they suggest may assist in interpretation; whether such a scheme will be adopted for ostracods (or for any other group) remains to be seen.

Class Copepoda: copepods

Copepods are marine and freshwater 'water fleas', rarely preserved and barely used in palaeolimnology (Frey 1964, 57-59). According to Warner (1990b) non-diagnostic resting eggs and the tear-drop shaped male spermatophores (up to 50 microns in length) preserve in some deposits. Fryer and Smyly (1954) discuss the biology of copepod cysts (resting eggs), giving an illustration which unfortunately may be of little assistance in identification of fossil material. Egg shells may be of some value, however; Knapp *et al.* (2001) used them to establish the historical presence of copepods in alpine lakes, identifying the remains as *Hesperodiaptomus*, while egg sacs containing resting eggs of *Diaptomus* cf. *castor* were identified from postglacial lake sediments in Greenland and Denmark by Bennike (1998).

Class Cladocera: water fleas

The remains of Cladocera in lake sediments have been studied by freshwater biologists for several decades (see for example the reviews by Frey 1960; 1964, 35-50; 1976; 1986; Hann 1990; Walker *et al.* 1993b; and references given by Goulden 1964a, b; Harmsworth 1968) and continue to be used to tackle a wide range of problems (determining changes in lake levels, e.g. Hyvärinen and Alhonen 1994; tracing salinity changes, e.g. Hoffman 1987; in studies of lake acidification, e.g. Nilssen and Sandøy1990; and climatic reconstruction, e.g. Lotter *et al.* 2000). Results for ecological reconstruction have not always been conclusive: Harmsworth and Whiteside (1968), for example, failed to find any relationship between primary productivity and cladoceran assemblages in the sediments of numerous Danish and North American lakes. Nilssen and Sandøv (1990) discuss the complexity of factors determining cladoceran communities in lakes, suggesting that fish and invertebrate populations have a substantial impact; it may be suspected that matters are even more complex in small water bodies, with a substantial random component introduced by the vagaries of colonisation. Jeppesen *et al.* (2001) discuss the way results from palaeolimnological investigations, including Cladocera analysis, may be set into a more ecological context. Whiteside and Swindoll (1988) discuss the problems and limitations of Cladocera analysis. Hann (1990) reviews the use of cladocerans in Quaternary deposits from a North American point of view.

The palaeolimnologists' techniques for the identification of carapaces have barely been applied to archaeological deposits. However, cladocerans produce characteristic tough resting 'eggs', moulted from the female and often having a somewhat 'saddle-like' shape which gives them the name **ephippia**. These structures, typically produced in response to environmental stress (Sarmaja-Korjonen 2003), can seemingly remain viable for a century or more (Cacares 1998; Limburg and Weider 2002) and are very resistant as fossils and frequently recorded from archaeological deposits, often in huge numbers. Those noted from archaeological occupation deposits are usually from the familiar *Daphnia* species, although several other characteristic types have been noted repeatedly but not yet identified even to genus (e.g. in a Romano-British ditch fill at the Flodden Hill site, Northumberland, Kenward EAU 2001/49, and Glebe Farm, Barton-upon-Humber, Carrott *et al.* EAU 1993/13). Ephippia have value as indicators of aquatic deposition, and with further work it is likely that most of the remains will be identifiable: illustrations of ephippia, including surface microsculpture, of some species have been published and they appear distinctive (e.g. Bottrell and Newsome 1976; Fryer 1972; Kai-Hong 2001; Korinek *et al.* 1997), and Sarmaja-Korjonen (2003) used ephippia from Finnish lakes for environmental reconstruction, though without citing sources for identification. If ephippia from occupation sites do prove to be identifiable, they could be used together with other invertebrates to determine water quality and the degree of permanence of water in features such as ditches and pits. Cladocera*n* ephippia are not only found in obviously waterlain sediments, however (see below).

There has been some work on DNA analysis of cladoceran ephippia (e.g. Colbourne *et al.* 1998; Limburg and Weider 2002). Analysis of DNA residues from archaeological sites might perhaps span the past few thousand years and provide evidence of relationships between regional populations, rates of migration of genotypes, their historical relationship to habitat types, and possibly local dispersal patterns among small water bodies.

A little systematic work on cladoceran remains from northern England has been carried out in the context of palaeo-limnology, using them as a tool in reconstructing the history of lakes and tarns. Scourfield (1943), in an early study of Cladocera from Lake Windermere, catalogued remains of 24 species (he noted the surprising lack of copepods and only a single ostracod). He suggested that the cladoceran fauna of the lake has apparently changed little since its postglacial colonisation; beyond this, no ecological or environmental reconstruction was attempted. He considered the mechanism by which littoral species might have been transported to bottom sediments. Harmsworth (1968) traced the developmental history of Blelham Tarn, in the English Lake District (Cumbria), using Cladocera. The succession started in the Late Glacial and could be related to conventional pollen zones. Goulden (1964a; 1964b) reports Cladocera successions at Esthwaite Water, Cumbria. Cladocerans have rather often been noted incidentally to other studies of natural deposits. *Daphnia* ephippia are the remains most often referred to, but there are occasional identifications of other taxa, for example fairly abundant *Moina macrocarpa* from Neasham, near Darlington (Blackburn 1952).

In a more 'archaeological' context, cladoceran ephippia were recorded from natural peat deposits associated with the Lindow II bog body by Dayton (1986). Carrott *et al.* (EAU 1993/08), in an evaluation of supposed natural and other deposits of medieval date at Gowthorpe, Finkle Street and Micklegate, Selby, found huge numbers of *Daphnia* ephippia in what were probably carr woodland deposits, and they were also present in various other layers. Many records of ephippia are from river and pond sediment or layers identified as ditch fills. Roman ditch fills at a site on the route of the Leven-Brandesburton by-pass contained numerous *Daphnia* ephippia and some aquatic beetles, sufficient to suggest deposition in (perhaps only temporary) water (Dobney *et al.* EAU 1993/20). Cladocerans, and especially *Daphnia*, were extremely abundant in Romano-British ditch fills at a site east of High Catton (Teeside to Saltend Ethylene Pipeline, TSEP 222), East Yorkshire (Kenward *et al.* EAU 2002/12). Various other examples could be cited in the region. Outside it, work by Polcyn (1996) may be mentioned as a rare study directly related to archaeology.

Records from wells are also perhaps not too unexpected, especially when they were shallow. At North Cave, East Yorkshire (Allison *et al.* EAU 1997/37; forthcoming a) there were abundant *Daphnia* ephippia in the fills of some of the Iron Age pits, but it was not certain that the aquatic biota were contemporaneous with occupation. At the Old Grapes Lane B site, Carlisle (Kenward *et al.* AML 77/92; Kenward *et al.* 2000), fills of an early-mid 2nd century well yielded four kinds of Cladocera represented by ephippia. Aquatic beetles were quite numerous, but all were migratory forms, so the evidence from water fleas was useful in establishing that the cut really held water. At the D C Cook site, Lawrence Street, York, Hall *et al.* (PRS 2003/33) recorded immense numbers of cladocerans and other aquatics in the fill of a 14th century barrel well, indicating that it held water (unless, as seemed unlikely, it was a soak-away for waste water obtained elsewhere), and that the water was not too polluted; the aquatics had presumably become mixed into the backfill when the latter was dumped. Cladocera are valuable indicators of the presence of open water in pits providing there is no reason to suppose that they were imported with water, and confirmation from a range of aquatic insects, the larger species of which were much less likely to be brought in substantial numbers in domestic water, is useful.

Some records of Cladocera come from more surprising features. Carrott *et al.* (EAU 93/05), during evaluation of material from North Beckside and Beckview Tilery, Beverley, found water beetles and *Daphnia* ephippia in a fill of a garderobe, presumably having been imported with water. It is less obvious how ephippia came to be present in other cases: *Daphnia* or other cladoceran ephippia were noted from 56 Anglo-Scandinavian contexts of assorted kinds at 16-22 Coppergate, York, for example (Kenward and Hall 1995, 678; database given by Hall and Kenward 2002). Records of this kind are considered more fully below (p. 387).

Recovery and preparation: Methods are outlined by Hann (1990), Harmsworth (1968), Frey (1986) and Korhola and Rautio (2001). Harmsworth disaggregated sediments by heating in 5-10% NaOH, then used a 55 micron mesh aperture sieve. The retent was treated with HF and re-sieved, and this new retent mixed with water, drops being mounted in glycerine jelly for examination. The other authors offer a range of methods according to the nature of the sediment. Ephippia are commonly recovered incidentally to insect extraction by paraffin flotation.

Identification and interpretation: Keys to entire examples of British species are given by Scourfield and Harding (1994), who illustrate a selection, but reference material or detailed illustrations are necessary for identification of fossils. Harmsworth (*loc. cit.*) lists the identification works found most useful in the 1960s, a list only slightly amplified by Frey (1986). Hann (1990) points out that it is necessary to go to primary literature for illustrations and descriptions in order to identify fossils, and emphasises the value of reference collections. There is no systematic work on fossil carapaces, but remains of many species are illustrated on a website created by Simpson (2001). The review of Korhola and Rautio (2001) is among the most useful general introductions to the palaeoecology of cladocerans and includes many references.

There seems to have been no systematic study of ephippia, and it would probably be necessary to rely on the preparation of bred reference material and on scattered published illustrations (e.g. Kai-Hong 2001; Scourfield and Harding 1994; Smyly 1957); research here would surely be rewarding, although identification beyond genus may often prove impossible. Fryer and Murphy (1991, 236-245) discuss cladoceran biology at some length.

Much work remains to be done on the identification and interpretation of fossil Cladocera, and there is a need for a comprehensive manual. Dayton (1986) makes the particular point that many species which have been recorded as more-or-less cosmopolitan (in particular, those supposedly occurring in Europe and North America) may in fact be more localised, different species occurring in different parts of the range. By analogy with the beetles, these species may have been redistributed by glaciations, making ecological reconstruction uncertain.

Class Malacostraca: woodlice, shrimps, crabs etc

The Malacostraca are a large and diverse group of crustaceans, mostly marine but with a substantial number of freshwater and terrestrial forms. Only the woodlice and crabs appear to have been recorded from archaeological deposits in northern England.

Order Isopoda: woodlice and their relatives

Isopods are variously marine, freshwater and terrestrial, but only the last of these, including the all-too familiar woodlice, seem likely to have much archaeological significance. There appear to be no records of marine isopods relevant here, and even the freshwater species appear to be barely known from natural deposits (Frey 1964, 59); the author knows of no records from archaeological deposits.

Woodlice usually feed on dead plant material, occasionally on animal remains or dung, and are thus a part of the 'decomposer' community (see p. 408). Indeed in some circumstances they appear (by the sheer quantity of their droppings) to be of great importance in this respect. Although they are immensely abundant today, and thus presumably equally so in the past, fossils of woodlice are surprisingly uncommon in most kinds of deposits. The exoskeletons appear robust enough, but they usually seem to require mineral-replacement to survive; a stage in the decay of woodlouse cuticle which may explain their disappearance was observed by Kenward (EAU 1997/04; 2001b). A rare case of well-preserved but apparently unmineralised woodlouse remains was documented by Carrott *et al.* (EAU 1995/53), but it has not been possible to study these particular remains further. The preservation of woodlice is discussed further on p. 42.

One reason for identifying woodlice may be to detect changes in the British fauna, particularly introductions of alien species. Various woodlice have been brought to Britain recently (Harding and Sutton 1985, from Hopkin 1991); Oliver and Meechan (1993) give a list of ten alien species which have occasionally been recorded, but it is uncertain how many were brought earlier. However, the animals generally have limited value in ecological reconstruction. They are probably really only useful when nothing else survives (e.g., out of this area, in many deposits at Southampton, Girling and Kenward AML 46/86), and even then produce rather little substantial information beyond, perhaps, that the forming layer was initially anoxic then (after mineral replacement) became oxidised.

Ligia, the sea slater, is a large woodlouse confined to sea shores. It may have been eaten in the past, though perhaps only as 'famine food'. Hopkin (1991) mentions that it is cooked and eaten today by unfortunates on survival courses, but that it is 'rather unappetising'. If it was indeed eaten in the past, cooking and passage through the acid environment of the gut would probably have made subsequent preservation of any surviving remains very unlikely. The numerous true marine isopods are introduced by Naylor (1972). They will, however, probably be of almost no importance in archaeology.

Recovery and identification: Remains of woodlice are found in bulk-sieved and General Biological Analysis residues; they are very rarely present in paraffin flots. They are generally too rare to be sought specifically. Sutton (1972) outlines the biology, ecology and systematics of the British terrestrial species. A reasonably accurate identification of well-preserved fossils can usually be made from Sutton's keys and (more often) illustrations, although of course confirmation using reference material is normally desirable. Hopkin (1991) represents an excellent alternative to Sutton, and (on p. 605) provides an up-to-date checklist, while a further, well-illustrated, key is given by Oliver and Meechan (1993). Marine isopods are keyed by Naylor (1972).

Order Amphipoda: sandhoppers, freshwater shrimps etc

Members of this group might be expected to occur in at least some deposits as they are common in fresh and saline waters, but Frey (1964, 59) was unable to cite any reliable records from freshwater deposits and none have been encountered during preparation of this review. Presumably they are too delicate to preserve under normal conditions of anoxic waterlogging, and are unlikely to occur in places where they might become mineral-replaced. Trace fossils of talitrid sandhoppers in interglacial littoral calcareous sandstones in Cornwall are reported by Scourse (1996), however. *Identification*: species in one group of British marine amphipods are covered by Lincoln (1979), and amphipods of Norway (useful for cooler waters of Europe generally) are described and illustrated by Sars (1890-1895) in what remains the basic reference for the region.

Order Decapoda: shrimps, prawns, crabs and lobsters

Remains of these familiar animals, with their strongly calcified exoskeletons ('shells'), may be more often present in archaeological deposits than published records suggest, although their shell becomes very fragile in some chemical environments: their taphonomy is poorly known. In the British Isles they represent a minor but significant food resource, easily obtained in coastal areas and transportable inland alive with care, so that they can be kept fresh for some while. Crabs in particular are rather more abundant in deposits at sites in warmer parts of the world, where they have been studied in rather more detail (e.g. Ashkenazi *et al.* 2005; in this case freshwater crabs were involved).

Many species of crabs occur in northwest Europe, including Britain, but there is little evidence that more than two have ever been regarded as a significant food source in this area (they are more important in other parts of the world, however). The common edible crab (*Cancer pagurus*) is of course widely eaten today and it is occasionally noted from archaeological deposits. The only other British crab which is edible according to Ingle (1996, 1) is the thorn-backed (or common, or spiny) spider crab, *Maja squinado*. This is not likely to be confused with *C. pagurus* if carapace fragments are recovered since it is very spiny, especially at the margins; according to Ingle it does not occur on the east coast of England so is most unlikely to be found in the area considered here.

Among the lobsters, the common lobster *Homarus gammarus* is the most likely to have been exploited in our region. The only other edible species are the Norway lobster (*Nephrops norvegicus*), now sold as scampi, and the crawfish (*Palinurus elephas*), also called langouste. The former may eventually be found in archaeological deposits in northern England, but the latter is unlikely to occur unless imported. There are records of lobsters from archaeological deposits elsewhere in the British Isles, e.g. N. norvegicus from Orkney (Howard 1994), and a lobster claw from Tewkesbury (Moore-Scott *et al.* 1999). A prawn, named as *Palaemon fabricii*, has been recorded from a cesspit dated 1350-1400 in Svendborg, Denmark (Jørgensen 1986, 61).

Only the common edible crab seems to have been recorded from archaeological deposits in the area considered here (p. 323), although the shore crab *Carcinus maenas* has been noted elsewhere (e.g. Howard 1994). *C. pagurus* is rather distinctive among British crabs, but care should be taken not to record all fragments of decapod shell as this species. *C. bellianus* is the only other species in the genus *Cancer*, occurring in deep water (below 30 m) in the far north of Britain (Ingle 1996, 98); judging from the illustration it is not too likely to be confused with its commoner relative. There are at least five introduced crab species in British waters (Ingle 1996, 35).

It is likely that decapod remains are noted in passing in stratigraphic, marine mollusc or vertebrate reports and so often overlooked in literature searches such as that carried out in constructing the EAB, a principal source for the present review. Useful information may be obtained from crab remains, as at the General Accident Extension (Tanner Row) site, York, where a contrast in abundance between the Roman and medieval periods was apparent (O'Connor AML 4768), suggesting that more careful investigation of these remains from a series of sites might produce interesting information.

Freshwater crayfish are an obvious food resource where suitable streams and rivers occur, and their remains may be found in British archaeological deposits eventually. Frey (1964, 60) mentioned seeing freshwater crayfish remains preserved in marls, but was unable to cite any other records. There are rare archaeological records from beyond Britain (e.g. Hall 1977; Leach 1979), while Jennings (1992) tentatively identified a pottery crayfish trap.

Recovery. Decapod shell is typically collected by hand or in Bulk Sieving samples, but only bulk sieving is likely to produce useful groups. *Identification and nomenclature*: Reasonably entire remains of large decapods will be identifiable to some extent using popular illustrated manuals such as Hayward *et al.* (1996, 146-169), but for most determinations detailed monographs and reference material will need to be consulted. Crabs are keyed by Crothers and Crothers (1983) and Ingle (1996), coastal shrimps and prawns by Smaldon *et al.* (1979), and stomatopods (mantis shrimps), euphausiids, and Leptostraca (no common name) by Mauchline (1984); these groups might conceivably occur, for example, where seaweed is present, although it is uncertain whether they are tough enough to survive. Brief outlines of the biology of these groups are included in the keys.

Phylum Arthropoda: insects, mites, spiders and their relatives

'Arthropods are as intimately associated with [human] welfare as are any animals. The economic importance of this group to agriculture, in terms both of beneficial and destructive effects, can hardly be over-emphasised. In addition, many species have a direct relationship to human health and well-being' (Markell and Voge 1976, 305). No wonder, then, that the arthropods have proved so remarkably useful in reconstructing the human past. Yet, ironically, it is not the species being alluded to by Markel and Voge which are of the greatest archaeological value, but a wide range of species, mostly decomposers (p. 408), which probably rarely impinged on the consciousness of people in the past.

The Arthropoda are a vast and diverse group, probably the most important invertebrates in archaeology, although molluscs replace them in sites without anoxic waterlogged preservation. Only the insects have been widely employed for work on terrestrial deposits (albeit by a small number of specialists), but the mites have great potential (p. 76). Identification works for the British arachnids and insects are listed by Barnard (1999).

Class Chilopoda: centipedes

Millipedes (see below) and centipedes are often confused by lay persons, not surprisingly since the names of both groups are far from appropriate! They are distinguished by the number of legs *per segment* (one pair in centipedes, two pairs in millipedes), rather than by the total number. The leg insertions can often be seen in archaeological material.

Remains of centipedes are often present in archaeological deposits, but rarely noted in reports and probably of fairly limited potential. They are recovered from samples examined for insects, in plant macrofossil samples, and in bulk sieved material. The fossils are waterlogged or (less often) mineral-replaced. The body sclerites rather resemble those of some robust insect larvae, and they may be overlooked as such. Most of the remains seen by the author are believed to have been members of the large and difficult genus *Lithobius*, into which about a third of the British species fall; the genus occurs in a wide range of natural and synanthropic habitats.

Recovery and identification: Remains of these animals are occasionally recovered in paraffin flots, or (as mineral-replaced remains) in bulk-sieved samples and General Biological Analysis residues being analysed for plant remains. A key to the British species is given by Easton (1964), together with a checklist and an account of their biology. They are mostly not very easy to name as fossil remains (or as modern specimens, in fact).

Class Diplopoda: millipedes

Like centipedes, millipedes are often present in archeological deposits, rarely recorded in reports and probably of fairly limited potential. They have calcified cuticles, which presumably favours survival under some conditions. They are recovered in samples examined for insects, in plant macrofossil samples, and in bulk sieved material; again, they are preserved by anoxic waterlogging or (rather more often) by mineral replacement (e.g. Dobney *et al.* EAU 1992/22).

Recovery and identification: Millipede remains are occasionally found in paraffin flots, but are far more common in residues and in bulk-sieved samples. Blower (1985) will be helpful in identifying some archaeological material, and provides a useful introduction to the group.

Class Insecta: insects, including bugs, lice, flies, beetles, bees, ants and wasps

Introduction

The class Insecta probably includes millions of species, and not far from 20,000 in the British Isles alone. Many of them are very difficult to identify even as entire modern specimens. There is much to be done before certain groups can be regularly identified as archaeological fossils, and there is no realistic possibility of dealing with some others. Nevertheless the insects represent one of the most important sources of information about the conditions created and endured by people in the past, as well as for reconstructing palaeoclimates and ancient natural ecosystems. A major bibliography of fossil insects (Tertiary onwards) is given by Buckland *et al.* (1997; http://www.bugs2000.org/qbib/qbibonline.html), and a broad review of work on Quaternary insects (including archaeological sites) is provided by Elias (1994), but a large proportion of archaeological records are unpublished, appearing in internal reports and archives, or only in databases. There is no single detailed account devoted to insects in archaeology, but useful general introductions are given by Buckland (1976b), Coope (1991), Elias (1994), Philip Buckland (2000) and, most recently, Robinson (2001). Sutton (1995) provides a rather different slant on the topic, with an emphasis on potential and the Americas.

The best way to gain an insight into the way insects can be used in investigating European archaeological sites is via recent site reports such as those for Anglo-Scandinavian Coppergate, York (Kenward and Hall 1995; Hall and Kenward 2002) or Runnymede, on the River Thames (Robinson 1991b; 2000c). For reviews of work on natural sites, with a bias towards climate studies rather than ecology, see recent works by Coope and others (e.g. Coope 1987; 1994;1995; 2000; Coope *et al.* 1998; and papers in Ashworth *et al.* 1997).

General works on insects which give overviews of the various groups and their biology and ecology include Chinery (1993; the *Field Guide*, not the *Pocket Guide*, contains an excellent text). 'Imms' (in the revision of Richards and Davies 1977) is widely regarded as the standard work on insects, while one especially useful modern textbook of entomology among several is that of Gullan and Cranston (2004).

Many insects are of medical or veterinary importance (e.g. Busvine 1976; 1980; Harwood and James 1979; Kettle 1995; Lane and Crosskey 1993; Smith 1973), but their greatest usefulness in archaeology lies in their association with a wide range of natural and artificial habitats including water, wood, decaying matter and living plants, allowing them to be used to reconstruct human living conditions, natural environments, resource utilisation, and many other aspects of the past.

Many kinds of insect remains are found in archaeological deposits. They are usually preserved by anoxic waterlogging, but sometimes by charring (very rare), mineral replacement (fairly common, especially in the case of fly puparia), or dryness (uncommon in NW Europe); preservation is considered more fully on p. 100. Adult beetles are by far the best studied archaeological insects, but beetle larvae, bugs, ants, fleas and lice are now regularly identified, while recent developments in studies of the immature stages of flies (usually the puparia) have shown the potential of this group. Other insects which have received special attention include larvae of the caddis flies (Trichoptera) and larvae of the midges (Chironomidae and others). These groups are all considered more fully below.

Extraction methods

All insect remains are normally recovered by paraffin floatation unless otherwise mentioned below. In brief, this technique involves sieving the sediment to 300 microns, using chemical disaggregants and boiling if necessary. (Some workers use finer mesh, see references below, but as meshes become smaller the workload of sieving quickly increases out of proportion to the value of the minute fragments recovered.) Disaggregation may require chemical and mechanical methods (Kenward *et al.* 1980; see also Bending 2005 for peats), but insects are damaged by some common reagents (van Geel *et al.* 2003 mention in passing the deleterious effect of strong alkalis on insect cuticle, for example). The sieved material is drained of free water and mixed with paraffin (kerosene), then water is added. Insect remains (and those of various other invertebrates) are wetted by the paraffin and float to the water surface. Paraffin is removed by detergent and the extracted remains stored in industrial methylated spirits (IMS).

Substantial variations in the details of methodology between individuals are revealed by the accounts offered by Coope and Osborne (1968), Buckland (1976b), Elias (2001) and Kenward *et al.* (1980; 1986a), suggesting that paraffin floatation is somewhat of an art; the present writer has found literal adherence to Buckland's technique to result in the extraction of a large proportion of the plant remains from typical urban samples, for example! The efficiency of the 'York' method was tested on various occasions in the past, both formally (e.g. Phipps 1986) and informally (EAU staff, unpublished), and was found very effective. However, this tried and tested method proved erratic in the EAU in the late 1990s onwards, and recovery has often been poor. Kenward *et al.* (AML 78/92), reporting material from the Old Grapes Lane A site, Carlisle, checked the efficiency of insect extraction by examining residues under the binocular microscope. The technique was generally very reliable, but in some cases extraction had been inexplicably incomplete. Several of the residues were rich in remains and it was necessary to re-process them. This was the first time that such a large-scale failure had been detected, and at the time it seemed likely that a lapse of technique was responsible, the most likely cause being inadequate draining of free water before the addition of paraffin. This rather optimistic view has not been supported by further observations, for in many cases, and for a wide range of sediment types, considerable numbers of remains have in the past few years been recovered from residues during examination for plant macrofossils. On occasion the proportion left in the residue has been very high, sufficient to affect interpretation substantially. Shaw (n.d.) investigated the efficiency of floatation systematically and found the results to be variable, and sometimes poor. Lancaster (1994) investigated mechanical damage during extraction; the present writer concurs with Lancaster's conclusion that fossils may be very badly damaged during extraction.

Research to discover some means of maintaining the efficiency of paraffin floatation is essential; first it will be necessary to establish the cause of the failures, which is by no means clear. Just how sensitive the method may be is illustrated by a report from Frances Large (personal communication) that extraction appeared to be improved by the use of pink rather than blue paraffin! (This difference was mentioned to the author by P. J. Osborne many years ago so it is perhaps not as unlikely as it may at first appear.)

In a few cases, the failure of paraffin floatation effectively to recover insect remains appears more explicable. In particular, well-rotted fossils often do not float. A case in point is presented by the remains of *Trox scaber* in Anglo-Scandinavian and post-Conquest deposits at the Layerthorpe Bridge site, York (Hall *et al.* EAU 2000/64). A very large proportion of the fossils of *T. scaber* were recovered during botanical analysis from the residues from paraffin flotation, perhaps having failed to float because hydrophobic layers in the cuticle (to which paraffin normally attaches) had been modified or destroyed in the unusual environment of the tan pit: the *Trox* fossils were certainly visually in an unusual state of decay, and this was regarded as significant evidence regarding their pathway to the deposit (p. 365). A further example is offered by material from Coopers Farm, Long Riston, East Yorkshire (Jaques *et al.* PRS 2002/07): it was suggested that the failure of insects in some ditch fills to float was a result of the loss of oleophilic surface layers through decay (many of the remains appeared heavily oxidised). Similarly, Hall *et al.* (PRS 2003/14) found that many of the insects in peat from the Guardian Glass site, Goole, did not float; they were poorly preserved and the same mechanism was evoked.

Fly puparia may not float well using this technique (Phipps 1986). Osborne (1977) reported that paraffin floatation successfully extracted charred insect remains; the present writer's impression has been that charred remains often float because they contain gas-filled voids, rather than because they reliably attract paraffin. Charred plant material in general does not float unless clearly of low density (i.e. gas-filled), and it would be unwise to assume that all charred insect material will be recovered.

Recording methods

Recording methods for insect remains (and for other invertebrates typically recorded with them) are discussed on p. 453. An essential element is the determination of the minimum number of individuals (MNI) for each taxon, i.e. the smallest number of individuals which could have given the recorded fragments, a process which is not as simple as might be expected since it is often apparent that, for example, a 'pair' of elytra are from different animals.

Nomenclature in the Insecta

The taxonomy and nomenclature of invertebrates in general tends to be unstable, reflecting the rapidly increasing understanding of these often difficult groups of animals, and the classification and names of insects are particularly given to revision. In this review, nomenclature for the insects generally follows the latest revisions of Kloet and Hincks' checklist (1964-1977), which are, however, in some cases very out of date. They have been updated piecemeal by various authors, principally in the Royal Entomological Society's series *Handbooks for the Identification of British Insects* and online. A great many of these have been published and they have not usually been specifically mentioned under the group headings to save space, but the nomenclature in them should really be used in preference to the sections of the checklist which they replace. References to the most recent lists are given under group headings where appropriate if they are not included in the *Handbooks*. Nomenclature in some groups is particularly unstable and there is still considerable (sometimes unjustifiable, almost perverse) disagreement between British and mainland European authorities in some groups. For the beetles, for example, the gradual acceptance of the nomenclature used by Lucht (1987) for the Central European fauna, has produced a particularly difficult situation in which two schemes of about equal merit exist in parallel. Acceptance of Lucht was delayed by its price and the difficulty of obtaining it on long loan through libraries, but also by the fact that some of the names used for very familiar beetles seem to have been rejected long ago. Some recent Royal Entomological Society keys have gone in yet another nomenclatural direction, doubtless well-merited. A provisional checklist which is currently being built on the internet by The Coleopterist (http://www.coleopterist.org.uk/) is likely to become the accepted one in Britain in due course for beetles. Its arrangement and nomenclature are very different from existing schemes.

Not all groups of insects are considered in the following sections; those which have never, or rarely or doubtfully, been found in archaeological deposits have been omitted unless some special interest attaches to them.

Order Odonata: dragonflies and damselflies

These large and distinctive insects have been recorded only vary rarely from natural or archaeological deposits. Gaunt *et al.* (1972) note '*Odonata Gen.* et sp. indet.' from interglacial deposits at Austerfield, southern Yorkshire, but no other records relevant here have been encountered. From elsewhere, Robinson notes them from Neolithic and Bronze Age Runnymede (Robinson 1991b; 2000c), and Osborne (1997b) recorded some from a palaeochannel at Caldicot, Gwent. Remains of larvae might be overlooked among the heterogeneous mass of fragments of insect 'immatures' found in many aquatic deposits.

Order Orthoptera: grasshoppers and crickets

There are almost no records of grasshoppers or crickets from Pleistocene or Holocene deposits (exceptions being given by Lockwood *et al.* 1990-1992, though these remains were frozen in glacier ice). It has been suggested that they decay readily, and this is supported to some extent by their absence from modern death assemblages formed in places where the animals might be expected to live. Why Orthoptera, some of which are extremely common and abundant, should preserve poorly when earwigs and cockroaches, with superficially similar cuticles, survive is hard to explain. The need for experimental work in invertebrate taphonomy to address questions such as this is discussed on p. 111. There are, however, archaeological records of grasshopper remains from North America, often from desiccated coprolites (e.g. Bryant 1974).

One cricket, the house cricket (*Acheta domestica*), is found in buildings, where it may become a nuisance, and may perhaps eventually be found in archaeological deposits. ***Identification and biology***. Accounts of the British grasshoppers and crickets are given by Bellman (1988), Marshall and Haes (1988) and Ragge (1965). Reference material would be essential for confirmation.

Order Dermaptera: earwigs

The remains of earwigs, including the very distinctive forceps (cerci) are extremely common in occupation deposits, but rarely likely to be of any great interpretative significance. In the past they seem to have been more or less ubiquitous where humans lived, as now. The elytra resemble those of some beetles and occasionally cause confusion among the inexperienced. Almost all the records are of *Forficula auricularia*, the common earwig, but the considerably smaller *Labia minor* has been found on occasion (e.g. in large numbers in an Anglo-Scandinavian pit fill at 16-22 Coppergate, York, Hall and Kenward 2002; Kenward and Hall 1995, 563) and at Roman St Albans (Bradley 1958). Earwigs were present in more than a tenth of the assemblages at Coppergate, and most were probably *F. auricularia* (although no effort was made to confirm all identifications of these ecologically tolerant creatures). *L. minor*, in contrast, was identified from only five contexts. ***Identification and biology***. The illustrated key of Hincks (1949) remains useful.

Order Dictyoptera suborder Blattodea: cockroaches

There are only very rare records of these reviled animals, but they are significant in that the species found indoors are certainly aliens and in Britain wholly dependent upon artificially heated buildings for the long-term survival of populations. They are thus seen as indicators of a rather high standard of social organisation. Although entomologists have regarded their introduction as rather recent (perhaps during the sixteenth century according to Ragge 1965), the oriental cockroach *Blatta orientalis* has been found in late Roman deposits at Lincoln, a discovery of considerable significance (Carrott *et al.* EAU 1995/10; Dobney *et al.* 1998). It probably died out after this, however. A much later record was made from The Bedern, York (mid 17th century or later, Hall *et al.* AML 56/93, 32). This specimen was unfortunately not identified closely when it was originally discovered, and it has proved impossible to locate the material in store. It was probably *B. orientalis*. Positive identification of this species were made in an assemblage from a late 18th-late 19th century pit fill at Bridge Street, Chester (Jaques *et al.* PRS 2004/46, where B. orientalis is discussed in more detail). It is also known from Dublin, where abundant fragments were found in the backfill of wood-lined butter storage pit dated late 17th or early 18th century (Hall *et al.* PRS 2004/23). *Identification and biology*. Identification keys and an outline of the biology of the British native and introduced cockroaches are given by Ragge (1965). Reference material is essential for confirmation of fragmented sclerites.

Order Psocoptera: booklice

Booklice are occasionally seen in archaeological assemblages, usually as heads and wings; it is hard to be sure whether they are modern or ancient in many cases. As fossils, some species, particularly of the genus *Liposcelis*, the true booklice found in houses, have a very strong superficial resemblance to parasitic lice (see for example Mound 1989, 7), and the wings are very reminiscent of those of psyllid bugs (below). This genus has been recorded in a Roman assemblage from outside the area being reviewed here, but it was impossible to be certain that the specimen was not modern (Kenward EAU 1997/09). *Identification and biology*. Some progress can be made with identification by reference to New (1974) when material is well preserved, but reference material is required in most cases. The same source gives brief habitat data.

Order Mallophaga: the biting lice

There are two groups of lice, superficially rather similar and probably quite closely related. Allison and Kenward (1991) give a popular introduction to archaeological lice of both groups.

The biting lice are essentially scavengers on the skin of the host. The British fauna is large, but a large proportion of the species are found on wild birds and mammals. Some species are of particular archaeological importance, however, especially the sheep louse *Damalinia ovis* which, together with the sheep ked *Melophagus ovinus* (a fly), is seen as an indicator of wool-processing (p. 363). Other species are discussed on p. 425. *Identification and biology*. Keys and illustrations, and host data, are provided by Séguy (1944). Reference material is necessary for most identifications.

Order Anoplura: the sucking lice

The Anoplura are blood-suckers. A quite small number of species occur in Britain, including the human louse (*Pediculus humanus*), crab louse (*Pthirus pubis*) and the pig lice (*Haematopinus* spp.). These animals are gradually acquiring a long fossil history, references to which are given by Kenward (1999; 2001a). The human louse is fairly commonly encountered in archaeological deposits; it occurred in at least 54 Anglo-Scandinavian contexts at 16-22 Coppergate, York, for example (Hall and Kenward 2002; Kenward and Hall 1995). It may occasionally be very abundant (e.g. Kenward and Allison 1994a; Allison *et al.* EAU 1999/08, 1999/10; Hall *et al.* EAU 2000/25; 2000/33). The pig lice are of interest in that the species found in archaeological deposits is now extinct in Britain, having been replaced by the modern pig louse (p. 425). Human lice are implicated in the spread of disease (p. 419), and have value in determining the use to which structures were put (p. 370).

Anopluran lice produce eggs or 'nits' which are which are firmly cemented to fabric fibres or hairs (Lapeere *et al.* 2005). Given adequate reference material, these are probably identifiable to genus at least if recovered from archaeological deposits: see illustrations given by Burkhart *et al.* (2000) and Burns and Clay (1988) for *Pthirus*, and by Clay (1973) for *Pediculus*. Maunder (1983) illustrates an abraded nit of *Pediculus*. There are appreciable numbers of archaeological records of nits from around the world, mostly from mummies and combs: Schelvis (1991a) reports nits of *Pediculus humanus* from medieval combs in the Netherlands, for example. It is worth noting as a warning for less experiences workers that on one occasion *Juncus* (rush) seeds were identified by a louse expert as nits, and that moss leaves in tufts of hair have been mistaken for them: the moral in the former case is that we should not rely too much on experts who do not have experience of *archaeological* material, which may have undergone substantial taphonomic change.

Identification and biology. Keys and illustrations are provided by Van den Broek (1977), Jancke (1938) and Séguy (1944); the last two also give quite extensive biological notes. Reference material is often required.

Order Hemiptera: true bugs including shieldbugs, capsids, froghoppers, leafhoppers, scale insects and aphids

Bugs are a fascinating and diverse group with representatives in many habitats. Most are plant-feeders or predators, but some are parasites, including the bedbugs (*Cimex* and its relatives), others obligate bloodsuckers (e.g. various reduviids, including vectors of Chagas' disease). Even species which are normally predators on invertebrates may attack humans in defence, or apparently to obtain blood (an example of the last is provided by *Lyctocoris campestris*, common in occupation-site deposits, reported as persistently 'biting' a person in New Zealand, Woodward 1951).

Bugs of various kinds are very commonly encountered in archaeological deposits, but generally in rather smaller numbers than the beetles. They are sometimes absent from species lists even when rich assemblages of beetles were present, suggesting a conscious omission. Preservation does appear to vary, however, with some sites particularly rich in bugs (e.g. in Iron Age ditch fills at Bolton Hall, East Yorkshire, Jaques *et al.* EAU 2002/04).

Given good fossil material, most of the *Heteroptera* (the group including shieldbugs, capsids and water bugs) can fairly easily be identified with an adequate reference collection and the appropriate manuals, as can many of the leafhoppers (*Homoptera partim*), and these groups provide valuable information concerning ancient ecological conditions, including soil types and the range of plants present. Water bugs are also important indicators of water quality and although the Corixidae (water boatmen) are difficult to identify from typical fragmented material, the diagnostic male fore tarsi are sometimes recovered (e.g. in a post-medieval ditch at Waterton, North Lincolnshire, Carrott *et al.* EAU 1996/40).

The Homoptera (froghoppers, scale insects, aphids etc.) have received little attention as fossils. Identification of the more difficult species amongst the froghoppers and their relatives (Auchenorhyncha) has often been neglected, although as suggested above most can be named with appropriate facilities. A notable demonstration of this fact for the north of England is the long list of taxa presented by Hill (1993, 185-6) for two natural sites near York. Psyllids (Psylloidea), both adults and nymphs, have much potential, the nymphs because they seem particularly likely to have been imported to occupation sites in plant raw materials.

Aphids (Aphidoidea) are often found in ancient deposits, but rarely in more than small numbers. Often they are 'mummies' - i.e. parasitised individuals, which seem to be preservationally more robust and to adhere to host plants, making them more likely to have been imported to archaeological sites in raw materials, but apparently unparasitised remains are fairly often encountered. These parasitised remains, examples of which are illustrated by Salim *et al.* (1996), may present additional difficulty in identification, however, since the parasite may induce abnormal development (Johnson 1958).

Scale insects (Coccidoidea) may be very abundant, for example in some Anglo-Scandinavian deposits of brushwood at 16-22 Coppergate, York (Hall and Kenward 2002; Kenward and Hall 1995, notably 555, 589) and a few layers at North Bridge (Low Fisher Gate) Doncaster (Carrott *et al.* EAU 1997/16; Kenward *et al.* 2004a). At Coppergate most of the remains were of *Chionaspis salicis* and *Lepidosaphes ulmi* (neither species confined to the host implied by their specific epithet); in some cases they were associated with willow twigs, but often they occur where there is no other evidence for small wood, and are thus useful indicators. Scale insects are probably very under-recorded since they are easily overlooked and difficult to identify; other than the York group, only Noe-Nygaard (1982) appears to have recorded them (*L. ulmi* from medieval Sevendborg, Denmark). Scales produce dyes, waxes and resins used by humans and were of great economic importance in the past (p. 361). Many alien scale insects are today present in Britain and archaeological records may eventually document their introduction, with interesting implications regarding trade (especially importation of live plants) and pest control.

Many bug nymphs can be identified, especially those of psyllids, which carry many useful characters (White and Hodkinson 1982). Such relatively immobile nymphs represent excellent indicators of imported plant resources, and every effort should be made to name them when they are found. Psyllid nymphs may be surprisingly frequent and abundant in archaeological deposits. *Craspedolepta nervosa* nymphal exuviae (shed skins) were identified from a substantial number of 1st and 2nd century Roman contexts at Castle Street, Carlisle, and in some cases were abundant (Allison *et al.* 1991a, b). Kenward *et al.* (AML 78/92; 2000), reporting insect assemblages from Roman layers at the Old Grapes Lane A site in the same city noted *C. nervosa* nymphs from three contexts, including several from a ditch fill, and at Carmelite Street, York, Carrott *et al.* (EAU 1991/15) tentatively identified *C. nervosa* nymphs from 16th century dumps. *C. nervosa* is particularly associated with yarrow, *Achillea millefolium* L., and there is every reason to suppose that the nymphs were brought in cut vegetation, presumably hay, although turf is a possible source. Nymphs of *Trioza urticae*, associated with nettles, are occasionally recorded and represent a valuable supplement to the range of beetles associated with the plant when attempting to establish whether it grew near to deposits or the fauna was of transported origin. Nymphs of 'froghoppers' are fairly common in archaeological deposits but have not been identified further.

Corixid (water boatman) nymphs are fairly frequent in deposits formed in still water, for example at Carmelite Street, York, Carrott *et al.* (EAU 91/15), but are probably mostly unidentifiable. Nymphs of the cimicid bug *Lyctocoris campestris*, associated with dry litter (including birds' nests) and common as adults in occupation deposits, are occasionally found and probably the source of the shed cimicid abdominal exuviae (skins) noted on numerous occasions in occupation deposits. Nymphal remains of other cimicids are sometimes found and probably usually belong to the very common genus *Anthocoris*, predators found on plants of many kinds.

Adult bugs, other than aphids and scale insects, are treated together with the adult beetles by the writer for the calculation of assemblage statistics (p. 63).

Identification and biology. Southwood and Leston (1959) is the most recent comprehensive key to the British *Heteroptera*, but there has been much subsequent minor revision; water bugs are keyed by Savage (1989). For the Homoptera, the Royal Entomological Society's *Handbooks* cover a large proportion of the British fauna, including some of the aphids. Aphids are extremely difficult to name as fossils (the same is true of modern material, witnessed by, for example, Stroyan 1984, who abandoned the fruitless effort of providing conventional identification keys!), but some have been identified (e.g. Hall *et al*. 1983a). There are no up-to-date key works for the British scale insect fauna. Some progress can be made with well-preserved archaeological material using Newstead (1901-3), but many species have been added to the British list since that time, and there has been profound nomenclatural change. One group, the Eriococcidae, have been revised, keyed and illustrated more recently by Williams (1985). Beyond this, it is necessary to rely on searching among large numbers of papers each concerned with small numbers of species. It is also necessary to make slide mounts for proper examination, and many fossil specimens have the essential characters obscured, further disincentives to identification

The check-list of Kloet and Hincks (1964), is now very out-of-date (and indeed extremely confusing for some groups); for the *Heteroptera* an update, very different in its arrangement, is in preparation, and for the 'froghoppers' Le Quesne and Payne (1981) give a revised list. Where Royal Entomological Society Handbooks exist the lists given in them can be followed for the Homoptera, and these represent the best source for brief habitat data. The most recent detailed account of the biology of the British *Heteroptera* is that of Southwood and Leston (1959), while Savage (1989) gives data for aquatic *Heteroptera*. Miller (1956) gives an outline of the biology and families of *Heteroptera*, and Dolling (1991) reviews the biology of the *Hemiptera* as a whole.

Order Thysanoptera: thrips or thunderflies

Thrips are enormously common at the present day and often noted as contaminants in samples (e.g. one from the Dominican Priory, Beverley, Allison *et al*. 1996c). This is not surprising, since they land on people in large numbers, come into houses in abundance, and accumulations of thrips can be found in modern houses dead under wallpaper, in picture frames, and so on. They were probably common in buildings in the past too. It is, however, hard to tell modern specimens from ancient ones as they are so small and suspected to decay quickly, and the present author rarely feels confident enough to record the remains as ancient. Thrips have occasionally been noted as probable fossils, although they have not often been identified closely. A particular exception is the record from Bronze Age deposits at Thorne Moor, South Yorkshire, of the very distinctive *Megathrips lativentris* (Kenward 1979b). Overall, the group seems to have little potential in archaeology, although doubtless there will be rare exceptions to this.

Identification and biology. At least some progress should be made in naming thrips from archaeological samples using the illustrations and descriptions provided by Mound *et al*. (1976), but of course access to a reference collection and to expert advice will be necessary for secure identification. The same authors give a few notes on the biology of the group.

Order Megaloptera (Neuroptera): alder flies

Remains of the larvae of *Sialis* are not uncommon in freshwater deposits (e.g. Hughes *et al*. EAU 1998/26; Jaques *et al*. EAU 2002/04; Kenward *et al*. EAU 1998/23) and occasionally occur in more strictly archaeological associations. They are not of great interpretative importance beyond providing evidence of deposition in fairly clean water, although some species demand flowing water (e.g. Fryer and Murphy 1991, 286-7). Keys to adults are provided by Fraser (1959), and to larvae by Elliott *et al*. (1979) and Elliott (1996).

Order Coleoptera: beetles

Introduction

The Coleoptera are much the best studied group of insects (and indeed perhaps invertebrates) in archaeology. They have also been extensively exploited for climatic and ecological reconstruction (for bibliography up to 1990 see Buckland and Coope 1991; updated in electronic form by Buckland *et al.* 1997; http://www.bugs2000.org/qbib/qbibonline.html). They have been the object of most of the refinements of interpretation of archaeological insect remains developed over the past three decades (although the true bugs, *Hemiptera*, have sometimes been included with them). Elias (1994) gives a detailed account of the use of beetles in Quaternary palaeoecology, including archaeology; a shorter review is given (in a North American context) by Morgan and Morgan (1990), while Elias (2001) considers Coleoptera in the context of lake sediments. Much of Robinson's (2001) excellent review of insects as (archaeological) palaeoenvironmental indicators is primarily directed towards the beetles.

There are many species of beetles, probably several millions in the world and approaching 4000 in Britain. They have a huge ecological range, being found from the seashore to mountain tops, from deserts to lakes and there are few terrestrial habitats whose invertebrate communities lack beetles. They are variously predators, plant feeders, fungus eaters and scavengers; a few are even parasites.

Most work on 'fossil' Coleoptera has focussed on adults, but remains of larvae are very often present, and sometimes abundant. Larvae can be identified in many cases, and are a valuable source of information, especially since they are less likely to occur away from their habitats than the (often highly mobile) adults. Beetle larvae are considered in a separate section (below, p. 65).

Biology. Useful reviews of the biology of beetles are given by Crowson (1981) at a detailed synthetic level, and by Evans, G. (1975) and Harde and Hammond (1984) in more accessible terms. The last of these books is particularly recommended to the enquiring student, not least because it gives a large number of excellent colour illustrations of British (and some mainland European) beetles. Modern biological information about species is generally included in the identification manuals. Koch (1989-96) gives summaries of species' biology in central Europe. However, for detailed biological information about the entire habitat range of species sometimes needed to make sense of archaeological records it is necessary to consult a huge and diffuse literature.

Identification. A reference collection is essential, but as the quality of identification manuals improves so more remains can be named with passable confidence by using them. Examples of such excellent works include the more recent Royal Entomological Society Handbooks. Many groups which are common in archeological deposits include species which can only be reliably separated by the genitalia; the immensely abundant *Lathridius minutus* group represents a typical case (in the region considered here has been *L. pseudominutus* the species present whenever genitalia were recovered, e.g. at 16-22 Coppergate, Kenward and Hall 1995, 471). Sometimes, clues as to the identity of frequently-occurring 'types' of very difficult groups such as the Aleocharinae may be obtained when genitalia are recovered; this was the case for *Atheta deformis* at Coppergate (Kenward and Hall *op. cit.*, 559).

The principal identification work for British beetles (in addition to the incomplete series of Royal Entomological Society *Handbooks* and numerous keys to genera or species groups in journal papers) is Joy (1932, reprinted 1976), which has difficult keys relying far too much on vague and comparative characters, and its recent supplement (Hodge and Jones 1995). The five volumes and supplement of Fowler (Fowler 1887-1891; Fowler and Donisthorpe 1913) remain immensely useful if approached carefully since they give detailed descriptions of most species. Freude *et al.* (1964-1983 and supplements; Lohse and Lucht 1989-1994) provide keys to the central European beetles, and is an essential adjunct to the British works. Recourse is frequently needed to the various volumes dealing with Coleoptera in the *Fauna de France*, *Danmarks Fauna* and *Fauna Entomologica Scandinavica* series. The *Fauna of the USSR* volumes are occasionally of use, especially when considering prehistoric remains. It is generally possible to use the nomenclature of Kloet and Hincks (1977), although there are many minor changes, and substantial later revisions for some groups. Lucht (1987) is being followed by many workers, but the on-line checklist mentioned above will probably be adopted by British workers when it is complete.

Interpretation of archaeological beetles (and bugs)

The remains of adult beetles are fairly easy to identify with experience, patience and a good reference collection. This is reflected by the existence of very early lists of beetles from archaeological sites, such as that from Silchester (published by Amsden and Boone 1975), St Albans (Bradley 1958) and, in our area, those of Balfour-Brown (1954) from Star Carr and Kimmins (1954) from Stanwick, both North Yorkshire. It is also seen in the predominance of beetles in the list of insects from Pleistocene deposits published by Bell (1922). However, the creation of lists of names and estimated minimum numbers of individuals is only the beginning of the challenging process of extracting reliable archeological information. (It is worth noting here that bugs other than aphids and scale insects can usefully be regarded as honorary beetles for analytical purposes.)

Some of the problems involved in the interpretation of archaeological insect assemblages (meaning beetles and bugs!) were reviewed by Kenward (1978a, 2-8), who confronted the inadequacies of an approach in which a mosaic of ancient habitats was identified and quantified on the basis of the biology and abundance of the recorded species. It was noted that some habitats have many more species associated with them than others, that some species (typically small and associated with temporary habitats) are inherently much more abundant than others (often large and found in stable habitats), and that the limited understanding of the biology of most species, the unpredictability of species composition of short-lived insect communities (e.g. Hall *et al.* 1983b, 191-2), and the wide habitat range of many common species, all place great limitations on the accuracy of the direct approach to interpretation. In addition, it had been shown (Kenward 1975a; 1976a) that there was a 'background rain' of insects from considerable distances likely to become incorporated into developing archaeological deposits. This latter phenomenon was illustrated graphically some years later by studies of modern roof spaces, cellars and underfloor cavities (Kenward 1985a).

Solutions to these very real difficulties developed in stages over the succeeding twenty years. The use of groups of ecologically related species was discussed by Kenward (1978a, 5-6). Comparison with modern death assemblages was urged, and some examples of the value of such work were given (*loc. cit.*, 9-12); subsequent work, much of it unpublished, has amply demonstrated the value of modern comparanda (e.g. Hellqvist 2004 for wells and a stable floor; Hill 1989 for compost; Hill 1993; 1994 for woodland habitats; Kenward EAU 1984/06 for grazing-land soils; Andersson (1992) and Kenward *et al.* EAU 1984/15 for turf roofs of different kinds; Andersson (1992) for roofs; Lancaster 1995 and Kenward unpublished for nettlebeds; Lemdahl (1990) for water surfaces as insect traps; Smith 1998 for hay stores; Smith (1996a; 1996b; 2000b) for materials on farms including thatch and turf; Smith *et al.* (2005) for non-cereal thatch; Smith *et al.* 1999 for smoke-blackened thatch).

Some ecological groupings considered to be of value in archaeological interpretation were identified (they are considered in the next section). The importance of species present in very large numbers as potentially significant indicators as well as in obscuring assemblage characteristics was noted, the not entirely helpful term 'superabundants' being applied to them (Kenward 1978, 16). The analysis of the structure of death assemblages was shown to be effective in determining the degree of mixture of assemblages (*loc. cit.*, p. 16-26). Rank order curves (first used in archaeology, albeit only implicitly, by Osborne 1971, also adopted by Robinson 1984, and for molluscs by Evans and Williams 1991) and an index of diversity (alpha of Fisher *et al.* 1943) were employed for this purpose. Representative sample assemblages were analysed using the new methods, and the possibilities for further development considered.

Developments in the next few years were in two directions - the development of more satisfactory ways of analysing community structure and the refinement of ecological categorisation.

Community structure

Work on community structure has involved the attainment of a clearer view of the factors affecting diversity (e.g. Kenward and Large 1998b) and the introduction of cumulative frequency graphs (first used by Kenward *et al.* 1986b, 246 and fiche figs. 59-61, fuller exposition by Kenward and Large 1998b). Cumulative frequency graphs require more detailed consideration, best done by quoting from Kenward and Large (*op. cit.*): 'Cumulative frequency curves reveal the nature of unevenness in the distribution of numbers between taxa in a death assemblage. Such unevenness is normal in living populations in nature, with some taxa more abundant than others, and usually a few which are numerous and many which are rare. It is thus necessary to compare [graphs] between assemblages or, better, with some standard. The distribution of numbers between taxa predicted from the model which has come to be known as 'MacArthur's broken stick' (MacArthur 1957) has been adopted, and although it may not be theoretically sound (or fit living faunas, Lloyd and Ghelardi 1964) it has the persuasive merit of approximating to the distribution of numbers seen in archaeological assemblages believed to be of random 'background' origin (Kenward *et al.* 1986b, 246). The presence of breeding components (autochthones) in death assemblages is believed to be revealed by positive deviations in the lower ranks of abundance (i.e. the commonest species are 'too common'). Deviations can be judged from the raw plot, but are much more easily appreciated if a separate plot of deviations from the model is made. Cumulative frequency data for death assemblages, which have a variable number of taxa, can usefully be presented standardised on both axes, plotting proportions for the taxa (usually percentages) against rank corrected to centiles. This permits ready comparison between the curves (and deviation plots) for different assemblages, although this method of presentation still has limitations for comparison of assemblages where the total number of taxa differs greatly.'

Ecological categorisation of the Coleoptera

The most obvious way of introducing order and simplicity into the huge and complex data sets generated by large-scale studies of archaeological insects is by assigning species to ecological categories and dealing with these much simpler higher-level data. This process is made more difficult than might have been expected by the fact that some species seem to have undergone a radical change in habitat, not through evolution, it is believed, but because the range of habitats available to them has changed as a result of human activity. Kenward and Allison (1994c) have discussed this in the context of the development of urban faunas from rural origins, but the problem was recognised earlier, for example for *Ptenidium punctatum* and *Carpelimus bilineatus* by Hall *et al.* (1983b). Other species which are important in archaeology and which seem to have occupied habitats in the past which they no longer exploit to a significant extent include *Carpelimus fuliginosus* (Kenward and Hall 1995) and *Aglenus brunneus* (Kenward 1975b; 1976c). *Anotylus nitidulus* presents a special problem, see p. 155. However, the existence of problematic species should not be (and has not been) a deterrent to ecological coding, since the benefits to archaeological interpretation of the evidence are very great. Most of these species have been placed in a category on the basis of their archaeological associations and a very critical examination of modern information, much of it unpublished and supplied by the most experienced entomologists, whose field data often greatly exceed the published records.

Various schemes of ecological categorisation have been employed, with somewhat different (but generally complementary rather than contradictory) approaches. Kenward (1978a) used a limited number of groups, reflecting a bias towards the problems of occupation site assemblages: 'outdoor' species (subdivided into 'certain' and probable, coded 'A' and 'B' respectively); and aquatic and aquatic-marginal species. The report on Saxo-Norman tenements in Durham saw the addition of two categories of species exploiting decomposing matter, those associated primarily with dung and foul rotting matter, and those primarily associated with dryer plant remains (Kenward 1979d, fig. 28).

The preparation of the first report on a large number of insect assemblages, that dealing with two Anglo-Scandinavian sites in York (Hall *et al.* 1983b) lead to the formalisation of these categories and the introduction of an explicit coding system, with the outdoor groups being coded 'OA' and 'OB', the species associated with decaying matter assigned to 'foul' (Cw, for Compost, wet!) and 'dry' (Cd) groups, and the 'water and waterside' category split into aquatics/obligate waterside (W) and waterside/damp ground (D) groups. These same codes were used by Hall and Kenward (1980). In parallel with the study of the Anglo-Scandinavian sites an investigation was made into the possibility of detecting communities of insects in death assemblages (Kenward 1982), during which the decaying-matter component of assemblages was subdivided in a more practical tripartite way, into a broad general group of species associated with rotting matter in general, and much narrower 'foul' and 'dry' groups. This classification was experimented with by Hall *et al.* (1983b) and Kenward (1988a), who applied the codes 'Rf' and 'Rd' to the narrow groups, and Rt to all species associated with decaying matter (*including* Rd and Rf for good reasons, but to the confoundment of some workers adopting the scheme). This subdivision of decomposers has stood the test of time well and is likely to be retained, but perhaps will be marginalised by the use of more refined ecological groups such as 'house fauna' as a result of the analysis of species associations (Carrott and Kenward 2001; Kenward and Carrott 2006; see below). Further categories were subsequently defined (e.g. Kenward 1988a; Hall and Kenward 1990): species associated with wood or bark (L); with stored grain (G); with living plants (P) and with heathland/moorland vegetation and soils (M). Under the present system, lower case ecological codes are applied to taxa, and upper case ones to the groups, so that (for example) species coded 'rf', 'rd' and 'rt' contribute to the overall decomposer category 'RT'.

A small attempt to extend the routinely-employed categories was made with respect to the Roman fort at Ribchester, Lancashire, by Large *et al.* (EAU 1994/11; see also publication report, Carrott *et al.* 2000), with the tentative addition of the following: (1) decomposers which, when found together, are regarded as indicative of decaying matter with the consistency of uncompressed stable manure, coded 'ST' (ST is now used for 'typical synanthropes', however, so a new code is required if this stable manure grouping is to be employed!); (2) taxa regarded as part of the 'house fauna' community (HO; see also p. 372); (3) species typical of *very* foul material including dung (VF); (4) eurytopic decomposers (EU); (5) species probably occupying semi-natural habitats in areas disturbed by human activity (SN); and (6) species thought, in the light of other evidence from this and other sites, perhaps to have been introduced in cut vegetation (HA). It should be noted that these codes were devised for the analysis of the Ribchester assemblages only and, although promising in some respects, were not intended to have immediate general application. The divisions were only tentative and some species were assigned to them on the basis of experience with archaeological material, with the dangers consequent upon circular argument.

The house fauna group is considered in more detail on p. 372. It is not yet routinely estimated but could usefully be added. A recent development has been the addition of codes for synanthropes, that is species favoured by human activity (Kenward 1997a). Taxa have been assigned codes for degree of synanthropy as follows: 'sf' - facultative synanthrope, common in 'natural' habitats but clearly favoured by artificial ones; 'st' - particularly favoured by, and typical of, artificial habitats but believed to be able to survive in nature in the long term; 'ss' - strong synanthrope, essentially dependent on human activity for survival. These definitions only have local relevance, of course; a species which is a strong synanthrope in England may survive happily in the open further south. These synanthropes have been quantified by site to give corresponding categories (SF, ST, SS), and all have been summed to give the category 'SA'. Free-living phytophages and open-field dung beetles favoured by human activity (and thus synanthropic in the full sense) have been excluded, but would usefully be considered in separate categories. It is strongly emphasised that these codes are in many cases only a first guess which is currently subject to modification, but the use of synanthrope analysis appears promising (e.g. Kenward 1997a; and recent work on the Viborg, Denmark and Kaupang, Norway, sites, Kenward CHP 2005/04; 2005b; Hall and Kenward CHP 2003/03).

Further ecological groups which might be quantified include 'house fauna', 'hay' insects, and the 'foul mouldering' group (the last including *Cercyon atricapillus*, *Oxytelus sculptus*, *Leptacinus* species, *Anthicus formicarius*, and *Monotoma* species, see for example Hall and Kenward 1990, 358; Kenward and Hall 1997).

Other schemes of ecological coding for beetles have been published. Some have been based on those reviewed above (unfortunately misusing them in some cases) and some are too clumsy to use or not appropriate to intensive occupation deposits, but others represent substantial contributions, particularly to the problems of natural and semi-natural rural fauna. Smith (1996a; 1996b; and in Moffett and Smith 1996), for example, essentially followed Kenward's scheme, but incorporated 'house fauna' as an additional code, his graphical representation of the data being striking. Philip Buckland (ARCUS 208) used a system in which species were assigned codes for all their possible habitats, an approach which highlights the dangers of the assumptions made in other coding schemes, but whose disadvantages are illustrated by the consequent implication that 68% of a large assemblage may have originated in a granary, even though only one grain pest was present! Bain (1998) used a small number of high-level categories: pests, compost and dung dwellers, carrion beetles and mould and fungus feeders.

Robinson (1981b), noting some of the limitations of Kenward's 'new approach' (1978a), identified ten categories: aquatic, pasture/dung, probable meadowland, wood and trees, marsh/aquatic plants, bare ground/arable, dung/foul organic material, Lathridiidae (presumably indicative of dry litter), synanthropes, and species especially associated with structural timbers. In a later paper, Robinson (1983) concentrated on the use of insect assemblages in distinguishing arable from pastoral land use, relating the proportions of a large number of ecological groups indicative of land use to modern observations and to arable/pastoral indices used in pollen analysis (e.g. Turner 1964). Robinson (1991b) suggested that 10% or more dung beetles might be expected in assemblages from largely pastoral catchments, and substantially below this in arable land. This approach is evaluated on p. 333. The reports on insect remains from Mingies Ditch and Runnymede provide further examples of Robinson's methods (Allen and Robinson 1993; Robinson 1991b; the former represents a particularly elegant exposition of interpretation). In the North, Robinson used the scheme in interpretation of the insects from the fills of the medieval moat at Cowick, East Yorkshire (in Hayfield and Greig 1989, 8 ff.). In his report on Silbury Hill, Robinson (1997) has refined this ecological classification even further, and defined numbered 'species groups' (ecological categories); the most recent summary is given by Robinson (2003). A somewhat similar scheme, using categories very explicitly related to archaeological reconstruction, is used by Hellqvist (1999). This sort of approach seems to have considerable potential, and further investigation of modern deposits throughout Britain, together with synthesis of archaeological results, should enable substantial refinement of the use of insect remains in reconstructing both urban and rural environments.

Girling (1980) calculated the representation of various ecological groups in assemblages from a site in the Somerset Levels, but did not state which species were assigned to categories. Hill (1993), in a study concentrating particularly on woodland habitats, produced a further scheme with clear affinities to Robinson's, subdividing the fauna into the following categories: eurytopic (EUR); aquatic (AQU); synanthropic/urban (SYN); arable/disturbed ground (ARA); pasture/dung (PAS); marsh/fen (MAR); heath/moorland (HEA); decomposers/litter dwellers (LIT); associated with trees (TRE); true woodland species (WOO); and uncoded

(UNC). Woodlanders were further subdivided into predators, deadwood (saproxylic), phytophagous, bark beetles, fungus feeders, litter dwellers, ant associates and dung beetles; some of these categories may cause confusion, however (many deadwood species are fungus feeders, as are most bark beetles, for example).

Boswijk and Whitehouse (2002) used an ecological categorisation of natural habitats in which some groups (notably woodland and wetland) were broken down into much finer detail than in the schemes discussed above: this is a useful way forward, providing a way of observing subtle environmental changes.

Hakbijl (1989) used a system of considerable merit, notable for including categories reflecting the salinity of the environment, and for a wide range of groups related to gradations of moisture and to a range of substrata and 'microenvironments'. The principal difficulty in working with such a scheme is that few species can be at all reliably placed in many of the categories, and many span several; this is not to reject the approach out of hand, however.

It is obviously desirable that these systems should be unified and generally agreed codes be adopted, as long as this does not stifle new developments. Unfortunately, such a common coding will not appropriately be reached by using the published summaries, the eco-taxonomic system of Dibb (1947; 1948), or the Koch (1989-96) categories for the modern Central European fauna, although these are useful and at least not subject to personal whim. Koch's categories are perhaps too rigid, and the coding of some species is certainly open to argument, because they seem too narrow or arbitrary, because they appear applicable to Central Europe and not Britain, or because the communities of species in the past were different from those in existence today (see for example Kenward and Allison 1994c). There is no doubt that there is room for much improvement in ecological categorisation, both by bringing together elements of the existing schemes and by more objective work on archeological and modern species associations.

Other aspects of interpretation of Coleoptera assemblages

There have been developments in interpretation of insect remains at a more synthetic level. There has been fuller recognition of how changing abundance of species, and changes in communities, complicate interpretations (Kenward and Allison 1994c). Robinson's (1983) work on arable/pastoral indicators (p. 61) showed that progress was perhaps possible in the analysis of some aspects of whole landscapes. At the site level, statistics were compared graphically sample by sample and subjected to simple analyses by Hall *et al.* (1983b), at the level of period and phase by Hall and Kenward (1990) and by date, tenement and feature type by Kenward and Hall (1995); in each case considerable light was cast on the evolution and/or spatial differentiation of the site. Other lines of higher-level analysis include examination of the synanthropic fauna (e.g. Kenward and Allison 1994a; Allison *et al.* EAU 1999/08; forthcoming; Carrott *et al.* EAU 1997/16; Hall *et al.* EAU 1996/05; 2003c; Kenward 1997a; CHP 2005/04; 2006b; Kenward *et al.* EAU 1994/42; EAU 1996/06). This component of archaeological assemblages is discussed in more detail on p. 468.

Documentation of the arrival of alien insects in the British Isles through time, and in some periods perhaps their extinction, has the potential to provide a dating tool as well as having importance as a guide to the intensity of international trade and the mechanisms of internal distribution of commodities. The grain pests have special significance in this respect, but other strong synanthropes have potential, and informal synthesis is revealing patterns which may eventually provide significant information (e.g. the abundance of *Tipnus unicolor* in Roman York, compared with its apparent rarity in Carlisle at that time, see p. 378). The danger of circular argument has to be avoided if invertebrates are to be used as a dating tool, however!

Various attempts have been made to use multivariate statistics to group archaeological assemblages. Strudwick (1979) applied principal component analysis to the lists from the 6-8 Pavement site, York, but no useful groupings emerged, those which were generated appearing to be determined by random rare occurrences of (almost certainly) ecologically insignificant taxa. Discriminant analysis was used by Hill (1993, 62-74, 132-3), who constructed discriminant functions using the numbers of individuals in a series of ecological groups for modern assemblages classified as 'woodland' or 'non-woodland', then used the functions to classify assemblages from later Bronze Age deposits at St George's Field, York with some success. Discriminant analysis has the considerable advantage of attaching a probability to classifications.

Hoganson *et al.* (1989) grouped beetle assemblages from Monte Verde, Chile, using the Jaccard index and the near-identical Dice coefficient. Cluster analysis has been used by Perry (1981) for grouping assemblages from the Brigg 'raft', North Lincolnshire, by Perry *et al.* (1985) for the site of Stóraborg, Iceland and by Kenward (unpublished) for assemblages from Anglo-Scandinavian Coppergate, York and Roman Castle Street, Carlisle. This technique has generally produced a reasonable match with the impression gained by inspection of the raw data or derived statistics, or has grouped time periods or feature types moderately well, but cannot yet be said to have solved any major problems of interpretation. Part of the problem is that cluster analysis has been applied to sets of essentially similar data, and there is undoubtedly a consequent tendency for clustering to be affected by what are to an experienced worker simply ecologically insignificant random variations in abundance or presence-absence data. Filtering of the data to remove rare species and transformation to reduce the effect of large differences in numbers of individuals (inherently very variable) may lead to improvements. Setting the analysis of each site against a range of other sites must surely be helpful, even though handling data for the large numbers of assemblages involved may tax the computers easily available to workers in the field of environmental archaeology. Multivariate statistical analysis of biological data is a field in which even expert computer statisticians tread most carefully, and there is always a great danger that quite spurious results will be taken as meaningful by the uninitiated.

Other techniques applied to insect death assemblages include correspondence analysis (used by Cong and Ashworth 1997 and Carrott and Kenward unpublished), which appears to be a particularly promising method. The approaches taken in statistical work on snail assemblages (p. 82) are relevant here.

Perhaps of more potential than grouping assemblages is searching for consistent associations of species in archaeological death assemblages. This was first attempted in a very crude way by Kenward (1982; see also Hall *et al.* 1983b, 213), using limited data and a very simple (perhaps inappropriate) index of association. Species now regarded as 'house fauna' and some seen as indicators of foul conditions did, however, form clumps. Unpublished work by the author in the 1990s, using the dataset for Anglo-Scandinavian 16-22 Coppergate, York, showed some clear groups, and this approach was developed further by Carrott and Kenward (2001), who found a series of tightly-defined groups in the data set for Coppergate, using Spearman's Rank Order Correlation. This approach was developed further by Kenward and Carrott (2006), who used it to compare the fauna of a series of sites.

In the context of climatic reconstruction, the Mutual Climatic Range (MCR) method of Atkinson *et al.* (1986; 1987) must be mentioned. This represents the only significant published quantitative approach to the problem of turning lists of beetles into climatic data, previously essentially subjective, and appears to be very successful. (The very simple method employed by Hughes *et al.* 2000 was also successful, but MCR appears infinitely preferable when the appropriate data and software are available.) It has been employed subsequently by, among others, Walker *et al.* (1993a), who also applied it retrospectively to the important sites at Glanllynnau, north Wales (Coope and Brophy 1972) and St Bees, Cheshire (Coope and Joachim 1980), and Elias (1997), who used it to compare European and North American Late Glacial climate change. Latterly it has been used to reconstruct climatic patterns across Europe in the past (Coope and Lemdahl 1995; Coope *et al.* 1998; Witte *et al.* 1998), and for inter-hemispheric comparison (Oliveros *et al.* 1997). There is, however, a need to test the assumptions behind the MCR method (Ponel *et al.* 2003); a study of the relationship between distribution and climate in Britain showed that climatic variables were not always good predictors of present distribution (Eyre *et al.* 2005), while Andersen (1993) argued limitations of palaeoclimatic interpretations from insects (which were strongly refuted by Coope and Lemdahl (1996). A similar approach to MCR which is argued to be statistically more appropriate is advanced by Marra *et al.* (2004; 2006).

Finally, it is worth mentioning that there have been attempts to lighten the load of identification in studies of archaeological beetles by examining only representatives of selected groups. Speight (1970) suggested using the Carabidae (ground beetles), Silphidae (burying beetles), Scarabeidae (dung beetles and chafers) and Curculionidae (weevils) as 'indicator families', the first group defining broad aspects of ecology, the last providing evidence of the range of plants available near the point of deposition, and the other two flagging other important habitat types. More recently, Desender and Ervynck (1992) and Ervynck *et al.* (1994) have suggested the use of Carabidae alone. Kenward and Hall (1997) argue that this is not a viable approach, and indeed it flies in the face of experience, which has clearly shown the value of identifying the widest possible range of remains, and not just of beetles. This application of 'indicators' is of course normal in neoecology, especially in environmental monitoring (e.g. Niemi and McDonald 2004), where environmental variables to be measured are clearer and simple answers desirable. For archaeology, the 'indicator group' approach is likely to be far more effective (p. 467).

Beetle larvae

Beetle larvae represent a big gap in current studies of archaeological insects, although they are present in a substantial proportion of deposits where there are adults, and are sometimes numerous where adults are rare. From the interpretative point of view, larvae have advantage of (presumably) usually being found where they lived, though there may be rare cases of larval remains in bird droppings, and they may also have been imported in materials such as turf or hay.

Larvae of several beetle species were found in Anglo-Scandinavian deposits at 16-22 Coppergate, York (Kenward and Hall 1995, table 163), and included at least four elaterids, which in some cases may have been imported in moss, although it was suspected that others may have managed to gain a foothold on the site (e.g. *Melanotus erythropus* and *Athous haemorrhoidalis*, *loc. cit.*, 591). Other larvae, such as that of *Tenebrio obscurus* and *Blaps* sp. (p. 163) belonged to species recorded as adults and which certainly lived on the site, and in one case *Blaps* larvae and adults were discovered together (p. 206). Other Anglo-Scandinavian records from York include *?Hister* and *?Melanotus erythropus* from the Queens Hotel site, (Dobney *et al.* EAU 1993/22), and a larval segment of the 'bacon beetle' *Dermestes lardarius* from 41-49 Walmgate (Johnstone *et al.* EAU 2000/04). Outside out area, *Trox scaber* larvae have been recorded with the adults in 11th century deposits at Viborg, Denmark (Kenward CHP 2005/04; 2005).

Kenward *et al.* (AML 78/92; Kenward *et al.* 2000) reported that several of the samples from Roman deposits at Old Grapes Lane A, Carlisle, contained considerable numbers of abdominal apices of characteristic `wireworm' larvae of `click beetles' (Elateridae), represented by the characteristic abdominal apices. These were tentatively identified as *Denticollis linearis*, an identification confirmed by later work by A. Kroupa (1993). *D. linearis* has now been discovered at various sites, and some dozen Elateridae have now been recognised as larvae at a range of sites in northern England, Scotland and Northern Ireland, the most frequent (in addition to *D. linearis*) being *Melanotus erythropus*, *Athous haemorrhoidalis*, *Ctenicera cuprea*, and *Actenicerus sjaelandicus*. In some cases these larvae probably colonised *in situ*, but most of them seem likely to have been imported in turf or peat and thus be of considerable interpretative value; an excellent example is provided by the abundant *A. sjaelandicus* and *D. linearis* from Lewthwaites Lane, Carlisle (Kenward *et al.* AML 77/92; 2000; see also p. 319). In natural contexts, elaterid and other beetle larvae have been recorded from sites outside England, for example in peats in southern Finland by Koponen and Nuorteva (1973, 74).

Recovery and identification of larvae: Beetle larvae are recovered by routine paraffin flotation. They are generally not easy to identify, although there are exceptions such as the Elateridae mentioned above. For all groups, reference material is desirable but often hard to obtain, and it is necessary to rely on published illustrations to a large extent. Larvae are delicate and archaeological specimens have usually lost critical features, making their determination even more difficult than for modern examples. Nevertheless, as the identification manuals improve, so it becomes more likely that important results will be obtained by persistence in work on archaeological material, provided it is sensibly targeted. Until recently the most useful single work dealing with beetle larvae was Klausnitzer (1978), with much of the literature scattered in papers dealing with single or a few species, but recent publication of a series of volumes in the *Käfer mittleuropas* series has greatly improved matters (Klausnitzer 1991-1999). The larvae of Elateridae are particularly well served; Klausnitzer (1991-1999), Palm (1972) and Rudolph (1974) have been found especially useful. Where there is a possibility that species now extinct in western Europe may be present, Dolin (1978) may be consulted. Keys for archaeological elaterid larvae, using characters preserved on the abdominal apices, are provided by Kroupa (EAU 1993/03). The key to larvae of Dermestidae given by Peacock (1993) is especially useful for this group which includes economically-important forms such as carpet beetles and bacon beetles.

Order Siphonaptera *: fleas*

Fleas - admittedly those of cats and dogs, rather than of humans - are familiar to most people, and a minor scourge of those allergic to their bites. Only the adults are ectoparasitic, the maggot-like larvae feeding on organic matter which is not too dry, usually accumulated in the nest (or other habitual resting place) of the host. Allison and Kenward (1990) give a popular introduction to fleas in archaeology with special reference to York. Human fleas (*Pulex irritans*) are very frequently found, the earliest records from Europe dating to the Neolithic (Buckland and Saddler 1997) and Iron Age (Allison *et al.* EAU 1990/07; Hakbjil 1989; Smith *et al.* 2000; Tomlinson *et al.* 2002). They may occasionally be extremely abundant, for example in some internal deposits at 16-22 Coppergate (Kenward and Hall 1995). Dog fleas (*Ctenocephalides canis*) are known from a small number of British sites, but have only been found in abundance at the Magistrates' Courts site, Hull (Hall *et al.* EAU 2000/25; 2000/33) and at a site in The Brooks, Winchester (Carrott *et al.* EAU 1996/20). Two species of rat fleas have been found: *Nosopsyllus fasciatus* and *Ctenophthalmus nobilis* (both from Anglo-Scandinavian Coppergate, Kenward and Hall 1995, and the latter from Roman Tanner Row, Hall and Kenward 1990; there are also other records for these genera not identified to species). The only other flea recorded from archaeological deposits in the British isles appears to be the mole flea *Hystrichopsylla talpae* from the Deer Park Farms site, Northern Ireland (Allison *et al.* EAU 1999/08; 1999/10; Kenward *et al.* EAU 2000/57).

A conspicuous absentee from the roster of archaeological fleas is the plague flea *Xenopsylla cheopis*. This is disappointing, but perhaps unsurprising, since it was probably only an intermittent and short-lived colonist of the British Isles. Care should be taken not to overlook *X. cheopis*, which has a superficial resemblance to the human flea. Records of plague fleas at the time of the Black Death would be particularly important in view of recent controversy concerning the identity of the disease responsible for this episode. It has been generally assumed the Black Death was caused by the plague bacterium, *Yersinia pestis*, with fleas and rats as intermediaries in the bubonic phase, but with extensive transmission via human to human infection in a pneumonic phase. Recently, various authors have argued that the Black Death was not caused by *Yersinia*, principally on the evidence of its extraordinarily rapid spread, proportion of population killed, and rarity of rats (Cohn 2002a; b; Scott and Duncan 2001; Wood *et al.* 2003). Scott and Duncan (*loc. cit.*, 356-362) give twenty points of argument against the identification of the Black Death and other early plagues as bubonic. As early as 1986 Davis had remarked on the scarcity of rat remains associated with the Black Death, suggesting that the pneumonic form was important, and pointing out both that rodents are not essential to transmission and that buboes can occur in pneumonic plague. Oeding (1990) suggested that the rapid spread of plague in Norway must have been mainly pneumonic. The search for DNA of *Yersinia* in plague victims is an obvious way forward but has produced mixed results: Drancourt *et al.* (1998), Raoult *et al.* (2000) and Drancourt and Raoult (2002) report detection of DNA in the dental pulp of plague victims, including some from the Black Death, but Gilbert *et al.* (2004) failed to recover DNA and suggested that Drancourt *et al.*'s samples may have been contaminated by soil bacteria. Drancourt and Raoult (2002; 2004) cogently defended their results; it is clearly too soon to be sure of the implications of this DNA work. One possibility which might be considered in relation to rapid spread and the absence of *Yersinia* DNA in the North of Europe is the occurrence of a virulent but short-lived pneumonic form, a possibility relevant to modern disease control.

While there may be good reasons for the lack of records of plague fleas, it is far more difficult to explain the rarity of bird fleas, when we believe chickens were commonly kept around buildings on many sites, and a range of commensal birds must have nested in roofs and elsewhere. Records of fleas from archaeological sites in northern England are briefly reviewed on pp. 417 and 425.

The significance of relative numbers of fleas and lice as evidence of use of structures for domestic purposes rather than as workshops or for stabling has been discussed by Kenward and Hall (1995, 728), who argue that lice are more likely to occur in domestic structures, while fleas may be common in stables and workshops, although this approach may need to be modified in the light of data presented by Allison *et al.* (EAU 1999/08; 1999/10). Otherwise the importance of fleas lies in their role as potential disease vectors (p. 417).

Identification and biology. Considerable progress in identifying many fleas can be made using Smit (1957) and Séguy (1944) providing preservation is good, and especially if abdomens are recovered in addition to heads. It is uncertain how distinctive the other parts are, although thoracic sclerites appear to bear useful characters in some species. The use of reference material is, of course, strongly recommended; it is not difficult to build up a collection of common fleas relevant to archaeology (although human and plague fleas are hard to come by). The free-living larvae may well be present in archaeological deposits but are likely to be overlooked among the larvae of other groups.

Order Diptera: true flies

The Diptera are a huge group, with an enormously wide habitat range, some representatives of which are all too familiar to many people for their activities in biting, parasitising, or simply annoying, humans and livestock, in spreading disease, and in damaging crops. They are best known in archaeological deposits through the robust remains of their puparia (sing. puparium), the hardened skin of the last stage larva within which the pupa develops in many species, but remains of larvae, naked pupae and adults are common. Structures which appeared to be fly eggs have been recorded on at least one occasion (author, unpublished).

Fly puparia are present in at least small numbers in almost all archaeological samples with any insect preservation. Attempts to identify them were made early in the development of modern environmental archaeology (e.g. Buckland 1976a; Buckland *et al.* 1974), and these and subsequent larger-scale studies (e.g. work by the late John Phipps, reported by Kenward and Hall 1995; and by P. Skidmore for many sites) have clearly shown the value of such remains. The potential of fly remains in archaeology is argued by Panagiotakopulu (2004a), using sites in Greenland as case studies. A handful of specialists are knowable to name an increasingly large proportion of specimens, but routine identification of fly puparia is still not possible within normal project budgets.

Puparia may still contain the unemerged remains of the adult fly, greatly facilitating identification. 'Hatched' puparia indicate successful development, while unemerged ones may indicate change of conditions, or sudden burial (first pointed out by Buckland *et al.* 1974; see also Kenward and Hall 1995). Methods for interpretation of fly puparia have advanced considerably recently, for example in the use of ecological groupings for material from Greenland by Buckland *et al.* (1996).

Because flies are under-utilised, the main groups found in archaeological deposits are outlined here. The more primitive flies (Nematocera) do not produce puparia but may be represented by other remains, and these may prove to have great potential. Larvae and pupae of nematoceran flies may be very abundant in both natural and occupation deposits. Psychodidae (moth flies, sewage flies) are sometimes recorded as wings of adults (e.g. Kenward and Hall 1995, 490), while Buckland (1976a, 13) gives records of abundant pupae, identified at least tentatively to genus, from the Roman sewer in Church Street, York.

The Chironomidae, the non-biting midges, are frequently represented in archaeological and natural deposits alike by their larvae, particularly the head capsules, and have been used in studies of lake and other sediments: see e.g. Frey (1964) for a review of early work, and Bryce (1962), Hofmann (1986; 1988), Sadler and Jones (1997), and Walker (1987; 2001) for more recent references. Saddler and Jones gave an extensive bibliography, but new studies appear frequently. Chironomids are important in environmental monitoring and their communities have been shown to be related to lake typology and water status (e.g. Brodin 1990; Kansanen *et al.* 1984). More recently their value in climatic reconstruction has been appreciated (e.g. Andreev *et al.* 2005; Brooks 1997; Brooks and Birks 2000; Brooks *et al.* 1997a-b; Heiri and Millet 2005; Walker 2001; Walker and Mathewes 1989a-b; Walker *et al.* 1991), while Ruiz *et al.* (2003) have begun to evaluate their use in occupation-site archaeology. Kurek *et al.* (2004) suggested that chironomids (and other 'midges') had limited value in tracking relatively brief small-scale climactic variations, and a similar conclusion was drawn by Rosen *et al.* (2003), while Langdon *et al.* (2004) argue that chironomid successions from lakes reflect climate more reliably than those from bogs, the former representing an environment buffered against local environmental perturbations such as pH change. They may also have value in determining salinity (Walker 1987; 2001).

Work on fossils in the area considered in this review has included Harmsworth (1968), who used them in a study of the development of Blelham Tarn, Bryce (1962) for Malham Tarn, Bedford *et al.* (2004) for the Late Glacial of Hawes Water, and Langdon *et al.* (2004) for Talkin Tarn; the last study showed significant temperature variations in the later Holocene. Chironomids are important indicators of water quality (e.g. Pinder and Morley 1995, who examined chironomids of Cumbrian tarns).

Fryer and Murphy (1991, 305, 12) give an accessible introduction to these ubiquitous chironomid flies, emphasising their importance in freshwater ecology. Extraction methods for lake sediments are discussed by Walker and Paterson (1985) and methodology reviewed by Hofmann (1986; 1988). Chironomid remains are often recovered from archaeological deposits by paraffin floatation. Bryce and Hobart (1972) give keys to the larvae of British chironomids, as well as a brief review of the biology of the family, and the larvae of the subfamily Orthocladiinae are keyed by Cranston (1982). Brooks *et al.* (1997, 162) give references to other sources for identification.

Remains suspected to be of the aquatic larvae and pupae of Culicidae, the family containing the mosquitos, have occasionally been observed, but not recorded as such, by the writer. Specific identification of such remains is clearly desirable in view of their nuisance value and the ability of Anopheles species to transmit malaria. Keys to adults, larvae and pupae of culicids, as well as notes on the ecology and medial importance of the group, are given by Cranston *et al.* (1987); some progress in identification may be possible where preservation is excellent. Another group of 'biting' flies with aquatic larvae, the Ceratopogonidae ('no-see-ums' in North America) may be found and prove useful if sufficient energy is put into identification. A recent study by Ilyashuk *et al.* (2005) employed chironomids together with midges of the families Chaoboridae and Ceratopogonidae in a study of Holocene climate in northern Russia. Blackflies (Simuliidae) are a serious pest in some areas. Their use in palaeoecology is discussed by Currie and Walker (1992), and Crosskey and Taylor (1986) give records from Pleistocene deposits in Norfolk. The larval, pupal and adult stages of the simuliids are keyed by Davies (1968). The palaeoecological use of Chaoboridae, Ceratopogonidae, Simuliidae and Culicidae collectively is reviewed by Walker (2001), who gives numerous references.

Respiratory processes of the larvae of certain hoverflies (Syrphidae, tribe Eristalini) are very distinctive, particularly in the genera Eristalis and its relatives (entire larvae are illustrated, for example, by K. Smith 1989, 193). The respiratory processes - the subject of considerable perplexity when first found at York (e.g. Anon 1985; Hakbijl and Phipps 1988) - are quite common in archaeological deposits, with records from over 90 contexts from Anglo-Scandinavian 16-22 Coppergate, for example (Hall and Kenward 2002; Kenward and Hall 1995, 490, 747). The material from Coppergate was recorded before these structures had been fully identified, and while only one example was confirmed as the common 'rat-tailed maggot' larva of *Eristalis tenax*, most or all of the remains were perhaps of this species. These flies are of some significance as indicators, since the larvae can tolerate extreme pollution. They may be preserved by mineral replacement in deposits where other invertebrates have decayed, for example in Roman or Romano-British deposits at the Layerthorpe Bridge site, York, where they were almost the only invertebrates in a layer considered to have been faecal on botanical grounds (Hall *et al.* EAU 2000/64).

The remains of adult Bibionidae (St Mark's fly and its relatives) are often noted, including the characteristic male tibiae large spurs, which have a remarkably robust and beetle-like appearance, resembling caricatures of certain chafer tibiae (see, for example, Freeman and Lane 1985, 52). These flies are often abundant in flight in Spring, especially in grassland. The larvae live in soil and decaying matter. Archaeological cranefly (Tipulidae) larvae and pupae have occasionally been noted by the writer, but no attempt was made to identify them further. Cranefly larvae live in soil, decaying wood and in detritus in water and they may occasionally prove to be useful ecological indicators.

Remains of fruit flies (Drosophilidae) are sometimes found (e.g. Drosophila melanogaster from 6-8 Pavement, York, Erzinclioglu and Phipps 1983). If abundant they would be useful ecological indicators.

Musca domestica (Family Muscidae), the 'housefly', though not the species typically found in modern houses, is among the more frequently occurring puparia, and is fortunately fairly distinctive. It was first identified in substantial numbers from one deposit at the Anglo-Scandinavian site at 6-8 Pavement, York (Buckland *et al.* 1974), and has subsequently been recorded as abundant at, for example, 16-22 Coppergate and Tanner Row, York (Kenward and Hall 1995, Hall and Kenward 1990). *M. domestica* is regarded as requiring actively fermenting dung-like material, and is thus of considerable value as an indicator species. At Coppergate it was largely confined to surface deposits, indicating local concentrations of foul matter not detected by the beetles (Kenward and Hall 1995, 677). The stable fly *Stomoxys calcitrans* (also Muscidae) is another indicator of warm, quite foul, decaying organic matter. It, too, was first noted from 6-8 Pavement, and has been recorded fairly often since. It was common at Coppergate, and occasionally abundant; like *M. domestica* it was generally found in surface-deposited layers (Kenward and Hall 1995, 677). *Muscina* spp., many of them probably *M. stabulans*, have been reported from several sites, notably Coppergate.

Other frequently recorded puparia include *Fannia* spp. (Fanniidae), *Nemopoda* (Sepsidae), Paregle (Anthomyidae), and *Tephroclamys* (Heliomyzidae). *T. ?rufiventris* was abundant in one layer at 6-8 Pavement (Buckland *et al.* 1974), while *T. tarsalis* was noted from at least ten contexts at Coppergate.

The family Sphaeroceridae is very important in archaeological deposits, especially in pit fills. Identification to species is generally difficult, but has sometimes been achieved, although most records are to genus at best (e.g. 131 contexts for *Leptocera* sp. at Coppergate). *Thoracochaeta zosterae* is one of the most frequently recognised puparia and may be immensely abundant (e.g. at Broadgate, London, Kenward and Carrott EAU 2001/32); it is generally found in pit fills (e.g. Kenward and Hall 1995, 593, 677), including latrines (e.g. at Sammy's Point, Hull, Carrott *et al.* EAU 1997/21), but sometimes in dumps (e.g. in a mid to late 2nd century stable manure association, Tanner Row, Hall and Kenward 1990, 353). In the latter case a large proportion of the flies had not emerged, perhaps as a result of unsuitable conditions such as drying, although they may simply have been sealed by rapid dumping. This species has been subject to long-standing nomenclatural confusion, discussed by Belshaw (1989). On the basis of its modern biology it is not the most likely fly to be found in abundance in archaeological deposits; it is typically found in seaweed. Presumably conditions in some foul deposits on occupation sites in the past were somehow especially favourable for it (e.g. Kenward and Hall 1995, 593, 747). It has been shown isotopically that the *T. zosterae* exploited terrestrial organic material and had not been imported with seaweed (Webb *et al.* 1998). Various other sphaerocerids have been identified from time to time (e.g. Kenward and Hall 1995, 746), but it is much too soon to try to see a pattern in the data.

The sheep ked *Melophagus ovinus* (family Hippoboscidae), whose puparia and wingless adults are frequently noted in small numbers, is discussed on p. 363 in the context of wool preparation. It was present in at least 185 Anglo-Scandinavian contexts at 16-22 Coppergate (Hall and Kenward 2002; Kenward and Hall 1995, 491, 775-7). Care must be taken not to miss similar puparia of other related parasites, with hosts including bats and deer (Hutson 1984); only the deer fly *Lipoptena cervi* (p. 429) has been found so far.

The larvae of certain flies burrow in the flesh of vertebrates: myiasis. The term ' myiasis' is defined by Zumpt (1965), in a review of the topic covering the Old World, as ' the infestation of live ... vertebrate animals with dipterous larvae, which, at least for a certain period, feed on the host's dead or living tissue, liquid body-substances, or ingested food'. Myiasis-producing flies infest a very wide range of hosts, including domestic animals, but the more specialised myiasis-causers have rarely, if ever, been recorded from archaeological deposits; they may well have been overlooked since so little systematic work has been carried out on fly puparia. Some facultative myiasis-producers have been recorded (*Musca domestica*, *Muscina stabulans*, *Stomoxys calcitrans*, and others, see Zumpt 1965, 238 for modern cases), but seem far more likely to have lived in decaying matter than to have been parasitic. Medical uses of such flies are discussed on p. 313.

Flies are important in forensic science, a discipline obviously closely related to archaeology. Smith (1986) discusses this topic, while flies in archaeological burials are considered on p. 435.

Recovery and identification: Puparia are not always extracted very efficiently by paraffin floatation (p. 47), presumably as a result of their cuticular characteristics, although enough normally float to warn of their presence and provide a representative sample. Identification is very time-consuming, requiring dissection, chemical preparation and often slide-mounting, but, as mentioned above, is moving forward. Many puparia seemingly cannot be identified unless they contain unemerged adults (P. Skidmore, personal communication). Fly puparia, like the mites, represent an open field for talented researchers wishing to make a mark in environmental archaeology, and a great deal of information would undoubtedly be obtained from them, particularly when beetles are rare or are clearly not autochthonous, for it is reasonable to assume that the immature stages are likely to be found not too far from where they developed. They may also be important as indicators of localised (patchy) habitats such as rotting flesh or faeces in areas otherwise relatively clean or even completely devoid of habitats for insects. Starting points for the identification of puparia (and other fly immatures) include Phipps (1983), Skidmore (1979), and K. Smith (1989), the last of these giving a general introduction to the immature stages and their biology. Beyond this, one is largely thrown onto journal papers dealing with particular species or genera, and of course reference collections. As regards nomenclature, the checklist of Kloet and Hincks (1975) is mostly still largely workable, although there are very substantial later revisions for some groups (given in the relevant Royal Entomological Society *Handbooks*). The biology of flies is introduced by Colyer and Hammond (1968), Oldroyd (1964), K. Smith (1989) and Stubbs and Chandler (1978). Skidmore (1985) reviewed the biology of the Muscidae, a group of particular interest in archaeology, but for most groups such detailed biological data as exist are scattered through a diffuse literature.

Order Lepidoptera: butterflies and moths

Larval head capsules, shrivelled larvae, and chrysalides (particularly the posterior end, bearing hooks) of Lepidoptera have occasionally been noted from archaeological deposits (e.g. Hellqvist and Lemdahl 1996; Kenward unpublished), although only one seems to have been identified further (a garden tiger moth, *Arctia caja*, pupa from Roman St Albans, Bradley 1958). Cocoons, too, have been found ('waterlogged': Allison and Kenward unpublished; mineralised, from Thera: Panagiotakopulu 2000; Panagiotakopulu *et al.* 1997). Bradley (*loc. cit.*) also notes well preserved scales of adult Lepidoptera. Some stored products and domestic species (mostly in the families Pyralidae and Tineidae, Mound 1989; Munro 1966) may prove to be of archaeological importance if found in significant numbers, but considerable time and patience will be needed to identify the remains, whether as adults or larvae. Silk-producers, too, will be of interest (p. 362). Lepidoptera are extremely well served with identification manuals in the literature, but how useful these will be for archaeological fragments is not certain. Illustrations of the modifications to host plants caused by moth larvae (and which might be seen in archaeological material) are provided by, for example, Bradley *et al.* (1973; 1979).

Order Trichoptera*: caddis flies*

Caddis have aquatic larvae and rather moth-like adults. Both have been found as fossils in archaeological deposits. The immature stages have considerable interpretative potential as they are good indicators of water quality and substratum. Many of the larvae produce cases constructed from plant or mineral material, and these are sometimes recovered from archaeological and natural deposits; an early record for the region was given by Kimmins (1954), for example.

Caddis are probably under-recorded in archaeological deposits, larvae perhaps often being noted simply as 'insect larvae'. The cases are often not extracted by paraffin floatation, and consequently overlooked; they are certainly sufficiently characteristic to be recorded in botanical reports (e.g. Huntley DEAR 28/96), but unfortunately may be reported just as 'caddis', rather than cases. These insects are rather common in waterlain deposits as larvae, and sometimes fragments of adult wings are noted. Immatures have been used to good effect alongside beetles in ecological reconstructions.

Caddis have sometimes been noted as present in The North but not identified further, for example in assessment of prehistoric fen deposits at Skipsea, East Yorks by Carrott *et al.* (EAU 1994/37); in Anglian pits at The Bedern, York (Kenward *et al.* 1986b, 273), where identification might have been helpful in understanding the rather enigmatic fills; by Hall and Kenward (1990, 338-9, 389) from Roman deposits at Tanner Row, York, where there was a substantial number of records, though of small quantities (most being recorded during botanical analysis of paraffin residues); and in some abundance in Iron Age pits at North Cave, East Yorkshire (Allison *et al.* EAU 1997/37; forthcoming a).

There have been more detailed studies. In the area under consideration, Wilkinson (in Girling 1985b; 1986) found caddis larvae in peat taken from around the Lindow II bog body. There were small numbers of larvae of two *Limnephilus* species and a characteristic, repeatedly recorded but as yet unidentified species. Some identifications, one specific, of caddis cases and adult wing fragments were made by Hill (1993) for later Bronze Age deposits at St George's Field, York. Wilkinson and Clapham (1996) published records of specifically identified caddis cases from a peat core in the Lake District, suggesting that such fossils were generally rare, not the experience of the current reviewer. Further work in the Lake District was published by Wilkinson (1981).

On the fringe of the area considered here, the history of the Late-glacial River Trent was traced using caddis by Greenwood *et al.* (2003).

From a more strictly archaeological context, Wilkinson (1989) provided a list of caddis from the medieval moat at Cowick, East Yorkshire, and the records contributed substantially to the reconstruction of developing ecological conditions in the moat. It is necessary to look outside northern England for examples of fuller and more useful work on the group (see for example Wilkinson 1987). The value of these remains in palaeoecology, including problems of interpretation, was discussed by Williams (1988; 1989).

Recovery and identification: Larval and adult fragments are extracted by paraffin floatation. Cases may float, but mostly remain in the residue, which therefore must be sorted to recover them. The identification of larval remains is possible, but not easy. Williams (1988) offers an introduction to identification of fossils; modern larvae are considered by Hickin (1967), Edington and Hildrew (1995) and Wallace *et al.* (2003). A key to adults is provided by Macan (1973); reference material would be essential. Cases will not be reliably identifiable, though an experienced worker may recognise characteristic forms.

Order Hymenoptera*: bees, wasps and ants*

Remains of a wide variety of Hymenoptera are often recorded from archaeological deposits, and certain groups are sometimes abundant. Most are, however, very hard to identify even from modern material, and very little effort has been made to achieve a systematic records of most groups.

Parasitica (**parasitic wasps**, including ichneumons) are common but rarely identifiable, although remains believed to be *Spalangia*, a genus parasitic on flies, have sometimes been noted. At Chapel Lane Staith, Hull (Kenward 1979c) one early mid-14th century dump behind the waterfront revetment gave abundant remains of this genus, while it was fairly often recorded in Anglo-Scandinavian layers at 16-22 Coppergate, York. Various small Parasitica can be recognised as chalcids (Chalcidoidea), proctotrupids (Proctotrupoidea), or braconids or ichneumonids (Ichneumonoidea). It would be interesting to try to identify these and other parasitic wasps further and to attempt to determine whether their occurrence is correlated with that of any particular species of fly puparia, but their contribution to archaeological interpretation is likely to be limited.

Secondary evidence of Hymenopteran parasites is fairly often encountered in the form of exit holes in puparia, aphids and bug nymphs, and occasionally the adults are found within the remains of the host.

Ants (Formicidae) are reasonably easily identified, as exemplified by the abundant and varied ants from a medieval site in Oslo (Kenward 1988a, identifications by Dr. M. Robinson), Barton's Court, Runnymede and Mingies Ditch (Robinson 1984, Fiche 9:D2; 1991b; Allen and Robinson 1993). They have not often been identified to species in northern sites, for they are usually (and perhaps surprisingly bearing in mind their abundance in modern communities) only present in small numbers and thus of doubtful ecological significance. Remains of ants have potential in identifying imported materials, particularly turf, and this was suspected for the 16-22 Pavement site in York (Buckland *et al.* 1974). A reference collection is necessary for identification of ants, although some progress can be made using the key of Boulton and Collingwood (1975). The biology of the British ants is summarised in a *New Naturalist* volume by Brian (1977).

Bees (Apoidea): The honey bee, *Apis mellifera*, is sometimes recorded in small numbers from archaeological deposits in the north of England (e.g. from a medieval/post-medieval pond at Fazakerley, Merseyside, Hall *et al.* EAU 1996/05), and from one site in much larger numbers, namely from two Anglo-Scandinavian layers at 16-22 Coppergate, York (Kenward and Hall 1995). Abundant bees have also been noted in medieval deposits in Oslo

(Kenward 1988a) and in 5th-7th century deposits in Germany (Goetze 1939). The widely referenced skep (beehive) from 16-22 Coppergate is probably mythical (Kenward 1991), although there is at least one authentic record of a skep from Feddersen Werde, NW Germany (Ruttner 1979; 1981). The role of bees in archaeology is reviewed by Crane (1988), and archaeological records in Britain reviewed by Kenward (2005a); they are considered as an economic resource on p. 358.

Insect eggs

Structures resembling insect eggs are occasionally noticed in flots (even if not assiduously recorded), and smaller remains are doubtless lost through the sieve meshes. Egg cases (oothecae, as opposed to single eggs), for example those of cockroaches, are also preservable and at least some are identifiable. An ootheca of the free-living cockroach *Ectobius silvestris* Poda from peat deposits in southern Finland is illustrated by Koponen and Nuorteva (1973, 40), for example, and a record of a desiccated example from an Egyptian mummy of the Roman period in the Manchester Museum is given by Curry (1979).

Many insect eggs are extremely distinctive (e.g. Hinton 1970) - those of the butterflies and some moths being well known (e.g. the sketches given by Sandars 1939), but many other groups showing similar diversity. Many less familiar eggs can probably be closely identified. Brumpt (1936) illustrates a range of mosquito eggs, giving the impression that they are extremely distinctive at the species level in this group with considerable impact on humans. Eggs of a group of flies likely to be found in archaeological deposits, the lesser dung flies (Sphaeroceridae) also seem to be very species-distinctive (Pitkin 1988). Some others may be distinctive when fresh but include gelatinous material which may rot away in ancient material (e.g. dixid flies, Goldie-Smith and Thorpe 1991). The varied eggs of bugs (*Hemiptera*) are illustrated by Miller (1956) and Cobben (1968).

Insect products

Several insect products may be recognised in archaeological deposits. Honey, beeswax and other waxes are discussed in the thematic section (p. 358). Cochineal is mentioned on p. 359, lac on p. 362 and silk on p. 362. Other secondary evidence of insects (e.g. burrows) is considered on p. 92.

Class Arachnida: spiders, mites and their relatives

Order Aranae: spiders

Remains of spiders, large and small, are often noted in small numbers, and Girling (nd) produced a preliminary key for the identification of archaeological material. Identification to species, and sometimes even to genus, is very difficult from fossil material, however, and spiders seem rarely likely to produce archeologically useful information. Identification manuals are provided by Lockett and Millidge (1951-1953), Locket *et al.* (1974), and Roberts (1993; 1995). A reference collection would be essential. From the biological point of view it may be worth trying to determine which species are aliens and when they became established in Britain. *Theridon tepidariorum*, for example, is said by Bristowe (1958) to have been imported 'from some warmer country': can it be found fossil? Spider biology is introduced most entertainingly by Bristowe; summaries are included in Roberts (1993; 1995).

Order Acari*na: Mites*

Mites - almost always Oribatida (= Oribatei, Cryptostigmata) - are very frequently recorded in archeological assemblages. They were, for example, present in at least three-quarters of the samples from Anglo-Scandinavian 16-22 Coppergate, and numerous in almost half (Hall and Kenward 2002). Often a wide range of morphological types can be seen. Although there are early archaeological lists (e.g. Bradley 1958), mites are probably often unrecorded even though present; they tend to be overlooked, perhaps simply because they are always there (Kenward 1992 discusses psychology of this phenomenon). However, mites are very rarely studied in detail despite their amply demonstrated value in archaeology (Denford 1978; 1979; 1980; Schelvis 1987;1990a-b; 1991b; 1992; 1997a; 2000). Their application to natural deposits dates back to Nordenskiöld (1901) and Knülle (1957), with a mention by Frey (1964), but most studies have been much more recent (e.g. Erickson 1988; Haarløv 1967; Karppinen and Koponen 1973; Karppinen *et al.* 1979; Krivolutsky and Druk 1986; Markkula 1986; Schelvis and van Geel 1989). A review of the use of oribatid mites from natural deposits, with an emphasis on lake sediments, is given by Solhøy (2001).

The mites include stored products and other synanthropic species (e.g. Munro 1966), exploit a very wide range of identifiable natural and semi-natural habitats, and are also important in medicine and veterinary science (reviewed by Fuller 1956). Schelvis (1990b) put forward a scheme of ecological categorisation for mites. They appear to be of value in identifying dung, and perhaps the species producing it (Schelvis 1994a), plant host species (Schelvis 1989) and salinity, including marine incursions (Schelvis 1989; 1997b; 2000). It has been argued that most mite remains will represent the fauna of the immediate surroundings (e.g. Erickson 1988), though Schelvis (2000) correctly points out that mites may naturally move considerable distance in a number of ways and, of course, like insects, they are particularly liable to be carried with resources of various kinds. Guerra *et al.* (2003) describe numerous mites from coprolites from northeast Brazil, perhaps not a promising source in northern Europe.

The principal reason for mites having been largely ignored is that they are very difficult to identify, requiring a great deal of experience, a natural talent for difficult taxonomic work, and familiarity with a range of languages. The only studies of archaeological mites in the region considered here known to reviewer are by Denford, who recorded Acari from six samples from Roman well fills at Skeldergate (1980) and produced a manuscript list from Tullie House, Carlisle, and Schelvis (unpublished), who examined a single sample from Pavement, both sites in York. In each case the potential value of work on mites in British archaeological deposits was amply demonstrated.

The various groups of mites show very different preservational properties, with oribatids much the best represented as fossils; Krivolutskii and Druk (1986) ascribe this to their more robust cuticles, noting that the less strongly sclerotised forms survive less well.

A general introduction to the terrestrial mites is given by G. Evans *et al.* (1961), whose account of their anatomy, overall classification and biology is essential.

Ixodidae - ticks - are specialised mites adapted to a 'parasitic' way of life. The most commonly encountered species at the present day is *Ixodes ricinus*, and this, the sheep tick, has been recorded from Anglo-Scandinavian deposits at 16-22 Coppergate (Kenward and Hall 1995). There are numerous records of I. ricinus adults and nymphs from the Early Christian site at Deer Park Farms, Antrim (Allison *et al.* EAU 1999/08; 1999/10; Kenward and Allison 1994a). Like most ticks, it has a wide range of hosts (Hillyard 1996).

Extraction and identification: Paraffin floatation (p. 47) works well in extracting mites (Erickson 1988; Schelvis 1987), but other methods have been used (e.g. Solhøy 2001). There are no systematic keys to the British mites as a whole (or those from any other region of Europe), and in general it is necessary to refer to revisions of small groups of species, and to employ reference material. Balogh and Balogh (1992) give a key to world genera of oribatids. Green and Macquitty (1978) give keys to Halicarid mites, which are marine and freshwater forms; it is not certain whether these are likely to be important in archaeological deposits. The biology of these animals is generally poorly known. British ticks are reviewed by Arthur (1963), while Hillyard (1996) provides keys to north-west European species; both have illustrations which should enable some progress to be made with archaeological material. Larval ticks found on small mammals in Britain are keyed by Snow (1978). There is no check list to the British mites.

Order Pseudoscorpiones: false scorpions

The remains of false scorpions (usually carapaces and chelicerae) are rather often noted in very small numbers, though they do not appear to have been identified to species; they are unlikely to have more than marginal value in archaeology.

Methods, identification and biology: False scorpions are extracted with insect remains using paraffin floatation. A general introduction to the group and a key to the British species is provided by Legg and Jones (1988); it may allow some progress in identifying archaeological remains, but resort to reference material will be necessary.

Order Opiliones: harvestmen, daddy-long-legs

These familiar animals are also quite often noted in archaeological deposits, although records have rarely been published. Their interpretative value will probably be small.

Extraction and identification: Harvestmen are retrieved by paraffin floatation. The British species are keyed by Sankey and Savory (1974), but reference material will be necessary for some species at least. These authors also give a brief introduction to the biology of the group. (Note that flying 'daddy long legs' are actually crane-flies, Tipulidae: a classic illustration of the dangers of using common names.)

Pycnogonids (Class Pycnogonida), sea spiders, are uncommon, stick-insect like marine forms, hardly likely to be found except by chance in archaeological deposits, and only mentioned here because they are so characteristic. Keys to British species, which are small, are given by King (1974) and King and Crapp (1971); identification is likely to be challenging unless critical parts are recovered. Remains of scorpions (Scorpionida) are known from some parts of the world (Elias 1994, 53-54). Although there are no native species, scorpions from the Mediterranean region might have been imported accidentally, and warmer climates may conceivably have allowed the small southern European species to live in Britain in the past (at least one is currently established locally in Southern England).

Phylum Mollusca: molluscs, including chitons, snails, slugs, shellfish and cephalopods

Most people are familiar with at least some kinds of molluscs, as food, as garden pests, as decorations, on the sea shore, or stuck into the bars of bird cages. They are of considerable archaeological importance, in some cases - a variety of large species - because they were used by people, and in other cases - most non-marine species - because they were *not* used, and are therefore good ecological indicators. On a world scale, molluscs have found uses as food, medicine, trade tokens, tools, musical instruments, personal adornments, raw materials for art, craft and industry, as decorations to buildings and monuments, and in addition they have been collectors' items for centuries. Mollusc exploitation is discussed in an archaeological context by Evans (1969c), while Claassen (1998) gives a recent review of molluscs in archaeology, notable for its approach to human social questions in addition to 'environmental' ones.

Marine and terrestrial (including freshwater) molluscs are used by bioarchaeologists for very different purposes and are best considered separately, rather than adopting the taxonomic approach used here for other groups. (There is a slight merging of marine and freshwater species in estuaries, but this not a problem as long as they are included in both ecological categories.) Most molluscs have hard, calcareous shells, usually external but occasionally buried within the flesh, which are easily preserved under a range of conditions but lost in acid deposits and apparently easily leached by rainwater (see below). The preservability of the hard parts of squids and their allies is uncertain (see below), while some slugs and sea-slugs have internal shells. Most mollusc shells are immediately recognisable as belonging to the group, but a few are highly modified. Among these, slug 'granules' and the rather grotesque shells of shipworms (Teredinidae, illustrated by Hayward et al. 1996, 261) are the most likely to be met with by archaeologists (although the author has encountered no records of the latter during this review). Chiton (Polyplacophora) plates have been reported from the Americas (Bird 1943, 210; G. Campbell in lit. 2003; R. Greenspan in lit. 2003); they show characteristic sculpture according to Jones and Baxter (1987). Barnacles are *not* molluscs, but highly modified crustaceans (p. 35).

The reader is referred to Peter Murphy's excellent introduction to molluscs in his review for the Midlands and East of England (CAR 68/2001).

Terrestrial and freshwater ('non-marine') molluscs

Non-marine molluscs provide ecological, and to an extent climatic, information from deposits in which no other invertebrates are preserved in quantity; they provide an invaluable complement to insects in this respect, although reflecting a much narrower range of habitats. There has been an unfortunate schism between works on terrestrial and freshwater snails, unforgivable since they merge ecologically through numerous damp ground and marshland forms. It makes far more sense to treat them all as 'non-marine molluscs' for interpretative purposes (as did Sparks as early as 1961). Indeed, it might be argued that even the marine/non-marine division is unhelpful since the two groups overlap in estuaries (and may be studied together, for example in work on estuarine pollution by Gilbertson and Hawkins 1985). It is very hard to see why Evans (1972) only treated terrestrial forms in his otherwise excellent monograph, giving only passing mention of aquatics. Sparks and West (1972) and Evans (1970) gave a brief introduction to non-marine molluscs, Miller and Bajc (1990) review their use in Quaternary studies in a North American context, and Miller and Tevesz (2001) review the analysis of freshwater forms with emphasis on North American lakes. Thomas (1985) provides a stimulating review of theory and applications of land snail analysis in archaeology which is still good reading, and Preece (2001) gives a more recent introduction to archaeological non-marine molluscs.

Integration of work on landsnails with studies of other classes of remains has often been weak, although there are honourable exceptions (e.g. Allen and Robinson 1993c; Baalam *et al.* 1987). Terrestrial and freshwater molluscs may be the only source for ecological reconstruction where there is no anoxic waterlogging and only charred, silicified and calcareous material survives. Charred plant remains will rarely provide reliable descriptions of local ecology since they are too likely to represent the remains of material deliberately imported by humans. Unfortunately, unlike the insects, there are no clear associations between molluscs and particular plant species (Boycott 1934). Snails also provide evidence for incorporation of certain materials, particularly cut vegetation (for example in 14th century floor deposits at the Dominican Priory, Beverley, Allison *et al.* 1996c). Unfortunately, for many published sites in The North only hand-collected molluscs have been examined, perhaps augmented by material from a few samples. There is thus a bias towards large species, with consequent loss of information. Far more work has been carried out in southern England and the Midlands (e.g. the reviews of Evans 1972; Murphy CAR 68/2001; and specific examples such as Allen and Robinson 1993; Bell 1989; Evans 1993; Evans and Jones 1981; Evans and Simpson 1991; Evans and Smith 1983; Evans and Williams 1991; Kerney 1976; Kerney *et al.* 1964; 1980). Reference to the EAB (Tomlinson EAU 1995/27; available via http://www.english-heritage.org.uk/server/show/nav.1518) serves to accentuate the north-south disparity.

Evans (1969c) gives a wide-ranging review of the use of land and freshwater molluscs in archaeology, which still repays reading. Work on landsnails in British archaeology up to 1972 was reviewed by Evans, and his treatment is both masterly and exhaustive, still relevant and often provocative after 25 years, but a great deal of work has been done since. Unfortunately, while there have been a modest number of sites in the Northern region where molluscs were sufficiently numerous for at least limited ecological reconstruction (Table 4), rather few of them have received detailed study such as that carried out routinely by the Evans school. Examples of more substantial studies from our region are: Carrott (EAU 2000/55); Dobney *et al.* (EAU 1994/18); Dobney *et al.* (EAU 1996/26); Milles (AML 114/93); (AML 4768); O'Connor (AML 4735); and Thew and Wagner (1991).

Murphy's (CAR 68/2001) review of work on Mollusca in the English Heritage Midlands region, where many sites have been studied, is recommended as an important modern source for information concerning both land and marine molluscs in archaeology; the present account cannot hope to complete either in volume of material available for review or depth of knowledge on the part of the writer. Work on molluscs at natural sites in the northern region has mostly been limited to Lateglacial and early Postglacial deposits in Holderness (p. 128). A biostratigraphic zonation scheme for Lateglacial and Holocene deposits based on land molluscs was proposed by Kerney (1977); it is uncertain whether it is applicable to the north of England. Limondin (1965) discusses zonation using British mollusc assemblages, in a paper considering zonation in northern France.

Molluscs have been widely used in reconstructing major climate change (e.g. Bates *et al.* 2000), but their potential for tracing minor climactic variations in the Holocene is less certain. Kerney (1968) considers the possible impact of the post-glacial thermal optimum on land snails. Their value as climatic indicators is not confined to distributional data. Jones *et al.* (2002) report the use of stable isotope analyses of freshwater snail shells and discuss the problems encountered; there is now a considerable number of examples of temperature reconstruction from shells. Holyoak and Preece (1985) tentatively used variation in banding of Cepaea from an Ipswichian (last interglacial) site as evidence of temperature. Mannino *et al.* (2003) report the results of a study of the potential of oxygen isotope analysis for determining seasonality in utilisation of molluscs, a technique explored as early as 1973 by Shackleton.

A substantial number of landsnails are believed to have been introduced to Britain by human activity (Evans 1972, 200-201). Work on archaeological assemblages provides an opportunity to determine the date of arrival of such species, and indeed whether any are in fact natives, and to examine any impact on the composition of communities of snails. One introduced land snail which is of considerable significance is *Cecilioides acicula*, a burrowing species which is frequently found intrusive in archaeological deposits. It is considered more fully on p. 482.

As notes above, slug shells ('plates' or 'granules'), illustrated for example by Quick (1960) and Evans (1972, 73-4), are occasionally recorded (e.g. Dobney *et al.* EAU 1994/60; Jones and O'Connor EAU 1986/33; O'Connor AML 4768) and probably often overlooked. The minute radular teeth of slugs and snails might exceptionally be found in archaeological deposits (those of slugs are illustrated by Quick 1960, for example), and just conceivably, the 'love darts' used by slugs and snails during mating might survive: they are distinctive (e.g. Schilthuizen 2005).

'Gastropod eggs' have been reported in appreciable numbers in a single sample from a large possibly pre-Roman depression at the Jewbury (County Hospital) site, York, by O'Connor (AML 4709) and have occasionally been tentatively identified from other sites in northern England but not reported. There seems to be no easy way of identifying these remains further except perhaps on the basis of size. The toughness of the chalky shell of snail eggs is attested by Step (1927, 368), who tells us that eggs of *Helix pomatia* can be blown like those of birds. The ultrastructure of some mollusc eggs is presented by Tompa (1976).

Extraction and identification: Land and freshwater mollusc remains have often been hand-collected, or recovered in General Biological Analysis or Bulk Sieving samples. Hand-picked landsnails are of severely limited value; for example Evans (AML 1771) was only able to record *Helix aspersa* and a single *Arianta arbustorum* from the Winterton Roman villa site, where hand-collection was employed. Sieving (typically using 500, and sometimes 300, micron meshes) is thus necessary. Sample size varies according to concentration in the deposits, and may be less than a kilogramme, or up to 10 kg or more. The shells are often very delicate, and tend to be damaged by normal extraction methods used for other macrofossils (this is especially true of Bulk Sieving processing). It is common for raw sediments containing numerous visible snails not to yield many identifiable remains, most having disintegrated and been lost during sieving. Disaggregation using reagents such as sodium pyrophosphate followed by very gentle sieving seems to be the best method. Hydrogen peroxide (recommended by Evans 1972, 44) is to be avoided in view of its effects on other biological remains. Methods are covered by Evans (1972, 44-5) and Ložek (1986), while Thew and Woodall (1984, 110) provide a flow chart for mollusc extraction in relation to particle size analysis and plant macrofossil extraction. Recording has generally been fully quantitative, using the fragments present to estimate a minimum number of individuals (MNI), but semi-quantitative recording, as used for plant remains by Hall (e.g. Kenward and Hall 1995, 459) and for insects by Kenward and associates (Kenward *et al.* 1986a; Kenward 1992) might often be more appropriate. Sampling for molluscs in relation to temporal resolution has been briefly considered by Carter (1986) and this is certainly a topic requiring further thought.

Identification of most terrestrial and freshwater molluscs is fairly straightforward, especially if a reasonably complete reference collection can be consulted, but some groups (e.g. *Pisidium* species) are very difficult. The land molluscs are well served in the literature, although Evans' (1972, 45) comments concerning the lack of treatment of juveniles remain largely true. Illustrated identification manuals for terrestrial species are given by Cameron and Redfern (1976), Ellis (1926) and Kerney and Cameron (1979), for fresh water and brackish water gastropods by Macan and Cooper (1977); and for freshwater bivalves by Ellis (1951; 1978, the latter summarising the known fossil records and listing bivalves only known as fossils). Janus (1965) is the most comprehensive work, dealing with the British terrestrial and freshwater fauna, but needs to be supplemented by more recent and precise keys and illustrations. Each of these reviews the biology of the species concerned. Evans (1972) remains an essential work for anyone attempting to come to grips with the subject. Identification of molluscs can often be accurate using illustrations and descriptions, but as always recourse should be made to reference material for confirmation. The early papers by Boycott (1934; 1936) remain useful as a source of information concerning the ecology of non-marine snails, especially as he treats ecological groupings, including synanthropes.

Interpretation of non-marine snail assemblages: A great deal of work has been done on the interpretation of non-marine mollusc assemblages, including significant studies of modern parallels, and some quite esoteric approaches have been taken. An example of the simplest – but in this case very effective – approach to interpretation is provided by Robinson (2004), who used the distribution of the aquatic snail *Bithynia tentaculata* as evidence of the extent of flooding at Yarnton, Oxfordshire, giving a maximum height below that of Saxon occupation. Problems of interpretation of assemblages of archaeological landsnails were considered by Evans (1972), O'Connor (1998); Preece (2001) and Thomas (1985). Evans and Williams (1991) applied a range of analytical methods to snails from the M3 archaeological sites, strongly parallelling those developed by Kenward (1978a) for insects. As for the insects, problems revolve around an understanding of death assemblage formation and of modern ecology, at the species (autecological) and community (synecological) levels. Quantitative field studies of mollusc ecology are surprisingly rare, as pointed out by Davies *et al.* (1996). These workers examined wet-ground faunas in turves in chalkland in Hampshire, and used principal components analysis to demonstrate that characterisation of communities in such environments was possible, something which is encouraging in the context of archaeological interpretation. Davies and Grimes (1999) examined small-scale variation of mollusc faunas in relict water meadows in Wiltshire and found good correspondence with habitat variables. Outeiro *et al.* (1993) related land snail communities to environmental factors, finding soil texture, calcium, and litter pH to be important. Rouse and Evans (1994) carried out studies of modern fauna, again from turf, for comparison with archaeological material from Maiden Castle, Dorset, relating the communities to environmental factors. They found that communities may be sharply delimited in space, underlining the need for multiple-sampling, but suggest that direct matching by species composition is not practicable. They point out the importance of distinguishing 'taxocenes', i.e. groups of ecologically related species of autochthonous origin, within death assemblages. Evans (1991) had earlier discussed wet- and dry-ground snail taxocenes in central-southern England. Evans *et al.* (1992) expounds on mollusc taxocenes from Holocene overbank alluvium in southern England, and Davies (1996) presents preliminary results of numerical analyses of overbank taxocenes.

Davies and Wolski (2001) examined migration rates of molluscs in a study of Neolithic woodland regeneration in the Avebury area. Smith, H. (1996) used correspondence analysis to examine snail assemblages from a series of 'functional areas' in a Hebridean farmstead. Bishop (1977; 1981) examined communities of wetland molluscs, then used the observed communities to predict back to environment, with variable success. There are other modern studies directly relevant to archaeological interpretation (something which is in contrast to the state of insect ecology): Cameron and Morgan-Huws (1975), for example, recorded snail faunas on downland vegetation, following the succession from grassland to scrub, exactly the kind of ecological change which we wish to study in relation to past land use.

Evans and Williams (1991) used assemblage structure, rank order, diversity indices and cluster analysis in their study of land molluscs from sites along the M3, identifying groupings of assemblages characterised by species composition, diversity and broad ecological nature and illustrating ways forward in the analysis of archaeological molluscs. Carrott (EAU 2000/55) used statistical analysis (Canoco) to differentiate snail assemblages from the Flixborough site. Gordon and Ellis (1985) use analysis of parameters supposed to reflect community structure and interactions to examine ecological change through deposits in southern England. A thoughtful paper by Evans (1993) reviews molluscan evidence for human impact on the English chalklands, work which might usefully be parallelled on the calcareous areas of the North. Also relevant here is Dimbleby and Evans' (1974) consideration of the difficulties of relating evidence from snails with that from pollen in calcareous soils, which appears to lead to the conclusion that the two groups of biological remains are not necessarily contemporaneous in any given deposit.

Some authors (e.g. Evans 1972; Loek 1986; Murphy AML 109/93) have presented overt ecological groupings of molluscs, although these may be geographically variable. There is a pressing need for better understanding of the ecology of the individual species, of communities in relation to habitat variables and climate, and for the development of a satisfactory scheme of ecological coding for the molluscs. The difficulty of ascribing a particular environment to any one species (a problem discussed by Evans 1972) is well illustrated by the records of *Vallonia* species from Roman deposits at the Rougier Street and Wellington Row sites, York (Allison *et al.* 1990c, 381-3); the presence of *V. excentrica,* considered to indicate dry calcareous grassland or scree, lead to a re-appraisal of its ecology, and to the conclusion that it might have exploited dense turfy grassland at the site rather than having been imported in hay, which seemed unlikely on other evidence. Landsnails apparently exhibit north-south gradients of shade requirements which complicate interpretation (T. P. O'Connor, personal communication). Many species have wide habitat ranges, and it will be necessary to study species associations in northern England before confident ecological reconstructions can be made.

O'Connor (unpublished database held in Department of Archaeology, University of York) assigned ecological codings to the British land and freshwater molluscs, and these were applied in the species list given by Kenward and Hall (1995, 504-505). They have yet to be fully employed, however, and although the system represents a useful starting point, further development is desirable.

The taphonomy of snails is considered by Carter (1990) and Cummins (1994); that they will decay unless buried in non-acid sediments of low permeability has been strongly suggested by an undergraduate student project (Taylor 2001). The possibility of decalcification of land snail shells even on calcareous substrata was raised by Evans (1972) and Milles (AML 114/93). Briggs *et al.* (1985) discussed mollusc taphonomy in braided river systems.

Marine molluscs

Marine molluscs represent a collected resource of considerable economic importance. Their remains provide evidence of food in the past, but much more than that. Mannino and Thomas (2002), for example, suggest that tracking of intertidal shellfish resources by hunter-gatherers may have been a factor in early human dispersal. Large quantities were consumed at some sites – shell middens have been reported from many parts of the world (review and discussion by Waselkov 1987). They have been deposited in the British Isles from a very early date, for example the Mesolithic middens in the South of England discussed as evidence of intensive exploitation of coastal resources by Mannino and Thomas (2001), but there are no spectacular examples from the North of England. Marine molluscs have had numerous other uses: as bait, for making lime, as decorations, as tools, and for tempering pottery, for example, and even as building materials (Salzman 1997); uses, some symbolic, to which they have been put are exemplified, summarised and discussed by various papers in Bar-Yosef Mayer (2005), and by Ceci (1984), Claassen (1998) and Thomas and Mannino (2001).

An enormous number of species of shellfish occur in north-west Europe, many of which have probably been used for food at some time (e.g. Lovell 1884), although certain molluscs are considered to be inedible. *Scrobicula plana* is said by Thomas (1978) to be 'rather distasteful', for example. Although marine shells have a wide range of habitats and ways of life, they are not often likely to be important in ecological reconstruction, although they may contribute indirectly to evidence of silting or other changes in shorelines. They are, however, useful indicators of the habitats exploited by food-gatherers, and thus of something of their range and the technology available to them. The molluscs may also offer evidence of status or famine. Limpets are often taken as evidence of low status (or even regarded as animal feed, a possibility raised by Drewett *et al.* 1978), although Step (1927, 192) appears to find nothing exceptional in the consumption of *Patella vulgata* and Lovell (1884) documents many examples of their willing consumption. Both authors also mention its importance as bait. Shellfish as famine food are briefly considered by Thomas (1981, 60); limpets are sometimes placed in this category. Shellfish are a rich food source, but eating them carries its risks, for the filter-feeding species may concentrate toxins from dinoflagellates when the latter undergo population explosions (eg. Ingram *et al.* 1968; Wood 1968), and of course if they begin to decay they may contain 'food poisoning' bacteria.

Rarely, remains of marine molluscs may have ecological or climatic significance. Thomas (1978) interpreted molluscs from around the 10th century Graveney boat (Kent), for example, while in our region Edwards (1987) suggested deposition in shallow brackish water for a putative Hoxnian assemblage from Filey Bay, North Yorkshire. Hickson *et al.* (1999) show that the isotopic composition of queen scallop (*Aequipecten opercularis*) is in equilibrium with the surrounding seawater, and is thus potentially a useful indicator of water temperature. The value of stable isotope analysis periwinkles (*Littorina littorea*) for high-resolution temperature analysis is demonstrated by Burman and Schmitz (2005).

Shellfish occur in vast quantities on many sites, although the North appears not to be able to rival the astonishing abundance of oysters reported at Poole, Dorset, by Horsey and Winder (1991). O'Connor (AML 4297), for example, observed that fragments of oyster shell contributed an appreciable proportion of the 'mineral' component of most deposits at 16-22 Coppergate, York. Common (or flat) oysters (*Ostrea edulis*) are by far the most numerous shellfish in most archaeological deposits in northern England, with common mussels (*Mytilus edulis*) and common cockles (*Cerastoderma edule*) also frequent. Periwinkles (*Littorina* spp.), common whelks (*Buccinum undatum*) and common limpets (*Patella vulgata*) probably account for most of the remaining records of marine molluscs from occupation sites, but it is emphasised that the small number of systematic accounts and scattered nature of the numerous casual records would make any attempt to collate the data for shellfish from our area premature.

Oysters are very common at a large proportion of sites and probably generally overlooked or recorded as 'finds' and not subjected to biological analysis in any way. It is not entirely clear how much value resides in detailed study of oysters; O'Connor (AML 4297), reflecting a commonly held view, stated 'recording all oysters would have been an excessively laborious task for minimal information return'. However, Winder (1992) has suggested that measurements of proportions and shapes of oyster valves may be useful. O'Connor (AML 4768), in a study of the General Accident Extension (= Tanner Row) site, York, measured representative groups of oyster shells and showed a reduction in typical size from the Roman to medieval periods (see p. 327), so there clearly is some value in recording size (in this case estimated in 5 mm classes). Outside our area, Winder (1980) discussed age-grouping (providing a diagram of seasonally incremented growth lines) and meat yield of oysters (and winkles, *Littorina littorea*) from a site in Southampton. Winder's thesis (1992) is a mine of information concerning oysters in archaeology, but is unlikely to represent the last word on the subject. Investigations of size, growth increment, shape, patterns of damage, and epibionts all have some value. Seasonal exploitation, for example, is considered by Milner (2001; 2002). House and Farrow (1968) reported daily banding in *Cerastoderma (Cardium) edule* (cockle) shells; if this survives in the ground (which seems a little unlikely) it may just possibly prove to be of some value in determining past climate patterns or in matching sources. Deith (1983; 1985) discusses the potential for determining season of collection of marine shells using growth-line analysis and oxygen isotope determination.

Thomas (1978) recorded damage to oyster shell consistent with their having been opened with a knife, and this is clearly something which should not be overlooked. Although Winder (1980) sought such damage, the valve margins were poorly preserved: however, there are now numerous records of knife damage on shells from northern England, sometimes mentioned in the chronological section, below. Regarding oysters, the reviews of historical, sociological and artistic aspects of oysters and pearls by Joyce and Addison (1992) and Stott (2004) may be mentioned here as useful or entertaining background reading.

Shells occasionally seem to have been deliberately perforated by people. Thomas (1981), in a paper which illustrates many of the ways in which marine molluscs may be of value in archaeology, mentions the danger of confusing damage caused naturally (e.g. by crabs) with that caused by humans. Holes made to suspend shells as personal adornments seem particularly likely to be confused with those made by carnivorous gastropods (such as muricid whelks), especially when sea-worn; Thomas suggests differences which might allow the two to be distinguished (convincing artificial holing of oyster shells is mentioned on p. 431). He also points out that shells bearing epibionts on internal faces must have been collected after death, and thus not as food.

Shellfish may offer clues as to site usage; coastal middens aside, large numbers will generally suggest domestic occupation (perhaps hostelries in later periods!) while, for some periods, occupation sites where their remains are rare - e.g. North Bridge, Doncaster (Carrott *et al.* EAU 1997/16) - are likely to have had some other use (industrial in this case).

There are a few records of edible species other than the common ones mentioned above from occupation sites in the north of England (deposits from sites close to the sea cannot be regarded as immune to the presence of accidentals). Fragments of the great scallop Pecten maximus, much favoured for food, were noted from later 2nd century dumps at Tanner Row, York (Hall and Kenward 1990, 355; O'Connor AML 4768), for example. Certain other records seem to be of shells which arrived for some other reason, perhaps in fish guts, seaweed, ballast, and as collector's items and decorations. A miscellaneous group of shells from Anglo-Scandinavian Coppergate, York, may have been from fish guts, or from sorting of a mixed catch of shellfish (Kenward and Hall 1995; O'Connor AML 4297). Shellfish are indicative of organisation in resource gathering and strong hints of organised trading systems when found in sites at some remove from suitable gathering places. Collection of oysters by some form of trawl is normally necessary as the animals live from low water downwards (Hayward *et al.* 1996, 240), implying more than casual exploitation.

A record of the Red Sea cowrie *Cypraea pantherina* from Anglo-Scandinavian Coppergate (Kenward and Hall 1995, 781) provides clear evidence of long-distance trading, direct or indirect; the way it was cut suggests that part was sawn off to make some form of decoration. (Cowrie shells are also known from archaeological sites in other parts of north-west Europe, e.g. Johansson 1990.) Other evidence of this kind should not be allowed to go unnoticed. The use of shells as beads is common throughout the world, of course, and they may be archaeological valuable; Vellanoweth (2001) discusses their use in establishing a radiocarbon-tested chronology and in tracing trade and group interactions in western North America, for example.

No archaeological records of cephalopod (cuttlefish, squid and octopus) remains have been encountered during this review, notable in view of an article by Smart (1997) asking why these animals are not recorded. Smart illustrates the 'pen' (internal shell) of the squid *Loligo vulgaris*, and 'beak' and 'cuttlebone' of the cuttlefish *Sepia* *officinalis* in the hope that archaeologists will recognise them if they occur. On the whole the present writer favours taphonomic loss of these very characteristic remains; it seems unlikely that any competent zooarchaeologist would overlook them. However, cephalopod beaks, at least, preserve in marine sediments, sometimes in very large numbers (Clarke 1962), and there are cuttlebones from archaeological deposits in the Middle East. Cuttlebones had a variety of uses in the past, including making toothpaste and moulds and as decorations, and they appear in art from ancient Greece. Presumably when cuttlefish ink (sepia) was used in the past production sites might be marked by accumulations of 'beaks'. Some other molluscs produce materials which can be used as dyes: these are discussed on p. 361.

Extraction of marine molluscs: Hand collection remains the principal, but nevertheless not wholly appropriate, method of recovering marine molluscs at most sites. Bulk-sieving, and to a lesser extent site-riddling (sensu Dobney *et al.* 1992) provide more representative assemblages, though care is needed to avoid damaging shells. The bias introduced by recovery methods was discussed briefly by Light (1995b). O'Connor (AML 4768) used a 3 point semi-quantitative scale to record comminuted shell from sieved samples quickly rather than simply ignoring it as seems commonly to be done. This is valuable in that material fragmented in antiquity may have considerable significance in understanding deposit formation and act as a guide to likely bias in the identifiable fraction of the assemblage. Large shellfish are often identified on site by non-experts, or collected as hand-picked finds then treated as honorary bone, neither approach being satisfactory; sieved assemblages are far more useful. A more systematic approach to the recovery and study of shellfish is desirable, although the practical and logistical problems involved are recognised.

Identification of marine molluscs: There are several useful works, from semi-popular (e.g. the excellent Hayward *et al.* 1995; Beedham 1972; McMillan 1973) to more technical (e.g. Graham 1971; Jones and Baxter 1987; Tebble 1976; Thompson and Brown 1976). A good reference collection showing the range of variation within species (often considerable) is important.

Brachiopods (lamp shells) are a minor marine group resembling bivalve molluscs but unrelated to them; close inspection of the valves reveals fundamental differences in gross structure. The phylum has a few representatives in British waters. Although robust, their remains are hardly likely to occur in archeological or natural deposits except by rare accident; they are mentioned here principally to correct the faux pas committed in an undergraduate textbook, where they were referred to 'branchiopods' (sic) and as a group of molluscs. (The name 'Branchiopoda' has been used for a group of crustaceans, however.) A synopsis of the British brachiopod fauna is given by Brunton and Curry (1979) and should enable identification of well-preserved shells in the unlikely event of their discovery. Ancient fossil brachiopods occasionally occur in archaeological deposits, a published example being provided by Donaldson and Rackham (1985).

Phylum Bryozoa

The bryozoans are an obscure but fascinating group, sadly lacking a popular name; perhaps 'moss animals' might be appropriate. They are mostly marine, with several hundred species in European waters (Hayward *et al.* 1996, 268), but there are a few freshwater representatives, some of which are fairly often found in natural and occupation-site deposits. The marine species are attached to rocks or seaweeds and look rather like hydroids or simple corals (both members of the Cnidaria or coelenterates). Bryozoans may be jelly-like or more or less heavily calcified, different species forming tight clumps or delicately branching strands. Like cnidarians (p. 22) they are colonies of individuals (zooids), but these individuals have a higher level of organisation than the superficially similar coelenterates.

The freshwater Bryozoa (mostly members of the class Phylactolaemata) look like jelly blobs and occur on plants and stones. The colonies are typically small, but may reach a few tens of centimetres in diameter. In some forms, including *Cristatella* mucedo, the colonies are motile; in this species they are several centimetres in length. The group is normally represented in the fossil record only by the tough statoblasts or floatoblasts (resting bodies, which are a specialised form of the zooids). These have frequently been observed in lake deposits (e.g. Frey 1964, 28-30; Francis 2001; Warner 1990b; for our area, Harmsworth (1968) noted *Cristatella* mucedo and *Plumatella* sp. from sediments of Blelham Tarn, Cumbria) and are also common in archaeological deposits formed in or near water.

An introduction to the biology of the group is given by Ryland (1970), while Mundy (1980) outlines the ecology of the British freshwater species. Their use in the palaeoecological reconstruction of lake sediments, with a North American slant, is reviewed by Francis (2001).

Class Phylactolaemata

The very distinctive statoblasts of two species occur fairly regularly as fossils: *Lophopus crystallinus* and *Cristatella mucedo*. A third taxon, *Plumatella* sp., has been noted from archaeological deposits in London by Tyers (1988). Other objects resembling bryozoan statoblasts have occasionally been recorded, but their identification requires confirmation.

Bryozoan statoblasts are occasionally abundant in archaeological deposits, usually in clearly waterlain sediments, but sometimes apparently imported with water. They appear to be very resistant and sometimes may provide the only evidence for an aquatic component. Carrott *et al.* (EAU 93/08), in an evaluation of medieval material from Gowthorpe, Finkle Street and Micklegate, Selby, found *Cristatella* and *Lophopus* in supposed flood deposits where biological remains were poorly preserved and most delicate fossils had decayed, leaving the bryozoans, Characeae (stonewort) oogonia and molluscs, with a few robust seeds. Similarly, at the riverside site at North Street, York (Carrott *et al.* EAU 93/14) assessment of a 12-13th century layer of alluvial sand gave a single statoblast of *Cristatella* but very few other remains, and an organic layer of 12th/13th century date at South Beckside, Beverley gave many *Lophopus* but only scraps of other invertebrates (Hall *et al.* EAU 2000/15). At the last site it was not certain whether the statoblasts originated contemporaneously at the site, or in imported fen peat.

At the North Bridge site, Doncaster (Carrott *et al.* EAU 97/16; Hall *et al.*2003c; Kenward *et al.* 2004a), remains of *Cristatella* provided much the best evidence for the presence of a component of aquatic origin through much of the (terrestrial) sequence, including in floors (though whether introduced in make-up or deposited by flood water was not clear), while Jaques *et al.* (PRS 2003/01) noted L. crystallinus in a pre-18th century pit fill at 54-7 High Street, Hull, perhaps introduced in water for (or drunk by) livestock. Carrott *et al.* (EAU 1991/12), in evaluation of the Adams Hydraulics II, York, site, found *Cristatella* statoblasts in deposits regarded as probably representing 18th century agricultural land, indicating that flooding may have occurred. Of course, they may have found their way into deposits by other means. Assessing samples from the Merchant Adventurers' Hall, York Carrott *et al.* (EAU 1996/44) found *C. mucedo* statoblasts in 14th century levelling or dump deposits. They suggested that they were perhaps evidence of flooding by the nearby River Foss, but that they could have been brought in trample or in some other indirect way. *Lophopus* in a 14th century deposit in a pit cut in the Hungate area of York (Jaques *et al.* EAU 2000/29) may have entered in stable manure, a likely route by which many aquatics entered archaeological layers (p. 398).

Elsewhere, in what are clearly aquatic deposits, the statoblasts are hardly unexpected. That they may be transported by flowing water is self-evident (the statoblasts are intended as a dispersal mechanism!) and well illustrated by the record of one *Lophopus* from the late 13th and 14th century waterfront deposits at Chapel Lane Staith, Hull (Kenward 1979c), since the animals were most unlikely to have lived in brackish water. Their value as indicators of water quality may thus be compromised - at the Layerthorpe Bridge site, York, for example, *Lophopus* and *Cristatella* were sometimes present in deposits in the River Foss which must have been heavily polluted by dumped waste, presumably having been carried downstream by the river (Hall *et al.* EAU 2000/64).

In some cases a range of bryozoan types has been encountered, for example at 84 Piccadilly, York, where Carrott *et al.* (EAU 1991/16), in an evaluation, found the fill of a 19th century wooden drain to be unusual and distinctive in consisting mainly of entire, very well preserved mollusc shells, with abundant ostracods and *Daphnia* ephippia. There were also various kinds of bryozoan statoblasts including *Lophopus crystallinus* and *Cristatella* mucedo, and 'branched tubular structures which may have been bryozoan', within which there were ovoid dark-coloured bodies, perhaps developing statoblasts. Unfortunately further investigation of these fascinating remains was not possible within the constraints of the evaluation mechanism, but they did suggest that the drain carried only clean water.

The statoblasts of *Cristatella* decay in a rather characteristic fashion, and even extremely rotted remains may be recognisable: a decay sequence for this species is illustrated by Hall *et al.* (2003c).

Classes Stenolaemata and Gymnolaemata

Stenolaemata are heavily calcified and represented in Europe by rather few species, while the Gymnolaemata include many species, ranging from completely uncalcified to very strongly calcified. These are almost all marine animals, although two members of the Gymnolaemata occur in fresh or brackish water in Europe. Calcified forms in both groups probably occur at least occasionally on shellfish valves in archaeological deposits, but are likely to have been overlooked or confused with calcified algae or the various coelenterates which secrete calcareous cases. No published archaeological records from northern England have been discovered during the preparation of this review, though some examples from elsewhere are mentioned by Bell (1981), who also mentions their importation with modern seaweed.

Recovery and identification of Bryozoa: Statoblasts are often seen in General Biological Analysis samples processed for insect remains. Skeletons are most likely to be found during botanical work, when whole sieved material is sorted. A key to European freshwater bryozoons (including illustrations of the statoblasts) is given by Mundy (1980). Marine taxa are keyed by Hayward (1985), Hayward and Ryland (1979; 1985) and Ryland and Hayward (1977).

Phylum Echinodermata: urchins, starfish, etc.

The echinoderms are a large group, unusual in being entirely marine - there are not even any brackish-water species. Most are quite large bottom-dwelling animals, and they range from essentially soft forms (the sea cucumbers, Class Holothurioidea, although even these have granules in their skin) through those with flexible bodies composed of small plates (the crinoids, Class Crinoidea, the starfish, Asteroidea and the brittlestars, Ophiuroidea) to others with tough box-like skeletons (the sea urchins, Class Echinoidea). Although urchins and starfish are very familiar to most people, echinoderms are of limited importance in archaeology. However, urchins, whose remains have occasionally been recorded, have probably always found use as a minor food resource in Europe, and one species, *Echinus esculentus*, has the popular name ‘edible urchin’ or ‘sea egg’ for this reason (Lovell 1884). It has occasionally been found in British archaeological deposits (e.g. Howard 1994). Urchins are eaten widely in other parts of the world, cooked or raw.

Class Crinoidea: sea lilies

Fragments of sea lilies are known as redeposited ancient fossils. An example is provided by Donaldson and Rackham (1985), who found abundant crinoid remains together with a brachiopod in deposits at Holy Island Village, Northumberland, presumably derived from the Carboniferous limestone bedrock. Antedon, fairly common in British waters, is composed of small plates which may well be overlooked in archaeological contexts..

Classes Asteroidea and Ophiuroidea: starfish and brittlestars

The hard parts of these animals might be expected to preserve at least occasionally, but perhaps might not be recognised. Identification to species would probably be very difficult without a reasonably complete collection of specially prepared reference material, although some species bear very large or otherwise characteristic spines and the skeletal elements of ophiuroids appear characteristic (illustrations given by Mortensen 1927).

Class Echinoidea: sea urchins

Remains of urchins in archaeological deposits are most likely to be hand-collected (and thus typically incorporated with assemblages of bone), or to be extracted by bulk-sieving. They have been widely exploited as food (Lawrence 2006). Remains of sea urchins are apparently not infrequent in archaeological deposits on a global scale (e.g. Bird 1943, 210, 235; Callen 1965; Howard 1994; Keegan *et al.* 2003), and sometimes reported in from England (e.g. spines probably from the 'sea potato' *Echinocardium cordatum* from 14th century London, Boyd 1981). Urchin shell fragments have very occasionally been seen by the author in bulk-sieved material, but no published records from the region have been noted during this review (there may be passing mention in the 'vertebrate' sections or general text of reports which have not been read). Ancient (hard-rock) fossils of urchins are not uncommon on archaeological sites and have sometimes clearly had a decorative function (review by Demnard and Néraudeau 2001); the classic example is the tumulus at Dunstable Downs, with large numbers of tests which were apparently arranged in an oval around the burial (Smith 1894, but see Oakley 1985).

Mortensen (1927) gave keys to British echinoderms, with illustrations of skeletal elements which may well be found in archaeological deposits. Urchins are fairly easy to prepare as reference material, and identification of large fragments should not be too difficult; some progress can be made using illustrations in handbooks such as Hayward *et al.* (1990), while Mortensen (1927) illustrates de-spined examples.

Secondary evidence for invertebrates

Most archaeological deposits could be seen as secondary evidence of invertebrates, since these animals are so crucial in soil formation and the decomposition of organic matter. A large proportion of deposits will have been acted on by them in some way! However, some other more immediately recognisable invertebrate artefacts may be encountered. Beeswax, sealing wax, scale insect waxes, dyes and resins, and silk are mentioned elsewhere as insect products (pp. 358 - 362).

Plant galls

Plant galls caused by insects can be regarded as secondary evidence of the causer. They have occasionally been recorded from archaeological deposits (e.g. Benson 1976; Robinson 1980; Robinson *et al.* 1984; Seaward 1976). The Anglo-Scandinavian deposits at 16-22 Coppergate, York, have yielded a dozen or so records of galls, and there are appreciable numbers of records from various other sites and periods in York and Hull (A. R. Hall unpublished). None have been closely identified.

Some galls have economic value, and their past use is discussed on p. 313. A useful guide to the identification and biology of galls is given by Darlington and Hirons (1968).

Modification to bones and skins

Modifications to vertebrate skeletons may be caused by invertebrate parasites. Flies, such as warbles (*Hypoderma* spp.), bore holes in mammalian skin on emergence, often leaving via in what will become the middle of the pelt, causing significant reduction in value and utility. The effect of these flies has been observed in leather from archaeological deposits (an illustration is given by Chaplin 1965). Baker and Brothwell (1980, 185) illustrate a deer skull apparently modified by screw-worm (presumably *Chrysomya* sp.), and a mustelid skull with 'nematode damage'. The biology of these disgusting flies, which may parasitise humans, is reviewed by Zumpt (1965, 217-229). Myiasis-causers were considered and rejected as causes of skull perforations by Brothwell *et al.* (1996).

Louse infestations can cause inflamation of the scalp and consequent modification of the skull in humans (e.g. Capasso and Di Tota 1998); their depredations may also leave marks on leather and pelts, reducing their quality and value (e.g. Coles *et al.* 2003 for cattle; Heath *et al.* 1995 for sheep). Invertebrates may also cause post-mortem damage to bones; surface grooving just possibly caused by insects is illustrated by Brothwell (1992), while Behrensmeyer (1978) mentions the (minor) role of insects in bone taphonomy.

Some dermestid beetles are able to attack bark-tanned leather, and their effects might be seen: whether the damage would be recognisable is uncertain.

Cestode cysts

Calcified hydatid cysts, caused in Britain by the tapeworm Echinococcus granulosus, but laid down by the host around a dead larva rather than being part of the tapeworm itself, are very rare in archaeological deposits. Although sometimes large they are thin and fragile, and probably easily lost through in-ground solution or mechanical damage. Echinococcus are parasites of dogs and other canids, the cysts occurring in an intermediate host, typically sheep but sometimes humans; their biology is summarised by Markell and Voge (1976, 224-230). Baker and Brothwell (1980, 185) report examples from the liver region of two Norse skeletons from Orkney.

Earthworm burrows and granules

The past occurrence of earthworms is often very obvious not because of the remains of the worms themselves, or of their egg capsules, but those of their burrows. These may be tubular voids a few centimetres in diameter, but are often lined or filled by mineral deposits, often orange iron salts, and sometimes blue vivianite. Alternatively, the burrows may be filled with a sediment which is clearly different from the general matrix of the surrounding deposit. The burrows may be important in allowing drainage, and access of air and oxygen-rich water to archaeological layers, and thus causing decay of remains which would otherwise have been preserved anoxically. Mineral-replaced burrows are sometimes found (p. 115).

Much of the sediment in some layers will, strictly speaking, consist of earthworm faeces, having passed through these animals after deposition. Earworm and enchytraeid faces are sometimes recorded in soil micromorphology slides. In addition, earthworms produce small crystalline granules of calcium carbonate, which occur in archaeological deposits and may prove to be identifiable to at least some extent (Armour-Chelu and Andrews 1994; Canti 1998; 2003; Canti and Piearce 2003).

Burrows and engravings in wood and bark

Insect burrows and emergence holes are frequently observed in archaeological timbers and artefacts, and occasionally on bark. Most of the surface perforations in timbers are the same size and shape as those produced by emerging woodworm beetles (*Anobium punctatum*) and there is no reason to suppose that many were not caused by this species since it is very common in archaeological deposits (though *Ptilinus pectinicornis* and

Lyctus linearis are frequently found, too, and produce only subtly different holes). Many such examples of burrows have been observed casually by the reviewer but regrettably have not been reported. A case from Neolithic Switzerland in which the bark beetle *Hylesinus fraxini* Panzer could be identified was published by Volkart (1967). From northern England, Girling (AML 3669) described probable cerambycid (longhorn) and anobiid (woodworm family) borings and putative scolytid (bark beetle) engravings in the cleats of the Brigg (North Lincolnshire) Raft, and reported on a series of charcoal fragments with insect burrows from Beeston Castle, Cheshire (AML 4585; 1993). Most of the latter were of a size consistent with the woodworm beetle, but some larger ones may have been caused by the deathwatch beetle *Xestobium rufovillosum*, and two pieces had smaller burrows whose causer was uncertain. Further examples of burrows in artefacts are given by Phillips and Heywood (1995, 83; 491; 518). In one case, what may have been longhorn beetle burrows were taken by the authors as evidence that a chest used as a coffin had been above ground for a considerable time before burial, though this is arguable. Mourier and Winding (1977) give illustrations of the emergence holes of many wood-borers, and the engravings of bark beetles are illustrated, for example, by Balachowsky (1949).

Frass

'Frass' is the debris left by the action of animals feeding on, or boring through, some medium. The dust created by wood-borers and the granular material left by woodlice when they infest compost heaps are familiar examples. It is not unknown for archaeological samples to consist of material resembling invertebrate frass, though this usually seems to have formed in storage rather than in antiquity. A few of the samples from 16-22 Coppergate, York, may have included ancient invertebrate frass, though others had certainly been attacked in store.

Holes in grain

Grain weevils, Sitophilus, develop inside cereal grains and the adults leave characteristic round holes on emergence. These should be easily recognisable in charred grain from archaeological deposits. The fact that large bulks of grain have sometimes been examined and found lacking in such holes is most interesting bearing in mind the abundance of the weevil in associated deposits (e.g. for Roman York, at Coney Street, Kenward and Williams 1979, where no insect holes could be found in the huge bulk of grain examined; Rougier Street, Hall *et al.* 1990, 411, where there were only traces of suspected insect damage; and South Shields fort, where Osborne (1994) and van der Veen (1988, 360) specifically note the lack of evidence for insect infestation from a large quantity of cereal grain). An explanation is suggested below (pp. 342, 398), where it is hypothesised that most grain pests found in occupation deposits came from poorly-stored horse feed, usually via stable manure.

The absence of insect-damaged grain from many rural sites even when the pests were present in towns is much less surprising, since the grain beetles may have found it difficult to reach isolated farms. Allison *et al.* (EAU 1990/05), for example, found no recognisable insect damage in a large quantity of charred cereals from late 4th century deposits at the Staniwells Farm site, Hibaldstow, N. Lincs.

Although a single carbonised *Sitophilus granarius* was recovered from the substantial layer of Roman charred grain at the Coney Street site, the splits and cavities seen in the grain appeared to have resulted from heating of the germinated seeds, and no traces of immature insects could be found in the voids, so that the grain does not seem to have been especially heavily infested. (It must be emphasised that, despite various misquotations, the grain pests and charred grain at this site were unrelated, separated by a thick layer of clay.) Buckland (1982b) suggested the extensive charred grain deposits associated with the Roman fort at Malton resulted from the deliberate destruction of infested grain. Although remains of grain pests including *Sitophilus granarius*, *Oryzaephilus surinamensis* and *Cryptolestes* sp. were recovered, no holing by weevils was recorded; these surely would be a crucial component of the argument. In addition, it is not clear whether the insects were charred (as would be expected if they were present in grain when it was burned). The general argument made in Buckland's paper, that the presence of burned grain cannot reasonably be ascribed to catastrophe, evacuation or enemy action without strong corroborative evidence, is an important one, and a great many useful references are provided. Carruthers (AML 11/93) provides rather better evidence for grain destroyed because it was infested, in this case by *Sitophilus granarius*. She quotes M. Robinson's view that the grain weevil cannot attack hulled grain, and that this may account for at least some of the cases where bulks of charred grain were undamaged despite the probable occurrence of the weevil.

Outside our area there are some notable records of insect infestations in charred grain associated with damaged grains, for example that from Iron Age Israel given by Kislev and Melamed (2000), where charred insects were abundant, with *Sitophilus granarius* most numerous and often found as adults, larvae or pupae within charred grains. Campbell (personal communication) observed larvae in charred grain from a 3rd-4th century corn drier at Grateley, Hampshire. Such cases are unequivocal, but where only 'insect damage' to grain has been recorded, and it should be noted that it is very difficult to be sure that in any particular case that the visible damage was caused by insects and is not a random effect of charring or abrasion during subsequent movement and recovery. Systematic investigation of insect-damaged charred grain is required; preliminary work in a project by Judith Roebuck (unpublished) indicated that the recognition of damage after charring may be less than straightforward.

Damage to other charred seeds may be recorded. Caseldine (1987) found charred bean weevils, probably *Bruchus rufimanus*, in Iron Age holed beans at Mere Village East in the Somerset Levels. Kislev and Melamed (2000) recorded charred beans (*Vicia* sp.) hollowed by a bruchid, again probably *Bruchus rufimanus* (p. 353), from Iron Age Israel; they give a review of earlier records of such remains. A similar observation of holed beans was made by Arobba and Murialdo (1996) for material from 1st century Italy, and holed lentils from the Ptolemaic period of Egypt were reported by Burleigh and Southgate (1975).

Moulds

Moulds or casts of fly puparia in faecal concretions have been mentioned above. Other materials may prove to bear similar impressions, daub being the most likely. Even metal objects should not be ruled out: Pincher (1951) reports the imprint of a woodlouse in a modern aluminium alloy casting - so possibly lead, copper or bronze casts might occur. These are most unlikely to have any value beyond novelty, however.

Trace fossils

Trace fossils - marks left by the activity of organisms in the past - are generally likely to be overlooked, with the exception of feeding damage or burrows. Invertebrates are not likely to leave footprints on archaeological sites in the way known for mammals! This said, there are a few examples in the literature: for example, Scourse (1996) describes trace fossils of sandhoppers (Crustacea) from interglacial concreted littoral sands in Cornwall, drawing ecological conclusions from their presence, while (for example) Radies *et al.* (2005) found a range of trace fossils including dung beetle pupal chambers and mineral-replaced dung balls, termite galleries and bee burrows in Oman, and Martin and West (1995) report pupation chambers of dermestid beetles in bones from Tertiary deposits in Idaho.

Taphonomy: the incorporation and preservation of invertebrates in archaeological deposits

Preservation places the primary limit on what can be achieved in reconstructing the past. Different invertebrate groups preserve under different conditions, and some are for practical purposes unpreservable. In order to survive, remains must first become incorporated into deposits. Some aspects of pre-burial taphonomy are particularly important, for invertebrates are liable to be accidentally carried by wind, water, people and other organisms, and also in some cases are highly mobile (by flight, for example, among the insects). There are thus two main aspects of invertebrate taphonomy: (a) deposit formation issues and (b) preservation issues.

Biological remains preserve in archaeological (and other) deposits by several means. They may survive as (essentially) the original material, or as casts, be mineral-replaced, charred or be represented by secondary products (e.g. mineral precipitates). Unaltered or slightly altered tissues are preserved by their inherent robustness (e.g. bones, shells), anoxic waterlogging of more delicate materials (e.g. plant tissues, arthropod cuticles), the effect of toxic salts, desiccation (any remains), tar, and freezing. The last two are never relevant in Britain, and desiccated remains are rare, though sometimes found in buildings.

It is useful to classify biological remains by resistance to decay (Kenward and Hall 2000): Labile - e.g. muscle, fat, and plant cell contents - normally decay very quickly through autolysis and fermentation; Delicate - e.g. plant cell walls and insect cuticle, generally survive only under conditions of anoxia; and Robust - mineralised tissue such as bone, shell and plant silica, and charred or mineral-replaced remains of more delicate fossils, or casts - able to survive in a much wider range of depositional environments. The fossils we are considering in the present review fall in the last two classes.

The detailed circumstances leading to preservation of invertebrate remains are very poorly understood, but developing an understanding of them is crucial in project planning, in interpretation, and in contriving effective policies concerning in-ground preservation. Preservation is therefore considered here in some detail; the equally vexatious but less politically charged question of how death assemblages of invertebrates, particularly insects, form, is reviewed rather more briefly, although some specific problems urgently requiring research are mentioned at various points in the text and summarised in Part 6.

Archaeological sites in the north of England present a very wide range of preservational conditions, even at restricted localities, either through natural variations in climate, bedrock and soils, or as a result of past human behaviour. There are dry, acid sites with preservation limited to charred material (mainly of plants), contrasting with wet acid ones (bogs) with excellent preservation of many kinds of remains, though not calcareous ones. Calcareous deposits are encountered in the limestone districts, chalklands and locally in marls and archaeological deposits containing calcareous building materials, but a calcareous bedrock is no guarantee of preservation of bone and mollusc shell since many soils are heavily leached. Other deposits are rich in ash, which seems to be deleterious to most organic remains but may locally enhance preservation of calcareous fossils (bone and shell at the Flixborough site providing an example, Canti AML 53/93; Dobney *et al.* forthcoming). Waterlogged preservation is rare in the chalk and limestone districts, and investigation of such deposits is of high priority when they are found. Deposits with a high water content and with a pH not too far from neutral are common, particularly in towns where the dumping of massive amounts of organic waste by humans has created what amount to artificial peats, and has interfered with drainage patterns. These deposits may contain a very wide range of remains which permit particularly detailed reconstruction of past ecology and human activity.

Deposit formation issues

How do invertebrate (and other) remains get into the ground? The mechanisms involved in the formation of death assemblages on archaeological sites are considered in some detail on p. 456 in the context of further development of techniques of interpretation. However, a brief introduction to the topic is necessary here. While the general principles are common to all, the various groups of invertebrates present rather different problems of pre-depositional taphonomy. The term 'death assemblage' (or 'thanatocoenosis') is used to highlight the fact that archaeological assemblages of biological remains do not correspond with living communities, something which seems to have been first explicitly recognised for archaeological invertebrates by Evans (1972, 19). Thus a prerequisite for palaeoecological work of any kind is the recognition of ‘taxocenes’ - groups of species associated in the past - via ‘species associations’ - groups of species found together in death assemblages (p. 464).

The terms 'autochthonous' and 'allochthonous' are useful, the former indicating remains found where they lived (autochthones), the latter referring to fossils which have moved (actively or passively) from where they lived (allochthones). The term ‘parautochthonous’ (used by Trueman *et al.* 2005, 8383) is perhaps better than ‘autochthonous’ when we are working on the small spatial scale typical of occupation sites, since few remains will literally have originated at the sampling point, though many will have come from within a metre or so. Kenward (1976a) proposed the terms *circumjacent*, *local* and *regional* as useful subdivisions of the allochthonous component for discussion of the origins of fossils. The problems of 'background fauna' in insect death assemblages is discussed on p. 57 (and highlighted where relevant elsewhere), and mentioned for the eggs of parasitic nematodes on p. 27. Such a component will almost always be present for most invertebrate groups, but the numbers may usually be vanishingly small for some groups (e.g. landsnails). Longer-term residuality is a more important problem for robust remains, for example those of marine molluscs.

Assemblages of biological remains may be brought together in various ways. The greater part of the individuals contributing to many assemblages certainly lived more-or-less where they were found, or were dumped there following human exploitation (as in the case of shellfish). Dumping of waste material, spoil, and so on, undoubtedly added biological remains to many forming deposits, and importation added others. There is no doubt that many invertebrates (and other remains) originated away from the point of formation of many deposits, and in some cases whole communities and death assemblages were probably transported over short or long distances (e.g. in dumped waste or in turf).

Background fauna in insect assemblages has generally been considered in terms of active movement, usually by flight, but dead insects were certainly carried by the wind or deposited in the droppings of various vertebrates. Kenward and Large (1998b), with some trepidation in view of the wider implications, considered the possibility that *Anobium punctatum* (woodworm) remains are so consistently present because its robust remains blew around as dust (the repeated occurrence of *A. punctatum* was remarked upon by Osborne (1983) in the context of cess pits). Transport by water has been recognised as a major problem in overtly riverine or flooded deposits, but remains were probably carried over short distances by trickles and splashing on most sites; one of the deposits at the 61-63 Saddler Street site, Durham probably provides an example (Kenward 1979d).

Other remains were undoubtedly carried inside animals. Bird droppings have been suggested to have been important on the basis of modern studies (Kenward 1976a), and occasionally more or less positively identified from archaeological deposits (e.g. Girling 1977; Robinson 1991b, 316). Such an origin was suspected for some twisted and fragmented remains from deposits at Saddler Street, Durham (Kenward 1979d), and for the late 13th and 14th century waterfront Chapel Lane Staith, Hull (Kenward 1979c) it was suggested that some *Aphodius* and *Sitona* remains may, on the basis of their appearance, have been introduced in bird droppings. Bird droppings may sometimes have been the source of whole plausible, but allochthonous, communities, for example at Tanner Row, York, where a mixture of dung beetles and grassland species appears to have been imported in this way (Hall and Kenward 1990, 343, 345). It has been suggested that the very fragmented remains of 'outdoor' insects found in floor deposits of some of the houses at 16-22 Coppergate, York, may have originated in predator droppings (Kenward and Hall 1995, 736), although other mechanisms were possible (the writer currently favours roofing materials as a probable source).

Amphibian guts are a likely source of remains, especially in pits and wells, insect cuticle at least passing through in good condition (e.g. Bland and Sinclair 1997, for a toad, *Bufo bufo* Linnaeus). Toads have even been recorded eating honey bees (Smith, M. 1951, 96). Molluscs as well as insects and other invertebrates have been found in frog's (*Rana temporaria* Linnaeus) stomachs (Blackith and Speight 1974; Smith, *loc. cit.*, 124-5). These observations suggest caution in interpretation of anomalous groups of invertebrates of kinds likely to have been eaten by amphibians. An example of invertebrates (in this case centipedes and woodlice) which may have been introduced in amphibian faeces is presented by material from Dundrennan Abbey, Kirkcudbrightshire (Kenward EAU 1997/04; 2001b).

Invertebrate remains may have been brought to sites in the dung of domestic animals, especially horses; or been deposited when gut contents were discarded during butchery. If this can reasonably be established in any particular case, the remains will be useful as 'samples' of the feeding habitats of the beasts concerned. Human faeces may also have carried invertebrates (in addition to parasites), Osborne (1981, 269; 1983) having established that insect remains pass through the human gut 'and emerge in perfectly identifiable condition'. The bean weevil *Bruchus rufimanus*, recorded at various sites, provides likely examples from the north of England (p. 353). Fish guts may have been one origin of freshwater organisms such as ostracods (Henderson 1990, 1), as well as a wide range of marine invertebrates.

Studies of the dissociation of corpses have been carried out on many occasions for vertebrates, and there is a little work on molluscs (some is cited below), but there is almost none on the insects. Duncan *et al.* (2003) examined the way cockroach sclerites disarticulated and broke, showing differences according to different environments. Although they were working in the ambit of Carboniferous palaeontology, their results are relevant to archaeology and suggest the kind of research which might be worthwhile in both natural and artificial depositional environments. The degree and distance of dissociation of sclerites is relevant to deposit formation issues, as well as to the estimation of minimum numbers (p. 51). Plotnick (1986) followed the decay and dispersal of shrimp corpses, suggesting that disturbance by scavengers and burrowing fauna was a major factor in their destruction.

Invertebrates, or their remains, were certainly imported to sites as a result of human activity, imported materials of particular significance in this respect including dyeplants, hay, turf, firewood, moss, and peat. Remains associated with these will be valuable as indicators of resources if their origin is recognised but may confuse interpretation of local environment if it is not. They are discussed under the relevant headings. Transport may have been over great distances. Some records of grain pests may be of insects carried from far away, even directly from overseas. The cowrie shell mentioned on pages was certainly imported, and a good example from outside the area considered here is provided by the southern European longhorn beetle recorded by Osborne (1971) from Roman Alcester. There were doubtless many importations of species which subsequently became established so that any transported remains cannot reasonably be distinguished, but records from ships (e.g. Hakbijl 1987; Pals and Hakbijl 1992) show that insects were carried, as happens now (e.g. Aitken 1975). The possibility that the southern bugs found in the Roman well at The Bedern, York, were brought from far away, perhaps in hay, is discussed on p. 157.

It is just possible that the specimens of *Arpedium brachypterum* found in Anglo-Scandinavian deposits at Coppergate and Pavement (Hall and Kenward 1995; Buckland *et al.* 1974) had been imported, perhaps from a Scandinavian source in moss used for packing. However, the beetle may have lived on the North York Moors, or even have been contaminant (p. 128).

Preservation issues: introduction

There are two main aspects of preservation of any kinds of remains: (a) survival during the process of deposit formation and (b) subsequent long-term preservation in the ground. Both are enormously important but neither has received much study. Survival during deposit formation is likely to be primarily related to rate of deposition of the matrix, its chemistry, and to biological activity, these factors being closely related. Subsequent survival will be affected by these parameters, but with water content, permeability and the nature of surrounding deposits enormously important too. Preservation is a dynamic phenomenon - it needs to be *maintained* in some way rather than being a stable 'rest' state, and the balance of factors permitting the survival of biological remains, especially the more delicate ones, is easily disturbed. There is a great need for systematic investigation of preservation of the various kinds of invertebrate tissue, particularly the cuticles of arthropods, as well as of other kinds of organic materials, in archaeological deposits, and especially in complex urban ones. Work in this direction has started, primarily in a geological context (p. 100), but empirical observations of remains in modern deposits, including analysis of cuticular degradation in relation to visually-recordable decay stages, and strategic laboratory studies of decay under controlled conditions probably represent the best way forward. We remain in a state of ignorance: it has, for example, been assumed tacitly that the quality of preservation of insect remains is primarily related to anoxia, but A. Hall has suggested (pers. comm.) that plant tannins may be a significant factor in preservation in many occupation deposits - and indeed this mechanism has been suggested for bog bodies and other remains in natural deposits (Hopkins 2000, 502). It may account for the very well preserved darkened insect fossils sometimes found in urban deposits (p. 103).

Prediction of the likely quality of preservation of invertebrates - even the more robust molluscs - in archaeological deposits is by no means easy (p. 105), and we know little of the structural and chemical changes which occur during and after burial. The question of differential preservation within the major groups has barely been examined, although within the insects it is suspected that some apparently robust remains, such as those of Orthoptera (grasshoppers and crickets) may decay much more easily than most others (p. 50), and it is reasonably assumed that calcareous remains will be more robust than uncalcified ones at medium to high sediment pH levels.

Invertebrate remains of some kind will probably be present in the deposits at almost every site, although which and in what concentration will depend on local conditions - they may be so rare as to be valueless. In any particular deposit invertebrates may, like other biological remains, be preserved in one or more ways: charred, mineral-replaced, by desiccation, by anoxic waterlogging, through decay-inhibiting toxins, and, in some parts of the world, frozen or in tar.

There is unquestionably bias in the fossil record caused by differential preservation (snails and bones survive best in calcareous deposits, plants and insects in waterlogged ones, for example). A major problem in reconstructing depositional environments is the concept of self-preserving organic accumulations and the bias in favour of foul environments likely to be cause by them: this problem was discussed by Hall *et al.* (1990, 389), for example. The more organic matter that is deposited, the more likely is preservation by anoxic waterlogging. But it is certainly not reasonable to assume that areas without organic preservation at any particular period were actually clean! This is something which is reasonably well understood by many archaeologists. Philips and Heywood (1995, 18), for example, suggested that carbonates in the deposits, earthworm activity, and perhaps changing water tables, had led to poor preservation of the less robust organic remains, including insects, in deposits at York Minster, and wisely avoided the conclusion that there had been little input of organic matter.

Work on the preservational taphonomy of invertebrates in archaeological deposits can hardly be said to have started, either at the level of deposit formation or of in-ground decay. An understanding of the taphonomic history of archaeological insect assemblages, as of other bioarchaeological remains, is an important component of their meaningful interpretation. A significant indicator of the depositional history of fossils is their state of preservation. The degree of decay, whether through chemical degradation or mechanical damage, may give clues concerning, among other things, differential preservation, residuality, the separate origins of ecological components, time sequences in communities, unusual origins (e.g. milling, bird droppings), and episodes of dehydration or other transient assaults on deposits. Objective schemes for recording the degree of decay will be crucial in evaluating these factors and in determining the success of schemes of in-ground preservation of the archaeological heritage. Kenward and Large (1998a) presented a scheme for recording preservation of insects and other invertebrates having similar preservational properties, such as cladocerans, mites, spiders and centipedes; this is considered, together with other scales relevant to invertebrates, below (p. 122).

Buried soils may give a range of preservational states, since they will typically have received a constant input of corpses which usually will have decayed completely in a few years: sealing the deposit may give range of preservational states from very fresh to badly decayed, a frozen moment in a dynamic system. This was discussed by Hall *et al.* (1980, 107-8) in regard to the buried Roman or pre-Roman soil at the Skeldergate site, York, site. A second example was recorded at Citadel Way, Hull (Hall *et al.* PRS 2001/03). This variable preservation may provide useful evidence for many deposits (see p. 121).

At a grosser level, what proportion of sites or deposits can be expected to yield a useful quantity of invertebrate remains? This question is not readily answerable since sites vary so greatly with location, period and type. Publications concerning bioarchaeological remains usually only deal with sites where there was preservation, and there is rarely any way of judging from site reports which lack an account of invertebrates whether this was oversight or they were genuinely rare or absent. Evaluation work carried out in relation to the planning process is useful in that a wide range of site and deposit types are investigated bioarchaeologically, albeit superficially. Unfortunately both senses of the word 'superficially' operate here: often only shallow layers, which tend to have poor preservation, are seen, as well as the remains being looked at cursorily.

There is a bias in the opposite direction, however. Inspection of the evaluation sites listed in Table 3 (insect sites) might lead to the assumption that a rather large proportion of sites have waterlogged preservation, since evaluation sites might be expected to represent a random sample of what is in the ground, and all EAU and

PRS evaluation sites (for which it is known that invertebrates were actively sought) have been included. However, even here there are biases introduced in two ways. Firstly, because they need to win contracts, there is a tendency for units to refuse to include a component in their tenders for investigation of material which they 'know' is not there (it often is, however!). Secondly, the author's experience suggests that further sites where no 'environmental' potential is perceived during excavation ever come to the notice of environmental archaeologists even though consultation and sampling may have been written into the specification for the excavation. Similarly, 'evaluations' carried out by organisations or individuals lacking expertise in, or even awareness of, invertebrate fossils seem – on the sample available to the author – often to fail to address the potential of these remains, or to mention them in reports, even when it might reasonably be assumed that they were present. This problem is discussed further on p. 484.

Survival of remains preserved by anoxic waterlogging

Anoxic waterlogging provides the most useful sample of ancient organisms for reconstruction of past climate, ecology and human life. It is usually defined as conditions under which decay is inhibited by the lack of free oxygen, greatly reducing the activity of decomposer organisms, but it may be more accurate to think in terms of the development of a complex set of chemical conditions, restricting biological activity through the unavailability of some compounds and the toxic effect of others. Certainly, some deposits do not appear to be saturated with water; certain layers, such as the brushwood, at 16-22 Coppergate, York (Kenward and Hall 1995) were open-textured with gas- rather than water-filled spaces, yet gave excellent preservation of insects, for example. That tannins may have been an important preservative has been suggested above. Toxic metabolites may have inhibited even anaerobic bacteria. Anoxic conditions (possibly with the addition of special factors yet unknown) may give quite astonishingly good preservation: examples are provided by some of the Anglo-Scandinavian deposits at 4-7 Parliament Street (Hall and Kenward EAU 2000/22) and by a pit fill at 1-9 Micklegate (Kenward and Hall EAU 2000/14).

There is, as mentioned above, little information concerning decay pathways of invertebrates, either in modern environments or buried. Assumptions have been made about the decay of insect cuticle by loss of protein, leaving the 'tougher' chitin, and there is now more objective evidence: Stankiewicz *et al.* (1998), for example, studied decay of the chitin-protein complex of crustacean cuticle (which has similarities to that of insects), finding that both elements degraded fairly quickly under anoxic conditions, but that chitin survived preferentially, concluding that some mechanism must operate to bring about preservation. Briggs *et al.* (1996) also found chitin to be stable (their statement at one point that chitin is rarely preserved refers to 'hard rock' fossils, not Quaternary or archaeological ones, in which it is certainly present). Briggs (1999) reviewed the evidence concerning cuticular preservation and decay. Other references are given by McCobb *et al.* (2001; 2004).

Observation of a large number of archaeological assemblages suggests that in real deposits decay may follow various pathways, so that insect remains in particular may show a range of characteristics. They may have lost their mechanical strength and become thin and 'filmy', but without significant loss of colour; or have retained colour, surface features (including hairs and scales) and form but become extremely brittle (e.g. in Late Iron Age to early Roman ditch fills at South Dyke, West Yorkshire, Kenward and Large EAU 1999/02; 2001b); or have lost colour and retained form; or have darkened (e.g. Hall and Kenward EAU 2000/22; Kenward 1983a; Kenward and Carrott PRS 2002/49); or have both lost colour and become thin and flexible; or have changed colour towards brown, orange-red or yellow. Some remains of the beetle *Trox scaber* from the Layerthorpe site (Hall *et al.* EAU 2000/64; Hall and Kenward 2003a) showed yet another kind of decay, being solid but brittle and having a peculiar surface texture: these may have passed through a tanning bath (p. 365).

This complexity is reflected in the recording scheme devised by Kenward and Large (1998a), which recognises chemical degradation ('erosion'), fragmentation, and colour change as well as many minor characteristics. Colour change to brown has been observed by Carrott *et al.* (EAU 1995/08, EAU 1996/15; Davis *et al.* 2002) at the 44-45 Parliament Street site, York and may reflect recent decay under artificially induced alkaline conditions. Red to yellow colours are usually assumed to indicate a generalised 'poor' state of preservation, although it may be that they, too, at least sometimes flag recent oxidative decay. Cuticle which is excellently preserved but shows darkening is assumed to have captured some substance, perhaps a sulphide or (as mentioned above) tannins: the change can be reversed by the use of acid (Kenward 1983a).

There is a need for research into cuticle decay using SEMs of sections and surfaces, and chemical analysis to determine which materials (elastin, chitin, sclerotin, pigments, waxes) disappear or are modified during different routes of decay. The loss of colour or trend to reds and browns is presumably a result of the breakdown of particular cuticular components.

Certain insects seem preservationally much more robust than others, cuticle which is thick and very dark cuticle in general appearing more durable than that which is pale and thin. Even within a single sclerite, the pale areas may decay, leaving only the darker ones.

Most other arthropods - mites, spiders, etc. - appear to behave much like insects in decay. The cuticles of some Crustacea seem to have very different patterns of degradation, presumably because they have chemically less robust, calcified, cuticles. Woodlice are normally found preserved by mineral replacement in archaeological deposits, it seems, but in one case (a 14-15th century well at 22 Piccadilly, York, Carrott *et al.*, EAU 1995/53) perhaps by anoxic waterlogging in a chemically buffered environment (there was much mortar or plaster).

Cladoceran resting eggs (ephippia) preserve well by anoxic waterlogging except under extreme conditions, but the filmy carapaces of water fleas seem to need special conditions, for example in fine-grained lake sediments. They occur rather rarely elsewhere, although perhaps they are not often sought sufficiently assiduously, in pit fills, for example. Ostracoda have calcareous 'shells' and seem robust except under acid conditions.

Eggs of parasitic nematodes seem to behave approximately as insects, but are rather more robust than most, and often (with very toughest beetles and fly puparia) among the last recognisable remains in very decayed assemblages. They may be so damaged as not to be closely identifiable, however. Earthworm egg capsules and *Heterodera* cysts appear very robust too, but they may often be later intrusions.

Models of post-depositional decay in waterlogged deposits at the macro (say, 100 m), meso (say, 10 m to 10 cm) and micro scale need to be constructed. Theoretically, uniform decay might be expected in a uniform deposit, but minor variations in deposit structure and chemistry doubtless make preservation patchy, as typically observed.

Groups of insect fossils assumed to have undergone such vigorous decay that only very tough remains, such as those of some weevils and ground beetles, survive have been observed rather frequently. At The Vivars, Selby, for example, it was thought likely that, because of poor preservational conditions, robust fragments of weevils and snails were all that remained from a larger invertebrate death assemblage (Carrott *et al.* EAU 1995/38). Some of the samples from excavations on the line of the M57 Link Road, Merseyside (Carrott *et al.* EAU 1994/17) gave strongly yellowed or reddened remains which appeared to be the product of differential decay through the activity of micro-organisms under oxidising conditions; the beetles which had survived (mostly weevils) were typical of the last remnants in oxidised deposits. Carrott *et al.* (EAU 1996/43) noted that in a post 18th century pit fill at Holmechurch Lane, Beverley, the only invertebrate was very poorly preserved fragment of weevil cuticle. Similar material was observed by Carrott *et al.* (EAU 1994/31) at a site at

Dringhouses, York; by Carrott *et al.* (EAU 1996/55) in a putative Romano-British ground surface at Kingswood, Hull; by Hall *et al.* (EAU 2000/49) from evaluation of a Roman ditch fill at land off Wiggington Road, York; and by Hall *et al.* (EAU 2002/01) in Romano-British ditch fills at West Lilling, North Yorkshire. Again in Hull, the Blanket Row excavations produced a series of cases where it appeared only a selection of the tougher remains had survived (Carrott *et al.* EAU 2001/12). In central York, an organic deposit of probable 10th-12th century date at 3 Little Stonegate contained mainly very decayed remains of large synanthropic beetles (Large *et al.* EAU 1999/46).

Carrott *et al.* (EAU 1994/13), in their assessment of material from sites in the Swinegate area of York, suggested that reddish and yellowish insect remains from some layers reflected poor preservation. They suggested that differential preservation may have occurred, posing the possibility that the predominance of woodworm and spider beetles in many medieval urban deposits is a result of preservational robustness rather than (as seems more probable) being evidence of the restriction of the fauna in relatively clean towns. It seems very likely that red, yellow and brown colours which are *uniform* across deposits may indicate recent decay, however see p. 109.

Another case when calcium-rich deposits may have brought about an unusual kind of preservation is provided by samples from a watching brief on land to the rear of Chapel Farm, Holme-on-Spalding-Moor, assessed by Hall *et al.* (PRS 2002/14). Two peculiar calcareous fills of a timber-lined pit contained a few insects and snails. The lower fill included some remarkable insects, articulated but completely decolourised. The stratigraphic position suggested that these were ancient, so that their condition appears to have resulted from the exceptional, calcium-rich, environment.

Predicting preservation by anoxic waterlogging

The ability to predict preservation of whatever type, but particularly of anoxic waterlogging in view of its research, financial and curatorial implications, is clearly desirable for curators and practitioners alike. Charred preservation of invertebrates is rare but general; preservation of calcareous material is fairly (if not entirely) predictable. While in many cases the likely presence or absence of anoxic waterlogging can be guessed at, for a very large proportion of sites the only way to be sure what is in the ground is by excavation and laboratory analysis.

The superficial rock or soil type is not necessarily a guide to potential. It might be expected that chalk or limestone bedrock would create conditions ideal for the survival of bones and shells, while acid substrata would lead to their destruction. This is not always so: leaching has occurred at many sites on calcareous subsoils, giving poor (or no) preservation. Conversely, pockets of neutral or high pH exist on acid subsoils as a result of human activity (depositing bone, ash or limestone) or biological processes (precipitation of marl by algae). Sharp drainage at the surface may belie the existence of deeper waterlogged layers: free-draining dune sands at Low Hauxley had organic deposits with anoxic waterlogging beneath them, for example (Issitt *et al.* EAU 1995/16). On the other hand, present-day waterlogging is by no means a guarantee of anoxic preservation! Deposits may have formed slowly, permitting decay, or surface deposits may have been well-drained in the past. Sea-level changes, river alluviation and human activity have raised water tables in places, saturating formerly well-drained deposits. A vertical gradation of quality of fossils is often encountered, the more superficial deposits giving progressively less good anoxic preservation. But human activity in the past seems to have tipped the balance in favour of anoxic preservation in some periods (by dumping large amounts of organic matter, as in some parts of Anglo-Scandinavian and post-Conquest York) or against it (by providing drainage and by organised waste disposal, as in the later phases of Roman towns generally, and in most later and post-medieval surface layers).

It is not at all surprising that preservation by anoxic waterlogging is usually lacking at sites where soils are free-draining or alkaline or depositional conditions were harsh. Samples from a kiln floor at a well-drained site at Bishop Wilton, East Yorkshire (Carrott *et al.* EAU 1993/06; EAU 1993/09), for example, gave only some charred plant remains, while evaluation of pre-Roman (presumed IA) ditch fills Duggleby Lodge, near Malton, North Yorkshire (Carrott *et al.* EAU 1993/12) showed the deposits to be completely barren, but this was predictable since the sediments were pale coloured, with flint and chalk, perhaps representing redeposited 'head'. Similarly Dobney *et al.* (EAU 1993/19) failed to find waterlogged fossils in surface deposits and fills of shallow cuts of Roman date at the Orchard Fields, Malton, site, in the vicus of the fort of Derventio, located on well-drained terrain, and Alldritt *et al.* (EAU 1991/02) found very limited preservation in sharply-drained deposits with clear evidence of earthworm activity and root penetration on high ground at The Mount, York. At 13-17 Coney Street, York, where superficial deposits in one of the better-drained areas of the central part of the city were being evaluated, Carrott *et al.* (EAU 1991/13) again found no preservation. Other examples from the same city are provided by Carrott *et al.* (EAU 1991/18; 1992/10; 1992/13; 1994/31; 1995/21).

Elsewhere, Carrott *et al.* (EAU 1994/07; 1995/15; see also Dobney *et al.* 2001) found only traces of preservation by anoxic waterlogging at the Filey Carr Naze site, on a high promontory on well-drained boulder clay; and shallow deposits at Cottam, high on the Yorkshire Wolds, were barren of such material (Carrott *et al.* 1999) (preservation of all classes of material which is not charred or siliceous is generally poor on the Wolds, the origin of whose soils is discussed on p. 275). At Catterick there were only traces of waterlogged preservation (Carrott *et al.* EAU 1994/41) and at Flixborough, on elevated sharply-draining dune sands, there were almost no invertebrates other than molluscs, and such insects as were recovered appeared to be modern contaminants (Dobney *et al.* EAU 1993/21; Hall EAU 2000/56). (At this last site, molluscs had apparently been preserved only because ash and (or) bones had buffered the deposits locally.)

These and many other sites have given no anoxic waterlogging (Table 4), but this emphatically should not be seen as a reason to fail to collect samples from 'unpromising' deposits! There may be preservation of delicate remains locally, but it may not be obvious where, and in addition there may be significant charred or mineralised remains. The implication is that thoughtful sampling is almost always worthwhile, certainly during full excavations. Sampling is cheap, and the less likely preservation is then the more valuable remains may be if present! It is also suggested that these 'barren' deposits may with further research prove to contain at least limited information of archeological value (p. 464). Large scale sampling will inevitably be inhibited by cost under competitive tendering for evaluations, however, and – unless extensive damage will be done to the deposits – cannot be justified where there is no prospect of subsequent investigation of the material.

In contrast to these examples, where survival of delicate remains was hardly to be expected, the rarity of preservation by anoxic waterlogging is surprising at some sites. Few of the samples from the North Bridge site, Doncaster contained insect remains, for example, although there was sporadic preservation of some rather remarkable groups of remains (Carrott *et al.* EAU 1997/16; Hall *et al.* 2003c; Kenward *et al.* 2004a). This was despite the location of the site adjacent to the New Cut, a diversion of the River Don, and the fact that it did not appear to be well drained. The explanation for this is unclear; perhaps a low rate of input on surfaces allowed decay before sealing took place. Carrott *et al.* (EAU 1995/38) found virtually no preservation of insects or other invertebrates in deposits at The Vivars, Selby, which were very fine-grained and considered by the excavator to be pond sediments - a prime case for a prediction of first-rate preservation. Similarly, deposits in some parts of the King's Fishpool, York do not reliably give the rich assemblages preserved by anoxic waterlogging that might be expected on the basis of their location (e.g. the Adams Hydraulics I site, Alldritt *et al.* EAU 1990/01; Rosemary Place, Carrott *et al.* EAU 1994/47). Another case where the rarity of anoxic waterlogging was surprising was Fishergate, York (Allison *et al.* EAU 1989/02; 1996b), where extensive Anglian occupation deposits, many in cut features, were examined for invertebrate macrofossils on a very large scale, yet only two small groups of insects were detected (with traces in a few other samples), and parasite eggs (and ‘waterlogged’ plants) were rare. The site is at low elevation beside the River Foss, so here it seems most probable that the rarity of preservation was related to low input of organic matter and consequent rapid decay (there was a little ‘mineralised’ plant material, A. Hall pers. comm, so clearly there was some organic input and temporary anoxia - see p. 113 for a brief discussion of rates of mineral-replacement).

In general, superficial (and thus generally chronologically later) deposits show poorer preservation, and deeper deposits better. This is not an invariable rule, though, and there may be ‘suspended’ deposits with anoxic preservation of delicate remains (Kenward and Hall 2006). Clearly input of organic matter is important, as exemplified by the contrast between (barren) deep Roman and (fossil-rich) more superficial Anglo-Scandinavian deposits at 16-22 Coppergate, York. Near-surface deposits may give good preservation: for York, this was the case in fairly shallow cuts at the NCP car park site, Skeldergate, (Jaques *et al.* EAU 2000/53), and on land to the rear of 7-15 Spurriergate (Hall *et al.* EAU 2000/80).

Post-medieval surface-formed deposits are generally (but not invariably) devoid of ‘waterlogged’ remains. Cuts, however, may give at least limited preservation, a contrast seen, for example in a latrine pit at Sammy’s Point, Hull (Carrott *et al.* EAU 1997/21) and fills of the nearby Citadel moat (Carrott *et al.* EAU 1997/22). More rarely they may give very good preservation: organic artefacts in excellent condition were seen in what appeared to be 19th century wells at the Magistrates’ Courts site, Hull, and Wellington Row, York, both examples unpublished. ‘Waterlogged’ cut features of later periods thus represent a priority for investigation, most especially of insects, concerning which there are many questions to be addressed (p. 275). Floors of late historic date sometimes have remains, as was the case at Coffee Yard, York, discussed below.

There are other cases where circumstances during deposition may have prevented preservation, rather than subsequent in-ground conditions having resulted in loss. The City Garage site, Blake Street, York, was located in an area where ‘waterlogged’ preservation is sometimes recorded, at least in medieval layers, yet none of the considerable number of Roman deposits investigated produced more than a trace of invertebrate macrofossils (Kenward EAU 1986/14). It can reasonably be suggested that this was a result of its position in the heart of the fortress, where extremely clean conditions were probably maintained over long periods as a result of military discipline (although there is admittedly a danger of circular argument here!). Low input was implicitly argued to be the cause of the lack of organic preservation in Roman levels at 1-5 Aldwark (Kenward *et al.* 1986b, 267). Roman deposits at 16-22 Coppergate again gave no anoxic waterlogging although there was superb preservation in later deposits. The lack of remains may thus merely reflect low input - in this case probably a result of cleanliness - during deposit formation. Filth seems to be self-preserving in the archaeological record.

It has been argued that most surface deposits at occupation sites are inherently likely to give poor preservation by anoxic waterlogging, because they were typically disturbed and well-aerated during formation. Deposits formed slowly on surfaces may sometimes have useful to good preservation, however. At the Coffee Yard, York, site (Robertson *et al.* EAU 1989/12) there were insect remains in very unpromising deposits, for example a layer of 18/19th century date described as crumbly silty sand with much mortar, yet containing a large insect fauna. Waterlogging may not have been primary mechanism in cases such as these, though. At Coffee Yard, deposits which had a rather low water and organic content at the time of excavation may not have been waterlogged at any time, and something akin to ‘mummification’ may have been the preservation mechanism. The state of the fossils - rather reddened and fragile - was considered to be compatible with this (but see discussion of in-ground decay on p. 110). The Anglo-Scandinavian floors at the 16-22 Coppergate site, York, gave excellent preservation of abundant and varied insect remains by anoxic waterlogging (Kenward and Hall 1995). In this case the mechanism is much less certain - a possibility is that the floors were sufficiently dry at the surface during use to prevent extensive decay of the insect corpses, which then became waterlogged when the overlying layers were deposited. Alternatively, the organic matter on the floors may have been compressed by trampling (but there was preservation in corners and other probably uncompressed areas). It seems unlikely that these rather thin floor layers were actually saturated with water during use. A further possibility (even less likely in view of the nature of the fauna and of the layers concerned) is that all the remains fell from the structure during demolition and then were immediately buried. Much needs to be done to if we are to arrive at a better understanding of the taphonomy of insect remains in deposits such as these.

In some cases there is preservation in deposits which are lithologically very unpromising. The case of Coffee Yard has been mentioned above. At the Annetwell Street site, Carlisle, some Roman sandy layers gave quite good preservation of fairly small numbers of remains (Kenward and Large EAU 1986/20; Allison *et al.* forthcoming b); these may have been preserved as a result of sealing by organic or impermeable mineral layers. It is important to be aware of the possibility of such phenomena! A thin layer of humic material, only a few millimetres to a few centimetres thick, of Roman date at Coney Street, York (R. Hall and Kenward 1976; Kenward and Williams 1979) contained immense numbers of quite well preserved insect remains, most of them grain beetles. Here, preservation seems to have been enabled by a thick impervious dump of clay having been immediately laid down after demolition of the building and prior to a new phase of construction. This material was nearly overlooked because it appeared so insignificant in the field, only being collected as a result of the enthusiasm of a member of the excavation team, emphasising the need for vigilance, strengthening the case for a general policy of intensive sampling and assessment (see p. 440).

Some unpromising near-surface deposits do prove to contain insects and other invertebrates (and plant remains) in good condition, but undoubtedly because they are very recent intrusions (p. 478).

In summary, deposit type and lithology give clues as to the likelihood of preservation, but exceptions are common and sampling and assessment are essential. We could be forgiven at this stage for believing there are almost no clear rules! And, to complicate matters further, 'there's none so blind as will not see' inconvenient and potentially expensive deposits with good preservation, in a world of contract archaeology driven by financial survival.

Recent decay of deposits with anoxic waterlogging

It is generally assumed that deposits devoid of remains preserved by anoxic waterlogging never had good preservation; destructive decay occurred during or immediately following deposit formation, or the deposits were inherently hostile to preservation. This is indeed suspected to be close to the truth for many sites. On the other hand, some to many deposits which have been waterlogged since they were laid down (naturally or in a suspended water table retained by dumps of clay, or in 'sponge' layers with a high organic content, Kenward and Hall 2006) may now be drying out as a result of de-watering caused by development, drainage, reduction in rainfall or over-abstraction. York presents cases of the first, while drainage appears to be the problem at many sites. The peats at Seamer Carr, near Scarborough, undoubtedly represent a case where there has been damage by drainage, which will continue unless immediate remedial action is taken (Carrott *et al.* EAU 1996/52; Kenward and Large EAU 1997/30). Fossils in deposits at many other sites may have decayed recently, but this is very hard to establish. An example is provided by Roman-British ditch fills at a site east of High Catton, East Yorkshire, where preservation was very variable, but whether through decay during deposition, subsequently in antiquity, or recently, could not be ascertained (Kenward *et al.* EAU 2002/12). Fossils at this site (and various others too) proved to be highly fragmented, and there must be a suspicion that this damage is recent, perhaps through the crushing effect of heavy machinery used to clear superficial deposits.

A substantial study of suspected in-ground decay was carried out on material from 44-45 Parliament Street, York (Carrott *et al.* EAU 1996/15; Davis *et al.* 2002), following observation of biological remains in an unusual preservational state during a routine evaluation (Carrott *et al.* EAU 1995/08). The more delicate organic remains in the samples analysed for plant and invertebrate remains showed strong evidence of oxidative decay. It was contended that such remains would have disappeared completely, had adverse conditions persisted over a long period, and that these remains had been preserved by anoxic waterlogging until recently, some change in ground conditions within the last few decades (at most) allowing the onset of decay. The most likely cause was thought to be a fall in groundwater levels, probably combined with leaching of alkali from the concrete slab overlying the deposits. These conclusions drawn from an examination of the fossils were strongly supported by direct observation of the samples of deposits. All of the deposits examined contained organic matter, in several cases in the form of concretions familiar from previous excavations and regarded as being faecal in origin. Some of these concretions showed signs of oxidation, with voids seemingly left by the decay of delicate remains, and the softer-textured areas rather orange in colour. Wood was soft and spongy in texture, reddish in colour, and would undoubtedly decay to dust very quickly with exposure, although some of it had a brittle core which may have been the result of mineral replacement. It was contended that organic material was most unlikely to have remained in this condition for nearly a millennium. It is worth noting that shrinkage of organic deposits under a concrete slab was observed at the BHS site, Feasegate, York, during 1998 (Carrott *et al.* EAU 1998/16), and that similar evidence has been obtained in Sweden (Ljung nd). At Feasgate, many deposits showed white flecks, probably calcium sulphate, just as at Parliament Street.

Some of the rather shallow deposits at St Andrewgate, not far from Parliament Street, contained insects with yellow-brown or orange-yellow colours, quite possibly recently decayed (assessed by Jaques *et al.* PRS 2002/12). Subjectively, other deposits at this site seem likely to have lost their delicate remains at the time of deposition. Insects from the Swinegate, York, site included many groups which were poorly preserved, being reddish or yellowish in colour and often highly fragmented (Carrott *et al.* EAU 1994/13). In a number of cases, it was noted that differential preservation may have occurred, and the samples appeared to provide an opportunity to examine stages in the decay of insect assemblages; with hindsight it seems entirely possible that there had been recent degradation. Remains in upper layers at many sites are poorly preserved, often red or yellow. It seems to be received wisdom that this simply reflects long-term poor conditions for preservation, the remains being suspended at some intermediate stage of decay or very gradually degrading, but it has been suggested that recent in-ground decay following water-table or drainage changes may be the cause (Carrott *et al.* EAU 1996/15; Kenward and Hall 2000; 2004a; b; 2006; see also p. 122). If this should prove to be the case, the implications are enormous. If the zone of decay is moving downwards, few sites are safe; this clearly needs intensive monitoring.

In a rural setting, insect remains from an undated (possibly Roman) ditch fill at Gadbrook Park, near Northwich, Cheshire (Carrott *et al.* EAU 1996/45) showed variable preservation, typically fresh or slightly pale, but in a few cases retaining their original colour but having localised areas of considerable or complete decay. There was no reason to suppose that the variable preservation indicated origin by redeposition or the presence of modern contaminants, and it seems possible that these remains were suffering the onset of oxidative decay caused by a lowering water table or other disturbance. At the North Cave, East Yorkshire, site (Allison *et al.* EAU 1997/37; forthcoming a) it is possible that organic remains in some Romano-British ditch fills have recently decayed as a result of water table changes, but it is equally possible that the damage occurred when water tables fell then rose in the past; it will always be important to consider past as well as present fluctuations when making decisions about in-ground preservation.

Information concerning differential preservability in urban insect assemblages will be of considerable value in the interpretation of poorly preserved groups generally. The persistence of some tough weevil remains is mentioned above (p. 104), and some carabid and staphylinid sclerites also seem exceptionally robust. Where such remains are present, it is generally obvious that they represent the last vestiges of a larger fauna. There are other issues, however. In particular, is the predominance of spider beetles and woodworm beetles in many medieval urban deposits (mentioned above) a result of a very restricted fauna or of the preservational robustness of these insects?

Lateral and vertical variation in anoxic preservation: deposit models

The construction of deposit models is a worthy aim, but fraught with difficulty so far as preservation of the more delicate biological remains is concerned. Every context is a different case, and what preserves in it depends on the way it formed, on the matrix, its inclusions, on the surrounding deposits, and on the overall characteristics of the site and the area (bedrock, water tables, rainfall). A model of preservation of delicate organic remains in a town is offered by Kenward and Hall (2006).

As pointed out above, there is often a vertical trend in the quality of anoxic preservation within deposit sequences: it is often better in the deeper deposits. This is by no means a hard-and-fast rule, however. As mentioned, in York and Carlisle early Roman deposits typically give rather good preservation by anoxic waterlogging, later Roman ones very little. This is not a result of some inherent property of the vertical sequence, however, for in both towns (and in York especially) there is again good preservation in post-Roman deposits overlying barren later Roman ones. Here the cause is surely a change in human behaviour - in early and post-Roman deposits there was a massive input of organic materials, in later ones, very little as a result of the use of stone in construction and paving and the establishment of a well-organised system of waste disposal. Similar effects can be observed on a much smaller scale within sites, or even within features.

Large-scale horizontal variation is a little easier to model. There are often gross changes across towns or sites, for example in central York where different areas undoubtedly have different extents of anoxic preservation. In general, the closer to the Minster area a site is, the worse preservation of organic matter tends to get, while the closer to the River Foss, the better is anoxic preservation. This is probably not a result of elevation, but of the history of land use. There are numerous localised exceptions, though, for example in cut features at The Bedern and in cuts and some midden-like layers Swinegate. And some of the best preservation is on relatively high ground in the Parliament Street area (Hall and Kenward EAU 2000/22). These observations tend to support the argument that rate of input of organic matter is a primary determinant of anoxic preservation.

There is clearly a great deal to be done in understanding patterns of preservation of invertebrate (and other biological) remains by anoxic waterlogging.

Preservation of invertebrates by mineral replacement ('mineralisation')

The term 'mineralisation' is used to describe two, very different, processes: in geology, and almost universally in archaeology, the formation of hard mineral fossils by replacement of soft parts as they decay, or infilling of voids to form a cast; but in soil biology, the decay of organic material into simple molecules and its consequent disappearance. Using the expression 'mineral replacement' for the former avoids this problem, but since there is almost never any likelihood of ambiguity, 'mineralisation' is perfectly acceptable in archaeology. It is necessary to distinguish between mineral replacement and the sealing of fossils within mineralised sediment - both are regularly seen. Parasite eggs, in particular, often seem to be 'hermetically sealed' in faecal concretions without themselves being mineralised, for they are released when the material is treated with acid in the laboratory. Mineral replacement is an important mechanism which has only recently been understood. Briggs and co-workers have shown that remains can be mineralised very rapidly (see below), which is why some fossils, even of great age, retain fine detail in soft tissues, and even cell structure. An additional preservation mechanism which may be confused with mineral-replacement is inhibition of decay by toxic salts, sometimes (confusingly) called 'mineral preservation'.

Dog coprolites

Objects identified as dog coprolites are common in archaeological deposits. It seems likely that dog faeces were often self-mineralising because they included large amounts of bone which provided calcium and phosphate ions. They sometimes contain parasite eggs. Examples are mentioned at various points in the text. It should be noted that the coprolites widely studied in the Americas are mostly desiccated; such material has not been encountered in Britain, though it might conceivably be found within old buildings.

Mineral replacement of discrete fossils

As for seeds (Green 1979), mineralisation of discrete invertebrate fossils is apparently not uncommon on a national scale (e.g. Girling 1979; 1984; Girling and Kenward AML 46/86; Robinson 1979; 1991a). At most sites in the North of England, isolated mineralised invertebrate fossils are typically rare or are (as far as can reasonably be established) absent. This is true whether or not there is preservation by anoxic waterlogging, and (subjectively) whatever the ground conditions. In York and Carlisle, for example, assemblages of *discrete* mineralised invertebrate fossils (as opposed to concretions) are rather rarely found. This represents a remarkable contrast with some other localities, such as Southampton, where mineralised fossils seem to be rather abundant and preservation by anoxic waterlogging may be very rare (e.g. Girling and Kenward AML 46/86; Kenward and Allison AML 124/87). Odd finds of mineralised invertebrates do occur in The North, however: Hall (pers. comm.) had noted such fossils from 78 contexts of more than 4500 examined. These rare, generally undiagnostic and interpretatively unimportant, remains are unlikely to be observed by a palaeoentomologist as they will not be recovered by paraffin flotation, and if they are seen tend to be considered unremarkable and so not put on record. However, it is to be hoped that large assemblages of mineralised invertebrates, if they should occur, would be observed during botanical investigation and brought to notice.

Examples of mineralised fossils from York include occasional puparia from various sites. At the Layerthorpe Bridge site the respiratory process of rat-tailed maggots (*Eristalis tenax*) were found (Hall *et al.* EAU 2000/64). Dobney *et al.* (EAU 1992/22) noted mineralised millipede remains in medieval buildup and cut fill deposits at 45-57 Gillygate, a site giving no appreciable preservation of invertebrates by anoxic waterlogging. McCobb *et al.* (2004) describe a range of mineralised invertebrates from St Saviourgate, and the discussion of mineralised seeds from Coppergate by McCobb *et al.* (2001) is relevant here. From Carlisle, the Roman mineralised pubic louse (*Pthirus pubis*) is notable (Kenward 1999; 2001a). Rural as well as urban settlements may yield mineralised remains (e.g. in the south of England by Robinson 1991a).

The formation of mineral-replaced fossils was discussed in the archaeological context by Kenward and Hall (1995, 718-9). It was suggested that they form when mobile calcium and phosphate ions combine in anoxic conditions to produce almost insoluble calcium phosphate complexes, a process which has been shown by Briggs and Kear (1993a, 1993b) to be very rapid (indeed necessarily so if the remains are not to decay before they are stabilised by the mineral deposition!). If this hypothesis is correct (and there is no reason to doubt that it is the principal mechanism), then the lack of mineralised fossils on certain kinds of sites is probably explained by the general absence of foul anoxic deposits, unlikely to occur, for example, on small rural sites where organic matter would almost always be removed rather than buried (but see Robinson 1991a).

Girling (1979) reports calcium carbonate-replaced fossils from various sites, but it was not clear from her text whether these fossils were entirely carbonate, or may have been primarily phosphatic; subsequent re-examination showed that they were phosphatic (McCobb *et al.* 2004), as are mineral-replaced seeds and other plant remains (Green 1979; McCobb *et al.* 2001; 2003). Nevertheless, Girling's paper focussed attention on mineral-replaced or cast invertebrates, and provides a useful discussion of the varied nature of the cuticle in different arthropod groups.

Although generally lacking clear detail, mineral-replaced fossils may rarely show very fine structures, as in the cases of the louse *Pthirus pubis* illustrated by Girling (1984, 208) and woodlice and millipedes illustrated by Girling (1979), for example. Such excellent preservation is exceptional in the present writer's experience, however.

Why are mineralised invertebrates not commoner, bearing in mind the work of Briggs and others? The ingredients for mineralisation were present at many sites. One reason may be that mineralisation affected whole organic deposits rather than single fossils, leading to the formation of gross concretions (see below).

It is not at all clear why puparia, woodlice, millipedes and some soft remains (e.g. rat-tailed maggots) are the commonest mineralised invertebrates. The cuticles of these creatures have little in common which is not shared by many other arthropods. The cuticles of woodlice and millipedes contain calcium salts, which may facilitate their mineralisation, but this is not the case for flies. Is mineralisation related to their occurrence in very foul places? Beetle casts are rare, and generally not closely identifiable, although a few beetles have been seen embedded in gross concretions. Perhaps the hard parts of beetles rot too slowly to be replaced (mineralisation apparently being a rapid process, see above), or possibly internal casts of them are less recognisable than the regularly segmented puparia or thin-walled maggots.

Faecal concretions

'Faecal concretions', in contrast to discrete mineral-replaced invertebrate fossils, are very common in urban deposits at least and seem to occur in a range of conditions. They are patches of whole sediment, apparently originally always highly or entirely organic, which have undergone mineral replacement. They range from discrete lumps (e.g. the 'Lloyds Bank stool', Jones 1983b) to metre-scale layers, usually in pit fills. The degree of mineralisation is extremely variable, from slight - giving a subtle but distinctive soft 'biscuity crispness' (from a resemblance to digestive biscuits) to the sediment - to extreme (producing 'glassy' masses which can easily be mistaken for slag).

Where tested, they appear to have been complexes dominated by calcium phosphate. They can usually be disaggregated with dilute hydrochloric acid, the rate at which they break down being roughly proportionate to their density, generally releasing identifiable fragments of bran, other plant or invertebrate macrofossils, nematode parasite eggs, and even vertebrate remains (e.g. Kenward and Hall 1995, 519). Preservation within concretions may be astonishingly good (e.g. the sloe, *Prunus spinosa*, fruits with the flesh preserved and retaining a purplish colour found at 16-22 Coppergate, York, Kenward and Hall 1995), presumably a result of very rapid formation. Much the commonest invertebrate remains in concretions are parasite eggs, although fly puparia, or voids left by their decay (moulds or casts) are fairly frequent.

The more dense faecal concretions are preservationally extremely robust and are consequently very likely to become redeposited. Residual faecal concretions were recorded rather often in surface deposits at Coppergate (Kenward and Hall 1995, 545), for example, and the 'Lloyds Bank stool' was apparently recovered from a surface-laid deposit (Hall *et al.* 1983b; Jones 1983b). Concretions, doubtless redeposited, appeared in a surface-laid dump of Anglo-Scandinavian date at 2 Clifford Street, York (Hall and Kenward EAU 2000/17). Our current understanding of the way the material forms (*op. cit.*, 718-9) suggests that surface formation is extremely unlikely, and that it must normally have originated in anoxic layers within pit fills. There may be exceptional circumstances leading to gross mineralisation in deep midden deposits; for example it was suggested by Carrott *et al.* (EAU 1994/13) that concretions at Swinegate, York, of medieval date may have formed in a mass of herbivore dung in view of the lack of eggs of parasitic worms; related material has been found elsewhere (Carruthers 2000; McCobb *et al.* 3003). This is something which deserves further investigation, though not possible for this particular site.

Iñiguez *et al.* (2003a) recovered (very degraded) DNA residues from South American coprolites, presumably preserved by desiccation. More interestingly, DNA of the pinworm Enterobius vermicularis was identified from North and South American coprolites by Iñiguez *et al.* (2003b). This suggests that it would be worthwhile to investigate residues in concretions from waterlogged deposits, and also un-mineralised faecal matrix in cesspit fills, in the hope of finding evidence of the less easily preserved parasites such as tapeworms, or the remains of adult nematodes.

Other mass mineralisation

Not all concretions in archaeological deposits appear to have formed where there was faecal matter. There are a few cases where carbonates seem to be the salts involved, though none appear to have been published from the north of England. Girling (1979) reported remains as carbonate replaced, apparently incorrectly (see p. 115 for discussion of these). Kenward and Hall (1995) have suggested that tufa-like calcitic lumps may have formed in York where there was carbonate-rich seepage from limestone rubble or even standing buildings; such material might rarely give some preservation of invertebrates, though their interpretative value would probably be slight. Tufa proper, in natural deposits, may yield invertebrates, especially snails and ostracods (e.g. at Lower Beck, Malham, North Yorkshire (Keen 1989), where there were abundant molluscs dated to the middle Flandrian). Marls, too may contain useful assemblages, e.g. the Late Devensian/early Flandrian fills in a kettle hole at Kildale Hall, Kildale (Keen *et al.* 1984), containing molluscs and ostracods. There have been various studies of tufa assemblages outside the region which demonstrate the potential of such work (e.g. Davies and Griffiths 2005; Preece *et al.* 1984).

Parasite eggs and faecal concretions

Eggs of *Trichuris* (especially) and *Ascaris* may be preserved in faecal concretions even where all or most of the other preservationally labile remains have decayed (Jones 1992b). Such concretions were present in Anglo-Scandinavian surface and pit fill deposits at 16-11 Coppergate, York (Kenward and Hall 1995), for example, and when tested, they were generally found to contain parasite eggs. Faecal concretions may often be overlooked, not least because the material varies so much in appearance, but their identity can often be established by disaggregating a small sub-sample with dilute acid and examining a squash for bran and parasite eggs. A layer of '?iron pan' samples during an evaluation at 20-4 Swinegate, York (Hall *et al.* EAU 1991/23), for example, proved to contain *Trichuris* and *Ascaris* eggs when disaggregated, and so clearly was concreted faecal material. At Parliament Street, York, there were strongly decayed, mottled orange, concretions, presumably only patchily mineral-replaced, which contained recognisable eggs (Carrott *et al.* EAU 1995/08; EAU 1996/15; Davis *et al.* 2002). In other cases, concretions have been described as appearing decayed, but it is possible that they were merely weakly-formed in the first place, especially where there is good preservation of delicate fossils (e.g. in the backfill of a timber lined pit, probably of the 14th century, at 41-49 Walmgate, York, Jaques *et al.* EAU 2001/26).

Material is often recorded as 'faecal concretion' on superficial appearance (e.g. Hall *et al.* AML 56/93, 3), but (although identification by experienced workers is fairly reliable) confirmation by a 'squash' (p. 29) is desirable.

Not all concretions necessarily formed from human faeces. Sometimes an origin in faeces of livestock is suspected, for example in stable manure, an example being provided by deposits at the Swinegate site, York (Carrott *et al.* EAU 1994/13).

Mineralised worm burrows

A common form of concretion, not related to the kind just discussed, is that which forms along earthworm burrows (and also the tubes left when plant roots decay). These seem most closely allied to the pans found in certain kinds of soils, and to consist of iron compounds, often including vivianite. Mineralised burrows are sometimes recovered in fragments from sieved samples, as in the case of a pre-cemetery pit fill at the Jewbury site, York (Hall *et al.* 1994, 562).

Preservation of invertebrates by charring (carbonisation)

Charred insects are occasionally observed, but they tend to break up when handled, however carefully, and so be lost, and consequently often go unrecorded. A charred specimen of *Aglenus brunneus* is illustrated by Kenward (1978a, plate I) and shows forceps damage rather well. Other examples on record include material noted by Carrott *et al.* (EAU 1992/03) during evaluation at 104-112 Walmgate, York, where mid 10th-mid 11th pit fills with 'waterlogged' insects typical of medieval urban deposits, including several taxa indicative of rather foul conditions, also yielded a few charred remains, among them a probable fly larva. Further charred insects were noted at a site behind Spurriergate, York, by Hall *et al.* (EAU 2000/80). One 13th/13th century layer at the NCP car park site, Skeldergate, was unusual in giving charred insects and mites, and also a 'toasted' snail shell (Carrott *et al.* PRS 2004/42). A few charred insects were seen in samples from Anglo-Scandinavian layers at 16-22 Coppergate (Kenward and Hall 1995, 718), but the database (Hall and Kenward 2002) includes only a record of a charred mite, emphasising the poor recording of such material. These arthropods seem likely to have been accidentally charred in the past, when rubbish was burned, in layers beneath hearths, and as a results of accidental fires. The mechanisms producing some charred remains are much less clear. The Jewbury site, York, provided quite large numbers of intriguing charred remains of what appeared to be fly or beetle larvae from a series of 'coffin stain' deposits (Hall *et al.* 1994). These were the only preserved invertebrates and their origin is not at all obvious.

Charred insects are far less often found associated with or in charred grains than might reasonably be expected, bearing in mind the abundance of the latter. From the Coney Street, York, site, for example, a vast quantity of Roman charred grain was examined, but the only charred insect found (despite careful searching) came from an associated timber slot; it was a specimen of the grain weevil *Sitophilus granarius.* A few examples of charred grain pests have been reported for the area considered here (p. 116). Outside this area there are some much better examples. Charred bean weevils (probably *Bruchus rufimanus*, p. 95) were reported from Iron Age Somerset Levels by Caseldine (1987). Osborne (1977) found abundant charred grain pests (and numerous unidentified charred larvae and pupae) from Roman Droitwich, while Matterne *et al.* (1998) discuss at length charred storage pests from a Roman granary in France and Kislev and Melamed (2000) describe abundant charred insects, mostly adults, larvae or pupae of *Sitophilus granarius*, from Iron Age Israel. Various records of charred beetles from eastern Mediterranean were given by Panagiotakopulu (2000).

The conditions required to produced charred insect remains are not known, but perhaps quite particular. Research parallelling that carried out for plant remains (e.g. Wright 2003) is desirable if assemblages of charred insects are to be used for interpretation.

'Burnt bone' is common on archaeological sites, but burnt mollusc shell of somewhat similar appearance is sometimes encountered (discussed by Murphy 2003). Such remains are generally of marine shells and may go unrecorded despite their possible significance, e.g. in lime-making, but a more intriguing example is provided by burnt *Hydrobia ulvae* at the Flixborough site (Hall EAU 2000/56).

Preservation by dryness

'Dryness' rather than 'desiccation' is used because it seems likely that in temperate Europe remains are never dry enough for this alone to prevent decay. Desiccation per se certainly operates in other parts of the world: for fly puparia in a pit fill in Wyoming (Chomko and Gilbert 1991), mummies and coprolites in the Americas (some references are cited by Kenward 1999b), and insects in desert deposits in Egypt (e.g. Panagiotakopulu 2000, 104-112). In Northern Europe, other factors are required for preservation, especially below ground, perhaps including a hard-packed sediment with some set of chemical characteristics which inhibit the activity of bacteria, fungi, and other invertebrates, without causing undue chemical degradation of the fossils. This may have been the case for insects in putlog holes at the church of St Mary Bishophill Junior, York (Kenward 1987), and in 'floors' at the Coffee Yard, York, site (Robertson *et al.* EAU 1989/12).

Preservation in fictiles (fired clay objects) and daub

Plant remains have occasionally been reported from daub (e.g. from Althrey Hall near Wrexham, by Carruthers 1991). Though plant impressions have been noted, plant remains as such have apparently not been found in daub from the North of England as defined here (Hall and Huntley 2007). Insects have not been sought in any systematic way, but seem likely to occur and might give clues as to the origin of the mineral component and the nature of the filler (straw, dung) incorporated. Related to this kind of evidence are the numerous casts of plant remains in daub and in tile and other fictiles. Equivalent evidence of arthropods may be found but is likely to be of rather slight value, both identification and provenancing being problematic.

Preservation by salts

Invertebrates may sometimes be preserved by very localised high concentrations of metal salts, either from artefacts *sensu stricto* or from slag. This topic is discussed in the special context of inhumations by Janaway 1987), who illustrates casts of fly puparia in corrosion products of an Anglo-Saxon buckle from Dorset, and also reports experiments using rat corpses. A group of nematodes preserved on the surface of a brooch from West Heslerton (p. 26) provides the best example from the north of England known to the author. In this case the remains of these soft-bodied creatures had taken on a bright green colour as a result of impregnation by copper salts. Other examples of invertebrates preserved by copper salts include remains associated with a copper alloy brooch from Orkney (Large *et al.* EAU 1993/29), and a series of remains from sites in Germany (Kenward unpublished).

It is not clear whether - in the long term - salt water assists preservation of delicate organic remains or promotes decay. The fills of pits on the foreshore at St Margaret's Bay, Kent, certainly contained excellently preserved insects (Kenward unpublished). Insect remains have been found in marine shipwrecks (e.g. Hakbjil 1987 reported a container of ground-up cuticle from a wrecked Dutch East Indies ship), and it has been suggested that survival of the wooden foundations of buildings in Bryggen was brought about by salt from fish preparation (Kenward and Hall 2004b).

Preservation in tar (asphalt) appears unknown in Britain, though it has been recorded elsewhere (e.g. Stankiewicz *et al.* 1997). Nelson (1972) gives an example of preservation of 4.5 ky old insects in bat guano in a cave in Nevada; such preservation is apparently not known in Britain but might occur, e.g. in old buildings where bird and bat droppings have been allowed to accumulate.

Preservation and decay of calcareous remains

Bones - substantially composed of calcium salts - are a familiar component of most archaeological deposits, though they are destroyed by acidity (whether from groundwater or rain-leaching). A number of invertebrate groups have skeletons composed of, or supported by, calcite, molluscs providing the best-known archaeological examples, while ostracods are important too. Bones and marine shells are often the only non-charred biological remains preserved, but in contrast to the enormous amount of work carried out on the taphonomy of archaeological bone (see, for example, the review of Lyman 1994), mollusc taphonomy seems to be relatively poorly understood.

Molluscs are often substantial (especially marine ones) and may preserve very well. Preservation is common in sediments which range from about neutral to alkaline, but a calcareous subsoil appears not to guarantee preservation. The reason for this appears to be leaching of superficial sediments (Murphy CAR 68/2001, 2-4). An undergraduate project by J. Taylor (2001) showed that mollusc shell was readily degraded by water at a pH close to that recorded for rainwater in Yorkshire. The effects of acids produced by human or natural biological activity in soils and sediments may represent another factor. Nicholson (1988) suggests that at Queen Street, Newcastle, shellfish were eroded by 'ashy, acidic conditions', presumably coal ash rather than alkaline wood ash? It is not entirely clear what determines whether molluscs, especially terrestrial ones, will survive in the ground. It is unsafe to assume that sandy, well-drained deposits will not provide useful assemblages of molluscs. Dobney *et al.* (EAU 1993/21) and Hall and Milles (EAU 1993/27), for example, in assessment of a wide range of context types, principally of Anglo-Saxon date, at Flixborough, North Lincolnshire, a site on sharply-draining sands, found that molluscs were preserved, perhaps because there was much wood ash, or a local buffering by large amounts of bone. On the other hand, sands certainly do not normally favour the survival of molluscs. Allen (1986) suggested that molluscs at West Heslerton, East Yorkshire, had decayed as a result of ground conditions (freely draining sands); only one trace fragment of a bivalve shell and some modern *Cecilioides acicula* (p. 482) were recovered.

Appreciable numbers of deposits appear in the field or on laboratory inspection to contain useful land or freshwater mollusc assemblages, but on even very gentle processing most of the fossils may break up into fragments too small for identification or prove to be extremely eroded (examples include a 14th century ditch fill at Holmechurch Lane, Beverley, Carrott *et al.* EAU 1996/43; a 17/18th century levelling deposit at Merchant Adventurers' Hall, York, Carrott *et al.* EAU 1996/44; and natural deposits associated with the Hasholme boat, Spencer 1988). These fossils must have undergone leaching *in situ*.

Coastal sand sites often have preserved molluscs, presumably because there is sufficient calcareous matter to buffer fossils against leaching: the site at Low Hauxley, Northumberland, provides an example for our region (Issitt *et al.* EAU 1995/16).

Mollusc remains may undergo other changes. There is sometimes deposition of minerals onto snail shells, masking identification features; the material is hard to remove since acid or mechanical scraping tends to damage shells.

Marine molluscs are often represented in terrestrial deposits by very friable remains, or have decomposed into fragments which are recognisable with certainty only as originating from seashells. Shells are sometimes seen in an early stage of decay into flakes (*Ostrea*) or rather prismatic clumps of fibres, sometimes retaining purplish colour (*Mytilus*). It is suspected that, although rarely recorded, such material is often present; O'Connor (AML 4297) mentioned the abundance of oyster shell fragments in Anglo-Scandinavian and medieval deposits at 16-22 Coppergate, York, for example.

Much of the marine shell in archaeological deposits is in fact in poor condition. A rather typical assemblage of poorly preserved marine shells was recovered by hand collecting at Kingswood, Hull (Carrott *et al.* EAU 1996/55). (The occurrence of large numbers of well-preserved shells of the landsnail *Cepaea* sp. in one context at this site was thus rather suspicious, and with hindsight these may well have been modern intrusive remains.) Differential preservation may be apparent, denser shells such as winkles being in better condition than bivalves with a laminar structure. Differential decay of marine molluscs is discussed by Trewin and Welsh (1976) in a notable study of modern death assemblage formation. Diagenesis varied with species; they note the tendency of *Mytilus* to disintegrate into fine needles of carbonate, a phenomenon frequently to be seen in archaeological deposits, as mentioned above. Birds caused great fragmentation of shell, which was deposited as regurgitate and in faeces. It was noted that eider ducks (*Somateria mollissima* (Linnaeus)) swallow mussels whole, grinding them to fragments in the gizzard, subsequently passing these in the faeces.

It has been established that molluscs and uncalcified arthropods (insects, mites etc) require different conditions for preservation. (Both sometimes occur in aquatic deposits, but it is unusual to find large numbers of both insects and landsnails preserved in the same context.) This is most useful since it means that in the molluscs we have a method of ecological reconstruction on dry neutral to calcareous sites where little else of ecological indicator value survives. Examples include Albion Street, Driffield, where Carrott *et al.* (EAU 1992/12) found molluscs in some features but no anoxic preservation of other invertebrates. Milles *et al.* (EAU 1992/39), in evaluation of the Castlethorpe 1 site, Scawby Brook, Brigg, North Lincolnshire, found primarily terrestrial molluscs; there was one sample with a limited and poorly preserved insect assemblage, which it was suggested would add little or nothing to the mollusc interpretation, rather supporting the exclusion 'rule'. Other sites of this kind are mentioned in the chronological section. A great deal of good work has been done in southern England, but (as noted in the taxonomic section) there are rather few cases where large land snail assemblages have been investigated in the north of England, and those are mostly unpublished.

Perhaps the main reason why rich assemblages of molluscs are rare in occupation deposits where insects are preserved is because insects are far more tolerant of (indeed, favoured by) human disturbance than molluscs, and such disturbance often produced the conditions for preservation of insect remains (e.g. where there were accumulations of decaying organic matter).

Among other calcified invertebrates, woodlice seem to decay quickly, the non-calcified part of the cuticle being poorly preserved in anoxic deposits and the calcareous part seeming to flake and crumble rather like well-rotted oyster shell (Kenward EAU1997/04; 2001b; unpublished). By contrast, some other Crustacea appear more robust: crabs sometimes preserve moderately well (but may be very fragile), and ostracods are frequent and their valves remain in excellent condition. There are some archaeological records of sea urchins, starfish and barnacles, suggesting they may survive if molluscs do. Calcified worm tubes and hydroids also seem likely to preserve in a wide range of non-acid deposits.

Varied preservation as an indicator of mixed origins

The importance of differences in preservational condition within death assemblages has been briefly mentioned above. Such differences may result from different pre-burial processes or histories which are interpretatively significant, such as multiple origins; components with different sources (whether ancient or modern) may show different preservation. Thus the insects introduced in floor sweepings may be less well preserved than the fauna invading them after dumping into a pit. The case of the peat fauna recovered from the Skeldergate well is mentioned on p. 166. Buried soils often show varied preservation, typically with a mixture of old, partly decayed, specimens and fresh corpses (p. 101): that at Skeldergate is one example, and another was observed at Appletree, near Birdoswald, Cumbria (Hall EAU 2000/46). Insects in a soakaway fill at Flemingate, Beverley

(Dobney *et al.* EAU 1995/48) showed varied preservation which appeared to indicate multiple origins - unfortunately no further investigation followed evaluation. However, varied preservation may flag the presence of residual or post-depositional contaminative remains which negate, or at least complicate, attempts at interpretation.

An example of the value of records of preservation for interpretation is presented by the insect remains from the fills of the Roman well at Skeldergate, York (Hall *et al.* 1980): in that case, almost all the remains were in good condition, indicating that any remains which entered the well were preserved, and the only substantial exceptions being a component from peatland, clearly redeposited after decay elsewhere, and (less clearly) house fauna (from floor sweepings?). Some of the Anglo-Scandinavian pits at 16-22 Coppergate, York (Kenward and Hall 1995) gave insect assemblages in which 'house fauna'; on average (and subjectively) showed poorer preservation than fauna of foul conditions, suggesting that the former may have been introduced as house floor sweepings. A more detailed objective record of preservation in different species and ecological groups would be useful in such cases.

Decay in storage

Richly organic samples and individual organic remains, and also more robust remains such as shells, can rot, or be damaged by invading invertebrates, in storage. Cases where this seems to have occurred have fairly often been encountered. Rather more serious is the effect of dehydration (though insects and parasite eggs can sometimes be recovered from dried sediment in surprisingly good condition), and decay through the action of bacteria and fungi. This is sometimes revealed by the presence of clearly visible zones of differential decay through the stored sediment.

Threats to the resource

A consideration of the preservation of bioarchaeological remains cannot be complete without mention of the threat posed by current and future human activity (and perhaps by climatic change). Aspects of this are considered in other sections, in-ground decay in particular being considered on p. 110. Two rarely-considered aspects are the destruction caused by archaeological excavation - often with poor post-excavation programmes of study for invertebrates – and (for deposits with an organic content, the doubtfully safe) locking-up of archeological sites beneath buildings and structures such as road embankments, dykes, and landfill mounds which are likely to remain in position for an indefinite (but often very long) period.

Methods of recording decay

It has been argued that variable decay of biological remains is of importance as a source of information about pathways to deposits, and (in the case of delicate remains) concerning threats to the buried heritage. Objective methods for recording quality of preservation are therefore important. Kenward and Large (1998a) briefly reviewed schemes for recording preservation of biological remains, with particular reference to insects. They found that the established scheme for recording the preservational condition of archaeological insect remains preserved by anoxic waterlogging employed in the EAU was inadequate, failing to represent the complexity of decay properties and pathways. A particular weakness lay it its focus on whole assemblages rather than the individual remains of which they were composed. A scheme produced by the Sheffield Group (used, for example, by Philip Buckland, ARCUS 208) was considered to be no more effective. A new scheme was proposed by Kenward and Large, taking account of the heterogeneity of preservation of fossils in single assemblages, and making use of a wider set of properties including colour changes. Range, mode, mode strength and distribution of values can be estimated for the major properties (i.e. erosion or chemical degradation, fragmentation or mechanical damage, and colour changes). A form and accompanying flow sheet designed to ensure systematic recording of these properties under the new scheme were presented, and its success to date considered. Although apparently complicated, the scheme was considered to be viable, and a record could be made for an assemblage in 2-3 minutes. It was also amenable to use in an abbreviated form.

Schemes for other invertebrate groups are rare. Jones's scale for recording preservation of parasite eggs is as follows. For *Trichuris* (taken from Jones EAU 1986/10): 1 = complete; 2 = complete but loss of one, or evidence of decay of, polar plugs; 3 = shell complete but both polar plugs lost; 4 = shell broken or crumpled. For *Ascaris* (taken from McKenna 1988): 1 = complete; 2 = decorticated (ie. some or all of mamillated outer shell lost); 3 = broken.

Carrott *et al.* (EAU 1996/15) put forward an alternative scheme for recording preservation of parasite eggs, making use of colour change, the loss of polar plugs and decay of the egg walls (for trichurids and capillarids) and, if appropriate, collapse. Completeness was recorded on a five-point scale based on the loss of polar plugs and completeness of egg wall membranes. Colour was recorded on a three-point scale, from dark (as fresh) to pale (Allison *et al.* 1991a, 71).

Scales for recording preservational quality of land and freshwater molluscs on one hand, and for marine shells on the other, are urgently required. Evans (1972) clearly recognised the problems of preservation in landsnails, and mentions characteristics indicative of degrees of decay (e.g. for *Acanthinula aculeata*, *loc. cit.*, 213 and for *Pomatias elegans*, p. 263-4, 314), while differential preservation is also mentioned (e.g. p. 341). Carrott *et al.* (EAU 2001/12) recorded the preservational condition of marine shell using separate, essentially subjective, four-point scales for erosion and fragmentation. Scale points were: 0 – none apparent; 1 - slight; 2 - moderate; 3 - high. This is a priority area for methodological development.

PART 3: CHRONOLOGICAL REVIEW

This section summarises the investigations which have been made of invertebrates in northern England by period, and highlights the information obtained from them concerning natural and artificial environments, human activity, health, diet, and living conditions. Evidence from all groups of invertebrates is usually considered together. To avoid repetition, casual information concerning the principal marine molluscs exploited as food is not usually considered here, but has been reviewed in the section dealing with the exploitation of marine resources (p. 323). Other aspects of molluscs in archaeological deposits are considered chronologically, however. It has been assumed that most users will refer to only small sections of this part the text at any time and for this reason reference to significant topics or species has been repeated. In general there is too little information for geological and topographical grouping of sites, exceptions being some of the towns, and areas such as the Humberhead Levels and the Yorkshire Wolds.

1. Early hunter-gatherers (500,000-10,000 BP)

This time period corresponds to the *Lower and Middle Palaeolithic* of tradition. The reconstruction of climate and natural ecology is primary aim of most bioarchaeological work on the early prehistoric period, humans being regarded as an insignificant component of the natural environment at this stage. But this information is obviously crucial to understanding the ecological limits placed on humans, in terms of climate and resources. The period saw a series of climatic changes of high amplitude, generally thought of in terms of alternating glacial and interglacial periods, with minor interstadial warm stages in the former. Modern work on palaeoclimates has revealed that this is too simplistic a scheme, and that climates have oscillated in complex ways with variable amplitude and with frequencies of hundreds of thousands of years to a few years (e.g. Lowe and Walker 1997a; Wilson *et al.* 2000). Chambers (1993a) gives a simplified diagram of the larger climatic stages based on oxygen isotope measurements from ocean cores (techniques summarised by Dodd and Stanton 1990, 91-124). Tens of substantial climatic stages, and fourteen major ones, are recognised for the past 500,000 years, with numerous minor episodes of a scale which would be of ecological significance and would impact severely on human society. The traditional terminology and approximate dates for the climatic stages are usefully summarised by Evans (1975a, 2, 28, 35, 42, 47). Palaeoclimatologists now tend to use the stage numbers based on variations in oxygen isotope ratios (reflecting climate change) rather than any systems of names - but this is proving as difficult to follow as the old, evocative, terminology. Wilson *et al.* (2000, 80) give diagrams showing the stage numbers, though without correlation to traditional names.

An important background reference to Quaternary geology in East Yorkshire and North Lincolnshire is Bateman *et al.* (2001b). The history of the British insect (mainly beetle) fauna, and its implication regarding landscapes, is reviewed by Dinnin and Sadler (1999), who also list known Holocene extinctions. A further list of extinctions is given by Smith and Whitehouse (2005).

Before the last (Devensian) glaciation

There seem to be no archaeological sites (in the sense of their having evidence for the presence of humans) datable to the Hoxnian (penultimate) or Ipswichian (last) interglacials in the North. Indeed only two reports dealing with terrestrial invertebrate remains from before the last glaciation relating to the area have been discovered, in marked contrast to more southerly areas of England. The generally accepted explanation for this paucity of sites is that such deposits are likely to have been removed by later glaciations, the probability of survival decreasing rapidly with successive ice advances.

There is a little marine material, somewhat peripheral to this review. Versy (1938) described a 'pre-glacial' shell bed at Speeton Cliff, Filey Bay, East Yorkshire. Edwards (1987) argued this bed to be most probably of Hoxnian date, although disturbed by later glacial events, while West (1969) suggested that it was Ipswichian. Deposition in shallow brackish water was indicated, with a cold, but not arctic, climate. Gaunt (2001) reviews the evidence concerning this site; an Ipswichian date appears most probable, despite the fact that part of the bed lies well above supposed Ipswichian sea level, closer to that of parts of the Hoxnian. Wilson (1991) places it in Oxygen Isotope Stage 7. Catt (1987b) listed Foraminifera, ostracods, molluscs, barnacles, and a brachiopod, from rafts of marine clay and sand in till at Dimlington, near Bridlington, East Yorkshire. The fauna was predominantly boreal; dating of these deposits is not certain, but probably mid-Pleistocene. Fisher *et al.* (1969) record foraminifera and pollen from marine deposits in the North Sea off the Humber estuary, and suggest that they are of Hoxnian date.

Invertebrates of Ipswichian interglacial age from silts near Austerfield, South Yorkshire are reported by Gaunt *et al.* (1972). The remains, which were mainly of beetles, had been deposited in what was probably a shallow lake with both open water and a rich vegetation; there was some evidence for dystrophy (effectively organic pollution). There were indications from the aquatic beetles of inflowing streams, while terrestrial insects suggested a dense deciduous woodland. Four species now extinct in Britain were noted, all suggesting temperatures considerably warmer than those of the present day. Catt (1987a) briefly lists marine molluscs from a beach shingle and terrestrial species from colluvium, both probably of Ipswichian date, at Sewerby, near Bridlington.

The Devensian (last) Glacial

There is a little evidence from invertebrates for conditions in northern England during the last (Devensian or Weichselian) glacial period, although not surprisingly the more substantial assemblages of beetles represent warmer (interstadial) episodes. Coope (1977) reviewed the evidence from beetles for Devensian environments. A little material from the North represents cold episodes: Penny *et al.* (1969) reported insects from silts exposed near the foot of a cliff at Dimlington, East Yorkshire, believed to have been deposited in an extremely cold climate during a Devensian interstadial. The silt appeared to have accumulated in a pond, with little vegetation, in an area with only sporadic plant cover; thermal conditions were very harsh, limiting the range of species able to survive. Another low-temperature beetle assemblage from Dimlington, probably of later Devensian date, was listed by Catt (1987a); a few ostracods were also noted. Worsley *et al.* (1983) describe the biota of a cold stage (stadial) deposit at Chelford, Cheshire. The date of the deposit is uncertain; it pre-dated the Early Devensian Chelford Interstadial (see below) but may have been of much earlier date. Assemblages of molluscs, ostracods and insects were listed, almost all indicating, or tolerant of, arctic environments and with a component of high arctic and eastern Siberian species. The sediment formed in shallow, more or less temporary, pool.

Coope (1959) identified a substantial assemblage of beetles from the first major Devensian interstadial, the Chelford, at the type locality (dated to around 60,000 BP). The Coleoptera indicated that the deposit had formed in a stagnant, acid, pool, choked with vegetable matter and with *Sphagnum* developing in places. Conifers, willow (*Salix*) and birch (*Betula*) grew in the wider surroundings. Some non-British species now of northern distribution in mainland Europe, and some now northerly in Britain, were recorded. Coope suggested that the climate resembled that in southern Finland, continental, with mean July temperatures around 15-16 °C and mean February temperatures about -12 to -10 °C; this area has average daily temperatures above zero only from April to October.

Gaunt *et al.* (1970) give an account of deposits at the Oxbow opencast coal quarry in the Aire Valley, West Yorkshire. The deposit was radiocarbon dated to around 38,600 BP, ie. to the Mid Devensian Upton Warren Interstadial. Silts low in the sequence provided a modest list of insects, almost all beetles with a very northerly and/or easterly distribution, indicative of tundra conditions, with July average temperatures probably not above 10 °C. Eight of the beetles are now absent from Britain, and an open, treeless landscape with a thin vegetation cover and patches of bare ground was deduced. There were ponds in poorly-drained areas, while higher ground supported a limited terrestrial fauna.

Overall, then, little is known of invertebrate faunas in the north of England in the period up to about 14,000 years ago. Destruction by subsequent glaciation may have reduced the number of sites awaiting discovery, but investigation of vegetation and terrestrial climates in the period must remain a priority, especially to provide comparison with other sites in the Midlands and East Anglia. Any glacial or interglacial sites yielding large suites of well dated invertebrates, especially insects, would be of substantial value in reconstructing the pattern of climate and vegetation across the British Isles, and if long continuous sequences rich in insect remains are discovered their importance in determining rates of change of terrestrial climates (especially at the end of temperate periods, and so relevant to our likely long-term future) would be enormous.

The end of the Devensian and earliest Flandrian

Terminology for the Devensian late glacial and early postglacial period (14-10 ka BP) is confused, having originally been based upon pollen zones (I-III) as well as geological episodes. The pollen zones are now known to reflect climatic change incompletely. Modern nomenclature recognises: (a) a warm period (Zone I in part, most of Zone II), the Lateglacial (Windermere) Interstadial, and (b) a cold one (Zone II in part, Zone III), the Loch Lomond Stadial (also known as the Younger Dryas). The warmer period is also known as the Allerød Interstadial. The nomenclatural confusion is further amplified by the traditional division of Pollen Zone I, as follows: Ia, the Oldest Dryas (cold); Zone Ib, the Bølling Interstadial (warmer); and Zone Ic, the Older Dryas (colder). All these terms other than Windermere and Loch Lomond are best avoided. A wide range of evidence, including that from insects and isotope records from sea, lake and ice cores, has over the past few decades produced a consistent picture, the warmest part of the late glacial period now being placed in Pollen Zone I, with various subsequent fluctuations (apparently including temporary glacial re-advances) set against an underlying cooling into the stadial. A review of the evidence concerning rates of climate change around the Loch Lomond Stadial is given by Ammann *et al.* (2000).

Here, 'Late Glacial' has been used as a convenient term when referring to the whole of the Late Devensian to early Flandrian oscillation (Zones I-III, about 14-10 ka BP), and 'Lateglacial Interstadial' to refer to the warm (Windermere) period. Several late glacial sites in northern England have provided invertebrate assemblages, most of the systematic research having been carried out on insect remains.

North Lincolnshire

A small insect assemblage from a Late Glacial peat from West Moor, Armthorpe, is described by Buckland (2001). An open landscape was indicated, and climate appears to have been not far from that of the 20th century, though with hints of continentality and one 'cold' species; a date early in the Windermere interstadial was suggested, perhaps between 12,500 and 12,000 years uncal. BP.

Buckland (1982a) considered the wind-blown cover sands of north Lincolnshire and the Vale of York, and the same author later (1984) reviewed evidence for conditions in north-west Lincolnshire at the Loch Lomond – Holocene transition. The first of these papers gave insect species lists for a series of samples from deposits below and within the aeolian cover sands and dated to around 10,000 years ago at **Messingham** and **Flixborough**, North Lincolnshire. Evidence from artifacts indicated contemporaneous human activity in the area. Eleven beetle taxa now extinct in Britain, mostly with northern and/or eastern distributions in the Palaearctic zone, were noted. The pre-cover sands landscape was reconstructed as a *Carex*-dominated marsh with some scrub willow and occasional semi-permanent pools, probably fed by meltwater. Evidence from within the cover sands, in deposits formed in a break in sand deposition, suggested a barren sandy landscape. January and July average temperatures of around -10 °C and 9 °C respectively were tentatively suggested. In the later (1984) paper, Buckland revised the summer temperature to 15.5 °C, with winters as first estimated; it is also suggested that the faunas were a little earlier than previously thought, and of Late Devensian date.

Further peat deposits at **Messingham** were subjected to evaluation by Carrott *et al.* (EAU 1997/48). Three samples produced an insect fauna which may have been contemporaneous with that reported by Buckland (1982a), with many taxa in common and suggesting similar conditions. Late Glacial deposits at **Yarborough Quarry**, were of late Loch Lomond or very early Holocene date, again producing an open-landscape fauna but with a range of cold-indicators (Murton *et al.* 2001).

Just beyond the southern boundary of the region considered here, Preece and Robinson (1984) reported molluscs and ostracods from calcareous tufa deposits spanning the Late Glacial and much of the Flandrian at sites in the Ancholme Valley, Lincolnshire.

East Yorkshire

Late Devensian or Early Flandrian deposits close to the West Beck in the valley of the River Hull, near **Brigham**, East Yorkshire, have been assessed by Carrott *et al.* (EAU 1996/10). The deposits consisted primarily of peats and humic silts which were rich in plant and invertebrate remains consistent with deposition in water and representing a range of regimes from fairly deep, flowing water to still, shallow water. In the earliest deposits examined there were insects indicative of cold conditions, together with plant remains suggesting a Flandrian date; the presence of alder perhaps suggested a date no earlier than 'Zone IV' (the Pre-Boreal), although cold-stage fauna might not be expected so late. Radiocarbon dates tended to confirm the possibility that the sequence was disturbed.

Mollusc assemblages of late glacial and early postglacial date from coastal exposures at **Skipsea** are described by Thew and Woodall (1984; for dating see Gilbertson 1984, 193-201). The infilling of a large lake, whose deposits have now been almost entirely eroded away by the North Sea, was traced. In the early stages the lake was rapidly colonised by molluscs, especially bivalves. Nutrient status and calcium content of the water increased from very low to moderately high levels, and the frequency of freezing declined. Subsequently, the lake level dropped temporarily, and eventually a period of deteriorating conditions followed. Mollusc abundance and diversity declined to some extent, and then much more dramatically. Warmth-indicating molluscs disappeared, and diversity and abundance fell further. These events correspond approximately with traditional Pollen Zones I-II, the amelioration representing the Windermere Interstadial. Thew and Woodall, and Gilbertson (1984, 44-46) summarise and re-examine earlier work on molluscs in Holderness, not all of which can usefully be considered in the present review. A late Devensian deposit at Skipsea yielded *Arpedium brachypterum* and a few other beetles consistent with a cold environment, but not conclusively indicating such conditions (Kenward 1984b); the remains could not be studied in detail.

Catt (1987a) briefly describes terrestrial molluscs from a Late Devensian deposit at **Sewerby**, near Bridlington, suggesting that they were compatible with a moderately severe periglacial environment. Three groups of molluscs from the Holocene of East Yorkshire were described by Boylan (1966); dating is not very precise.

Snails from a lake peat at Skipsea gave indications of water of good quality and open dry ground. A Late- and postglacial mere deposit at Barmston gave a mixture of species from flowing and stagnant water, presumably mixed by a stream inflow. Swamp deposits at North Ferriby, 'not later than middle Bronze Age', had a fauna suggesting wooded swamp.

In an important paper, Walker *et al.* (1993a) gave data for pollen and Coleoptera from a Lateglacial succession at Gransmoor. A detailed temperature curve was obtained for the beetles using the mutual climatic range method of Atkinson *et al.* (1986; 1987; see p. 64). The beetles indicated a climatic optimum (mean July temperatures perhaps in excess of 18 °C) in the early Windermere, prior to the deposition of a pollen record. Temperatures had fallen by 2-4 °C (to levels rather like those of the mid 20th century) by the time of *Juniperus* expansion, and fell further following the expansion of *Betula* during the later part of the Windermere (Lateglacial) Interstadial. There was a further decline at the boundary of the interstadial and the Loch Lomond Stadial. During the latter, mean July temperatures of 9-11 °C prevailed, winter temperatures dropping to -15 to -20 °C. During the first part of the Lateglacial Interstadial there was 'disequilibrium' between the pollen and insect evidence, reflecting differential migration rates, but the evidence was in accord later on (after the first 1000 years). There seemed to be evidence of an episode of low temperatures during the middle and later parts of the interstadial, reflected in fluctuations in birch pollen and parallelled in proxy data from various other sites and in Greenland ice cores and Atlantic sediments (this cooler episode is now termed the Amphi-Atlantic Oscillation, Levesque *et al.* 1993). A mutual climatic range curve for the site at St Bees in Cumbria (below) was also presented.

North Yorkshire

Dinnin and Welsh (2001) briefly outline beetles from a thin peat within the cover sands at Star Carr Farm, in the Vale of Pickering. A cool-climate fauna was present, though arctic conditions were not indicated, with open sandy heath and *Carex* marsh. The deposit was thought most probably to date to the later part of the Windermere Interstadial. Not far away, samples from Late Devensian and early Holocene deposits at Wykeham were assessed by Hall and Kenward (NAA 04/83). The lowest deposits containing insects contained a fauna indicative of a cool climate such as that of upland northern Scotland (later Windermere or early Loch Lomond), and overlying this were layers with a high arctic fauna (certainly dating to the Loch Lomond stadial).

The succession of Late Devensian/early Flandrian fills in a kettle hole at Kildale Hall, Kildale, were analysed for pollen, plant macrofossils, ostracods and molluscs by Keen *et al.* (1984), who pointed out how few mollusc or ostracod assemblages of this date had previously been examined. The early deposits, from the Late Devensian, yielded no molluscs or ostracods (it is not clear whether insects were present here or elsewhere in the sequence). Marl interpreted as being of Windermere Stadial age gave primarily aquatic snails, these being catholic species tolerant of poor oxygenation, and a few land snails indicating marshy surroundings. A cool to cold climate was indicated, according with other evidence for later Windermere cooling. Ostracods were of low diversity and again suggested low temperatures. The next part of the succession was barren, the fauna perhaps having been eradicated by the very cold Loch Lomond Stadial. The succeeding Early Flandrian layers gave a snail fauna indicating a transition from fresh water to terrestrial environments, with a cold tolerant fauna, but no species typical of very cold climates. The uppermost part of the succession gave almost exclusively terrestrial snails, probably from marsh, but with no open water; a temperate climate was indicated. Ostracods were rare in these later layers.

Howard *et al.* (2000) reported plant and invertebrate remains from a sequence of peat and calcareous organic mud in the floodplain of the River Ure near Ripon, with a radiocarbon date of 9710±60 BP. Molluscs were mostly aquatics, suggesting a pond environment with mud and sand substrata and a limited vegetation. Beetles indicated stagnant water 'much overgrown with emergent and submerged vegetation', with only one flowing-water indicator (*Limnius volckmari*). The adjacent terrain was swampy, but there was evidence of trees. The beetles indicated a climate not significantly different from that of Ripon today, using the MCR method. Ostracods suggested shallow freshwater, eutrophic and vegetated.

County Durham

Blackburn (1952), during a botanical investigation, noted a few beetles and a single caddis, together with modest numbers of the cladoceran *Moina macrocarpus* and traces of ostracods, *Cristatella* statoblasts and molluscs (*Pisidum*) from deposits at **Neasham near Darlington**, dated to the broad Late Glacial period.

Cumbria

Coleoptera from a Lateglacial section exposed in the sea cliffs at **St Bees, Cumbria**, were studied by Coope and Joachim (1980; see also Coope 1978, Pearson 1962, and Walker *et al.* 1993a). The climatic optimum of the Windermere Interstadial was placed prior to 12 ka BP, being somewhat warmer than the mid 20th century. Climatic amelioration preceded the deposition of organic-rich sediments. Later in the interstadial temperatures declined, and in classical pollen zone III (Loch Lomond Stadial) very cold conditions were indicated by obligate arctic-alpine taxa, several of them no longer found in Britain.

Lancashire

Insects (and a few other invertebrates) from a Devensian Lateglacial and early Holocene sequence of peats and muds at **Red Moss, Lancashire**, exposed during construction of the M61 motorway, were described by Ashworth (1972). The earliest part of the sequence, corresponding to the 'Older Dryas', appeared on entomological evidence to reflect warm conditions, and there was cooling then warming during the later part of the Windermere Interstadial. Very low temperatures prevailed during the 'Younger Dryas' (Loch Lomond Stadial), and warming corresponding with the 'Pre-Boreal' was detectable. The warming following the stadial appeared to have been of the order of 6 °C (from 10-16 °C) over 300-400 years. Bedford *et al.* (2004) report the climatic implications of chironomid midges in a Late Glacial sequence at **Hawes Water**, with an estimated temperature curve from the Windermere through the Loch Lomond.

Cheshire

Excavations of deposits filling a closed basin within glacial drift at **Church Moss, Davenham, near Northwich, Cheshire**, revealed a sequence of late-glacial and early post-glacial organic sediments (Hughes *et al.* 2000). What appeared to be the infilling of a frost-crack, probably from early Pollen Zone I times, gave insect remains indicating extremely low temperatures and a tundra environment. The pollen record from a sequence of 3.5 m of peat towards the deepest part of the basin, supported by radiocarbon dates, showed that organic deposition was initiated in Pollen Zones I or II and continued to the later part of Zone VI. The earliest insect assemblages from this main sequence represented the later part of the Windermere Interstadial, perhaps starting in the cooler Amphi-Atlantic Oscillation, with the Loch Lomond Stadial well represented. The stadial was also clearly seen in a sequence nearer to the margin of the basin. In both of these trenches, there was evidence from plants and invertebrates for a mosaic of fen dominated by sedges and often also mosses, with short-lived small pools. Investigations at **Danes Moss, Macclesfield**, revealed a succession in which insect remains were often present in appreciable amounts (Carrott PRS 2003/06), and analysis of these was reported by Allison *et al.* (PRS

2005/109). The sample column was dated from the mid 10th to mid 5th millennium BP. All of the assemblages showed aquatic deposition, and abundant marshland species. Acid conditions were indicated by various bugs and beetles. The lower levels gave little indication of drier land, but species associated with heathland plant appeared in the upper half of the insect-rich part of the column. The uppermost listed assemblage included two beetles regarded as ancient forest indicators: *Teredus cylindricus* and *Thymalus limbatus*. It was suggested that some species perhaps indicated temperatures above those of the present day (though habitat loss cannot be ruled out).

West Yorkshire

Late Devensian and early Flandrian molluscs and ostracods from a sequence at Bingley Bog, Airedale, were reported by Keen *et al.* (1988), who erected biozones based on these remains, related to ecological change and climatic variation, with the cooling of the Loch Lomond stadial indicated.

South Yorkshire

A late glacial site at **Cove Farm Quarry, Westwoodside**, is described by Bateman *et al.* (2001a). Preliminary results are given for a series of beetle assemblages of Windermere Interstadial date. A well-vegetated pool is suggested by the fauna from the lower unit, with a climate substantially cooler than 20th century, perhaps in the period leading up to the Loch Lomond Interstadial. The fauna from the upper unit indicated marshy conditions, with a fauna of a colder, but still not arctic, climate.

Although several sites from the Devensian have been investigated in varying degrees of detail, some producing important results, there is much left to do. The changing ecology and climate of the region can only be understood by examining numerous sites, building up a mosaic picture, and it will be important to compare rates and patterns of climatic change north-south and east-west, building on the work of Coope and others. Recent work in constructing pan-European climate maps (Coope and Lemdahl 1995; Coope *et al.* 1998; Witte *et al.* 1998) can be developed further and on a smaller scale: what gradients existed across the north of England? Here, collaborative studies of invertebrates and plant macrofossils will be invaluable; by comparison the pollen evidence appears much more limited in its ability to reveal climatic change and local ecology. The relative rates of plant and invertebrate invasion in response to climatic change can be followed in detail at this time, providing a yardstick for work on earlier, less well understood, periods. Comparison of terrestrial climate in North Britain with the marine and ice core records in this period of rapid and large-scale change will provide a valuable insight into the likely effects of future global and local climatic change on human culture (see Pearce 2005 concerning faltering North Atlantic circulation, for example), and there are also aspects of invertebrate biogeography relevant to conservation (e.g. rates of invasion, causes of exclusion, persistence in changing environments) to be pursued.

2. Later hunter-gatherers (10,000-5500 BP, c. 8000-3500 BC)

The Holocene; *Upper Palaeolithic (to 8000 BC) and Mesolithic (8000-3500 BC)*. As for the Lateglacial, there are various nomenclatures for the stages of the current, Flandrian, Interglacial, which is usually inappropriately aggrandised to a full geological 'period' by the name 'Holocene'. The most familiar to many bioarchaeologists are the traditional pollen zones (IV-VIII in mainland Britain), their descriptive names reflecting the climate interpreted from the pollen record. Relevant here are Zones IV = Pre-Boreal, up to about 9500 BC; V+ VI = Boreal, up to about 7500 BP; VIIa = Atlantic, up to about 5000 BP; VIIb = Sub-boreal, to about 3000 BP; VIII = Sub-Atlantic. These terms are overlaid by the various cultural ones used by archaeologists, unfortunately corresponding rather poorly with them. Tables 4-5 of Evans (1975a) provide a useful summary of these rather confusing systems. More recently, climatic reconstruction using isotopes and dendrochronology has begun to reveal a pattern of climatic change more complex than formerly accepted, with claims of quite substantial changes which can be related to human cultural change (e.g. Bonsall *et al.* 2002; Van Geel *et al.* 1996; see also the list of 'events' on p. 286). These connections are yet to be evaluated.

Work on the prehistoric Holocene is largely concerned with reconstructing vegetation - usually forest - history, and the sites considered here are not reconsidered in the forest history section (p. 291).

There is some evidence from invertebrate faunas of early to mid Flandrian sites in the North of England, but remarkably little detailed work has been carried out. An assessment by Carrott *et al.* (EAU 1994/37) of a rapidly-eroding series of valley fill deposits on the seafront at Skipsea, East Yorkshire, revealed aquatic and marsh deposits, lake mud then peat, eventually followed by clay inwash. Insect remains had some potential for local ecological reconstruction but work was not considered justifiable under archaeology funding or to be a priority in terms of reconstructing natural habitats; the most useful deposits had undoubtedly long ago been washed away by the sea. Bush (1988; 1993; see also Bush and Ellis 1987), in primarily botanical reports, mention a few insects, interpreted as indicative of grassland, from a deposited with a date of 8290 + 80 at Willow Garth in the Great Wolds Valley. This site was of great significance as a rare case of waterlogged preservation in the chalklands of Yorkshire and it is unfortunate that more systematic analysis of the invertebrates was not carried out: investigation of insects from a full sequence at this site might prove most enlightening. Hall *et al.* (PRS 2003/14) carried out evaluation of ?Mesolithic peat at the Guardian Glass site, Goole. Insect fragments were abundant but generally poorly preserved, the assemblage being subjectively that of a woodland floor.

A shell marl and peat deposit dated to 7000-5000 BP at Burton Salmon, North Yorkshire, yielded a series of substantial freshwater mollusc assemblages (Norris *et al.* 1971). The lowest marl was dated to the Boreal period, and that above it to the Atlantic, and there were clear changes in the fauna. *Aplexia hypnorum* disappeared in the upper layers, while *Valvata cristata*, *Planorbis laevis* and *P. crista* decreased. At the same time, *Bithynia tentaculata*, *Lymnaea stagnalis*, *Sphaerium corneum* and *Pisidium pseudosphaerium* appeared and became dominant. This was interpreted as a result of the expansion of the lake in which marl formation was taking place, so that deposition was no longer marginal, perhaps as a result of increasing rainfall in the Atlantic period. There were also hints of increasing 'stagnation', with more vegetation and shade from trees. There was further change at the Atlantic to Sub-boreal transition, with a revival of *Valvata cristata* and *Planorbis crista*, perhaps because the water level became lower again. Keen (1989) reports abundant molluscs dated to the middle Flandrian from tufa at Lower Beck, Malham, North Yorkshire. Woodland was indicated, in stark contrast to the present-day treeless landscape.

Four sites in the extensive peat deposits in the Vale of Pickering have produced records of invertebrates. The classic site of Star Carr, Flixton, North Yorkshire (Clark 1954; Moore 1950; see also Mellars and Dark 1998) gave radiocarbon dates of around 7500-7600 bc. No systematic investigation of invertebrate remains was carried out, but a few casual finds of beetles, all large, were reported by Balfour-Browne (1954). Proper investigation of insect remains from around Star Carr must be a priority; assessment of some samples by the current writer is planned.

Osborne (AML 3063) gave a preliminary report of insect assemblages from peats at Seamer Carr, not far from Starr Carr. Although not dated in the report, these peats appear to have been of Mesolithic date (it was guessed that they were from 8-9000 BP on the basis of the fauna). Samples from the upper part of a column gave no useful remains, but there were increasing numbers of insects in the deeper layers, with a rich fauna indicative of fen with some open water. Terrestrial (as opposed to aquatic, waterside or facultatively waterside) insects were not abundant. A range of species associated with dead wood probably exploited willows in the fen. Full analysis and publication of a final report on this material is highly desirable, particularly in view of the results of work in 1996-7 (below). Modest numbers of freshwater molluscs from the sediment (dated 7360 + 120 bp) surrounding a red deer skeleton at **Seamer Carr** were recorded by Tooley *et al.* (1982); the lower levels gave indications of flowing water, while the upper deposits were probably formed in still or sluggish conditions with silt and vegetation.

At a nearby site at **Long (or Ling) Lane, Seamer Carr**, deposits containing Mesolithic flints and under threat from damage by further landfill were excavated in 1996, an evaluation of the invertebrate remains in six samples being carried out by Carrott *et al.* (EAU 1996/52) and a detailed analysis of one deposit by Kenward and Large (EAU 1997/30). The insect fauna of the deposit studied, believed to represent muds just below shore level since what appeared to be a wave-eroded shore could be seen in the excavated trench, gave evidence concerning local aquatic, aquatic-marginal and terrestrial habitats. Aquatic, waterside/swamp and terrestrial beetles and bugs were abundant and rather diverse. Water beetles and bugs, and waterside insects, indicated a fen environment. Terrestrial insects included some (such as click beetles and chafers) which suggested that the local dry-land vegetation may have been grassy, and there were some hints of disturbance. There were no indications of woodland (though scrub may have been present), and dung beetles were rare. None of the species were regarded as strongly favoured by artificial accumulations of decaying matter. It appeared likely on stratigraphic grounds that formation of this deposit was contemporaneous with Mesolithic exploitation of the adjacent land surface, providing a class of information lacking at Star Carr. Some of the remaining deposits had limited potential, others none; it was suggested that further excavation would reveal more deposits containing useful assemblages of insect remains. These deposits, which appear to have wasted substantially as the water table has dropped, are likely to decay further unless remedial action is taken.

The Vale of Pickering has been the object of much study with a pronounced botanical slant (see Cloutman 1988a-c; Day 1996; Mellars and Dark 1998), but a full and systematic programme of research using insect remains, involving further excavation of larger areas and a detailed programme of analysis of longer sections, would undoubtedly be of great value in increasing our understanding of the hydrological and ecological development, and human exploitation, of the area.

An assessment of organic silts and detritus peats of early Holocene (Mesolithic) date at the rear of **26 Market Place, Bedale, North Yorkshire**, by Carrott *et al.* (PRS 2004/11) showed that most of the deposits contained appreciable numbers of insect remains, while aquatic snails were present in some, and cladocerans abundant in a few. These and the insects showed aquatic deposition, small numbers of elminthid riffle beetles suggesting flowing water. Beetles and bugs indicating swampy vegetation were well-represented, and included remains of a froghopper which appeared to be *Aphrophora major*, typically associated with sweet gale, *Myrica gale* L. There were traces of wood-associated beetles.

A 'forest bed' on the **County Durham** coast at **Hartlepool** is attributed by Trechmann (1947) to the Atlantic period, with a suggested date of 6000-7000 BC. Molluscs, identified by A. S. Kennard, were numerous and diverse. Freshwater and waterside or damp ground taxa predominated; the absence of *Succinea* and *Vallonia* species was noted as curious. Beetles were observed but not analysed. This bed was underlain by estuarine clays with an appropriate mollusc fauna. 'Pond' deposits probably of early Holocene date at the **Faverdale East Business Park, Darlington** gave small groups of poorly preserved insects, not ecologically characterised in the assessment report (Akeret *et al.* PRS 2005/103).

A buried soil and waterlain peats at **Low Hauxley, Amble-by-the-Sea, Northumberland**, were assessed by Issitt *et al.* (EAU 1995/16). Although dating was not firmly established, some of the deposits probably were Mesolithic. A substantial proportion of these contained appreciable numbers of insect and other invertebrate remains, sufficiently well-preserved for identification. In the assemblages as a whole, the fauna consisted of a mixture of aquatic and terrestrial species. The former had the potential to provide a definition of the nature of the depositional basin, with a guide to water quality, while the terrestrial species, if recovered in sufficiently large numbers, would allow reconstruction of vegetation and land-use (if any) of nearby 'dry land'. Molluscs from spot samples (some of which may have been post-Mesolithic) did not appear to represent the debris of human activity, the evidence suggesting that they arrived through some natural or incidental mechanism. Several routes were considered possible, including conflation of thinly distributed material as dunes were blown out, deposition of seaweed by humans, or the throwing up of shells or seaweed by storms.

Sediments from Howick Burn, near to a Mesolithic settlement site at **Howick, Northumberland**, radiocarbon dated to around 7800 cal BP, gave a range of biological remains including ostracods, foraminifera and molluscs (Waddington 2003); this was a preliminary report, with no detail given.

Analysis of insect remains from two samples from deposits associated with a trackway-like structure at **Kate's Pond, east of Fleetwood, Lancashire**, radiocabon dated to 2459-2039 cal BC, was reported by Osborne (1995). Aquatic and waterside species indicated deposition in mire conditions, perhaps acidic. Several beetles associated with trees, including dead wood, were present, so perhaps there was birch or alder scrub carr woodland. Ants were abundant, and at least three types present. The uncommon rove beetle *Stenus kiesenwetteri* was recorded, well to the north of its 20th century range, though Osborne suggested that habitat loss rather than climate change may have restricted it.

A fauna from a peat at **Cove Farm Quarry, Westwoodside, South Yorkshire**, is described by Bateman *et al.* (2001a). The deposit appeared, on the basis of its beetles, to be of 'early to mid Holocene date', having formed during a hiatus in cover sand deposition. A mosaic of habitats was indicated, including marsh and pools, with drier heathy areas and pine and deciduous woodland.

Invertebrates from the earlier part of the Flandrian in northern England have received far too little attention in relation to their undoubted potential to address wide questions concerning changing climate, the relationship of local terrestrial to world climates, climatic zonation in the British Isles, and the early history of postglacial human exploitation in the area. This is a period for which the buried resource exists but is widely threatened, and a range of sites should be investigated urgently.

3. The rise of agriculture (5500-3200 BP, c. 3500-1200 BC)

The Neolithic, Early Bronze Age, and Middle Bronze Age. This was a crucial period for human society in Britain, as well as the beginning of major human impact on the natural environment through the direct and indirect effects of forest clearance. Bonsall *et al.* (2002) suggest that farming spread rapidly into Britain and Scandinavia at around 6000 BP (giving the range 4100-3800 cal. BC). They postulate that this was at least in part a result of climate change, a hypothesis which should be amenable to investigation using invertebrates, especially insects.

Neolithic (c5500-4,000 BP, 3500-2,000 BC)

Few northern English sites of Neolithic date have been examined for invertebrates, most of those for which a record exists being in Yorkshire; the natural deposits of the Humber Wetlands excepted, we have seen nothing like the superb insect material described by Robinson (1997) from Silbury Hill, Wiltshire, the mollusc evidence such as described for southern England by Evans (1971; 1972; 1983 and many more recent papers, some mentioned in the taxonomic section, above), or the synthesis of human impact on forest made by Robinson (2000b). Equally, we lack waterlogged deposits from structures, such as was recorded by Nielsen *et al.* (2000) from Neolithic Switzerland.

From East Yorkshire, Dobney *et al.* (EAU 1993/20) reported ?Neolithic pits from a site on the route of the Leven-Brandesburton by-pass, but unfortunately they yielded no invertebrates. Thew and Wagner (1991) described Neolithic land snail assemblages from Kirkburn, near Driffield. They indicated that 'the prevailing landscape was of fairly moist, tall, well-established, stable herbaceous vegetation'. There was no evidence for trees or scrub, and there seemed to have been little disturbance before the Neolithic features were constructed; there was little or no grazing. These conclusions can only apply to a very limited area, within a few metres of the deposit, however. Evans (1972, 277-279) reports the lack of snails beneath the Neolithic long barrow at Kilham, 9 km north-east of Driffield, illustrating the general problem of rarity of mollusc preservation in this part of the region. Carrott and Hall (PRS 2003/08) examined Bulk Sieving samples from Neolithic posthole and ditch fills at Sewerby Cottage Farm, Bridlington, but found no ancient remains. Further work at this site examined cut fills and spreads, but again none produced any interpretatively useful invertebrate remains (Carrott and Johnson PRS 2003/84). Assessment of a Neolithic pit fill from a site alongside the A63 at Melton by Akeret *et al.* (PRS 2005/93) produced only traces of land snail shell. Mant *et al.* (PRS 2005/97) examined the fill of a Neolithic pit during an evaluation at Pocklington Waste Water Treatment Works, Canal Lane, Pocklington; it gave only considerable numbers of intrusive *Cecilioides acicula* (p. 482) and a trace of other land snails.

In North Yorkshire, Neolithic contexts at West Heslerton, only yielded traces of bivalve shell and some intrusive *Cecilioides acicula* (Allen 1986). A rather more substantial group, apparently of this date, was reported by Castell (1963) from a long barrow at Willerby Wold. Arianta arbustorum and *Cepaea (as Helix) hortensis* were abundant and there were traces of a few other taxa. These remains were interpreted as indicating 'damp woodland conditions', although reference to Kerney and Cameron (1979) suggests that herbaceous vegetation would provide suitable habitats providing there was some moisture. Jaques *et al.* (EAU 2001/34) reported assessment of three samples from ditch and pit fills of probable mid-late Neolithic date from Wath Quarry, Wath, near Hovingham. The pit fills contained small numbers of snails: *Cecilioides acicula* was present, presumably intrusive, while taxa indicative of dry calcareous grassland, with hints of shadier conditions, were probably ancient.

To the north of the region, a series of samples, including some from Neolithic features, from the Cheviot Quarry, Milfield, near Wooler, Northumberland, examined by Hall (EAU 2000/78) during a botanical assessment produced only modern fly puparia and earthworm egg capsules. Neolithic and later material from the Milfield Basin Project examined by bulk sieving by Archaeological Services University of Durham (2000) yielded some puparia and other insect fragments, insufficient for useful study.

Carrott (PRS 2003/35) analysed mollusc assemblages of ?Neolithic date from Ferrybridge, recovering assemblages indicating open grassland with shadier places locally.

There is much more evidence from South Yorkshire. Whitehouse (1998) described insect remains from a series of sites in the Humberhead Levels, including some dating to the period considered here. The earliest part of one sequence at Lindholme Island (Whitehouse *et al.* 2001b) was of Neolithic date but is considered with the Bronze Age material below. Whitehouse (2000) discusses a range of beetles (some now rare or extinct in Britain) favoured by forest fires which have been recorded in association with burned trees of Neolithic and Bronze Age date at Hatfield Chase and Thorne Moor. Boswijk and Whitehouse (2002) recovered beetles from rot-holes in pine (*Pinus*) trunks in peats at Tyrham Hall Quarry, Hatfield Moors, South Yorkshire; they are considered above with the earlier material from the site. They discuss the role of forest fires in British woodland ecosystems, and suggests that much charcoal which has been regarded as 'anthropogenic' (as the result of woodland clearance, for example) may be of natural origin. Whitehouse and Eversham (2002) discuss the implications of a fossil specimen of the ground beetle *Pterostichus angustatus* from Hatfield Moors, dated to about 4000 BP, for the importance of pine and fire habitats. Palaeoentomological work for this and other periods at Thorne and Hatfield is outlined by Boswijk *et al.* (2001), Buckland and Dinnin (1997a), Whitehouse (1997a, with discussion of fires) and Whitehouse *et al.* (2001a).

The development of Neolithic landscapes is poorly understood in the north of England (Stallibrass and Huntley 1996), only the essentially natural environment of the Humberhead Levels being at all well investigated through invertebrates. It is hard to believe that the evidence for land use across the region does not exist in the form of mollusc and insect assemblages. Study of invertebrate remains from this crucial period in the development of human culture in Britain clearly deserves to be regarded as of high priority. No opportunity to examine material from any site, whether or not there is clear association with human activity, should be missed.

Early-mid Bronze Age (c. 4000- 3200 BP, 2000-1200 BC)

Invertebrates of this period have rarely been reported from the North of England and deposits tend not to be rich in remains. Pit fill deposits on the route of the Leven-Brandesburton by-pass, East Yorkshire, for example, lacked preservation by anoxic waterlogging and no invertebrates were found (Hall *et al.* EAU 1994/15). Occasionally, useful assemblages have been recovered. Jaques *et al.* (EAU 2002/08) analysed the fauna of an Early Bronze Age pit at Low Farm, near Cottingham, north-west of Hull, East Yorkshire (Teeside to Saltend Ethylene Pipeline, TSEP418). Seeds from this feature gave an AMS date of 3300±50 BP (Cal. BC 1690 to 1450; Cal. BP 3640 to 3400). The insect fossils were mostly highly fragmented and fell apart easily, many being visibly strongly decayed. Deposition in water seemed certain, for *Daphnia* ephippia were quite abundant, and about a third of the beetles and bugs were aquatics, suggesting shallow water, not too polluted and not necessarily permanent. Much of the rest of the fauna may have lived in a rather damp area with herbaceous vegetation and a range of fairly dry to damp litter. Conditions further afield were represented by a few dung beetles: there may have been grazing land nearby, though the numbers of beetles were too small for certainty. Poor grassland was suggested by the chafer *Phyllopertha horticola*. There were no species strongly suggestive of human structures or artificial accumulations of decaying matter, and only one associated with dead wood. The biological evidence overall suggested a landscape dominated by human activity, presumably through agriculture, and probably including grazing, but with no evidence for arable cultivation. Assessment of a ring ditch fill and a coffin stain deposit at a site alongside the A63 at Melton by Akeret *et al.* (PRS 2005/93) produced some land snails indicative of dry calcareous sparsely vegetation terrain, with hints of damper conditions locally.

In North Yorkshire, Kenward and Carrott (PRS 2002/49) report an assessment of deposits associated with a timber structure at Staithes, which gave dates around 1600 bc. Four samples gave invertebrate assemblages of various size, with variable and sometimes poor preservation, but their implications were consistent in suggesting marshy conditions with some plant litter. One sample contained two indicators of running water and another, in which remains were sometimes well decayed, yielded two species typical of the post-depositional beetle group (p. 482), perhaps indicating de-watering of the deposit at some stage.

Cowell *et al.* (1993; see also Milles EAU 1992/37) reported the presence of insects and molluscs in deposits associated with the footprints of a range of animals including humans at Formby Point Beach, Merseyside; they were argued to be of Late Neolithic or Early Bronze Age date and to indicate an estuarine tidal flat environment.

Boswijk and Whitehouse (2002) describe assemblages of beetles from rot-holes in one oak (*Quercus*) and five pine (*Pinus*) trunks in peats at Tyrham Hall Quarry, Hatfield Moors, South Yorkshire. Dendrochronological dates of 3618-3418 BC and 2921-2445 BC were obtained for oak and pine respectively; all are considered here. Superb preservation and the completeness of individuals indicated that much of the wood-associated fauna had originated *in situ*, though other elements, notably aquatics and plant feeders, had entered during burial. The earlier oak gave a fauna indicating damp oak fen-woodland, while the later pine assemblages indicated sandy *Pinus*-heath woodland, with a range of deciduous trees. This pine woodland died back progressively, some trees collapsing, as a result of a rising water table, peat development being initiated. Flooding was perhaps caused by a combination of rising sea level and increased runoff caused by clearance by humans; it was suggested that increasing rainfall was not implicated. Also on Hatfield Moors, Whitehouse (2004) brings together evidence of changes in mire vegetation and hydrology, and in climate, from various locations. Peat initiation was generally around 3000 BC, though delayed locally. There was a transition from eutrophic and mesotrophic fen to ombotrophic raised mire, though with heath locally. The various beetles from Hatfield and related sites which are now extinct in Britain are considered. The palynological background to this work is given by B. Smith (2002), and Dinnin (1997b) provides an outline of the palaeoenvironmental potential of the area.

This too is a period in which important archaeological, landscape and biological issues can be addressed through insects in particular, and no opportunity to make such studies should be passed by.

Material dated broadly to the Bronze Age

Some sites in **East Yorkshire** have been examined. Thew and Wagner (1991) listed Bronze Age molluscs from **Garton Station** and **Kirkburn**, but did not discuss their implications. Dobney *et al.* (EAU 1993/20) reported analysis of fills of a pit dated to the Bronze Age from a site on the route of the **Leven-Brandesburton by-pass**; Jaques *et al.* (EAU 2000/63; 2002/07) processed samples from layers containing Bronze Age artefacts at **Poplar Farm, Dunswell, North of Hull** (TSEP905); Hall *et al.* (EAU 2000/60) examined a ditch fill from a site north-east of Castle Hill Farm, Swine (TSEP458); in each case the samples were barren of ancient invertebrate remains. Molluscs from deposits associated with Boat 3 at **North Ferriby** contained estuarine molluscs (Wright and Churchill 1965, 10). A series of samples of sediment from the sockets of bronze axes found along the route of the **Transco Hull Gas Pipeline** were also devoid of ancient invertebrate remains (Hall EAU 2001/19), and Jaques *et al.* (EAU 2000/69) found no delicate invertebrate remains in a (perhaps natural) gully fill at **Goodmanham Wold** (TSEP 904); in this last case there were traces of land snail shell, though these were of no interpretative value. It is worth mentioning that invertebrates, especially insects, from any of the lake dwellings of the Holderness Meres (e.g. those described by R. Smith 1911 and apparently datable to the Bronze Age) which survive intact could hardly fail to be of immense interest. The meres certainly can provide surprises, for example in the presence of water chestnut, *Trapa natans* L. in Holocene deposits in Lambwath Mere (with its greatest abundance between 6200-4200 cal. BP) and meres at Skipsea (post elm decline but pre Bronze Age) (Schofield and Bunting 2005; Flenley *et al.* 1975; these workers believed that the plant probably invaded naturally rather than being introduced). Varley (1968) mentions the Holderness crannogs, but the Bronze Age site he discusses appears to have been situated – at least initially – on dry land; there were a few molluscs, but their relation to the underlying shell bed (as described by Boylan 1966) is uncertain.

By contrast, peat deposits containing a large Neolithic limestone handaxe and some early Bronze Age pottery at **St Paul's Green, York**, examined briefly by Hall and Kenward (and only reported informally: EAU 1999/54), gave a variety of insect remains. This appeared to be significant material and analysis is desirable.

A series of samples, including some from Bronze Age features, from the **Cheviot Quarry, Milfield, near Wooler, Northumberland**, examined by Hall (EAU 2000/78) during a botanical assessment produced only modern fly puparia and earthworm egg capsules. In **West Yorkshire**, Carrott (PRS 2003/35) recorded snail assemblages from deposits associated with Bronze Age barrows. There was probably short turf grassland, though with some shadier places.

Some of the sequences of deposits examined in the Thorne-Hatfield area, South Yorkshire, traverse the Bronze Age. Most are mentioned elsewhere. Whitehouse (1997b) reported insects from a series of samples of peats associated with charred wood at Thorne Moors; the material was argued to be of Bronze Age date. There was a strong old-forest fauna, including species now rare or extinct in Britain. Among the extinct forms were three species of wood-boring beetles, *Rhyncolus*. Whitehouse *et al.* (2001b) gave preliminary results from parts of two sequences at Lindholme Island, one dated 2700-2350 to 1130-840 cal BC, the other to roughly 2000 cal BC onwards on its stratigraphic link to the first. The former gave evidence of sandy heath conditions, especially in the later part. Pools appeared in the middle part, but were probably temporary. There was bog, which became dominant at the top. The lower part of the second succession gave many dead wood taxa associated with pine, but also some which exploit deciduous wood. The upper part showed loss of pine and the development of birch and heath flora, and hints of acid raised bog with pools. Skidmore (1971) reported an insect fauna from an undated bog oak found near Askern (mentioned here since it may well be of Bronze Age date). Several unusual beetles were present, the large chafer *Gnorimus nobilis* suggesting temperatures above those of the mid 20th century, and this and others suggesting ancient forest.

The Neolithic to Early Bronze Age period is thus poorly represented in the invertebrate fossil record from most of the region (the Humberhead Levels being the only exception) and recovery of material must be a priority, both for climatic reconstruction and for investigation of human interaction with the natural environment. Providing suitable deposits can be found, insects will provide an excellent source of information about local vegetation changes such as *landnam* or other clearances (see Evans 1975, 113-115 and Edwards 1993, 136-145 for general discussion of early clearance). Land and freshwater molluscs, too, will have value; Evans (1993) reviews their potential for reconstructing human impact on the English chalklands. The history of the Wolds (and perhaps the limestone soils elsewhere in the region) requires particular consideration in view of the hypothesis of Bush (1988; 1993) and Bush and Flenley (1987) that grassland persisted through the Mesolithic period on the Yorkshire Wolds and other chalklands as a result of human disturbance, rather than a complete forest cover having developed (a view subjected to critical analysis by Thomas 1989, and tested for the Sussex chalk by Waller and Hamilton 2000). Detailed studies are required, probably inevitably primarily through the use of land snails, parallelling the work in southern England carried out over several decades from the 1960s (see, for example, references on p. 79). Light is thrown on the possible means of formation of the soils of the Wolds by Perrin (1956), who suggests that chalkland soils may have two quite separate origins, some as residues of solution and others as wind-blown material; the latter are perhaps particularly likely to be acidic, contributing to the poor preservation of calcareous remains often seen on the Wolds (p. 106).

4. Diversification and intensification (3200-1880 BP, 1250 BC-AD 70)

Invertebrates from settlements or managed landscapes of the Later Bronze age, and of any kind dating to the Iron Age, are poorly represented in the record from most of Northern England.

Later Bronze Age (3200 - 2650 BP, 1250 BC-700 BC)

Important results have been obtained from natural (or essentially natural) deposits at several sites of this period in the region, most being in the Humber basin and the Vale of York. There appear effectively to have been no investigations of invertebrate remains of this period from the North or West of the region except where it is spanned by long lake or bog sequences (which are typically of limited value for work on most invertebrates). Some of the material discussed in the previous section may, of course, belong to this period.

North Lincolnshire

A range of biological analyses was applied to sediments associated with the Late Bronze Age (radiocarbon dates around 2600 bp) 'raft' at Brigg, North Lincolnshire. Small numbers of Foraminifera were recorded by Adams (1981); they were indicative of brackish conditions. Similarly, most of the small ostracod assemblages were of brackish-water species, though a substantially different environment was indicated by one freshwater assemblage (Whittaker 1981). Most of the samples from beneath the boat examined by Buckland (1981a; see also Perry 1981) contained at least a few insects, but three from sediment on top of the planking were barren. Estuarine reedswamp was indicated, probably close to the high water mark and with occasional pools. Brackish conditions were indicated by small numbers of *Dyschirius nitidus* and *Ochthebius auriculatus*. Waterside taxa were moderately well represented, and terrestrial species fairly numerous but usually with only small numbers of individuals. There were indications of grassland (e.g. from *Phyllopertha horticola* and *Dascillus cervinus*), open ground, trees including dead wood, and dung, but the distance of such habitats was uncertain. Two ancient forest taxa were noted (*Gnorimus variabilis* and *Pyrrhidium sanguineum*). Small numbers of molluscs were recorded by Kerney (1981); they indicated still or sluggish fresh water.

Robinson (2000a) give brief notes on two insect assemblages from Late Bronze Age palaeosols revealed by excavations at the former Stock Market, Brigg. The concentration of insects (ants and beetles) was low, and they were fragmentary. Grassland and dung beetles were present, and damp pasture, perhaps being encroached by reeds as the water table rose, was indicated.

East Yorkshire

There is limited evidence for this period from East Yorkshire and the deposits from which it came were often of uncertain date. Ditch fills at Church Farm, Lily Lane, Flamborough (Carrott *et al.* EAU 1999/16), proved barren apart from earthworm egg capsules and shells *of Cecilioides acicula*, doubtless intrusive (p. 482). Carrott (PRS 2001/01) listed molluscs from pit, ditch and grave fills excavated at Swinescaif Quarry, South Cave, again of Late Bronze Age or early iron Age date. All of the bulk-sieved samples examined included snails, which collectively suggested dry, short grassland with damper places, perhaps provided by the shade created within the cuts. *C. acicula* was, however, the most abundant species. No other invertebrates were found. A few molluscs and foraminifera were recorded from around a sewn plank boat at North Ferriby (Wright and Churchill 1965); the brackish water species *Hydrobia ulvae* was common. Pit fills and material from a burn mound at a site near Stamford Bridge produced no invertebrate remains (Hall *et al.* PRS 2004/57). Evaluation of two Bronze Age or Iron Age pit fills at Pocklington Waste Water Treatment Works, Canal Lane, Pocklington gave only snails, mostly terrestrial but with a few aquatics in one pit (Mant *et al.* PRS 2005/97).

North Yorkshire and York

Plant and invertebrate remains from Bronze Age natural peat deposits from the lower Derwent valley at North Duffield Carrs were examined by Carrott *et al.* (EAU 1994/34). It appeared that water table changes or flooding had suppressed formerly well-developed woodland. Four radiocarbon dates bracketed the period 3100 to 2600 BP (errors being ±60-70 years). In the field a lower clay sand deposit, a bed of peat of varying thickness, and an overlying alluvial clay were recorded, a sequence tentatively interpreted as a progression from fairly dry terrain, via wet woodland to a more fully terrestrial phase, followed by the deposition of alluvium by rising river levels. The small proportion of the beetle and bug assemblages contributed by true open-water aquatics, in comparison with taxa more likely to have inhabited muddy shallows and marshland, suggested that the area was not permanently under water.

Numbers of individual dung beetles (*Aphodius* and *Geotrupes* spp.) were small, well below 1%, in contrast to figures of 10% or more in assemblages from largely pastoral catchments given by Robinson (1991b; p. 62) and suggesting that grazing land was not a significant component of the adjacent landscape. On the other hand, the proportion of the assemblages made up of species associated with trees or found in woodlands was relatively large: between 10 and 20% of the *total* insect assemblage (including aquatics) recovered. Robinson (1991b) suggests that around 20% of the terrestrial insect assemblage laid down in closed woodland conditions will belong to these groups. Among the woodland taxa recovered were the bark beetles *Hylesinus crenatus* and *H. fraxini* or *orni*, associated with ash (*Fraxinus*) trees, and herbivores such as the weevil *Phyllobius calcaratus*.

Several saproxylic species (dead-wood feeders) were recorded, including the anobiids *Grynobius planus* and *Anobium* sp., the weevil *Acalles roboris* (usually associated with oak), and the cerambycid *Grammoptera ?ruficornis*. Saproxylic insects are particularly abundant in woodland where less intensive management ensures the continuity of a dead-wood resource for the larvae of such species to feed on. However, none of the rare or extinct 'old woodland' taxa identified by Buckland (1979) from Thorne Moors (see below) were present in the limited number of samples examined.

The presence in roughly contemporaneous deposits in the Thorne-Hatfield area of several species which have become extinct in Britain (e.g. Buckland 1979, Dinnin and Sadler 1999; Whitehouse 1998 etc.) suggests that it would be worthwhile to survey large quantities of material from North Duffield for these. It was suggest that 'A fundamental difference in the insect assemblages for the two sites would be very significant—if there is genuinely a lack of Old Woodland species at North Duffield it might be suspected that the area had completely lost its tree cover (perhaps through sustained flooding or human activity) and that the re-growth of woodland was too recent for the slow-colonising woodland specialists to invade. The preserved fauna of North Duffield may represent only the post-flooding recolonisation phase, whilst that at Thorne Moors seems to date to the time when dead trees stood in a drowned landscape.' These deposits deserve further investigation.

Another later Bronze Age natural fauna is reported from **St George's Field, York**, by Hill (1993). Deep excavation revealed organic-rich deposits at 0-1 m AOD. Radiocarbon dates fell in the mid to late Bronze Age. The insect assemblage included a substantial proportion of aquatic and marshland individuals. From terrestrial habitats, the chafer *Phyllopertha horticola,* probably indicating grassland, was quite numerous, but other open-ground species were rare. Deciduous woodland was represented by numerous oak shieldbugs, *Pentatoma rufipes*, but again other species from this habitat were only present in small numbers. Despite this, woodland taxa contributed an appreciable proportion of the fauna (around 20%). Ash, oak, alder and birch were suggested by the insects. There was little indication of arable land, and dung beetles were not common - much rarer than suggested by Robinson (1983; 1991b) to be typical of pasture-dominated environments. There was a clear component from heathland, perhaps reflecting small patches on leached soils nearby - significant in view of questions concerning the availability of heathland resources in later periods.

Bronze Age and/or Iron age post hole fills at **Newbridge Quarry, Pickering, North Yorkshire** gave no useful invertebrate remains (Hall *et al.* EAU 2000/27).

Northumberland

The site at **Low Hauxley** was discussed in the previous section (p. 135); the relationship of the investigated deposits to Bronze Age activity in the area was not fully established. Ditch and other fills of probable late Bronze Age date examined during evaluation at land to the north of **North Road Industrial Estate, Berwick-upon-Tweed** (Akeret *et al.* PRS 2005/21) produced no arthropod remains, but one fill gave appreciable amounts of marine shell. This assemblage was composed of about equal quantities of limpets (both common limpet, *Patella vulgaris*, and China limpet, *P. ulyssiponensis*) and common periwinkles (*Littorina littorea*) and thus unlike other assemblages reported in the region.

West Yorkshire

One site has given a little evidence of likely Bronze Age agricultural land use in West Yorkshire: Kenward and Large (EAU 1999/03; 2001a) describe an invertebrate assemblage from a ditch fill, associated with a layer radiocarbon dated to 762-406 BC (1 SD range), at Grim's Ditch, on the line of the A1-M1 link road. Aquatics represented a substantial part of the fauna and there were abundant *Daphnia* ephippia, so deposition was undoubtedly in water, but there was little to suggest a well-developed aquatic or marginal flora. Terrestrial insects included a few dung beetles, and some indicators of grassland so, on limited evidence, the surroundings seem to have included grazing land. Synanthropes were very rare and there were no species associated with trees.

South Yorkshire

A great deal of significant work has been carried out by Buckland, Whitehouse, and others on the low-lying peatlands of the Humberhead Levels in the Thorne and Hatfield area, briefly reviewed by Boswijk *et al.* (2001) and Whitehouse *et al.* (2001a) respectively. Buckland and Kenward (1973) gave a preliminary report of an exotic 'ancient forest' element in the beetle fauna of Late Bronze Age peats at Thorne Moor, and suggested that a rising water table (reflected in the construction of a crude trackway) drowned mixed forest, at the same time providing abundant habitat for insects associated with dead wood and a mechanism for their preservation. The cause of flooding was postulated to be changes in the configuration of the mouth of the Humber, perhaps a breach of Spurn Point. It was suggested that the extinction of the exotic species and the restriction to the south of England of various other species found at Thorne was caused by human modification of natural habitats rather than by climatic factors. Buckland (1979) carried out a detailed study of the insect remains from these Late Bronze Age deposits at Thorne. The range of exotics and southerly species was extended and a picture of changing land use and ecology developed. It was suggested that a relatively dry area of landscape with at least limited human exploitation was 'drowned' by the rising water table; Buckland traced the subsequent death and decay of the forest trees and development of raised bog, pooled at first then subsequently drier, in graphic detail. The mechanism of the rising water table was considered further, the possible effect of rising sea levels and forest clearance in the Humber catchment being recognised. The exotic fauna, and a range of other species, were considered in detail, and a review of beetle extinctions in Britain as a whole was presented. In addition to species which have become extinct in Britain, or restricted to the south, Buckland recorded a single individual of the bark beetle *Scolytus ratzeburgi*, together with birch wood showing the characteristic exit holes. *S. ratzeburgi* is now restricted to Scotland; the explanation for this change in range is obscure, but there are quite southerly archaeological records (e.g. from the Mesolithic of the Severn Estuary, Smith *et al.* 2000). The report concluded with an extensive consideration of the interaction of human and climatic influences on the British insect fauna, strongly recommended reading for everyone. (It is worth noting that Buckland and Johnson (1983) subsequently suggested that the record of *Curimopsis* from this site was probably *C. nigrita*, discovered by them living at the site as an addition to the modern British fauna.)

Whitehouse (1998) describes material from various Humberhead sites, some of Bronze Age date. Whitehouse (1993) studied material from Thorne Moor. Whitehouse (1997a) discusses insects from mid-Holocene sites on the Humberhead Levels, with special reference to forest, and to pine fauna in particular. Several beetles now extinct in Britain were added to the growing list for the period. Causes of the restriction of these and other species are discussed, the demise of pine being identified as a likely factor for some. Numerous references are given, both to species records and general principles concerning forest fauna. Roper (1996) discusses the fossil insect evidence concerning the development of raised mire at Thorne, giving a series of species lists from undated prehistoric deposits, while Whitehouse *et al.* (1997) use the Humberhead Levels sites as a basis for a wider discussion of principles in peatland palaeoecology and conservation. Beetles recorded in association with burned trees of Neolithic and Bronze Age date at Hatfield Chase and Thorne Moor (Whitehouse 2000) are mentioned above (p. 137).

The later Bronze Age is clearly a period for which much worthwhile research could be carried out, at natural and occupation or agricultural sites, with clear problems related to climate, sea level change, the impact of human activity, and biological questions concerned with faunal change and woodland conservation. Studies of invertebrates from deposits in the Humberhead Levels could usefully be continued, since recent work has produced novel results, and could be extended into the contiguous areas of the Derwent valley and beyond in North Yorkshire. Natural sites in the north and west of the region, and occupation sites with anoxic preservation anywhere, are to be sought as a matter of priority.

Iron Age (2450-1880 BP, 500 BC- AD70)

The pre-Roman Iron Age in the north of England is only patchily known through invertebrate remains, although the sites which have received attention have shown that there is potential to address important questions. Some occupation and farmland sites have given notable results, although many others have proved barren (it is likely that most Iron Age sites were not in the past investigated for invertebrates because the deposits appeared unpromising).

North Lincolnshire

A pitfill of later Iron Age date at Aylesby, west of Grimsby, gave only a few landsnails (Carrott *et al.* 1995).

East Yorkshire

Iron Age ditch fills at Rectory Lane, Beeford (10 km ESE of Great Driffield) were examined by Carrott *et al.* (EAU 1996/50). Most of the samples produced only traces of invertebrates, but one bulk-sieved sample yielded a small group of poorly-preserved snails, suggesting impermanent slow or still water. It seems possible that a full excavation with an appropriate sampling regime would have produced useful evidence. Some pit fills, probably of Late Bronze Age or Early Iron Age date, at the Kirmington Runway site (Hall and Nicholson EAU 1991/27) were barren, apart from small numbers of snails. All those identified were the burrowing *Cecilioides acicula* and doubtless of recent origin (p. 482). Molluscs from Iron Age features at Kirkburn, reported by Thew and Wagner (1991), indicated dry, grazed short-turf grassland. Linear ditches probably represented field boundaries, and appeared damper than the surfaces, also providing hints of a hedgerow.

The Teeside to Saltend Ethylene Pipeline (TSEP) provided as series of opportunities to inspect, and sometimes analyse in detail, invertebrates from Iron Age settlements and field systems, and as a result to begin to build up an overview of land use in this (and later) periods. Not all of these provided much material: Jaques *et al.* (EAU 2002/09) found no useful invertebrate remains in Late Iron Age ditches at a site south of Ganstead. In some cases, however, remarkable assemblages of material were obtained, offering significant contributions to our knowledge of prehistoric landscapes. At Carberry Hall Farm, NE of Wilberfoss, Jaques *et al.* (EAU 2002/05) examined six samples from pits and gullies. Five were barren of invertebrates, but the sixth produced a very large assemblage, although preservation was varied and many remains were pale and filmy, limiting identification. Some *Sambucus* twig fragments gave an AMS date of Cal BC 110 to Cal AD 70 (Cal BP 2060 to 1880). The deposit was undoubtedly formed in water, for there were large numbers of water flea resting eggs (ephippia), including hundreds of *Daphnia*, and there were caddis larval cases, and numerous aquatic beetles. All of these could all have lived in a rather shallow body of water, probably with a muddy bottom and a little submerged or emergent vegetation. There was clear evidence of waterside vegetation, and probably mud and litter. Among the fauna of the latter, *Oxytelus fulvipes* is of special note, since it is now a rare species, confined to a few fen locations, although the fossil record suggests that it was more abundant in Yorkshire in the past (p. 281). The presence of *O. fulvipes* and of *Microcara testacea*, a carr species whose larvae are found in wet rotting leaves in shallow water, suggests that this feature may have been a long-established swamp.

Vegetation beyond the immediate vicinity of the water was not strongly represented. Grassland was the predominant component, indicated by the chafer *Phyllopertha horticola*, which was abundant, and *Hoplia philanthus* (p. 357), *Agrypnus murinus*, and *Dascillus cervinus* suggest similar habitats. This was most likely poor pastureland, for dung beetles were abundant, dominated by *Aphodius contaminatus* and *A. sphacelatus*, but with a range of other species. There was no evidence from the beetles for nearby buildings or artificial accumulations of organic waste and no species confined to living trees were recorded (though trees only a few metres from developing deposits may be unrepresented by the insects, see p. 458). There was some evidence of dead wood, although the commonest wood-borer was reported as *Anobium inexpectatum*, associated with old ivy (this identification requires confirmation).

The second of these TSEP pipline sites to yield significant evidence of Iron Age land use in rural East Yorkshire was at **Bolton Hall, Bolton,** NE of Pocklington and not far from Carberry Hall, from which a small group of samples was analysed by Jaques *et al.* (EAU 2002/04). The primary fill of a pit or ditch terminal, AMS dated to the Iron Age (cal BC 400 to 200, cal BP 2350 to 2150), was rich in invertebrate remains, often excellently preserved and including specimens of a range of bugs. Aquatics were abundant and suggested a shallow body of weedy, still or sluggish, water. Plant feeders typical of waterside vegetation were numerous, too. Beyond the depositional basin, short vegetation, probably poorish grazing, was indicated by the chafer *Phyllopertha horticola* (which was remarkably numerous), substantial numbers of *Agriotes obscurus*, a click beetle most likely to have been abundant in grassland, and *Hoplia philanthus* (another chafer), *Dascillus cervinus* and *Agrypnus murinus*. There were no indications of woody plants from insect herbivores (contrasting with the strong indication from the plant remains that trees grew close by, but see p. 458). Scarabaeid dung beetles were very abundant, the dung fauna being dominated by large numbers of *Aphodius contaminatus* and *A. sphacelatus* (as at Carberry Hall Farm), with small numbers a range of others. It thus seems that the feature was set in grazing land, although what kind of livestock was present is uncertain. *Facultative synanthropes* (p. 61) were present, but they probably exploited essentially natural habitats (although in a landscape dominated by human activity). The possibility that this fauna was brought together in flood debris by the nearby Spittal Beck was examined and rejected.

Invertebrates from what were probably Iron Age deposits at another nearby site at **Bolton Common** were subjected to evaluation by Hall *et al.* (EAU2000/67). A post-pit fill was barren, but two ditch fills gave assemblages of remains preserved by anoxic waterlogging, the first small, a mixture of aquatic, waterside and terrestrial forms but with no clear character, the second a similar mixture, but with indications that the deposit formed in a swampy pool overhung by trees. There was no evidence of human occupation.

The earliest phase of features at the **North Cave** site was considered mainly to date to the very late Iron Age (Allison *et al.* AML 105/90; EAU 1997/37; forthcoming a; Carrott *et al.* EAU 1996/42). The deposits examined for invertebrate remains were all cut fills, mainly pits but also including a supposed posthole fill and fills of a well. On the invertebrate evidence most of these features certainly held water, and there were sometimes large numbers of cladoceran ephippia (*Daphnia* and *Ceriodaphnia* in one case), and occasionally ostracods. Aquatic insects, too, were generally well represented and in some cases numerous. There were no more than traces of synanthropes, and decomposers were rare, certainly no more than might exploit small patches of natural litter. If there were contemporaneous structures, they seem to have been temporary or slight, perhaps no more than shelters for livestock. There were sufficient dung beetles to indicate the presence of livestock nearby, though not necessarily on the site. These cuts were perhaps water holes rather than being intended for processes, storage or waste disposal. Their infilling may have post-dated the main phase of Iron Age occupation and generally appeared to be a natural process (fills of one cut may have included dumped surface soil, however, in view of the abundant *Heterodera*-type cysts and earthworm egg capsules). They thus unfortunately do not provide evidence for conditions on the site during occupation (unless it was short-term or seasonal, a possibility entertained in the publication report), nor do they provide a sample of Iron Age synanthropic insects, potentially so valuable in research terms.

Carrott and Jaques (EAU 2001/47) carried out evaluation of two sediment samples from Iron Age or Romano-British ditch fills found during excavations on land off **Little Wold Lane, South Cave**. One contained a few snails, mainly *Vallonia* sp., the other only a fragment of the post-depositional invader *Cecilioides acicula* (p. 482). There were also a few hand-collected shells, all *Cepaea/Ariantia* or *Helix*.

Iron Age or Romano-British peats at **Long Lane, Beverley** were mostly barren or gave only a few traces of invertebrates, in certain cases clearly modern contaminants (Alldritt *et al.* EAU 1991/35), but there were some modest-sized assemblages of beetles (and a few bugs) dominated by aquatics and species able to exploit waterside habitats. They probably represented weedy open water or fen. There were very few terrestrial insects, small numbers of *Aphodius* dung beetles (not considered to stand as evidence of grazing land), and specimens of *Grynobius planus* and *?Xestobium rufovillosum* quite possibly derived from dead parts of trees standing in carr vegetation. The insects gave no evidence of human activity, synanthropes being absent apart from a tentatively identified *Acritus nigricornis*. Iron Age deposits at a site on the route of the **Leven-Brandesburton by-pass** (Dobney *et al.* EAU 1993/20) proved barren.

Analyses of landsnails from a series of sites in East Yorkshire were reported by Wagner (2004). Ditch and pit fills at **East Field** and **The Pit, Burton Agnes** produced mostly small groups with numerous *Cecilioides acicula*, presumed to be post-depositionally intrusive (p. 482). Some samples from ditches at the former site produced more snails which were probably ancient, however, with *Vallonia costata* and *V. excentrica* abundant. Another assemblage was dominated by *Trichia hispida*. A remarkable and inexplicable find at The Pit was a coastal weevil, in excellent preservation despite apparently unsuitable conditions. Ditch fills at **The Enclosure, Rudston**, sometimes yielded moderately large numbers of snails, with appreciable numbers of *Vallonia* species, *Helicella itala* and *Trichia hispida*. There were hints of ecological change through sections, but the indicator species tended to be rare. *Cecilioides* was almost always present. Samples from pit fills at **North Wood** and **Denby Farm, Rudston** produced little molluscan evidence. Assemblages from ditch fills at **Hanging Cliff, Kilham**, varied. *Cecilioides acicula* was sometimes very abundant, but several other species were present in substantial numbers in some of the samples. It was suggested that one of the ditches was rather rapidly infilled. The assemblage in a second ditch (whose lower fill may have incorporated material of Neolithic date) gave indications of leaf litter or the shady litter below grasses (*Carychium tridentatum*, *Discus rotundatus*), and a species often found below bark (*Oxychilus alliarius*); the lowest sample gave a group dominated by Vitrea *contra*cta, often found in rock rubble but perhaps a burrower. The very fragile *Phenocolimax major*, found in moist sheltered places, was present in appreciable numbers and this appears to be the first archaeological record for this species. It was considered difficult to interpret the assemblages from this feature, though one wonders whether a hedge line or band of scrub may have provided the right mix of habitats without favouring ancient woodland species, which were not represented.

North Yorkshire

Assessment of numerous samples from various Iron Age features at **Crankley's Lane, on the Easingwold by-pass**, gave almost no invertebrate remains, those found probably being modern (Carrott *et al.* EAU 1993/32).

Shallow stratigraphy and free drainage seem the likely causes. Other sites have lacked preservation, for example Carrott *et al.* (EAU 1993/12), carrying out evaluation at Duggleby Lodge, found the presumed Iron Age pre-Roman ditch fills to be completely barren, and deposits at Burythorpe Church were effectively devoid of invertebrate remains (Hall *et al.* EAU 1994/15; Carrott *et al.* EAU 1995/50).

Kimmins (1954) listed some insects from late Iron Age (1st century AD) ditch deposits at Stanwick. All were large, and of no interpretative importance. From the same deposits, Harding (1954) gave a bare list of ostracods, and Davis (1954) described mollusc assemblages. There were small numbers of terrestrial and freshwater snails; the former were all associated with damp ground and the latter were eurytopic species. It would be of considerable interest to make systematic investigation of such ditch deposits, particularly to attempt to detect the presence of grain pests and other species regarded as Roman importations. Any secure records would be useful evidence of contact with the Roman south.

Evaluation of fills of Iron Age and ?Iron Age features at the Heslington East development site, York, showed several to be barren, but two ditch fills yielded aquatics and waterside forms, with terrestrial insects including significant numbers of dung beetles and the chafer *Phyllopertha horticola*, probably indicating grazed land (Hall *et al.* PRS 2004/28).

County Durham

Evaluation of 'later Iron Age' ditch and pit fills at the site of the proposed Heighington Lane West Industrial Area, Newton Aycliffe produced no invertebrate remains (Hall and Kenward PRS 02/28): this appears to be the only Iron Age site in the county subjected to any form of investigation specifically searching for archaeological invertebrates.

Northumberland

Akeret *et al.* (PRS 2005/105) assessed samples from Iron Age deposits, mostly ditch fills, at the North Road Industrial Estate, Berwick-upon-Tweed. Some were barren of invertebrates, but one had a few waterlogged insects (ecological character not recorded), and two contained quite large amounts of shell, mainly *Littorina littorea* (periwinkle) and *Patella* spp. (limpets) in roughly equal amounts. A shell midden tentatively assigned to the Iron Age gave abundant marine molluscs, some well preserved, about a third being *Littorina littorea*, with oyster, mussel and limpets.

Cumbria

There is a little evidence from Carlisle. At the Old Grapes Lane A site (Kenward *et al.* AML 78/92; Kenward *et al.* 2000) Phase 1 was believed to represent pre-Roman material, though was not clearly dated. Insects were rare but indicated human settlement; whether these remains were prehistoric or were Roman material trampled or carried down into earlier deposits was uncertain.

Lancashire

Material from an Iron Age farmstead at Lathom, West Lancashire, was reported by Hall *et al.* (PRS 2004/45). None of the 41 samples yielded any invertebrate remains, not surprising since many were collected for their content of charcoal.

West Yorkshire

Late Iron Age to early Roman ditch fills at South Dyke (on the M1/A1 link road) gave substantial insect assemblages which were analysed in detail (Kenward and Large EAU 1999/02; 2001b). All the material is considered in this section. The fossils were somewhat decayed, fragile and fragmentary, but surface features were well preserved. As the earlier fill formed (radiocarbon date: one SD range 44 BC - AD 66) the ditch held water and supported a rich aquatic-marginal flora, with at least some insects carried in by a stream. The fauna from a later deposit (one SD range AD 232-243) indicated that the cut held water for at least part of the year. Terrestrial insects from both indicated that the surroundings were open, with herbaceous vegetation; some species favoured by cultivation were identified, while dung beetles were not particularly abundant. Arable farming may thus have predominated. The earlier deposit gave no evidence of trees or scrub, while the later one yielded a few species indicative of birch or willow, perhaps no more than scrub, but only one beetle associated with dead wood. Insects favoured by, or dependent upon, human occupation sites were rare (only 5% of the fauna, and all but one individual being facultative synanthropes, typically associated with natural and semi-natural habitats but able to take advantage of artificial ones, p. 61). None of the species were dependent upon human occupation. While the rate of transfer of insects from settlements to nearby cut features giving preservation is unknown (p. 459), it appeared unlikely that there were buildings close by.

The fauna of a ditch fill, probably of Iron Age date, at Grim's Ditch, also on the line of the A1-M1 link road, was described by Kenward and Large (EAU 1999/03; 2001a). A large assemblage of insects was recovered, evoking a picture of the range of habitats typically found in field edges and along well-established drains in modern landscapes. The ditch itself probably contained more or less permanent water, which supported emergent vegetation and had a muddy bottom. There was perhaps a little scrub willow or birch, but the vegetation on the banks, and probably beyond, was predominantly herbaceous. Land use was probably primarily arable, but there was perhaps some livestock.

Carrott (PRS 2003/35) reported land snail assemblages from Iron Age deposits associated with a roundhouse at Ferrybridge; there were few remains, giving hints of an open environment.

South Yorkshire

Carter (1997) gave an account of land snails from an enclosure ditch and pits, probably of Iron Age date, at Dale Lane, South Elmsall, north-east of Doncaster. The ditch was inhabited by diverse snail community, dominated by eurytopic species, so that it was not in dense woodland or completely open, but must have been stony, damp and well-vegetated, though perhaps only with rank grass or low shrubs. Similar assemblages were recovered from the pits, except for one whose snails suggested an open dry environment. Aquatic and waterside beetles predominated, with some terrestrial forms including bark beetles (Scolytidae). Rackham and Scaife (2002) carried out evaluation of a series of ditch fills, some dated to the Iron Age, mainly undated, from Carr Lodge Farm, Loversall, Doncaster. Bulk sieving was employed, but invertebrates (insects and cladocerans) were noted in almost half of the samples.

Roper and Whitehouse (ACUS 181) give a brief assessment of material from the Iron Age enclosure site at Sutton Common. A large-scale study of material from this site was carried out by Hall and Kenward (CHP 2005/10; CHP 2005/11). Of 96 samples examined, only four gave appreciable numbers of insect remains, though this was not unexpected as many post-hole fills and other unpromising deposits were included for botanical analysis. Three of the ditch fill assemblages were large enough for full analysis: they indicated a rich natural environment, with aquatics abundant (up to a third of the fauna), and also substantial waterside and damp ground components. There were some species associated with trees and dead wood. Decomposers were rare (by comparison with occupation sites in general), and very few of them suggested dry matter. Foul matter taxa were consistently present in appreciable amounts, and rather abundant in two cases. Synanthropes were rare, and half or more of those present were facultative taxa; there was no evidence from the insect remains for human occupation at the stage that these ditch deposits formed, so that they presumably represent abandonment.

An evaluation of material from Catesby Business Park, Balby Carr, near Doncaster, was carried out by Hall *et al.* (PRS 2004/98). A series of fills of ditches associated with a trackway mostly gave insects, sometimes in quite large numbers. Aquatics were abundant, indicating a substantial period with open water, there were damp ground or waterside species, and the terrestrial fauna suggested grazing land in the surroundings. There were modest numbers of tree-associated beetles, and one bug (*Drymus brunneus*) which is typical of tree-shaded locations.

Natural deposits of the pre-Roman Iron Age

Invertebrates from natural sites dated to the pre-Roman Iron Age have barely been studied in the area under review.

East Yorkshire

The deposits around the Iron Age boat at Hasholme, near Holme-on-Spalding Moor, were for all intents and purposes 'natural'. Holdridge (1988) described two insect assemblages, with numerous aquatic, marshland and damp ground species. There were several tree-feeding phytophages, and indications of dead wood, probably on standing trees (from bark beetles). *Arpedium brachypterum* and *Olophrum fuscum* were noted, surprising records as in other company these would have been regarded as cold indicators in a site in lowland Yorkshire (further investigation is desirable; deposits in the area seem likely still to be accessible for research). *Phyllopertha horticola* suggested meadowland nearby. Spencer (1988) examined molluscs from the same deposits but found only fragmentary remains, although abundant shells had been seen in the field. She suggested that sampling had missed the concentrations seen in the field (although the present writer's experience is that shells may be very delicate and may have merely disintegrated during sampling, storage and processing, p. 81).

Hill (1993, 101-122) described insects from a later Iron Age to post-Roman natural succession (^{14}C cal BC 170 - cal AD 630) at Thornton. The fauna was dominated by aquatic and marshland taxa, the latter increasing proportionally up the sequence, leading to a swamp probably dominated by common reed, *Phragmites australis*. All the recorded molluscs were aquatic. The invertebrates as a whole suggested slow-flowing or still water. Terrestrial insects contributed only a small proportion of the fauna; there were some dung beetles, though insufficient to suggest abundant pastoral habitats, and almost no evidence of woodland. It was not entirely clear whether this was a result of regional or local rarity of trees, but it was suggested that the catchment area of the site was small and that it was largely isolated from allochthonous influence.

Cheshire

Girling (AML 4725; 1986a, b) investigated insects from natural sediments around the human body at Lindow Moss (Lindow II). The insect assemblages were small in relation to the perceived importance of the site, but were fairly diverse ecologically. Overall, acid swamp with some open water was indicated by caddis fly larvae and beetles, with a small number of individuals which probably came from drier places. Only a single fragment was attributable to a beetle species which may have been attracted to the corpse, suggesting that it was immersed (although of course the individual may have fallen, or been pushed, into the bog in winter). Skidmore (1986) suggested that the rarity of other fly remains, and particularly the absence of forms likely to be attracted to a corpses, indicated that the body was not exposed to the atmosphere, being totally submerged at the time of, or not long after, death. From the same site, Oldfield *et al.* (1986) recorded rhizopods (testate amoebae), *Amphitrema wrightianum*, indicating bog pools and restricted to only part of the sequence. Dayton (1986) studied cladocerans (water fleas) and chironomids (midges). The environment at Lindow Moss appears not to have been hospitable for cladocerans, a limited range of species being found, those present being consistent with a peaty, rather acidic site, with bare substratum and perhaps some rooted plants. Littoral species and the presence of ephippia suggested a shallow pool which may even have dried out at times. Unusually large numbers of the scavenging species *Pseudochydorus globosus* were found and it was suggested that these may have been associated with the decaying corpse. This would suggest that the body had lain in the water and was not buried, of course. Rather few midge larval head capsules were recovered, and they were of limited value in ecological reconstruction. Jones (1986a) found eggs of both common nematode gut parasites, *Trichuris* being slightly more abundant than *Ascaris*. Egg measurement established the former as *T. trichiura*, the species normally found in humans.

Dinnin and Skidmore (1995) reported insects from deposits associated with the Lindow III bog body, arriving at a reconstruction of a wet *Sphagnum* bog with pools of rather acid water and typical bogland vegetation beyond. The now supposedly rare water beetle *Hydroporus scalesianus* was quite common, and Dinnin suggests that its rarity may be an artefact of collection methods, something perhaps supported by recent field observations (Hammond 2002).

West Yorkshire

From a completely different kind of landscape. Milles (AML 114/93) reported molluscs from fills of the henge ditch at Ferrybridge Henge, near Castleford, of uncertain date, but perhaps Iron Age. The lowest layers contained a limited range of species, and there were worn shells. It appeared likely that there was short grassland in the surroundings. Changing species composition suggested that this may have been followed by vegetation of increasing height.

Invertebrate assemblages from occupation sites and natural deposits of pre-Roman Iron Age should be actively sought, for the period has received inadequate attention in relation to the range of pressing questions to be addressed. These questions fall into several main categories: (a) concerning the destruction of natural vegetation, the extent of woodland, and the development of an agricultural landscape, and the nature of land-use (arable/pastoral, forest and wetland exploitation); (b) concerning climatic change in a period when there may have been a number of extinctions among the British insects and when other evidence suggests a climatic deterioration from the Bronze Age, and the relationship of climatic change to human culture; (c) concerning the importation of invertebrates - especially synanthropic insects - and their effects on the natural fauna - and to establish which of the synanthropic insect species were already present and so perhaps native; these species are particularly important for some aspects of site reconstruction (p. 468); (d) detecting early contact with the Roman world through grain pests; and (e) concerning the degree of continuity between Iron Age and Roman settlements (addressing questions posed, for example, by Dent 1988). Without information concerning the pre-Roman Iron Age it is difficult to determine the degree or impact of romanisation.

5. The Roman Period (1880-1550 BP, AD 70-400)

Introduction

This section reviews invertebrate remains from the Roman period, including Roman 'Iron Age' sites. The evidence is, perhaps predictably, very strongly biased in favour of urban settlements, with significant information from several military establishments and civilian settlement associated with them, some from rural occupation sites, and rather little from natural deposits or agricultural land away from settlement foci. Evidence from York has been outlined in a review of the British Colonia*e* (Dobney *et al.* 1999).

What did the Romans find in northern England?

The first question to ask regarding the Roman period is 'what did the Romans find when they arrived in northern England?' Without an answer, the impact of romanisation cannot be judged. Dark (2000) summarises bioarchaeological data relevant to this question. However, Iron Age sites where ecological reconstruction from invertebrates is possible are too rare to help much (see above): there are few significant data concerning pre-Roman Iron Age invertebrates from the area. We are thus largely thrown back on evidence of land use immediately preceding Roman construction or other activities which caused ground surfaces to be buried in the initial stages of occupation. This is rather unsatisfactory since it is often impossible to decide whether buried soils relate to pre-Roman use or to the Roman period immediately prior to settlement at the particular site in question, and of course it may not be possible to determine to what extent Roman land use differed from that in the pre-Roman Iron Age (pedological studies may give evidence as to how long soils and their vegetation had remained stable). Although suitable deposits are probably quite common, invertebrate remains from remarkably few pre-Roman land surfaces have been investigated. Fortunately York, at least, has been moderately well served in this respect.

Pre-Roman land use at York

At Coney Street (Kenward and Williams 1979) a series of fine sandy loams of very low organic content underlay the earliest recognisable occupation phase. These were shown by soil analysis to represent alluvial deposits upon which a living soil had subsequently developed. The upper part of this soil, equated with the A horizon, contained modest numbers of insect remains, with far fewer in the lower horizon. The fauna (and flora) clearly indicated natural or semi-natural habitats, most probably rather poorly drained rough grassland. This was presumably the vegetation immediately pre-dating the construction of the overlying buildings (sometime in the period AD 70-90). Although dung beetles were not especially abundant the most likely land use would have been for grazing. Whether this fauna represents pre-, or early, Roman exploitation, is not clear; there were traces of grain pests and other synanthropes, perhaps suggesting a Roman date, but a contaminative origin for these remains cannot be ruled out bearing in mind the huge numbers of such insects in the overlying humic silt deposit. It seems most likely that the sealing of this soil occurred not long after construction of the first fortress in AD 71-4 (Royal Commission on Historical Monuments 1962, 6), since it is hard to conceive that an area adjacent to the fortress walls and near to the SW gate (*porta praetoria*) would not quickly have been developed, or if not actually built on then been so disturbed as to destroy or prevent the development of a soil.

On the opposite side of the River Ouse, a deep trench at the Skeldergate site also revealed a buried soil, samples from which gave radiocarbon dates in the first and second centuries (Hall *et al.* 1980; data archive for invertebrates given by Kenward EAU 2000/41). The soil was buried by an overlying dump of redeposited sediment, perhaps early in the second century. This soil, which was identified on pedological grounds, appeared to have been well drained, but then permanently waterlogged, presumably following burial. Plant and insect remains suggested that it supported grassland, and the area seems to have been poor grazing land. Dung beetles were present in rather large numbers (an *Aphodius* species was the second most abundant beetle in two of the three samples, for example). The most numerous insect was a staphylinid beetle, *Anotylus nitidulus* which, although modern British records suggest a preference for wetland litter, may have been typical of foul matter (including dung) around occupation sites in the past (see p. 283). Other foul-matter taxa were rare, although *Megasternum obscurum* was well-represented (it is typical of foul-matter habitats in the open, but occurs in many other habitats). There was no evidence to suggest flooding, the aquatics being dominated by *Helophorus* species, which are highly dispersive and typical colonisers of temporary puddles such as those formed in cattle footprints. Species likely to have been deposited in floodwater (e.g. Elmidae, Dytiscidae, aquatic Hydrophilidae other than *Helophorus*) were conspicuously rare or absent. A few wood-boring and bark beetles were present, and one sample yielded abundant *Dryocoetinus villosus*, especially found under patches of dead bark on large oaks, which it was suggested may have grown along a steep slope above the site (alternatively there may have been something resembling pasture woodland, p. 294, with scattered old trees providing shelter for livestock). There were traces of grain pests and a few other occupation-site synanthropes, which may have originated far from the site. With hindsight, these synanthropes in all probability arrived in the dung of grazing horses, so that, if a Roman introduction of the grain pests is accepted, this soil certainly represents activity and conditions in the Roman period rather than earlier. However, the well-developed soil profile suggests that conditions had been stable for a long time, and the area may have seen much the same use since the pre-Roman period.

The pre-structural phases at Tanner Row and Rougier Street appear to represent land use in the early Roman period, with what appear to have been a series of watercourses, probably artificial, traversing grazing land (Hall and Kenward 1990). They thus fairly certainly cannot be taken as representative of pre-Roman land use and are considered elsewhere (p. 187). A notable group of samples from the major excavations at the nearby Wellington Row site (Carrott *et al.* EAU 1995/14) was taken from a 1st to mid-late 2nd century bank thought to have been constructed of turf. That these were turves is clear from the biological analyses, even at assessment level. Further investigation is required to establish the precise nature of the vegetation represented and the likely source of the turves. In particular, if they had been cut from soil adjacent to the River Ouse, they would stand as further evidence of pre-Roman or early Roman land-use in the area. Full analysis of the material from this site is a high priority.

Reporting on material from the Jewbury (County Hospital) Site, on the north-east fringes of central York, O'Connor (AML 4709) described a substantial assemblage of landsnails from a large, undated but possibly pre-Roman, depression. An aquatic assemblage had been anticipated since it had been postulated that the depression was a creek leading to the River Foss but, although there were some damp ground/waterside species, most of the snails were terrestrial forms indicating 'rather damp, rank vegetation, with minimal human interference'. Grassland and scrub species were conspicuously poorly represented. It thus appears that this deposit was above the contemporaneous river level and carried a lush herbaceous vegetation. An improved understanding of the feature would be most valuable; AMS dating of fossils (seeds were numerous) would presumably be possible.

Elsewhere in northern England, an understanding of the impact of the Romans often comes down to accepting guesswork about the Iron Age as indicative of what the Romans found. Hard evidence is sparse, particularly from invertebrates. This is clearly another period (or, more accurately, type of deposit) much in need of research.

Roman military sites

This section considers areas which are known or reasonably believed to have a primarily military function. Preservation of delicate organic materials by anoxic waterlogging is often poor at such sites (probably as a result of low input and good drainage combined), but several have produced at least a few assemblages of useful insect remains and some have been among the largest-scale studies of insects (and plant macrofossils) in The North. Shellfish are commonly present but have received little systematic attention, and there are some reported assemblages of landsnails. The following discussion is structured following a hierarchy of military establishments rather than geographically.

The fortress at York

There is remarkably little information from within the Roman fortress in York bearing in mind the number of excavations carried out and the quality of preservation of surface deposits of later date in the area. None of the considerable number of Roman surface deposits investigated at City Garage, Blake Street (Kenward EAU 1986/14) produced more than a trace of invertebrate macrofossils. Assessment of 1st-4th century material from the rear of 3 Little Stonegate (Johnstone *et al.* EAU 1999/21; Large *et al.* EAU 1999/46) produced only very poorly preserved scraps of insect cuticle and some earthworm egg capsules, while Roman deposits in the Swinegate area only produced traces of landsnails (Carrott *et al.* EAU 1994/13). Presumably, extremely clean conditions were maintained over a long period in the heart of the fortress. A ?late Roman deposit close to the fortress wall at Davygate gave only traces of insects and very rotted marine shell (Carrott *et al.* EAU 1997/51).

Similarly, during investigation of Roman surface deposits in The Bedern and Aldwark (Kenward *et al.*1986b) a substantial number of samples were processed, but almost no invertebrate remains were recovered. The reasons offered to explain this were (a) than most of the deposits were clean clays or sands, considered inherently unlikely to have contained many biological remains and (b) that the deposits did not appear to have been waterlogged in the early phases of their life, although deeply buried by thick waterlogged medieval accumulations when excavated. The evidence thus suggested that this area, too, had well-drained surfaces which did not receive much organic matter or were frequently cleaned. Some Late Roman deposits at The Bedern appeared unpromising for bioarchaeological investigation, and were not examined, in retrospect perhaps a mistake.

Deep features have provided some insights into conditions within the fortress. Analyses of fills of the Roman well at The Bedern (Kenward *et al.* 1986b) revealed rich and excellently preserved assemblages of insects. Like so many wells, it was not fully excavated; in this respect the project represented a lost opportunity (compare the full and meticulous excavation of the structurally rather similar well at Skeldergate, York, whose fills were very different, Hall *et al.* 1980). The stratigraphy and excavation record suggested that the excavated fills were deliberate dumps over a short period and that no post-depositional infiltration by macrofossil remains was likely, greatly enhancing the value of the material. The fills examined appeared to be of mid to late third century date at the latest. Twenty-six samples were collected, but only six could be analysed in detail. There were traces of parasite eggs (*Trichuris* and *Ascaris*) in one sample (details given by Jones AML 4310), but insufficient to suggest deliberate disposal of human faeces. Numerous plant and invertebrate macrofossils were considered to have entered in the dumped material. Grain pests were present in varying proportions in the assemblages (5-47%), dominating the assemblages from the upper layers but with the concentration falling off steeply downwards, mirroring the pattern seen in the fills of the well at Skeldergate, York (see p. 168), perhaps for the same reason; as at Skeldergate, house fauna taxa did not show the same distribution, suggesting separate origins (and hence perhaps that at least a substantial proportion of the grain pests did not originate in stable manure?). A large, but very variable, proportion of outdoor taxa was present, the variability perhaps being a result of variations in the quantities of grain pests and others. The mode of entry of the remains was uncertain. The original conclusion was that grazed soil, perhaps from the rampart, had been dumped, but with hindsight stable manure may have been present (Kenward and Hall 1997). Careful re-examination of the original lists does not resolve the problem - the foul mouldering component identified at other sites (e.g. Tanner Row, York, Hall and Kenward 1990) was only rather weakly represented, and may have entered by various means. 'Hay' weevils and a range of other species may have come from grassy vegetation on the adjacent banks, perhaps after it was cut and left in piles for a while. There were some strongly thermophilous bugs, confined to the south of England in the 20th century: *Sehirus luctuosus*, *Syromastus rhombeus* and *Aphanus rolandri*, the first two each represented by three individuals, the last by one. All in all, the most likely explanation for the origin of this fauna is that originally given in the report, perhaps with some fairly rapidly cleared stable manure in which foul decomposers had not multiplied (although there were some *Muscina* fly puparia). There were some snails, and it was suggested that *Planorbis planorbis* may have colonised the well. The insect remains and other biota of this well might repay further investigation before the samples decay completely in storage.

The fills of the Roman sewer in Church Street, investigated intensively by a team of specialists lead by Buckland (1976a), represent a special and unusual kind of deposit. They presented considerable challenges for environmental archaeology, succinctly understated in the report: 'The sewer did not represent an ideal locality for the recovery of biological remains. The system was neither entirely filled with silt nor completely waterlogged, and there was some evidence that the top few centimetres of sediment were being reworked by an active soil fauna' (Buckland, *op. cit.*, 3). In fact, although the report is rightly recognised as a landmark in the development of integrated environmental archaeology (see p. 473), and is deservedly much quoted as a result, returning to it after the passage of 20 years leaves the reader even more certain that, although some of the remains are undoubtedly Roman (e.g. the freshwater molluscs and ostracods), and many (or most) probably are, the likelihood of contamination by invertebrate remains of any or all subsequent dates is so great that the site serves more as a cautionary object lesson than a source of information about Roman York. It did, however, draw attention to a range of questions, from the nature of water supplies to the position of sewage outflows.

In summary, the invertebrate remains from within the Fortress in York represent atypical deposit types and further investigation is desirable. One possibility is that extensive dumps of clearly military origin, parallelling those at Ribchester (Buxton and Howard-Davis 2000) and Carlisle (the Millennium site: an underpass between Tullie House and the Castle, as yet unpublished) may be discovered outside the Fortress, perhaps adjacent to the River Foss.

Military sites in Carlisle

A great deal of bioarchaeological information has been recovered from excavations in and adjacent to the fort at Carlisle. Deposits at **Annetwell Street**, in the area of the fort gate, were rather extensively sampled, and numerous analyses for insect remains carried out (Kenward and Large EAU 1986/20; Large and Kenward EAU 1987/14-16; EAU 1988/15-19; Kenward EAU 1999/32; Allison *et al.* forthcoming b). Parasite eggs were investigated by Jones and Hutchinson (nd). A draft publication text was produced in the early 1990s (Allison *et al.* nd) but the passage of time means that extensive revision should be made (the original appears to be lost in any case), with current phasing to hand and in the light of subsequent development of interpretative techniques, for example the recognition of the components of stable manure (Kenward and Hall 1997), and the identification of species associations (Carrott and Kenward 2001; Kenward and Carrott 2006), both of which have implications for the site (see Kenward EAU 1999/43, and p. 397 below). Samples from the timber fort generally gave excellent preservation, and insects were sometimes very abundant. Grain pests were generally present or abundant, and samples from roads, surfaces (including floors) and pits all gave what with hindsight is clear evidence for stable manure (grain pests, house fauna, 'foul mouldering' decomposers, 'hay' insects). Deposits associated with structures at this stage often gave only small numbers of insects, but here and there large accumulations of foul matter existed. Samples from the stone phase of the fort were essentially barren. Overall, this site seems - not surprisingly in view of its location - to have been decidedly cleaner than some others in Carlisle. Detailed re-examination of the data for Annetwell Street has not been possible within the scope of this review, but would surely repay the time required, as might a return to the original material (was, for example, *Tipnus unicolor* overlooked at this site, see p. 378).

Denford (1976), in an apparently unpublished investigation, listed mites from a site to the north of the Fort at the **Tullie House** site. The fauna appeared to have been introduced in turves from a wet grassland.

Invertebrates from Roman forts

Moving down in scale, three forts in the region have given assemblages of insects and other invertebrates, with a little work at some others. Investigation of two samples of turves from Roman features at **Cawthorn Camps, North Yorkshire**, produced at most well-decayed beetles thought to be of recent date; 24 bulk-sieved samples produced no recognisable ancient invertebrates (Hall and Kenward EAU 2000/09). Similarly, assessment for botanical remains by Hall (EAU 2001/17) of a large number of samples from pre-Roman and Roman deposits exposed during later excavations at the same site produced only traces of modern insects. Assessment of ditch fills at the Roman camp at **Monks Cross**, York, failed to reveal any invertebrate remains (Hall *et al.* PRS 2002/23). A single insect assemblage from a pit at the Roman fort at **South Shields**, **South Tyneside**, was reported by Osborne (1994). Although very small, the fauna suggested that stable manure was present; grain pests had reached the site.

The fort at **Papcastle, near Cockermouth, Cumbria**, was investigated through a rather small group of samples (Kenward and Allison EAU 1995/01; AML 145/88). An occupation phase with hints of stable manure was followed by supposed abandonment; the latter gave mainly background fauna, but there was a probable stable manure group (with grain pests, suggesting that the fort had not really been abandoned). A phase of industrial activity after this gave few remains, and deposits of a subsequent phase were barren. The sampling regime was probably not ideal in this case. Aspects of this site are mentioned by Kenward (1997a). Jones (AML 4600) investigated a pit fill of Roman date from **Ambleside, Cumbria**, for eggs of intestinal parasites. *Trichuris* (probably *T. trichiura*) was rather numerous, and there were a few *Ascaris*, and it appeared that the fill included human excrement. At **Stanwix, Carlisle** (Hall *et al.* EAU 1994/57), a buried soil with horse dung or stable manure on its surface was revealed, overlain by putative parade ground make-up.

The fort at **Ribchester, Lancashire**, was the subject of an intensive study of invertebrate remains (Buxton *et al.* 20001a-d; Carrott *et al.* 2000; Large *et al.* EAU 1994/11; Kenward and Carrott 2006), over 120 insect assemblages being recorded quantitatively or (in a few cases) semi-quantitatively; a survey for parasite eggs was also made. Many cut features (mostly ditches, but some pits) gave modest-sized to quite large assemblages of beetles and bugs, although preservation in surface-lain deposits was very rare. A large proportion of the groups included fauna indicating stable manure: numerous grain pests, plant feeders possibly introduced in hay, and a characteristic suite of decomposers associated with rather foul, but coarse-textured, material. While stable manure seems to have been very abundant at the site, there was little to suggest that other artificial habitats were available for insects. In particular, there was remarkably little evidence for human dwellings from 'house fauna', presumably because buildings other than stables were kept clean, preventing the development of large insect populations. External surfaces, too, appear to have been kept rather clean. Analysis of eggs of parasitic worms gave only very limited evidence for contamination by human faeces. Grain pests were present from the earliest stage of Roman presence, indicating their importation with supplies for the troops responsible for the construction of the fort. Some of the ditch fills gave insects and other invertebrates indicating the presence of open water, sometimes probably long-lasting.

At the fort at **Kirkham (Dowbridge Close), Lancashire** (Carrott *et al.* EAU 1995/02), several ditch fills contained plant and insect remains which probably originated in stable manure or horse dung. In some cases there was evidence for temporary open water in the cuts. A large proportion of the fills may have consisted of surface deposits used to backfill the ditches, bringing with them horse dung and other material including turf; no layers of stable manure or turf as such were identified, however. It is possible that 'indoor' insects in some of the samples had been eaten incidentally in stables and voided with dung in the open. The grain pests recorded doubtless came from horse feed rather than food for human consumption. It appears that waste disposal at this site was generally well organised, for the fills examined gave little evidence for the detritus of human occupation. There was a notable lack of evidence for human housing or foods.

In addition to these analyses of insect assemblages there are some more casual records from the fort at **Vindolanda** (Seaward 1976). *Stomoxys calcitrans*, the stable fly, was abundant in deposits of bracken and straw, while a gall-gnat (*Dasyneura filicina*), associated with bracken, was represented by its galls. There were beetles, but analysis was very limited; the presence of *Anthicus formicarius*, typical of 'stable manure' assemblages, was notable. Investigation of insect assemblages from the Wall, whether from military establishments or from natural and agricultural environments, remains a priority.

Other military sites

Deposits associated with the use and abandonment signalling station at **Car Naze, Filey, North Yorkshire** (Carrott *et al.* EAU 1994/07, Dobney *et al.* EAU 96/26; 2001), provided an example of a small, isolated military establishment. Unfortunately there was no preservation of invertebrates other than a small assemblage of marine molluscs and a few fragments of crab shell, probably a mixture of human food and material dropped by seabirds, and some terrestrial molluscs. The landsnails were generally thinly distributed, but one context from the courtyard, dated to the abandonment of the signal station, gave a more substantial assemblage indicating grassland habitats with some shade, dominated by *Vallonia excentrica* and *Lauria cylindracea*. The distribution of limpets (*Patella* sp.), most common in occupation layers, suggested that these unappealing animals were collected to be eaten. It was postulated that most of the shellfish were of local origin, but that the oysters (*Ostrea edulis*) must have come from further away, since it is argued by Winder (1992 and personal communication) that there were no oyster beds in the region. This contention is discussed in more detail on p. 329.

Four samples from ditch and ?tank fills at the Roman fort at Park View School, Chester-le-Street gave substantial insect assemblages including aquatics (many *Daphnia* ephippia) and a range of terrestrial species indicating dung, herbaceous vegetation, stored grain, acid vegetation, and (probably structural) dead wood (Schmidl *et al.* PRS 2006/47). There was a provisionally identified fragment of the nettlebug *Heterogaster urticae*, well north of its mid-20th century range.

Other than the forts, sites along Hadrian's Wall are effectively rural and considered under the appropriate section below (p. 177).

General comments on Roman military sites

Although there is an appreciable amount of evidence from these military sites, it is by no means sufficient for synthesis at this stage. What may be stated is that stables and stable manure were the predominant habitat for the insects which have been recovered. Various questions concerning this class of site present themselves as addressable through invertebrates, some prompted by McCarthy's (2005) review of social dynamics on the northern frontier: determining pre-construction vegetation and land use at the chosen locations; elucidating conditions within military establishments (in particular, were they really as biologically barren as appears on the evidence so far?); detection of changes of intensity and style of use (including periods of abandonment and the balance of military and civilian influence); determining whether animals other than equines were kept (and, incidentally, establishing through other means whether the equines were horses, donkeys or mules); the level of parasitic infection in sites presumed to be equipped with proper sanitation; the range of crafts based on organic resources, including the use of dyes; tracing the exploitation of turf and peat (was it uniform across the region or can any systematic differences be detected? Was peat generally used, or a material unfamiliar to the Roman colonists, exploited primarily by 'natives' already acquainted with its value – perhaps as fuel – but who perhaps turned it to a new use in stabling?) What was the impact of military resourcing on the agricultural and natural - wetland and forest - environment? Were there changes in lakes and rivers caused by agricultural and industrial activity? Can the importation of grain pests (and hence presumably transported grain) at the initial stages of sites be traced? Can the importation of other organic resources, including hay, be traced and from how far away? Military sites, especially at frontiers, represent the focus of change at least at the beginning of this period. Further investigation of them can hardly fail to produce significant results.

Civilian areas directly related to military establishments

It is often hard to draw a line between sites (or periods of sites) primarily catering for the military and those more fully concerned with civilian life but which incidentally have a close spatial, and thus perhaps economic, relationship with military establishments. In some cases a strong military connection seems almost certain (at Coney Street, York, and Blackfriars Street and Castle Street, Carlisle, for example), while at others there was probably a more tenuous relationship (The Lanes in Carlisle, and Tanner Row, York, providing examples). Some sites south-west of the Ouse in York present particular difficulties, especially in the period when a bridge probably existed.

York

York, the principal settlement in the North (Wacher 1974, 156-77), has provided substantial amounts of material. The earliest building at 39-41 Coney Street, York, on the waterfront of the NE bank of the River Ouse, in an area immediately to the SW of the fortress and dated to its earliest phase, was a timber structure interpreted as a warehouse (R. Hall and Kenward 1976). The horizontal beam slots for this building were excellently preserved, and filled by a humic silt which also spread thinly between them. This silt was remarkably for its immense concentration of insects, almost all of them grain pests (Kenward and Williams 1979). Four 5 g sub-samples were examined in detail; study of larger amounts of sediment would have been impracticable! The most abundant species was the 'saw-toothed grain beetle' *Oryzaephilus surinamensis* (about 46% of the individuals), followed by the 'rust-red grain beetle' *Cryptolestes ferrugineus* (about 37%), the 'grain weevil' *Sitophilus granarius* (about 7%) and the 'small-eyed flour beetle' *Palorus ratzeburgi* (about 4%). These four typical grain pests thus accounted for 94% of the fauna, and another 4-5% was contributed by other species commonly associated with stored products habitats. The concentration of insect remains was estimated to be around 100,000 per kilogramme, and the number of insects in the deposit (assuming it was rectangular and the excavated area was representative) to be of the order of ten million.

This deposit clearly resulted from the biological destruction of a large quantity of grain, although it is impossible to be sure whether it represented decay of residues over a long period or of a single bulk in a relatively short period. If this building was indeed a transit warehouse, receiving grain off-loaded from ships on the Ouse waterfront before transfer to points of use and the granary within the fortress, then the infestation would have had a significant economic effect, probably resulting in the contamination of shipments as they passed through. Reproduction in grain subsequently stored would have led quite quickly to the development of large populations of pests. Although quite heavily contaminated grain can be eaten without obvious ill-effect, the combined action of moulds and insects in grain with an appreciable water content (probably inevitable in Britain, whatever measures were taken to dry it) would have reduced it to a foul mass with a strong smell of ammonia, unpalatable even to horses, before too long. Grain could probably have been kept reasonably safe for a year (and infantry granaries, at least, seem to have been intended to hold a year's supply, Richardson 2004), but carry-over of surpluses for longer periods to act as a buffer against misfortune such as crop failure or unrest would have been uncertain. The fly in this historically attractive ointment is the possibility that the grain stored at Coney Street was horse feed, a view discussed in the sections concerned with stable manure (p. 397) and grain pests (p. 342).

The evidence from Coney Street is also important as an indication of the ease with which alien pest species were introduced as a result of large-scale Roman importation during the initial stages of colonisation. It seems quite likely that the humic silt dates to the first decade of the fort, yet the four grain pests most typical of the Roman period had already been brought to York, together with the 'cadelle' *Tenebroides mauritanicus*, certainly not native, and *Blaps lethifera*, *Aglenus brunneus*, *Tenebrio obscurus* and others, considered much more likely to have originated in transported grain than from local wild populations. This subject is considered in more detail on p. 195. An early casual record of insect remains from rampart turf in the Davygate area, is given by Davis (1961).

To the South-East of the fortress, assessment of an early Roman cut fill and some ?4th century pits at St Saviourgate gave a few insect remains (Carrott *et al.* EAU 1998/14); as for the rest of the material from this site, further work is a priority. A little further from the centre, Hall *et al.* (EAU 2000/64) reported a little evidence from Roman deposits revealed during excavations on the banks of the Foss, associated with the improvement of Layerthorpe Bridge. There were rather few biological remains from these layers, but one pit fill in the trench in Peasholm Green offered evidence for very decayed human faecal material.

Carlisle, Cumbria

An early study was made of material from some distance to the south of an annexe to the fort later investigated extensively through work at Castle Street; the fort itself was seen at Annetwell Street, for which another major investigation of insect remains was made (above). The samples from **Blackfriars Street** (Kenward 1990) were processed in a non-standard way and consequently were considered to be best recorded semi-quantitatively. They served primarily to establish the remarkable degree of preservation by anoxic waterlogging at this site, something which at the time the material was studied (the early 1980s) was quite unexpected for near-surface deposits of the Roman period. Various grain pests and decomposer beetles were recorded, and it was suggested that the former probably migrated from a grain store, illustrating the ubiquity of grain storage problems, a topic which was discussed at length. However, in the light of further research it seems entirely likely that the fauna reflected stable manure, the grain beetles coming from low-grade cereals used for horse feed (this is discussed on pp. 344, 401). The plant feeders may have been background fauna or have reflected local conditions as suggested in the report; they may equally have originated in hay or plants used for litter. Surprisingly few molluscs were collected (Rackham 1990).

The extensively-excavated site of **Castle Street** (Allison *et al.* 1991a-b; see also Kenward and Carrott 2006) lay a short distance (50 m or less) to the SE of the fort at Annetwell Street, and thus seems likely to have been dedicated to servicing it; the area is regarded as an annexe. Productive samples of the Roman period were dated from the late first century (Period 2) through to the late second century (Period 8). As at Annetwell Street (see above), the later, stone, phases of the fort were poorly represented by deposits with anoxic waterlogging. The earliest deposits, an old ground surface, were unfortunately not examined for invertebrate remains. The earliest material studied, pit fills of c. early 70s to late 70s or early 80s AD, gave assemblages suggesting the presence of stable manure, and already by this stage grain pests were important, supporting the hypothesis that they were almost inevitably dispersed in supplies for the army. The human flea (*Pulex irritans*) was also present at this stage (and throughout much of the Roman sequence), and the human louse (*Pediculus humanus*) was found in 1st century deposits.

Stable manure was suggested to be present in some layers at Castle Street in the original report, and re-examination of the data suggest that it was probably common, although clear stable manure groups including a well-developed foul matter component were unusual. Generally it seems that filth was cleared away before large populations of foul decomposers built up. This is in contrast to, for example, Tanner Row, York (Hall and Kenward 1990), and Ribchester, Lancashire (Buxton *et al.* 2000a-d; Carrott *et al.* 2000; Large *et al.* EAU 1994/11), although in these cases the deposits examined were probably dumps away from occupation. An exception was a building of the late first century, deposits from which gave clear indications of stable manure, and also housefly (*Musca domestica*) puparia, and a *Damalinia bovis* (cattle louse), which may have come from a live beast or indirectly with skins. Grain pests, now considered generally to be indicators of stable manure or horse dung rather than of grain stores (p. 344, 401), were common throughout the Roman period at the site, and sometimes very much the most abundant beetles. Moulted skins (exuviae, see p. 54, 398) of the bug *Craspedolepta nervosa* were found in many of the deposits; these are thought almost certainly to have come from cut grassland vegetation, presumably hay for livestock on the site. Buildings ranged from clean to quite mucky, mostly the former.

External layers at Castle Street included a thick organic-rich layer of the late 1st/early second century, probably a series of dumps, with foul matter insects including housefly puparia, a second, blanketing, dump deposit containing two eggs of the horse parasite *Oxyurus equi* (considered in more detail on p. 424), an organic deposit in a muddy, puddled area, and a deposit of turf whose fauna and flora suggested origins in poor pasture land. Even allowing for the fact that sampling and analysis probably was biased in favour of such conditions, the external surfaces on the site do seem to have been allowed to become quite unpleasant at times, although in some cases probably in periods of re-arrangement or short-term low-grade use. A second 'turf' layer was associated with the construction of one of the early first century buildings; the identification was made on the content of dung beetles and water and waterside beetles, strongly suggesting material cut from rather damp grazing land with some pools. A specimen of *Helophorus tuberculatus* (see p. 317) may have been brought in turf. Pits seem not to have been the standard means of waste disposal, although one pit may have received litter from within a house.

Overall, the invertebrate remains (and of course the other biota) of the Castle Street site have contributed a rather good picture of conditions just outside the Roman fort in the first and second centuries: buildings which were generally reasonably well cleaned out, surfaces which at times became mucky, periods when organic waste was dumped during levelling, and the all-pervading influence of equines, both their fodder (grain and hay) and faeces being present in many of the deposits. Human gut nematodes were, in strong contrast, never abundant, underlining the different (and adaptively advantageous) attitudes to herbivore and human faeces which persist in human society even today. This site can perhaps be seen as a producer area for the sort of refuse seen at Rougier Street in York.

Land-use zonation in Roman Carlisle was examined through insect remains by Kenward (EAU 1999/43), see p. 403, and the data for the sites were subjected to species association by Kenward and Carrott (2006).

Other towns

Dobney *et al.* (EAU 1993/19) reported on evaluation of biological remains from a site located in the vicus of the fort of Derventio, at Malton, North Yorkshire. There were numerous mollusc assemblages, mostly small but indicating grassland in the vicinity. It was not clear whether any of these snails lived on the site, and if so where, or if they were they imported in hay or other materials. Roman deposits at Bridge Street, Chester, proved barren of invertebrate remains (Jaques *et al.* PRS 2004/46).

Civilian and supposed civilian urban sites in the Roman period

A substantial amount of information has accumulated concerning sites which had a primarily civilian nature. York has produced significant material in this category, so far as invertebrate remains are concerned. Most of the Carlisle sites appear to have had a service relationship to the military (e.g. Castle Street) or to be of a rural character (e.g. the first tranche of sites investigated at The Lanes, Lanes 1); however, the 'Lanes 2' sites seem to represent civilian occupation of a more urban character.

Roman civilian York

NE of the Ouse

Allison *et al.* (EAU 1991/05), in an evaluation of material from the Adams Hydraulics III site, (located between Peasholme Green and the River Foss) investigated various Roman deposits. A mid 2nd-3rd century organic build up gave a rather small group of insects whose mode of deposition was not obvious - the commonest species was a member of the *Platystethus cornutus* group, associated with mud. There were some synanthropes, including the grain pests *Oryzaephilus surinamensis* and *Sitophilus granarius*. Fills of a putative ditch also gave abundant insects, remains from the lower fill indicating aquatic deposition, possibly only in temporary water. There were insects associated with weedy waste ground, grain pests, a human flea (*Pulex irritans*), and decomposers perhaps indicating material like stable manure - the combination of plant and insect evidence tending to confirm this identification. The upper fill contained large numbers of ephippia, these including at least one *Daphnia* but being dominated by an as yet unidentified but repeatedly recorded type. There were some beetles regarded as post-depositional invaders, suggesting that the deposits had been de-watered at some stage. Layers into which this feature was cut gave no useful invertebrate remains. Clearly deposits in this area - now part of the proposed 'Hungate Development' - have substantial potential for investigating Roman land use, settlement and waste disposal.

Samples from Roman deposits at the 22 Piccadilly site, a little further down the River Foss, were assessed by Carrott *et al.* (EAU 1995/53); no clear evidence was obtained. It seems likely that this area will have intermittent preservation, and may occasionally produce valuable material.

York SW of the Ouse

Various civilian sites on the SW fringes of the River Ouse in York have been investigated. All of these may have had a greater or lesser connection with the fortress across the River Ouse, but can probably be regarded as primarily civilian. This area is believed to represent what eventually became the Colonia. Evidence from it is summarised by Dobney *et al.* (1999).

Three sites have been studied in some detail: the General Accident Extension at 24-30 Tanner Row, considered together with material from the second site, 5 Rougier Street, by Hall and Kenward (1990; molluscs described in more detail by O'Connor AML 4768; parasite eggs by McKenna *et al.* EAU 87/28); and the well at Skeldergate (Hall *et al.* 1980). The Tanner Row/Rougier Street report was significant in representing the first attempt to produce a fully integrated account of plant and invertebrate evidence from a very large scale investigation of a site with anoxic waterlogging. As such it generated many new ideas, and this is reflected in the abundant references to it in the methodological and thematic sections of this review; only the Anglo-Scandinavian material from Coppergate (Kenward and Hall 1995) has provided more substance. Some other important sites in the area, notably Wellington Row (Carrott *et al.* EAU 1995/14) and Roman material from 22 Micklegate (Dobney *et al.* EAU 1993/22), regrettably have not progressed beyond assessment and remain as lost opportunities.

The Tanner Row and Rougier Street sites were located close to the supposed heart of the Roman town and represented a superb opportunity to examine the development of a major Roman urban settlement. The earliest periods of the Tanner Row site have been considered elsewhere as broadly of rural character (p. 187). In the late second century the site was built over (Period 3). In Phase 1 the site was re-modelled by the construction of various revetments, terraces and banks. Two notable contexts were the fill of a small cut, which may have been redeposited grazing-land soil and a bank or mound deposit which contained numerous aquatic and waterside snails (and mosses and higher plants from similar habitats), and which seems to have been dug from a nearby permanently wet ditch or pond. Both of these deposits presumably represent the previous use of the site.

Phase 2 deposits of Period 3 yielded a wide variety of invertebrate assemblages, some very characteristic. One gave a substantial house fauna and may have fallen from a wooden floor during demolition; another house fauna group included numerous specimens of the spider beetle *Tipnus unicolor*, very typical of Roman urban deposits in York (see p. 378). Some drain fills contained food remains and abundant *Trichuris* and *Ascaris* eggs and clearly contained a faecal component. A distinctive group of peatland insects was recovered from deposits associated with one of the buildings, and accompanied peatland plants and indeed fragments of peat. Clearly this was imported material, probably (on botanical evidence) peat *sensu stricto* (perhaps for burning or as litter). One surface deposit gave hints of the kind of insect fauna considered likely to have been imported in hay. Another included large numbers of dung beetles and some other remains, including grassland taxa, which were highly fragmented and may have been deposited in bird droppings. Another fauna apparently from bird droppings and with a strong grassland component was noted in a Phase 3 surface deposit. Also from the latter phase was a deposit interpreted as part of a hearth which gave (in addition to a rather mixed fauna) several specimens of the bark beetle *Leperisinus varius*, which is typically found in ash (*Fraxinus*) trunks and may well have emerged from logs (p. 315).

One of the external surface deposits from Phase 4 of Period 3 gave house fauna, remains probably imported in hay, and grain pests and a horse louse (*Damalinia equi*), together suggesting an origin in stable manure. There was also a single sheep ked (*Melophagus ovinus*). Normally regarded as evidence of wool cleaning (p. 363), in this instance the fly may have come from sheep killed and butchered on or near the site. Overall, Period 3 saw the replacement of a natural or semi-natural fauna by that of an urban occupation site, with much house fauna and evidence of stable manure.

Period 4 (mid to late 2nd century) represented site-wide accumulation, which eventually covered the Period 3 structures. Many of the deposits seem to have been dumps, and they gave a variety of insect assemblages reflecting stable manure (including a classic group indicating foul mouldering matter) and human occupation. Such fauna was more common than in the previous period, and aquatics rarer. In Period 5 (still late 2nd century) a new range of timber buildings was constructed. The fauna was essentially that of intensive but rather low-grade occupation, with indications of abundant stable manure (including some archetypical 'hay fauna', see p. 316), and some groups of fly puparia indicating foul conditions. A third phase of buildings marked Period 6 (late 2nd to early 3rd century), and at this time a change in site usage, presumably a reduction in the input of organic waste, greatly reduced the number of deposits which gave 'anoxic' preservation of invertebrates. There was still some evidence of stable manure, however. By Period 7, the first stone buildings, dated to the early to mid third century, there was little preservation of insects, but a group of oxytelines from a timber-lined cut demonstrated that foul matter (perhaps not faeces, however) was still occasionally left exposed. There was very little preservation in various pit fill deposits dated to the fourth century and later (Period 8), although fauna believed to be subterranean (see p. 482) suggests that a large quantity of buried organic matter may have decayed *in situ*. Some of these deposits contained abundant eggs of parasitic nematodes and also foodplant remains, and were undoubtedly rich in human faeces.

The evidence from mid to late 2nd century deposits at **Rougier Street** (Allison *et al.* 1990c) was broadly consistent with that from the contemporaneous phases of the Tanner Row site. A ditch traversed the site, and was presumably part of the same system seen at Tanner Row. Stable manure seems to have been dumped, and there was evidence for heathland/moorland material and human faeces. Some assemblages of snails from the ditch fills were of unusual character, and at first sight out of place, the presence of *Vallonia excentrica* suggesting dry calcareous grassland. It was argued that these snails were not imported with hay since other species should also have been caught up; the conclusion was that they may have found habitat at the site in dense turfy grassland; evidence from the Wellington Row site appeared to support this (Allison *et al. loc. cit.*, 381-2). Populations of beetles suggesting rather foul conditions had developed locally in an extensive deposit of charred and uncharred grain at Rougier Street dated to the late 2nd century, but whether before or after destruction was not clear; probably the latter. This same grain showed some traces of insect damage. Later Roman deposits gave only limited evidence from invertebrates.

This major study (which obviously cannot be summarised fully here) represented a test-bed for ideas and methods developed during the even larger Anglo-Scandinavian 16-22 Coppergate project. It allowed the efficacy of rapid recording methods to be established (p. 14) and together with work on Coppergate led to the subjective recognition of a series of interpretatively-significant insect 'species associations', including those believed to indicate house or other floors, cut grassland vegetation, and stable manure (p. 464). An understanding of transported groups of insects characterising acid turf and bird droppings was also crystallised.

The third of these intensive studies of Roman civilian sites to the SW of the River Ouse in York was of the fills of the superbly constructed timber-lined well at Skeldergate (Hall *et al.* 1980). Late 2nd to mid 3rd century pottery in the construction cut gave a likely mid 3rd century date for the insertion of the well (radiocarbon dates of wood from the lining gave earlier dates, but it was timber from large trees). Dating of the organic matter in the fills gave much earlier dates, but this was undoubtedly a result of the presence of imported peat; dating of a discrete block of peat gave a result of 1470+ 100 bc. Pottery dates suggested that the fills of the well fell into two groups: the lowest tenth of the fills, with 2nd to 4th century dates, representing use; and the remaining fills, with dates in the 1st to 4th centuries, representing dumping in the 4th century. Large numbers of insects were recovered from a series of samples representing most of the recognisable backfill layers, the concentration of remains sometimes being high. Ideally this early dataset should be re-examined using contemporary methods, but this is impracticable for the present review since the data for the well have not been recorded electronically; however, it is suspected that re-interpretation would not lead to substantially different conclusions. The insect fauna had diverse origins, with recognisable components from freshwater and its margins, dry to foul rotting matter including dung, weedy vegetation, peatlands, stored grain, dead wood and buildings. It was accepted (in a carefully argued discussion of the problems of interpreting well fills generally) that the biological remains in the fills were of Roman date and could not have entered later. The exception was the fauna and flora of the peat, which were clearly recognisable and represented Roman resource exploitation of much earlier natural deposits.

For the insects, it was argued that a component of the fauna may have entered the well as background fauna during the phase of use, and that one species, the waterside staphylinid *Lesteva longoelytrata*, probably lived within the well, but that it did not function as a pitfall trap catching ground fauna. This implied the presence of a substantial surround to the well opening. The remainder of the insect fauna was seen as originating in dumps of waste material and surface deposits from the surrounding area. The area around the well was 'kept clean and in a good state of repair and [was] free of weeds and [large] accumulations of rotting material'. Grain pests were abundant and it was argued from their distribution through the fills that they originated in spoiled grain which was one of the first dumps. Re-examination of the manuscript species lists indicates that there was no characteristic fauna of stable manure (Kenward and Hall 1997), although a range of house fauna was present and spider beetles (*Tipnus unicolor* and *Ptinus fur*) and woodworm beetles (*Anobium punctatum*) were very abundant. It was considered possible that the spider beetles had a separate origin from the grain pests, and they, with *A. punctatum*, may have represented the fauna of the building(s) with which the well was associated, having entered as strays or (perhaps more probably) in house sweepings included in the dumps. In either case, buildings of good quality, kept rather clean, were indicated.

This well is notable as having been the subject of the only fully published study of mites from an archaeological site in the region. Denford (1980) examined six samples, and found a range of ecological groups to be present.

Two principal origins appeared likely, one indicated by mites able to exploit rather barren conditions with some moss and lichen, perhaps from around the well, and the other by peatland species, including some from raised bog, undoubtedly imported in peat.

Overall, this study of an outstanding example of an archaeological well showed both the weakness and strength of such features as a source of reconstructions of past occupation sites: although the inevitably secondary nature of the evidence makes for convoluted arguments, the fact that they often represent the only source of information about areas kept clean of organic matter renders them invaluable (the problems of wells are considered further on p. 461).

Some other sites in the Colonia area of York have been subjected to assessment, but unfortunately none have progressed further despite their clear value. The North Street site (Carrott *et al.* EAU 1993/14) was located on the SW bank of the River Ouse. The earliest part of the succession was dated to the late 2nd century; these deposits were identified as dumps and buildups, and one of them included plant and insect remains indicative of herbivore dung, probably as a component of stable manure. A single 4th century deposit was assessed but contained no useful invertebrate macrofossils. Hall *et al.* (EAU 2001/13) found only traces of shellfish in an evaluation of 2nd-3rd century dumps at the site of the former Presto supermarket, George Hudson Street. Carrott *et al.* (EAU 1995/14) reported assessment of material from the Wellington Row site. Here, overbank deposits near the Roman river crossing (probably latterly by a bridge), and various occupation layers were revealed, with some evidence suggesting stable manure, while the site probably saw late Roman low-grade re-use. Preservation was localised, but considerable potential to contribute to a variety of important questions was evident. Funding could not be obtained to examine this material fully.

Dobney *et al.* (EAU 1993/22) assessed samples from various feature and deposit types at the Queen's Hotel site, Micklegate. A series of ditch fills were not assessed (an unfortunate consequence of the way samples were selected) but were clearly important. Some of the Roman (mid 2nd to mid 3rd) dumps and backfills gave preservation of invertebrates, particularly insects (grain pests, decomposers, outdoor forms including aquatics), but most were effectively barren. These samples need to be investigated in relation to the early parts of the sequences at Tanner Row and other sites in the area. Subsequent late and post-Roman layers at Queen's Hotel gave little preservation. A Roman 'ashy deposit' at the nearby Fetter Lane site, evaluated by Carrott *et al.* (EAU 1997/45), produced no invertebrates apart from a poorly preserved landsnail.

The nature of occupation in the area of York Railway Station investigated in an evaluation by Carrott *et al.* (EAU 1999/29) is uncertain, but two samples proved to be effectively barren of invertebrate remains.

York NE of the Ouse

Known civilian settlement in the area of York to the north-east of the Ouse would have largely fallen in the Canabae, under military control. There appears to be no record of invertebrates from Roman deposits close to central York (in the triangle between the Ouse, the Foss and the Fortress).

Carlisle

It is difficult to categorise the Roman occupation revealed at the 'Lanes 2' sites, Keay's and Law's Lanes (Kenward *et al.* EAU 1998/32). The area doubtless had links with the military, but can perhaps usefully be regarded as simply urban and considered in the present section. It appears that this area of the Lanes was, in the parts of the Roman period represented by the deposits examined for insect remains, very much concerned with livestock, probably mainly horses or other equines. Unfortunately the only parasite of equines recorded was a single tentatively identified egg of the intestinal nematode *Oxyuris equi* (p. 424). There was clear evidence from some samples of dumped stable manure, in the form of grain pests, house fauna, characteristic decomposers, species from turf or peat, and 'hay' fauna. Numerous assemblages included a range of remains which probably originated in this material. Many other deposits (often in pit or ditch cuts) seemed to have originated as surface accumulations in disturbed areas with scattered plants, where equine dung or scattered stable manure was present. A substantial number of the assemblages were seemingly dominated by a rather random fauna (probably much of it 'background fauna'); such assemblages were recovered from many of the cuts, perhaps representing insects from the adjacent open ground which had arrived naturally or in dumped soil. The typical environment of the sites seems to have been disturbed open ground with scattered plants, with various amounts of filth - in some cases surely dung - on the surface.

Eggs of intestinal parasitic nematodes were rare Keay's and Law's Lanes, and in only two cases (both pit fills) were more than traces of *Trichuris* present. For one of these it was possible to identify these eggs as *T. trichiura*, the species found in humans. Human faeces thus seem rarely to have entered the Roman deposits at Keay's and Law's Lanes. There were, however, abundant insect parasites of humans. Human fleas (*Pulex irritans*) or human lice (*Pediculus humanus*) were recorded from several samples, and less diagnostic body parts of fleas were common. Note, though, that human fleas are commonly found in archaeological stable manure associations (p. 397). A pubic louse (*Pthirus pubis*) from an early Roman pit fill at Keay's Lane is notable; though mineralised so that detail was obscured, it could be identified by its general body form and such structure as could be discerned (Kenward 1999; 2001a). Records of insect parasites of livestock from 'Lanes 2' were limited to a few records of non-diagnostic remains of the genus *Damalinia*, various species of which are parasitic on particular domestic mammals, and one of the sheep ked *Melophagus ovinus*. In general, poor preservation probably limited recovery of the very delicate lice, perhaps often as a result of long storage of samples. The rarity of the robust puparia of *D. ovinus* may indicate that wool-cleaning was not a common activity.

Just to the north of these Lanes sites, insects recovered by non-standard methods from samples from excavations at Rickergate were assessed by Kenward (EAU 2002/13). A pre-Roman infilled river channel gave aquatics (none suggesting flowing water), and sufficient dung beetles to hint at the presence of grazing land. The sample from a pit or ditch proved barren, and a tentatively identified occupation deposit gave few, pale remains, though with hints of a stable manure fauna including the three main grain pests. Three groups of remains from what may have been a drainage ditch again gave grain pests, but only a limited fauna otherwise.

Other urban sites

The settlement at Brough, East Yorkshire is hard to categorise but perhaps should be considered here. Evans (1969b) reported a small assemblage of land snails of presumed Roman date from the town. An extensive assessment of 66 samples from 2nd-4th century material by Carrott *et al.* (EAU 1994/50) unfortunately produced almost no useful invertebrate material. One 'backfill' of 3rd century date gave a small insect assemblage, perhaps indicative of stable manure (an interpretation not clearly supported by the plant remains). Some samples gave traces of land or freshwater snails, but these were not considered to have any significant potential. There were some marine molluscs, at least a few showing evidence of epibionts. Also at Brough, ditch and other cut fills examined by Issitt *et al.* (EAU 1995/09) were barren, while pit, ditch and other cut fills, layers and post holes at Catterick (Carrott *et al.* EAU 1994/41) provided another example of lack of preservation. Milles and Kenward (EAU 1992/42) reported non-marine molluscs from an evaluation of samples from a ditch and trackway at West Lodge, Malton; various types of grassland and bare ground were indicated. Assessment of a large number of samples from various early to 2nd century Roman deposits at the Beetham Hilton Hotel, Deansgate, Manchester (Carrott *et al.* PRS 2004/42) produced no invertebrate remains of any kind; even marine shell was absent.

These analyses of invertebrates from civilian urban deposits provide many glimpses of Roman life, but work to date serves more as an advertisement for what might be achieved than as a synthesisable body of information. Many of the issues mentioned in the context of Roman military establishments might be addressed through further work on civilian towns, in addition to investigation of the range of civilian living conditions. Invertebrates are especially valuable in reconstructing low-grade townscapes, but may also prove useful in testing assumptions concerning cleanliness in stone-built towns. The problems of civilian grain storage require further investigation, bearing in mind the likely origin of most grain pests in horse feed via stable manure (p. 342, 401). Providing there is preservation, the late Roman period is especially open to study through invertebrates where artefactual and structural evidence is unclear (p. 194).

Urban fringes in the Roman period

In contrast to our knowledge of the military centre and urbanised areas of York, we know very little of the environmental archaeology of the town's fringes, doubtless because many of the sites are on freely-draining soils, because population density was lower, and because deposition of large bulks of organic material was rare. Other towns which have been examined, for example Malton, have given little material preserved by anoxic waterlogging, but sometimes there has been good preservation of molluscs which, however, have been rather hard to relate to human activity. The situation is very different for Carlisle, where the extensive excavations in the area of the 'Lanes 1' sites have given fascinating evidence concerning what appears to be a transitional area between the built-up town and the surrounding countryside: sub-urban, but not suburban in the modern sense. (Higher rainfall in the west may be a contributory factor to the contrast between preservation on the fringes of these two towns, in addition to differences in soils.) For this reason, Carlisle will be examined first, and the fragments of evidence from elsewhere considered afterwards. It is hard to decide whether some sites belong in this section or were truly rural (the two groups merging imperceptibly); the intention has been to place here those sites which were probably subject to daily interaction with the town (e.g. in providing living accommodation or keeping horses used by the townsfolk).

The urban fringe of Carlisle: The Southern Lanes

Kenward *et al.* (AML 78/92; Kenward *et al.* 2000; see also McCarthy 2000) reported analysis of a body of samples from the Old Grapes Lane A site. This was a fairly large-scale project, producing a variety of important results which can only be briefly alluded to here. There was little evidence for conditions at the site in Phase 3, dated to the earliest Roman period, although some of the deposits seem to have formed in the open. Grain pests (*Oryzaephilus surinamensis*, *Cryptolestes ferrugineus* and *Sitophilus granarius*) were already present at this stage, but the somewhat limited evidence suggests that the full range of occupation-site synanthropes had not arrived, and that they may have been substituted for by facultative forms (p. 61). *Helophorus tuberculatus* was recorded from one sample; this species is discussed on p. 317. Phases 4 to 6 were dated to the early Roman period. Although few samples of Phase 4 were examined, several additional synanthropic species were recorded, including *Cryptophagus scutellatus* and the human flea (*Pulex irritans*). This period also produced an assemblage which included a range of elaterid (click beetle) larvae and some adult beetles (including *Xantholinus* sp. and *Hoplia philanthus*, the latter identification confirmed since the report was produced, p. 357) suggesting the possibility that turf had been incorporated. A small group of samples from 'soil deposits' of Phase 5 together suggested grazing land in which there was some open water; one sample in particular gave large numbers of dung beetles.

There were numerous samples from Phase 6, including floors, soils and ditch fills. The former group included one assemblage which suggested a stable, another which may have been a stable which was kept well cleaned out, and a third which suggested a fairly clean, dry structure, hinting at some diversity of use. The ditch fills also produced varied results, indicating that the cuts were in some cases damp but not water-filled, with little dumping but with something resembling a stockyard adjacent. Others appeared to have received dumps, which in one case may have included spoiled grain (containing, in addition to the commonest three grain pests, *Palorus ratzeburgi*, probably indicating fairly advanced decay of a mass of grain). Another gave some further strong synanthropes, including *Typhaea stercorea*, *Aglenus brunneus*, *Alphitobius diaperinus* and *Tenebrio obscurus*, with the grain pests, again suggesting spoiling grain from within a structure, but perhaps in this case from stable manure. One ditch appeared to have held water at least occasionally. External surfaces gave a variety of assemblages, not surprisingly, but they, together with a lens of material containing pig lice (*Haematpinus* apri, the louse of European wild pigs, p. 425), contributed to the general impression that stock-handling was an important activity. Fills of putative post-pits indicated, both from the nature of the sediment and the biota (*Daphnia* and water beetles), that cuts were left open and infilled slowly. The remaining Roman phases gave little evidence, although one deposit may have formed where there were grazing animals.

A large proportion of the assemblages from the Old Grapes Lane A site had a rich and abundant 'outdoor' fauna, often with substantial contributions from aquatic and waterside habitats, herb communities likely to occur in grassland or disturbed places, moorland/heathland, and dung. It seems likely that much of this fauna originated in areas where there was dung, in grazing land, paddocks, byres or stables. A single *Damalinia bovis* (cattle louse) was recorded, but this cannot stand as evidence that cattle were kept in fields bounded by the ditches at the site. Other remains perhaps originated in stabling for horses, donkeys or mules, although this was by no means as clear as for some other sites; the 'stable manure' insect community was only weakly represented. Insects which may have been imported in cut, hay-like, vegetation were occasionally present, but in numbers too small to be clearly significant. Puparia of the sheep ked, *Melophagus ovinus*, were recorded; again, these are not clear evidence for the keeping of their host animals at the site (p. 363). One sample gave somewhat more substantial evidence for the keeping of pigs, as there were 'several' *Haematpinus apri*, from one context. A further hint that pigs were important at this site came from the eggs of nematode parasites of vertebrates. *Ascaris*, the maw-worm, was rather better represented in relation to *Trichuris* the whipworm than normal in assemblages of eggs from deposits containing what is believed to be human excrement. While it is possible that this is a non-significant result of the small numbers of eggs observed, a high relative count for *Ascaris* eggs has been associated with pig faeces (p. 27). Unfortunately none of the contexts with a high proportion of *Ascaris* eggs contained sufficient well-preserved *Trichuris* to allow firm identification using measurements.

A few of the assemblages contained a 'house fauna' component of beetles believed to be typical of deposits formed within humble human dwellings and outhouses including stables. There were a few fleas, some of them tentatively or certainly identified as the human flea, *Pulex irritans*, and at least two human lice (*Pediculus humanus*) were found. These numbers were too small to stand as definite evidence for occupation floors (or ejectamenta from them), though, and it seems as likely that these taxa originated in outhouses used to shelter animals as in houses *sensu stricto*. House fauna was certainly limited by comparison with central Carlisle sites.

This site gave a rare and fascinating picture of land use on the fringes of Roman Carlisle, contrasting strongly with evidence from the military and civilian heart of the settlement (Kenward EAU 1999/43; Kenward and Carrott 2006).

Investigation of material from the nearby **Old Grapes Lane B** site was on a much more limited scale (Kenward *et al.* AML 77/92; Kenward *et al.* 2000). Late first century material indicated the presence of stock, probably stable manure in view of the presence of a well-developed house fauna component (including a human flea) in one of the samples. The three main grain pests (p. 343) were already present, together with a limited range of other synanthropes. Traces of heathland or moorland taxa were recorded. Early-mid second century well fills contained several kinds of water flea resting eggs and numerous aquatic insects, suggesting that such species were able to colonise, and the fauna also probably indicated stable manure (house fauna, a human flea, grain pests and decomposers favoured by foul open textured matter). There were remains of *Melophagus ovinus* (sheep ked), whose origin might lay in wool cleaning (p. 363) or (unusually in this case) live sheep on the site.

The third site in the southern Lanes area of Carlisle for which analysis has been completed was at **Lewthwaite's Lane** (Kenward *et al.* AML 77/92; 2000a). Here, a series of Roman deposits was analysed, most of them apparently surface-laid. Much of the material was of late first century date, and even at this early stage the familiar range of grain pests was present, together with a number of other synanthropes. The overall impression was of principally open areas with some weeds, a little stable manure, dung, or scatter from stabling being present. One assemblage included grain pests and beetles suggesting rather dry, mouldy, plant debris - perhaps the driest extreme of stable manure. Peat was indicated, perhaps having been used for stable litter. Deposits dated to the late first/early second century gave rather more substantial indications of stable manure, with hay and peat. The synanthropic decomposer fauna was much more developed than in the earlier material, although this may have been a result of habitat availability rather than inability to colonise. Perhaps the most striking material from the site was a series of 'deposits' of probable early second century date. Three of these gave evidence for the importation of turf. One appeared to represent turf from a damp area by water (perhaps even occasionally flooded), since there were more water beetles than seem likely to have arrived by chance. Two others were remarkable for their rich heath/moor component (see p. 316). A late 2nd century pit fill gave abundant grain pests and house fauna, but only very limited fauna of foul matter; perhaps such species had only had time to colonise, and not to breed, before a stable was cleared out and the litter dumped in the pit.

Together the sites in Roman Carlisle represent a range from intensive military use to rural settlement. This mapping of land use was continued by work on a series of further sites in The Lanes ('Lanes 2'), considered above. Kenward (EAU 1999/43; Kenward and Carrott 2006) used various kinds of analysis of the insect assemblages in order to investigate land use zonation across Roman Carlisle: this kind of approach is discussed briefly on p. 403.

York's urban fringes

Remarkably little is known of the palaeoecology of the periphery of York considering the large number of minor developments which have taken place. It is uncertain how much material was overlooked in the pre-PPG 16 era, but subsequent investigations have produced only sparse bioarchaeological evidence, even from bone. The periphery of York is clearly a priority zone for the future, and no sites should be allowed to be destroyed (or have their water tables affected) without a careful search for waterlogged material. Evidence from the earliest phase at Tanner Row (Hall and Kenward 1990) might reasonably be included here but has been reviewed on p. 187. The samples from the 50 Piccadilly site (see below) would provide a starting point for research were funds available.

The information available from evaluations is as follows. To the northwest, an evaluation at Ankers Garage, 45-57 Gillygate, revealed a Roman levelling or floor layer and ditch fills, all barren apart from traces of *Mytilus* shell (Dobney *et al.* EAU 1992/22).On the southwest side of York, probable Roman ditch/slot fills at Nunnery Lane gave no useful preservation (Carrott *et al.* EAU 1993/10) and ?Roman cut fills at Royal Chase, Tadcaster Road, Dringhouses, were judged barren on visual inspection of a sample (Carrott *et al.* EAU 1998/04), while 2nd/3rd century levelling, build-up, pit fill, and other features at 12-20 Blossom Street (Carrott *et al.* EAU 1991/18) were mostly clearly sterile, and processed samples produced no invertebrate remains other than a trace of snail shell, and a few plants and insects of limited interpretative significance in a sump (in which contamination was possible, although the remains were judged probably Roman in the report). This last record perhaps underlines the need to sample even on unpromising sites. Carrott *et al.* (EAU 2000/50) found only traces of oyster shell during evaluation of various deposits at 28-40 Blossom Street. An evaluation at 3 Driffield Terrace produced no invertebrate remains beyond a trace of marine shell from a pit of probable late 2nd century date (Carrott *et al.* PRS 2005/53); a series of squashes of samples from the abdominal region of human inhumations produced no parasite eggs.

In the north-east, Roman dump deposits at County House, Monkgate, yielded only shellfish (Carrott *et al.* EAU 1997/52). A Roman ditch fill at 50-52 Monkgate gave no invertebrate remains (Carrott *et al.* EAU 1995/20). To the south-east of the town centre, one Roman deposit at 38 Piccadilly was bulk-sieved, the only invertebrates being oyster shells (Carrott *et al.* EAU 1992/09). Invertebrates in underlying ?natural deposits were mostly fragments of immature stages of what were probably aquatic insects, together with some aquatic beetles and bugs. Plant remains suggested some human influence, so these layers were in fact probably early Roman. A short distance away, at 50 Piccadilly, a series of samples was collected from 2nd-3rd century deposits but only small number processed (Carrott *et al.* EAU 1992/08). Cut fills in a layout of early Roman ditches gave variable preservation. There was effectively no waterlogged preservation in two, but three contained abundant invertebrates. One of these gave numerous *Daphnia* ephippia, but aquatic insects were rare (although there were several bibionid flies, some species of which are much given to drowning on water surfaces). There were decomposers from dry to foul material, and various phytophages (including nettle feeders) and other plant-associated species suggesting an area of waste ground. Grain pests (species not listed) were noted. A second ditch gave numerous insects, with a few aquatics. The remaining fauna was very mixed, but consisted predominantly of a fauna likely to be found in an area of rough grazing. (The associated plants were annual and perennial weeds.) A shieldbug which seemed not to match any British species was recovered from this ditch. This is important material for which full analysis would have been desirable.

An evaluation of two fills of a Roman ditch at St Maurice's Road, just outside the Roman walls, produced no invertebrates other than tiny flecks of marine mollusc shells (Dainton *et al.* EAU 1992/14). There were, however, some tubular concretions, conceivably formed round earthworm burrows. Rather further from York, evaluation of Roman ditch fills at The Fox, Tadcaster Road, Dringhouses, showed them to be barren of invertebrate remains (Carrott *et al.* EAU 1997/41).

Had there been full analysis of all of the samples datable to the Roman period from these sites in the periphery of York, useful information would have accrued; that this information has effectively been lost sharply highlights the shortcomings of the present system of evaluation in a regime in which no alternative funding is available for site-based research. Particular problems to be addressed obviously revolve around land-use (can horticulture be detected? Was most of the land tied up in providing grazing for a large horse population? Did any woodland remain? Were areas stripped for turf?). Other topics open to investigation through invertebrates include patterns of waste disposal, including its use for manure and its concentration in dumps. Because preservation is localised, bioarchaeological work on this kind of site is likely to have unpredictable results, but the rare chances to study well-preserved material should not be lost.

Roman rural sites including villas

A substantial number of sites fall in this category, which excludes minor military sites such as marching camps, and urban fringes; here we are concerned with the lives of people living in and managing the countryside proper, and the landscape they occupied. These sites have the potential to provide information relevant to a wide range of questions related to trade and exchange, the exploitation of natural resources, environmental impact, living conditions and agriculture. The sites studied in detail are far too few and diverse to form the basis of generalisations at the present stage, apart from remarking that surface-lain deposits, especially floors, are extremely rare, the evidence coming from cut fills, particularly wells and ditches, whose temporal or spatial relationship to (and degree of representation of) occupation is typically difficult to establish. This problem is discussed in more detail on pages 458 and 459. The sites have been grouped geographically.

North Lincolnshire

Hall *et al.* (PRS 2003/45) assessed a large number of samples from ditch, pit and other fills at 66 Burringham Road, Scunthorpe; most were of Roman date. There were no invertebrates preserved by anoxia, but a few groups of molluscs were recovered, including aquatic and terrestrial species.

A single large insect assemblage from the fill of a broad erosion cone associated with a wicker-lined pit or well at Dragonby was investigated by Buckland (1996). The original construction was in the late Iron Age, but the erosion cone fill contained Iron Age and Romano-British pottery and the insect assemblage was dated to after the Roman conquest, apparently during the first century. A long list of taxa was recorded, a large proportion of them from open-air habitats. Abundant aquatics showed clearly that the hollow had been water-filled, with a rich aquatic vegetation. The surroundings included mud and drier open ground, and herbaceous vegetation with nettles and grassland species. Buckland considered that there were sufficient dung beetles to suggest that this was a watering hole for stock, although inspection of the species list shows that the numbers were quite small (26 individuals in over 500, or less than 5%, cf. Robinson 1991b and Osborne 1969; 1989, and some reports considered in this review) and, with hindsight, unconvincing evidence that the hollow was a 'watering hole for domestic animals in pasture' unless the density of stock was very low. It was postulated that the presence of a range of synanthropic beetles might indicate horse faeces, but small numbers of individuals were involved; however, a continued human presence seems very likely in view of records of numerous *Acritus nigricornis*, *Lathridius minutus* group and smaller numbers of some other beetles. A specimen of *Sitophilus granarius* (grain weevil) was recorded, but two other strong synanthropes (*Stegobium paniceum* and *Tribolium castaneum*) mentioned in the discussion are not included in the species list. A single individual of the very robust grain weevil might be residual (or a contaminant), of course (see p. 476). Alvey (1996a) reported on over 7000 terrestrial and freshwater molluscs from Dragonby, but the material was hand-collected and the data amalgamated across features and dates. Much the most abundant snail was *Arianta arbustorum*, always found in damp places according to Kerney and Cameron (1979). It was suggested that ditches contained standing water, that towards the end of occupation the site was becoming covered with tall vegetation, and that at this time it was damp. Marine shell was abundant (Alvey 1996b), but almost entirely oysters, with only traces of any others.

About half of the valves bore evidence of opening with a knife or similar implement, and parasite borings, 'sea matting' and barnacles were not uncommon; there was a single tube worm, *Hydroides* sp.

Invertebrates from the mid-late 4th century Romano-British settlement at Glebe Farm, Barton-upon-Humber were reported by Carrott *et al.* (EAU 1993/13), following assessment by Dainton *et al.* (EAU 1992/15). The fauna of samples from a mid to late 4th century AD pit with a free-standing plank structure at its base indicated that it contained water and appeared to have infilled gradually. There were abundant Cladocera (ephippia, of more than one kind, including *Daphnia*), ostracods and aquatic snails (mainly *Lymnaea truncatula*), and over a quarter of the beetles and bugs were aquatics. There were numerous *Ochthebius minutus*, *Tanysphyrus lemnae*, *O.?viridis*, *Helophorus* spp. and *O. ?dilatatus*, with a range of other water beetles. These suggested reasonably clean, weedy water, not much disturbed, with some mud. *O. viridis* is a brackish water and heath pool species, apparently out of place here. However, it probably lived along the shores of the Humber, less than 2 km to the North (and perhaps closer in the past), so it may have invaded and established in an atypical habitat. There was a paucity of remains of aquatic plants, presumably because this was a small isolated water body. Waterside insect taxa were well-represented, with *Lesteva longoelytrata*, *Platystethus nitens*, *P. degener* and *Carpelimus rivularis* dominant; these would have been at home in muddy margins. There were also aquatic-marginal species typically associated with decomposer habitats in archaeological deposits (*Carpelimus bilineatus, Anotylus nitidulus*, and *A. rugosus*), which it was suggested probably lived in the pit too. Evidence of human occupation was very limited (the terrestrial forms would all have been in place in semi-natural or disturbed habitats such as agricultural land not subjected to intensive farming), but equally there was not much to suggest the presence of undisturbed natural vegetation. Species associated with trees were rare. There were hints of dung, but not close to the pit. This material illustrates well a general and fundamental question (discussed on p. 457): how representative of the wider surroundings are death assemblages from such cut-fill deposits?

Girling (AML 3929) described two insect assemblages from Winterton, one from near the bottom of a waterhole or wood-lined well of 3rd or early 4th century date and the other from an enclosure ditch. The former gave a few aquatics and waterside species, indicating damp conditions but not permanent open water, and perhaps suggested pastureland in the surroundings (although only traces of dung beetles were recorded). The only strong synanthrope was a single *Oryzaephilus surinamensis*. Since it is suggested that this feature lay near to the entrance of a barn, it quite possibly post-dated occupation. The assemblage from the ditch was too small to be of interpretative value. The relationship of this material to that described by Robinson (AML 1786) from Winterton is not clear. Robinson found only traces of grain pests (*Sitophilus granarius*) and other synanthropes in well and ditch fills. The fauna of the latter suggested grassland and disturbed ground in the vicinity. Also in Winterton, Hall *et al.* (PRS 2003/30) reported evaluation of various deposits of Roman date: all were barren of invertebrate remains apart from a trace of shell.

Enclosure ditch fills at a Romano-British settlement at Sandtoft (Samuels and Buckland 1978) produced insects suggesting that occupied buildings existed within the enclosure. *Oryzaephilus surinamensis* and *Sitophilus granarius* were recovered from an organic lens in one of the fills, notable records at a site of this type. Jaques *et al.* (EAU 2000/32) investigated a series of deposits, mostly fills of ditches, dated to the mid-1st to late 4th centuries, at East Halton Skitter. Even though very large sub-samples were used, no invertebrates preserved by anoxic waterlogging were recovered. There were sometimes small numbers of landsnails, and rarely larger quantities, with some aquatics and terrestrial forms indicating open, damp to dry, grassy vegetation. There were only traces of marine shell. A Roman-British ditch fill at Aylesby produced only a few landsnails (Carrott *et al.* 1995).

Allison *et al.* (EAU 1990/05) investigated a series of samples from late 1st to late 4th century deposits associated with settlement at the Staniwells Farm site, Hibaldstow. The archive analysis report was based on Bulk Sieving samples only, all of the samples having been processed in this way on site. Most of the material represented pit and ditch fills, although there were flue spreads of later date. The methodology (sieving to 1 mm) reduced the chance of recovering useful assemblages of the smaller invertebrates, and such insects as were recovered often appeared to be of modern origin. The only well-represented invertebrates were the land molluscs, and nine of the largest assemblages were recorded fully. Although the recently introduced burrowing snail *Cecilioides acicula* (p. 482) was much the most abundant species, it was argued (on the basis of the absence of two species which are very abundant at present in the Wolds-Humberside area, and therefore to be expected as contaminants) that the remaining components of the assemblages were of Roman date. Grassland, possibly with a mosaic of damper areas (perhaps within the ditches, although this was not suggested in the report), was indicated. Snails associated with taller herbaceous vegetation were absent, suggesting grassland maintained by grazing or cutting. There were no aquatic or marshland molluscs, so the ditches may not have held open water. The lack of General Biological Analysis samples from this site was unfortunate, for although remains preserved by anoxic waterlogging were rare, a far more detailed reconstruction might have been possible had sufficient sediment been processed.

An assessment of samples from features of Romano-British date from land between Rosper Road and the Conoco Humber Refinery at Immingham was carried out by Jaques *et al.* (PRS 2004/08). Two of three ditch fills were productive of insect remains, which though rather decayed were interpretatively useful. Deposition had been in water, with numerous aquatics, and there were also mud-dwellers. A restricted range of plant feeders and species able to exploit natural plant litter was noted. There was a quite strong component of dung beetles, and these together with some click beetles pointed towards the presence of grazing land in the surroundings. A well fill gave similar evidence, though lacked aquatics. Two pit fills and a third ditch fill were barren of invertebrates. There were traces of cockle shell (*Cerastoderma edule*), and a few land snails.

Roman rural East Yorkshire

This area is rather well-represented by rural settlements. Buckland (1980) reported insects from the fills of a deep, wide well at Rudston villa. The fills were probably of the mid-4th century onwards, for an unknown length of time. The insect fauna was of mixed character but overall suggested a landscape with strong human influence. It is hard to accept the contention that there were sufficient dung beetles to indicate grazing land (cf. Robinson 1991b, and p. 61), although it may well have existed in the surroundings; there was a clear grassland component, with numerous individuals of the chafer *Phyllopertha horticola*. Other plant feeders indicated annual and perennial herbaceous 'weed' vegetation with some scrub or hedges. Synanthropic insects were very rare, and all but a single individual of the grain pest *Oryzaephilus surinamensis* could have exploited semi-natural habitats (the origin of a single individual is of course open to speculation, and may even have been laboratory contamination, see p. 476). The assemblage from Rudston might best be interpreted as indicating at most low-grade occupation of the villa, with agriculture continuing in the surroundings. It seems unlikely that the fauna developed at a stage when the bath-house was still functioning; full occupation of the site would have produced a very different fauna which would surely have been represented by stray elements at least. An enigmatic layer of moss within the well may have formed in the damp atmosphere within the upper part of its opening during disuse and fallen down in lumps at intervals, which would explain the lack of twigs and other plant macrofossils typically present if moss is collected from woodland floors. Providing dating could be tied down, the difficult excavation of this well could have been made far more productive had intensive sampling and bulk-sieving been carried out.

A substantial number of invertebrate assemblages of Roman date from the settlement at North Cave are described by Allison *et al.* (AML 105/90; EAU 1997/37; forthcoming a; see also Carrott *et al.* EAU 1996/42). Phase 3 was dated to the 2nd -?mid third centuries; a series of fills of boundary ditches associated with buildings included some with clear evidence of aquatic deposition from *Daphnia*, insects (including beetles and caddis fly cases) and molluscs. A predominant snail was *Anisus leucostoma*, found in aquatic habitats, tolerant of fairly polluted waters including those subjected to periodic drying, and a component of Evans' (1972) 'slum' community. There were appreciable quantities of small bivalves, two species of the genera *Pisidium* or *Sphaerium* being present but too damaged for closer identification. That at least some water plants had become established was suggested by the general nature of the aquatic insect fauna, and particularly by the weevil *Tanysphyrus lemnae*, associated with duckweeds, *Lemna*.

The most striking feature from this period of the North Cave site was a large pit, whose organic-rich fills were sampled in a column. Abundant aquatic invertebrates, particularly beetles, cladocerans and ostracods, clearly demonstrated that the pit had held water, and with the plant remains conjured an image of verdant mosses gradually infilling the pit. Decomposer insects were rare, and likely to have originated at the margins of the pit or in small patches of natural litter; synanthropes were effectively absent and there was no evidence that stock visited to drink. There were indications of a mixture of disturbed vegetation and developing scrub or even woodland, the insect fauna in particular being very rich and diverse. Overall, the fauna suggested that this was a disused water hole, infilling after the site was abandoned or in only intermittent and non-intensive use.

From Phase 4 at North Cave, dated to the late 3rd to late 4th centuries, a series of pit fills and deposits associated with a flue and stoke hole were found to be effectively barren of invertebrates, although there were traces of *Daphnia* ephippia in the pits. A single ditch fill dated to the mid-late 4th century or beyond gave a modest-sized fauna suggesting natural infilling, but there were traces of the bug *Ulopa reticulata*, probably imported with cut heather or acid turves. The lack of clear evidence for populations of synanthropic insects of any kind (even those favoured by disturbed ground or agriculture) at this site rather suggests that it was not intensively occupied, and the possibility of temporary or seasonal use might perhaps be entertained. The explanation that synanthropes may not have found their way into cut fills (p. 459) is hardly tenable for the many and varied cuts at North Cave.

Assessment of ditch and pit fills of Iron Age/Romano British to 4th century date at **Newport Road Quarry, North Cave** by Hall *et al.* (PRS 2004/33) revealed preservation of insect and other arthropod remains in several. In some cases there was insufficient material from the assessment samples, but the larger assemblages indicated waterlain deposits, though not necessarily permanent (there ware numerous *Daphnia* ephippia in some, and generally appreciable numbers of water beetles). In one case mites were unusually abundant. Two groups contained rather more dung beetles than expected by accident, suggesting local grazing, and two gave some synanthropes which hinted at the debris human occupation. There were a few land snails, which were in poor condition. A second phase of assessment at this site involved analysis of samples from a range of feature types including ditch and pit fills and deposits associated with a hedge line and a corn-drier (Hall *et al.* PRS 2004/52). Most of the samples were barren or contained a trace of land snails (material from a corn-drier fill giving a rather larger group hinting at short calcareous grassland), but the fill of a large pit produced abundant *Daphnia*, a second cladoceran, aquatic insects (especially *Ochthebius* species), as well as dung beetles suggesting grazing or nearby penning of livestock.

Evaluation of ditch and pit fills at 'Rowdales', nr **South Cave** by Hall *et al.* (PRS 2003/26) produced no ancient invertebrate remains.

There was sporadic preservation of invertebrates in a substantial group of cut fills associated with a Romano-British settlement along the route of the **Leven-Brandesburton By-pass** (Dobney *et al.* EAU 1993/20; Hall *et al.* EAU 1994/15). Ditches, probably of the 2nd to 4th centuries, gave assemblages with many aquatics (insects and *Daphnia* sp.), and species associated with herbaceous vegetation, but there was no evidence of grazing. There were no insects strongly indicative of human dwellings or the stalling of animals (a single *Sitophilus granarius* was almost certainly a contaminant, p. 476) and there was little evidence of anything but natural accumulations of decaying matter. These remains thus either represent periods of abandonment, or we have an example of the low rate of dispersal of invertebrates into cuts near settlement (see p. 459).

Evaluation of Roman-British pit fills, one of 4th-5th century date, at Eastgate South, Driffield (Hall and Carrott EAU 2001/36) produced small groups of land snails indicative of dry, open, calcarous soils, with a component from damper and more richly vegetated habitats; there was also a trace of aquatics. Late Iron Age or early Roman field ditches at Auckinleck Close, Driffield were bulk-sieved during assessment; all contained at least some land snails (Carrott, PRS 2003/52). The assemblages were ecologically mixed, with representatives of dry exposed habitats and more moist, shaded ones. Three samples gave *Carychium* sp. in rather large numbers, suggesting rank vegetation, and ten had abundant intrusive *Cecilioides acicula* (p. 482). Evaluation of a single 3rd century ditch fill sample from land to the west of the Railway Hotel, 5 Middle Street South Driffield (Akeret *et al.* PRS 2005/64) produced only a trace of land snail shell.

Some useful Romano-British invertebrate assemblages were recovered from sites along the Teeside to Saltend Ethylene Pipeline (TSEP). A series of ditch fills dated to the 2nd /3rd centuries AD at a site east of High Catton (TSEP222) yielded abundant invertebrate remains, though at low concentrations, in variable states of chemical preservation, and sometimes very fragmented (Kenward *et al.* EAU 2002/12). It was postulated that this might have resulted from recent de-watering, though ancient decay cannot be ruled out. The insect assemblages were very diverse, suggesting that a range of communities had contributed to them and that they thus reflected the wider surroundings. Grazing land was indicated by some of the assemblages, as was a perennial weed vegetation, but there was little to indicate the presence of structures or intense uman activity. Where dung beetles were abundant, *Aphodius sphacelatus* dominated. This species may have been under-recorded by the author in the past through confusion with *A. prodromus* (p. 341). Synanthropes were rare and mostly facultative forms (defined on p. 61). Deposition was in water, for there were usually large numbers of *Daphnia*and other water fleas, as well as rather numerous water beetles. Two deposits seem to have formed where there was temporary shallow water, while a third was probably laid down under permanent water with aquatic and marsh vegetation. Assessment of material from this site had shown that there were traces of large land snails and oyster (Jaques *et al.* EAU 2000/71).

Some of these TSEP sites were not so productive. Jaques *et al.* (EAU 2002/09) studied a series of ditch fills at a site south of Ganstead, but the only useful invertebrates were aquatic snails in a single layer (in quite large numbers, though all the identifiable remains were *Planorbis planorbis*). Jaques *et al.* (EAU 2002/08) and Hall *et al.* (PRS 2003/20) examined samples from Romano-British pit and ditch fills, and from a peaty deposit which may have been a ditch or damp hollow, at Low Farm, near Cottingham, north-west of Hull; unfortunately these produced at most very decayed scraps of insect cuticle. Romano-British ditch and posthole fills at a site south of Bishop Burton, east of Dale Gate (Jaques *et al.* EAU 2000/65) gave no arthropods, but there were a few snails suggesting open, dry to rather damper, calcareous soils. The recently-introduced *Celilioides acicula* (p. 482) was common, doubtless intrusive. Jaques *et al.* (EAU 2000/70; EAU 2002/15) found only traces of oyster shell in late Roman ditch, pit and oven or kiln fills at a site north-east of High Catton. Hall *et al.* (EAU 2000/73; see also Hall *et al.* CHP 2003/01), examining material dated to the 1st-2nd and 3rd-4th centuries from various cut features at a site north-east of Goodmanham, found only rather small amounts of snail and oyster shell, some of the latter opened using a knife; there were explicitly no insect remains.

Assessment of a substantial number of samples of Iron Age/Roman date at the site of the proposed waste water treatment works at Melton by Hall *et al.* (PRS 2002/27) showed several to contain useful insect remains. Ditch fills contained aquatics, with terrestrial fauna including dung beetles. A '?peat' layer also contained aquatics and dung beetles, with plant-feeders including the nettlebug *Heterogaster urticae* (p. 290) and other nettle-feeders. From another site, dated Iron Age to Romano-British, at Melton, Carrott *et al.* (1999) reported land snails, occasionally in considerable numbers, from what were interpreted as dry ditches. There was also a trace of very rotted mussel shell. A further evaluation associated with this development, at **Low Common Lane**, revealed some Roman deposits; fills and a surface deposit all contained a few snails, but no other invertebrates (Carrott *et al.* PRS 2003/83). There was a little hand-collected marine shell, including a few oysters with knife-marks from opening. Also at Melton, assessment of a large group of samples, mainly from ditch and pit fills, at **a site alongside the A63** produced no 'delicate' invertebrate remains, but a substantial number of snail assemblages, a few fairly large (Akeret *et al.* PRS 2005/93). However, many samples gave predominantly or exclusively the burrowing *Cecilioides acicula* (p. 482). The ancient snails were of mixed ecological character, but with clear indications of open calcareous short-turf grassland. Hand collected shell included small quantities of oysters and some larger land snails.

Hall *et al.* (PRS 2002/41) reported evaluation by bulk-sieving of various deposits at a site at **Elloughton**, dated Late Iron Age or Romano-British. No insects were present, but five samples gave snail assemblages, which overall were typical of short-turfed calcareous grassland with variable amounts of shade; a ditch fill included species requiring at least temporary standing water.

Jaques *et al.* (EAU 2000/35) reported the assessment of a series of samples from the single fill of a timber-lined well at **Hayton, east of Pocklington**. Preservation of insects was generally superb, and abundant remains were recovered. The assemblages were species-rich and represented a range of habitats, and appeared to have formed by slow accretion over a moderately long period. There were a few synanthropes, representing the fauna of the adjacent buildings. Unusually for any Roman site, grain pests were conspicuously rare (restricted to a single *Cryptolestes*). There was a range of decomposers typically associated with fairly foul conditions, together indicative of dung and probably reflecting livestock in the surroundings, and thus presumably perhaps grazing land. Remains of what appeared to be *Damalinia* lice offer a hint that this 'well' was drunk from by livestock. There were some species associated with litter in open ground, but no more than could survive in an intensively disturbed area with a few weeds, or might arrive in flight from an open agricultural landscape. Aquatics were present in moderate numbers, and plant feeders were abundant, suggesting a varied herbaceous vegetation. The nettlebug *Heterogaster urticae* was noted, probably indicative of temperatures above those of the present day (p. 285). No species associated with living trees or dead wood were recognised. There were rather few ground beetles (Carabidae) or other ground-living insects, suggesting that this structure did not act as a pitfall trap. Selected assemblages from this well have been analysed in detail (Kenward, unpublished). A second site at Hayton was investigated only via BS samples; no insects were found (Jaques *et al.* PRS 2004/63). Jaques and Carrott (PRS 2002/31) reported evaluation of a ditch fill, probably 2nd century, at **Snuff Mill Lane, Cottingham**; there were no invertebrates. A further group of samples, again from ditch fills, from this location was also barren (Carrott *et al.* PRS 2004/67).

Mant *et al.* (PRS 2005/97) examined the fills of pits and ditches during an evaluation at **Pocklington Waste Water Treatment Works, Canal Lane, Pocklington** but recovered only snails, with *Cecilioides acicula* (p. 482) predominant. Ancient snails were mostly terrestrial, but with a trace of aquatics.

Hall *et al.* (EAU 2001/38) carried out evaluation of two samples from alluvial silts revealed during excavations at the **Magistrates' Court site, Brough**. One contained aquatic beetles and *Daphnia*, with a few terrestrial beetles. There were, however, also some synanthropes, including the grain pests *Sitophilus granarius* and *Oryzaephilus surinamensis*. The second sample (which contained salt marsh plants) gave freshwater invertebrates, terrestrial insects which probably came from waterside habitats, and numerous snails, all the brackish water species *Hydrobia ventrosa*. A remarkable find was the very southerly shieldbug *Thyreocoris scarabaeoides*, also known from the North Cave site (Carrott *et al.* EAU 1996/42).

Evaluation of ditch fills associated with a Roman road and field boundaries at **Welton Low Road, Elloughton**, near Brough, produced a little evidence (Carrott *et al.* EAU 1996/17). One primary fill yielded a variety of aquatic and terrestrial snails, unfortunately poorly preserved and giving little information. Other ditches gave insects associated with herbaceous vegetation, open ground and plant litter in addition to a few aquatic and waterside species, but the scale of work possible within an evaluation prevented adequate analysis. More should be done. Evaluation of further material from this area (Carrott and Large EAU 1997/29) produced no insect remains, but snails and bivalves indicating standing water were recovered from two layers in one ditch, and indicators of damp vegetation from a second, putative, ditch.

Extensive evaluation of samples from the Aldbrough Gas Storage Project (Carrott *et al.* PRS 2004/53) showed most to be barren of invertebrates. Two, from ditch fills, gave small groups of insects indicating aquatic deposition; one sample included abundant *Daphnia*, another numerous mites.

Evaluations of sites near to Hull have produced little evidence about Roman rural life, the best information coming from Kingswood. At Malmo Road, Carrott *et al.* (EAU 1992/01) found Romano-British ditch deposits to be barren; a deposit described as 'lowermost material', presumably Roman, was on the invertebrate evidence waterlain, perhaps in an area of grazing land. An evaluation of a ditch fill from a second site at Malmo Road (Carrott *et al.* EAU 1997/38) produced only *Heterodera* (soil nematode) cysts and earthworm egg capsules, quite possibly intrusive, and a few poorly preserved insect remains of no interpretative value. A probable Romano-British ditch fill at Kingswood (Carrott *et al.* EAU 1996/55) gave only traces of remains other than *Heterodera* cysts and earthworm egg capsules, and a 'ground surface' gave only robust remains such as those of some weevils, suggesting almost complete loss of insects by decay (*cf* p.105). Further Romano- British deposits at Kingswood were subjected to evaluation by Carrott *et al.* (EAU 1997/17). The fill of a robbed construction cut gave a few badly eroded seeds, and no invertebrates other than earthworm egg capsules and cysts of soil nematodes (?*Heterodera*), suggesting that the deposit may have been part of an active soil. Two samples from an early Romano-British ditch fill (or possibly the river edge) illustrated the problem of heterogeneity of deposits, with a marked difference in numbers of plant and invertebrate macrofossils recovered. The first yielded only a few invertebrate remains of no interpretative value, but the second contained abundant and well preserved invertebrates. *Heterodera*-type cysts were numerous, with some earthworm egg capsules, so there was either soil inwash or post-depositional burrowing. Insects were species of natural or semi-natural habitats, together with others typical of human occupation. Aquatic and waterside species were sufficiently abundant to indicate sediment formation in or immediately by water while terrestrial fauna included dung beetles and some plant feeders; subjectively it would appear that the surroundings were strongly modified by human activity, presumably in agricultural use. Synanthropic insects included species typically found together in and around buildings, probably from rather dry material such as might be found on a house, barn or stable floor. It was not clear whether this was an artificial drainage ditch or a natural water course, though the first interpretation was favoured by the lack of a clear river-transported component. A second similar deposit gave rather small numbers of aquatic and waterside species, a few species associated with herbaceous vegetation and a substantial synanthropic component typical of artificial accumulations of decaying matter on occupation sites. Synanthropes were considered too frequent in these two deposits to have had a naturally transported origin, and it appeared likely that waste material containing plant and insect remains had been deliberately dumped or more indirectly introduced from nearby structures. The plant feeders indicated waterside habitats, but no more than herbaceous vegetation in the surroundings, reinforcing the impression of strong human influence. A third deposit, again either riverbank or ditch fill, also contained *Heterodera*-like cysts and earthworm egg capsules, and the impression that there had been either soil inwash or a phase of *in situ* soil formation was strengthened by the presence of several larvae (wire worms) of the click beetle *Athous haemorrhoidalis*. Other invertebrates were a mixture of species from semi-natural habitats, although subjectively with some hints of rather foul decaying matter, conceivably dung. There were no grain pests in any of the assemblages, and it was tentatively suggested that this, together with the fairly limited range of other synanthropic insects, perhaps indicated a small isolated settlement (following arguments presented by Kenward 1997a, see also p. 468).

Also at Kingswood, assessment of Romano-British deposits at the **Gibraltar Farm** site (Kenward *et al.* EAU 1998/06) showed that a proportion contained insect remains. Invertebrates were present in a channel fill and two riverbank deposits, mostly being aquatic or waterside taxa, but with a terrestrial component associated with plant litter and perhaps dung. Weedy sluggish water was suggested, and there was no evidence for a tidal influence. Some pit and gulley fills were effectively barren.

To the north of Hull, Jaques *et al.* (EAU 2002/06) examined samples from ditch fills and a hearth deposit, perhaps Iron Age or Romano-British, from **Lawns Farm, Dunswell**, but all were devoid of invertebrate remains.

Romano British ditch fill silts at **Waterside Road, Beverley**, examined in an evaluation by Hall *et al.* (EAU 2001/39) gave rather small numbers of invertebrates. Aquatics were present, together with species likely to have lived in waterside habitats. Terrestrial forms included some which suggested artificial accumulations of decaying matter. There was no clear indication of land use (beyond ambiguous hints of dung), though it was suggested that detailed analysis might produce such information.

At the western extreme of this area, Carrott *et al.* (EAU 1993/11) evaluated samples from Roman deposits at a site near **Stamford Bridge.** The lowest deposit within what may have been a boundary ditch gave small amounts of poorly preserved material including *Daphnia* ephippia and beetles of slow or still water. A second fill within a putative property division again gave poorly preserved remains but with hints of open ground. Another, from another boundary ditch, produced *Daphnia*, a single water beetle and assorted terrestrial forms, conceivably from grazing land. It is unfortunate that there was no funding to sample and investigate this unusual material on a large scale, since it would probably have been possible to arrive at a reasonably good description of the surroundings using the insect and plant remains together. Also at Stamford Bridge, Holden (1999) assessed plant macrofossils from a single sample from a 3rd century ditch fill at a ladder settlement, noting the presence of insect remains and pointing out their potential value in reconstructing conditions beyond the ditch. A second assessment of sites on a pipeline near Stamford Bridge (Hall *et al.* PRS 2004/57) gave some positive results. Insects and snails in pit and ditch fills gave evidence of standing (but not necessarily permanent) water in an area with an open landscape, probably with grassland. There were enough dung beetles to suggest the presence of stock, but only very limited hints of human occupation, although a single *Trichuris* egg was noted from a squash from an undated column sample.

Jaques *et al.* (EAU 2002/10) investigated a sample from a Romano-British ditch fill dates to the 2nd century at **Flat Lane, Barmby Moor, nr Pocklington**, but found only a few landsnails; small amounts of hand collected shell were recovered, too. The material was of no interpretative significance.

Roman rural York and North Yorkshire

It is hard to classify the earliest phases (Period 1 and Period 2 Phase 1-3) of Roman exploitation at the **Tanner Row** site, York, which appear to be contemporaneous with the first few decades of the Roman fort, up to the middle of the second century, but to have been grazing land traversed by natural water courses or (more probably) ditches (Hall and Kenward 1990; fuller report on molluscs by O'Connor AML 4768). Whether they should be seen as urban fringes or rural is open to argument, but they are included here since they appear to cast some light on essentially rural landuse. The area was subject to steadily increasing human influence, however, as reflected in a growing proportion of synanthropic insects. Phase 1, seen only in trial holes and consequently represented by few samples, gave an essentially natural fauna. There were a few synanthropes, including grain pests, but it was not clear how these arrived (they may have been from dumps or even from horse droppings).

Period 2 gave a rich and varied synanthropic fauna throughout, almost certainly as a result of dumping of waste from nearby occupation. One of the samples from Phase 1 gave numerous dung beetles and other foul decomposers, and insects, snails and plants suggesting rough grazing land. Invertebrates from Phase 2 of Period 2 suggested disturbed waste ground, the snails indicating a swampy area with lush waterside vegetation. Insects gave clear evidence of an aquatic influence, with numerous water beetles in some cases, and *Daphnia* ephippia (water flea resting eggs) were common and occasionally abundant. The waterside staphylinid *Carpelimus rivularis* was sometimes abundant and probably exploited the damp ditches; it is discussed in relation to the closely related *C. bilineatus*, common in occupation deposits, on p. 389. There was some evidence of human faeces from the eggs of intestinal parasites (*Trichuris* and *Ascaris*). A sponge fragment may have been associated with faeces (following the argument of Buckland 1976a), but may have had any of several other sources. By Phase 3 of Period 2, insects of various origins were well represented, and one deposit gave a fauna suggesting the dumping of litter from in or immediately by a building. Intestinal parasite eggs were present, and abundant in some lumps of faecal concretion, presumably re-excavated from older deposits elsewhere. The wetland or riverine influence continued, however. There was no evidence for flooding, although this might conceivably have been the origin of some of the wetland organisms in these early second century deposits. By the later second century the site had been built over (see p. 167).

In and around York, ditch fills of probable Roman date at **Metcalfe Lane, Osbaldwick**, examined by Carrott *et al.* (PRS 2002/18), proved barren of invertebrate remains. A series of ditch and grave fills dated Romano-British or Iron Age/Romano-British examined during evaluations at **Millfield Farm, Wheldrake** (Hall *et al.* PRS 2003/19) produced no invertebrate remains, and Romano-British ditch fills at a site on the **Elvington to Riccall pipeline** were barren except for fragments of what appeared to be modern contaminant insects (Carrott and Cousins PRS 2003/55). Fill, probably of a ditch, at the **Bedford Hotel, 108-110 Bootham** was also barren (Hall *et al.* PRS 2003/32), as were Roman deposits at **Rawcliffe Manor, Manor Lane, Rawcliffe**, examined in an evaluation by Dainton *et al.* (EAU 1992/16), samples from the **Starting Gate site, Tadcaster Road** (Carrott *et al.* EAU 1996/34), and **Flaxby** (Carrott *et al.* EAU 1994/35). Hall *et al.* (EAU 2000/49) reported only very decayed weevil fragment, presumably robust remains surviving when other fossils had decayed (p. 105), from evaluation at land off Wiggington Road. Evaluation of ditch and cut fills at **Terry's chocolate factory** by Carrott *et al.* (PRS 2005/60) produced at most some ?*Heterodera* (soil nematode) cysts. Iron Age or Romano-British, and Roman, pits and ditches at the **Heslington East** development site were subjected to evaluation by Hall *et al.* (PRS 2004/28). Although many of the samples were barren of invertebrates, one gave a fauna in which aquatics were predominant (even the terrestrial component may all have originated in waterside habitats), and another included some beetles suggesting an open landscape. Some of the deposits at this site clearly have substantial potential for detailed analysis providing dating can be confirmed.

Hall *et al.* (PRS 2003/42) reported evaluation of a dump or levelling deposit of Roman date at **The Spinney, Sherburn-in-Elmet**; it yielded only a few land snails. Ditch fills tentatively interpreted as forming a boundary to a Romano-British rectangular enclosure at **Crossgates Farm, Seamer** (Hall *et al.* EAU 1996/56) provided only traces of insect remains. A notable record was a single snail identified as the salt marsh species *Hydrobia ulvae* (discussed on p. 300), suggesting the possibility that further investigation might reveal a brackish water influence in these ditches. Confusion with the rather similar freshwater snail *Potamopygurus jenkinsi* is unlikely as this species, now common, was not known in Britain before the late 19th century (Fryer and Murphy 1991, 220). (Note the *caveat* concerning this species on p. 285, however.) Excavations at **Crossgates, near Scarborough**, revealed Romano-British huts, probably of 3rd-4th century date (Rutter and Duke 1958). One of the huts was notable for abundant mussel shells (*Mytilus edulis*), presumably a food resource easily obtained from the nearby coast. Only a single oyster was recorded, but whether this indicates rarity, choice or ease of collection (oysters are typically difficult to obtain without trawls unless cultured) cannot be determined. Hall *et al.* (EAU 2000/34; 1996) evaluated samples of presumed Roman deposits (fills of a circular feature and a shallow gully) at the **former convent school, St Thomas Street, Scarborough**. No invertebrate remains were recovered.

Turning to a site of considerably higher status, Jackson (1951) gave an account of abundant marine shells from the Romano-British baths at Well, SE of Northallerton. Shells occurred all through the Romano-British deposits, with oyster (*Ostrea edulis*) by far the most abundant. There were also some *Mytilus edulis* and *Cerastoderma* (*Cardium*) *edule*. Traces of landsnails (*Helix aspersa* and *Cepaea (Helix) hortensis*) were also noted. Jackson quoted an early account by Lethieullier (1735-6), who had observed 'great quantities of old dryed oyster shells' at this site, and had remarked that he had noted the same phenomenon at similar sites elsewhere in Britain. Transport of large quantities of shellfish to this site cannot have been easy - although the Rivers Ure and Swale are not far off, and the A1 (roughly following the main Roman N-S road) runs a few kilometres away, a long and tedious journey must have been involved in reaching the site from the sea, whether by land or river. One wonders what proportion of oysters would have survived the trip to this site alive; perhaps they were preserved in some way for transport.

Analysis of Romano-British pit fills and ashy flue fills at Bridge Road, Brompton on Swale, NE of Catterick, gave no insects, and only very decayed marine shell, together with a trace of land snails, mostly the burrowing *Cecilioides acicula* (Jaques *et al.* PRS 2003/51).

Pipeline surveys and associated excavations in the Vale of York and East Yorkshire have recently revealed a series of prehistoric to Romano-British rural sites which provide a starting point for landscape reconstruction for the area. Some of a series of ditch fills associated with a 3rd-4th century Romano-British villa site at West Lilling (TSEP 169), assessed by Johnstone *et al.* (EAU 1999/19), and a second group of samples assessed by Hall *et al.* (EAU 2000/82), gave useful assemblages of beetles and other invertebrates. Selected material was subsequently reported in detail by Hall *et al.* (EAU 2002/01). Numerous aquatics (insects and Cladocera) indicated that the ditches had held water, and there was evidence of aquatic and emergent or marginal plants, and waterside mud and litter. A specimen of *Esolus parallellpipedus*, associated with flowing water, from a ditch beside a droveway perhaps indicated a stream inflow, but it may have arrived on the wing. The assemblage from this deposit included beetles which gave a hint of material resembling stable manure. Grassland and dung beetles suggested that grazing land was present in the surroundings, and perennial weeds, including docks, nettles, plantains and vetches or their relatives, were indicated by various plant feeders. A few other deposits, examined using Bulk Sieving samples, yielded traces of insects, including some characteristic groups of very decayed tough remains including weevils (see p. 105). The authors concluded 'Overall, the impression is of an intensively exploited agricultural landscape, of a kind which is being seen repeatedly in Iron Age and Roman rural deposits in the Vale of York and areas to the east of it ... and not dissimilar to the landscape (although not the crops) seen today.'

County Durham

Romano-British deposits the Faverdale East Business Park, Darlington were assessed by Akeret *et al.* (PRS 2005/103). Two well fills gave small groups of insects, mainly beetles but with some fly puparia, and also mites, and a ditch fill also yielded small numbers of insects. None of these assemblages were ecologically characterised in the report. There were generally no molluscs, or only traces, but one gully gave some oysters, and another deposit a few fragments of mussel. Two ditch fills, probably Roman, at Chalmers Orchard, Newcastle Road, Chester-le-Streetwere barren apart form some modern beetles and mites (Carrott *et al.* PRS 2005/88).

Northumberland

Invertebrates from a fill of a Romano-British ditch terminal at the Flodden Hill rectilinear enclosure were described by Kenward (EAU 2001/49). Preservation was superb, with many entire or nearly entire sclerites of even large species, as well as the delicate nymphs of bugs. The deposit was interpreted archaeologically as a primary fill, probably accumulated while the site was in use, allowing reconstruction of conditions at that time. A very clear reconstruction could be made; in particular, many species represented by one or a few individuals in the analysed sub-sample were present in larger numbers in a bulk sample, suggesting that they were significant components of the local fauna The insect assemblage was very species-rich and an exceptionally large proportion fell in the 'outdoor' category. Species associated with decomposing matter were relatively rare, and of this component about a third was contributed by species usually found in dung and other very foul matter. Synanthropes were rare and there were no insects dependant upon human dwellings or other structures.

The deposit formed in water on the evidence of a range of aquatics, including abundant cladocerans (principally *Daphnia*, but also at least three other types), and appreciable numbers of a range of aquatic beetles and bugs. The latter were almost all species which would be at home in shallow, reasonably clean, water with a little vegetation, and not necessarily permanent. There were two species of elmid beetles, indicative of flowing water; these may have come from a clean, permanent stream inflow, but seem more likely to have arrived on the wing as 'background fauna'. The immediate surroundings of the ditch supported a flora of perennial weeds. In particular, insects typical of well-established, sunny, beds of stinging nettles (*Urtica dioica* L.) were numerous. Among these, *Heterogaster urticae* was very much to the north of its mid 20th century range in Northumberland and presumably indicated temperatures above those of that period (see p. 289). Other perennial weeds indicated were docks and their relatives (*Rumex* and *Polygonum*), various crucifers, plantains (*Plantago*), clovers and vetches. Many of the other species recorded probably lived on the ground or in litter below these plants.

The wider landscape appeared to be well defined. Species indicating short herbaceous vegetation, including grassland, were conspicuous, while true dung beetles, and other beetles found in foul matter, were well represented, probably indicating grazing land nearby. There was no evidence of material such as house floor litter, midden accumulations, hay, or stable manure. Much of the fauna consisted of species favoured by human modification of the natural landscape (i.e. 'semi-natural' environments, cf. Kenward and Allison 1994c). This impact may have been quite strong, leading to a generally open landscape, as no species associated with trees or shrubs were found in either sub-sample despite the presence of 'branch wood' in the sediment. This is regarded as good evidence that the deposit formed during a period when the site saw intensive use. It was argued that although tree-associated species may not occur in deposits formed even quite close to woodland (p. 458), scrub would cover an abandoned site, including the ditch margins, in only a few years and so be detectable in the ditch fill.

There was nothing to suggest that occupation waste was dumped into this ditch in the way sometimes seen at other sites, and it seemed likely that there were no structures *immediately* adjacent; the conspicuous absence of species strongly tied to artificial habitats suggested an isolated settlement (following the argument of Kenward 1997a).

Akeret *et al.* (PRS 2005/105) assessed samples from a Romano-British pit at the North Road Industrial Estate, Berwick-upon-Tweed; no invertebrate remains were recovered.

Cumbria

Little work has been done on invertebrates from sites along Hadrian's Wall, which is appropriately considered here as yielding evidence of rural conditions; much more should be done. Hall (EAU 2000/46) included notes on insect remains from the turf wall and associated ditch at Appletree, near Birdoswald. The lowermost peaty layer gave a few insect remains, but turves above were barren. The peaty basal ditch fill gave a rather large assemblage of beetles suggesting poor rough grazing land, including *Geotrupes* and *Aphodius* dung beetles, some ground beetles and larval apices of click beetles ('wireworms').

Cheshire

A large sub-sample from fills of an undated ditch close to a Roman road at Gadbrook Park, near Northwich, examined during evaluation (Carrott *et al.* EAU 1996/45), produced insect remains with variable preservation (even within single fossils). The assemblage recovered was of sufficient size to permit reconstruction of the depositional environment and something of the surroundings if material were to be identified closely. Aquatics were fairly well represented, with a wide range of species. Quiet or very slowly flowing water with at least some vegetation was indicated. The surroundings of the ditch appear to have been somewhat disturbed so that crucifers and probably also grasses were able to establish and there were indications of at least some scrub, but no good evidence of synanthropic insects consistent with the presence of buildings nearby. Scarabaeid dung beetles were not noted; they would have been expected had the surroundings been grazing land (though see p. 334).

Tomlinson (1987) reports on a sample from the fill of a Roman wooden tank at Nantwich. Fly puparia and parasite eggs were noted, though whether this structure was a cesspit or had an industrial function is uncertain.

West Yorkshire

A single insect assemblage from the well at the villa site of **Dalton Parlours, Collingham**, was described by Sudell (1990). It gave rather little evidence for contemporaneous human occupation. There were some spider beetles (notably several *Tipnus unicolor*; see p. 378), but only traces of synanthropes other than *Lathridius minutus* group, which may have been present in semi-natural habitats. Numerous individuals of the bark beetle *Leperisinus varius*, typically found in dead or moribund ash (*Fraxinus*) branches and trunks, may have been introduced in wood brought by humans (p. 315). There were hints of dung, but only the eurytopic *Aphodius granarius* was at all abundant. The ground-dwelling species gave no evidence of a 'pitfall' effect, *contra* Sudell (*op. cit.*, 269). Sudell's conclusion (p. 271) that conditions were open, dry, without much decaying matter, appears justified, but it is possible that the fauna relates to abandonment or low-grade use, perhaps in the later 4th century (Wrathmell 1970).

Two Late Iron Age to early Roman ditch fills at **South Dyke** (on the **M1/A1 link road**) gave substantial insect assemblages which were analysed in detail (Kenward and Large EAU 1999/02; 2001b). Both are considered in the section dealing with Iron Age material. A notable record from the Roman period was a singe specimen of the rare weevil *Procas armillatus*. Carter (2001) reported a small group of land snails from ditch fills of Romano-British date at **Becca Banks** on the same road development; much larger numbers were found in later fills (considered in the appropriate sections below). Assessment of deposits associated with a Roman road at **Adel, Leeds**, gave small quantities of insect remains, with representatives from water, waterside mud, vegetation and litter, and terrestrial habitats (Hall and Kenward CHP 2003/02).

Evaluation of ditch and feature fills of Romano-British date at **Bradley Street, Castleford**, produced no invertebrate remains (Carrott *et al.* PRS 2004/41). Milles (AML 114/93) examined molluscs from a sequence of ditch fill deposits at **Ferrybridge Henge, near Castleford**. Erosion and an increase in bare ground appeared to be indicated. Also at Ferrybridge, Carrott (PRS 2003/35) reported snail groups of the Roman Iron Age (perhaps earlier in some cases); they indicated open environments, very dry in some places, with some scrub or hedgerows at some stages. Carrott (PRS 2003/22) assessed snails from and Iron Age or Romano-British pit fill at **Micklefield**. There were a few snails, suggesting disturbed habitats. *Cecilioides acicula* was also present (p. 482).

Hall *et al.* (EAU 1999/31) reported evaluation of a sample from what was interpreted in the field as a small pond or ditch, perhaps of Roman date, on the route of the **Chapel Haddlesey to Eggborough pipeline.** Invertebrates were abundant, with beetles and water fleas (*Daphnia*) indicating that the cut held water, some species likely to have lived amongst vegetation and the water's edge, and (from species associated with short vegetation and dung) indications of grazing land. Plant remains had similar implications, but added hints of human occupation (there was no distinct occupation-site synanthrope community amongst the insects).

South Yorkshire

Sadler (1985) examined insect remains (mainly beetles, with some caddis) from samples from fills of an old river channel, dated to the Roman period, and late Roman ditches at **Sandtoft, Hatfield Chase.** The fauna of the lower channel fill suggested a slow river, with some indicators of faster flow. There were abundant submerged and emergent plants. Terrestrial insects implied a treeless landscape, probably agricultural. There were hints of adjacent human occupation from two grain pests (*Sitophilus granarius* and *Oryzaephilus surinamensis*), though the possibility that these arrived in the dung of livestock or had been carried downstream over some distance was not considered. A later deposit gave a fauna suggesting stiller water and perhaps eutrophication, and more rotting matter or dung. The spider beetle *Tipnus unicolor* was recorded, and its origins and implications discussed at length; it is now, of course, known to be a typical denizen of Roman occupation sites (p. 378). The upper sampled layers contained only rare, poorly preserved insects. Late Roman ditch fills gave limited evidence.

Overall, then, with rare exceptions, Roman rural sites have provided only limited quantities of invertebrate remains. There have been frustrating glimpses of occupation site fauna; the degree to, and route by, which strong synanthropes such as grain pests reached these sites is unclear, and there is a nagging worry that such grain pests as have been found may at least sometimes have been contaminants of some kind. The fills of many features giving anoxic preservation seem to date to periods of abandonment - unless sites were used in a very unintensive way. Where preservation has been found in field ditches, the opportunity to carry out intensive studies has not always been afforded.

The potential of invertebrate studies to contribute to our understanding of such sites its quite clear, however. Recovery of larger assemblages - whether of insects or snails - representing the Roman agricultural landscape and the settlements in it would be most valuable, and insect assemblages contemporaneous with occupation from sites of the period would allow a range of issues to be addressed. Regarding the wider landscape, the changing intensity of exploitation and the character of agriculture (especially pastoral versus arable, and periods of disuse) might be detected; for settlements, the degree of contact with urban centres, and the quality of structures, at particular sites might be investigated. With good fortune, a wider range of activities may be detected, and evidence concerning health, hygiene and resource exploitation be found. Rural sites will also provide samples of the local fauna which are unlikely to be contaminated by 'natural habitats' species imported over long distances, and are thus of use in climatic reconstruction, a matter of some importance at this period. At many sites, there is the problem of dating ditch fills and relating their biota to phases of occupation (or abandonment) to be overcome and investment in radiocarbon dates would surely be worthwhile. Fills may post-date occupation, or include much older remains which have been redeposited. Suitable sites with good dating constraints will eventually be found; it would be unforgivable should they not be subjected to the fullest study when this happens.

'Natural' sites of the Roman period

Although rural sites offer the opportunity to examine some aspects of the fauna of natural and semi-natural habitats, there is a great need to see natural deposits of this period. Other than where long sequences traverse the Roman period in peat bogs and lakes, which are of somewhat limited value in detailed landscape reconstruction and tend to provide a limited range and quantity of invertebrates, no such material appears to have been seen in the region. Reconstruction of forest, peatland, heath and marshland, all important as resource-gathering areas as well as in terms of floral and faunal history, is a priority.

Very late and immediately post-Roman occupation

Many important questions attach to this period, and relatively poor artefactual evidence and in many cases apparent low-grade occupation place an emphasis on environmental archaeology (through sediment analysis as well as biological remains) as the most promising source of answers. Two broad threads need to be followed: changing conditions on occupation sites, and changes in the countryside. Synanthropic insects in particular show potential, exemplified by work at Lincoln (Dobney *et al.* 1998). The material from Lincoln seems to show that a quite high level of socio-economic organisation continued late into the fourth century - we need to confirm this and determine what happened on a wider scale. It is also important to bring to bear the fullest range of techniques on sites representing late or post-Roman low-grade use - some approaches are suggested in the discussion of the Anglian period (p. 201); see also Dobney *et al.* (1999; 2000b). For rural sites, it would be highly desirable to follow changes at the end of the Roman periods - parallelling work using plant remains at Metchly Roman fort in the Midlands by Greig (2002).

Late Roman York

A series of rather unsatisfactory glimpses of very late or immediately post-Roman occupation in York have been obtained. Analysis of a single sample from an organic layer within the outline of a Roman building investigated during a small-scale excavation in cellars at **8 High Ousegate**, just outside the Fortress wall, produced an insect fauna suggesting an accumulation of somewhat foul organic debris (Kenward *et al.* AML 4822). The radiocarbon date of 470+80 (HAR 2708) indicated a late or immediately post-Roman date, although the fauna would not have been out of place in an Anglo-Scandinavian context. It was suggested that this might have been a deposit formed during abandonment or low-grade occupation in the (perhaps still roofed) shell of the Roman building. The presence of a pronounced 'subterranean' component (see p. 482), with *Trechus micros* and *Coprophilus striatulus* among the most abundant species, was perhaps consistent with this. Had more extensive investigation of deposits been possible, and sampling been more thorough, this might have proved to be a highly significant site, providing a date by which York was in decline and a picture of conditions during it; it is essential that similar opportunities are not lost in future.

An evaluation at the Castle Car Park (Carrott *et al.* EAU 1995/32) revealed a late or post-Roman pit whose fills contained *Trichuris* eggs, grassy plant detritus and insects suggestive of mouldering hay, and some insects associated with fouler conditions. A single tentatively-identified cattle louse *Damalinia* ?bovis was also recovered. There was no funding for further work and the archaeology was poorly understood as excavation was carried out on a very small scale, another lost opportunity for investigation of this crucial period.

The site at **Wellington Row** gave evidence of low-grade occupation within the shell of a large Roman building. The assessment (Carrott *et al.* EAU 1995/14) was unfortunately of necessity carried out on too small a scale for the potential of these deposits to be clearly understood, and an intensive programme of review, and analysis where appropriate, is an urgent priority - any evidence, however sparse, must be of some value.

The late and immediately post- Roman period has thus been very poorly served through analyses of invertebrates in northern England; existing material should be studied using the fullest practicable range of techniques, and no opportunity to collect well-provenanced samples should be lost.

General considerations regarding Roman sites

Study of many Roman sites has emphasised the problem of probable over-representation of unclean conditions (self-preserving accumulations) and abandonment phases (slow accumulation allowing concentrations of remains to build up), or of dumping from elsewhere. The greater part of the occupation of many sites may be at most barely represented *in situ* in the fossil record of the invertebrates, because the sites were clean. On rural sites rubbish was removed to the fields, no doubt, and in built-up areas occupation debris was generally transferred to disposal areas far away. While dumps such as those at Tanner Row in York (Hall *et al.* 1990), and outside this area, in Lincoln (Dobney *et al.* 1998), have provided an immense amount of valuable information, it is inevitably second-hand and somewhat limited in scope. However, had we made proper analyses of large numbers of samples from all of the Roman sites in the North which have been excavated in some way during the past 20 years, and especially if sampling had been carried out in the awareness of the crucial problems of the period, we would have learned an enormous amount about the effect of the Roman occupation and subsequent changes on the region. As it is, we have a few rather well-studied points on the map, and a bad taste left by numerous lost opportunities.

Roman introductions and ecological changes

The Roman period in Britain probably saw many profound ecological changes as a result of intensive exploitation of resources such as stone, timber, turf and peat, and caused by increasing demands on agricultural production. The last of these is considered by Wacher (1974, 69-70), and the impact of Romanisation, as exemplified by Carlisle, by McCarthy (1995; 2005). Roman clearance in the vicinity of Hadrian's wall has been demonstrated on the wider scale using pollen diagrams from bogs by Dumayne and Barber (1994): the use of insect remains and plant macrofossils in buried soils and turf used in construction should provide more localised pictures. We have all too little evidence regarding what happened in the countryside, particularly whether Roman practices changed the nature of the landscape or merely accentuated existing trends. Similarly, were changes brought about in the Roman period simply reversed subsequently, or did the rural environment alter in new ways as populations (presumably) dispersed and declined (Chambers 1993b, 252)? Discovering more is a priority.

Roman trade brought about another kind of ecological change, for it appears that many alien species were imported, some restricted to buildings and others able to gain a footing in a wider range of habitats. For the insects, most of the species suspected of being introduced at this time are synanthropes (ie. favoured by artificial habitats) at these latitudes. Natural habitats species may also have been brought, but would be much harder to detect. There are various questions to be addressed concerning these synanthropes. Firstly, it is necessary to determine which were present in the Pre-Roman Iron Age, necessitating the investigation of rather elusive deposits with anoxic waterlogging at a large number of prehistoric occupation sites. Secondly, the pattern of arrival of the synanthropes may be revealing, for many were clearly imported in the first years (or more probably days) of the Roman invasion, but others may have arrived later. The records of an oriental cockroach (*Blatta orientalis*) from Late Roman Lincoln (Carrott *et al.* EAU 1995/10; Dobney *et al.* 1998) and of the longhorn *Hesperophanes fasciculatus* from Alcester (Osborne 1971) illustrate the remarkable importations which may be detected. The discovery that the black rat (*Rattus rattus*) was brought to Britain in the Roman period (Rackham 1979; 1980a; O'Connor 1991) leads one to wonder what else will be found - was the plague flea (*Xenopsylla cheopis*) introduced at this time too, for example? When did alien cockroaches arrive and were they widespread in settlements? Were silkworms known in the West (*cf* p. 361)? The relationship of synanthrope populations to site utilisation and trade is a separate issue considered elsewhere (p. 468). Further issues here concern the degree to which the aliens became established in Britain as viable populations, and whether constant 'topping up' by importation was necessary to maintain the presence of some of them. Lastly, the pattern of extinction (or localisation) of these aliens (and of some natives particularly favoured by extensive artificial habitats) needs to be traced, since they will probably reveal as much about declining communications, economy and living conditions as any of the other available lines of evidence, as well as providing information of value to ecologists. The need to examine natural sites of the 1st to 5th centuries has been mentioned above.

6. Medieval to the Black Death (1,550-600 BP, AD 400-1350)

The term 'medieval' is used here in the mainland European sense; universal adoption of this convention would avoid much needless confusion and (for example) obviate the absurdity of giving different culture names to contemporaneous sites across Britain.

Post-Roman abandonment

Late-Roman decline and post Roman abandonment may be difficult to distinguish, and some deposits mentioned above might be as well paced in this section. The abandonment phase of the Roman signal tower at Filey (Dobney *et al.* EAU 1996/26; 2001) offered a clear example relevant here; unfortunately there was no preservation of invertebrates other than some molluscs.

Deposits initially suspected to be 'dark earths' at 16-22 Coppergate proved to belong to the early Anglo-Scandinavian period (surface deposits of Period 3, Kenward and Hall 1995). Usai (EAU 1999/26) examined dark greyish post-Roman deposits at Fetter Lane, York. Micromorphology showed that they were not the same as dark earths in Southern England or elsewhere in Europe, seemingly rapidly formed and not a slowly-developed soil like true dark earths. Usai (EAU 2001/11) studied similar deposits at Station Rise, York, with similar conclusions. A single post-Roman 'dark earth' deposit at Rickergate, Carlisle, was assessed by Kenward (EAU 2002/13), but proved barren. No other records of investigation of invertebrates from deposits of this type have been found.

Anglian and Early Saxon settlement

Only frustrating glimpses of the invertebrates of the period prior to the impact of Scandinavian colonisation have been obtained - even where it is clear there was Saxon or Anglian occupation, deposits are typically insubstantial and preservation of invertebrate remains (or those of plants) is rare. The (slight) evidence for Anglian Yorkshire is drawn together by Dobney *et al.* (2000b), who also suggest possible ways forward, including developing approaches to thinly-distributed and poorly-preserved remains.

Anglian York

Deposits of Anglian or putative Anglian date at a small number of sites in York have been investigated bioarchaeologically, but little evidence has been recovered so far as invertebrates (and plant remains) are concerned.

The fills of a series of pits at The Bedern, cut through Late Roman surfaces, were investigated by Kenward *et al.* (1986b, 268 ff.). They are re-considered here at some length in view of their considerable implications for land-use in central York (little more than 200 m from the Minster, whose precursor presumably existed at the time these deposits were forming) in this poorly known period. Two of these pits were 'bell-shaped', around a metre in depth and diameter, with distinctly undercut sides. One seemed to have been recut. Although its lowest primary fill was almost barren of invertebrate remains, the upper one (radiocarbon dated to ad 740+ 80, firmly within the Anglian period) gave a large and very unusual assemblage. This deposit was a peat, probably formed from grasses, sedges or rushes, and contained seeds of *Juncus* spp. (rushes), *Carex* spp. (sedges), *Eleocharis palustris* (spike-rush) and *Ranunculus flammula* (lesser spearwort), strongly suggesting a damp ground/waterside community. Aquatic beetles in modest numbers, together with some caddis cases and *Daphnia* ephippia, indicated that there were periods when the pit held open water. There were many plant-feeding insects, including numerous individuals of the froghopper *Conomelus anceps*, which feeds on *Juncus*. Beetles associated with decomposing plant remains were abundant. It was suggested in the original report (p. 273) that these decomposers may have lived in plant litter on the surrounding ground surface as true synanthropes were absent. Re-examination of the species lists (fiche table 120) with the benefit of hindsight and a revised classification of synanthropes among the beetles suggests alternative origins. *Mycetaea hirta* and *Ptinus fur* were both rather common, and there was distinct indication of a 'house fauna' community including, for example, numerous *Lathridius minutus* group and *Xylodromus concinnus*. *Corticaria serrata*, the most abundant species, is also favoured by artificial habitats including haystacks. This material may have been cleared from a building of some kind which had a limited synanthropic fauna - as might be predicted for Anglian York if population density was low and the site lay in an open area (see below). Alternatively, these species many have invaded a natural accumulation of litter (unlikely to provide a favourable habitat for some of them, however) or more plausibly a heap of material collected by humans, perhaps as poor hay or for spreading on a house floor. In either case, re-interpretation of these remains places a building of some kind containing litter or other habitats for house fauna (for example a thatched roof), nearby.

Such a re-interpretation of one component of the fauna does not alter the original conclusion that the land in which this pit stood was 'a largely neglected and somewhat marshy area'. It is very difficult to believe that the whole of the rich non-synanthropic fauna in this fill was transported. In addition, the fills of the last recut of the pit gave an assemblage of insects with a large proportion of aquatics including a range of beetles and numerous *Daphnia* ephippia, clearly autochthonous. Aquatic deposition also seemed likely on the basis of the sediment type. There was little evidence for decomposing matter in this layer, but a range of plant-feeding beetles indicated docks/knotgrasses (*Rumex* spp.) and nettles (*Urtica* spp.), suggesting some disturbance by human activity such as cutting, trampling, or putting livestock out to graze.

The second of the bell-shaped pits at The Bedern gave an insect fauna dominated by outdoor forms (primarily plant feeders) suggesting weedy waste ground, and this was supported by the plant remains. *Ceutorhynchus contractus* was particularly abundant, this and some other species indicating crucifers of some kind. A second fill produced insects with similar implications, although lacking the abundant crucifer feeders. This pit gave a single trichurid egg, not regarded as significant in view of the likely dispersal and redeposition of such remains. There was little in the fills of the recut of the first pit, or in the fills of the second one, to suggest dense occupation nearby (but see the consideration of dispersal of synanthropes to areas of deposition on p. 459).

These pits remain as the best evidence for conditions within the area of the Roman fortress during the Anglian period. There has been some suggestion that (*contra* the radiocarbon date) they are Anglo-Scandinavian; if so they remain extremely significant for different reasons, for this period is also poorly represented in the heart of York.

Deposits associated with Anglian occupation at **Fishergate** (Allison *et al.* EAU 1989/02; 1996b) gave disappointingly little evidence despite extensive sampling and the execution of a large-scale review of the samples for biological remains carried out on the grounds that any substantial evidence of this date would be of the greatest importance in understanding the use of the site and perhaps the wider nature of York at the period. Preservation by anoxic waterlogging was extraordinarily rare, and charred and mineralised material other than coprolites not much commoner. Objects identified as dog coprolites (or fragments of such) were quite numerous, particularly in the earlier Anglian phases. Some proved to contain eggs of *Trichuris* and (more rarely) *Ascaris*, perhaps present as a result of dogs eating human faeces, and one gave a single egg identified as *Capillaria ?aerophila* (a parasite of rodents). Only two insect assemblages of any useful size were detected. One was a ditch fill, with aquatics (insects and ephippia of *Daphnia*, *Ceriodaphnia*and at least one other water flea). There were no indications of more than a few herbaceous plants and thinly dispersed organic detritus in the surroundings. The second small group of insects was recovered from a pit fill; there were only traces of a weak synanthropic fauna.

A modest number of other deposits at Fishergate gave traces or small numbers of parasite eggs (*Trichuris*, *Ascaris*, or both), but only occasionally were the numbers sufficient to give clear evidence of the disposal of faeces. The only other invertebrates were odd records of beetles or fly puparia, and some *Heterodera* cysts in one pit. It is not clear why this site gave so little preservation, bearing in mind its low elevation and close proximity to the River Foss, but it is tempting to suggest that there was a very low rate of input of organic matter. Perhaps most waste disposal was into the river, or the site was close enough to farms for waste to be removed as manure. Alternatively, if (as discussed by Kemp 1996) this was a trading post, the nature, density, and perhaps timing, of occupation may have been such that little waste was produced, the numerous pits perhaps being short-lived cesspits (in which the organic component was slight and able to decay rapidly) or dug for some other purpose entirely. Subjectively, the invertebrate remains from Fishergate suggest a low density of occupation, or even intermittent use, but the evidence relies too heavily on the negative to be reliable.

The deposits associated with the Anglian helmet discovered at the **Coppergate Development** site, York (Tweddle 1992) present an interesting dating challenge, and the biological remains in the pit may have been of Anglian or Anglo-Scandinavian date, or both. Two large samples from this important but enigmatic feature were examined, one from the sediment within a lining of oak planks giving an Anglian date, and one from between the lining and the natural clays into which the pit was cut (Hall *et al.* 1992). The biota of these deposits were essentially similar, indicating an area of disturbed ground with annual and perennial weeds and an associated insect fauna. There was foul matter, perhaps dung (though there were no intestinal parasites, Jones AML 4599), and litter amongst the plants. There was nothing to suggest that the pit had been used systematically for waste disposal, although there were small quantities of plant and animal remains which must have originated in or around buildings, and quite a lot of oyster shells (O'Connor 1985d). Aquatic and aquatic marginal species seem likely to have arrived as 'background' or in flood water. It was suggested, particularly on the evidence of the insect remains, that the pit was open for a long time, with gradual accumulation of insects. It was perhaps a shallow well (it appeared to have been truncated during earlier building works), dug and lined in the Anglian period, in primary use for an unspecified period, then abandoned. During abandonment and perhaps as late as the Anglo-Scandinavian period, the helmet was dropped or placed in the pit, which was later backfilled with surface deposits from nearby. Although the development of this hypothesis concerning the history of the pit was very much the result of a full integration of all the evidence, stratigraphic, artefactual and biological, the insect remains were a particularly important component, providing the most reliable picture of the surroundings and evidence that the pit was open for a long period.

On SW side of the Ouse, assessment of some 8th century layers at North Street unfortunately revealed that there was virtually no preservation of invertebrate remains (Carrott *et al.* EAU 1993/14); similarly, deposits of 4th-9th century date nearby at Rougier Street gave no useful invertebrate remains (Allison *et al.* 1990c).

Sites other than in York in the 'Anglian' period

Few sites of Anglian date other than in York have been investigated for invertebrate remains. For **Carlisle, Cumbria**, Allison *et al.* (1991a) reported material from a well at **Castle Street**. There was house fauna, including a flea, and the deposit probably included material cleared from a building. Several *Pterostichus melanarius* (large ground beetles), and species feeding on cruciferous plants (notably the weevil *Ceutorhynchus contractus*), suggested open ground with some weeds. A few grain beetles (*Oryzaephilus surinamensis* and *Cryptolestes ferrugineus*) were recorded; if truly of Anglian date these would be of considerable significance, indicating continuity of bulk grain storage and thus a substantial degree of social organisation or perhaps trade to mainland

Europe (or alternatively an ability to survive for periods at isolated sites which ecological theory would predict to be improbably long). However, it seems quite possible that these remains were redeposited from Roman layers, in which grain pests were immensely abundant (see above).

Snails from Anglian graves at **Kirkburn, East Yorkshire**, were reported by Thew and Wagner (1991). The evidence suggested grazed grassland. Johnstone *et al.* (EAU 1998/42) reported assessment of a series of samples from fills of an ?early Saxon pit at **Easington, south-east of Withernsea, East Yorkshire**; no significant invertebrate remains (even molluscs) were recovered. The backfill of what may have been a boat at **Welham Bridge** gave numerous invertebrates, mainly aquatic and waterside or marshland species (Hall *et al.* PRS 2004/74).

Carrott *et al.* (EAU 1992/02) reported a series of analyses of deposits at the Anglian cemetery at **Castledyke, Barton-on-Humber, North Lincolnshire.** Deposits associated with skeletons gave some snails. There were two groups of sufficient size to indicate grassland, though of what type could not be determined. Samples from pots gave a few molluscs, again indicating grassland. Other than snails there were only small numbers of earthworm egg capsules and *Heterodera* type cysts; it is uncertain whether these were ancient or of more recent origin. The recently-introduced snail *Cecilioides acicula* (p. 482) was present in many of the samples, and a few slug 'granules' (p. 79) were observed.

The Anglian period is poorly known through bioarchaeology, although the remains of plants and animals should have particular potential to address problems in a period when structural and artefactual evidence tends to be thin. However, it appears that human lifestyles in the period did not generally favour preservation of the more delicate biological remains by anoxic waterlogging, greatly reducing what can be achieved routinely. Consequently we need to take new approaches in the future. Firstly, we must ensure that the rare instances of well-preserved Anglian waterlogged plant and animal assemblages are exceptionally well recorded in the field and that they are meticulously and extensively sampled. Secondly, we need to develop analytical techniques more appropriate to 'barren' deposits than those now in general use (Dobney *et al.* 2000b). Stable manure can be recognised with ease in waterlogged deposits (Kenward and Hall 1997), for example, but what traces will remain when humification has been complete? The use of sediment thin sections (Macphail 1994), of chemical techniques to identify dung derivates (e.g. Evershed *et al.* 1997), of phytolith analysis to recognise concentrations of grass remains, and the identification of sphaerulites derived from herbivore dung (Canti 1997; 1999), spring to mind, and perhaps if an array of methods is applied then the sum of the evidence will be convincing. Similar approaches may be possible for the identification of the trace evidence of other materials and activities. The current state of ignorance of the period under consideration would surely justify the expense incurred by such intensive study. A thoughtful exercise in predictive modelling may open up many possibilities: the question to be asked is 'what might remain if such-and-such was present or done in the past', rather than 'what do these few poor remains tell us'. Prediction and testing is as applicable to environmental archaeology as to other sciences. If we approach the Anglian period, or other intractable archaeological problems, with the traditional baggage of environmental archaeology, the results may inevitably be limited and disappointing; a fresh look at the possibilities, both practical and theoretical, may show that there is a way forward.

The Saxon/Anglo-Scandinavian period

This section deals with evidence from medieval deposits believed to have formed before the Norman conquest. It is difficult at any site considered here to draw a line even approximately at the year 1066. For York, for example, the formation of the King's Pool and other artificial bodies of water such as the Castle ditches provides an end point in some areas, but elsewhere (nearby at Coppergate, for example) there seems to have been little effect on daily life. The diversity of sites and of the way they were investigated makes it difficult to do more than discuss them individually in the present section, though information from them has contributed very substantially to the thematic parts of this review. While urban deposits of this period are (locally) rich, rural and natural ones have generally not been very productive of useful invertebrate remains.

East Yorkshire: Beverley

Central Beverly has yielded some deposits of this period. Hall and Kenward (1980) published an analysis of plant and invertebrate macrofossils from 11th century (radiocarbon dated) surface accumulation, probably formed over a fairly long period of time, at **Highgate**. They considered in detail how these deposits may have been accumulated, using the site as a model of the way interpretation of bioarchaeological data might be argued out objectively, including the use of the techniques proposed by Kenward (1978a; b). The conclusion that the insect assemblages included a component brought with dumped organic waste from in or around buildings (wetland plants having the same origin) stands the test of time, as does the suggestion that background fauna was important, the deposits having accumulated rather slowly on a damp surface. In retrospect, it is suspected that (contrary to the original interpretation) there was an autochthonous component, including *Platystethus* and *Anotylus* species, exploiting the damp, muddy conditions.

The earliest phases at the **Eastgate** site (McKenna 1992) were dated to the pre-Conquest period. No detailed analyses were made of the invertebrates, but rapid inspection of the insect assemblage from an extensive pre-occupation sandy silt indicated semi-natural conditions, wet and well-vegetated; there were no synanthropes. A later, extensive, organic layer included insects suggesting foul matter such as stable manure. Deposits of Saxon date at **Lurk Lane** were similarly only examined for invertebrates somewhat patchily (McKenna EAU 84/16; 1991). Primary fills of pre-Conquest ditches yielded some caddis larvae, traces of parasite eggs, and molluscs suggesting intermittent drying out, and well-vegetated areas in the surroundings. There were also species common around human settlement. Secondary fills gave some caddis and 'a statoblast ... of a freshwater ectoproct' (i.e. a bryozoon, p. 88), and a pit fill included rather abundant *Trichuris* eggs, and some *Ascaris*.

Anglo-Scandinavian York

The environmental archaeology of Anglo-Scandinavian York is generally considered to have been the subject of a great deal of investigation. In one sense this is so, but the large-scale the work carried out so far has concentrated on the Coppergate/Pavement area, and in truth only one site (16-22 Coppergate) has been usefully investigated. Although a substantial number of samples from 6-8 Pavement and 5-7 Coppergate have been studied, both sites were excavated in small trenches whose archaeology was not entirely clear, limiting their value and, in the case of 5-7 Coppergate, leaving dating rather uncertain. However, there are enough data for the period for a synthesis to have been attempted, and for some preliminary indications of zonation to have emerged (Hall and Kenward 2004). York at this period is considered under a series of geographical heads.

York NE of the Ouse

Many of the sites in this area can be considered together as a group associated more or less closely with the River Foss, which it is suspected was fringed with marsh at this period. Following the preliminary study of Buckland *et al.* (1974), the main programme of work on the **6-8 Pavement site** (variously known as 'York Coffee House' and 'Lloyds Bank') represented the first major study of the biota of deposits with anoxic waterlogging from an occupation site in the north of England, and of urban 'waterlogged' material from anywhere (Hall *et al.* 1983b; data archive for insects given by Kenward EAU 2000/39). The archaeological record was limited by the way the excavation was carried out, in four small trenches in confined conditions in cellars (Addyman and Hall 1991), and consequently it is difficult to relate the implications of the plant and invertebrate remains to identifiable features. However, much of the succession appears to have represented a series of floors in wattle buildings. The principal value of work on the invertebrates (effectively insects) from this site was in providing a baseline for subsequent work, and in stimulating the development of models (e.g. of deposition on floors, Hall *et al.* 1983b, 194-5, 204-5) and a set of techniques for further study. Kenward (1978a) presented a stage in the refinement of these methods, which had been taken further by the time the site report was finalised (see p. 57). The report was also the first to confront the problem of presenting very large and complex datasets; in retrospect, the method adopted, using multi-sample 'top ten' lists, can be seen as merely better than nothing, and the presentation of data on fiche as highly unsatisfactory (p. 454). For this review, the raw data, now stored electronically (see Kenward EAU 2000/39), have been briefly re-examined; they would repay closer study.

The insect assemblages from 6-8 Pavement were regarded as superficially rather uniform at the time, varying mainly in the abundances of a rather small number of species. With hindsight they can be seen as rather more varied, but still mostly of uniform implications and with a strong resemblance to the house floors at 16-22 Coppergate (Kenward and Hall 1995). A few deposits were probably of different origin, and in particular the thick featureless layers in the lowest part of the sequence, examined by auger, gave aquatic snails and *Daphnia* ephippia suggesting a marshland environment onto which occupation had encroached. The original report gave an impression of abundant waterside insects in the floors (e.g. fig. 41), but re-examination of the data using current criteria shows that the main series of deposits at 6-8 Pavement contained very few aquatic and marshland insects - using the ecological coding now adopted, about 1% individuals of aquatic species and less than 2% damp ground/marshland forms (much as at Coppergate). There was no evidence of flooding at the site from the main sequence of identifiable floor layers. The influence of the nearby Foss, as measured by the insect remains, was thus weak. The abundance of seeds of *Ranunculus sceleratus* still requires explanation, however, and it seems likely that these and some of the insects were introduced in trample or water.

The assemblages from the 'floors' were mostly dominated by what is now described as 'house fauna' (p. 372), and there were some groups which stand as excellent representatives of this kind. Species associated with foul matter were surprisingly rare, with only eleven cases where a foul-matter taxon was represented by more than two individuals in a sample (*Platystethus arenarius* four times, *Aphodius granarius* three, *Aphodius* sp. twice, and *Cercyon haemorrhoidalis* and *Cryptopleurum minutum* once each). There were sporadic records of fly puparia suggesting foul conditions, but these may only have reflected small short-lived habitats. A few samples include a fauna reminiscent of the characteristic decomposer group now regarded as typical of stable manure (p. 397), but it is entirely possible that some other kind of rather damp, mouldering, organic material was being exploited by these insects. Two main types of assemblages were identified among those from the site (p. 196-203), broadly those with fairly high diversity, rather larger outdoor components and more foul decomposers ('intermediate' group in the report), and those with substantially lower values for these parameters. The significance of these differences was discussed, starting from the obvious conclusion that the first group formed in the open and the second indoors, but it was concluded that most of the assemblages developed indoors, with variable amounts of background fauna being incorporated, perhaps reflecting changes in the structure or use of the buildings. Only a few layers ('high' group in the report) were suspected to have formed out of doors. Although it provided an important stimulus to development of archaeo-entomology, the 6-8 Pavement site represents a point on the map of Anglo-Scandinavian York rather than a major source of information.

Jones (1983b) reported and illustrated what was interpreted as a discrete mineralised human stool from this site; it contained abundant parasite eggs (*Trichuris trichiura* and *Ascaris*).

The second site considered by Hall *et al.* (1983a) was that at 5-7 Coppergate (alias 'Hardings', 'Habitat'). Here the archaeology was even less well understood, and it is possible that some or all of the layers examined were of immediately post-Conquest date. The insect assemblages were notable in that some included large numbers of oxyteline staphylinids. The conclusion that these were probably damp deposits in the open seems correct, but the most abundant species, *Anotylus nitidulus*, is now believed to have exploited artificial terrestrial habitats as well as waterside ones (p. 281).

The nearby site of **16-22 Coppergate** was the object of what remains the largest integrated investigation of waterlogged archaeological deposits (although for the insects the number of contexts analysed is roughly matched by the total for Roman deposits in Carlisle). This massive study was carried out over some 15 years, which had the advantage of allowing appropriate practical and interpretative methodology to be developed, but led to what was sometimes an inefficient and disjointed project. It is clearly not practicable or appropriate to attempt more than the briefest summary of highlights of the results here, and the closely integrated nature of the report makes it difficult to extract those results which were particularly generated by studies of the invertebrate remains. As for other extensively studied sites (e.g. Tanner Row, York), many of the notable results are discussed under thematic or other headings rather than in the present section. Insects and other 'waterlogged' macro-invertebrates, landsnails, marine molluscs and shellfish were studied, together with plant macrofossils and nematode eggs; it was, unfortunately, not possible to present the results of studies of vertebrate remains under the same cover (they were reported by O'Connor 1989b). A very detailed picture of conditions and events on the site throughout the Anglo-Scandinavian period (mid 9th to mid 11th centuries) was obtained (Hall and Kenward 2004; Kenward and Hall 1995).

Six chronological subdivisions were recognised in the Anglo-Scandinavian levels at Coppergate. The broad picture of the development of the site as indicated by the invertebrate remains is as follows. In the first phase of Anglo-Scandinavian occupation (Phase 3), dated to the mid 9th to late 9th/early 10th centuries, there was no clear excavation evidence of structures on the site. There were numerous pits, a substantial proportion of whose fills were shown to contain human faeces, although various other kinds of waste were also dumped. Remains of decomposer insects, including flies, were very abundant in some of these pits, indicating that foul matter had been left exposed for a long period, and were thus a potential source of disease transmission. Other pit fills had been quickly covered over. Surfaces seem to have been greatly disturbed, limiting the vegetation which could develop to scattered weeds supporting a very restricted insect fauna. While there was no clear evidence of buildings on the site, it appeared that some of the pit fills included floor sweepings, for house fauna was sometimes abundant.

The next period, 4A, represented the late 9th to early 10th centuries, during which the site was re-arranged prior to the construction of the Period 4B buildings in AD 930-35. Surfaces had received organic waste, some at least probably household, in which modest communities of insects were able to develop here and there, but nematode eggs were not common. In contrast, some of the pit fills were clearly faecal, with numerous *Trichuris* and *Ascaris* eggs, but beetles had not produced large populations (there was one case where huge numbers of housefly puparia were present, however). It appeared that foul waste, disposed of in pits, was being covered quite quickly, but that less objectionable matter on the ground surface was allowed to linger rather longer, although probably not for very long periods.

In Period 4B, dated from about 930-5 to about AD 974, wattle buildings were erected on the tenements. Sufficient material accumulated on their floors to allow preservation of insects in excellent condition (that the deposits were use-phase and did not date to abandonment or low grade use is argued by Kenward and Hall 1995, 725-726; see also p. 372, below). The existence of very high concentrations of insects in some of the floor layers indicated that they accumulated quite slowly. In general, the fauna indicated fairly dry conditions and, although there was a covering of filth in a 20th century sense, the floors would mostly not have been objectionable for human occupation. Fleas were regularly present, however, and sometimes enormously abundant, and occasionally fouler patches developed, indicated by the beetles and also by fly puparia (particularly *Musca domestica* and *Stomoxys calcitrans*: house- and stable flies). In once case the beetles indicated a deposit resembling stable manure, with a 'foul mouldering' fauna typical of deposits thus interpreted, one of few at the site. This deposit could not be confirmed as anything more than a patch of unusually mucky floor, however. None of the floor deposits gave evidence of animal dung, although there were rare hints of a fauna perhaps introduced in cut vegetation resembling hay. Although traces of nematode eggs were recorded in some floor contexts, only in one case were they abundant. Their means of entry was not clear, though many possible routes may be imagined. Parasites of sheep (keds, *Melophagus ovinus*, and lice, *Damalinia ovis*) were rather frequent and sheep lice were present in large numbers in one case; these remains are interpreted as indicating wool cleaning rather than the presence of their host (p. 363). Scale insects (*Chionaspis salicis* and *Lepidosaphes ulmi*) were abundant in some layers, doubtless originating from wattle in walls and perhaps in furniture and roofs including brushwood. Some of the floor deposits included large numbers of very fragmentary remains of 'outdoor' insects whose origin is uncertain (see p. 378 for further discussion of these fossils). There were some enigmatic cuts inside the building on Tenement C, apparently contemporary with its occupation, and fills of two of these contained honey bees (*Apis mellifera*), in one case in very large numbers (p. 358).

Although there was evidence from the plant remains that dyebath waste had been dumped on the external surfaces in Period 4B, few insects had colonised this presumably rich habitat, because it was either quickly buried or chemically inhospitable since ash was often present, perhaps dumped from house floors as house fauna was consistently present in modest amounts and food plants were recorded in the absence of parasite eggs. Here and there large colonies of fly larvae established and pupated, the abundant species being *Muscina stabulans*, *Stomoxys calcitrans* and *Musca domestica*, together indicating very foul conditions. Honey bees were recorded here and there, perhaps of the same origin as to those in the internal pits on Tenement C. Conditions in the rear of the site were not conducive to insect preservation, perhaps because the rate of accumulation was slow.

Pit fills towards the front of the tenements, close to the houses, often contained large numbers of eggs of parasitic worms and other evidence for faeces, but the parasites were rarer towards the rear of the site. Despite this, food plants suggested the presence of faeces in certain of the pits at the rear, and some large populations of beetles associated with foul, dung-like, organic waste developed. As in a few of the surface layers there were some huge concentrations of fly puparia, mostly *Musca domestica*, and of beetles, indicating exposure of foul matter for a considerable period. One pit at the rear whose fauna included abundant 'outdoor' forms including water beetles appeared to have remained open for a long period, and to have contained open water; it also seems to have functioned as a 'pitfall trap' for the larger ground beetles, which were unusually numerous. A gully at the rear also gave some hints of open water, at least temporary, although one of several sub-samples from its fills was clearly faecal on the basis of the large numbers of parasite eggs recorded.

Period 5A at 16-22 Coppergate seems to represent a short-lived phase of reorganisation in about 975, and left a limited record. In the surface deposits, parasite eggs were generally rare, although food- and other waste was deposited on the evidence of the plant remains (there were also some bean weevils, *Bruchus ?rufimanus*, probably from food debris or faeces, see also p. 353). Sheep keds, *Blaps* (churchyard beetle) larvae and adults, human fleas, and in one case a strong house fauna, were observed, and the presence of foul matter here and there was indicated by local concentrations of housefly (*Musca domestica*) puparia. These surface layers seem to have been accumulations of miscellaneous debris, although there may also have been redeposition of earlier deposits. Two were distinguished by the presence of numerous resting eggs (ephippia) of water fleas (Cladocera: *Daphnia* sp. and at least two other types), suggesting that there may have been pools of water at the surface for some time. Alternatively, waste water may have been poured onto the ground in large quantities.

Pits of Period 5A mostly gave rather limited groups of insects, and some at least may have been backfill scraped from nearby surfaces; the same was thought to be the case for the fill of a barrel-lined well. Some of these pits may have been abandoned before use, or have been dug as sumps for urine or liquid waste such as that from dye-baths. One large pit was the subject of a detailed study of intra- and inter-context variation of insect remains in its fills. It gave rich insect assemblages including house fauna, beetles and fly puparia indicating foul conditions, and a distinctive component of woodland insects, deduced to have been imported in moss (p. 315).

In Period 5B (c. 975-early/mid 11th century) a series of 'plank-built' structures were present, partly sunken so that the excavated floors were a metre or more below the supposed contemporaneous ground surface. Most of the floor layers contained moderate to very large numbers of 'house fauna' insects, sometimes including large numbers of human fleas; human lice were far less numerous than in the floors of Period 4B, however (the interpretative significance of this is discussed on p. 68). In addition to the 'house fauna', there were often abundant oxytelines, perhaps indicating moister conditions (p. 389). A gully within one building appeared on the evidence of numerous water fleas to have received imported water. One fill included a range of lice: *Damalinia ovis* from sheep, *Haematopinus* apri from pig, and *Felicola subrostratus* from cat, perhaps indicating wool and skin-processing, as well as *Pediculus humanus* from the occupants of the building. Another internal gully was notable for the presence of members of the supposed 'post-depositional invader' group (p. 482), although in this case they may have been living a cavernicolous life in a covered drain. Over the thin floor layers (and some remarkable gullies associated with them) there were extensive dumps, presumably used to infill the cellar-like buildings before the next phase of use of the site. These backfills generally gave fairly restricted insect faunas, but in some cases included house fauna (perhaps indicating misidentification of a floor layer in one case) and water fleas. From the entomological point of view, the most notable of these backfills were some consisting of willow (*Salix*) brushwood, and containing vary large numbers of scale insects (*Chionaspis salicis* and *Lepidosaphes ulmi*, p. 53) and post-depositional invaders, the latter presumably favoured by the open texture of the layers.

Analysis of deposits identified as representing external layers of Period 5B showed that there were local patches of foul matter, in which flies (especially the housefly *Musca domestica*, and stable fly, *Muscina stabulans*), and sometimes communities of beetles, developed. Here and there were dumps of material from house floors. In one place a deposit included remains of heather (*Calluna vulgaris*) and associated heathland insects. Two layers in the strip between the structures on two of the tenements yielded large to very large numbers of honey bees.

The fills of the pits of Period 5B were varied. Some were clearly very foul and contained faeces, on the basis of food remains, parasite eggs and the insect fauna. Some seem to have been too foul for beetles to invade, but flies, including *Thoracochaeta zosterae* (p. 71) and *Leptocera* spp., were able to survive. Rarely, the pit fills included 'foul mouldering' beetle communities, and it is just possible (but by no means certain) that stable manure was present. Another pit included a deposit with a heathland biota, including a particularly large and characteristic group of insects; such assemblages are discussed on p. 316. Some of the pits at the rear of the site seem not to have been used for waste disposal, but had remained open for a long time, containing aquatic insects which probably lived in open water in the pits and ground beetles which may have fallen in and drowned. Gullies at the rear of the site were apparently backfilled with waste or scraped-up surface deposits, and the sampled material gave no clue as to their primary function.

Structures of period 5C (mid-later 11th century) were barely investigated bioarchaeologically. Pits of this period ranged from some with very foul contents, indicated by plants remains and parasite eggs, but which were apparently sealed too quickly for insects to establish, to some at the rear of the site which seemed to have been left open for a long period, and which water beetles had colonised and into which ground beetles had tumbled. Outdoor insects were predominant in some of these, and there were hints from both plants and insects that the rear of the site had developed a vegetation cover, perhaps even being grazed in view of the numbers of dung beetles in one layer.

In addition to providing a wealth of information about many aspects of life in one part of Anglo-Scandinavian York, work at Coppergate was important in learning, unfortunately often from our mistakes, about sampling strategies. Certain types of contexts should have been sampled in far more detail and with more thoughtful respect to the stratigraphy: context boundaries should have been examined because they represented hiatuses at which insect populations might have developed, and floor surfaces should have been studied in detail across their full extent, for example. A rather large proportion of contexts which were suitable for extraction of at least a General Biological Analysis were not sampled (see, for example, the floors and associated deposits shown in matrix form in the report). At a very rough estimate, 3-5 times as many samples should have been collected and more should have been processed. (These comments should not be seen as critical of the excavators, but reflect improved understanding over the past decades, much of it the result of work at Coppergate.) These matters are discussed in some detail on p. 439.

The investigations at this site also generated, or contributed significantly to, a long series of 'spinoff' research papers concerning insect and nematode parasite remains, notably Carrott and Kenward (2001), Hall and Kenward (1998), Hall *et al.* (1983a), Jones (1984b; 1987b), Kenward (1997a; 2004; 2005), Kenward and Allison (1994c), Kenward and Carrott (2006), Kenward and Hall (1997) Kenward and Large (1998a; b). Numerous more popular articles were also generated by work on the site. The project represented a baseline study for the future, and gave pointers to what can be achieved, as well as to what should be done, but of course it only produced a description of one small area, which may or may not be typical of Anglo-Scandinavian York or other contemporaneous settlements.

Four samples collected from the basement of Littlewoods Store, **4-7 Parliament Street** (Hall and Kenward EAU 2000/22) exhibited some of the best preserved plant and invertebrate remains recorded from archaeological deposits in York, though it must be remembered that they were processed within three weeks of excavation when little change had occurred (other than a general darkening of the sediments through oxidation). It may be noted, however, that those samples from 16-22 Coppergate which were processed within a few days of collection did not in general show such superb preservation. While none came from a deposit clearly identified as a pit fill, all the samples gave assemblages of plant and invertebrate remains reminiscent of those from some of the cesspits at 16-22 Coppergate. However, uncharred cereal chaff and the ratio of *Trichuris* to *Ascaris* (as low as 1:1 in one case; see p. 27 for discussion) gave hints that the faecal material might partly or entirely have been that of pigs. These deposits appear to have formed well away from the street frontage, considerably behind the likely position of houses, and so may represent an area where the foul conditions generated by livestock would be tolerated. Insects included significant proportions of species indicating foul matter, compatible with interpretation as faeces of humans or livestock. Water fleas were abundant in some deposits, quite possibly having passed through the guts of animals (they would perhaps have been noticeable in drinking water for humans, and would have sedimented out in brewing), unless the water was waste from a process such as dyeing or skin cleaning. Honeybees were present in all the samples, and in one seemed too abundant to be present by chance as 'background'. The possibility that bees were kept in Anglo-Scandinavian York, and other routes by which bees may have arrived in deposits, are discussed on p. 361. A range of notable observations was made at this site: there were sheep ked (*Melophagus ovinus*) and lice (*Damalinia* ovis), adding to the evidence that wool-cleaning was a widespread activity (p. 363); perhaps they arrived in floor litter together with the adult and nymph of the human louse *Pediculus humanus* recorded from one sample.

The biota of this site appeared to be unlike anything studied at 16-22 Coppergate, especially if the three 'dumps' were really formed on surfaces and not large pits which were not recognised in section. (Cuts as large as those in what may well be equivalent tenements fronting the Ousegate-Pavement line at 44-5 Parliament Street would not necessarily be recognizable in section in small excavations like that at 4-7 Parliament Street.) It appears probably, however, that deposits at the present site formed in an area with much poorer drainage, or were inherently more water-retentive, than in nearby areas so far studied, and had subsequently remained fully anoxic.

Towards the River Ouse from the Coppergate site, samples of late 9th to mid 10th century date from a small-scale excavation at **2 Clifford Street** were analysed by Hall and Kenward (EAU 2000/17). All of the deposits investigated appeared to have been laid on surfaces, probably as dumps. The insect remains gave very limited evidence, and preservation was generally poor. To the extent that the small numbers of assemblages and remains permit realistic comparison, the insect assemblages were mixed, probably including redeposited and background elements, though in character like those from other Anglo-Scandinavian sites, and particularly from 16-22 Coppergate. There was evidence of foul matter, perhaps faecal, from beetles and fly puparia. Some components were almost certainly re-excavated from earlier (Anglo-Scandinavian) pits, for one sample included hoverfly larvae, probably the rat-tailed maggot *Eristalis tenax*, and another included concretions in which there were parasites eggs (both *Ascaris* and *Trichuris*) together with *Bruchus ?rufimanus*, probably introduced via faeces, having been eaten in pulses (p. 353). There were some other useful observations: in addition to the *Bruchus*, one sample produced several honey bees; while a sheep ked puparium and a charred beetle larva were noted.

To the rear of the main Coppergate site was the **Coppergate Development** watching brief. The pit from which the Anglian helmet was recovered has been considered above; it is uncertain whether the insect remains represent the later Anglian or early Anglo-Scandinavian period, or both. Although samples were collected from various other features during the Coppergate Development watching brief, the material has not been examined further. Assessment and some detailed investigation of borehole samples of deposits of probable Anglo-Scandinavian date pre-dating **All Saints Church, Pavement**, just across the street from 16-22 Coppergate, produced assemblages with the same general character as many from contemporaneous deposits at the latter site; they were probably external accumulations (Carrott *et al.* EAU 1996/47; Hall *et al.* EAU 1998/30). Not far from this site, assessment of material from **28-29 High Ousegate** (Waterstones Bookshop) by Kenward *et al.* (PRS 2003/50) produced further assemblages of insects which would not have been out of place at 16-22 Coppergate. Pit fills yielded at least some, and often many, insects, including one group indicating extremely foul conditions. Surface lain deposits also contained insects, though ranging from well to poorly preserved. Most of the samples contained parasite eggs (*Trichuris* and *Ascaris*), and there were records of sheep keds (*Melophagus ovinus*), honey bees (*Apis mellifera*), a probably human louse, and a mummified aphid, conceivably from food. There were remains of the bark beetle *Scolytus ?rugulosus*, perhaps from fruit trees (see discussion by Hall and Kenward 2004). There was some marine shell, all oysters and mostly poorly-preserved, though notches caused by opening could be seen on some.

To the east of the Pavement site discussed above, in **St Saviourgate**, a series of Anglo-Scandinavian pit fills (including some associated with a 'cauldron' containing tools) and a dump were sampled (Carrott *et al.* EAU 1998/14). The dump gave a mixed insect assemblage, while some of the pit fills gave only traces of invertebrates. In contrast, some others were very rich in superbly preserved insect remains. Four were unusual in containing large numbers of *Aphodius* dung beetles (and a single *Onthophagus*), the reason for whose presence is far from clear although a possible indication is given by a tentatively named louse (?*Haematopinus* sp.), probably a pig parasite. Further work on these samples from St Saviourgate is among the highest priorities in the backlog of material from York.

Close to the Coppergate sites was the ABC Cinema excavation at **22 Piccadilly**, material from which was assessed by Carrott *et al.* (EAU 1995/53). The site was located on the Foss waterfront, and there were probable river revetments. Periods 2-4.1 were probably of Anglo-Scandinavian date and included dumps and some cuts. There was evidence of a wide range of materials, and traces of parasite eggs were present as well as aquatics. These were probably dumps of various origins and flood deposits. It is to be hoped that further work will be carried out on the samples from this site, as it is effectively contiguous with the 16-22 Coppergate excavation area and may have been functionally complementary to it, receiving waste not represented at that site, for example.

Some other pre-Conquest sites in Piccadilly have been the subject of assessment or evaluation. Very close to 22 Piccadilly was the excavation at 38 Piccadilly, where Carrott *et al.* (EAU 1992/09), in an evaluation of 10th/11th century build-up over a cobbled surface, noted aquatic and terrestrial insects, and numerous freshwater molluscs. There was no evidence for dumping from the insects, which were perhaps background fauna, although there were traces of 'useful' plants. Rather further south-east was 84 Piccadilly, subjected to evaluation by Carrott *et al.* (EAU 1991/16). The lowest sampled deposits were believed to be pre-Conquest, and perhaps formed in the Foss or on marshy ground along its margins. Plants from one sample suggested an occupation surface with some seasonal waterlogging, but the rather small group of insects included typical urban forms (perhaps background fauna rather than dumping) as well as a few aquatics.

Some Anglo-Scandinavian deposits were recognised during excavations at the Adams Hydraulics I site, between the Foss/King's Pond and Peasholme Green, the subject of an early evaluation exercise (Alldritt *et al.* EAU 1990/01). A thick 10th century levelling or agricultural deposit produced no invertebrate remains. Some 10th to 11th century pits were effectively barren. Also presumed pre-Conquest, but undated, were natural river silts with aquatic snails, abundant ostracods and *Daphnia* ephippia, some remains noted as 'Foraminifera' (requiring re-examination in view of their possible significance!), and aquatic and terrestrial insects recorded as lacking an urban component.

Excavations further upstream on the banks of the Foss, associated with the improvement of Layerthorpe Bridge, produced a range of evidence (Hall *et al.* EAU 2000/64). Some of the material ascribed to the Roman and post-Conquest periods at this site appeared on biological evidence to be of Anglo-Scandinavian date. Most contexts appeared to represent dumping of some kind, although the fill of a timber-lined sluice may possibly have been outwash from a tanning process. Some of the deposits were notable for containing numerous *Trox scaber*, often abundant tree bark fragments, together interpreted as evidence for tanning (see p. 365). Aquatics were present in variable numbers, and some layers clearly consisted of waste which was rapidly deposited in bulk, unless deposited on the river bank. In some cases there was a component of insects which seemed likely to have come from in or around occupied structures, with house fauna (including human fleas, *Pulex irritans*) and sheep keds (*Melophagus ovinus*, presumably from wool cleaning, see p. 363). There were communities of insects likely to have lived in moist, rather foul, waste; in one case there was a 'foul mouldering' community reminiscent of those found in stable manure (p. 397), although this may have been some other kind of foul waste. Freshwater molluscs were present in several layers, but did not give a clear view of water quality.

Across the Rover Foss from the Pavement-St Saviourgate area, a site at 41-49 Walmgate was initially investigated during a 'Time Team' extravaganza; a rather detailed assessment was carried out by Johnstone *et al.* EAU 2000/04) in association with the synthesis of data from macrofossils for Anglo-Scandinavian York (Hall and Kenward 2004), and material from further excavation assessed by Jaques *et al.* (EAU 2001/26). All of the Anglo-Scandinavian samples examined for insect remains contained appreciable numbers. There was a strong resemblance to material from Coppergate and other contemporaneous sites in the town. Three deposits thought in the field perhaps to be floors were rich in house fauna, including human fleas (abundant in one case), and seem undoubtedly to have formed indoors under well-closed conditions. One was clean by the standards of the day (i.e. covered in fairly dry litter). The second contained beetles suggesting rather fouler matter, which, since there were some sheep keds, *Melophagus ovinus*, may have been attracted to 'dags' in wool-cleaning waste. A floor deposit examined in the second assessment phase gave a rather mixed fauna, with human fleas and a ?human louse, and several ?*Damalinia ovis* (sheep lice) as well as keds. Of the other Anglo-Scandinavian deposits, some seemed to contain floor litter (again with house fauna and fleas) and others appeared to have formed in the open, sometimes under fairly foul conditions. One of the floors gave the rare cryptic synanthropic ground beetle *Sphodrus leucophthalmus*, the only record of this large, striking species encountered during preparation of this review, and a second was noted to contain appreciable numbers of large beetles which may have strayed in from outdoors. A small component of invertebrates may have been imported to the site in water or with marsh or waterside plants: the ground beetle *Odacantha melanura* and a statoblast of the bryozoan *Lophopus crystallinus* (discussed on p. 88). There was a little hand-collected shell, mostly oysters, some with opening marks.

Evaluation of pit fills at St George's School, Margaret Street, further East along Walmgate, by Philip Buckland (ARCUS 208) showed that preservation was generally poor, but one large assemblage was listed. Damp, but not foul, plant litter seems to be the most likely habitat for much of the assemblage. A single *Oryzaephilus surinamensis* was noted, on the basis of which it was suggested that this grain pest at least was present in Anglo-Scandinavian York. However, dating of the pit fills was uncertain; artefacts were rare, and although Anglo-Scandinavian material was present it may have been residual, something which was suggested by the poor condition of the bone. (Temporal variation in the abundance of grain pests is discussed on p. 342). This feature seems to have been clay lined and may have been a pit like those of a later date seen nearby in Walmgate and described by O'Connor (1984b), who interpreted them as most probably related to the processing of skins.

Closer to Walmgate Bar, analyses of samples collected during excavations at 118-126 Walmgate in 1978-9 were reported by Kenward and Hall (EAU 2000/20) as a component of the synthesis of Anglo-Scandinavian data (Hall and Kenward 2004). Most of the insect assemblages were rather small, partly a function of the predominant use of 1 kg 'test' samples, but probably also reflecting the nature of the deposits, many of which may have formed on surfaces even if they were subsequently disposed of into cuts. The floors did not yield seething assemblages of house fauna like those seen at other sites, suggesting that they had a different function, and there was a great deal of evidence for foul matter from the insects (*Platysethus arenarius* was often abundant, as were *Anotylus*, *Carpelimus* and other *Platystethus* species). Where house fauna was at all common it was accompanied by species regarded as typical of material resembling stable manure. Evidence from plant remains, too, suggested a different kind of environment. Parasite eggs were rather common in a range of deposits, those *Trichuris* which were measurable falling roughly in the range for *T. trichiura* (of humans, although perhaps able to infect pigs too, see p. 29). It was considered possible is that conditions not unlike those in an old-fashioned farmyard existed at the site, the buildings being byres or stables, the food remains representing either domestic occupation or the feeding of livestock with scraps (or, if humans and livestock cohabited, both); pigs do seem the most likely animals to be kept at a site such as this. They might well have been fed cereal cleaning waste, accounting for records of cereal chaff, and might produce ambiguous evidence in the worm egg record (either through their own infections or by recycling human faeces). The Walmgate area of York may thus represent an early, diffuse, stage of urban settlement, with small-holdings which would later be subdivided into tenements. This is clearly a topic for further research using structural and bioarchaeological evidence. The 118-126 Walmgate site also produced remains of some bugs suggesting temperatures above those of the middle of the 20th century (p. 289).

Central York

The central area of York, approximately that formerly occupied by the Roman fortress, has provided rather limited amounts of 'waterlogged' Anglo-Scandinavian material despite a considerable number of excavations having taken place. It appears that accumulation in this area was far less rapid than along the fringes of the River Foss. Two samples from pit fills revealed at York Minster gave small assemblages of beetles dominated by decomposers and much like many of those from contemporaneous deposits at, for example, 16-22 Coppergate (Kenward nd.). Anglo-Scandinavian pit fills at 7-9 Aldwark in many cases contained parasite eggs, typically *Trichuris*, with rather fewer records of *Ascaris* (McKenna *et al.* AML 37/88). In some cases the numbers were so large that there was no doubt that the deposits were faecal, and measurements showed the eggs to be compatible with *T. trichiura*. There was no funding for work on insect remains from these deposits. Organic deposits dated to the 10-12th centuries at **3 Little Stonegate** gave small groups of very poorly preserved synanthropic insects, in one case notable for the presence mainly of the larger more robust forms (Large *et al.* EAU 1999/46).

The extent to which the rarity of waterlogged material of this period in central York reflects lack of occupation (or even use for horticulture) rather than 'higher status' occupation requires investigation.

York SW of the Ouse

The southern bank of the Ouse appears to have been extensively settled in the Anglo-Scandinavian period. An evaluation by Jaques *et al.* (EAU 2000/53) of samples from the NCP Car Park, Skeldergate, showed variable preservation of insects and parasite eggs (*Trichuris* and ?*Ascaris*) in deposits dated 11th-12th century. These deposits possibly also contained Anglo-Scandinavian material in view of the presence of characteristic dye plants and the lack of grain pests, though there were some assemblages of insects (and plants) from pits which suggested material like stable manure, more characteristic of the post-Conquest period. A build-up over a floor layer proved not to contain a 'house' assemblage, suggesting that it did not accumulate during occupation. Sheep keds (*Melophagus ovinus*) were recorded from one of the pit fills. Shellfish were present in modest numbers, mostly oyster (some with the marks left by opening with knives), with traces of cockle and mussel. Their preservation was variable, and some were charred. There were also fragments of shell of freshwater mussels from some layers. The insects and plant remains from this site were considered to deserve further investigation, but no funding was forthcoming.

Across the road, assessment (Dobney *et al.* EAU 1993/22), followed by analysis (Kenward and Hall EAU 2000/14), of Anglo-Scandinavian material from the Queen's Hotel site, 1-9 Micklegate, revealed abundant insect remains, with a variety of assemblage types which were broadly similar to those from other Anglo-Scandinavian deposits in York, but they could not be regarded as simply a repetition of the material observed at, for example, 16-22 Coppergate and 6-8 Pavement (Hall and Kenward 2002 ; Kenward and Hall 1995; Hall *et al.* 1993b). A series of 9th-10th century floors (some only identified biologically) yielded house fauna, including human fleas and lice, with moderate numbers of sheep keds and *Damalinia* lice, presumably from wool cleaning (see p. 363; dyeplants were abundant, suggesting that textile production was as important here as at Coppergate). In some cases floors had become rather moist. One pit fill appeared to incorporate floor litter; although outdoor fauna had accumulated, there was little evidence of long exposure of foul matter. Insects in a second pit fill seemed to indicate an early stage of colonisation by foul decomposers, while a 'layer', also rich in 'outdoor' fauna, probably accumulated in the open, with some deposition of organic waste.

The deposits of 10th-11th century date analysed were all pit fills. House litter appeared to have been dumped into the pits in most cases, for there was abundant house fauna, including human fleas and lice, keds and *Damalinia* lice. There was evidence of faeces, presumably human, from *Ascaris* and *Trichuris*, and from bean weevils (*Bruchus ?rufimanus*) (and also from plant foods likely to have been passed with stools along with these). Rat-tailed maggots (*Eristalis tenax*) may have colonised foul water in the pits or have arrived in waste water. Some other aquatics, including Cladocera, may have come by the same route: one possibility is that the water was dye bath waste, in view of the large volume of dyeplants. Two of the fills were rich in woodworm beetles (*Anobium punctatum*), which may have come from a surrounding structure rather than having been introduced with the house fauna component; this would presumably indicate a primary function as a latrine.

Honeybees (*Apis mellifera*) were repeatedly recorded from 1-9 Micklegate, and there were also several records of 'Apoidea', probably this species. There seemed to be too many records to be accounted for by accidental deaths unless there was a hive nearby, though the possibility that bees entered sites in honeycomb must be entertained (p. 358).

This site provided rather more 'unusual' insect remains *pro rata* than samples from other sites of the same period analysed in detail. This may be a real phenomenon, but it is just conceivably an artefact of a further ten years of experience. However, the position of the site close to the main Ouse waterfront, where there may have been large quantities of imported materials, may have led to the importation of insects. Likely candidates to have been brought with raw materials from southern England or the continental mainland (including the southern fringes of the Baltic) are the longhorn beetle *Phymatodes testaceus*, the shieldbug *Eurydema oleracea*, the sub-cortical *Cryptolestes duplicatus*, and *Anthicus antherinus* (all discussed on p. 289); if not imported, these insects are useful climatic indicators (Kenward 2004). Other notable records were of the 'riffle beetle' *Macronychus quadrituberculatus* (p. 407), and the small bark beetle *Scolytus rugulosus* (p. 386).

Samples from boreholes at the former Victoria House site, Micklegate gave well-preserved remains, including what is apparently the only British archaeological record of the deer fly *Lipoptena cervi* (p. 429). Lack of clear dating greatly reduced the value of these remains, although the fauna and flora hinted at an Anglo-Scandinavian date (Hall *et al.* EAU 2001/51).

Nearby at North Street a series of deposits dated to 10th-11th centuries was assessed by Carrott *et al.* (EAU 1993/14). There was variable preservation and concentration of insects. There were some very well preserved groups of interpretative value, appearing to indicate dumping of occupation debris which would be useful in reconstructing living conditions and activity in local buildings. In one case the dumps appeared to have originated in a structure in which wool was cleaned and dyeing was carried out (there were tentatively identified dyeplant remains). There was also a natural component - of both aquatic and terrestrial species - in some layers. Deposits of Anglo-Scandinavian date at the Rougier Street site, close by, were effectively barren of invertebrate remains (Allison *et al.* 1990c, 385). A little material of 11th-12th century date at Tanner Row may have included Anglo-Scandinavian deposits; there were parasite eggs in surface deposits and pit fills, and some rather nondescript groups of insects (Hall and Kenward 1990, 368-70).

Some assemblages of insects which were most unusual both in origin and nature were described by Kenward (1987) from putlog holes in the walls of tower of the church of St Mary Bishophill Junior. The construction was dated to the 11th century and it was suggested that the holes may have remained sealed since that time. Two of the holes gave sufficient insect remains for useful analysis; they were predominantly domestic or stored products species, with a smattering of others which may have entered a structure accidentally. The overall impression is of the kind of insects which might be trapped in spider webs in crevices in a reasonably clean building with human occupation. If these were Anglo-Scandinavian (or immediately post-Conquest) insects, they have considerable historical importance in showing the great difference which existed in the quality of buildings in different parts of York: the abundance of *Tipnus unicolor* (p. 378) and presence of *Pterostichus madidus*, *Tenebrio molitor* and *Sitophilus granarius* being particularly significant when the lists are compared with those from contemporaneous sites in York. The possibility of continuity of occupation from the Roman period was speculatively entertained. Alternatively the holes may have been open at a much later date, in the last few hundred years perhaps, since both *P. madidus* (p. 283) and *T. molitor* (p. 285) seem only to have become abundant in Britain quite recently. The remains could now be AMS dated to resolve this question, but the technique was not available when the original study was made. Clearly this part of York deserves closer examination through more securely dated material.

How much do we really know about the bioarchaeology of Anglo-Scandinavian York? Hall and Kenward (2004) have attempted a synthesis of the available information. It may appear that the period has been 'done', but what we really have is a few snapshots of a few areas. We need to establish how representative a site such as that at

16-22 Coppergate is of the town as a whole. Was there functional zonation? Were some areas of 'high status' and consequently poorly represented in the record? Using the results from work on plant and animal remains from 16-22 Coppergate, 2 Clifford Street, 41-9 Walmgate, 6-8 Pavement, 4-7 Parliament Street, Layerthorpe Bridge, and various minor sites, we are perhaps obtaining the beginnings of an understanding of land use zonation in Anglo-Scandinavian York, parallelling results from a detailed study of Roman Carlisle based on insects (Kenward EAU 1999/43; Kenward and Carrott 2006).

There are more specific issues to be addressed. Are variations in preservation primarily related to ground conditions, or to organic input (and by implication cleanliness or land-use such as cultivation which encouraged decay)? Were Roman buildings still in use in York? Were some structures domestic, others purely workshops? What livestock was kept in towns? What roofing materials were used? Was beekeeping an urban pastime? Can we extend the known ranges of activities and materials exploited through studies of invertebrate remains? What were the rivers and their fringes like? And, not least, are the remaining Anglo-Scandinavian deposits safe *in situ*, or may they be decaying? Clearly every opportunity should be taken to improve our knowledge of this period in York, building on the foundations provided by the major studies already carried out.

Durham

Deposits at the rear of **61-63 Saddler Street, Durham** were amongst the first urban deposits in the North to be investigated systematically for insect remains (Kenward 1979d), and as a result the data require critical re-examination. Period 1 of this site was dated to the 10th-11th centuries, Period 2 to the 11th-12th (see p. 221). The ultimate fill of a storm drain of Period 1 produced what was described in the original report as the most remarkable of the assemblages, and it remains as something of a 'type'. Outdoor forms were abundant and the assemblage as a whole diverse (although many groups of higher diversity have subsequently been discovered on occupation sites and even more at natural ones). There were numerous *Daphnia* ephippia. The fauna and the nature of the sediment suggested that this deposit formed in the gully as a result of run-off from the slopes behind the site, and that small pools lingered long enough for the *Daphnia* to reproduce (unless of course they came in waste water). A 'midden' of this period appeared to have been an accumulation of rotting vegetation, with hints that it may have been like stable manure. The identification of *Cercyon pygmaeus* from this site requires confirmation, since *C. atricapillus*, with which *pygmaeus* is easily confused, is almost invariably the small *Cercyon* present in occupation site assemblages in our region. These two assemblages, and the three of Period 2 which were examined, were too small and random a sample of the deposits at the site; they were unrelated and the evidence from plant remains (examined in Durham) was not integrated with that from the insects (examined in York), demonstrating the danger of carrying out work in different institutions without a very high level of project co-ordination.

Chester

Apart from some marine shell, few invertebrate remains dated to this period were found during an extensive assessment of **Bridge Street**, based principally on Bulk Sieving samples (Hall *et al.* PRS 2002/16; see also Jaques *et al.* PRS 2004/46).

South Yorkshire: Doncaster

Two deposits of putative Anglo-Scandinavian date at the **North Bridge** site proved to contain no invertebrate remains (Carrott *et al.* EAU 1997/16).

Rural sites of 'Dark Age' date

Some bulk-sieved samples from pit, post hole and ditch fills of middle to late Saxon date at Riby, Lincolnshire, gave no invertebrate remains (Hall and Nicholson EAU 1991/28). Saxon (and some Anglian) deposits, dated 7th-11th century, at Flixborough, North Lincolnshire, were investigated extensively, primarily by bulk-sieved samples. No certainly ancient arthropod remains or parasite eggs were recovered (Hall EAU 2000/56), but there were quite large quantities of snails and marine molluscs. The former were reported by Carrott (EAU 2000/55), who found that the assemblages were broadly consistent through time and across the site, indicating dry, probably short-turfed, grassland, with some damper or more shaded conditions locally, and perhaps woodland or scrub nearby. There were salt-marsh *Hydrobia* snails in seven contexts, principally *H. ulvae* (p. 301). These were probably imported with salt-marsh plants, whose exploitation is discussed in detail by Hall (EAU 2000/56), who also notes that some of the *Hydrobia* were charred. *Cecilioides acicula* was common, presumably intrusive (p. 481). Hand-collected molluscs from the Flixborough site, again of Anglian to early post-Conquest date (mid/late 7th-early 11th centuries), were analysed by Carrott (EAU 2000/54). The remains were almost entirely of marine forms, most of them oysters, mainly from dump deposits. Many were measurable, the average size remaining very constant through time, and over 40% showed opening marks. Carrott speculated as to the origin of these shellfish, noting that locally-available species had not been exploited to a significant extent. A few oyster valves had apparently artificial perforations, though whether ancient or caused during excavation was unclear. The shells appeared to have degenerated substantially in storage: they had been recorded as in good condition by Hall and Milles (EAU 1993/27), but had often broken into flakes when re-examined. There were a few hand-collected landsnails of no interpretative significance.

Girling (1985) reported fly puparia (apparently preserved by mineral replacement of metal salts) from a brooch in an Anglo-Saxon burial at Sewerby, East Yorkshire, suggesting that they indicated pre-burial exposure of the body. Evaluation of a 'pre-medieval' ditch fill at The Spinney, Sherburn-in-Elmet (Hall *et al.* PRS 2003/42) gave a useful group of insects, with aquatics important, hints of emergent vegetation, and indications of herbaceous vegetation, probably pasture, in the surroundings; there were some dung beetles. Some BS samples from a site at Hayton produced no insects and no more than traces of snails (Jaques *et al.* PRS 2004/63).

Deposits recorded as Anglo-Saxon on the Ainderby Steeple to Bullamore pipeline in North Yorkshire proved barren of invertebrate remains (Jaques *et al.* PRS 2004/29). Evaluation of ?oven fills at D C Cook, Lawrence Street, York Hall *et al.* (PRS 2003/33) produced no invertebrate remains.

A rather small assemblage of land snails from Becca Banks, on the line of the A1-M1 link road, West Yorkshire, was analysed by Carter (2001). A picture of overgrown vegetation in the ditch was evoked, but little could be said of the wider landscape beyond venturing that it was perhaps essentially open.

The Saxon/Anglo-Scandinavian period: conclusions

Urban deposits of Anglo-Scandinavian date in northern England are represented by a very large number of recorded insect assemblages and numerous analyses for parasite eggs; other remains such as mites and Cladocera have been noted frequently but not subjected to detailed investigation, and molluscs appear often to have been largely neglected. There are thus abundant data for insects in particular, but only a small part of one town (York) can be said to have been studied at all closely. We need to see many more sites from many more towns in order to build up a picture of variation of living conditions and activities in space and time, and to widen the range of information from the period. Careful studies of marine molluscs are required in order to attempt to elucidate their origin and patterns of exploitation and supply.

Insect remains (and doubtless mites) will provide an excellent source of information about the early development of the Anglo-Scandinavian towns in Britain, at present very poorly understood: were the small tenements laid out essentially de novo, or did they develop organically from less intensely subdivided holdings, perhaps farmsteads, whose ephemeral remains have yet to be discovered? Did any originate from existing Anglian or Saxon nuclei? Invertebrate remains (integrated with a broad range of other sources) may give further evidence concerning trade, both local and international, the exploitation of natural resources, and the nature and origin of cultural traditions (from Scandinavia or Britain). A particular area of interest is the keeping of livestock in towns; pigs and chickens might logically be expected to have been kept, so why is there so little evidence of this? Comparison with detailed and extensive analyses of material from settlements of the same date elsewhere in Britain and Europe (e.g. Novgorod) is also highly desirable.

Anglo-Scandinavian urban sites, because there was at least locally a massive input of organic matter with consequent excellent preservation, offer a superb source of assemblages of invertebrate remains, especially insects, for statistical and ecological analysis. Such studies lead to an improved understanding of past biological communities and consequently to enhancement of interpretation at archaeological sites generally; 16-22 Coppergate has been outstanding in this respect (see p. 204).

Urban sites of this period may have been subjected to many analyses for invertebrates, but further opportunities must not be lost as a result: the period has not been 'done'.

As far as rural sites are concerned, there is effectively no information from any group of invertebrates, and detailed studies of Saxon and Anglo-Scandinavian rural sites must be seen as a particularly high priority, to address a broad range of questions, especially those concerned with comparisons of urban and rural conditions, the effects of changes of political control on the way of life at isolated farmsteads, and comparison with contemporaneous sites in Iceland and Greenland (e.g. Amorosi *et al.* 1992; 1994; Buckland *et al.* 1996; Buckland and Sadler1991; McGovern *et al.* 1983). Rural sites (and natural deposits, of which none appear to have been studied) will also be important as a source of information about climate from large insect assemblages relatively unaffected by human activity; the evidence for temperatures higher than those of the 20th century from towns is persuasive, but largely depends on a single bug species (p. 289).

From the Norman conquest to the Black Death

The outbreak of plague in the 1340s, which subsequently came to be known as the 'Black Death', killed around 25 million people in Europe, between a quarter and a third of the population, in only two years. In Britain it supposedly caused rural depopulation and apparently drove a trend from arable to pastoral agriculture (although the impact of the plague may have been less dramatic than often supposed, e.g. Getz 1991). For this reason evidence from either side of the Black death has been treated separately. The approximate date of AD 1350 has been used since few deposits are decadally dated. (According to Busvine (1976) the name 'black death' was only applied to the 14th century plague long after the event, perhaps through mistranslation of *pestis atra* or *atra mors*, *atra* meaning 'dreadful' rather than 'black' here.)

Political changes following the Norman Conquest are reasonably well understood through historical studies, and the impact on town and countryside through the construction of fortifications and eventually through changes in land ownership is clear enough. Environmental archaeology offers the opportunity to dig deeper into the effects of the Conquest, to test whether these high-profile changes are reflected in the evidence concerning the daily lives of ordinary people, in trade, in the resources exploited, and in systems of resource control and distribution. The re-appearance of grain pests in strength in this period probably reflects both new trading patterns and the centralisation of control of grain storage, for example (p. 342), while the rise of the spider beetle *Tipnus* *unicolor* perhaps reflects changing building methods and greater permanence of structures (p. 378). Many sites (or phases of sites) of this period have been studied to some extent, but few can be regarded as very significant. The evidence has been summarised by site type (urban or rural) and geographical area.

Urban sites 1066-1350

Hull, Beverley and York have provided a modest amount of information, but there has been rather little work elsewhere. In some cases it is not clear from reports whether the deposits were actually laid down under urban conditions, so division between this section and the next is sometimes arbitrary.

North Lincolnshire

Samples from fills of cuts including pits and ditches at Barrow Road, Barton-upon-Humber proved barren of invertebrates, yielding only earthworm egg capsules (Carrott *et al.* EAU 2000/03). A medieval pit at Baldwin Avenue, Bottesford, Scunthorpe (Akeret *et al.* PRS 2005/14) gave no insects but there was an appreciable amount of shell, some marine (mussels), mostly aquatic and some terrestrial. There were indications from planorbid snails of hard, weedy water, and hints of brackish conditions from some hydrobiids.

Towns in East Yorkshire 1066-1350

Hull

Some evidence is available for medieval Hull (which was founded in the late 12th century), but in several cases the deposits concerned have been of special kinds, limiting their wider value. Much the largest body of data has come from the site originally intended for erection of the new Magistrates' Courts (Hall *et al.* EAU 2000/25; 2000/33). The earliest excavated material (site Period 1) was dated to the earliest part of the 14th century, before the foundation of the Augustinian friary. Many deposits dated to Period 1 contained few biological remains preserved by anoxic waterlogging, but some were very rich. Those investigated included large and small ditches, pits, floors and external layers. Insects were abundant and varied, and there were some unusual and intriguing records.

As at some other sites in Hull, there was clear indication of the influence of the tidal River Hull: the fills of two major cuts regularly contained suites of beetles indicating saline mud or litter which had been soaked in seawater, and they may have been connected to a creek, although it is just possible that they were simply occasionally filled with seawater by flooding. Such invertebrates are discussed further on pp. 298, 299. Some deposits produced abundant freshwater molluscs, mostly species tolerant of a range of conditions, but several of the samples inexplicably included *Theodoxus fluviatilis*, a large species of swift-flowing rivers and streams and the wave-wash zones of lakes, unlikely to be found in the immediate vicinity of the site. Its remains were perhaps brought into the deposits directly by flooding of the river, or brought downstream by flooding and subsequently incorporated into the deposits as a result of human activity. Alternatively these, and other mollusc remains, may have been reworked from deposits earlier than any which were available for analysis.

The insects and other biological evidence indicated domestic occupation of the tenements. Here, as at numerous other post-Conquest sites, grain beetles and the spider beetle *Tipnus unicolor* appear as significant components of the fauna; the latter seems likely to be an indicator of long-lived buildings which were rather damp but of at least moderately good quality (p. 378). Two species of grain pests were recorded: *Sitophilus granarius* and *Oryzaephilus surinamensis*, with the former proportionally more abundant than normal in Roman or early post-Norman Conquest associations, which probably indicates well-cleaned grain intended for human consumption. In one well fill *O. surinamensis* was much the more abundant of the two and this deposit may have included very spoiled grain, perhaps from horse feed or from spillage on stable floors. Floors seem to have usually been kept fairly clean, although with litter which provided habitat for the larvae of fleas, both of humans (*Pulex irritans*) and of dogs (*Ctenocephalides canis*). Dog fleas were present in quite large numbers and perhaps suggest that their hosts were kept in the buildings, while records of human lice (*Pediculus humanus*) suggest domestic use of at least some of the structures. While fleas may have bred in buildings of any kind, lice are more likely to have been shed in a domestic setting, although both may have been transported in waste from elsewhere.

The botanical evidence for stable manure was quite strong, but the insect assemblages gave no clear evidence for mature stable manure decomposer communities, though grain pests and weevils which may have been imported in hay were common and something resembling stable manure was suggested by the results of a species association analysis (see also Kenward and Carrott 2006). Perhaps stables were cleaned out frequently, preventing the build-up of numbers of decomposers.

The clover weevil *Sitona lineatus* was recorded from many contexts and was occasionally unusually abundant. It is regarded as a very typical component of hay in archaeological deposits (Kenward and Hall 1997), and so may have been imported with cut vegetation (indicated by the plant remains). However, there were few other insects likely to have been brought with hay, and newly-emerged specimens of *Sitona* and *Apion* clover weevils were rare. The possible origin of the *Sitona* is discussed on p. 354.

Material from the Augustinian Friary established in the second decade of the 14th century (site Period 2) is all considered here, since there can be little doubt that most of the biological remains from deposits dated to this period were, in fact, redeposited from Period 1 - the assemblages were often indistinguishable from those recovered from certain of the earlier deposits. (The redeposition of delicate biological remains is discussed on p. 478). It seems certain that organic deposits were redistributed during the construction of the friary buildings and also disturbed during the digging and refilling of graves.

Some of the Period 2 deposits contained biological remains which were probably contemporaneous with the friary (even though they were sometimes mixed with earlier material). Among the invertebrates, and clearly linked to the burials, were records from several contexts of beetles regarded as typical of post-depositional invader communities in buried organic matter and, in particular, in inhumations: *Coprophilus striatulus*, *Rhizophagus parallelocollis* and *Trechus micros*. These are considered in more detail on p. 482. Small numbers of insects, often house fauna, in some of the floors dated to Period 2 appeared to belong to that period, and one floor yielded water fleas and water beetles which, if they were not imported in make-up, presumably arrived in water (*cf.* p. 403).

A series of related excavations at **Blanket Row** (Carrott *et al.* EAU 1997/18; 1999/12; 2001/12; 2001/48; Johnstone *et al.* EAU 1999/01) encountered occupation deposits, of which the earliest analysed were of the first half of the 14th century. Some pit fills, putative tips, and a surface layer all yielded insect and other invertebrate remains, sometimes in abundance. Evidence from the insects and plants indicated stable manure in most of these deposits, and conditions were sometimes very foul. There was a clear saline influence in three assemblages, from a range of beetles (notably *Ochthebius dilatatus*, *Cercyon depressus* and *Limnoxenus niger*, the last of these north of its 20th century range) and from the foram *Elphidium (Polystomella)*. Peat, well represented in the plant record, was indicated by a few beetles, including the now rare *Hydroporus scalesianus*. Grain pests, mostly *Sitophilus granarius*, with rare *Oryzaephilus surinamensis*, were present, though not abundant, and there were both human lice (*Pediculus humanus*) and fleas (*Pulex irritans*).

A column sample through the fills of a watercourse, dated to the late 13th/early 14th century, at **Sewer Lane** (Kenward 1977) produced only small assemblages of insects, a result partly of low concentration and partly of non-standard extraction. The fauna presented a mixture of aquatics (principally beetles, ostracods and *Daphnia* ephippia) and typical taxa of occupation sites, including *Sitophilus granarius*. Two taxa suggested brackish water: a foraminiferan which appeared to be an *Elphidium* species and the beetle *Berosus spinosus*. The latter was outside its main present day range.

At Chapel Lane Staith (Kenward 1979c), a late 13th and 14th century waterfront gave some notable insect assemblages. A late 13th-early 14th century clay deposit, presumed to be the west bank of the River Hull, gave some synanthropes, which may have been trampled in, but the remaining assemblage was primarily natural or semi-natural, predominantly indicating weedy vegetation. Clean flowing water was indicated by two *Esolus parallelopipedus*. Two other samples from this early phase gave very small assemblages of limited interpretative value. The remaining deposits were fills behind the timber waterfront revetment. Two samples from the early mid 14th century contained abundant remains of beetles associated with rotting seaweed, although they may have been exploiting other salt-soaked organic debris in this case. *Actidium coarctatum*, *Cercyon depressus* and *Ptenidium punctatum* fell in this category. Three further samples gave smaller, more mixed, assemblages, perhaps representing more rapidly buried dumps, and possibly with a waterlain component. The single assemblage of mid-later 14th century date included enormous numbers of grain pests (*Oryzaephilus surinamensis* and *Sitophilus granarius* - *Cryptolestes ferrugineus* and *Palorus ratzeburgi* were conspicuously absent from this site) and a substantial house fauna. There were also foul decomposers and species which may have originated in hay, so (with hindsight) it seems possible that this deposit included stable manure.

Early 14th century deposits at Liberty Lane were examined in an assessment by Large *et al.* (EAU 1999/57). A garderobe fill gave house fauna, a few foul decomposers, and abundant saw-toothed grain beetles, *Oryzaephilus surinamensis*; a fill of a wicker-lined pit gave abundant adult and immature flies but the beetle assemblage was of uncertain significance; and a ditch fill gave what appeared to be a stable manure insect community. The spider beetle *Tipnus unicolor* was present, as in so many deposits of the later medieval period (p. 378).

Deposits described as 'medieval' at 54-7 High Street were evaluated by Jaques *et al.* (PRS 2003/01): they yielded some notable evidence and have been arbitrarily included here. A cesspit or dump layer gave a substantial group of species associated with foul open-textured material, as well as a grain weevil (*Sitophilus granarius*), and was perhaps stable manure (although a human louse, *Pediculus humanus*, was also noted). Floor silts gave few insects, but those found were very typical of later post-Conquest houses, with *Tipnus unicolor* (p. 378), grain pests (*S. granarius* and *Oryzaephilus surinamensis*), and a dog flea (*Ctenocephalides canis*, p. 428). A culvert fill contained abundant ostracods and some water beetles and aquatic snails; *Trechus micros*, typically subterranean (p. 482) was abundant, and overall the impression was of an assemblage formed in a closed aquatic environment. There was a little marine shell, principally oysters. At High Street and Blackfriargate, McKenna (1987) reported *Ascaris* and *Trichuris* from many deposits. There were also some *?Hymenolepis* (p. 24) eggs from a floor layer. The only reference to insects is a record of a few fly puparia from a spot find. Medieval features at Scale Lane/Lowgate gave records of *Ascaris* and *Trichuris* eggs from a concretion, and marine shell dominated by oyster, mussel and cockle, with traces of land snails (Phillips 1980).

Clearly any opportunity to examine occupation deposits of this period in Hull in detail would be valuable, allowing the early stages of development of the town, and its spread across marshland adjacent to the River Hull, to be traced.

Urban Beverley, 1066-1350

Some sites in Beverley have provided examples of good preservation by anoxic waterlogging in post-Conquest layers, at least in the earlier deposits, but many are almost barren, or completely so, to judge from evaluations. The town is considered in a series of arbitrary subdivisions.

Central Beverley

A good number of sites in central Beverly have been examined, though mostly through PPG16 exercises. Evaluation of material from **37 North Bar Within** (Carrott *et al.* EAU 1995/54) and **Trinity Lane** (Hall *et al.* EAU 2002/03) produced, at most, fragments of mollusc shell; at the latter there were some oysters with opening marks. At **Champney Road** (Carrott *et al.* EAU 1993/01), 12th century floor silts and pit fills, perhaps dating to before c. AD 1188, generally had limited preservation, but there were hints of stable manure beetles and *Melophagus ovinus* (sheep ked) from pit fill contexts, and a record from one pit of *Trichuris* eggs without other evidence of faeces. No mention was made of grain pests in either report; it would be interesting if they were indeed absent (see p. 342). Evaluation of samples from excavations at the **Magistrates' Court** site (Hall *et al.* EAU 2001/06) produced varied insect assemblages. A pre-12th century layer gave beetles indicating that it formed under essentially natural conditions, in a closely-vegetated swamp with some open pools. A well fill of later 12th century date gave only traces of insects, while a pit fill of the same date gave some, poorly preserved, insects: a generalised group indicating artificial habitats, and a single sheep ked. A second 'pit fill', also of the later 12th century, gave a range of remains indicating essentially natural conditions and it was suggested that it was in fact the infill of a stream channel, unless redeposited in bulk. A loose black ash from a floor of the early 13th century was barren of invertebrate remains. A group of samples from **9-17 Well Lane**, from deposits dated late 11th-mid 12th century through to mid 13th century, represented a series of layers described as blankets of peat (Carrott *et al.* EAU 1999/04). Although apparently formed in the open, with appreciable numbers of aquatics and a range of open ground taxa, most layers also contained synanthropes from occupation areas, though their route to the deposit was unclear. Presumably dumped material from in or around buildings was present, since there was sometimes house fauna, including the human flea, *Pulex irritans*.

Hall *et al.* (EAU 2001/25) reported evaluation of samples from mid 12th to mid 13th century rake-out, floor silt, and pit fill deposits at **County Hall.** Although large quantities of charred plant material thought most probably to be associated with roofing were present, no charred invertebrates were noted. It would be worthwhile to investigate material of this kind more carefully for charred insects. The site produced a few hand collected marine shells, mostly oyster, some with opening marks (p. 85), but also some large terrestrial snails in suspiciously good condition, perhaps intrusive.

Kenward and Carrott (PRS 2003/58) reported analysis of insect and other invertebrate remains from 12th or early 13th century pit fills at **Morton Lane.** Beetles were abundant in two of the fills and indicated plant litter, probably from within a building - either stable manure or house floor sweepings. A third fill contained fauna which may have been of 'background' origin (p. 58), although it contained a single fragment of the small stag beetle *Sinodendron cylindicum*. There were no grain pests or *Tipnus unicolor*; in contrast with later deposits at this site. A remarkable record from one of these fills was a head of the beetle *Prostomis mandibularis*. Unknown in modern Britain, this species is an 'urwaldiere', associated in mainland Europe with rotting wood in ancient forests; the record is discussed on p. 295. A human flea and some sheep keds were noted. Further evaluation at 69-73 Morton Lane was carried out by Hall *et al.* (PRS 2004/18). A late 12th century fill of a large cut, probably a pit, gave small numbers of insects typical of occupation sites, including a human flea, but the assemblage had no special character. A second pit gave a mixed assemblage with outdoor forms abundant; faeces were indicated by some *Trichuris* eggs. A third pit fill yielded no invertebrates, and two surface deposits gave only a few land snails, including the intrusive *Cecilioides acicula* (p. 482).

An evaluation by Akeret *et al.* (PRS 2005/87) of samples from excavation at **Beverley Health Centre**, Manor Road, gave only traces of land, freshwater and marine shell, though a sample of concreted organic matter proved to contain eggs of *Ascaris* and *Trichuris* in small but roughly equal quantities: it was speculated that this might imply that they were from pig (see p. 27). Deposits dated 16th-17th century at a site at **Hall Garth** (Dobney *et al.* EAU 1994/60) gave assemblages indicating weedy still water, perhaps de-oxygenated at times, with marshland forms and indications of damp grassland (perhaps the moat banks). There were also abundant oysters and some cockles and mussels at this stage. 19th-20th century layers gave only a few oysters and a whelk (*Buccinum undatum*).

Turning to very a different kind of site, the stratigraphically lowest investigated phases at the **Dominican Priory** were dated to the 12th century or earlier, although the sequence of deposits analysed for invertebrate remains ran into the later 14th (Allison *et al.* AML 21/90; 1996c). All of this material is dealt with in the present section. The fill of a feature pre-dating ?12th century landfill gave no identifiable invertebrate remains. By contrast, a series of fills of cuts associated with the landfill were often rich in remains. Some appeared to have held water (or received waste water), for there were several cases where water flea resting eggs were recorded, and one fill contained rather more aquatic insects than might be expected by chance. In some cases a distinct 'house fauna' component was present, including a human flea, and sheep keds (*Melophagus ovinus*) were recorded from some fills; there were a few lice, too poorly preserved for identification. It thus seemed likely that material cleared from buildings was present, and this was supported by a snail assemblage including species from base-poor marsh, supporting evidence from plants (and to a small extent insects) for cut vegetation such as might be strewn on a floor. One sample gave five, and two others two, specimens of the small longhorn beetle *Gracilia minuta*, probably originating in small twigs such as basket work within a building (see p. 372). Conditions in some of the pits were, from the beetle assemblages, were fairly foul, with species which may have exploited organic-rich mud. A series of early and mid 14th century floor deposits were impoverished of insects, but most produced useful assemblages of snails. These included components from grassland, freshwater and water margins, all presumably imported in cut vegetation, and also synanthropic species favoured by human disturbance. Snails from the later 14th century included some suggesting disturbance and fairly damp conditions.

Although eggs of both *Ascaris* and *Trichuris* (*T. trichiura* on the basis of measurement) were recovered from over half of the samples from the Dominican Priory which were examined, they were present only in very small numbers. This was perhaps because they were of 'background' origin in most cases, but the general matrix of one pit fill (which on the basis of the botanical evidence appeared likely to include faeces) also gave very small numbers; samples of concretion from this same layer contained rather more parasite eggs, however. The significance of these results is not clear, but possibly the people using the site generally carried few parasites as a result of good hygiene.

Through lack of funding, the nearby **Eastgate** site (McKenna 1992, EAU 88/30) represented a missed opportunity to examine insect remains from a large number of samples from medieval properties. Well-preserved waterlogged plant remains were present in many samples, but only a few groups of insects could be recorded, and then only subjectively and without species lists. From later 13th century deposits there were typical 'urban' insect groups indicating dryish to foul conditions, and perhaps stable manure. *Trichuris* and *Ascaris* eggs were abundant in pit fills, and were present in a late 13th or early 14th century woody deposit, apparently a dump on a yard surface. Testate amoebae were frequently present in modest numbers; their significance in occupation deposits is not yet clear, though they may have been imported in (undetected) peat since they are abundant in some natural peat deposits (see p. 18), or carried in water.

Jaques *et al.* (PRS 2002/09), in an evaluation, examined three samples from late 12th to early 13th century fills at **Wilbert Grove**. There were a few snails, a pit fill giving a few terrestrial and marshland species, and a slot fill yielding a trace of terrestrial forms. Hand collected shell was mainly from large terrestrial snails, although there was a trace of oyster. No delicate remains were found. A single sediment sample – from a 'mortary floor surface' – from the site of the Preceptory of the **Knights Hospitallers** was examined by Dobney *et al.* (EAU 1992/21). The only invertebrates were non-marine molluscs offering little interpretative information, and small numbers of hand-collected marine shells, mostly oysters (*Ostrea edulis*), but with traces of other edible species. Evaluation of a series of fills of a large ditch at Station Yard, thought by the excavator to be associated with the

Preceptory of Holy Trinity (Carrott *et al.* 1991/17) could only be carried out on a limited scale. Samples from only a few of the series collected could be processed for insects and other invertebrates, although freshwater snails were recorded from many. The lowest deposit examined for invertebrates produced aquatic and aquatic-marginal insects and resting eggs of *Daphnia*, indicating still or sluggish water. Terrestrial forms were too rare to attempt subjective reconstruction of the surroundings. The succeeding two analysed layers produced broadly similar evidence, but there were in addition records of *Oulimnius ?tuberculatus* (at least four individuals), indicating clean flowing water and suggesting at least some inflow from an unpolluted stream. The small weevil *Tanysphyrus lemnae* attested the presence of its host, duckweed, *Lemna* sp. This weevil also occurred in the remaining two analysed layers, which again were clearly waterlain. Terrestrial insects were a little more abundant at these levels, and mostly indicated weedy vegetation, although the uppermost sample, from a recut, included two bark beetles, one of them (*Leperisinus varius*) typically associated with ash, *Fraxinus*.

Carrott *et al.* (EAU 1999/07) reported evaluation of samples from excavation at Lord Robert's Road, close to the former Walker Beck, a stream which ran through the centre of the town. 'Loams' dated to the 13th century yielded insects suggesting soil-like conditions, with some organic matter. One contained abundant earthworm egg capsules, another indicated a weed flora including nettles. A pit fill seemed to contain soil scraped from a surface. A bottom ditch fill seemed to contain occupation waste, and perhaps seasonal water, while an upper fill indicated wet, foul conditions. Aquatics were present in the pit fill and some loams, as well as in the bottom ditch fill, and it seemed possible that there was flooding at times (in accord with the location in an area historically subject to seasonal inundation). Synanthropes were rare, with no indication of buildings immediately nearby, although a pupa of the sheep ked *Melophagus ovinus* was perhaps more likely to have originated from wool cleaning than from animals living *in situ* (p. 363). There were a few shellfish, mostly oyster, some of which showed marks left by opening. Pre-14th century to modern moat fills at a site at Hall Garth (Dobney *et al.* EAU 1994/60) represented another lost opportunity through limited provision so far as insect remains were concerned. Molluscs from the 14th-15th century fills indicated slow moving water with dense plants in pre-14th century deposits; there were few terrestrial forms.

Southern Beverley

Jaques *et al.* (EAU 2001/35) reported evaluation of samples from excavations on land behind and adjacent to 52 Keldgate. Three deposits dating to the period before occupation in the 13th or 14th century were examined. A turf line gave only rare, extremely decayed and generally unidentifiable, invertebrates and a depression fill gave even fewer remains (though including a *Lophopus crystallinus* statoblast, p. 89), but an 'organic deposit' revealed in a sondage gave appreciable numbers of remains, dominated by aquatics and some waterside forms. Swampy conditions were indicated. Terrestrial insects were rare, but included a few dung beetles. There was no indication of human occupation. Two fills of a watercourse were examined. These appeared to date to a period of occupation: synanthropes were quite common in one of the fills and there were plants associated with textile working, accompanied by *Melophagus ovinus* and what appeared to be *Damalinia* lice, presumably from wool cleaning (see p. 362). A small amount of marine shell, mostly oyster (some showing opening marks, p. 85), was recovered by hand, though principally from deposits of 14th-15th century date, and there were a few large landsnails. From a second site in Keldgate (Carrott *et al.* EAU 1995/03), 12th-13th century urban occupation, floors, pits and other features gave fauna which had much in common with that of Anglo-Scandinavian deposits at Coppergate, York. The earliest deposit, an organic layer over 'natural', gave evidence of wetland prior to occupation.

South-Eastern Beverly

An evaluation at Flemingate House (Carrott *et al.* EAU 1993/07) produced a 12th century floor deposit, essentially barren of invertebrates, and other deposits of 12th-13th century date which were barren or nearly so. Evaluation of deposits of 12-14th century date at Jack Taylor Lane (Carrott *et al.* EAU 1998/10) showed that, although they were sporadically distributed, this site had potential for work on invertebrates. A putative natural peat gave aquatic and marginal fauna, but also some synanthropes (including *Tipnus unicolor*, p. 378), while a pit fill gave beetles indicating foul matter. There were a few *Trichuris* eggs in these deposits, which seem to have included human faeces. Importation of water was suggested by a record of the bryozoon *Lophopus crystallinus*. There were small quantities of marine shells (*Ostrea, Cerastoderma*) and traces of landsnails.

Material from Beckside North and Beckview Tilery, evaluated by Carrott *et al.* (EAU 1993/05), provided the opportunity to examine a varied group of deposits, but work was constrained by the budget: a layer and some pit fills dated pre-1300 contained insects, but identifications could not be made, while peats (presumably pre-occupation) probably would have rewarded further investigation. Additional evaluation of various occupation deposits of late 12th-early 13th and 14th-17th century date at Beckside North was reported by Jaques *et al.* (PRS 2002/06). Three samples in the former group contained useful assemblages of invertebrates. Some of the remains appeared to have originated in imported peat, identified in the botanical analyses. There were few (or no) aquatics, though one pit fill sample gave a few statoblasts of *Lophopus crystallinus* (p. 89), which presumably either originated in peat or in imported water. Occupation-site insects were present, doubtless brought with, or invading, dumped waste. There was a record of the sheep ked *Melophagus ovinus*, presumably of the same origin (p. 363). Four other deposits of this date, including occupation accumulations and hearth-associated layers, were barren or gave only traces of decayed insects. A little hand-collected marine shell was recorded, mostly oyster (some with opening marks, p. 85), and a few cockles (*Cerastoderma edule*).

Hall *et al.* (EAU 2000/15) carried out evaluation of samples from South Beckside. Insects from pre-occupation (pre-12th century) 'organic material' hinted at foul matter, while aquatic and waterside species perhaps originated through flooding or in waste water. One organic layer of 12th/13th century date gave rather poor preservation, with hints of water and occupation site fauna, and another gave large numbers of statoblasts of the bryozoon *Lophorpus crystallinus* (p. 89), indicating rather clean water, but only scraps of insects. Samples from a late 12th/13th century pit fill and a 13th/mid 14th century pit or slot fill at Waterside Road examined in an evaluation by Hall *et al.* (EAU 2001/21) gave no delicate invertebrate remains but there were some snails, mostly terrestrial but with a trace of aquatics. *Cecilioides acicula*, presumably intrusive (p. 482), was present in both cases. Evaluation of deposits at a site at Figham Common (Carrott *et al.* EAU 1998/17) showed that some contained insect remains, and most included at least fragmentary terrestrial or freshwater molluscs. Late 12th/early 13th century layers yielded snails but no more than traces of insects. One ditch fill of the 13th century gave only some snails fragments, but another included a few insects, some suggesting material derived from occupation. Hand collected molluscs from these fills included oysters and snails. A peat deposit, whose dating was uncertain, gave a range of invertebrates indicating natural or semi-natural aquatic and waterside habitats.

These deposits at Beverley clearly have great potential, at least locally, for reconstruction of many aspects of economy and environment using a range of invertebrate remains. The opportunity to investigate a series of sites from the urban centre into the rural surroundings undoubtedly exists, and comparison with York and other towns would certainly be instructive. It is unfortunate that levels of funding within the planning process have to date produced a pattern of lost opportunities rather than the detailed analyses which would have resulted from support more commensurate with the nature of the material, but synthesis of the existing data, with strategic analysis of samples in store, would surely be rewarding and must be seen as a priority.

Other towns in East Yorkshire, 1066-1350

Samples from a pit and 'ground-raising deposits' at a site to the west side of St Augustine's Gate, Hedon, East Yorkshire, yielded only a trace of marine shell, landsnails which may have been intrusive, and earthworm egg capsules (Carrott *et al.* EAU 2000/02). In the same town, Hall *et al.* (EAU 2001/29) carried out evaluation of material from late 12the-13th century deposits at **16 Baxtergate**. A pit fill gave no invertebrates, but a channel fill gave a rich and diverse plant macrofossil assemblage including taxa likely to have arrived in hay or straw, as weeds growing locally, as food waste, or from wetland, including salt marsh, together with moderate quantities of invertebrate remains. Aquatics were rather well represented, and included several ostracods, together with beetles. There were taxa which probably originated by water, and some plant feeders which may have lived in weedy waste ground or have been imported in hay and entered deposits via stable manure (as seems to have been the case at some other sites, p. 316), though there were no clear indications of such material from the insects. Decomposers ranged from species associated with dung or other foul matter to those from dryer material such as floor litter or hay, with generalist taxa in between. It was not clear whether these insects were background fauna or had been introduced in dumps.

Samples from a watching brief on land to the rear of **Chapel Farm, Holme-on-Spalding-Moor** were assessed by Hall *et al.* (PRS 2002/14). A ditch fill contained only traces of cuticle (and a modern weevil), but two peculiar calcareous fills of a timber-lined pit contained a few insects and snails. The latter included taxa indicative of dry, open, calcareous places, and had perhaps been originally imported with chalk or limestone. The lower fill included some remarkable insects, articulated but completely decolourised. The stratigraphic position suggested that these were ancient, so that their condition appears to had resulted from the unusual, calcium-rich, preservational environment.

Evaluation of samples from 'medieval' cut features at **Bridgegate, Howden**, for plant remains using bulk sieving produced incidental records of insect remains including caddis larvae (ASUD 791); it is unfortunate that there was no study of invertebrates in this case.

Urban York 1066-1350

There is a substantial amount of small-scale evidence concerning this period in York, but the most significant source, 16-22 Coppergate and associated sites, has yet to pass beyond the assessment stage (Carrott *et al.* EAU 1995/53; EAU 1996/01; EAU 1996/09; EAU 1996/44, and others). As for other periods, York is best considered in a series of areas; in this case the creation of the King's Fishpool during the construction of the Norman defences has added a further and very significant zone for study.

Sites in York NE of the Ouse

This area has provided a range of sites with invertebrates dated AD 1066-1350. Many are close to, or within, the River Foss and the lake caused by its damming to form the King's Fishpool and may conveniently be considered together first. The evidence from other sites in this area is summarised separately.

Sites associated with the Foss/King's Fishpool

The site at 16-22 Coppergate probably backed closely on to the fringes of the fishpool. A large-scale assessment carried out by Carrott *et al.* (EAU 1996/09) showed the great potential of the sampled post-Conquest material for reconstructing site activity and environment, and for contributing to wider issues such as spatial differentiation, time trend analysis and higher level synthesis. In many respects the biota were reminiscent of those from the Anglo-Scandinavian deposits at this site, although there appeared to be some systematic differences, particularly in the lack of assemblages with pronounced woodland, heathland or dyeplant components. Many samples were rich in plant remains interpreted as indicating faecal material, often accompanied by rather characteristic insect assemblages and large numbers of parasite eggs. Particularly notable were the many samples with an appreciable component of grassland plant remains and/or cornfield weeds together with insects suggesting stable manure (cf. Kenward and Hall 1997). A subjective impression was gained that the insect assemblages were less varied than those from Anglo-Scandinavian deposits, this being in part accounted for by the rarity of assemblages dominated by 'house fauna', the lack of groups suggesting the natural infilling of pits, and the presence of stable manure. However, grain pests (effectively absent before the Conquest) were present in a large proportion of the samples and occasionally abundant, and the spider beetle *Tipnus unicolor* appeared to be very much more abundant than in the earlier material (see p. 378). These changes reflect a pattern which, on the basis of rather limited evidence, seems to be emerging as a general one for medieval British occupation sites. At Coppergate, it may be that the site saw a reduction in the range of crafts and industries carried out (reducing the range of waste materials for disposal), so that the proportion of pit fills consisting of human or perhaps horse faeces rose. Further work on this and some related material is of the highest priority.

The Coppergate site indicated conditions in occupation sites fringing the Foss. Various other sites nearby were more intimately associated with the river. At **22 Piccadilly** (Carrott *et al.* EAU 1995/53), Periods 4.2-5.2 were dated late 11th to (presumably early) 14th centuries. Assessment showed that there were terrestrial and aquatic insects which promised evidence concerning the nature of dumps and surfaces, and information concerning flood episodes. Ostracods were present in useful numbers. As for the Anglo-Scandinavian period, there appeared to be a contrast with 16-22 Coppergate in terms of land use. The site was clearly an area of massive accumulation, with surface dumping and a strong aquatic influence. Nearby at the **Merchant Adventurers' Hall** (opposite No. 22 Piccadilly) Carrott *et al.* (EAU 1996/44) assessed 12th-14th century buildup; there were many beetles suggesting stable manure and some damp ground/waterside taxa reflecting the nearby Foss.

A series of evaluations gave further preliminary data. Some 13th to early 14th century deposits at **50 Piccadilly** added to the evidence of dumping and a wet environment (Carrott *et al.* EAU 1992/08). A 13th century dump gave grass or straw material with newly-emerged *Apion* and *Hypera* weevil remains, modest numbers of decomposers likely to invade hay and hints of an origin within a building; there were also some grain beetles and a single *Tipnus unicolor*, so there may have been stable manure. There were small numbers of aquatic crustaceans and molluscs, but no prominent component of aquatic insects (or plants); perhaps the crustaceans arrived via water for livestock (p. 403). Aquatic insects were also rare in a mid 13th/early 14th century build-up, but ostracods were rather common, and there were assorted decomposers, grain pests, house fauna, *Tipnus*, and some *Melanotus* and *?Athous* (click beetle) larvae, these larvae perhaps suggesting soil development. Some borehole samples, perhaps of immediately post-Conquest date, from **84 Piccadilly** gave more evidence of truly aquatic deposition (Carrott *et al.* EAU 1991/16), but there was a human flea (*Pulex irritans*) and a probable sheep ked (?*Melophagus ovinus*), presumably from domestic dumps including wool-cleanings (p. 363; plants from this core segment also suggested the dumping of domestic waste). Notable results were obtained from **17-21 Piccadilly** (= Reynard's Garage) (Alldritt *et al.* EAU 1991/01), where deposits dated to the later 14th century produced grain pests, a 'foul mouldering' beetle community, *Pulex irritans*, and *Melophagus ovinus*; there were *Damalinia* lice too, but they could not be named to species. These and other insects suggested dumping of material from within buildings. There was a later 14th record of *Heterogaster urticae*, the nettlebug, a species with climatic significance (p. 290; see also Kenward 2004). Plant remains also included some notable material and had this been a full excavation it would undoubtedly have produced bioarchaeological results of considerable importance. The presence of both *Tipnus unicolor* and the grain pests at these sites conforms with the perceived pattern for the post-Conquest period (pp. 342, 378).

Some sites in the approximate rectangle defined by Peasholme Green, Dundas Street and the River Foss were investigated in the early days of developer funding. Although numerous samples from several sites were investigated, most came from boreholes, severely limiting their value. In particular, dating was generally vague. The results of analysis for invertebrates were as follows: Excavations at the **Adams Hydraulics I and III sites**

(Alldritt *et al.* EAU 1990/01; Allison *et al.* EAU 1991/05) appear to have encountered only terrestrial deposits, 10th/11th and late 12th/early 13th century pits being barren of invertebrate remains and a putative slot fill giving only a few earthworm egg capsules. Invertebrates from borehole samples from **Dundas Street** (Hall *et al.* EAU 1990/09) showed aquatic deposition with dumping of occupation material, and there were some grain pests (species not listed). Dating evidence was sparse, but on both plant and insect evidence the productive layers were placed post Norman conquest. At **Garden Place** (Carrott *et al.* EAU 1990/08) the earliest deposits were stiff brown 'boulder clay', succeeded by a layer of gravel, both barren of biological remains. Over this was stiff laminated clay, clearly deposited in a low energy aquatic environment, although some sand lenses indicated periods of more rapid flow. This deposit gave some biological remains including *Daphnia* ephippia and traces of plants of probably natural and human origin. An overlying organic silty clay or clay silt contained abundant plant and invertebrate macrofossils indicating deposition in still or slow-flowing water, but with clear evidence of the incorporation of weeds, foodplants and insects associated with occupation as well as natural or semi-natural habitats. Grain pests and the deathwatch beetle *Xestobium rufovillosum* were present. Three General Biological Analysis samples whose provenance was not immediately clear from a reading of the report seemed to have a more developed form of the biota observed at this level. Dating of this sequence was uncertain, but the laminated clay perhaps represented the early stages of the King's Pool.

The sequence at the **Adams Hydraulics II** site (Carrott *et al.* EAU 1991/12) appeared to start earlier, the boreholes probably representing pre-Roman to medieval deposits. The latter suggested an environment much like those reconstructed elsewhere in the area, with aquatics (few to many *Daphnia* ephippia) and variable amounts of taxa probably introduced by dumping of a range of materials at the water's edge. *Sitophilus granarius*, *Melophagus ovinus* and *Tipnus unicolor* were present, and there was locally superb preservation of ostracods and snails. This material represented yet another lost opportunity to investigate crucial aspects of York's past. The **Palmer Lane** site, too, appeared to have substantial potential (Carrott *et al.* EAU 1992/05). Boreholes produced samples of deposits interpreted as probably being 12th-14th century dumps into the fishpool, with grain beetles and an assortment of decomposers, mostly indicating fairly dry material, and grain pests; this component probably came from within buildings, an interpretation supported by records of single human and dog fleas (*Pulex irritans* and *Ctenocephalides canis*) and a sheep ked puparium fragment. *Daphnia* resting eggs and a few water beetles again suggested dumping into water.

At the upstream end of the fishpool, cemetery deposits, mostly of 12th-13th century date, on somewhat raised ground near to the river in **Jewbury** (Hall *et al.* EAU 1991/24) were barren of significant invertebrate remains. Supposedly post-Conquest deposits at the nearby excavation at the river's edge at the **Layerthorpe Bridge** site were rich in invertebrate remains, but many were probably of Anglo-Scandinavian date (Hall *et al.* EAU 2000/64). Notable were some samples in which large numbers of the beetle *Trox scaber* occurred together with the remains of finely comminuted bark - perhaps evidence of a tanning industry at this location removed from the city centre (p. 365).

These sites associated with the River Foss in York have offered an opportunity to make a systematic study of the origin and history of a major feature of the medieval city, the King's Fishpool. That the funding system under which most of the work was carried out did not make provision for more than assessment or crude evaluation must be seen as a serious failure. Full analysis of the well-provenanced samples should be carried out before they degrade completely, but it should be noted that the funding of evaluations in this area was generally not sufficient for the kind of detailed sampling desirable, and that any further opportunities to excavate in the areas concerned should be taken; there is a danger that redevelopment will seal all the deposits so that they are unavailable for the foreseeable future. A sequence from an exposure at the centre of the fishpool might be particularly valuable (hopefully providing a history of the status, e.g. water quality, of the water body, and of its infilling), but studies of its margins should not be neglected (was there agricultural land or waste ground? What industries used the area? What can be learned about source areas from the composition of the dumps? Was the water level stable?).

Other sites NE of the Ouse

The supposed castle ditch at **1-2 Tower Street** (Castle Garage) presumably had some connection with the fishpool. Assessment by Carrott *et al.* (EAU 1995/35) suggested that the ditch did not hold permanent water, or if it did then it was not deep and something (severe pollution?) prevented the development of rich aquatic communities. Those aquatic invertebrates which were recorded would have been able to colonise temporary water at the bottom of the ditch, perhaps even amongst standing vegetation. There was evidence for dumping of organic waste from hints of material resembling stable manure, and perhaps also food waste. This latter may have been in the form of faeces, but the numbers of eggs of parasitic nematodes (*Trichuris* sp. and perhaps also *Ascaris* sp.) were always small. There was no evidence that the ditch was fed by the rivers, apart from the records of statoblasts (resting stages) of the bryozoans *Lophopus crystallinus* and *Cristatella mucedo* (p. 88), species not very likely to have lived in the ditch in stagnant, temporary, water even if only slightly polluted. The lack of plant and insect remains indicative of flowing water suggested that inwash from the rivers was not a regular event unless some remarkable set of circumstances prevented deposition of river silts. There were no layers with a biota resembling those seen in clearly waterlain deposits at the series of sites close to the Foss discussed above.

Evaluation of 11th-13th century urban yard surface and pit deposits at **44-5 Parliament Street** produced notable results (Carrott *et al.* EAU 1995/08). The insects were a mixture of typical urban species, associated with decaying matter ranging from dry to very foul, with some aquatics and open-air species which may have lived on weeds on the site. Beetles typically found inside buildings were present but (other than the grain pests) only in small numbers. Grain beetles were present in several of the deposits, and quite abundant in two. It was notable that the grain weevil *Sitophilus granarius* was more common than usual in relation to the other regularly occurring storage pests (in this case *Oryzaephilus surinamensis* and *Cryptolestes ferrugineus*), a trend seen in later deposits elsewhere (p. 342). It was suggested that these remains of grain pests may have entered with faeces. S. *granarius* develops inside grains and is particularly likely to be eaten in grain-based food. Further investigations at this site during research into in-ground decay produced some additional evidence (Carrott *et al.* EAU 1996/15; Davis *et al.* 2002). Where interpretation was possible the insects pointed to deposition in the open, with indications of stable manure and other waste material. Grain pests were again fairly consistently present. One pit fill indicated (from aquatic insects and *Daphnia* ephippia) temporary open water. Parasite eggs (mostly small numbers of *Trichuris*) suggested contamination by human faeces, perhaps as a primary component in some cases in view of evidence from plant remains. These results gave a small insight into the way yards were used in the medieval city centre; it would be useful to obtain similar information from a range of sites in order to investigate spatial and temporal patterning.

A little to the east, some dumps dated to the 11th-13th centuries at **St Saviourgate** (Carrott *et al.* EAU 1998/14) mostly contained few invertebrates, though one gave a mixed insect assemblage including grain pests (*Oryzaephilus surinamensis* and *Sitophilus granarius*) and the spider beetle *Tipnus unicolor* (p. 378). An assessment of samples from 12th to early 14th century build up and levelling deposits at the former Henlys of York filling station, **The Stonebow** (Akeret *et al.* PRS 2005/10) produced a trace of marine shell.

Away from the influence of the rivers at **Coffee Yard**, late 13th-early 14th century occupation deposits gave almost no insects, for reasons which were not clear, but possibly input was too slow to prevent surface decay (Robertson *et al.* EAU 1989/12). Samples from 14th century layers gave grain pests (*Sitophilus granarius* and *Oryzaephilus surinamensis*), together with a limited house fauna, and almost no other remains; a high level of cleanliness was probably indicated. There were traces of *Daphnia* (more common in later phases, and discussed below, p. 253). There was no reason to suppose that remains in these deposits had been lost by decay; rather, there was probably very low input, again evidence of clean conditions. Parasite eggs were effectively absent. Cleanliness was also suggested by material from **The Bedern** (Hall *et al.* AML 56-58/93), where a complex of contiguous or barely separated areas was investigated (see Richards 1993, fig. 55) which unfortunately have been separated for the purpose of reporting. Most of the deposits relevant here were dated to the mid 14th century or later, but some were from the mid 13th-mid 14th. Many of these samples were barren of invertebrate remains, or almost so. There were occasional records of *Trichuris* eggs in small numbers, and there were also some eggs determined as ?*Hymenolepis* sp. (see p. 22). One pit fill gave a modest-sized insect assemblage suggesting compost-like material, perhaps rather dry stable manure.

Excavations at sites in the **Swinegate** area, not far from Coffee Yard, revealed a series of deposits of 11th to 14th century date. Assessment (Carrott *et al.* EAU 1994/13) revealed extensive waterlogged preservation, and there was a clear potential for productive further analysis. The insect assemblages were varied, although a substantial proportion may have included a component from stable manure. Foul conditions existed a mere 150m from the Minster. Some deposits contained numerous water flea ephippia, and one at least included appreciable numbers of aquatic insects, but whether this reflected open water *in situ* or nearby, or importation of water, was not certain. Some of the samples contained eggs of intestinal parasites, but there was no clear evidence for disposal of human faeces. Marine shell (recovered in the Bulk Sieving samples) was present throughout the sequence. Further work on the material from these sites is highly desirable to provide a clearer view of conditions in this important area of York.

Samples from deposits at St Andrewgate were assessed by Jaques et al. (PRS 2002/12). An early 13th century mixed dump gave a range of invertebrates, with beetles typical of urban occupation, indicating dryish to rather foul decaying matter. There were some *Daphnia*and water beetles. Stable manure may have been present. A mid-late 13th century pit fill gave plants indicative of stable manure, and this was supplemented by a mixture of insects from foul open-textured matter, weevils likely to have originated in hay, and the grain weevil *Sitophilus granarius*. These insects often had a yellow-brown colour, giving hint that there had been recent decay (see p. 109). There were some parasite eggs (*Trichuris* and ?*Ascaris*). A second dump, of early 14th century date, was effectively barren.

McKenna *et al.* (AML 37/88) examined a range of 'medieval' deposits at **7-9 Aldwark** for parasite eggs; traces of *Trichuris* were found. Evaluation of 14th century dump or accumulation layers at **62-68 Low Petergate** (Hall *et al.* PRS 2003/25) revealed notable assemblages of insect remains (they have been arbitrary assigned to the pre-1350 period here). A range of decomposing matter from dryish to foul was indicated, with hints of components typical of stable manure (grain pests, peat or turf fauna and aquatics). Sheep keds and lice, perhaps *Damalinia*, probably from wool cleaning (p. 363) were present in small numbers, and the spider beetle *Tipnus unicolor* was also noted. One of the samples contained numerous lice, which were probably *Pediculus humanus* but too decayed for confirmation to be attempted on the time scale of evaluation. Assessment of a 13th/14th century cess pit fill at **62-68 Low Petergate** gave abundant insects typical of medieval urban deposits, including *Tipnus unicolor* (p. 378). There were traces of marine shell. *Trichuris* eggs were abundant and there were some *Ascaris* (Akeret *et al.* PRS 2005/89).

Evaluation of material from the former **Davygate Centre** showed that some deposits included useful invertebrates, particularly a putative well backfill (Carrott *et al.* EAU 1998/09). There may have been stable manure, and a sheep ked (*Melophagus ovinus*) was noted. Pit fills and dumps of 11th-12th century date at **Davygate** (Carrott *et al.* EAU 1997/51) proved to contain only poorly preserved insects, those present being indicative of decaying matter. Two concretions contained parasite eggs (*Trichuris* and *Ascaris*). *Heterodera* type cysts were abundant, perhaps indicating a phase of stasis and soil development, or backfilling with soil. Nearby at the **BHS Store, Feasgate**, a series of pit fills and dumps of 11/12th to 12/13th century date all contained insect remains in various numbers, and there were some shellfish (Carrott *et al* EAU 1998/16). Squashes for parasite eggs were all negative. Many of the deposits contained white flecks, probably calcium sulphate, reminiscent of those seen at 44-5 Parliament Street and regarded as symptoms of conditions promoting in-ground decay (Carrott *et al.* EAU 1995/8; EAU 1996/15; Kenward and Hall 2000; Davis *et al.* 2002) and perhaps indicative of the migration of salts from the overlying concrete slab. There was a void beneath this slab, a further echo of the Parliament Street site. The insects suggested an outdoor environment, sometimes with rather large numbers of dung beetles. There were indications of stable manure. One sample gave an assemblage which suggested open water, and another hinted at muddy foul matter in the open. It seems possible that this area was well to the rear of buildings so that wet and foul conditions could be tolerated. Was this use related to the presence of the standing Roman wall (and perhaps other structures), which may have inhibited drainage, or was it normal in such places? The spaces behind York's streets in the medieval period (and earlier), now seen in a tantalising way at several sites, deserve detailed investigation.

Hall *et al.* (EAU 2000/80) carried out evaluation of samples from near-surface deposits of 10th-12th century date revealed by excavations on land to the rear of 7-15 Spurriergate. All contained insect remains, often in abundance, and there were frequent records of eggs of intestinal parasites (both *Trichuris* and *Ascaris*). There were strong hints of stable manure from several of the insect assemblages. The presence of the spider beetle *Tipnus unicolor* and absence of grain pests was notable, suggesting a date very soon after the Norman conquest in view of other records of these beetles (pp. 342 and 378). There were *Damalinia* lice and sheep keds, presumably waste from wool-cleaning (p. 363), some possibly milled beetle remains (p. 363), charred insect remains (p.116), a honeybee, and aquatics which may have arrived via faeces (p. 403). These were most significant groups of remains, for reconstructing economic change after the Conquest and because the deposits lay so close to the surface and thus may be at threat from de-watering. The lack of funding to investigate them when the samples were fresh illustrates the academic limitations of PPG16 archaeology all too well.

Evaluation of 'medieval' buildup and backfill deposits at 45-57 Gillygate produced only yellowed traces of beetle remains and some mineralised millipedes (Dobney *et al.* EAU 1992/22). A little further out of town, Hall *et al.* (EAU 2001/15) examined a little material from ?14th and ?15th century build-ups at the St John's Coach Park, Clarence Street. The former contained only some rotted oyster shell, but the latter was more productive, yielding modest numbers of (generally rather poorly preserved) invertebrate remains, including earthworm egg capsules, soil nematode (*Heterodera* sp.) cysts, and beetles. Overall, the invertebrates suggest that this deposit was a buried soil which formed under grazing, or consisted of such soil which had been transported (as turf?). Beetles associated with foul decaying matter, often in grazed turf, were predominant, with very foul matter, probably dung, suggested, and there were specimens of some weevils typical of soil bearing short vegetation. Fauna of human occupation was represented only by a single *Typhaea stercorea*, which may have arrived in dung or hay, unless it originated in flight.

Evidence from a site beyond the walls to the north-east of York, at 50-52 Monkgate (Carrott *et al.* EAU 1995/20), suggested that further work in this area might be useful. One fill of a pit of 12th/13th century date gave traces of invertebrate remains, but a lower fill produced a small group of insects comprising components typical of the fauna of urban occupation sites, and some poorly preserved *Trichuris* eggs. A series of analyses of samples from deposits - mostly associated with graves - from the Jewbury site produced no invertebrates preserved by anoxic waterlogging (Hall *et al.* 1994). Several 'coffin stains' produced (inexplicable) charred remains of insect larvae, probably of flies or beetles, but these - as is common in such material - lacked diagnostic features (p. 116). The only other invertebrate remains found were some slug 'granules' (p. 79) and some objects which may have been invertebrate eggs.

Crossing the River Foss, a floor deposit of 11th/12th century date at 41-49 Walmgate proved barren of invertebrates (Kenward and Hall EAU 2000/20). At a site towards the likely periphery of York at this stage, 104-

112 Walmgate (Carrott *et al.* EAU 1992/03), evaluation of mid 10th-mid 11th century pits gave modest results. There were small groups of insects typical of medieval urban deposits, including several taxa typical of cess pit fills and other foul deposits. There were a few charred remains, including what was a probably a fly larva. Sites such as this one are of interest as potential sources of information about zonation across the full extent of York, and represent a priority for further work.

On the Ouse frontage, the **Gilbertine priory of St Andrew** was extensively investigated for biological remains (Allison *et al.* 1996a). Little was preserved by 'waterlogging', which was ascribed to a low input of organic matter and hostile ground conditions. Even charred and mineral-replaced remains were rare. Some of the waterlogged insects may have been imported to the site in peat. A few deposits contained eggs of intestinal parasites.

Much could be learned by a systematic study of sites of this period across central York, ranging from reconstruction of details of everyday life (living conditions, parasites, and so on) to investigation of broader issues such as the organisation of waste disposal, social and functional zonation and the degree of synchronicity of changes in housing quality and land use, and of course concerning the impact of the Norman Conquest.

York SW of the Ouse

There is little information from invertebrates of this period in York south-west of the River Ouse. Such records as do exist are from evaluation or assessment. Evaluation of cores from 11-13th century riverside deposits at **North Street** (Dainton *et al.* EAU 1992/17) showed preservation but (as is all too common with borehole samples) gave little substantial information. The proximity of River Ouse was echoed by two *Oulimnius* sp. (associated with clean flowing water and rather common in Ouse overbank deposits today). Following further excavation at this site, an assessment of material from a series of 11th-early 14th century dumps showed that the deposits were mostly rather impoverished of invertebrates, but that some useful groups were present (Carrott *et al.* EAU 1993/14). There were indications of dumped organic waste, but also a component which probably came from nearby semi-natural habitats. Deposits of 12th-13th century date at the nearby **Rougier Street** site were effectively barren of invertebrate remains (Allison *et al.* 1990c, 385), while organic matter, perhaps the remains of a wooden lining, from a pit containing 12th century pottery at 47-55 Tanner Row gave a trace of *Trichuris* eggs; no other analyses were undertaken (Carrott *et al.* EAU 197/24). At the **former Presto supermarket, George Hudson Street**, Hall *et al.* (EAU 2001/13) found no more than poorly preserved scraps of insect remains in deposits of 11th-?14th century date, although one pit fill did give some *Trichuris* and *Ascaris* eggs; this fill was not analysed for insect remains, however.

Downriver at **14 Skeldergate** (Allison *et al.* EAU 1991/06) a series of deposits accumulating against a 13th century wall were subjected to evaluation. The assemblages were varied, but there were indications of rather foul decomposing matter. The sheep ked *Melophagus ovinus* occurred in a sample with fullers' teasel and dyeplant seeds, probably indicating ejectamenta from wool processing (p. 363). Assessment of samples from 13th/13th century deposits (feature types not given) at the **NCP car park, Skeldergate** by Carrott *et al.* (PRS 2004/43) showed preservation of a range of invertebrates; in some cases there were hints of stable manure, dung and hay, and eggs of *Trichuris* and *Ascaris* were found. One layer was unusual in giving charred insects and mites, and a 'toasted' snail shell. Shellfish were present, mainly oyster. There was a single grain weevil, *Sitophilus granarius*.

As for central York, deposits in these peripheral areas present exciting opportunities for studies of patterns of social and commercial use as well as the whole gamut of details of daily life in a medieval town.

North Yorkshire, 1066-1350

Selby

Occupation deposits dated to the 12th-17th centuries were revealed in tree pits excavated in central Selby and samples from them assessed by Carrott *et al.* (EAU 1998/29). There were low to high concentrations of invertebrate remains, particularly insects, indicating an outdoor area of accumulating waste, at times muddy and perhaps with short-lived pools. There seemed to have been little vegetation nearby, suggesting very intensive disturbance. Stable manure was probably dumped, and domestic debris may have been present. There were some human fleas, and a single sheep louse, the latter probably shed during wool-cleaning, hints of stable manure, grain pests (*Sitophilus granarius* and *Oryzaephilus surinamensis*), and *Tipnus unicolor* (p. 378). There can be no doubt that large-scale excavations in some areas of Selby would reveal extensive deposits with good preservation by anoxic waterlogging, and the importance of this resource, rather rare in small towns and invaluable both for reconstructing the town's past, and for comparison with settlements elsewhere, was emphasised. To judge from this and other evaluations and assessments, Selby has immense potential for bioarchaeological investigations and may even prove to be on a par with Beverley in this respect.

Ripon, 1066-1350

Cut fills and surface deposits dated 12th-14th/15th century at The Arcade, subjected to evaluation by Jaques *et al.* (EAU 2000/59), proved to contain at most very decayed traces of insects and mites, and in one case *Trichuris* and *Ascaris* eggs. There was only a very small amount of marine shell, all oyster. A boundary ditch fill dated 12/13th century at the New School, Priest Lane, site gave only unidentifiable snail fragments (Jaques *et al.* EAU 2001/03). Rowland *et al.* (EAU 2001/24) reported evaluation of three samples from Skellgarths. Two were barren of invertebrates, but the third, from a 'waterlogged deposit', contained abundant remains. There were numerous cladocerans (mainly *Daphnia*) and ostracods, and immatures which were probably of aquatic insects, but only a few water beetles and bugs. Terrestrial insects indicated weed vegetation and the sorts of artificial habitats found round human habitation. There was, however, no strong 'house fauna' or indication of material such as stable manure. A sheep ked, *Melophagus ovinus*, perhaps from wool cleaning (p. 363), the spider beetle *Tipnus unicolor* (whose significance is discussed on p. 378), and ?*Heterogaster urticae* (p. 290) were noted; this material deserved further investigation. Evaluation of 11th/12th century pit fills at Wakeman's House by Jaques *et al.* (EAU 2001/09) produced at most traces of fly puparia and beetles, of no interpretative value, and 12th century pit fills at the Former Cathedral School, Low St Agnesgate, were barren of invertebrate remains (Jaques *et al.* PRS 2003/63).

Urban Scarborough 1066-1350

Elsewhere in Yorkshire few urban sites of this period have been investigated for invertebrate remains. A single sample, not well dated, from medieval occupation deposits at the 24-6 The Bolts (Hall and Kenward EAU 1990/11) gave a strongly synanthropic fauna, with house fauna and grain pests (*Sitophilus granarius*, *Oryzaephilus surinamensis*). Probably (with hindsight) this was stable manure. The marine littoral *Cercyon depressus* was recorded, perhaps indicating flooding by seawater or importation of seaweed – though perhaps just 'background fauna'. Deposits interpreted as infilling an ancient watercourse (the Damyet) at St Sepulchre Street were assessed by Hall *et al.* (EAU 1997/26). A layer representing 'natural silting' contained few invertebrates. A second layer gave a more substantial assemblage, including a range of 'house fauna' taxa and indicators of foul rotting matter. There were hints that stable manure may have been present. A 12th century buried ground surface at the Former Convent School, Queen Street, examined by Hall *et al.* (EAU 1996/54; 1996) proved barren of invertebrates. Deposits of 'medieval' date at 22 Quay Street were subjected to evaluation by Hall *et al.* (EAU 1996/35). Putative domestic refuse yielded only traces of ?crab and *Littorina* sp. (winkles in the wide sense), but a sample from what was probably a floor deposit contained a small insect assemblage, mostly synanthropes, suggesting rather damp organic detritus, a newly emerged ?*Apion* weevil offering a hint of cut vegetation, perhaps in stable manure. The grain pest *Oryzaephilus surinamensis* was present.

Insects from a sample from 13th century valley infill sediments at Springfield, were subjected to detailed assessment by Hall *et al.* (PRS 2004/48). Preservation of invertebrates was mostly good, sometimes very good. The fauna was predominantly of forms typical of medieval (post-Conquest) intensive occupation sites with plenty of waste organic matter. Overall, conditions seem not to have been too foul, with many beetles favoured by fairly dry litter, probably moister and fouler in places. Notable records were of a human flea (*Pulex irritans*), a sheep ked (*Melophagus ovinus*, probably from wool cleaning), and a bee, probably a honey bee (*Apis mellifera*). There were also some grain pests, *Sitophilus granarius* and *Oryzaephilus surinamensis*, and an unusual record of Ahasversus advena, typical of storage environments. These, with species perhaps imported with hay (*Apion* and *Sitona* spp.), and some others, hint at the presence of stable manure—corroborating one possible interpretation of the evidence from plant remains. (Human fleas are very typical of stable manure deposits, too.) There were at least two individuals of the spider beetle *Tipnus unicolor*, like the grain pests very typical of post-Conquest occupation deposits. A small insect component was indicative of heathland or moorland vegetation (*Micrelus ericae* and a strongly-sculptured *Altica* sp.). There was also a single elytron of one of the species of *Cercyon* found in stranded seaweed, perhaps just a stray rather than indicative of the importation of wrack (e.g. for animal feed or bedding). There was some marine shell, largely consisting of small fragments of limpet (?common limpet, cf. *Patella vulgata*), winkle (*Littorina littorea*) and mussel (*Mytilus edulis*).

Clearly, bioarchaeological evidence from waterlogged deposits in Scarborough has substantial potential to contribute to archaeological interpretation, and will also be illuminating in wider synthesis. The opportunity to carry out a large-scale detailed study of one or more sites with anoxic waterlogging in the town would be academically highly desirable.

Other towns in North Yorkshire, 1066-1350

In North Yorkshire, Johnstone *et al.* (EAU 1999/22) failed to find any invertebrate remains in ditch fills dated to the 11/12th-14th centuries at the Crown Hotel, Boroughbridge. Evaluation of a 12-14th century dump and a 'medieval' pit or well fill at Main Street, Spaunton, North Yorkshire, produced only traces of invertebrate remains (Carrott *et al.* EAU 1997/50). Evaluation of samples from 12th century ditch fills samples during excavation on land off Masonic Lane, Thirsk, by Carrott *et al.* (PRS 2001/04) produced no invertebrate remains. Assessment of two samples from a medieval ditch at the rear of 26 Market Place, Bedale, produced assemblages of freshwater snails, cladocerans and insects, with evidence of grassland and dung – presumably grazing land – beyond; there were traces of dead wood fauna (Carrott *et al.* PRS 2004/11). Assessment of ?12th century material from Castle Gate (formerly Scott Lane), Wetherby (Mant *et al.* PRS 2005/102) produced only small quantities of land snails and traces of marine shell. Molluscs from mid 13th to late 14th century deposits at St Giles by Brompton Bridge, between Catterick and Richmond, were described by Milles and O'Connor (1996). There was a little marine shell, a few land snails (opportunists of occupation sites, and some suggesting shadier spots), and freshwater species indicative of clean flowing water.

Urban Durham 1066-1350

A single site in the City of Durham has been investigated for invertebrates (principally insects): deposits at the rear of 61-63 Saddler Street (Kenward 1979d). Period 2 was dated to the 11th-12th centuries. A midden gave house fauna and foul decomposers and was perhaps stable manure; a pit backfill gave house fauna and weak hints of somewhat foul matter. With hindsight, a layer of uncertain origin may, on the basis of the insect fauna, also have contained stable manure. These were, so far as the invertebrate remains were concerned, very typical urban deposits of the post-Conquest period, although grain pests seem to have been absent. The evidence from the samples as a whole (pre- and post-Conquest) indicated vegetation of disturbed ground, with broom (*Cytisus scoparius*), presumably growing on the slope behind the site. See comments on the earlier deposits at this site concerning the need for re-interpretation (p. 216).

Evaluation of 12th-14th century pit fills from excavation at 5 High Street, Yarm, Stockton on Tees, produced no invertebrate remains (Akeret *et al.* PRS 2005/61).

Northumberland: urban Newcastle, 1066-1350

There is little urban material of this period from the North-East. A group of freshwater molluscs (with a single brackish water species) was recovered from beneath a street surface at the Crown Court site, Newcastle (Nicholson 1989b). It was suggested that this was an imported deposit, presumably from the nearby Tyne or a tributary. Also in Newcastle, marine molluscs from Queen Street were listed by Nicholson (1988; 1989a); mussels (*Mytilus edulis*) predominated in the period considered here, with some oysters (*Ostrea edulis*) and traces of a few other taxa. The same site yielded some insects, but full analysis was not possible (Nicholson and Kenward EAU 1986/22). There were traces of marine shell dated mid 13th-early 14th century at the Castle Ditch site (Rackham 1981).

Cumbria: Urban Carlisle 1066-1350

Evidence from invertebrates concerning the immediately post-Conquest period in Carlisle is very limited. At Lewthwaites Lane, Kenward *et al.* (AML 77/92; 2000) examined a single ?12th-13th century medieval deposit; there were no grain pests (in conspicuous contrast to Roman deposits), but a strong synanthropic component was present. The deposit may have been waste from a building, rapidly dumped and buried. Kenward *et al.* (AML 78/92; 2000) examined 12th-13th century well fills at Old Grapes Lane A. A classic house fauna group, very reminiscent of some from Anglo-Scandinavian Coppergate, York, was present and included a single *Tipnus unicolor* (see p. 378) and a human louse. There were abundant *Aglenus brunneus*, probably part of the house fauna rather than post-depositional in this case (*cf.* p. 482). Presumably this material was dumped into the well after it fell into disuse since the species present (including those just mentioned) were unlikely to have entered naturally in the recorded association. Some 'medieval' pit fills gave rather little evidence, but there were three occurrences of single *Oryzaephilus surinamensis*. Assuming that these are not contaminants from the abundant grain pests in the Roman layers, they perhaps indicate the re-invasion of these species as the medieval period progressed in Carlisle, parallelling evidence from elsewhere (p. 342). 'Medieval' pits and wells were investigated at the Annetwell Street site (Large and Kenward EAU 1987/15); the insect fauna from the wells suggested weedy open ground, with perhaps a 'pitfall' effect trapping ground beetles, and hints of imported heath or moor vegetation or turf. The pits produced an undistinguished fauna indicating decaying matter, although one yielded abundant remains of the large dung beetle *Aphodius rufipes*, suggesting herbivore dung on nearby surfaces, or dumping of herbivore faeces into the pit.

Insects recovered by non-standard methods from samples from excavations at Rickergate, just to the north of the Lanes sites, were assessed by Kenward (EAU 2002/13). Most of the material came from the fills of a large ditch fronting the medieval city wall, giving abundant ostracods, and Cladocera, chironomids and aquatic insects. Subjectively, the water was still and not too polluted, and the rarity of synanthropes of the kind likely to have been present in dumped waste material was striking, suggesting rigorously-enforced statutes banning dumping in the ditch. Terrestrial insects suggested herbaceous weeds along the ditch sides. A cut fill gave few invertebrates, but they included the three main grain pests.

Chester 1066-1350

An extensive assessment of material from **Bridge Street**, mainly based on Bulk Sieving samples, produced only very small amounts of invertebrate remains other than shellfish (Hall *et al.* PRS 2002/16; Jaques *et al.* PRS 2004/46). Morris (1990) reported 13th century molluscs from the **Domincan Friary** site: there were oysters and mussels, and abundant *Helix aspersa*, thought probably to have died in hibernation places and not to have been part of the diet. There were also a few *Cepaea nemoralis* and traces of other land snails.

Urban South Yorkshire 1066-1350

A large number of samples from deposits of 12th-14th century date from the **North Bridge** site, Doncaster have been examined (Carrott *et al.* EAU 1997/16; Hall *et al.* 2003c; Kenward *et al.* 2004a). Most were barren of invertebrates, or almost so, but useful results were obtained nonetheless. Several of the deposits contained small to large numbers of statoblasts of the bryozoan *Cristatella mucedo* (p. 88); these deposits were often floors. It was not clear whether *C. mucedo*, and in one case a group of helmid beetles (associated with clean flowing water), had been deposited by flooding, or introduced in silt used to make level floors, or even whether they might have been brought in buckets of water. One well fill gave a small group of beetles, including house fauna, and abundant puparia of the fly *Thoracochaeta zosterae*, regarded as tolerant of very foul conditions. It seemed possible that, at the stage represented by the fauna, the fill was too foul for successful invasion by many beetles, the presence of *Creophilus maxillosus*, a maggot-predating rove beetle sometimes found in vile conditions, perhaps supporting this. Alternatively, the layer may have been sealed too rapidly for large beetle populations to build up. Food plant remains, including bran, suggested a possible origin in faeces but no parasite eggs could be detected. Shellfish remains were very rare and the evidence as a whole suggested non-domestic use of the site despite abundant structural evidence. The material from Doncaster demonstrates effectively the value of large-scale (and relatively cheap) survey of sites with sporadic preservation. Any opportunities to make bioarchaeological investigations of material of this date in the city should be grasped.

Jones and Nicholson (AML 229/87) examined some 'medieval' pit fills from the **Tanners Row** site, Pontefract, for parasite eggs. Quite large numbers of *Trichuris* and *Ascaris* were present in three of them, and smaller numbers in two others. Measurements showed that most, if not all, of the *Trichuris* were *T. trichiura*, although some (probably aberrant) 'wide' eggs were found. They reported that 'almost all the samples contained large numbers of insect fragments', but no analyses were carried out.

Samples from various features dated as 'medieval' at **Sprotbrough Hall Gardens, Sprotborough**, were investigated by Jaques *et al.* (PRS 2004/37). Most were barren of invertebrates, but a putative cess pit gave some concretions containing *Trichuris* and ?*Ascaris* eggs, the former measured and probably *T. trichiura*, while a ditch fill gave poorly preserved remains of large numbers of cladocerans and chironomid midge larvae. Insects were present in small numbers in the latter sample, and suggested herbaceous vegetation, with no synanthropes or dung beetles.

The potential of urban invertebrate remains of this period from the north of England for reconstruction at the context and site level, as well as for investigation zonation within towns, and contrasts between towns, and for wider synthesis, is great, and many topics might be addressed. Investigation of conditions in small towns is desirable, although deposits with good preservation have so far proved hard to locate. A specific problem related to the invertebrates is the timing of re-appearance of the grain pests across the region (and elsewhere), since this is likely to be closely related to both local and large scale changes in economic systems. The evolution of building types and the nature of open areas, and of waste disposal systems, and changes in the abundance of ectoparasites and disease-carriers, will also be traceable, using insects in particular.

Rural northern England 1066-1350

Evidence from 'waterlogged' deposits from rural (farm and village) sites of the later 11th to 14th centuries is very limited, remarkably so in view of the enormous numbers of settlements which existed at the beginning of the period on the evidence of the Domesday Book (e.g. Darby and Versey 1975; Rowley 1978, 105 ff.). Division of sites between this and the previous section has not been easy and is sometimes arbitrary.

Rural North-East Lincolnshire 1066-1350

Pit and ditch fills of 12th-13th century date associated with a medieval village at Healing, near Grimsby, North Lincs, were evaluated by Carrott *et al.* (EAU 1995/45). Scant evidence was recovered. There were only traces of insects, and worm egg capsules and *Heterodera*-type cysts were of doubtful age in view of the presence of the burrowing snail *Cecilioides acicula* (p. 483). One pit fill gave a (presumably ancient) mollusc assemblage, with numerous *Cochlicopa lubrica*, which perhaps lived amongst damp vegetation. A further evaluation at Healing (Carrott *et al.* EAU 1998/18) mostly proved that the deposits were similarly impoverished, though a fill of an enclosure ditch did contain aquatic snails and insects, as well as *Daphnia*; most of the remaining insects may have lived by water, and no synanthropes were detected. There was a little hand-collected marine and freshwater mollusc shell. Post holes of 12th-14th century date at Ayelsby, west of Grimsby, gave a few snails (including *Celiciloides acicula*, p. 483) and a trace of insect cuticle (Carrott *et al.* 1995).

Rural East Yorkshire 1066-1350

In East Yorkshire, deposits at some rural sites in and around Hull have been examined for invertebrates under PPG 16. A single ditch fill of 'medieval' date at a site at Malmo Road was examined by Carrott *et al.* (EAU 1997/38). The only invertebrates were a few earthworm egg capsules. A ditch fill of 11-13th century date at a site at the junction of the Foredyke and the River Hull, Kingswood, produced a range of invertebrates, the insects including aquatic and waterside forms, house fauna, and species from disturbed ground, while a single honey bee was noted (Carrott *et al.* EAU 1998/07). Another site near Hull, the Old Manor House, Baynard Castle, Cottingham (Carrott *et al.* EAU 1995/34), gave very limited preservation of most invertebrates in deposits of 12th-14th century date, but there were some marine molluscs. The very large size of some of the whelk (*Buccinum*) and oyster (*Ostrea edulis*) shells was notable; it is unfortunate that a more detailed study of more material could not be made. Other invertebrate remains (*Heterodera* cysts and *Cecilioides acicula*, p. 483) seem likely to be post-depositional contaminants. Ditch fills dated late11th-early 13th century at the Coopers Farm site, Long Riston (evaluation by Hall *et al.* EAU 1999/13) produced only traces of invertebrate remains. Evaluation of material from a later excavation at this location by Jaques *et al.* (PRS 2002/07) was more successful. Three ditch fills dated in the range late 12th to early 14th century produced assemblages of invertebrates indicative of aquatic deposition. In one case *Daphnia* were extremely abundant, together with numerous ostracods. Terrestrial beetles were not common, although one fill included a fauna suggesting herbaceous vegetation on foul matter, and there was a record of the enigmatic ground beetle *Pterostichus madidus* (p. 283). There was a trace of hand-collected marine shell. Evaluation of 12th-13th century (and undated) pit, ditch and post-hole fills at Station Farm Cottage, Souttergate, Hedon, gave only traces of land and freshwater snails and a trace of ?charred insect cuticle (Akeret *et al.* PRS 2004/71). Romano-British ditch fill and surface-lain deposits at 5 The Burrs, Brough, examined during evaluation gave no 'delicate' invertebrate remains, but there wes a fairly large group of land snails in a demolition deposit (Akeret *et al.* PRS 2004/72). The site produced some hand-collected shell, mostly rather poorly preserved oysters. A series of samples from pit and ditch fills dated as 'medieval' at Welham Bridge gave no invertebrate remains (Hall *et al.* PRS 2004/74).

Pit fills associated with a medieval building platform at West End, Kilham were barren (Hall *et al.* EAU 1999/17).

Rural North Yorkshire and York 1066-1350

Assessment of 'medieval' ditch fills at Crankleys Lane, on the route of the Easingwold by-pass (Carrott *et al.* EAU 1993/32) gave assemblages of insects and aquatic snails suggesting still or sluggish weedy water, the surroundings being disturbed ground with a limited vegetation cover, some dung and litter. Ditch fills of 13/14th century date at Slingsby yielded no invertebrate remains (Carrott *et al.* EAU 1998/08). Hall *et al.* (PRS 2003/42) examined a 12th century ditch fill at The Spinney, Sherburn-in-Elmet. Insects were abundant, with aquatics numerous; there were also some cladocerans and aquatic snails. Terrestrial forms indicated litter and herbaceous vegetation, with rather few dung beetles. Girling and Robinson (AML 36/88) investigated insects in the fills of a putative mill pond (perhaps later a fishpond) of Saxon or later date at Wharram Percy. The aquatic fauna was impoverished, and there were no species associated with emergent vegetation. It was suggested that this resulted from occasional emptying of the pond because its flow was limited (but if it was used as a fish pond, the activity of large numbers of fish may have controlled insect populations and comminuted their corpses). The surroundings seem to have had little or no woodland or scrub, and only cruciferous weeds and some other herbaceous plants were indicated. There were a few dung beetles, but perhaps insufficient to stand as evidence that the area was intensively grazed. No species primarily associated with human occupation were noted. Mant *et al.* (PRS 2005/51) found only traces of snails, mostly *Cecilioides acicula* in an evaluation of 12th/13th and 12th/14th century pit and ditch fills and a single floor layer at Back Side, Duggleby.

Carrott *et al.* (EAU 1992/11) carried out an evaluation of 'medieval' deposits at Rawcliffe Manor, Manor Lane, Rawcliffe, York. A fill of the original moat cut gave *Daphnia* ephippia and a primarily aquatic and waterside insect assemblage (*Helophorus* spp. being predominant). Terrestrial insects were rare, and no synanthropes were recorded. Other medieval deposits which were analysed, including fills of what may have been a fishpond, gave no useful invertebrate remains. Hall *et al.* (EAU 2001/15) examined a ?15th century build-up at the St John's Coach Park, Clarence Street, York, which may have been a grazed soil (p. 236). A 12th century ditch fill at D C Cook, Lawrence Street, York (Hall *et al.* PRS 2003/33) gave a useful assemblage of remains. There were some water beetles (mostly *Limnebius* sp.) and a few ostracods. Waterside insects were present, but rare. The terrestrial fauna included species from weeds and more established vegetation (perhaps even trees or shrubs), dung, and perhaps from in or around buildings. This ditch may have only held water for part of the year, or have been overhung by trees and thus been too shaded for the development of a rich aquatic fauna.

Johnstone *et al.* (EAU 2000/06) reported an evaluation of an 12/13th century ditch fill at Sherburn: they found only numerous *Cecilioides acicula* (p. 483), some other landsnails and a weevil head, which may or may not have been ancient.

Rural sites in the west of the region 1066-1350

Hall and Large (EAU 1996/46) reported assessment of two samples of sediment from cut fills from a site near Penrith, Cumbria, of 'early medieval' date. No useful invertebrate remains were recorded, and those present may have been intrusive. Some 11/12th-16/17th century pond or moat fills at a site at Higher Lane, Fazakerley, Merseyside were examined by Dobney *et al.* (EAU 1995/22) and Hall *et al.* (EAU 1996/05). The feature was adjacent to a domestic enclosure in use through 500 years in the medieval and post-medieval periods. Three radiocarbon dates were obtained: cal AD 1055 to 1090 or 1150 to 1295 (the second being more probable); cal. AD 1440-1665; and cal AD 1180 to 1310 or 1365 to 1375 (the first being the more probable). Thus the sequence extends beyond the current period, but the material is most usefully considered as a unit. Analysis of pollen, plant macrofossils and insect remains indicated an initial phase of aquatic deposition, probably with slumping from the pond sides, followed by a prolonged phase of stable, eutrophic but not heavily polluted, aquatic conditions with a rich insect fauna, this in turn giving way to a phase of terrestrialisation, again with a substantial input of mineral sediment. Remarkably few organisms indicative of intensive occupation were recorded, which seemed odd in view of the excavation evidence for a structure within 30 m of the pond. This may have been a result of the presence of a boundary between the pond and the building, and perhaps also of the prevailing wind direction at times when insects were migrating (see below, p. 462). The wider area around the site may have been largely arable land with mature hedges or patches of trees; there was no evidence for the watering of stock.

A fill of a 12th century ditch, believed to be part of the defences of Nantwich Castle, Cheshire, was reported by Colledge (AML 3347); a qualitative list of beetles, compiled with the assistance of P. J. Osborne, from the lower fill (an organic mud) was given. The beetles included species likely to have lived in and on the margins of the ditch, indicating that there was not excessive disturbance. There was also a range of taxa likely to have exploited fairly foul decaying matter, with hints of something resembling stable manure. The plant remains included components suggesting hay or straw, perhaps supporting the presence of stable litter.

Rural sites in West Yorkshire 1066-1350

Carter (2001) described land snail assemblages of 'post Anglo-Saxon' and 13th century date from ditch fills at Becca Banks, on the line of the A1-M1 link road. The earlier group perhaps reflected the spread of an adjacent arable field across the infilling ditch, but the latter was dominated by (presumably intrusive, p. 483) *Cecilioides acicula*.

Themes for the period 1066-1350

Invertebrate remains from sites of the period 1066-1350 have much potential to address archaeological questions, and doubtless to generate new ones. It will be possible to determine the impact of the Norman Conquest on everyday life and living conditions in towns, using insect remains in particular (together, of course, with evidence from plant and vertebrate remains). One central entomological aim will be to follow the return and dispersal of the grain pests (with concomitant implications for the pattern of trade and systems of grain storage, p. 342). A reconstruction of changes (or lack of them) in rural life is also to be aimed for. The rarity of anoxic preservation in rural deposits places a great premium on such material. We should seek explanations for the rarity of sites with organic preservation, although one suspects that the primary one is the removal of organic waste to the fields, something that was often not an easy option in towns, where it was often left in self-preserving masses where it fell, or removed to middens and pits where preservation was likely. Another likely cause is the fact that rural houses could generally be sited on elevated ground, for drainage, whereas pressure for land in towns frequently lead to exploitation of unsuitable, less well drained, terrain, so that floors were more likely to experience net accumulation of organic matter. This makes those cases where preservation is found on rural sites disproportionally important, even if the deposits are only in wells or ditches rather than in activity areas. Landsnails may provide a source of information about rural land use, but any datable insect assemblages associated with fields should be studied. Natural deposits dated to this (as to almost any other historical) period would be invaluable both for investigating the impact of human activity on natural and semi-natural ecosystems, and for climatic reconstruction (particularly interesting in relation to the medieval warm period and perhaps the first warnings of the Little Ice Age). Bridging this and the succeeding period, studies of sites or groups of sites which allow the impact of the Black Death to be judged are a promising area of research (see Rowley 1978, 120 for discussion of effect of plague on villages, for example).

7. Late medieval to modern (AD 1350 to present)

This period, starting with the recovery from the 'Black Death' plague outbreak (1348-9), saw more or less uninterrupted cultural 'progress' leading to the present day. Deposits of this late date were much neglected in the early years of modern environmental archaeology, because they were widely regarded as not being 'proper' archaeology, academically of limited value compared with the earlier ones (and for many archaeologists, especially by comparison with the Roman!). The institution of PPG16 (HMSO 1990) has meant that numerous later and post-medieval sites have been investigated in the past few years but the information obtained has been patchy since most have been subjected only to evaluation (Hall and Kenward 2006). However, the rare detailed studies have produced some particularly interesting results. Formerly often being cleared without record, deposits of this period now tend to be excavated more frequently as a result of the digging of numerous shallow evaluation trenches. From the palaeoecological point of view, this period is of special interest in encompassing the Little Ice Age, the effects of which are to be sought both in changes in natural communities and in evidence concerning human economy and activity. (For a recent review of climate change in Europe in the past millennium see Guiot *et al.* 2005.) The impact of the Little Ice Age on human society has been graphically demonstrated for Greenland (e.g. Buckland *et al.* 1996); its economic effect in northern England may not have been so dramatic, but was perhaps more significant in that far greater populations and urban societies were involved. Set against this are the effects of recovery from the Black Death, of increasing overseas trade, of rapidly growing population, of the rise of technology, and the consequences of the last two in escalating demand for resources and land.

Urban sites post 1350

Urban material of the late- and post-medieval, and especially of the early modern, periods has tended not to be collected for bioarchaeological analysis until very recently, and the enormous potential of such deposits still seems generally unappreciated. This is a serious loss; for although these late deposits are often barren of material preserved by anoxic waterlogging, or nearly so, and they may have been damaged by recent groundwater changes (e.g. superficial deposits in York), they may contain remains of great importance to archaeological reconstruction and to historical biology. Material of very recent date, since the beginning of the systematic study of insects and other invertebrates, has much potential since it provides opportunities for checking early collecting records against death assemblages, and for tracking the arrival and spread of aliens, as well as for relating archaeological interpretations to what are in some cases extremely full documentary records. There is rather more archaeological material of the later medieval period than of more recent date, however.

Urban East Yorkshire post 1350

There is a moderate amount of material of this period from Hull and Beverley (below), but little else from the county. Hall *et al.* (EAU 1999/59) reported assessment of moat, hearth and pit fill deposits associated with an Augustinian Priory at Cottingham. This was founded circa 1321, so the deposits probably belong to the period being considered here. Only the primary fill of the moat yielded useful invertebrate remains, which were abundant and very well-preserved and indicated a rich aquatic environment with much vegetation and no indication of dumping (although there was some indication of human settlement). A small assemblage of molluscs was predominantly of freshwater forms. AMS dating and further analysis of these remains would have been worthwhile.

Hull

Analyses of rather poor material from Mytongate carried out in 1977 were published in Miller *et al.* (1993). There were records of *Tipnus unicolor* (see p. 378), the grain pests *Sitophilus granarius* and *Oryzaephilus surinamensis*, and the human flea *Pulex irritans* from 15th century pits, and hints of weedy but rather barren surroundings and disposal of miscellaneous materials. Nearby, at Queen Street (McKenna 1993), a 17th century garderobe gave abundant parasite eggs (*Trichuris* and *Ascaris*). The whipworms were shown by measurement to be *T. trichiura*. Insects (fly puparia at least) were preserved in this pit, but not analysed, and crabshell was noted. A 14th century pit fill with plants of wetland and disturbed ground produced a large number of *Daphnia* (water flea) ephippia, which McKenna suggested was indicative of at least seasonal standing water.

Samples from deposits of 14th-20th century date from the Magistrates' Court site were assessed by Carrott *et al.* EAU 1995/17 and Hall *et al.* EAU 2000/19 Hall. Unfortunately it transpired that almost all the delicate biological remains from the Friary phase of the site relevant to this section were redeposited from earlier occupation, the exception being some post-depositional invaders of grave fills (Hall *et al.* EAU 2000/25; see also p. 434).

A series of samples from Sammy's Point, predating and associated with the construction of the citadel (about 1681), and from later deposits, was examined by Carrott *et al.* (EAU 1997/21; 1998/25). Of the earlier material, one sample yielded only mollusc shell fragments, the other a small insect assemblage reflecting synanthropic and natural habitats, and including the only grain pest from the site (*Sitophilus granarius*). The material associated with the construction phase included four General Biological Analysis samples, all of which gave invertebrates indicating aquatic deposition, weedy vegetation (especially nettles, *Urtica* sp.), artificial habitats, and in two cases foul matter. Deposits associated with the 16th century gun emplacement were essentially barren. A feature identified as probably an earth closet, of 18th-mid 19th century date, yielded numerous fly puparia, including *Thoracochaeta zosterae*, discussed on p. 71. Hand collected shell was often poorly preserved, mostly Ostrea, with traces of *Mytilus* and *Cerastoderma*. Some of the deposits associated with the **Hull Citadel Moat** gave small groups of invertebrates: a few insects, mostly aquatics or of probable transported origin, and some water fleas (Carrott *et al.* EAU 1997/22).

Evaluation of a sample from a suspected buried soil of mid 15th-late 17th century date at **Citadel Way** (Hall *et al.* EAU 2001/37) produced an insect fauna (and flora) indicative of poor pasture or weedy waste ground; there were also beetles suggesting fairly foul matter. A second sample, from a deposit identified as a ground raising dump of the early 15th century or earlier, gave only a few scraps of poorly preserved seeds and insects, but tests of Foraminifera were quite common, indicating an estuarine influence. There were also a few ostracods, further study of which might have given an additional guide to salinity. Additional excavation at this site revealed buried turf lines and a moat fill (Hall *et al.* PRS 2001/03). A 'pre-Henrician' buried turfline (? early 16th century) gave abundant insects, with freshwater aquatics, waterside and terrestrial species, including indicators of human occupation. In the last category, the spider beetle *Tipnus unicolor* was notable (*cf* p. 378). The snail *Hydrobia ventrosa*, typical of wetlands with a saline influence, was quite abundant, suggesting flooding from the River Hull. A turfline (or windblown deposit) of the mid 16th century also gave aquatic, waterside and terrestrial invertebrates, but with only weak indications of insects typical of human occupation, and a snail assemblage dominated by *H. ventrosa*. A third turfline, of 17th century date, was also rich in insects, with variable preservation of the kind considered to be typical of soils (p. 121). Again formed in a marshy area, with aquatic and waterside taxa, this deposit contained few terrestrial forms and only a trace of species favoured by human occupation. A 17th century moat fill gave only a trace of very decayed insects - making the site an unusual case where surface deposits rather than cut fills gave preservation of delicate remains. Further investigation at Citadel Way, at the **Paragon BMW showroom** involved evaluation of various deposits associated with the Citadel, gave a little more information (Hall *et al.* PRS 2004/31). One of three deposits from mid 16th-17th century turflines produced insects with variable preservation – not surprising in a turf (Hall *et al.* 1980). There were some aquatics (including *Daphnia*) and waterside species, while dry land fauna comprised disturbance-tolerant forms, including modest numbers of dung beetles. There were almost no insects suggesting human occupation. A moat fill of late 17th to early 19th century date gave few invertebrates, with hints of aquatic deposition, while an early 19th century clay dump gave a few insects, including dung beetles; two related dumps gave only traces of invertebrates. Fragments of freshwater mussel shells (not identifiable to species) were noted in some of the samples from this evaluation, suggesting stable aquatic habitats.

In the same area, evaluation of 16th-18th century deposits at **Tower Street** by Carrot *et al.* (PRS 2003/07) produced a few assemblages of invertebrates. An early 16th century (or earlier) floor deposit was barren apart from *Heterodera* (soil nematode) cysts and a trace of land snails, while a mid 16th-late 17th organic silt contained abundant water flea ephippia and a trace of Foraminifera, the latter attesting a saline influence, and insects giving hints of foul matter. Also of the latter date, a pit or ditch fill gave cladocerans, including *Daphnia*, and a few insects, among them enough *Aphodius* dung beetles to hint at grazing nearby. A late 17th-mid 19th century turf line contained only earthworm egg capsules, while another of 'pre-citadel' date was completely barren. A late 17th-18th century ?moat fill contained fragmented freshwater mussel valves, probably *Anodonta*, suggesting long-term flooding of a rather large body of water. Samples from evaluation in **Castle Street** were rather depauperate so far as invertebrates were concerned (Hall *et al.* PRS 2004/32). A 12th-14th century floor layer gave only a few, ecologically-mixed, insects, but there were numerous *Daphnia* ephippia and *Lophopus crystallinus* statoblasts, which must either have been from spilled water or from imported waterlain sediment. A 'medieval' ditch fill gave a sheep ked, *Melophagus ovinus* (p. 363), and a pit fill dated 14th century or later included well-decayed *Daphnia*. There were a few molluscs, mainly oysters, but also traces of freshwater mussel.

Several associated excavations at **Blanket Row** have provided invertebrates from occupation deposits of the late 14th through to 17th centuries (Carrott *et al.* EAU 1997/18; 1999/12; 2001/12; 2001/48; Johnstone *et al.* EAU 1999/01). Preservation was sporadic (in contrast to the earlier 14th century deposits at the same site, p. 222), and it seemed likely that in several cases the insect remains recovered represented the more resistant component of a formerly large assemblage. There were indications of house fauna, and *Sitophilus granarius* was present in a 17th century pit. There were quite large numbers of shellfish, dominated by oyster (often with marks made during their opening, see p. 85), cockle and mussel, with occasional common whelks. Some oysters had slots or cuts, whose purpose was discussed; see also p. 430. Assessment of two samples dating to this period from Liberty Lane was carried out by Large *et al.* (EAU 1999/57). A barrel well fill of 15th-17th century date contained primarily house fauna (p. 372), with some components from elsewhere, and a culvert fill of 16th-18th century date gave only traces of insects and a few freshwater snails.

Rackham (2001) reported assessment of fifteen bulk-sieved samples from supposed alluvial and foreshore deposits at Chapel Lane Staithe. Almost all contained beetles, though there was no ecological breakdown or quantification. It was suggested that the deposits may have formed in a protected situation behind the waterfront, and analysis of insects (and other remains) was advocated. Marine shell was present in modest quantities, and there were some snails, including the halophile *Hydrobia ulvae* (discussed on p. 301). At Blaydes Staith, High Street, Akeret *et al.* (PRS 2004/76) examined various deposits during an evaluation; half gave appreciable numbers of insects. Two groups from ground raising deposits appeared to be largely natural-habitat fauna, with numerous aquatics and waterside taxa and plant feeders well represented. The halobiont *Ochthebius ?auriculatus* was present, and there was a grain beetle, *Cryptolestes ferrugineus* and other hints of dumping from a building. A foreshore dump included numerous *Cercyon depressus*, associated with rotting stranded seaweed, but also occupation-site fauna including species from dryish decomposing matter and from fouler open-textured material, and the grain weevil *Sitophilus granarius*. This deposit was perhaps stable manure in view of its content of plant remains. Decayed wattle, perhaps of the 14th century, gave aquatics, plant feeders, and another *S. granarius*. Hand collected shell was mostly oyster, but one context gave numerous remains of the large land snail *Helix aspersa*.

Jaques *et al.* (PRS 2003/01) examined 'pre-18th century' cess pit or dump deposits at 54-7 High Street in an evaluation. One layer gave clean-water indicators including the Bryozoon *Lophopus crystallinus* (p. 88), house fauna and foul decomposers, the other an assemblage of decomposers typical of foul open-textured material and some plant feeders perhaps brought with hay, as well as a grain weevil (*Sitophilus granarius*): both layers probably included stable manure (see p. 400). Dating of samples from Hull central Dry Dock, Humber Street, examined during evaluation by Akeret *et al.* (PRS 2004/87) cannot be easily determined from the report, but one from a land reclamation deposit gave occupation site fauna, including decomposers from dryer and fouler decomposing matter and grain pests, perhaps stable manure. There was a specimen of the ground beetle *Pterostichus madidus* (p. 283).

Evaluation (using non-standard methods) at Site R3, Island Wharf, Hull Marina (Hall *et al.* PRS 2003/23) produced a small group of well-preserved insect remains, including aquatics, one of the 'seaweed' *Cercyon* species (p. 298), and several clover weevils (*Sitona* sp.). The last are discussed on p. ; in the present case, importation with stable manure seems possible, the weevils having originated in hay, or leguminous crops (such as the haulms of beans, vetches or other plants or the seeds of beans used for fodder). There were also a few snails, two of which were cautiously identified as the salt-loving *Potamopyrgus jenkinsi*, first recorded in this country in the mid-19th century (p. 301), giving cause to question the dating of the deposit.

Thus, as in the case of Beverly, later- and post-medieval invertebrates in Hull have received remarkably little attention, and there is much which could be done. One particular area for investigation is the arrival of aliens through the port and their subsequent establishment or failure. The expansion of the town across the marshlands of the River Hull will provide opportunities to reconstruct land use and environment there. Waterlogged preservation appears to be widespread, if not necessarily excellent, in later deposits in Hull.

Urban Beverley post 1350

Few opportunities for full examination of later medieval or post-medieval deposits have been taken in Beverley, and dating has sometimes been broad.

Central Beverley

Some evaluations have yielded information relevant here. That at Champney Road (Carrott *et al.* EAU 1993/01) showed that 15th-16th century pit fills were mostly effectively barren of invertebrate remains, but one gave hints of decaying organic matter resembling stable manure. Mid-late 14th century pit fills, including a garderobe pit, at Eastgate were not fully analysed for invertebrate remains, but there were abundant *Trichuris* and *Ascaris* (McKenna 1992). A garderobe fill dated c. 1400-1500 at Lurk Lane produced abundant *Trichuris*, identified by measurement as *T. trichiura*, and some *Ascaris* (McKenna EAU 84/16; 1991).

Assessment, then analysis, of samples from 15th century fills of a large pit at Morton Lane (Hall *et al.* EAU 2002/02; Kenward and Carrott PRS 2003/58) revealed large plant and invertebrate assemblages, the former including numerous tree buds and bud scales as well as numerous useful or cultivated species. Aquatic insects were abundant, and *Daphnia* and ostracods present in appreciable numbers, suggesting that the pit held water, which was not too foul and contained aquatic plants, or that waste water was directly or indirectly disposed of into it in very large quantities. There was some evidence from the insects concerning conditions nearby, with indications of typical occupation site weeds. Organic waste seems to have been dumped in the pit, surprising in view of the indications of clean water, for there were numerous decomposers from dry to foul matter. This contradiction was discussed (assuming that the aquatics did not arrive in waste water), and it was suggested that there were three possible explanations: (a) small amounts of litter, insufficient to pollute the water excessively, may have been deposited over a period; (b) there may have been two short episodes of dumping (for the two contexts recognised); or (c) the cut may have been completely backfilled at one time. In the last two cases, remains in sediment already in the pit may have become dispersed among the dumped material, in the way postulated for the Roman well at Skeldergate, York (Hall *et al.* 1980). The dumped material appeared likely to have included stable manure. There were grain pests (*Oryzaephilus surinamensis* and *Sitophilus granarius*) and *Tipnus unicolor* , in contrast to their absence from earlier deposits (the significance of variations in abundance of these insects is discussed on pp. 343 and 378 respectively). The bark beetle *Leperisinus varius* (see p. 314) was rather abundant, and in this case perhaps originated with the bud scales recorded by Hall *et al.* (EAU 2002/02) rather than from timber or firewood; a deathwatch beetle (*Xestobium rufovillosum*, indicative of old timbers in a building), the ground beetle *Pterostichus madidus* (p. 283) and a honey bee, *Apis mellifera* (p. 358), were found, among other notable remains. At Hall Garth, moat fills of pre-14th century to modern date were sampled for analysis but bulk-sieved, no recovery appropriate to small invertebrate remains being carried out (Dobney *et al.* EAU 1994/60). The bulk sieving washovers contained insects showing clear potential for reconstruction of conditions in and around the moat, but of course the smaller remains were lost - an unfortunate lost opportunity. Molluscs indicated slow moving or still water with a muddy substrate, probably abundant aquatic vegetation, with hints of an inflow. Land snails were rare, all catholic forms, and the assemblages were dominated by slug plates.

Southern Beverley

Jaques *et al.* (EAU 2001/35) reported evaluation of samples from deposits dated to the 17th century exposed by excavations on land behind and adjacent to 52 Keldgate. A ditch backfill gave only a few landsnails, while a cistern fill gave a range of terrestrial snails indicating rather damp, sparsely-vegetated, soil. There were no 'delicate' invertebrate remains. Six pitfill samples from land north of Keldgate Close were assessed by Hall *et al.* (PRS 2003/48); the only invertebrates were fragments of shell, including traces of land snails.

Evaluation at North Beckside and Beckview Tilery (Carrott *et al.* EAU 1993/05) produced a variety of deposits of 13th-17/18th century date. A garderobe fill gave some beetles and *Daphnia* ephippia, but dating was too vague for the data to be of much use. At South Beckside, Hall *et al.* (EAU 2000/15) examined two deposits relevant here: a 14th-17th century organic layer with peat, insects from which included aquatics and species from foul and dryer decaying matter which may have originated in dumps; and a 19th century ditch fill, with aquatic and waterside beetles and others suggesting dung or moist plant litter. The latter may have originated in stable manure, suggested by the plant remains, but there was no 'classic' stable manure fauna (of the kind discussed on p. 400). Dumping was suggested by a sheep ked (*Melophagus ovinus*), probably from wool cleaning (p. 363). Evaluation of two occupation deposits of 14th-17th century date sampled during further excavation at North Beckside was reported by Jaques *et al.* (PRS 2002/06). One deposit was barren, and a putative external accumulation layer gave only small numbers of insect remains, including, however, the spider beetle *Tipnus unicolor*, very typical of post-medieval material (p. 378). Small amounts of marine shell, mainly oyster, were hand-collected. Hall *et al.* (EAU 2001/21) reported evaluation of a pit fill dated late15th/16th century at Waterside Road, finding only some terrestrial and freshwater snails and a trace of marine shell.

Two 'deposits' at Jack Taylor Lane (Carrott *et al.* EAU 1998/10), dated to the 14/15th and 16/18th centuries, gave a range of invertebrate remains including insect assemblages; in both cases the fauna was primarily indicative of natural or semi-natural conditions, but with some synanthropes and parasites eggs suggesting dumping from occupation. There were sheep keds (*Melophagus ovinus*), too, probably from wool cleaning (p. 363). Grain pests (*Oryzaephilus* sp. and *Sitophilus granarius*) and *Tipnus unicolor* were noted.

This period in Beverley clearly requires further attention, and any well-dated deposits should be properly investigated bioarchaeologically.

Other towns in East Yorkshire

As mentioned above, it is often hard to determine whether deposits in smaller towns and villages were deposited in urban or rural environments, and some sites may be mis-classified in this review as a result.

Pit fills of 18th century date revealed by evaluation excavation at land to the west of the Railway Hotel, 5 Middle Street, South Driffield, contained considerable numbers of water fleas (*Daphnia* and some other types) and insects, the ecological nature of the latter unfortunately not being given in view of the rarity and potential interest of material of such late date (Akeret *et al.* PRS 2005/64).

Urban York post 1350

Numerous later medieval and post-medieval sites have been investigated in York, although most have been subjected only to evaluations, with consequent limitation to the data obtained. Highly informative material has, however, been obtained from sites at The Bedern and Coffee Yard.

North-East of the Ouse

This area has been well-served, but mostly by evaluation so that the limitations on results mentioned above apply. Well fills, dated to 13th or 14th century, at the City Garage, Blake Street, site (Kenward EAU 1986/14) were mentioned in a rather poor report. Re-examination of the species list showed the presence of a subterranean element (discussed on p. 482) which suggested that the deposits were not permanently waterlogged. A wide range of decomposer insects typical of occupation deposits were present in small numbers; there was no clear dominant element, and probably the fauna was largely background fauna entirely introduced in backfill from surfaces, or conceivably carried in ground or roof drainage. Grain pests were noted in one of the samples. An archaeological evaluation undertaken to the rear of **St. Williams College** produced a small amount of marine shell dated to the late medieval, post-medieval and modern periods (Johnstone and Carrott EAU 1999/55). The bias of the shells towards edible marine taxa, and shells showing evidence of having been opened using tools, indicated that they were human food waste.

A short distance away, the **Coffee Yard** site provided an important 'type' site for assemblages formed in clean medieval town houses (Robertson *et al.* EAU 1989/12). Period 4 was dated to the late 14th-early 15th centuries. The samples usually contained usually few insects, but there were two larger assemblages, both dominated by the grain weevil *Sitophilus granarius*. It seems likely that these originated in clean grain being stored, probably for domestic use, within the building. The only other beetle which was at all common was the spider beetle *Tipnus unicolor* (discussed at length on p. 378). Some other house fauna taxa were present, but more generalised decomposers very rare, indicating rather clean conditions. Parasite eggs were effectively absent, too. Notable were records of water flea (*Daphnia*) ephippia and *Lophopus crystallinus* statoblasts; these aquatics had no immediately obvious origin but may have been imported in water or in waterlain deposits used as floor make-up.

In Period 5a (15th-16th century), most of the samples were barren or nearly so, although there were small numbers of grain pests in some. The most notable remains were of house fauna, particularly *Tipnus unicolor* (which was rather abundant in some samples), with few other decomposers and only traces of outdoor forms; again, conditions appear to have been clean. *Daphnia* ephippia were present in several samples in this period too. Many samples from Period 5b (16th century) were barren. Where insects were present, *Tipnus unicolor* was predominant (with small numbers of some other house fauna taxa), and grain pests occasionally fairly common. More generalised decomposers were almost absent, as were outdoor forms. At this stage, the building was clearly clean and seems to have lacked the substantial air flow believed to be needed to deposit significant amounts of background fauna. A notable record was of the golden spider beetle, *Niptus hololeucus*, apparently not a later contaminant. This species appears to have had an interesting history and is discussed on p. 382. Period 5c presented a picture reminiscent of the previous stage, but insect remains were rare; only *T. unicolor* was at all well represented. The final period, 6 (18-19th century) was represented only by three processed samples, but produced some notable assemblages. House fauna predominated, with appreciable numbers of *Tipnus unicolor* and the white-marked spider beetle *Ptinus fur*. There were numerous *Aglenus brunneus*; in deposits located so close to the surface a post-depositional origin for this burrowing species seems particularly likely (and might perhaps be tested by AMS dating). *Niptus hololeucus* was well represented, and clearly fully established by this stage.

A little further to the north-east, biological remains from a complex of contiguous or barely separated areas at **The Bedern** (unfortunately broken up for the purpose of reporting, see Richards 1993, fig. 55) were investigated by Hall *et al.* (AML 56-58/93). Deposits dated to mid-late 14th to the early 17th centuries were biologically rather uniform and can be treated as a unit. Many of the deposits were barren, or almost so, but a large number, almost all pit fills, gave useful assemblages of insects. Eggs of *Trichuris* were noted in small numbers from some samples, and in modest quantities in very few, and there were some records of *?Hymenolepis* sp. (see p. 24). Weak hints of stable manure were given by a few assemblages and one included a number of weevils regarded as 'hay' indicators (p. 355). A small number of pit fills appeared to have been rather foul, but not exposed for too long. Only one may have held open water, and even in this case the aquatics may have been imported in water, as was almost certainly the case for a group including *Daphnia* ephippia and water crowfoot seeds. However, the predominant impression was, perhaps not surprisingly in view of the nature of the site, of rather clean conditions. Many of the pit fills seemed to contain house floor sweepings. One of the most abundant and frequently occurring species was the spider beetle *Tipnus unicolor*, considered to be indicative of long-lived buildings of quite good quality when found in occupation deposits (p. 378). Species which might live with *T. unicolor*, including the woodworm *Anobium punctatum*, were recorded in significant numbers too. A few human fleas (*Pulex irritans*) were noted, and there was a single dog flea (*Ctenocephalides canis*) from a 'peaty clay spread', perhaps a trampled floor, of mid 15-early 17th century date. Grain pests were present in small numbers throughout these deposits, but never abundant.

The latest material investigated from The Bedern dated to the period from the mid 17th century onwards. Two samples from a pit fill produced a total of three bedbugs, *Cimex lectularius* (p. 422), three golden spider beetles, *Niptus hololeucus*, and a cockroach, unfortunately not named to species (p. 50). *C. lectularius* has a patchy fossil record, and may not have been favoured by poor quality buildings; it is discussed on p. 422. *N. hololeucus* has a similarly odd pattern of occurrences; perhaps again it was favoured by buildings of high quality, or it may not have been introduced to Britain until recently (p. 382).

Jaques *et al.* (PRS 2002/12) assessed a series of samples from floor deposits of later 14th to early 17th century date from St Andrewgate. Most were barren of invertebrates, or contained only traces of shell, but a floor of later 14th-early 15th century date gave in addition a small group of insects, including the spider beetle *Tipnus unicolor* and the grain pests *Sitophilus granarius* and *Oryzaephilus* sp., very typical of later and post-medieval urban layers. Fossils from this deposit had colours indicative of strong decay, and other remains were thought likely to have rotted completely, the decay having perhaps occurred both recently and in antiquity. Delicate remains had probably been lost from the other deposits at or soon after the time of formation.

At St Andrewgate (Carrott *et al.* EAU 1993/02), a 15th/16th century 'probable floor' yielded typical occupation site insects and a human flea (a lost opportunity to study a rare floor of such late date). A 16/17th-18th century deposit, apparently a build-up, was virtually barren; there was a trace of marine and terrestrial mollusc shell. Carrott *et al.* (EAU 1995/51), examining samples from late medieval pit and hollow fill deposits at St Saviourgate, found parasite eggs, insects associated with foul matter, grain pests, and nettle feeders. A second site in the street gave a series of samples from pit fills and dumps dated 14/15th to 16th century (Carrott *et al.* EAU 1998/14). Most gave appreciable quantities of insect remains, with decomposers indicating dryish to foul matter. *Tipnus unicolor* (p. 378) and the grain pests *Oryzaephilus surinamensis* and *Sitophilus granarius* were repeatedly recorded, as was a single sheep ked (*Melophagus ovinus*), probably indicating wool cleaning (p. 363). Full analysis of this material is a priority.

An assessment of samples from former Henlys of York filling station, The Stonebow (Akeret *et al.* PRS 2005/10) produced two 15th century insect assemblages. The first, from a pit fill, gave house fauna, including *Pulex irritans* and *Pediculus humanus*, the grain pest *Oryzaephilus surinamensis*, some cladocerans, and fly puparia and other immatures. This was probably household waste (the beetles perhaps introduced in floor sweepings, the water fleas perhaps from waste water). A build-up or dump gave abundant beetles and various other insects and mites. There was house fauna and some grain pests (*O. surinamensis* and *Sitophilus granarius*), which together with species perhaps brought in cut plants may indicate stable manure. There was some marine shell, primarily mussel. Other deposits gave only traces of shell or cuticle, or were barren.

Evaluation sites from York city centre have provided limited evidence from this period. Samples from 9 Little Stonegate (Carrott *et al.* EAU 1998/27) gave no useful macro-invertebrate remains, and only traces of parasite eggs. Carrott *et al.* (EAU 1997/51) found only traces of invertebrates in a 15th century pit at Davygate. A single slot fill of 15-16th century date examined during an evaluation at Norman Court, off Grape Lane, York (Carrott *et al.* EAU 1995/21) gave a few poorly preserved insect remains, all characteristic synanthropes (*Palorus ratzeburgi*, a late archaeological record for this species; *Ptinus* sp., *Anobium punctatum*). An extensive assessment of pit fills and surface deposits dated to the 14th and 15th centuries at 62-68 Low Petergate by

Akeret *et al.* (PRS 2005/89) showed many of the layers to be barren of invertebrates, or to contain only traces of shell or insect cuticle. A few fills of pits – mostly regarded as cess pits – gave insects typical of towns of this period, including *Tipnus unicolor* (p. 378). The fills, or concretions from them, sometimes gave *Trichuris* eggs in amounts ranging from traces to abundant, together with a few *Ascaris*. Some of the surface layers were productive; a backyard dump gave another group of typical urban insects, and others contained parasite eggs. A pit fill and a 'deposit' were notable in that the only macro-invertebrates recorded were *Daphnia* ephippia, presumably derived from imported water. A ?17th century pit gave only traces of shell and rotted insect cuticle, while 18th/19th century deposits (including drain fills) produced only a few shellfish fragments. A 19th century culvert or drain fill contained thousands of fly puparia, mainly *Thoracochaeta zosterae* (p. 71), a few beetles and a single *Trichuris* egg.

Moving to the strip adjoining the Foss, a single feature of this period at **16-22 Coppergate** has been examined (Hall and Kenward EAU 1999/27; Hall and Kenward 2003b). This was a large rectangular cut (14.5x3 m, about 1 m deep) of late 14th century date at the rear of the site. This was investigated because it was suggested that it may have been a tanning pit, containing currying or tanning waste, but the plant and invertebrate remains lent no support to this hypothesis (evidence for tanning is discussed on p. 365). There were no insects which would have been attracted to untreated skins or waste from cleaning them, and the biota indicated that the fills were probably dumps of occupation material, especially stable manure, and perhaps including human faeces. Even the leather waste, it was suggested, may have arrived indirectly via a stable floor, having been used as litter. The presence of stable manure was supported by the plant assemblages, by characteristic decomposer insect fauna, and by abundant grain pests (*Oryzaephilus surinamensis*, *Sitophilus granarius*, and rather unusually in Post-Conquest groups, *Palorus ratzeburgi* and a larva of *Tenebroides mauritanicus*). *Tipnus unicolor* was also present (p. 378).

Further from the central area of York, Johnstone *et al.* (EAU 2000/04) reported an insect assemblage of late medieval date from **41-49 Walmgate**. There were traces of *Trichuris* eggs and a small beetle assemblage reminiscent of many from pits at 16-22 Coppergate. The absence of grain pests and presence of *Diphasium* (clubmoss) led to the suspicion that the analysed material had been redeposited from an Anglo-Scandinavian layer. Further material, dated 14th-15th century, from the site was assessed by Jaques *et al.* (EAU 2001/26). Surface deposits, including floor accumulations, were barren of invertebrates, apart from a few fragments of marine shell. The basal fill of a timber lined pit contained some rotted (or weakly mineralised?) concretions, but insects suggested that any faecal material was from horses, since grain pests (*O. surinamensis* and *S. granarius*), 'hay' weevils (p. 355) and characteristic decomposers (p. 400) were present. Evaluation by Carrott *et al.* (EAU 1992/03) of 15th century dump or levelling material at **104-112 Walmgate** showed it to be barren apart from a probably intrusive ant.

These few samples from evaluations in the intensively occupied parts of York demonstrate the patchy nature of preservation, emphasising the need to collect samples whenever possible and carry out large-scale surveys in the laboratory to ensure rare significant assemblages are not overlooked.

Further east, beyond the walls, evaluation of a sample from a ditch fill, probably of the 15th century, at the **Bootham Engineering Works, Lawrence Street** (Carrott *et al.* EAU 2000/45) revealed a rich and well-preserved invertebrate assemblage. *Daphnia* ephippia (water flea resting eggs) were numerous, with ostracods also common, and a substantial proportion of the beetles and bugs were aquatics, suggesting open water, but not necessarily with very much in the way of submerged or emergent vegetation. There was little evidence of waterside vegetation either. Terrestrial insects were present in modest numbers, some from weed vegetation, but also a range of taxa which when found together are regarded as typical of settlements, indicating the presence of buildings nearby, or dumping of rubbish from in and around them. There were remains of a saw-toothed grain beetle (*Oryzaephilus* sp.).

Piccadilly and the Foss basin

A good number of sites in the Piccadilly area with later medieval or post-medieval deposits have been subjected to evaluation or assessment. Well fills dated to the 14-15th centuries (Period 6) at 22 Piccadilly gave a mixed insect group together with some parasite eggs, and there was some material from other cuts (assessment by Carrott *et al.* EAU 1995/53). Across Piccadilly, at the Merchant Adventurers' Hall, another assessment included examination of samples from 14th century levelling or dump deposits (Carrott *et al.* EAU 1996/44). Beetles and fly puparia indicated rather foul material in some layers, with fairly strong evidence of stable manure (including some newly emerged *Apion* weevils probably brought with hay). One deposit contained some aquatics, including *Cristatella mucedo* statoblasts (p. 88), but it was not considered that they provided clear evidence of flooding. Eggs of *Trichuris* were present in small to modest numbers, perhaps indicating contamination by human faeces, although the species present was not established by measurements. It was hoped that these deposits would receive further study in a proposed project dealing with post-Conquest material in the Coppergate-Piccadilly area (Dobney *et al.* EAU 1997/02), but funding could not be obtained. Samples from 17/18th century levelling at Merchant Adventurers' Hall were barren apart from intrusive *Cecilioides acicula* (p. 483) and some very decayed landsnails, presumably ancient. A second evaluation of material of 14th-17th century date from this site produced only traces of invertebrate remains, including rotten shell of marine molluscs (Carrott *et al.* EAU 1996/01).

Carrott *et al.* (EAU 1992/09) carried out evaluation of 14/16th and 16/17th century material from 38 Piccadilly. Pond silts of 14/16th century date gave, overall, strong evidence from the invertebrates for aquatic deposition, with a variety of aquatic beetles and bugs, ostracods, cladoceran ephippia, *Cristatella* statoblast*s* (p. 88) and aquatic molluscs. Terrestrial insects were not very abundant and perhaps were background fauna or redeposited from marginal dumping areas (as may have been the 'useful' plants remains). There was a record of *Oryzaephilus* sp. Deposits associated with wicker and timber revetment of 16/17th century date gave no evidence for aquatic deposition, and were apparently dumps. Subjectively there was a stable manure component in two samples, but these were notable for the presence of *Sitophilus granarius* in the absence of the other common grain pests (see p. 342) and also for an unfamiliar *Pterostichus* sp. which could not be identified within project constraints. A hearth/fire residue with charred and uncharred gorse was of note but gave no invertebrates (although any charred remains present may have been damaged beyond recognition during extraction, p. 116). At 50 Piccadilly, Carrott *et al.* (EAU 1992/08), in evaluation of riverside dumps and 'reclamation' of 14th century date (earlier material is dealt with in the pre-1350 section, above) found a mixture of aquatic and terrestrial insects, with typical urban decomposers and phytophages likely to be associated with weedy vegetation, in build-up around revetment timbers. A second similar deposit contained abundant fragments of immature insects, probably aquatics. There were aquatic molluscs, and a few typical urban decomposer insects and the deposit perhaps represented surface clearance dumped into water. Insects were rare in a peaty build-up associated with wattle; freshly emerged *Apion* weevils perhaps suggested the presence of hay or even stable manure, but the decomposers were restricted to what may have been rapid colonisers.

Carrott *et al.* (EAU 1991/16) reported an evaluation of bioarchaeological material from 84 Piccadilly. Here silts, apparently formed in the King's Fishpool, effectively undated but some probably from the 14/15th centuries, were encountered. The biota of the deposits suggested that they were indeed of aquatic origin, with little evidence of dumping and only small numbers of non-aquatic invertebrates. The fill of a 19th century wooden drain was unusual and distinctive in being composed largely of entire, very well preserved mollusc shells, mostly the bivalve *Pisidium*, but with abundant *Planorbis* (s. lat.) spp. and *Lymnaea* spp. Accompanying these were abundant ostracods, and *Daphnia* ephippia and various kinds of bryozoan statoblasts including *Lophopus crystallinus* and *Cristatella mucedo* (p. 88). There were also 'branched tubular structures which may have been bryozoan', within which there were ovoid dark-coloured bodies, perhaps developing statoblasts. Plant and insect remains were rare, the latter including a few aquatics. This quite remarkable group of remains deserved further study, but this was not possible within the constraints of the evaluation mechanism. A second 19th century drain at the site, this time ceramic, gave a limited fauna of aquatic insects, including the bug *Velia*. Both of these drains seem to have carried clean water from a source of colonising organisms, the molluscs and bryozoans perhaps establishing colonies in the wooden one, posing interesting questions as to water supplies or culverting arrangements in the area. 'Clay dumping' of 19th century date gave only traces of invertebrate remains, while material between this and the underlying pond silts, perhaps waterlain then incipiently terrestrialised, included *Cristatella* statoblasts (p. 88) and mainly terrestrial beetles, together with earthworm egg capsules.

The evidence thus suggests miscellaneous and rather low-grade use of much of the area now traversed by Piccadilly, but formerly leading down to the margins of the fishpool or Foss marshes. A much clearer view would have emerged had proper analysis of some of the samples been possible. A second group of sites (also evaluation) represented the area further upstream along the banks of the Foss between the river basin and Peasholme Green and gave a rather similar story. At the **Adams Hydraulics I** site, Alldritt *et al.* (EAU 1990/01) investigated 14th century deposits which may have been dumps into the fishpool. There were poorly preserved aquatic and terrestrial insects and some *Daphnia*. A large rubbish pit of the late 14th century proved barren, while very late 15th century layers, perhaps naturally deposited river silts, gave *Daphnia* ephippia. Samples from pits of 15/16th century date contained only traces of invertebrates. An undated silting or dump deposit gave *Daphnia* and modest-sized group of aquatic and terrestrial insects. The **Adams Hydraulics II** site (Carrott *et al.* EAU 1991/12) gave samples from 14/15th century deposits which may have been agricultural soils; they were barren of invertebrates apart from oyster shells (one layer was made up mostly of them!) and ?freshwater mussel fragments. A 17th century cut, perhaps a ditch, was barren and material from later 18th century ?agricultural land produced a small group of insects but needed a larger sample for interpretation; in this case there were *Cristatella mucedo* statoblasts (p. 88), suggesting incorporation of at least a proportion of waterlain material. Eighteenth century agricultural build-up contained poorly preserved insects but again there were several *C. mucedo* statoblasts; subjectively there were hints of a natural assemblage deposited where preservation was poor.

A late medieval or early post medieval dump, presumably into the King's Fishpool, at the Adams Hydraulics II site produced unusually large numbers of *Trox scaber*, typically found in birds' nests but able to exploit various kinds of (usually dryish) animal remains (Carrott *et al.* EAU 1991/12). There was much leather in the residue, and *T. scaber* may have lived in this, waste from its production, or stored skins. A similar concentration of *T. scaber* has been found at the upstream end of the fishpool, at the **Layerthorpe Bridge** site (Hall *et al.* EAU 2000/64)), in this case associated with comminuted tree bark, and it seems possible that these pieces of evidence point to the presence of tanneries along the banks of the fishpool (p. 365).

At another site in this area, at **Carmelite Street** (Carrott *et al.* EAU 1991/15), evaluation of 16th century dumps and borehole samples probably from late deposits revealed unusually good preservation by anoxic waterlogging for this late period, and some substantial assemblages of invertebrates, making these deposits of considerable importance. They deserve full investigation. There were insects from domestic and storage habitats in the 16th century dumps. Some of the deposits clearly formed in water (there were aquatic insects, various freshwater snails, and huge numbers of *Daphnia* ephippia), but for others the evidence was not so definite; the proportion of dumped material seemed to vary from near zero to almost all. Decomposing matter, from foul to fairly dry, was indicated, and the combined plant and insect evidence pointed to the presence of at least some stable manure, while a human flea and the spider beetle *Tipnus unicolor* were presumably brought from within a building. A late medieval dump or alluvial deposit gave abundant ostracod valves and *Daphnia* ephippia, but few insects; as there were traces of charred cereals it seems likely that this was an alluvial deposit with some in-washed occupation material. In contrast, both plants and insects suggested subsequent incorporation of terrestrial forms into a late medieval or early post-medieval putative alluvial layer, perhaps as vegetation became established. Among the borehole samples from Carmelite Street, one, tentatively dated as late medieval, appeared to contain hay or straw, and included several bug nymphs which closely resembled *Craspedolepta nervosa*, typically associated with yarrow and discussed on pp. 53, 355. The remaining borehole samples were of little significance.

Evaluation of a small number of General Biological Analysis samples chosen to represent 14 trenches in the **Hungate** area (Jaques *et al.* EAU 2000/29) included some from deposits of the 14th-15th century (on pottery spot dates). A 15th century pit fill included numerous fly puparia and foul decomposers as well as house fauna; the 14th century infill of the wicker lining of a pit gave a group of insects which hinted at stable manure (typical decomposers, house fauna, grain pests and aquatics, see pp. 400 and 403); and an accumulation or dump containing leather working waste gave rather stronger evidence of stable manure, containing these components together with weevils perhaps brought in hay. *Tipnus unicolor* (see p. 378) was recorded in all three samples with more than a trace of insects, and the grain pests (p. 342) were represented by *Sitophilus granarius* and *Oryzaephilus ?surinamensis*. There was a quite large amount of hand-collected mollusc shell, with oyster predominant, some mussel, and a little cockle and whelk (*Buccinum undatum*). Oysters were often poorly preserved, flaky, and frequently bore edge damage suggesting opening with a knife (see p. 85).

Waterlain early modern deposits at the **Layerthorpe Bridge** site gave abundant invertebrate remains, especially aquatics, including insects, molluscs, ostracods and cladocerans (Hall *et al.* EAU 2000/64). These deposits therefore represented river silts, and this phase of deposition presumably reflects the raised river level of the Foss brought about by the installation of a lock downstream, near the confluence with the Ouse.

The results from the deposits at these sites between Peasholme Green and the Foss have been deliberately emphasised so as to underline the immense potential of the archaeological record in the area and the likely loss of information resulting from the failure to carry out full excavation and post-excavation analysis at these and any future sites.

York south-west of the Ouse

There is astoundingly little material of later medieval or post-medieval date on record from this area. Evaluation of late medieval levelling/dump and ?occupation deposits **26-34 Skeldergate** showed them to be barren (Carrott *et al.* EAU 1991/10). A single pit with 16th-17th century fills (on the pottery spot date) at the **NCP Car Park site, Skeldergate**, gave only traces of decayed invertebrates; there were mineralised seeds, so post-depositional decay had probably occurred (Jaques *et al.* EAU 2000/53). Assessment of samples from 14th/15th and 15th/16th century deposits (feature types not given) at this site by Carrott *et al.* (PRS 2004/43) generally showed the sediments to be barren of invertebrate remains other than shell, though one sample gave a modest number of insects including *Tipnus unicolor* (p. 378). There was some marine shell, mostly oyster, with a trace of mussel.

It seems likely that other deposits of this period have been excavated at various sites, but not sampled. Such material should not be overlooked in future.

Urban North Yorkshire, post 1350

Whitby, like Hull, has much potential, in this case as a representative of a small and rather isolated, yet important, port. Investigation of 13th-14th century occupation deposits from **Baxtergate** (Carrott *et al.* EAU 1992/04; Hall *et al.* EAU 1993/26) gave insect assemblages with a strong human influence, some 'house fauna' groups, including human lice (*Pediculus humanus* - one sample contained 'many' of these, both adults and nymphs) and fleas. *Melophagus ovinus* and *Damalinia* sp. were found together, suggesting wool-cleaning (p. 363), and there were traces of heather-associated insects. A notable deposit containing *Sphagnum*, strawy herbaceous detritus, arable weeds and a freshly emerged *Apion* weevil may have been a form of stable litter. One sample produced fragments of unfamiliar cuticle, perhaps from a marine crustacean. Apart from this and the presence of *Cercyon depressus*(a marine littoral beetle, see p. 297) in two deposits, the fauna would not have been out of place in Anglo-Scandinavian or immediately post-conquest York, perhaps hinting that changes seen in larger towns had not yet occurred in Whitby. Extensive sampling and thorough analysis of deposits such as these could not fail to provide a wealth of valuable information.

Also in Whitby, Kenward *et al.* (EAU 2001/46) evaluated three samples of 18th-?early 19th century date from excavations at Whitehall Shipyard, Spital Bridge. None of the samples was rich in remains, though a few insects were present in two, including the grain beetle *Oryzaephilus* sp.

Post-medieval pit fills at a site at the New School, Priest Lane, Ripon (Jaques *et al.* EAU 2001/03) were barren or contained only traces of marine shell. A pit fill dated to the 18th century gave a small number of snails suggesting dry grassland. Hand collected shell from these pits included a few oysters and cockles, a single whelk and a fragment of claw from an edible crab (*Cancer pagurus*).

The North-East counties post 1350

Several small groups of landsnails from Barnard Castle, Durham were examined by Allen (AML 4144). One sample dated to the period AD 1330-1479 produced a tiny fauna, but gave hints of rubble and shade. Two groups of 17th century or later date had similar, but rather clearer, implications, and two further groups indicated human disturbance. The 15th century fills of a drain associated with the inner ward of Barnard Castle produced large quantities of bone and fragmentary marine shell, primarily oyster, cockle (*C. edule*), and mussel (Donaldson *et al.* 1980). The shell was described as poorly preserved, friable or powdery.

A small quantity of marine shell was recovered from 17th/18th century deposits at Queen's Court, 2 North Bailey, Durham (Rackham 1980b), and in the same town Stallibrass (1999) noted a few marine molluscs from ?16th-19th century deposits at Crossgate. Donaldson and Rackham (AML 2931) mentioned insect remains from modern deposits in a culvert at Norton Mill, Norton-on-Tees, Stockton, and provided a species list for molluscs. The latter were primarily aquatics, together indicating reasonably clean water. Tan pit fills dated 18th/19th century at Burn Lane, Hexham, gave only traces of earthworm egg capsules and unidentified cuticle (Hall *et al.* PRS 2003/69).

In Newcastle, Rackham (AML 4788) recorded small assemblages of landsnails typical of gardens and damp calcareous places from 18th century deposits at the Cordwainers site, Blackfriars. Shellfish were quite numerous at Queen Street (Nicholson 1988), and many taxa, including some which are unusual in archaeological deposits, were recorded. Oysters (*Ostrea edulis*) were the most abundant, followed by mussels, cockles (*Cerastoderma edule*) and limpets. Shellfish were also abundant at the Crown Court site, in deposits dated 14th-19th century – again a rather wide range of species was noted, with mussels, oysters and cockles predominant but in varying proportions through time; there were also records of rather abundant barnacles (recorded as *Cirripedia*) from the early 14th century, and some crab shell (Nicholson 1989a). A group of freshwater molluscs gave evidence of flowing water (Nicholson 1989b). At the Castle Ditch site, deposits dated late 14th-late 16th century gave modest quantities of marine shell, mostly oyster and periwinkle (*Littorina littorea*), with some cockles and a few other species; there was also some edible crab, all from the late 15th to early 16th centuries (Rackham 1981).

Lancashire post 1350

A fill of a linear feature containing 16th century pottery at Gillibrand Hall, Chorley (Hall *et al.* PRS 03/70) contained numerous *Daphnia* ephippia (water flea resting eggs) and ostracod valves, and various aquatic insects; the deposit formed in water. However, the range of aquatic insects was limited, and there were no indicators of well-developed submerged or emergent vegetation, so some factor seems to have inhibited plant development. Either the water was only temporary or, more likely in view of the tree leaf fragments recorded during botanical analysis, there was heavy shade. Terrestrial insects were not abundant, and most could have found habitat in herbaceous or scrub vegetation by water. There was little to indicate decomposing matter beyond hints of dung, and no indicators of trees or dead wood. There was no indication of typical occupation-site fauna.

Merseyside post 1350

Mollusc remains from deposits of 17th century and later date at South Castle Street, Liverpool, are tabulated by McMillan (1985). Oysters were abundant, and a wide range of other marine molluscs present in varying quantities. There were also some freshwater and terrestrial forms.

Chester post 1350

Molluscs from deposits of 14th-16th century date at the Dominican Friary site were reported by G. Morris (1990). Remains of *Helix aspersa* and *Ostrea edulis* were abundant. There were some mussels, cockles and whelks, and traces of other marine shells, but the only other land snail was *Cepaea nemoralis*.

Oyster shell from a 'passage fill' dated to the mid 17th century from 3-15 Eastgate Street, was considered in some detail by Harrison (1995). The condition (worn, flaky) and location (in a passage infill) of the valves suggested that they had been redeposited, and the possibility that they were residual Roman remains unfortunately had to be entertained. Valves were measured, and most appeared to be in the age range 6-8 years, probably rapidly grown. Boring by sponges (*Cliona celata*) and the worm *Polydora hoplura* was noted, and there were epizoonts: bryozoans and the tube-forming worm *Pomatoceros*. Marks were observed which clearly resulted from opening the shells with a knife (p. 85). The origin of these oysters was discussed; although the large size suggests a Roman date or an origin in the south of England, a more local origin might be possible, perhaps (on the basis of shell structure) from the Colwyn Bay area. Against this was the presence of the (now) southerly *Polydora hoplura*, suggested to indicate an origin on the south coast, but this does not take account of probable climate change. A few shells of *Cerastoderma edule* (cockle) and *Mytilus edulis* (mussel) were also noted.

A sample from sondage into what were perhaps reclamation dumps under the New Crane Street car park was submitted to evaluation by Hall *et al.* (PRS 2002/08). Insects were present in considerable numbers, and dominated by synanthropes. Grain pests (mainly *Oryzaephilus surinamensis*, with some *Sitophilus granarius*) were abundant, and there were dung beetles and weevils together with a trace of aquatics (this combination of beetles suggesting to the present writer that the botanical interpretation of stable manure was correct). The spider beetle *Tipnus unicolor* (discussed on p. 378) was numerous. Small numbers of the brackish-water snail *Hydrobia* ?*neglecta* may have arrived in hay or dung together with the salt marsh plants which were also recorded. *H neglecta* requires a moderately high salinity (Hayward *et al.* 1996, 190).

Carrott *et al.* (PRS 2001/06) reported evaluation of samples from 18th century deposits at a site at Canalside/Witter Place. What may have been canal upcast gave only unidentifiable scraps of cuticle. Two fills of a putative tanning pit were examined; one gave only scraps of macro-invertebrates (although there were traces of badly decayed *Trichuris* and *Ascaris* eggs), but the lower fill gave an insect assemblage typical of later and post-medieval occupation deposits. Although there was very decayed bark, a likely component of tanning pit fills, there were no insects indicative of skins (*cf.* p. 367). There was some marine shell, principally oyster and mussel.

An extensive assessment of material from Bridge Street was mainly based on Bulk Sieving samples (Hall *et al.* PRS 2002/16). Beetles or fly puparia were recorded from 27 samples from the period considered here, though concentrations were generally low. Of group of 12 General Biological Analysis samples, chosen on the basis of the Bulk Sieving results, seven gave at least a few insects. Samples dated 15th-20th century gave a restricted urban fauna, mostly decomposers associated with dryish material. Subsequent analysis of five insect assemblages (Jaques *et al.* PRS 2004/46) showed that some were unusual. A pit fill of 14th-late 15th century date gave mostly very decayed insects, but there were abundant remains of *Cercyon depressus*, a beetle found in decaying stranded wrack. It was not clear whether this represented waste from some process using seaweed (e.g. packing shellfish), or whether conditions parallelling those in seaweed were created in some way. Wrack fauna is discussed on p. 297. Apart from *C. depressus*, this sample gave mainly house fauna and species found in fairly foul decaying matter. *Tipnus unicolor* (p. 378) and the grain pests *Oryzaephilus* ?surinamensis and *Sitophilus granarius* were present. A garderobe fill gave some poorly preserved *Trichuris* eggs and abundant insects, which were decayed to a filmy state. *Omalium ?allardi*, *Tipnus unicolor* and *Aglenus brunneus* (the last perhaps a post-depositional invader) were dominant, but there was also house fauna and a subterranean group (p. 482). A second pit fill gave abundant insects, perhaps recently decayed. *T. unicolor* and *S. granarius* were again present, but a notable component was *Apion ?genistae* and a *Micrambe* species, perhaps imported with the gorse found during botanical analysis. A third pit produced *O. ?allardi* in quantity, and house fauna including *T. unicolor.*, *O. surinamensis* and *S. granarius* were represented by single individuals, and *Cercyon depressus* was also noted. A late 18th to late 19th century pit fill also gave some insects, with rather few beetles, *Niptus hololeucus* (golden spider beetle, probably a late arrival in Britain, p. 382, being the most abundant), but numerous fragments of cockroaches, *Blatta orientalis* (p. 51) were found. Marine shell was abundant at Bridge Street, mainly from the 18th-20th century deposits. Most was oyster, often showing marks caused by opening, but there was a little cockle, mussel, scallop and periwinkle, and from one samples traces of a few other species. Sources of these molluscs were discussed, emphasising the uncertain location of oyster fisheries in the past (see also p. 329). As is usual for urban sites, land snails were very rare. Assessment of material from the former Deva garage, 27 Grosvenor Park Road (Hall *et al.* PRS 2002/16), was also unfortunately carried out using bulk samples, but it did at least establish that most of a range of deposits types contained insect remains.

West Yorkshire

Bastow (2000) reported botanical analysis of 29 samples from later medieval and post-medieval deposits on land off Venn Street, Huddersfield. No invertebrate analyses were carried out, but the presence of insects in seven of the samples was mentioned; the importance of local pockets of 'waterlogged' preservation in the town was emphasised.

Urban south Yorkshire, post 1350

Samples from deposits of 14th/15th century to post-medieval date at North Bridge, Doncaster were examined by Carrott *et al.* (EAU 1997/16; Hall *et al.* 2003c; Kenward *et al.* 2004a). Although most of the samples proved to contain traces of invertebrates at most, an intensive survey revealed a proportion which gave some remarkable evidence. As in earlier phases of the site (p. 217), some floor layers contained *Cristatella mucedo* statoblasts, suggesting incorporation of waterlain sediment, probably by flooding, or by the use of river sediment as make-up. The basal deposit in a large rectangular cut seemed to either have been deposited by flooding, or during a fairly long period when the cut remained open and water-filled.

A very large cut of 15th/16th century date gave some unusual assemblages of insects (Carrott *et al.* EAU 1997/16; Kenward *et al.* 2004a). One was remarkable for including immense numbers of dung beetles, predominantly *Aphodius sphacelatus*, but also numerous large 'dor beetles', *Geotrupes spiniger*. (The remains of *A. sphacelatus* were incorrectly attributed to *A. prodromus* by Carrott *et al.* EAU 1997/16; see above p. 341). Other insects indicated muddy water margins and a pond-like environment, so this may have been a pond in an area used to pen large herbivores (although its steep sides suggested a function as a storage tank rather than as a watering hole accessible to animals). There was evidence for river flooding into the cut, which was therefore perhaps used to hold water collected during floods. Later fills gave some evidence of 'house fauna', and also a large group of heathland/moorland beetles and bugs, probably from imported turf. Post-medieval soil in a hollow above this pond (presumably formed by subsidence) included refuse from a clean building, the waste probably having been colonised *in situ* after dumping. Marine shell was only sporadically present at the site, and the impoverished synanthropic insect component (as well as evidence from plants and vertebrates) suggested industrial rather than domestic use.

Also in Doncaster, Smith (1989) described insect assemblages from two samples from an organic layer on a clay floor at the '**Subscription Rooms**' site. This excavation revealed putative burgage plots fronting the main north-south route through the town and was very close to the gate house of the Carmelite Friary. The date is not clear from the report, but may have been 15th century. The small groups of remains included spider beetles and grain pests, but two species believed to be modern introductions were present. A record of *Cetonia* sp. in an urban context is notable in view of the supposed medicinal use of this chafer (p. 313), but it may have been a stray.

Norris (1983) listed hand collected marine and terrestrial molluscs of 12th-17th century date from Sandal Castle, between Weatherby and Leeds; most were of later or post-medieval date. Oysters were the most numerous shellfish, with appreciable numbers of cockles (*C. edule*), while *Helix aspersa* and *Cepaea* spp. were the only abundant land molluscs.

Material from pit, culvert and well fills, dated as late medieval to post medieval, at **Sprotbrough Hall Gardens**, Sprotborough, was reported by Jaques *et al.* (PRS 2004/37), but only traces of invertebrates were recovered. From the same site, a 17th/18th century dump gave only a few land snails and some *Pisidium*, the latter perhaps from waste water, while a 18th/19th century layer which was thought perhaps to represent tanning waste gave grain pests (modest numbers of *Oryzaephilus surinamensis* and a single *Sitophilus granarius*), and house fauna including *Tipnus unicolor* (p. 378) and *Xestobium rufovillosum* (death watch beetle). There was nothing to suggest tanning waste from the fauna, and only one insect which was likely to have come from outdoors.

Most towns in the region have produced little or no evidence from invertebrates of this period. From many areas only marine molluscs have been examined, and systematic work on these is rare. The main research problems of this period as a whole are discussed on p. 273.

Rural and village sites post 1350

Rural material of this period seems rather rarely to have been recorded, and natural deposits even less so. Some are, or at least appear likely to be, unproductive, and perhaps there is a feeling that late deposits will inherently give poor preservation of the most delicate remains (this is sometimes true: the sites at Rawcliffe, York, Dobney *et al.* EAU 1994/8, and Kingswood, Hull, Carrott *et al.* EAU 1996/55, for example, gave little preservation), or of little interest. The last point of view could hardly be further from the truth! There is an enormous amount we can learn, for archaeology, biology and climatology, from any well provenanced and reasonably closely dated invertebrate remains from rural sites of this period (see below, p. 273).

The only record of insects from natural deposits of post-1350 date appears to be a casual report of the great silver water beetle *Hydrophilus piceus,* together with two other southern taxa, at Shirley Pool, South Yorkshire, in deposits 'assigned to the early post-medieval period' (Dinnin 1991).

Rural North Lincolnshire post 1350

At Waterton (Carrott *et al.* EAU 1996/40), a ditch fill of later 15th to mid 16th century date contained numerous ostracods and *Daphnia* (water flea) ephippia, large numbers of chironomid (midge) larval head capsules and abundant beetles and bugs. Aquatics were numerous both in terms of species and individuals and undoubtedly indicated reasonably unpolluted, more-or-less permanent water with abundant aquatic vegetation. Several species found at water margins evoked mud with some vegetation, such as might be found on a somewhat unstable ditch bank. The adjacent terrestrial environment seems to have included abundant herbaceous vegetation but there were no more than one or two individuals which seem likely to have lived on woody plants. Dung was indicated by several beetles, especially *Aphodius* species. While these terrestrial insects may have indicated the nature of the wider surroundings, most of them might have been able to live on the banks and margins of the ditch (the author has observed dung beetles in a patch of rodent droppings in just such a place, for example). Few of the insects were more than facultative synanthropes (p. 61), but there were rare well-preserved remains of some 'house fauna' taxa, probably representing the fauna of structures nearby, either in contemporaneous occupation or in early abandonment.

Ditch fills of 14th-16th century date at the site of a medieval village at Healing, near Grimsby (Carrott *et al.* EAU 1995/45) gave only modern insects, and worm egg capsules and *Cecilioides acicula* snails were numerous, suggesting post-depositional penetration (p. 483). There were a few other landsnails, and quite large quantities of shellfish, especially cockles (*Cerastoderma* sp.), with traces of oysters (*Ostrea edulis*), mussels (*Mytilus edulis*), and whelks (*Buccinum* sp.). Carrott *et al.* (1995) noted traces of insects, probably modern, and some snails in some of a series of ditch fills dated 14th-16th century at Aylesby, west of Grimsby. One operculum of *Bithynia tentaculata* suggested flowing water; overall the snails indicated dry grassland with damper habitats locally. Presumed medieval to post-medieval deposits at the former Normanby Park Steelworks, north of Scunthorpe were examined in an evaluation by Hall *et al.* (EAU 2001/10). Three moat fills suggested changing conditions, with swamp fauna dominant at times, and more open water with abundant weeds at others. One deposit was very rich in a range of cladocerans and ostracods; there were also larval and adult caddis flies. Terrestrial insects were present in variable numbers and suggested herbaceous vegetation, with hints of herbivore dung. Species associated with buildings were present, and the grain weevil *Sitophilus granarius* was noted in two samples. One sample gave hints of trees, but (as is common, p. 459) there was a contrast between the abundant botanical evidence for woody plants and the rarity of associated insects. The enigmatic ground beetle *Pterostichus madidus* (p. 283) was recorded. A sample from the moat platform gave no significant invertebrate remains. The deposits as a whole yielded small amounts of hand-collected marine shell and terrestrial molluscs.

Rural East Yorkshire post 1350

South-east Yorkshire has provided a few rural sites of this period. Two samples from 15th century primary ditch fills at 17-19 St Augustine's Gate, Hedon, were subjected to detailed analysis by Carrott *et al.* (EAU 1993/04). One deposit had formed slowly under (perhaps only intermittently) wet conditions, with rather random input of insects but clear evidence of human occupation in the form of typical synanthropes such as *Tipnus unicolor*

(p. 378), *Mycetaea hirta* and *Sitophilus granarius*. There was also a sheep ked, *Melophagus ovinus*, probably from wool cleaning in view of the presence of house fauna (p. 363). A second sample from another, parallel, ditch produced abundant, well preserved, insects of mixed origins; house fauna and grain pests, and traces of weevils which may have originated in hay. This was probably dumped litter from within a building, perhaps stable manure. Samples from 15th/16th to ?17th century ditch fills at a site near **Homelands Farm, Selby Road, Holme-on-Spalding-Moor** proved to contain no more than very decayed insect fragments (Carrott *et al.* PRS 2003/11). Post-medieval deposits investigated by bulk sieving at a site at Hayton produced no useful invertebrate remains (Jaques *et al.* PRS 2004/63).

Evaluation of deposits from a site at **Barmby-on-the-Marsh**, SE of Selby (Carrott *et al.* PRS 2001/02) produced an assemblage of insect remains (and a few snails) from a channel fill dated 'pre 14th-16th century'. The deposit formed in water and there was evidence of human activity. A silt, also pre 14th-16th century, gave a few snails, and a 14th-16th century floor was barren. The site yielded only a single marine shell (an oyster).

A 'medieval' site at **Kingswood, Hull**, perhaps associated with the estate of Meaux Abbey (Carrott *et al.* EAU 1996/55) gave almost no preservation by anoxic waterlogging. One assemblage consisted of what appeared to be differentially preserved robust remains, for example of weevils (see p. 105). Samples from two putative alluvial deposits both gave remains of the salt marsh snail *Hydrobia ulvae* (p. 301), supporting the hypothesis of alluviation in a creek or channel. Hand collected mollusc remains (mostly very decayed oyster fragments, *Ostrea edulis*, but also a few fragments of other species) thus may just possibly have been carried by tidal water rather than representing food waste, although the bones at least were clearly of the latter origin. By contrast, several of the samples from a site at the junction of the **Foredyke** and River Hull, **Kingswood**, were rather rich in invertebrate remains preserved by anoxic waterlogging (Carrott *et al.* EAU 1998/07). Two fills of a garderobe yielded insects which showed considerable decay (toward orange-brown colouration). House fauna was well represented, with abundant *Tipnus unicolor* (this robust beetle perhaps being favoured by differential preservation), a rather clean building being suggested. Aquatic and waterside fauna, plant feeders, and foul decomposers had all entered the garderobe, which discharged by an outflow whose fills gave very similar assemblage. No grain pests were noted in the assessment report, but there was a single honey bee, a bean weevil (*Bruchus* sp.) which may have passed through someone's gut, having been eaten with pulses, and some *Trichuris* (whipworm) eggs. The presence of two species of flightless synanthropic beetle, the churchyard beetle (*Blaps* sp.) and the spider beetle *Tipnus unicolor*, in an isolated rural location is notable, for both are probably dependent upon humans for distant transport. Their arrival at an occupation site is a chance event, and their occurrence at Foredyke, together with a few other characteristic synanthropes, probably reflects a long period of occupation. Numerous fragments of shell were collected from the site, mostly oyster from 14-17th century layers.

Further east, samples from **Old Hall, Baxtergate**, **Hedon**, proved to contain few invertebrates (Carrott *et al.* EAU 1996/22). A medieval pit gave numerous *Heterodera*-type (soil nematode) cysts, possibly intrusive, and a small and undiagnostic group of insects; a second, ?Post-medieval pit yielded only earthworm egg capsules and traces of insects.

At **Bolton Hall, Bolton** (TSEP 238), a site on the Teeside to Saltend Ethylene Pipeline, excavation revealed what were thought possibly to be infills of a meander of the nearby Spittall Beck (Jaques *et al.* EAU 2002/04). Two samples were not dated, but perhaps medieval, while partly-charred Salix wood from a third gave an AMS date of Cal AD 1440 to 1640 (Cal BP 510 to 310). Of the undated samples, one gave only a few invertebrates, but the second was moderately rich in remains, although these were generally poorly preserved, limiting identification in many cases. Water beetles were abundant (*Ochthebius minimus* especially so) and suggested fairly shallow stagnant water with mud and some vegetation in water, while there were indications of emergent or waterside vegetation, waterside mud and litter. Dung beetles were notable absentees, suggesting that livestock did not graze in the immediate vicinity (a strong contrast with the assemblage from an Iron Age deposit at the same site). Insects strongly or obligately associated with human occupation were absent, and indeed species associated with accumulations of decaying matter of any kind were remarkably rare. The AMS dated layer was ashy, part-burnt wood, bark and twig fragments are perhaps suggesting a bonfire rather than a domestic or industrial origin. Invertebrate remains were present in small numbers and poorly preserved, and provided little evidence of local ecology or activity. Samples from two post-medieval features at a second site on the pipeline, south of Bishop Burton, east of Dale Gate (TSEP 373, Jaques *et al.* EAU 2000/65) were barren of arthropods, but there were a few snails of limited interpretative value, including hand-collected Cepea which may have been modern. An organic deposit spot dated 16th/17th century at Market Weighton gave very well preserved insects and mites, but contained what may have been a recent animal burial, throwing doubt on the date of the invertebrates (Mant *et al.* PRS 2005/66).

Jaques *et al.* (PRS 2002/07) reported an evaluation of deposits at Main Street, Long Riston. A burnt layer and a posthole fill of 14th-15th century date contained no delicate invertebrate remains, although the latter contained some snails, mostly intrusive *Cecilioides acicula* (p. 483). Also at Main Street, Jaques *et al.* (PRS 2002/29) investigated fills of a pond of 'late medieval' date. Aquatics (water fleas and insects) were abundant, indicating more-or-less permanent water, not too polluted, with some emergent or waterside plants. A few synanthropes, some suggesting foul matter such as stable manure, were noted, but there was no clear indication of occupation nearby. There was but a trace of terrestrial and marine mollusc shell.

Fills of the 14th century moat at Cowick gave a rich insect fauna (Girling and Robinson 1989). The fauna largely reflected semi-natural habitats. The ditch seems to have contained fairly clean, probably still, water, helmid beetles probably being indicative of a ditch inflow. Caddis larvae (Wilkinson 1989) contributed significantly to the reconstruction of the aquatic environment. A limited range of synanthropes was present, presumably from the manor house. The spider beetle *Tipnus unicolor* was abundant (see p. 378 for a discussion of this beetle), and with the other more numerous synanthropes suggested a structure of quite good quality. There were a few grain pests. There was little evidence of foul matter such as stable manure. The surrounding landscape seems to have been open, but with some trees (there were some notable records of beetles associated with dead wood). Grassland seems to have been important, but there were insufficient dung beetles to indicate the presence of stock immediately adjacent to the moat. The fills of a pit of 15th/16th century date at West Cowick proved to contain only earthworm egg capsules and some insects which were clearly modern contaminants (Hall *et al.* EAU 1997/40), and evaluation of flue pit fills (and a single pre-kiln deposit) from nearby showed them to be similarly barren (Johnstone *et al.* EAU 1999/18).

Rural North Yorkshire and York post 1350

Hall *et al.* (PRS 2003/42) reported evaluation of deposits at The Spinney, Sherburn-in-Elmet. Deposits at the edge of a '14th century' cut (arbitrarily placed here) contained aquatic insects (including chironomid midge larvae) and cladocerans; terrestrial forms may mostly have originated at the edge of the cut. A 15th century pit fill also gave aquatics, with some chironomids, and terrestrial insects suggesting herbaceous vegetation close by. There was a single grain weevil, *Sitophilus granarius*, although it was suggested that this may have been a contaminant. Evaluation of a 14th/15th century posthole fill at Back Side, Duggleby gave only a few snails, mostly intrusive *Cecilioides acicula* (Mant *et al.* PRS 2005/51).

Allen (AML 4203) examined molluscs from one sample from Wharram Percy. They had no date so discussion of this report has been placed here arbitrarily rather than completely omitting it, since it represents a rare example of a quantitative study of land molluscs from the region. The assemblage was dominated by open country species, and most were favoured by very dry calcareous habitats. These indicated either heavily grazed turf or arable agriculture, the latter being on balance more likely in view of the predominance of *Vallonia excentrica* over *V. costata*, and the presence of appreciable numbers of *Trichia hispida*. A second report on Wharram Percy, by Evans (AML 1823) also lacked dating but was possibly the same material as reported by Evans (1979) as of early 15th century to modern date. Numerous records were given. Almost incredibly, they were of molluscs individually marked with spot find numbers. Beyond emphasising the fact that hand-collection is not a sensible way of collecting snails, the report has limited value. The most numerous species were, not surprisingly, large: *Helix aspersa*, *Cepaea nemoralis*, *C. hortensis* and *Arianta arbustorum*. There were only traces of marine molluscs (two *Ostrea edulis* and one *Littorina littorea*), but it is not clear whether this was a result of rarity or pre-submission selection. Similarly, Evans (AML 1826) recorded only small numbers of three large species (*C. hortensis, C. nemoralis* and *Arianta arbustorum*) from Mount Grace Priory. An assessment of material from later excavations at Mount grace by Bailey *et al.* (EAU 1994/10) produced only a few non-marine molluscs, but quite large quantities of shellfish, mainly oysters, with a substantial minority of cockles. Land and freshwater snails from St Giles by Brompton Bridge suggested clean flowing water, with terrestrial species able to exploit occupation sites, and some preferring damp shady conditions (Milles and O'Connor 1996). A mid 18th century pit filled with large stones produced numerous slug plates (p. 81), a small *Limax* being commonest.

While the date of many of the deposits at Gowthorpe, Finkle Street and Micklegate, Selby, subjected to evaluation by Carrott *et al.* (EAU 1993/08) was uncertain, most appeared to be of the later medieval period. Although probably at the edge of the town when deposited, much of the material seems to reflect semi-natural conditions on the basis of invertebrates (insects, snails and cladocera). It can be divided into four groups: (a) some apparently essentially natural deposits with phases of flooding and deposition in standing water which surprisingly gave little or no preservation of invertebrates; (b) fish pool deposits with aquatic and terrestrial insects and hints of carr woodland, including the rare staphylinid beetle *Oxytelus fulvipes* (see p. 284) and a woodland component which included ?*Colydium elongatum* and *Sinodendron cylindricum*. It was suggested that there might be an ancient woodland fauna in these deposits and that they should be investigated further, but no funding was forthcoming. The third group were (c) tentatively identified fills of the 'Kirk Dyke', which gave aquatic and terrestrial insects, numerous *Daphnia*, some synanthropes including grain pests, and hints of stable manure and perhaps included inwash from ditches; and the fourth were (d) early medieval-15th century ditches with rather poor evidence but hints of a woodland component. *Trichuris* was recorded in small amounts in various of these deposits, and there was a record of *?Ptenidium punctatum*, now a marine-littoral species (but see p. 300).

Near to York, Carrott *et al.* (EAU 1992/11) and Dainton *et al.* (EAU 1992/16) carried out evaluations of medieval or Post-medieval material from Rawcliffe Manor, Manor Lane, Rawcliffe. The fills of pits gave no invertebrate remains and while most of the ditch fills gave no more than traces of invertebrates, one gave preservation, as did an undated cut. Little information could be gained within the constraints of evaluation. Another evaluation, at D C Cook, Lawrence Street Hall *et al.* (PRS 2003/33) produced much more significant results from the fill of a barrel well containing 13th-16th century artefacts, and this and a ditch fill were subsequently analysed in detail by Kenward *et al.* (PRS 2004/04). Ostracods and resting eggs (ephippia) of water fleas were immensely abundant in the well, and there were numerous aquatic beetles (two *Limnebius* species and *Ochthebius minimus* being much the most common), midge larvae and planorbid snails. These indicated that the well held water (unless, as seemed unlikely, it was a soak-away for waste water obtained elsewhere), and that the water was not too polluted. The aquatics had perhaps become mixed into the backfill when the latter was dumped, in the way postulated for grain pests in the Roman well at Skeldergate, York, by Hall *et al.* (1980). There were also abundant *Lesteva longoelytrata*, which perhaps lived in the well. A range of terrestrial insects was present, with plant feeding species indicative of habitats ranging from damp-ground vegetation to drier semi-natural habitats, and species from litter such as might occur in or around houses to foul rotting matter and dung. There was some house fauna, including several *Pulex irritans* (human fleas), *Tipnus unicolor* (p. 378) and death watch beetle (*Xestobium rufovillusum*), as well as grain weevils (*Sitophilus granarius*). It was unclear how the insects entered this well. A ditch fill with 12th-16th century artefacts gave a somewhat similar fauna. Apparently this was an occupied area, but one in which semi-natural habitats had survived—therefore presumably not *intensively* occupied. The well seems to have been well-protected at its mouth, since it had apparently not acted as a pitfall trap. A notable record was of three individuals of the ground beetle *Pterostichus madidus* (p. 283); perhaps by the time these deposits formed this beetle had become more synanthropic, as it is today. It was concluded that the best reconstruction for this site was a roadside settlement with farmland beyond.

A post-medieval pond backfill at the **Heslington East** site, York, was subjected to evaluation by Hall *et al.* (PRS 2004/28). Aquatics were numerous and diverse, and included aquatic snails; together they indicated still water with well established marginal vegetation. There were fragments of a large beetle tentatively identified as *Hydrophilus piceus*, a notable record in this area. Some species from terrestrial plants and litter were noted, but dung beetles were conspicuously absent.

In the extreme south of the county, Wagner and Pelling (SEFP 9404) describe invertebrates from deposits of 15th-mid 18th century date from the moat at **Wood Hall, Womersley**. There were numerous aquatic insects and molluscs in the earliest material, with indications of flowing water (presumably from an inflowing stream) from Elmidae. The terrestrial landscape was wooded (or at least supported some scrub). Dung beetles were fairly abundant, suggesting livestock and there were some synanthropes perhaps from mouldy plant debris indoors. It was not clear whether a small heathland component was of local origin or had been imported with heather or turf. A mid 17th century layer seemed to have been laid down when the moat was almost dry; there were numerous chironomids and cladoceran ephippia, but only a few water beetles. By the mid 18th century the moat had re-filled on the evidence of beetles and molluscs. There were trees in the surroundings, and herbaceous vegetation including grassland. There were some synanthropes, but little evidence of rotting matter.

Rural sites in the north-west of the region post 1350

At **Speke Hall, Merseyside**, fills of a watercourse sealed by the hall (constructed in the mid 15th century) were studied (Kenward and Tomlinson 1992). They appeared to be of late 15-early 16th century date. Invertebrate analysis was limited by non-standard processing, but some interesting results were nevertheless obtained. The lower fills gave assemblages with a large proportion of aquatic insects, but these became rarer in the upper fills. The terrestrial component of the assemblages indicated a variety of natural habitats, perhaps in an area of tussocky grass with mixed herbage, some litter and dead wood, and abundant dung. Dung beetles contributed a large proportion of the fauna. They were mostly *Aphodius* spp., but some *Geotrupes* sp. and a single *Onthophagus* were also recorded. These dung beetles became proportionally and absolutely more abundant in the upper levels, one of which contained numerous *Aphodius* which were apparently not fully hardened. This suggested that some environmental change had occurred which killed the beetles in their pupal chambers - perhaps drowning by waterlogging of the soil, but perhaps dumping or other events associated with construction of the hall. Their presence also indicates that the ditch had become fully terrestrialised and was grazed by this time.

The later fills of the pond at **Higher Lane, Fazakerley, Merseyside** (Dobney *et al.* EAU 1995/22; Hall *et al.* EAU 1996/05) were of this period; they have been considered with the earlier deposits in the previous section. Also on the western side of the region, material from **Old Abbey Farm, Risley, Cheshire**, has been examined (Carrott *et al.* EAU 1996/13; Kenward *et al.* EAU 1998/23; Kenward *et al.* 2004b). A sample from a surface within the house and another from the fill of a linear feature within a barn were effectively barren. A series from the fills of the moat adjacent to the house platform, with dates from the early 15th to 18th or 19th centuries, gave well preserved assemblages of plant and insect remains with considerable value in reconstructing conditions in and around the moat. The insect assemblages were rich in outdoor forms, with aquatics (and *Daphnia*) indicating shallow standing water, permanent but probably much reduced seasonally. Two beetles characteristic of running water probably came from elsewhere in flight or via an inflow. There was rich herbaceous vegetation in the surroundings, perhaps overhanging the ditch itself, and trees (including ash, *Fraxinus*) were indicated. The proportions of aquatics, synanthropes and dung beetles varied with time. Some of the synanthropes are very likely to have come from a building, though perhaps not by direct dumping of waste, but the range of such species was limited, either because the site was isolated or because there was limited transfer from living areas to the moat. There was evidence for grazing in the 17-18th century layers.

Rural West Yorkshire post 1350

Deposits formed in a sunken wooden structure built into the bank of a moat at Oakwell Hall, Birstall, were examined by Allison *et al.* (EAU 1988/03). Three assemblages were recorded in detail, all rich in insect remains. Ostracods and Cladocera were also noted. The insect assemblages were all broadly similar and dominated by species associated with outdoor habitats. There was no evidence for contemporaneous human activity, apart from hints that the surroundings may have been used for grazing, according to the report, but re-examination of the lists reveals a number of synanthropes including taxa often found in what are now interpreted as stable manure assemblages. The structure may have been put to some use - unless these synanthropes were able to continue to exploit its decaying remains, in thatch for example (in the way suggested by Smith 1996b). Species associated with dead wood were quite well represented, but seem to have had various origins. It was suggested that at least a proportion of the fauna may have been transported by water.

Spaul (1973) reported a small group of molluscs, all aquatic, from the fill of the ditch of a medieval moated site at Rest Park, 4 km E of Sherburn in Elmet. Rather clean weedy water was indicated by the species listed.

Problems for the period post 1350

Numerous evaluations and a few analytical projects have now show006E that many sites in many places give later- and post-medieval deposits with at least limited preservation of invertebrates. Doubtless other deposits containing numerous well-preserved invertebrate remains will be discovered in due course. The remains have substantial potential for archaeological reconstruction generally, and for addressing a range of specific questions. The opportunity to test documents against deductions from excavation may often be afforded, for example. This review has also suggested that there are important phenomena to be discovered. Already, for the insects, there is evidence of progressive restriction of fauna in densely settled areas, to an extent not formerly thought likely to have occurred until the 19th and 20th centuries; this may prove to have considerable relevance to biological conservation studies. The restriction of the grain pest fauna (perhaps leaving *Sitophilus granarius* as the only common species outside major grain stores) is of interest in tracing economic change. There is a little information about recent invasions by aliens, but much remains to be discovered in this respect.

Many other topics might be tackled in this period. From the intestinal parasites, is there any valid evidence that improved waste disposal reduced the incidence of parasitism? Do parasite eggs, and insects associated with filth, indicate informal waste disposal ('fly-tipping') where documents imply strict control? For the insects, we would wish to trace the development of town fauna from early medieval richness to the divergent modern urban and suburban communities; human living conditions may be reconstructed in detail; and variation from place to place within and between towns might be detected; the arrival, upsurgeance or re-invasion of pests such as crab lice, bed bugs and cockroaches could be followed; it will be possible to give earliest dates to the arrival of various aliens, with implications concerning volumes of trade into different towns, and to follow their wider penetration into the British fauna, a matter of both economic and ecological interest. Comparison of rural and urban change must be enlightening, in reconstructing peoples' way of life and in estimating the level of exchange of materials. In natural habitats, there will be an opportunity to document the effect of climate and human activity, including pollution, in changing the abundance of species and in modifying communities, particularly of insects and molluscs. The effects of the Little Ice Age on human populations and in altering the distributions of natural communities should be followed. The subjective impression that the worst effects of ecological damage have been very recent, gained from collectors' records of rare species, can also be tested.

Notes on particular areas of the North

With one or two exceptions, the time is not yet ripe for a detailed synthesis of the evidence from invertebrates area-by area, but the following observations may be useful. There is a very patchy record across the region, with some areas barely or completely unknown for most periods (Figure 1). The amount of bioarchaeological evidence often bears little relationship to the archaeological data, particularly for the prehistoric period, where rural sites abound but seem rarely to give much preservation. Thus, while we need to build on archaeological surveys by area and period, such as Manby (1980; 1986) for Eastern and Western Yorkshire respectively in the Bronze Age, for the Wolds by Fenton-Thomas (2003), or the series of reviews edited by Manby *et al.* (2003) for Yorkshire as a whole, environmental archaeology requires its own area-based agendas, with topics such as climate, land-use, deforestation, the nature of agriculture, soil destabilisation, and connectedness of settlements to the fore, as well as the more obvious questions of living conditions and activity.

The Holderness Meres must surely have left a plethora of sites with organic deposits, or shelly layers, suitable for invertebrate analysis; they have already provided surprises in other respects. This area of Yorkshire may prove important in climatic reconstruction, in addition to the information about local vegetation and land use which might be obtained, since it lies not far from the northern limits of many insects. There is also the possibility of discovering invertebrate remains associated with prehistoric occupation sites on the mere margins: such material would be of exceptional, international, importance.

Beverley: The town of Beverley has seen a large number of evaluation excavations and a few major excavations, and a large quantity of data either exists or could be retrieved from stored material. The town would be an ideal test-bed for bioarchaeological synthesis.

Kingston upon Hull: Most of the evidence from Hull is from one area, and invertebrates from some sites have received less attention than would have been ideal, but the town presents some interesting problems and at least a preliminary synthesis would be useful at this stage.

The City of York: York appears well-studied until particular focussed questions are addressed (e.g. land-use zonation by period), when the data are seen to be insubstantial: there is much more to do. Ideally, selected areas of the city should be subjected to research excavations with meticulous post-excavation analysis and research, building on the lessons of Coppergate and Tanner Row.

The Vale of York presents a varied landscape and equally varied problems. In the south, it runs into the Humberhead Levels, investigation of which is always likely to be productive. Studies of land use in the central Vale are required. The old assumption of an inhospitable waterlogged 'waste' seems to be losing ground, and studies of waterlogged deposits should give a picture of land use and changing ecology, especially the history of wetland and forest.

The Yorkshire Wolds are beset with the problem of sharp drainage and calcareous deposits, preventing survival of delicate remains. Very few 'anoxic' sites are known, Willow Garth (Bush 1993) being an exception which perhaps deserves re-investigation specifically for insects. Snail and bone survival on the Wolds is not as good as might be expected in area on chalk, probably because of leaching by rainwater. There may be local pockets of preservation in valley bottoms, and even here and there in deep features. Any wells would surely repay full excavation (to the bottom: less than this is likely to be pointless) and biological analysis. Clay lined ponds may prove to give preservation of organics, though this was apparently not the case at Vessy Ponds, two irregular hollows high on the Wolds, associated with Mesolithic to Bronze Age flint scatters and possibly a water supply (Hayfield *et al.* 1995). Perhaps an auger survey of such high-level features might be carried out, though recognising the danger of penetrating the clays responsible for their functioning as ponds.

The Vale of Pickering: This area has received a great deal of bioarchaeological attention, not least as a result of the discoveries at Star Carr. However, almost all the work has been palynological, with some studies of vertebrates and a tiny amount of analysis of insect assemblages. The case for detailed studies using insect remains, and probably other invertebrates such as cladocerans, ostracods and testate amoebae, before the resource is lost, is very strong: in addition to the archaeological and ecological questions, any substantial time sequences would probably be important in climatological studies. Any work on invertebrates in this area should be accompanied by analysis of plant macrofossils as well as palynology.

The North York Moors: Rather a lot of work has been done on the moors using pollen. There should be many deposits suitable for investigation of invertebrates, and the peats may hide some deeper basins where a long record exists. There are numerous questions to be addressed concerning this area: many are prompted by the review of Spratt and Simmons (1976).

The Dales: Almost nothing has been done with invertebrates in the Dales, which are surely a prime area for landscape history studies. Despite the unsuitable alkaline and freely drained rocks, there must be pockets of waterlogged preservation and colluvial accumulations with snail preservation.

The North-East: This review has discovered very little evidence from Durham, Northumberland and the urban districts within them. There are many questions to be addressed, for example concerning prehistoric to modern land use and ecological impact, the development of towns and villages, and the extent of Roman impact. This is an area with great potential for climatic studies, as many 'southerly' species were absent from it in the 20th century, or are at the edge of their ranges in the area now. The impact of (for example) climate changes in the Late Bronze Age or the Little Ice Age on both insects and human activity (e.g. the distribution and function of field systems) may prove to be traceable here.

Hadrian's Wall: 'Natural' sites along the wall surely have much potential for work on insect remains (in concert with other specialisms), even though the few investigations to date have not discovered deposits rich in insects. It should, for example, be possible to trace landscape changes associated with the construction of the wall systems, and subsequent reversion to more natural conditions. Detailed studies of insect and other remains from military sites along the wall are desirable, too: it seems likely that opportunities have been lost in the past for various reasons.

Carlisle: Several important sites have been investigated in the town. Synthesis of existing bioarchaeological evidence from the Roman period, and particularly the publication of the results of the study of Roman land-use zonation, is a priority, but no opportunity should be lost to sample further deposits in detail. As is the case for Anglo-Scandinavian York, Roman Carlisle has seen many analyses, but they must be seen as essentially groundwork and the basis for the erection of hypotheses for testing using the techniques developed over the past decades.

The North-West: This is an area with enormous palaeoecological potential, as witnessed by numerous studies of Devensian and Holocene lakes and bogs, rather few of which have concerned invertebrates other than testate amoebae and midges. Archaeological sites in the strict sense may prove to harbour invertebrate remains, though so few have been investigated to date that their potential for analysis is not known.

Cheshire: Cheshire is very much an unknown bioarchaeologically, with very few sites studied. Any material will be important, not least because this is an area on the limit of many insect distributions and therefore has substantial potential for Holocene climatic reconstruction. Chester itself has recently proved to contain significant waterlogged deposits, which should receive detailed analysis, not least to enable comparison of living conditions and insect fauna in towns in the East and West of the region.

West Yorkshire presents a variety of landscapes, but the uplands and the old towns are of special interest.

South Yorkshire and the Humberhead levels: Many studies of the astonishing material contained in the Humberhead peats have been made, but there is much more to do. In the meantime, an accessible synthesis of the existing data is needed, built around a chronological structure, since a flowing history of the levels - surely one of the most important palaeoecological resources in Britain - does not emerge easily from the publications to date, although Whitehouse (2004) has gone a considerable way towards meeting this need. Many of the lowland occupation sites in South Yorkshire promise to contain invertebrate remains: parts of Doncaster certainly do.

PART 4: THEMATIC REVIEW

This part of the review brings together information concerning a series of themes and topics which are particularly informed by archaeological invertebrate remains in the north of England. Other areas of study to which they can (or might) contribute are also highlighted. The flow is (broadly) from climate, through matters concerning the nature of, and human impact on and exploitation of, the natural environment, then via rural landscapes to (largely urban) living conditions, health and hygiene, leading eventually to burials.

Climate and the natural environment

Introduction

This section deals firstly with the climatic background of the past half-million or so years, and with the natural development of vegetation and landscape in the period before humans became significant as an ecological factor, and secondly, for more recent times, with areas whose ecology, though perhaps disturbed at some time and thus somewhat influenced by human activity, was essentially following natural pathways. The term 'semi-natural' can conveniently be applied to the latter (Kenward and Allison 1994c, 56), although it is commonly (and usefully) extended to encompass a rather wider range, including, for example, hedgerows and field edges. In practice, doubtless by the Bronze Age, and perhaps earlier, almost all lowland areas had been exploited for wood (and perhaps turf, in the sense of grass sods used for building), and then generally grazed or cultivated, at some time, even if the vegetation had regenerated subsequently. These essentially natural areas were of importance as a resource base for human populations, so their quantification and ecological reconstruction are desirable. They are also of importance as the refuges for many species adversely affected by human activity. Natural habitats are defined here as those areas which were not modified by human activity, or had only been ecologically enriched by it (e.g. by small clearances), and thus in theory give a view of what 'natural' conditions might be.

The arrangement adopted is necessarily a chronological one, and natural sites of pre-Roman date in the north of England are considered in the chronological section (above) so there is no need to repeat the information concerning ecological and climatic reconstruction here. The present section is largely confined to broader discussion, and to considering the difficulties of researching climate and the natural environment in later periods, for which most of the evidence has been obtained from occupation sites.

There is an inevitable preservation bias in the record in favour of wetlands (and often the prehistoric period); in northern England, sites such as those at Skipsea, Davenham, Thorne, Hatfield and Seamer. There is remarkably little evidence from the historic period, although deposits must surely exist. The results of the Humber and North-West Wetlands Surveys illustrate this (e.g. Cowell and Innes 1994; Ellis *et al.* 2001; D. Hall *et al.* 1995; Leah *et al.* 1997; Middleton *et al.* 1995; Van de Noort and Davies 1993; Van de Noort and Ellis 1995; 1997; 1998, 2000), as well as emphasising the potential of prehistoric material: all or most of the sites in these surveys found to have organic preservation would probably yield useful invertebrate remains, and others may contain snails.

A problem in studies of biota from natural deposits is that they typically lack artefactual dating. If they are revealed during developer-funded exercises it is most uncommon for funding for radiocarbon (ideally AMS) dating to be carried out. As a consequence, a number of sites which have yielded insect assemblages which were apparently worthy of study have not progressed to analysis; an example is provided by the putative stream deposits at Storking Lane, Wilberfoss, East Yorkshire, which were subjected to evaluation by Large *et al.* (EAU 1999/50).

The changing abundance and distribution of invertebrates

Changes in the abundance and distribution of organisms are of great interest to biologists, in throwing light on the way the biota have developed, the interaction of climate, human activity and ecological change, and the effects of the arrival of new species, and of course providing an invaluable (if sometimes uncomfortable) background to conservation debates. In some respects, tracking changes in invertebrate distribution and abundance is fairly straightforward: we know a great deal about such changes between some periods in urban York, for example. In other respects the problem is more difficult: did grain pests completely disappear after the Roman period? For species from natural habitats, when did various 'old forest relicts' actually become extinct? (The record of *Prostomis mandibularis* from 12th century deposits at Morton Lane, Beverley (Kenward and Carrott PRS 2003/58), if not a redeposited specimen, begs serious questions about the date of such extinctions!) Which species among the synanthropic fauna are natives? Can we track the redistribution of species brought about by Holocene climatic change?

The gross changes in the British fauna brought about by climatic upheavals during the Pleistocene are moderately well known for the beetles and molluscs, but even for these the information is very patchy in northern England. The limited evidence for changes in the natural-habitats insect (principally beetle) fauna from the North is outlined in the section dealing with the prehistoric period (p. 124). The interaction of climatic change and stochastic effects on distribution has at various times allowed a wide range of species to colonise Britain which are now no longer found here. Some reflect much colder conditions than those at the present day (those dated to the end of the last glaciation and to the Loch Lomond Stadial), others substantially warmer climates (during the early part of the Windermere Interstadial, and at various times during the Flandrian Interglacial, especially the 'Climatic Optimum', around 8 (or 9)-4.5 kya). Some others have perhaps simply not been able to reach Britain, or depend on habitats such as fir (*Abies*) forests which do not naturally exist here in the present interglacial. These changes in distribution make insects an extremely valuable source of information concerning past climatic change, providing habitat variables and the vagaries of invasion are taken into account (p. 285).

These changes in distribution which are presumed to be climatically controlled are a different matter from those brought about by human activity. In more recent times, perhaps from as early as the later Mesolithic, the interaction of climate and human influence has had a complicated effect on the abundance and distribution of insects at least (the evidence for other invertebrate groups is much less satisfactory as yet). Kenward and Allison (1994c) considered aspects of this problem in a review of the likely natural origins of species typical of occupation sites; for an outline of current knowledge regarding changes in the insect fauna of natural habitats see the review of Dinnin and Sadler (1999). It is clear that humans were the primary (and perhaps only) cause of changes in distribution and abundance for some species, but in other cases the effect of climate needs disentangling, and for some species climate alone may have been limiting.

It is often assumed that the effect of *Homo sapiens* on the natural environment has been largely negative, but this is not so clear from an objective ecological perspective, at least until the escalating impact of the past hundred years or less. Before this, humans on the whole had the effect of increasing the variety of habitats available for insects (while admittedly reducing the *quantity* of most natural ones) and probably had not seriously endangered the invertebrate fauna of most natural habitats on a national scale, despite gross modification. Dead wood habitats associated with ancient forest may have been the most affected. In this context it is important to recognise that species which are now rare may not have been reduced or imperilled by human activity; they may be inherently rare, yet stable, something concerning which studies of fossil assemblages will perhaps eventually provide evidence.

There are three effects at work in human interaction with the invertebrate fauna (and with other living organisms): destruction of natural habitats; modification of natural environments; and the creation of novel, artificial, habitats in which quite new kinds of communities formed, with components derived from many natural habitats. Although many species seem to have become extinct in Britain up to the 19th century (e.g. Buckland and Dinnin 1993; Dinnin 1997a; Dinnin and Sadler 1999; Hammond 1974; Smith and Whitehouse 2005; Whitehouse 1997b), and many appear threatened now (Foster 2000; Hyman and Parsons 1992; 1994), very few (if any) can be argued to have been lost primarily as a result of human activity - the synergistic effects of humans, climatic change, natural vegetation succession and sheer chance have probably all played their part. At the same time, many introduced species (perhaps hundreds) have become established in the past 2000 years, some of them able to survive in the wild and others wholly dependent upon artificial habitats, while natural invasion continues at a slow rate. There has probably been a net gain of invertebrate species during this time, admittedly with the long term danger of 'ecological homogenisation' (e.g. McKinney and Lockwood 1999; Sax and Gaines 2003; and in more emotive terms, Putz 1998).

The Romans seem to have brought all manner of species (of plants as well as animals) to Britain for the first time. The insect grain pests represent an economically important case, but it seems probable that many others, particularly members of artificial decomposer communities, were imported by them. The ant *Ponera punctatissima* (if the remains from the Roman sewer in York described by Buckland 1976a, 20 are not later contaminants), the oriental cockroach *Blatta orientalis* (recorded from 4th century Lincoln, Carrott *et al.* EAU 1995/10; Dobney *et al.* 1998), the typical grain pests, and an unknown proportion of the other more strongly synanthropic beetles, seem to be Roman introductions. The earliest clear examples of some kinds of decomposer communities (e.g. stable manure) are Roman. Buckland (1996, 169) briefly discusses the possibility that several species associated with dung or hay have their earliest records in the Roman period, a view supported for a range of species by the present writer and by P. M. Hammond (personal communication). Buckland specifically mentions *Cercyon quisquilius*, *Cryptopleurum atomarium* (= *minutum*), *Scydmaenus tarsatus*, *Xylodromus concinnus* and *Dienerella filum* in this respect, but the list may run to tens of species (Hammond 1974 and personal communication). However, we have yet to see enough appropriate Iron Age material to be sure that synanthropic decomposer species had not already invaded by then, their communities simply being favoured or preserved on a large scale for the first time by Roman activity. Several workers have recorded some of the more strongly (but not exclusively) synanthropic species such as *Aglenus brunneus* and *Stegobium paniceum* from Iron Age or even Bronze Age deposits (e.g. Buckland 1996; Lambrick and Robinson 1979; Osborne 1969; 1989; Robinson 1991b; Smith *et al.* 1997; 2000). Others named as possibly introduced have since been discovered at prehistoric sites, for example *C. minutum* and *X. concinnus* from Iron Age Goldcliffe (Smith *et al. loc. cit.*). Elucidating the history of these species will be a fascinating study. Some may have been pre-Roman importations, but no species definitely regarded as of alien origin are known from Iron Age or earlier deposits. *Aglenus brunneus*, for example, may be a native now extinct in nature or, if a Roman introduction, may have burrowed into earlier deposits (although the latter explanation is becoming less sustainable as evidence mounts).

The staphylinid beetle *Oxytelus fulvipes* provides an example of a natural-habitats species which seems to have been greatly restricted by human activity, in this case by drainage. *O. fulvipes* is rare today and associated with swamps (Kenward 1978d; 1980). Unlike *O. sculptus*, and some related species in the genera *Anotylus* and *Carpelimus*, it does not seem to have made the transition to artificial habitats on occupation sites, and the archaeological records are all from natural deposits. Carrott *et al.* (EAU 1993/08), noted it from medieval deposits at the evaluation excavations at Gowthorpe, Finkle Street and Micklegate, Selby, the plants and other insects suggesting natural woodland. It was found in fen deposits of mid Holocene date at Skipsea (Carrott *et al.* EAU 1994/37; Kenward 1984b, 220-1) and in naturally accumulated 2nd to ?mid 3rd century pit fills at North Cave, East Yorkshire (Allison *et al.* AML 105/90; EAU 1997/37). Jaques *et al.* EAU 2002/05 recorded it in an

Iron Age ditch fill at Carberry Hall Farm, East Yorkshire. The beetle was discussed by Buckland (1979, 87) in the context of Late Bronze Age Thorne Moor, but no records appear in his table.

Species whose abundance has changed without apparent cause

It is easy to erect reasonable hypotheses about the causes of the changing abundance of many habitats species, for example those mentioned above, and others which are strongly synanthropic (in particular the grain pests, p. 342, and the spider beetle *Tipnus unicolor*, p. 378). These seem to make some sense in ecological terms, in relation to human economy, environmental impact, behaviour and building types. However, some species have changed their abundance with no obvious cause. A few such examples are discussed here - it must be emphasised that no systematic study of the species-time data has been made.

Pterostichus madidus. There are surprisingly few fossil records of this large and distinctive ground beetle, which is now extremely common in large areas of Britain and usually (though not exclusively) found around areas strongly modified by humans. It is very commonly found in modern death assemblages, too, sometimes in abundance (Kenward unpublished). Yet fossils are only sporadically found: no records were made by Hall and Kenward (1990) or Kenward and Hall (1995), for example, although hundreds of archaeological samples were analysed for insect remains. Fossils will certainly not often have been overlooked. The reason for the paucity of records is unclear, but *P. madidus* appears to have undergone a significant change in abundance. Its present distribution is peculiar (given as westerly in Europe, Freude *et al.* 1976, although it is apparently common in a Central German beech forest according to Judas *et al.* 2002). It may only recently have adapted to a synanthropic way of life. Conceivably it originated outside its present known range, although there is no evidence for this. Certainly, if it was as common and synanthropic in the past as now, it would surely be a frequent component of archaeological assemblages, especially from cut fills. Records of *P. madidus* from archaeological deposits in the north (nearly always as single individuals) include: from a pit and a well of medieval date at Annetwell Street, Carlisle (Large and Kenward EAU 1987/15); from putlog holes in the walls of tower of the church of St Mary Bishophill Junior, York (Kenward 1987 - the construction was dated to the 11th century and it was suggested that the holes may have remained sealed since that time, but some insect records, including *P. madidus*, may suggest otherwise); from sandy river deposits dated to cal. AD 900-1170 at the Layerthorpe Bridge site, York (Hall *et al.* EAU 2000/64); from late 12th-early 13th ditch fill at Coopers Farm, Long Riston (Jaques *et al.* PRS 2002/07); from a 15th/16th century pit or pond at North Bridge, Doncaster (Carrott *et al.* EAU 1997/16); from post-medieval deposits at Hull Central Dry Dock (Akeret *et al.* 2004/87); from fills of a barrel well with 13th-16th century artefacts on the eastern fringes of York (Kenward *et al.* PRS 2004/04); from post-medieval moat fills at the former Normanby Park Steelworks, north of Scunthorpe (Hall *et al.* EAU 2001/10); and from the primary fill, dated 15th century, of very large pit at Morton Lane, Beverley (Kenward and Carrott PRS 2003/58). Outside the area, notable records are those of Bradley (1958) from Roman St Albans and of Coope and Osborne (1968) from the fills of Roman well at Barnsley Park, Gloucestershire. The beetle was thus present across a broad spatial and chronological range, but apparently not in large populations.

Abax parallelopipedus. This species, like *P. madidus* a large and very distinctive ground beetle which is now often common, seems to be far too rare in the archaeological record. Modern records suggest that it should have occurred in substantial numbers on occupation sites. It is often extremely numerous in pitfall traps in areas more or less strongly modified by humans in the York area (author, unpublished). There is no obvious explanation for this apparent change in abundance. The following records exist for The North (all single individuals): Late first century Old Grapes Lane B (Kenward *et al.* AML 76/92; 2000); Anglo-Scandinavian 16-22 Coppergate (Kenward and Hall 1995); and 13th century North Bridge, Doncaster Carrott *et al.* EAU 1997/16).

Remarkably, the beetle was found twice at the Early Christian Deer Park Farms site, Co. Antrim, Northern Ireland (Allison *et al.* EAU 1999/08; 1999/10).

Anotylus nitidulus. Records from the 19th and early 20th centuries suggest this small rove beetle to be typical of waterside and fenland litter as well as of artificial accumulations of decaying matter in Britain; there are also records from fungi and stranded seaweed. Older works describe it as common (e.g. Fowler 1888, 381), but the species is certainly not at all common in northern England (the writer having failed to find it in three decades, for example). However, it was abundant on occupation sites in the past, both in towns, e.g. in York (Kenward 1978a, 44; Kenward and Hall 1995) and at some rural sites, e.g. at North Cave (Allison *et al.* AML 105/90; EAU 1997/37; forthcoming a), where it was the most abundant decomposer species) and at Wharram Percy (Girling and Robinson AML 36/88), where it was abundant in one sample There must be a strong suspicion that it typically occurred in artificial accumulations of foul matter in the past. It is conceivable that two morphologically similar species with different habitat preferences exist, the wetland species having survived to the present day in Britain, the foul-matter species having been dependent on some special kind of artificial accumulations of decaying matter in the past, and having now become extinct or at least very rare, but there is no obvious reason for such an extinction.

*Anotylus tetr*Acari*natus*. There are numerous records of one or a few individuals of *A. tetr*Acari*natus* from most periods, but this species is notable for occurring erratically in large numbers, such records being almost entirely of Roman date. It is extremely common at the present day (e.g. in compost heaps and dung in fields), and often the most abundant of its genus; 'it might be said that [it] is the commonest beetle in our fauna, as it occurs in vast numbers, so much that on occasions the bottom of the net was black with them...' (Williams 1930). In the Anglo-Scandinavian period *A. complanatus* and *A. nitidulus* seem to be the usual abundant species: at 16-22 Coppergate, for example, 260 samples had *complanatus* (total 1226 individuals), 270 had *nitidulus* (1346 individuals) and only 29 had *tetr*Acari*natus* (42?2 individuals; Hall and Kenward 2002). In contrast, in the data for Roman Annetwell Street, Carlisle, 13 samples had *complanatus* (total 39 individuals), 73 had *nitidulus* (109 individuals) and 65 had *tetr*Acari*natus* (128 individuals). Systematic examination of the data for a wide range of sites is necessary, but these differences may prove significant in some way.

Platystethus species. *P. arenarius* apart, these small and often obscure rove beetles seem to have been much more abundant in northern England in the past than in the late 20th century; it is uncertain whether climate change, habitat loss, or both are involved, or even whether poor recording of the modern fauna may have lead to their being overlooked (Kenward 2004).

The *Anthicus formicarius* and *floralis* pair: These two beetles are notable as a closely related pair which appear (on a human scale) to have identical habitats, sometimes occurring together. Both are known from archaeological deposits, but *A. formicarius* is much the most abundant, in contrast to present-day records, which indicate rather similar abundances. There is no obvious explanation for this, unless *A. floralis* has gradually adapted to artificial habitats.

***Tenebrio molitor* and *obscurus* (mealworm beetles)**: *Tenebrio molitor* is apparently the more abundant of these 'mealworm beetles' at the present day, *T. obscurus* being described by Mound (1989) as 'uncommon, with a scattered distribution throughout Britain', but *T. obscurus* is effectively the only one of the two found in archaeological deposits of the Roman period onwards, in the north of England at least. (There is one odd record of two individuals of *T. molitor* from the lowest fills of an early 14th century barrel well at The Bedern, York; see Richards 1993 for an account of the archaeology, but the insect records are unpublished). Outside the region, Lambrick and Robinson (1979) recorded *T. molitor* from a Roman pit at Farmoor, Oxfordshire. Another record, from the putlog holes in the walls of tower of the church of St Mary Bishophill Junior, York (Kenward 1987) is possibly of 11th century date, but there is a real likelihood of later contamination. A remarkable record was made from natural deposits dated about 4000 BP in the Trent Valley by Howard *et al.* (1999); AMS dating of this fossil seems justifiable to eliminate a possible contaminative origin. Pals and Hakbijl (1992) recorded *T. molitor* from a Roman grain cargo in Holland, and their description of the fossil makes it clear that the identification is correct. (However, at least one published record, that of Buckland *et al.* 1974, is a misidentification of *T. obscurus*, and all the British material 'molitor' should perhaps be re-examined since even the most experienced workers may make mistakes, as did the present writer in the case of the Buckland *et al.* ?? record.) There also a remarkable record from Late Neolithic/Early Bronze Age alluvium in the Trent Valley (Howard *et al.* 1999). Thus something peculiar appears to have occurred in the biology of the two British species of the genus. Were it not for the few archaeological records it would be assumed that *T. molitor* was a recent introduction; as it is, it may have occasionally established itself for a while in human company, but only recently adapted more fully to artificial habitats. This species pair (like several other species discussed above) is of some importance in the study of invasions and the adaptation of species to artificial environments, and deserves further and more careful study. The presence of a third species in mainland Europe and Scandinavia (*T. opacus*, now found under the bark of old trees, Palm 1959, 301) may present a complication which has yet to be recognised.

Scolytus ratzeburgi: Now a northern species in Britain, there are prehistoric records from further south (Buckland 1979 from Yorkshire, Smith *et al.* 2000 from South Wales). Neither climate nor change in host abundance appears likely to be the cause of its retraction.

***Vespula* and *Dolichovespula* species ('yellowjacket' or stinging wasps)**: The lack of records of these now all-too common insects is discussed on p. 429.

There are a few archaeological records from the region which are relevant to studies of what are quite clearly very recent introductions. The remains of *Sitophilus oryzae* from a 17th to 19th century deposit at Tower Street, Hull (Carrott *et al.* EAU 1995/37; see also p. 355) are one case in point, apparently representing the first specimens of *S. oryzae* recorded from archaeological deposits in Britain. Similarly, the little water snail *Potamopyrgus jenkinsi* was recorded from 19th century river deposits at Layerthorpe Bridge, York (Hall *et al.* 2000/64). Now immensely common, this snail was unknown in Britain before 1889, after which it colonised most of England and Wales over about 30 years (Fryer and Murphy 1991); its original source unknown (though perhaps archaeological records will eventually reveal it). Maybe the development of the canals is implicated in the spread in some way? Note however, that while Fryer and Murphy say it is not known where *P. jenkinsi* came from, some authors suggest it migrated from brackish water rather than appearing de novo, and Cowell *et al.* (1993) report the snail from prehistoric estuarine deposits in Merseyside. Various earlier introductions might be traced using archaeological evidence. Tracing later invasions and changes of abundance will be of considerable ecological interest as well as providing important archaeological information; one of the primary research motivations for examining Post-medieval to early modern insect assemblages must be to pursue such matters. Studies of the impact of past introductions represent an opportunity to test their long-term effect on communities, for example, something which cannot be done at the present day but which is highly relevant to prediction of the impact of future introductions (whether deliberate or accidental) or releases of genetically-modified organisms.

Reconstructing climatic change

Introduction

Climatic reconstruction is currently at the forefront of science because of its perceived value in predicting future climatic change, both natural and as a result of human activity. The recent literature is large, and a very detailed record of change on a world or hemispheric scale has been obtained, particularly by using marine sediments (e.g. Dodd and Stanton 1990, 99-124) and ice cores (e.g. Alley 2000; Brook 2005; Dansgaard *et al.* 1993; EPICA community members 2004; Meese *et al.*, 1994; O'Brien *et al.*, 1995; Petit *et al.* 1999; Walker 2004), but also a wide range of other geomorphological, sedimentological, chemical, isotopic and biological evidence. Ice cores and tree rings may even provide evidence of changes in weather at a seasonal level (e.g. Morgan and Ommen 1997; Loader *et al.* 1995). More than three decades ago it was suggested on the basis of work on beetles from Late Glacial deposits that climatic change may at times have been very rapid (Coope and Brophy 1972; see also Coope 1987), and this has now more than amply been confirmed (Lowe and Walker 1997b); it appears that very large changes may occur within a decade (e.g. Dowdeswell and White 1995). The underlying pattern of climatic change through the Pleistocene has been of large-scale cycles ('cold' glacials and 'warm' interglacials), overlain by change in the long and short term, of large and small amplitude, with rates of change very variable. Climate is typically very unstable, and the past 10,000 years has apparently been unusually stable (Dowdeswell and White, 1995), although even the relatively subtle changes which have occurred have been significant to human well-being (e.g. Burroughs 2005; Haberle and Chepstow 2000; Lamb, 1982).

Insects are a particularly good source of climatic information, because they migrate rapidly and occupy a very wide range of habitats. Beetles have mostly been used, but other terrestrial insects can be important (e.g. the true bugs), as can some freshwater aquatics (notably the larvae of Chironomidae, midges, p. 69). Other invertebrate groups are emerging as important climate proxies, for example the testate amoebae (p. 18), cladocerans (p. 39) and ostracods (p. 36). For the future, we need to extend beyond basic estimates of summer and winter temperature - e.g. to determining season length and precipitation (the latter to tie in with the botanical studies of bog wetness such as that by Langdon *et al.* 2003, to test for periodicity). We particularly need to find natural sites at which the response of insects to changes deduced from other evidence can be observed: e.g. during the episodes or events recorded at 8200 BP (Alley *et al* 1997; Rohling and Pälike 2005), around 6000 BP (Bonsall *et al.* 2002; see also Kurek *et al.* 2003 and von Grafenstein *et al.* 1998), around 5300 BP (Magny and Haas 2004), at about 4250 BP (Plunkett *et al.* 2004), at 3900-3500 BP (Anderson *et al.* 1998), at around 2650 BP (Van Geel *et al.* 1996), at about 2300 BP (Davis and Wilkinson 2004), perhaps even short-lived phenomena such as the 'AD 540 event' (Baillie 1994; 1995; 1999; Keys 1999), and of course the Little Ice Age (Buckland and Wagner 2001).

Coope (1994) provides a review of the response of insects (mainly beetles) to glacial-interglacial climatic fluctuations. An earlier paper (Atkinson *et al.* 1987) is also particularly important, covering part of the Devensian Glaciation. The broad sweep of glacial climatic changes at the end of the last glaciation is summarised by Lowe and Walker (1997b). Work on terrestrial indicators such as insects is essential, for, however accurate the global reconstruction, the effect of global climate on local weather (which is what affects humans and other species alike) is not easily modelled. Lamb and others have used a variety of approaches in reconstructing climate and weather over the past millennia and documented, or speculated about, its impact (e.g. Anderson 1981; Beresford 1981; Dalfes *et al.* 1994; Dury 1981; Harding 1982; Houghton 1997; Lamb 1972a, b; 1977; 1982; Parry 1978; Pearce 1989). However good other methods or climatic reconstruction may become, insect remains are likely to provide especially useful information about terrestrial conditions. The techniques have now been refined to the point where temperature patterns across Europe can be constructed for some periods (e.g. Coope and Lemdahl 1995; Coope *et al.* 1998; Witte *et al.* 1998).

Most archaeological records of insects for the past 2,000 years are from urban deposits, with consequent problems related to the artificial nature of the habitats, heating, and importation of materials containing insects. Temperatures in towns may be artificially high as a result of the deliberate heating of buildings, of the heat generated by decay of large quantities of organic matter, of the sheltering effect of structures, and overall, of the urban 'heat island' effect (discussed in an archaeological context by Brimblecombe 1982). However, it has been argued by Kenward (2004) that useful climatic information can be obtained from records of insect remains from urban as well as rural occupation deposits, and in particular from plant-feeding bugs.

Distributions of some natural-habitats species, especially those found in woodland and wetland, have almost certainly been modified by habitat changes wrought by human activity as much as by oscillations in climate. This was discussed by Buckland (1979) in the context of the evidence from Thorne Moor, for example, and to some extent by Addyman *et al.* (1976, 225-7). The problem is acute for the Little Ice Age (e.g. Buckland and Wagner 2001; Wagner 1997). Many synanthropes, of course, are able to exist far outside their natural climatic ranges in the protected environment of artificial habitats. This topic is introduced by Kenward (2004).

Prehistoric climates

The potential for climatic reconstruction from invertebrate animals in our region only becomes significant from the Late Glacial period onwards; earlier deposits are simply too scarce. In the early part of this period (the Late Glacial and early Postglacial) there were large-scale climatic changes, easily reconstructed on the basis of massive differences in the insect fauna (in particular) and seen at several sites across the region. A broad geographic spread of sites is needed since there is no guarantee that climatic changes were synchronous across the region (cf. pan-European studies cited above); indeed, the presence of massive ice sheets must have created steep climatic gradients, and the east of the region may have suffered a very strongly continental regime before the infilling of the North Sea, the west perhaps being more buffered by the Atlantic Ocean. These are very much issues for research.

Part of the succession at Church Moss, Davenham, Cheshire, represented the period following the Loch Lomond Stadial (Hughes *et al.* 2000), but insufficient remains were recovered to provide more than crude climatic information. In fact, there is rather little evidence from insects for climatic or environmental change in the Flandrian Interglacial of the north of England and sites of this date should actively be searched for. The few Mesolithic sites in the region which have contained large invertebrate assemblages have not given much indication of subtleties of climatic variation in time or space; such evidence should be sought; the later Mesolithic climate change postulated by Bonsall *et al.* (2002) to be causal in the adoption of agriculture in north-west Europe clearly needs special attention.

For the Bronze Age, climatic interpretation from terrestrial fauna is complicated by the possibility that human exploitation and destruction of natural habitats was beginning to have a major impact. This interaction is discussed in the context of the insects from Thorne Moor by Buckland (1979), but is certainly a general problem. A range of beetle species have been recorded from Thorne and nearby sites which are now extinct in Britain or confined to the south (e.g. Buckland op. cit.; Buckland and Kenward 1973; Whitehouse 1993; 1997a; b). Hill (1993, 139-41, 151-2) obtained some useful records from Bronze Age deposits at St George's Field, York: *Ledra aurita*, now found only as far north as Herefordshire and Norfolk; *Mononychus punctumalbum*, now restricted to southern England and *Badister dilatatus*, also southerly (Hyman and Parsons 1992, 109). While some of these species were associated with reduced habitats (particularly old forests, '*Urwald*'), others seem less likely to have been affected by human activity and a climatic cause is probable. The accumulation of a much larger volume of data for this period would undoubtedly produce many significant results and, one suspects, some surprises. An extensive series of deposits at North Duffield, North Yorkshire, awaits investigation (Carrott *et al.* EAU 1994/34), but funding has not been available. For this period too there are postulated climatic changes to be tested against the evidence from invertebrates (e.g. Van Geel *et al.* 1996).

Information from invertebrates for terrestrial climatic change in the Iron Age is extremely limited, unfortunate since this was probably a period in which climate degenerated (e.g. Davis and Wilkinson 2004), perhaps accentuating human impact on the natural environment. Holdridge (1988) found *Arpedium brachypterum* and *Olophrum fuscum* in deposits around the Iron Age Hasholme boat (6660-2490 BP). These are not species typically found in lowland Yorkshire today and perhaps indicate a cooler climate (but see p. 476). By contrast, Kimmins (1954) discovered remains of the now southerly great silver water beetle (*Hydrophilus piceus*) in Iron Age ditch silts at Stanwick, North Yorkshire, and Alldritt *et al.* (EAU 1991/35) recorded remains which were almost certainly of the death watch beetle ?*Xestobium rufovillosum* from Iron Age or Romano-British peats at Park Grange Farm, Long Lane, Beverley. If Buckland's (1975a) argument concerning the thermal requirements of *X. rufovillosum* is correct, higher-than-present-day temperatures are indicated by a record from natural deposits.

Dating of natural deposits may be a problem where financial support is limited. Kenward (EAU 1991/29), for example, examined invertebrates from undated natural clays, silts and peats at Seaton Beach, Hartlepool, Cleveland. Most samples contained *Daphnia*, but the beetles included aquatic, waterside and terrestrial species, including indicators of dead wood. This was perhaps a drowned woodland and as such would be of high priority for analysis if dating was available.

Roman climate

There is somewhat more substantial evidence of climate from bugs and beetles dated to the Roman period, reviewed by Kenward (2004; see also references therein) and only briefly outlined here. Roman occupation sites have provided a variety of species 'out of range', and while some may conceivably have been imported, and others perhaps have been overlooked by modern collectors in the North, some surely indicate a warmer climate. Bugs from the Roman well at Skeldergate, York, are notable (Kenward *et al.* 1986b, 265), but numerous records of the nettlebug *Heterogaster urticae* from this and several other sites are particularly interesting. It was, in the mid 20th century, restricted primarily to the south-east of England, with sporadic modern records into Norfolk, and what seem to have been strays from Cheshire and Yorkshire. There are various records from York, including a substantial number of 2nd and one of 3rd century date at Tanner Row and Rougier Street. Outside York, there are various records of the nettlebug from Romano-British rural sites, significant since arguments about the role of urban heat islands cannot be applied to them. From much further north, there is a single record of *H. urticae* from a late first century floor at Castle Street, Carlisle, while four examples were found in the primary fill of a Romano-British enclosure ditch terminal at Flodden Hill, Northumberland (Kenward EAU 2001/49), and a single fragment provisionally identified from the Roman fort at Park View School, Chester-le-Street, County Durham (Schmidl *et al.* PRS 2006/47). For Flodden Hill, it was argued that a colony of the bug was established at the site, on the grounds that a single specimen may be a stray migrant, but several cannot be. The possibility of importation from the south in (for example) hay could be ruled out since (a) there is no evidence of disposal of such material in the ditch; (b) the bugs were co-habiting with a range of other typical denizens of nettlebeds, and that most of these species are far more likely to drop off vegetation as it was cut than to remain with it, making importation of the whole community extremely unlikely; and (c) it is hard to imagine bulk plant material having been brought great distances to a rural site of this kind. *H. urticae* is most unlikely to have been affected by human modification of the habitat (nettles have always been ubiquitous according to the archaeobotanical studies) and thus gives very convincing evidence of climatic change. It might be suggested that it was driven south in the 'Little Ice Age' and has been unable to re-invade, but it is a very active flyer and should not have difficulty in dispersal. Remarkably, in the late 1990s it re-appeared in Yorkshire, suggesting that temperatures are beginning to revert to those before the Little Ice Age. Mapping the occurrence of this species alone in time and space may provide invaluable evidence of the pattern of climatic change across England.

Climate in the Anglo-Scandinavian period

This and the immediately post-Conquest period fall in the postulated medieval warm period (see, for example, Crowley and Lowery 2000). *Heterogaster urticae* has been very regularly recorded in Anglo-Scandinavian York. There were eight records from the 6-8 Pavement site (Hall *et al.* 1983b, 219; Kenward EAU 2000/39), and 64 from 16-22 Coppergate (Kenward and Hall 1995, 489), for example, but it is unusual not to find the bug if more than one or two samples are examined from a site. Although plant materials (dyeplants, see Hall and Huntley 2007) may have been imported in bulk from the south or even from overseas, it is quite impossible to believe *H. urticae* was carried with such frequency without being accompanied by a range of thermophilous aliens, or that it would appear at such a variety of sites. It must have been a very common insect in the nettlebeds of Viking-Age York.

The method of recording adopted for the material from 16-22 Coppergate (and indeed most other sites) was intended to maximise archaeological reconstruction rather than to obtain large numbers of records of rarities, so information about some climatically-significant species may have been lost (the same is true of some of the Roman sites mentioned above). Nevertheless, some other species with possible climatic implications have been noted from this period, for example *Anthicus bifasciatus*, *A. antherinus*, *Acritus homoeopathicus*, *Odocantha melanura*, *Eurydema oleracea*, ?*Coreus margiantus*, *Cryptolestes duplicatus*, and *Phymatodes testaceus*. Some of these may have been affected by habitat loss or have been imported, however (see discussion by Kenward 2004).

Climate after the Norman Conquest

The nettlebug has been recorded from a series of post-Conquest sites in northern England, the latest dates appearing to be from later 14th century 17-21 Piccadilly (= Reynard's Garage), York (Alldritt *et al.* EAU 1991/01), and from 15th/16th century North Bridge, Doncaster (Carrott *et al.* EAU 1997/16), both interesting in relation to the likely effect on insect distributions of the beginning of the Little Ice Age.

Buckland (1975a) discussed the possible climatic significance of the deathwatch beetle, *Xestobium rufovillosum*. It occurs sporadically in urban deposits of Anglo-Scandinavian date onwards, although in towns it would doubtless be able to survive even at considerably lower temperatures than today's (although it does not extend very far north in Scandinavia, Lindroth 1960). However, records from isolated sites such as that for 14th century Cowick, North Lincolnshire (Girling and Robinson 1989) may be of climatic significance.

Dinnin (1991; 1997a) suggests that the loss of some taxa with southerly distributions from Yorkshire since the early post-medieval period may have at least in part been the result of the 'Little Ice Age', although habitat destruction probably affected some species. The failure of a highly mobile insect with abundant habitat - the nettlebug *Heterogaster urticae* - to re-invade until the later 1990s suggests that some aspect of climate had not fully reverted to the medieval state. However, we have almost no information from invertebrates concerning climate in the later medieval and post-medieval to modern periods. Such evidence should be garnered from both cultural and natural deposits whenever the opportunity presents itself.

Wagner (1997) has rehearsed the arguments as to whether extinctions across the Little Ice Age were the result of human impact or cooling climate. Buckland and Wagner (2001), in an important review, discussed the degree to which the existing evidence from insect (primarily beetles) remains provide a signal for the LIA across the Northern Hemisphere. They concluded that the effects of climate and human activity on range and abundance are very difficult to disentangle, that the timing of the local extinction of most species is unknown and hard to establish, but that some species were probably victims of cooling. Tracing extinctions in the fossil record is inherently difficult, however (Benton 1994; Hallam and Wignall 1997).

Reconstruction of climatic change in northern England using insect remains is still an essentially open field, with huge potential to investigate in detail terrestrial climate and weather responses to increasingly well-documented global changes, the gradients of climate East to West and North to South, and the relationship between vegetation and climate as indicated by the more rapidly-responding insects. Some species at least are sufficiently independent of human-induced habitat modification to provide evidence for patterns of change during the Holocene, and particularly in the past 2-3000 years, when climate history can be matched with a fairly detailed record of cultural change. Indeed, they may eventually allow at least some aspects of the balance between human and climatic factors in changing vegetation (discussed for example by Chambers 1993b) to be disentangled. How sensitive are insects to shorter-term climate change? Can they, for example, match the sensitivity of bog vegetation (as reported by Mauquoy *et al.* 2002)? Little Ice Age climate change and its effects on society represent a priority area for further research using invertebrate remains from both natural and occupation sites.

Determining depositional environment

The question of the depositional environment is implicit in any attempts to reconstruct the past, a fundamental underpinning of interpretation of the evidence as a whole. In particular, we cannot reconstruct without knowing whether remains originated (approximately) *in situ* or are likely to have been transported. Tackling this problem requires integration of evidence from the stratigraphic record, from the sedimentary matrix and its inclusions, and from the full range of biological remains, especially plants and invertebrates. One promising line of evidence is the use of detailed studies of variations in preservational condition of remains, since these may give clues as to the rate of deposition, mixed origins of remains, and the conditions within the sediment as it formed.

The nature of water bodies is a special case, though with important implications: was deposition in flowing or still water, and thus were biological remains local or transported? This has special significance in relation to records of elmid 'riffle beetles' occurring in what seems to have been still water. When these beetles are used to argue for clear rivers, were they carried into polluted still areas by water flowing from their upstream habitats (p. 406)? Or did they fly in large numbers? Similarly, the abundant aquatic invertebrates found in seemingly terrestrial deposits would be misinterpreted were other evidence for the depositional environment, and materials being incorporated, not taken into account (p. 321).

An understanding of depositional circumstances is also important in studies of in-ground decay: we need to understand the quality and range of preservation resulting from different depositional histories so that we can make judgment as to whether decay may have occurred during and immediately after deposition, or more recently (Kenward and Hall 2004a).

Forest history

Forest history is obviously only one aspect of the development of natural and semi-natural habitats, but is a particularly emotive one which has been subject to considerable research and speculation (e.g. Rackham 2003). The current debate about the nature of 'natural' forest ('wildwood', often supposed to have formed a continuous cover, e.g. Rackham 1994) and the effect of grazing stimulated by Vera (2000), and subjected to careful criticism by Rackham (2003), requires investigation. Publications, mostly recent, relevant to this crucial debate – which clearly touched many ecological nerves – include: Birks (2005); Bradshaw and Mitchell (1999); Bradshaw *et al.* (2003); Kramer *et al.* (2003); Mitchell (1990; 2005); Moore (2005); Rowley-Conwy (1982); and Svenning (2002).

Whether or not Vera is correct in envisaging a mosaic of trees and open herb-dominated areas as 'natural', *human* activity in opening up forests may have created a patchwork of grassland, herb stands, scrub and tall trees very early on. We are only now beginning to appreciate the degree of impact of pre-agricultural societies on woodland, even in the supposedly virgin forest of Amazonia (e.g. Bush *et al.* 2000; Heckenberger *et al.* 2003). Mesolithic clearance is discussed by Innes and Blackford (2003).

Forest history may be considered in terms of the balance of woodland to non-woodland (usually grassland or arable, but also heath and swamp), or in terms of the composition and structure (e.g. species heterogeneity, nature of clearings) of woodland. The primary tool for its investigation has been pollen analysis (e.g. the classic work of Godwin 1975; Bell and Walker 1992; Ingrouille 1995; Pennington 1969, and recent period reviews by Dark 2000 and Dark and Dark 1997), but its has limitations, especially in detecting small clearances, small woodlands or isolated hedges and trees. Other lines of evidence, including plant macrofossils and invertebrates, can contribute substantially - the latter not least because many insects, especially beetles, depend on old forest habitats, which are of particular relevance to research in ecology and conservation.

As early as 1978 Osborne had reviewed the evidence from insect fossils for human impact - essentially clearance - on the landscape over the past 6000 years. He concluded that there had been little impact before 5000 BC, but that subsequently grazed grassland became more important; by the Bronze Age, grassland was probably a major component of the landscape in the South and Midlands. This conclusion can probably be extended to lowland Northern Britain too. Buckland and Dinnin (1993) reviewed the Holocene history of forest insects in Britain, discussing extinctions and range changes as well as climatic effects, drawing substantially on sites in South Yorkshire (mentioned in the chronological account, above). Insects from woodland deposits certainly give very important evidence of the nature of forests. However, just as clearances may be hard too see in forest pollen records, or small woodlands obscured in cultural landscape pollen spectra (Bunting 2002), so scattered trees or distant forest may be invisible in the insect fossil record. The problem of the degree of visibility of nearby habitats is discussed further on p. 459.

There is archaeological evidence to support the hypothesis that insects may not reveal trees even when they were presumably nearby. At Bolton Hall, Bolton, for example, a sample from a pit or ditch terminal (probably the latter) with an Iron Age AMS date gave no indications of woody plants from insect herbivores, surprising in view of the strong indication from the plant remains that trees grew close by (Jaques *et al.* EAU 2002/04). Similarly, presumed post-medieval moat fills at the former Normanby Park Steelworks, north of Scunthorpe, examined in an evaluation by Hall *et al.* (EAU 2001/10) showed a contrast between the abundant botanical evidence for woody plants and the rarity of associated insects. By contrast, fills of a 15th century pit at Morton Lane, Beverley (Kenward and Carrott PRS 2003/58) revealed numerous tree buds and bud scales, and in this case there were quite large numbers of bark beetles, mainly *Leperisinus varius* (see p. 314), principally found in ash, but also a single *Dryocoetinus villosus*, typically in oak, which may have flown into the deposit or have been transported by humans in material containing the tree remains, but probably came from trees nearby. A study of modern deposits in relation to woodland habitats suggests that trees may not be visible even at a short distance (Kenward 2006).

Evidence for woodland normally comes from rural or natural sites, where trees grew. However, sites in urban areas may provide direct or indirect opportunities to investigate, though not locate, woodland. Numerous woodland insects have been recorded from various urban sites, notably from Anglo-Scandinavian pits at 16-22 Coppergate (Kenward and Hall 1995). While deadwood insects may have lived on the sites, many woodlanders seem to have been imported in moss or firewood, adding to the definition of the woodland source environment obtained from the plant remains. We do not know how close to towns woodland may have occurred. Carrott *et al.* (EAU 1993/08), in an evaluation of supposed natural and fish pool deposits, probably of later medieval date, found hints of a good, apparently *in situ*, woodland fauna close to the centre of Selby, North Yorkshire. Unfortunately there was no funding to pursue this outstanding opportunity to examine a wooded environment close to the town.

Sites of the **prehistoric period** mostly have some clear relevance to the subject of vegetation history and are reviewed in the chronological section (p. 124). It is worth noting that forest history has received little explicit attention through work on insect remains in most of northern England and indeed only the Humberhead Levels can be said to have been well-served. This despite questions concerning whether woodland cover was even complete on the high chalklands of the Downs and Wolds (p. 140). Few natural sites of the Roman and later periods have so far been investigated for insect remains (indeed, none in most areas of the North). Rural occupation sites have provided a little information, although most of it has been negative, documenting the rarity or absence of woodland taxa.

Romano-British sites

There is little evidence for the nature or location of woodland in Northen England in the Roman period from insect remains, and when woodland insects are found, it is generally hard to determine their significance. A site on the route of the Leven-Brandesburton by-pass (Carrott *et al.* EAU 1995/06), for example, the insects gave no evidence for living trees or shrubs, and only two individuals of species associated with dead wood were recorded (*Melasis buprestoides* and ?*Anobium* sp.). It was concluded that 'any areas of scrub or hedgerows which might have been inferred from the records of plant remains were not immediately adjacent to the site of deposition, local development of scrub, and eventually trees, presumably being suppressed directly or indirectly by human activity.' Similarly, the mid-late 4th century Romano-British site at Glebe Farm, Barton-upon-Humber, North Lincolnshire, provided few tree-associated forms; two bark beetles may have come from posts rather than nearby trees (Carrott *et al.* EAU 1993/13). Studies of various other Roman-British rural sites in the North with preservation of insect remains have effectively lead to the same conclusion (see the sites reviewed on p.177 ff.).

'Pasture woodland', grazing land with scattered large trees, a habitat now important for the survival of many insect species (e.g. Alexander 1998; Harding 1978; Harding and Rose 1986), has probably been an important vegetation type from the medieval period on, initially as a result of the creation of deer parks (Rackham 2003, 193), but may have existed much earlier. At the Skeldergate site in York, a Roman buried soil gave evidence of poor grazing land, but with strong hints of decaying trees, and this has tentatively been suggested as a possible example of trees standing in grazing land (p. 152 and Hall *et al.* 1980).

Woodland after the Roman period

Invertebrates offer remarkably little evidence for woodland from the end of the Roman period onwards; few sites have produced more than the occasional tree-associated insect. There is some evidence from insects imported to towns, for example in some Anglo-Scandinavian pit fills at 16-22 Coppergate, York, where it appears that a range of insects (and plant remains) was brought in moss gathered from beneath tree cover (Kenward and Hall 1995, 745-6 and *passim*; see also the data archive, Hall and Kenward 2002). Plant and insect remains together allow a limited reconstruction of the woodland. Unfortunately such evidence only establishes the existence of woodland close enough and sufficiently extensive to be exploited for large quantities of a resource as prosaic as moss for wiping bottoms; its location remains unknown.

Insect assemblages from deposits formed in a sunken wooden structure of medieval date built into the bank of a moat at Oakwell Hall, Birstall, West Yorkshire, examined by Kenward and Allison (EAU 1988/12), were dominated by species associated with outdoor habitats, with species associated with dead wood quite well represented but perhaps with various origins.

The record of a single head of the beetle *Prostomis mandibularis* from a pit with 12th century pottery at Morton Lane, Beverley, is remarkable (Kenward and Carrott PRS 2003/58). This extremely distinctive species (illustrated by Buckland and Kenward 1973) is unknown in modern Britain, and is regarded as an 'urwaldiere', associated in mainland Europe with rotting wood in ancient forests. There are records from prehistoric sites in Britain, the most recent apparently being for the Late Bronze Age (Buckland and Kenward 1973; Buckland 1979). The Morton Lane record requires careful evaluation since it would move the species forward into the second millennium AD, rather than being a first millennium BC extinction as formerly supposed, and perhaps beg questions about the whole process of extinction of forest insects. The specimen is very fresh-looking and robust, with the jaws still articulated, so importation as a free fossil in prehistoric peat seems extremely unlikely: remains from peat are mostly rather fragile and thinned by comparison, and often pale (e.g. those in the Roman well at Skeldergate, York, Hall *et al.* 1980). An alternative possibility is that it was brought in bog timber, still beneath the bark. This might account for its freshness. Until further evidence can be gathered, we must leave the discussion open: the survival of supposedly extinct species such as this into the second millennium would require both re-evaluation of the causes of their demise and investigation of medieval natural deposits with more vigour than shown to date.

Kinds of woodland

'Woodland' or 'forest' are terms which cover a wide range of landscape types, from primeval forest to pasture woodland, and from alder carr to upland scrub. Almost certainly, what was drowned at Thorne Moor (p. 136 ff.) was ancient forest as generally understood, disturbed only to a limited extent by human activity. The woodlands available to the inhabitants of Viking-Age York must have been constantly worked over for a range of resources, and might have been largely scrub, or resembled many small, over-exploited, woods near settlements today, although perhaps some areas were preserved for coppice or pollard. At the far end of the range, it has been suggested on p. 155 that the Roman riverside at Skeldergate, York, may possibly have resembled pasture woodland. Reconstruction of forest history, from the prehistoric *Urwald* (whatever its true nature) to the last vestiges of woodland and hedgerow represents a most promising area for future research. The potential and difficulties of such research are illustrated by the work of Hill (1993) as well as by the sites discussed above; further investigation of a topic of such profound importance in biological conservation, as well as in understanding resource availability and landscape modification in the past, must be a priority.

It is worth mentioning here the possible role of the bark beetle *Scolytus* in relation to the elm decline - see for example Girling (1988) and Girling and Greig (1985) concerning records of the beetle, and Maloney (1984) in relation to the fungal causer of the disease. Evidence of the beetles capable of transmitting the disease might usefully be sought in the North: a recent review of entomological evidence concerning the elm decline in Britain is given by Robinson (2000b), Clark and Edwards (2004) give records of S. *Scolytus* from northeast Scotland dated around 8800-5660 cal BP, and causal factors are evaluated by Parker *et al.* (2002), who concluded that the interplay of climatic and human factors probably drove a disease outbreak.

The topic of hedgerows as forest relics is also of interest (see for example Robinson 1978; Lambrick and Robinson 1979, 121-122) since hedges may have been the main source of 'woodland' insects in many landscapes. Because ditches and hedgerows often run side-by-side, there is some hope of recovering useful evidence of hedges from ditch fills, if also a danger of over-representation of 'woodland' as a result! (The same hedgerows may enhance settling of flying insects (e.g. Lewis 1965; 1969), giving increased representation of habitats over some distance.) So far as species composition of woodland is concerned, the history of pine is of special interest in the region.

Overall, the reconstruction of woodland history in northern England using invertebrates can hardly be said to have more than started. There is some superb evidence from a few prehistoric sites in one area, but no more than tantalising hints from later periods. Taken literally the evidence for the Roman period onwards would imply for many areas landscapes largely devoid of trees. While this may have been so (we may have under-estimated the degree of destruction of woodland, especially from the Iron Age onwards), the use of either insects or snails to detect trees or woodland seems to suffer interpretative problems (pp. 82 and 462).

Reconstructing areas immediately preceding intensive occupation: a special problem

The problem of determining whether fossils in natural, semi-natural or agricultural deposits below occupation layers relate to long-term conditions or only to the period immediately before burial has been briefly mentioned in the discussion of Roman settlement (p. 154). The problem is obviously a general one, however. Deposits which are of value in reconstructing land use prior to intensive occupation may be slight and easily overlooked; it is important that they are recorded and appropriately sampled. They may be obvious and extensive buried soils, or substantial natural alluvial or peat deposits, but often they will be obscure - rare patches of soil in areas otherwise destroyed by trampling and later cuts. Another approach to reconstructing pre-occupation land surfaces may be through the analysis of turves used in construction. These seem unlikely to have been carried too far in the early stages of occupation at any particular site, although later on they may have been brought over greater distances as nearby sources were exhausted. Evidence for imported turves is outlined on p. 316.

Invertebrates from deposits below the earliest Roman occupation in York have been observed at the sites in Skeldergate, Coney Street, Rougier Street, and Tanner Row, York (p. 187), and at Stanwix, near Carlisle (p. 341). Such evidence is sparse for later periods. Carrott *et al.* (EAU 1995/03) examined a ?12th century organic layer over 'natural' at Keldgate, Beverly. It appears to have built-up *in situ*, and if so indicates the nature of an area onto which occupation extended in the late 12th century. Insects and ostracods indicated aquatic deposition, and there were species associated with damp moss, decomposer insects typically found in natural habitats, some plant feeders and a single species found under bark. Plant remains suggested trees in damp habitat with abundant moss. The biological evidence as a whole pointed to this being an undisturbed wetland deposit, perhaps formed in alder carr with tall-herb vegetation. Jaques *et al.* (EAU 2001/35) reported evaluation of samples from a series of pre-occupation deposits at excavations on land behind and adjacent to 52 Keldgate, dated 13th/14th century or earlier; a turfline and a depression fill were effectively barren, while an 'organic deposit' appeared to have formed naturally in a swamp. In Hull, Kenward (1977) briefly described invertebrates from the fills of a pre-occupation watercourse with fills of 13th to 14th century date at Sewer Lane. Some other pre-urban deposits have been observed in Hull at the Magistrates' Court and Castle Street sites, but gave little information (Hall *et al.* EAU 2000/25; Carrott *et al.* EAU 1995/31).

Coastlines and estuaries

The potential for studies of invertebrates to contribute to problems of sea and river levels is obvious, but in Eastern England there is untapped potential in the extensive deposits which must have formed in the area which is now the North Sea and its coast prior to flooding by rising sea level. Two brief articles which give a general view of the kind of archaeological site which may exist are Murphy and Trow (2005) and Flemming (2005). Deposits of this kind in Sweden were investigated successfully by Gaillard and Lemdahl (1994).

Sea and river levels

Marine and freshwater flooding are brought together here because they frequently represent aspects of a single process or set of interacting processes. Changes in water tables may also be related, although recent ones generally seem to have been a product of increased abstraction of water (variations in rainfall have perhaps been unusually significant in the past decade or so).

There have been very large changes in sea level during the period considered in this review - of the order of 100 m between glacials and interglacials, associated with gross climatic changes, as water became locked up in the polar ice caps and in glaciers (e.g. Funnell 1995; Wilson *et al.* 2000). However, sea level changes - whether absolute (i.e. as the volume of water in the oceans changes) or relative (as a result of isostatic adjustment of 'floating' land masses) continued into the Holocene and are still going on. The literature of Holocene sea-level changes in northwest Europe is extensive, but often hard to apply to any particular period or location in our region. Useful sources include: Gaunt and Tooley (1974); Lambeck 1995; Long *et al.* (1998); Shennan and Andrews (2000); Tooley (1974; 1990); and Tooley and Shennan (1987). A brief review for Yorkshire is given by Long (2003), and for Northumberland by Horton *et al.* (1999b), while Usai (CAR 54/2005; 2005) provides a short review of literature for the region.

Studies of inland sites have provided some evidence of changing river, and by implication sea, levels. The evidence from Thorne and Hatfield, South Yorkshire (p. 136) suggested a rising water table which drowned ancient forest, a rise perhaps driven by rising sea level, although changes in the configuration of the mouth of the Humber (i.e. in the 'proto Spurn Head') may have been involved (de Boer 1964), as may increasing rainfall. Deposits at North Duffield appear to contain related evidence and require investigation (Carrott *et al.* EAU 1994/34).

For the Roman period, analysis of insects from the buried soil at the Skeldergate site, York, suggested that the River Ouse was well below its present level, and probably below 4 m OD since the soil was at most only intermittently waterlogged and there was no reason to suspect substantial flooding (Hall *et al.* 1980, 109-111). While the earlier phases at the nearby Tanner Row site clearly reflect damp conditions, with abundant aquatic organisms, there is no evidence for river flooding although the site was close to the Ouse (Hall and Kenward 1990). The Roman to medieval riverside succession at North Street, York (assessed by Carrott *et al.* EAU 1993/14) may contribute some information if funding for analysis is released. We need urgently to investigate flood silts and ditch silting deposits of the earlier periods at the Wellington Row site, so far only subject to a rather limited assessment (Carrott *et al.* EAU 1995/14). It was provisionally suggested that this low-lying riverside area was subject to sufficiently frequent inundation to bring about the gradual accumulation of overbank deposits, probably slowly enough for the growth of vegetation to be continuous where not affected by human activity. The relationship of this evidence to the accepted Roman incursions in East Anglia and the broad scheme of sea-level change needs to be established.

The relationship of floods and water tables to sea level changes in later periods, certainly from the Roman period onwards but conceivably even earlier, is not wholly certain since human activity in clearance and drainage (accelerating runoff) and canalisation (raising water levels locally by confining floodwater) must be taken into account. Whatever the difficulties encountered, invertebrates from sites in the lower Ouse and Humber, in particular, must have substantial potential in investigating these issues, crucial to past human populations, to natural communities of plants and animals, and to the survival of 'waterlogged' archaeological evidence.

For discussion of the effect of changing water tables on the preservation of delicate organic remains see p. 109.

Coastlines

Invertebrates may provide evidence relevant to changing coastlines by enabling reconstruction of littoral-zone ecology, but there appear to be no relevant examples from the north of England other than an undated intertidal peat at Chowder Ness, Barton-upon-Humber, North Lincolnshire, which gave a few insects (Akeret *et al.* PRS 2005/63), and the submerged forest beds off the Durham coast discussed by Trechmann (1947). Such investigations are desirable in view of questions relating to the availability of shellfish, especially oysters (p. 329). There may be important and well-preserved natural deposits below current sea level which would repay study; such deposits in Sweden were investigated successfully by Gaillard and Lemdahl (1994). Shipwrecks are another matter, of course. There have been several cases where invertebrates have been found in wrecks, and archaeological inferences made: examples are Welter-Schultes (2001) for land snails, and Hakbijl (1987) for insects. There appear to be no records of invertebrates from wrecks in northern England; no opportunity to make such studies should be lost, since a wide range of information may be obtained, ranging from identification of cargoes and conditions on board to obtaining evidence concerning the dispersal of invertebrates, including pests.

Marine littoral insects

Records of marine invertebrates such as shellfish and crabs in occupation deposits are usually clearly attributable to their deliberate exploitation in the past, and are considered elsewhere (p. 323). The occurrence of a wider range of marine littoral species in deposits closer to estuaries is not at all unexpected, and has been observed at a number of sites, especially at Hull. The Magistrates' Courts site provided numerous *Cercyon depressus* (Hall *et al.* EAU 2000/25), a species associated with accumulations of organic matter, typically seaweed, on the marine shoreline. At 36A-40 High Street (Carrott *et al.* EAU 1994/01), all the samples contained at least a few (and in one case many) individuals of *C. depressus* or *C. littoralis* (which has similar habitats). These beetles may indicate inundation from the River Hull, but it is also possible that they were exploiting manure. Urine-soaked litter may have much in common with salt-rich strandline detritus from the point of view of an insect, requiring similar adaptations. Elsewhere in Hull, these *Cercyon* were abundant in some layers at the waterfront site at Chapel Lane Staith (Kenward 1979c). The fauna of stranded wrack is very characteristic (Backlund 1945) and will be recognised when found. At Sewer Lane, Kenward (1977) examined a column sample through the fills of a watercourse, dated to the late 13th/early 14th century, and found two taxa suggesting brackish water: a foraminiferan which appeared to be an *Elphidium (Polystomella)* species, and the water beetle *Berosus spinosus*. Although these may have had some accidental origin, the most likely explanation is that this was a salt creek. At Blanket Row a salt-water influence was attested by a single *Elphidium* (Carrott *et al.* EAU 2001/12), in addition to *C. littoralis* and salt marsh species discussed in the next section.

At 63-64 Baxtergate, Whitby, 13th-14th century occupation deposits showed a strong human influence, but *Cercyon depressus* was present in two samples (Hall *et al.* EAU 1993/26). There was a notable absence of other marine or salt-tolerant forms (such as small marine invertebrates or calcareous algae) and it was suggested that while these beetles may have lived on the site in organic debris which had been flooded by seawater, they may possibly have been background fauna (cf. *C. depressus* at Buiston Crannog, Kenward *et al.* EAU 1994/42; 2000). A single sample, not well dated, from medieval occupation deposits at the 24-6 The Bolts, Scarborough contained a strongly synanthropic insect assemblage, with house fauna and grain pests, probably (with hindsight) from stable manure, but *Cercyon depressus* was also recorded (Hall and Kenward EAU 1990/11).

It is worth noting that parallels to these records are known from outside the area considered here, at Bridge Street, Ipswich (Kenward AML 195/87), for example, where there were large numbers of *Cercyon littoralis* in 13th century organic refuse. The North of England has not produced any assemblages with a rich assortment of seaweed insect species to parallel those found at the Dun Vula site, South Uist, by Roper (1999).

The marine littoral species, and some estuarine and salt marsh ones, provide a valuable tool for tracing the extent of marine influence into estuaries in the past. However, as an ecological grouping they are not without their complications. *Ptenidium punctatum*, a small beetle primarily associated with seaweed on the strandline, was found in large numbers in some Anglo-Scandinavian layers at 6-8 Pavement, York by Hall *et al.* (1983b, 191-2; see also Kenward EAU 2000/39), who discuss the significance of this species at length, concluding that it probably exploited some specialised kind of decaying matter on the site. Rather remarkably, the species was not found at the nearby (and one would have imagined very similar) 16-22 Coppergate site (Kenward and Hall 1995, 747). There is a record of *P. ?punctatum* from an evaluation of medieval deposits in the Gowthorpe, Finkle Street and Micklegate area, Selby (Carrott *et al.* 1993/08), from the supposed Kirk Dyke, in company with a rather unusual assemblage of insects and not far from the tidal River Ouse. In the absence of the York records this might have been interpreted as evidence of saline water, but obviously this is not the only possible explanation.

Another marine littoral insect which adapted itself to habitats on occupation sites in the past was the fly *Thoracochaeta zosterae*, whose puparia are often abundant, especially in deposits interpreted as cess pit fills. It is discussed on p. 71.

It is possible that some or all of the species discussed in this section might find their way to areas above high water, including occupation sites, in seaweed used for fodder or manure (p. 331).

Salt marsh and brackish water invertebrates

Salt marsh and estuarine invertebrates have the potential to contribute information concerning both local ecology, including marine incursions, and the exploitation of natural resources. A very distinctive insect fauna is known from salt marshes and estuarine shores (keys and illustrations to brackish water fauna are provided by Barnes 1994). Salt marsh plants are rather often noted at inland sites (Hall and Huntley 2007), and are regarded as probably imported in hay or in the guts of grazing animals, for example in the cases of the Roman wells at The Bedern and Skeldergate (Kenward *et al.* 1986b, 264 and Hall *et al.* 1980, 133), Roman Tanner Row (Hall and Kenward 1990, 387); North Street (Carrott *et al.* 1993/14), all in York; and Cartergate, Grimsby (Carrott *et al.* EAU 1994/22). There seem as yet to be no good examples of salt marsh (as opposed to wrack) insects from northern England to parallel these: they are perhaps too unlikely to be grazed in large numbers, so that only more generalist meadowland insects of indeterminate origin are likely to appear. If upper salt marsh hay was imported with more than a trace of insects, however, some characteristic remains should be found eventually. From elsewhere, Hakbijl *et al.* (1989) found a range of halobiont beetles in a Late Neolithic well at Kolhorn in the Netherlands, and Schelvis has reported salt-indicating mites (p. 76).

The snails seem to provide more evidence. There is a single instance of the possible importation of *Assiminea grayana* in salt marsh plants (or, much less probably, in dung) to Roman Tanner Row, York (Hall and Kenward 1990, 418). *Hydrobia ulvae*, a snail typical of estuarine mudflats and salt marshes but able to tolerate very low salinity (Hayward *et al* 1996, 190; Janus 1965, 62), occurred in Saxon deposits at the Flixborough site, North Lincolnshire, most probably having been brought with salt marsh hay (Carrott EAU 2000/55; Hall EAU 2000/56). *H. ventrosa*, tolerant of fairly low salinity (Hayward, *loc. cit.*), has sometimes been recorded, for example by Hall *et al.* (PRS 2001/03) in evaluation samples from 16th-17th century buried turflines on land adjacent to Paragon BMW, Citadel Way, Hull. Here it may have been deposited by flooding. A third member of the genus, *H. neglecta*, requiring somewhat higher salinity (Hayward *loc. cit.*), was provisionally identified from post-medieval deposits, perhaps reclamation dumps, encountered in sondage at the New Crane Street car park, Chester, probably having arrived in hay or dung (Hall *et al.* PRS 2002/08). The brackish-water and salt marsh snail *Assiminea grayana* was found amongst freshwater forms in a deposit under a street surface at the Crown Court site, Newcastle, by Nicholson (1989b); it was suggested that silt from the upper tidal limit of the estuary had been imported as make-up.

Salt marsh and brackish water species may occasionally be found *in situ*. Some of the cases mentioned in the previous section may fall in this category, while at Kingswood, Hull, medieval alluvial deposits gave shells of *Hydrobia ulvae* and so probably formed in a salt creek (Carrott *et al.* EAU 1996/55). The snail was also recorded at Chapel Lane Staithe, Hull, by Rackham (2001). Away from the North of England, Gilbertson and Hawkins (1985) discuss *H. ulvae* at length and suggest the possibility that changes in its abundance and distribution (and that of *Macoma balthica*) in the Severn Estuary were related to pollution, suggesting another use of these molluscs which might be applied, for example, in the Humber Estuary.

Hull has provided cases where both 'wrack' and brackish water invertebrates have occurred, sometimes on occupation sites in ditches and pits. At Blanket Row (Carrott *et al.* EAU 2001/12), *Cercyon littoralis* was present, together with the halophile water beetles *Enochrus ?halophilus*, *Ochthebius dilatatus*, *O ?lenensis*, *O. ?marinus*, and *Limnoxenus niger*; and the ground beetle *Bembidion ?normannum*. (*L. niger* is halophile in Britain but less so in continental Europe, Balfour-Browne 1958; Hansen 1987.) The Magistrates' Courts site (Hall *et al.* EAU 2000/25) presented numerous deposits in which halophiles were present, some of them occasionally abundant, with records of *Bembidion irricolor*, *Berosus affinis*, *Ochthebius viridis*, and *Carpelimus halophilus*, as well as the two *Cercyon* species. There were also some *Hydrobia ?ventrosa* snails.

Hall *et al.* (EAU 2001/38) found numerous examples of *Hydrobia ventrosa* during evaluation of a sample from alluvial silts revealed during excavations at the Magistrates' Court site, Brough. Salt marsh plants were also present, but (where they were sufficiently closely identified) all the other aquatic invertebrates were freshwater species.

From an earlier period, Buckland (1981a) noted the ground beetle *Dyschirius nitidus* and the water beetle *Ochthebius auriculatus* from sediments beneath the Late Bronze Age 'raft' at Brigg, North Lincolnshire, suggesting that the vessel had been abandoned close to the high water mark in brackish reed swamp.

Suites of mites characteristic of saline conditions have been recognised from medieval Holland by Schelvis (1997b), and these animals may provide evidence of incursions or imported salt marsh resources.

Wetlands and riverine environments

Two very contrasting kinds of environment are favoured in terms of preservation of biological remains by anoxic waterlogging: occupation areas with massive dumping of organic matter, and natural wetlands. The latter have been rather less well investigated using invertebrate remains than might be hoped in view of the abundance of deposits formed in them, their potential to address a range of pressing issues related to climate, hydrology and biological conservation, and the threat to their continued existence as a useful palaeoecological resource.

Natural wetlands and water bodies

While most of the 'natural' sites examined in the region for invertebrates have been wetland ones, the results are somewhat disjointed. A detailed review would be out of place here and would perhaps be premature. There is a considerable corpus of bioarchaeological work on lake sediments, pollen analyses in particular, again largely outside the scope of this review.

Some invertebrates from lake sediments have been examined. Recent climatological motivations seem to be accelerating the pace of investigation, but there is little early work on record. Cladocera and Ostracoda have been used to some extent (pages 39 and 36). Scourfield (1943) listed Cladocera from Windermere, but without attempting any reconstruction of past ecology. Cladocera from Esthwaite Water and Blelham Tarn were studied by Goulden (1964a; b) and Harmsworth (1968) respectively, while the latter also examined testate amoebae from Blelham; the results were perhaps limited in terms of ecological reconstruction. The larvae of chironomid midges have been investigated at a few locations (p. 70), including a study, with very limited results, of the peats around the Lindow II bog body (Dayton 1986). There are many questions to be addressed through studies of invertebrates from lake sediments, including palaeoclimate and landscape change, increased sediment and nutrient inwash; the progressive acidification of may water bodies in more recent times is of considerable significance (see, for example, Battarbee *et al.* 1990).

Those wetland sites in northern England for which there has been at least some investigation of invertebrates (usually snails or insects, rarely testate amoebae or ostracods) have tended to be prehistoric, with a bias towards the Mesolithic and Bronze Age of the Humberhead levels. Results from the sites concerned are summarised in the chronological section (p. 132 ff.). From later periods evidence is rare. The Iron Age acid swamp at Lindow Moss and the Lindow II body were subjected to a series of investigations, but the results were limited (see Dayton 1986; Girling 1986; AML 4725; Jones 1986; Skidmore 1986). A succession from deposits associated with the Lindow III body gave a picture of a wet *Sphagnum* bog with pools of rather acid water (Dinnin and Skidmore 1995). Hill (1993) investigated later Iron Age to Roman marshland deposits at Thornton, East Yorkshire, and Alldritt *et al.* (EAU 1991/35) put on record some material interpreted as representing weedy open water or fen at Park Grange Farm, Long Lane, Beverley. Undated, but presumably medieval, deposits at Saltshouse Road, Hull, subjected to evaluation by Hall and Kenward (EAU 1991/26) gave plants and invertebrates suggesting a natural peat forming in a woodland pond or fen carr, where the only input was plant debris, autochthonous invertebrates and a small component of insects transported from further away. The 'peaty layers' with a rich carr woodland fauna in supposed fish pool deposits at Gowthorpe, Finkle Street and Micklegate, Selby (Carrott *et al.* 1993/08), may be mentioned here.

Clearly there is a great need to investigate wetlands of any date, and the rarity of sites of later than Bronze Age date is conspicuous. The paucity of investigations is probably primarily a result of the lack of 'archaeology' at these sites, and the absence of a tradition of studying very recent deposits amongst Quaternary palaeoecologists. Such voids between subjects are to be avoided, particularly, as here, they are likely to lead to loss of valuable information. This is an important area for further work, as is the study of *any* natural (or essentially natural) deposits dating to the past ten thousand years. Climate changes from the Late Bronze Age trend to oceanicity onwards (and perhaps also earlier changes supposedly favouring the adoption of agriculture, Bonsall *et al.* 2002) are particularly interesting in relation to agriculture and the human economy. Difficulty of precise dating of very recent natural deposits is a factor militating against their adequate investigation, especially since a high resolution is needed; from most sites, replicated AMS dating of selected fossils, rather than of bulk sediment, is desirable, but it is expensive. Natural deposits of the past few centuries are typically regarded as uninteresting and expendable, and matters are worse by their superficial position, making them more liable to the onset of decay caused by lowering water tables and human interference. Yet these very deposits may document three of the most significant events of the Holocene - the Little Ice Age, the impact of industrialisation and exponential population growth, and the effect of globalisation of trade and its consequences in transporting biota.

Rivers and their fringes

The north of England is traversed by numerous and varied rivers, but there appears to be remarkably little evidence from invertebrates for their appearance, development and condition in the past. Although there are difficulties related to water transport and the possibility of redeposition of earlier material (e.g. Brasier 1981), the potential of studies of invertebrates from riverine deposits is illustrated by a limited amount of work, in our region (e.g. Hill 1993) and elsewhere (e.g. Boyd 1981; Dinnin 1997a; Howard *et al.* 1999; Osborne 1974; 1996; Smith 2000a; Smith *et al.* 2001; Smith and Howard 2004; see also the review of Shennan and Andrews 2000).

Riverine deposits of prehistoric date appear to have been neglected in the North, perhaps surprising bearing in mind the likely importance of rivers for various resources and for transport. Hill (1993) recorded invertebrates, mostly beetles, from later Bronze Age deposits at St George's Field, York, where there was a rich fauna, but no other sites appear to have been investigated. There has been work on the Trent, just outside the region, however.

Work in York has provided a little information for the Roman period. At Tanner Row (Hall and Kenward 1990) a broad reconstruction was possible, indicating marshy river fringes traversed by watercourses which were probably drains, both to dispose of water from upslope and to drain the area for use - perhaps for grazing. Areas on both sides of the River Ouse in York seem to have been grazed from the earliest stage of the Roman period and probably before that (Kenward and Williams 1979, 65; Hall *et al.* 1980 , 107-111). For the last of these sites (Skeldergate), it was suggested that there was poorish grazing land next to the river, with trees on the steep river slope inland, but a subtly different interpretation might be that the area was what would now be called pasture woodland (p. 155). Evidence from the pre-fishpool River Foss is limited, although deposits which were perhaps of this period have been seen in various boreholes.

There is hardly any information about minor streams. Various sites along Walker Beck, Beverley have been at least subjected to evaluation: at Lord Robert's Road,13th-14th century, plant and invertebrate assemblages were thought likely to indicate occasional inundation, for example (Carrott *et al.* EAU 1999/07). Jaques *et al.* (EAU 2002/04) speculated on the possibility that fill of pit or ditch terminal at Bolton Hall, East Yorkshire, originated as flood debris, but there was no clear support for the hypothesis.

River pollution is considered on p. 406.

Urban waterfronts and their special problems

That anoxic waterlogging is common in waterfront deposits, as well as logically to be expected, is clear from papers in Hobley and Milne (1981) or Good *et al.* (1991); it seems likely that most such sites with preservation of timber would yield a rich variety of invertebrate remains even though they are not discussed in any of the papers included in those volumes. Almost any interpretations of waterfronts are likely to be enhanced in some way by investigation of invertebrates, especially Foraminifera, Ostracoda and insects, providing the inherent problems are recognised and chronologically mixed material is rejected. Studies of urban waterfronts will need to be tied in with work on river and sea levels, but in this section other aspects are being considered: reconstruction of local riverine environments, and economic aspects including the value of dump deposits as a source of information concerning the settlement with which they are associated (considered further on p. 411). Such deposits are likely to be mixed and to include residual material, providing challenges to dating, but may represent the best source of large assemblages of biological remains. Mixture of remains from different *contemporaneous* sources is not a major problem, especially if lenses or layers of broadly uniform material are present and, on the basis of literature seen during the present review, invertebrates (together with other remains) may lead to recognition of many kinds of material, including stable manure, house floor sweepings, roofing materials, and possibly tanning waste. Residuality, too, may only be a minor problem where discrete layers are present, but requires further investigation for deposits of all kinds (Dobney *et al.* 1997; see also p. 479). The value of biological remains from riverfront deposits has been well demonstrated by work in Lincoln (Carrott *et al.* EAU 1995/10; Dobney *et al.* 1998) and York (Hall *et al.* EAU 2000/64). Little detailed work has been carried out on invertebrates from waterfront deposits in northern England, although there is a growing body of evidence from evaluations concerning the Ouse and Foss in York. Some of the sites mentioned here are considered more fully in the context of waste disposal on p. 411.

York's formal waterfronts are reviewed by Hall, R. (1991); they have produced remarkably little in the way of invertebrates, though many exposures appear not to have been sampled. Roman riverfront deposits were revealed in the 1970s excavations in Skeldergate, but no useful invertebrate assemblages were recovered from them. Evaluation at 14 Skeldergate (Allison *et al.* EAU 1991/06) revealed some putative riverfront deposits; the identity of one, recovered in a borehole, was confirmed with reasonable certainty by insect remains, while an organic lens in river silts seemed subjectively to consist of stable manure. Carrott *et al.* (EAU 1995/14) assessed material from Wellington Row, again on the south-west bank of the Ouse. Overbank deposits near to the river crossing (probably latterly by bridge) gave rather limited preservation, but were considered to have considerable potential. Useful material was revealed nearby at North Street (Carrott *et al.* EAU 1993/14), but again not studied fully.

Numerous sites associated with the River Foss have been examined, at least through evaluation, but most relate to the King's Fishpool; they are considered on p. 230, but it may be again emphasised that these deposits require proper analysis as part of a project to elucidate the history of the fishpool, a major feature in past York. One site, that at Layerthorpe Bridge (Hall *et al.* EAU 2000/64), deserves mention here. It was located at the upstream end of the fishpool and gave evidence of dumping, but more interestingly, of exploitation of the river edge for foul industrial activities: from flax remains, retting, and from bark fragments and unusually abundant remains of the beetle *Trox scaber*, probably tanning (p. 365).

In Hull, the site at Chapel Lane Staithe included a superb waterfront, and a series of analyses of insect remains were made of associated deposits. Possibly much more information would have been obtained from a larger-scale investigation, but the potential to determine the nature of dumped material and to divine something of conditions on the spot was clear (p. 221). The area of the waterfront at Newcastle has been investigated on a small scale by Nicholson (1988; 1989a; b), Nicholson and Hall (AML 45/86) and Nicholson and Kenward (EAU 1986/22; 1987/17). Some potential was shown by the invertebrate remains, but the scale of investigation was too small for useful results to be obtained.

Some bioarchaeologists have fought shy of waterfront sites in the past because of the interpretative difficulties involved, but there is every reason to suppose that, if approached carefully and recorded properly, they will provide substantial amounts of information and allow a wide range of questions to be addressed.

Rural ponds, ditches and moats

Ponds and ditches were often associated with dwelling sites, potentially giving information about occupation. Unfortunately it is not always clear from the archaeological record (and especially from bioarchaeological archive reports) whether there was an association, or whether such features were set in fields away from buildings so that their fills are of particular value in landscape reconstruction.

Some ditches round towns and forts obviously abutted rural habitats, but are considered elsewhere in the context of the built-up environment since the fills often include dumps from within which dilute both the autochthonous fauna and that from the rural surroundings. The fort at Ribchester provides an example (Buxton *et al.* 2000a-d; Carrott *et al.* 2000; Large *et al.* EAU 1994/11). For rural sites, the situation is rather different, since waste disposal systems probably almost always removed filth to the fields during full occupation (this has probably been the case from the early days of farming, since manuring appears to be a very ancient practice, Bakels 1997). The author is not aware of any rural sites in northern England showing preservation of surface-deposited occupation layers like those at Deer Park Farms, County Antrim (Kenward and Allison 1994a; Allison *et al.* EAU 1999/08; 1999/10; Kenward *et al.* accepted) or at the Iron Age sites at Goldcliff, Gwent, Wales (Smith *et al.* 1997). This places a premium on fills of peripheral ditches and moats as the best source of information about activity and living conditions in a settlement. Unfortunately, the interpretation of insects from cut features in relation to adjacent occupation areas presents special problems, discussed on p. 462. Similarly, field ditches, whether waterlogged (typically yielding insects) or not (sometimes producing snails), may be much the best, and usually the only, source of information about land use and the resulting ecological conditions in arable and pastoral areas.

Many ditch fills are rich in aquatics, presumably because there is a bias towards preservation in water-filled features. At Roman Ribchester, for example, there were rich and well-developed aquatic faunas in some of the ditches (Buxton *et al.* 2000a-d; Carrott *et al.* 2000; Large *et al.* EAU 1994/11), while ditch fills at a site on the route of the M57 in Merseyside were rich in aquatics but gave no more than hints of human presence beyond the effect of grazing or other modification of vegetation (Carrott *et al.* EAU 1994/17; Kenward 2000; Kenward and Large EAU 1997/20). The same is true in many other cases. It may sometimes be difficult to determine whether the rarity, or lack, of species associated with human occupation in such features is indicative of very well ordered waste disposal which saved ditches from being used as dumping places, of abandonment, or of limited representation of nearby terrestrial habitats (p. 462).

Prehistoric: The north of England has provided very few good examples of invertebrate assemblages from clearly-identified peripheral ditches of rural occupation sites of pre-Roman date, preservation by anoxic waterlogging usually being poor or lacking entirely. Late Bronze Age or early Iron Age fills of a ditch at Church Farm, Lily Lane, Flamborough, East Yorkshire (Carrott *et al.* EAU 1999/16), contained only (presumed intrusive) earthworm egg capsules and the recently-introduced snail *Cecilioides acicula*, for example (p. 483). Various ditches of less certain nature, perhaps associated with field boundaries, have produced insect assemblages, however, and these have given indications of land use (see chronological section).

Any prehistoric material of this kind with good waterlogged preservation, whether associated with structures or isolated in fields, would be of the highest priority for study.

Roman: In **East Yorkshire** Carrott *et al.* (EAU 1993/11), in an evaluation, examined fills of what may have been boundary ditches near Stamford Bridge. Preservation was poor, but one fill gave *Daphnia* ephippia and beetles of slow or still water, a second gave a small fauna from which there were hints of open ground, and a third produced *Daphnia*, a single water beetle and assorted terrestrial forms, conceivably from grazing land. Larger-scale investigation and AMS dating of fossils would probably have given rather more information. At the North Cave site (Allison *et al.* EAU 1997/37; forthcoming a) 2nd-?mid 3rd century boundary ditches close to structures had probably undergone natural infill post-occupation; there were aquatic molluscs, a range of water beetles, caddis, and *Daphnia*. Romano British ditch fill silts at Waterside Road, Beverley (Hall *et al.* EAU 2001/39: evaluation) gave aquatic and waterside species, as well as terrestrial forms, some of which suggested artificial accumulations of decaying matter. There was no clear indication from the invertebrates of land use (beyond ambiguous hints of dung) or human occupation, though it was suggested that detailed analysis might produce such information. Ditches at High Catton (Kenward *et al.* EAU 2002/12) again gave no synanthropic community in ecologically rich assemblages which indicated grazing land; two deposits seem to have formed where there was temporary shallow water, while a third was probably laid down under permanent water with aquatic and marsh vegetation.

In North Yorkshire, ditch fills associated with a 3rd-4th century Romano-British villa site at West Lilling gave numerous aquatics, with evidence of waterside plants, mud and litter. The beetles suggested that grazing land was present in the surroundings, and in one case (in a ditch which ran beside a droveway) there was a small synanthropic fauna suggesting material like stable manure (Hall *et al.* EAU 2002/01). Evaluation of invertebrates from a sample from a small pond or ditch, perhaps of Roman date, on the route of the Chapel Haddlesey to Eggborough pipeline (Hall *et al.* EAU 1999/31) showed that the feature held water, and that there was probably grazing land adjacent. Here, the plant remains gave hints of human occupation, but the insects included no clear occupation-site synanthrope community. Fill of the terminal of an enclosure ditch at Flodden, Northumberland (Kenward EAU 2001/49) similarly gave a rich assemblage in which there were effectively no synanthropes.

Post-Roman to post-medieval: The fills of a 14th century moat at Cowick, East Yorkshire, gave a rich invertebrate fauna (Girling and Robinson 1989), with a limited range of synanthropes presumably derived from the manor.

In Selby, North Yorkshire, evaluation of deposits identified as having formed in the Kirk Dyke, a ditch cut in the medieval period, at Gowthorpe, Finkle Street and Micklegate (Carrott *et al.* EAU 1993/08) gave aquatic and terrestrial fauna, including synanthropes, these last possibly having been transported by water in drains or gullies leading to the ditch. Evaluation of the fill of the original moat cut at Rawcliffe Manor, Manor Lane, Rawcliffe, York, gave *Daphnia* ephippia and a primarily aquatic and waterside insect assemblage (*Helophorus* spp. being predominant). Terrestrial insects were rare, and no synanthropes were recorded; there was no evidence for the dumping of waste.

Sediments in a pond or moat of 11/12th-16/17th century date adjacent to a small settlement at Higher Lane, Fazakerley, Merseyside, were reported by Dobney *et al.* (EAU 1995/22) and Hall *et al.* (EAU 1996/05). Analysis of a range of biological remains, including insects, showed an initial phase of aquatic deposition with probable slumping from the pond sides, followed by a phase of stable aquatic conditions with a rich insect fauna, then terrestrialisation. The area around the settlement may have been largely arable land with mature hedges or patches of trees. Few plants and insects indicative of intensive occupation were recorded, although there was apparently evidence for a structure within 30 m of the pond. This may have been a result of the presence of a boundary between the pond and the building, and perhaps also of prevailing wind direction at times when insects were migrating (p. 463). Fills of a natural watercourse sealed by Speke Hall, Merseyside (constructed in the mid 15th century) were analysed by Kenward and Tomlinson (1992); they appeared to be of late 15th-early 16th century date. The lower fills gave assemblages with a large proportion of aquatic insects, but these became rarer in the upper fills, the watercourse clearly terrestrialising and eventually being grazed. These deposits were presumably formed in agricultural land.

Insect (and plant) remains from a series of fills of a moat adjacent to the house platform at Risley, Cheshire, with dates from the early 15th to 18/19th centuries, gave insect remains with considerable value in reconstructing water quality, and vegatation and land use (grazing at one period) in the surroundings (Carrott *et al.* EAU 1996/13; Kenward *et al.* EAU 1998/23). The range of synanthropes was limited, either because the site was isolated or because there was limited transfer from living areas to the moat.

Invertebrates have much potential in reconstructing the nature of occupation and land use in rural areas, and the most likely source of remains other than those of landsnails is from deposits in artificial cut features, and more rarely in natural watercourses and buried soils. Unless clearly disturbed or oxidised, such deposits should be sampled thoroughly and assessed in the laboratory, even though many will prove barren. The use of ditches in waste disposal is considered on p. 409, and the value of rural cut features as a source of information about nearby occupation is discussed further on p. 462.

Large artificial water bodies

Although it is known that various large fish ponds were created at monastic sites, there appears to be no record of their investigation for invertebrate remains. The potential of such work may be limited, but invertebrates should contribute to the reconstruction of water quality in, and infilling of, such features, and provide information about land use in the surroundings.

The most substantial artificial water body in The North which has been investigated is the King's Fishpool in York. A long series of sites within and marginal to this huge dammed lake, created following the Norman conquest as part of the castle defences, have been excavated, but most of the work has been during the course of evaluations, sometimes only via boreholes. The results of these studies are summarised elsewhere (p. 229) and amount to frustratingly little at this stage: just tantalising glimpses which demonstrate enormous potential. It is, however, worthwhile to outline the range of questions which might be addressed by proper studies of such sites. It would be inappropriate to separate off those aspects particularly suited to work on invertebrates, however, as any investigation should be fully integrated.

Initial flooding of former 'dry land' in the Fishpool area may have preserved terrestrial vegetation and associated invertebrates, and perhaps even wharves and associated deposits, *in situ*, providing an exceptional opportunity to study the former function and nature of this area. The episode of flooding when the pool was first formed must have represented a substantial ecological catastrophe. Presumably a large area of marshland was flooded, and it is most likely that the submerged vegetation would have decayed rapidly and that this would have produced an episode of extreme eutrophication, if not anoxia. At this stage, much of the fauna, invertebrate and vertebrate, may have been adversely affected. There may also have been substantial silting as the formerly flowing river was reduced to what was essentially a shallow stagnant lake; initial and later sedimentation rates might be followed. The subsequent changes in water quality should be traceable, as should any episodes of excess runoff carrying mineral sediment from upstream, and flooding. The development of the flora and fauna over the next few hundred years could be reconstructed, and at least limited information about conditions in the river basin upstream be obtained. Such a shallow basin might be expected to have terrestrialised rapidly, and the possibility of detecting dredging to retard this process should be entertained. Episodes of drainage and refilling, whether deliberate (as part of maintenance work on the castle defences downstream, for example) or accidental (failure of the dam or weir) should be detectable at least locally. Sudden drainage would presumably create deep scoured channels containing sorted coarse material which would be very recognisable on excavation. The use of the margins of the pool for waste disposal is clear even from the limited evaluation analyses; this process should be followed in more detail, timed, and the dumps used as a source of information about source areas and activities (for the later medieval and Post-medieval periods, such dumps may be the best evidence we can obtain for certain kinds of activity). Discharge of sewage and other foul effluent might be traced. The marginal areas should be studied for evidence of special activities (such as likely retting and tanning at Layerthorpe Bridge, and butchery) and for evidence of agricultural use. The final stages of infilling, as dumps and vegetation encroached and the open water silted up, should be followed and dated.

In Selby, evaluation of 'peaty layers' in supposed fish pool deposits at Gowthorpe, Finkle Street and Micklegate (Carrott *et al.* EAU 1993/08) gave good evidence for woodland, probably in the form of well-developed species-rich carr. This may have represented 'drowned' woodland, flooded when the 'fish pool' was formed. The failure to carry out intensive analyses of these and other related deposits represented an important opportunity lost, and no further deep interventions in the area should be permitted without provision for full sampling and analysis and publication of this very promising material.

Aquatic habitats within occupation sites (pits, ditches and wells, for example) are considered on p. 387.

Exploitation of natural resources

The investigation of the resource base of populations of any period is clearly central in the study of human palaeoecology. The invertebrates were sometimes themselves the exploited resource (e.g. shellfish for food, bait, and perhaps dyes, p. 361). They are also very important indicators of other resources, mainly plant (e.g. wood, brushwood, dyeplants, moss, hay, peat and turf) but sometimes animal (e.g. species incidentally brought with fish or shellfish, and the parasites of birds and mammals). Invertebrates may also be indicators of the importation of sediments, especially waterlain ones. Some snails may have been imported with building stone – especially calciphiles with limestones – and become established in settlements.

Few invertebrates appear to have been exploited for food in Britain other than those which are still generally acceptable at table: a few species of marine molluscs, freshwater bivalves, crustaceans (mostly marine, but also perhaps freshwater crayfish) and (probably very rarely) echinoderms. Bees were exploited secondarily through honey and wax and a few species were employed in medicine (p. 358). This is very much in contrast to the dietary use of a wider range of invertebrates, especially insects, when a world perspective is taken (see below). Some other invertebrates may have occasionally been used for decoration (notably shells), and sponges have doubtless had various functions (p. 20).

The only insect 'wild resources' which have been deliberately exploited on a regular basis in Holocene Britain are probably honey and wax, although conceivably some native moth cocoons were occasionally used for silk, and maybe some insects were eaten, particularly when starvation was near (below). Despite this (in fact, because of it) the insects are able to reveal a great deal about past resource utilisation, having been accidentally imported with a range of materials. Other invertebrates were, of course, an important food source, sometimes perhaps the only good source of protein for certain human populations. Some terrestrial molluscs were doubtless eaten, but the main source of invertebrate food was the sea.

Terrestrial invertebrates as food

On a world scale, and in the long perspective, terrestrial invertebrates have been a very significant source of food – and other materials – for humans. Bodenheimer (1951) provides an exhaustive review of entomophagy (in the broad sense, including other arthropods), but a great deal has been written on the subject over the years (e.g. Holt 1885; Steward 1938; Sutton 1995) and there is substantial ethnographic and archaeological evidence for insects as food across the world (e.g. Bryant 1974; Bukkens 1997; Dufour 1987; Essig 1934; Green 1998; Pellett 1997; Ramos-Elorduy and Moreno 2002). Tellingly, a recent review urges westerners to be aware of the negative impact of their bias against eating terrestrial invertebrates, in discouraging their exploitation in poorer countries, underlining both our bias and their importance elsewhere (DeFoliart 1999). The food value of insects may be considerable (e.g. Bukkens 1997; Ramos-Elorduy *et al.* 1997). Even earthworms appear to be a valuable resource: Sabine (1983) reviews their potential as a source of food and drugs for humans and livestock, suggesting they will become valuable as food but that the scientific evidence for medical potency is meagre, while Guerrero (1983) reports experimental use of worms as a protein source for fish and quail culture.

Insects have sometimes represented a significant food resource for humans in some parts of the world (e.g. Madsen and Kirkman 1988), but are not generally thought of as at all important in Europe. However, there is substantial evidence for the use of some insects, especially cockchafer larvae, in Europe until the 20th century. It is recorded that cockchafers were eaten in Ireland during the famine (Bodenheimer 1951, especially pp. 54, 66 ff). Bodenheimer also records instances of the use of spiders as food in Europe into the 20th century. The Greeks and Romans appear to have eaten grasshoppers and beetle grubs, as well as cicadas (Bates 1959; Bequaert 1921). Bates also points out that the consumption of locusts and other grasshoppers is specifically permitted in the Jewish dietary laws. However, with rare exceptions, insect food seems to have become unfashionable in Britain a very long time ago, and entomophagy became a symbol of insanity (as in Bram Stoker's Dracula).

Snails are a more familiar food source (Elmslie 1984). The very common 'garden snail' *Helix aspersa* is one of the few terrestrial invertebrates known to have been exploited for food to a significant extent in the British Isles. However, the presence of *H. aspersa* shells in occupation deposits is not in itself evidence of use for food, since it is sometimes immensely abundant in habitats strongly modified by human activity (Kerney and Cameron 1979, 205). O'Connor (AML 4735) considered that it was 'an opportunist detritivore exploiting the debris of human settlement' at Anglo-Scandinavian 16-22 Coppergate, York. *H. aspersa* often hibernates in clusters, so groups of shells should not be assumed to have been deposited by humans. Step, in 1927 (366), wrote that the snail 'appears still to be eaten in the north of England'. Evans (1979) stated that it was still sold on markets at the beginning of the 20th century, under the name 'wallfish', as well as highlighting the problem of determining whether remains were to be interpreted as human food or wild populations. It has been argued that *H. aspersa* was introduced to Britain by humans, perhaps the Romans, and possibly as a food resource (Cameron and Killeen 2001; Evans 1972, 175; Kerney 1966), although the last author remarks that it is curious that no accumulations of its shells are known from Roman sites.

It has been suggested that the 'Roman snail' *Helix pomatia*, a large and succulent species, was deliberately introduced to Britain for food. It is still cultured for this purpose in southern Europe at least. Evans (1972, 176) quotes Kerney (1966) as suggesting that this introduction has not been *disproved*. This contention is discussed by Step (1927, 366-7), who points out that although *H. pomatia* has been claimed to be associated with Roman sites in the south, 'there are many important Roman stations - such as York - where there is no vestige of the snail' - a topic worth pursuing, perhaps. Records of its appearance around Roman settlements in areas for which prehistoric mollusc faunas are well known would be more convincing evidence. Kerney and Cameron (1979, 205) point out the possibility of confusion of *H. pomatia* with other large species imported for food (e.g. *H. lucorum* from southern Europe) so archaeological material should be examined with care.

Some other snails are large and common enough to be considered for human food (Elmslie 1984), including the two *Cepaea* species (banded snails). *Arianta arbustorum* might be considered a candidate, for famine food at least, though Evans (AML 1823), writing of Medieval Wharram Percy, suggests that it is questionable whether this and other smaller species were eaten. Lovell (1884) records *Cepaea* (as *Helix*) being eaten. It will be extremely difficult to determine whether any of these snails were eaten in particular cases, even when they are abundant in occupation deposits.

Wild honey has doubtless been exploited as a sweetener and energy source from a very early time, and bee-collected pollen used to some extent (Crane 1983; Zeuner 1963b). Even in Europe this may not have been restricted to honey bees (*Apis mellifera*), for Bodenheimer (1951, 67) mentions that children in Hanover caught bumblebees and sucked the nectar from their crops; this may be a hangover from an earlier food resource. We have no idea when bee-keeping, rather than raiding wild hives, first became established in the north of England. The evidence for apiculture is considered on p. 358. Honey will be hard to identify in archaeological deposits as it would have decayed extremely quickly; massive concentrations of pollen of flowers favoured by bees would be convincing evidence providing there was no other obvious source for the remains (e.g. Dickson 1978; Hansson 1955). Pollen analysis of cesspit deposits might be worth undertaking in an attempt to detect such concentrations. Where residues exist, it may be possible to identify honey chemically (p. 359).

It is worth mentioning here another sweet substance produced by insects: manna. This has been identified as the sugary secretion from certain scale insects and aphids (Bates 1959; Bodenheimer 1951, 217-225). It was (at least into the 20th century) widely exploited in the middle east but seems most unlikely to have been imported to Britain. Many British plant-sucking bugs produce secretions rich in sugars, generally called 'honeydew', but there appears to be no record of their use here. Indeed, they would not be very easy to exploit. However, it is not impossible that they were used locally in times of need. The only evidence which might be found (apart conceivably from the analysis of sugar residues, since manna at least contains rare and characteristic sugars, Bates 1959) is deposits containing very large concentrations of honeydew-producing bugs introduced as contaminants.

An indirect food use of terrestrial invertebrates is as bait for fishing. Various marine worms have traditionally been used to bait fish hooks, but other invertebrates including limpets, earthworms and fly larvae (and apparently wasp grubs too) are also used. It has occasionally been suggested that the accumulations of limpets found at some sites represent bait rather than human food. Presumably fly fishing originated by using the real insects, which subsequently were mimicked by artificial 'flies'. Detection of such use in the past seems unlikely, however.

Galls

Galls are plant tissue modified by insects, and some have had economic value. Ink was prepared from the 'marble gall', 'bullet gall', 'oak nut' or 'Devonshire gall' produced on oaks by the cynipid wasp *Andricus kollari*. The causer of this familiar gall is said by Darlington and Hirons (1968, 152) to have been introduced to Devon from the Middle East about 1830 for ink-making and subsequently to have spread across Britain naturally, but they state that British-grown galls produce too little tannic acid to be of much value, though this presumably does not rule out their use as a second-grade source. Galls may have been imported in earlier periods, and should not be overlooked. Celoria (1971, 20-21) discusses their use as a mordant in dyeing, while Bodenheimer (1951) mentions the use of soft galls (perhaps unlikely to be preserved) as food. Other galls, surely without economic importance, are recorded moderately often from occupation deposits: from more than ten Anglo-Scandinavian contexts at 16-22 Coppergate, and five Roman contexts at Tanner Row, both York, for example (A. R. Hall, personal communication).

Some other insect products of economic value are discussed on p. 76.

Invertebrates as medicine

Invertebrates have doubtless found various uses in medicine over the millennia, whether simply superstitious or based on the doctrine of signatures. Bristowe (1958, 193-4) mentions that eating a house spider (*Tegenaria*) was once believed to be a cure for malaria, and also the swallowing of spiders to overcome arachnophobia - a medical use of a sort! Bodenheimer (1951, 67-8) gives several references to the use of spiders as medicine (and food), while Lovell (1884) records that snails (*Helix aspersa*) were recommended as medicine for various ailments, quoting recipes, some of which include earthworms too. The application of insects in folk medicine is reviewed by Cloudsley-Thompson (1976), while Busvine (1976) mentions the use of various parasites, especially bed bugs, as medicines. Insects have certainly found many medical uses among both simple societies and urbanised ones on a world scale.

The best known medical invertebrates are leeches, once a cure-all, long out of favour, but now sometimes again used: they were sufficiently important to have given the words 'leech' for a doctor, 'leechbook' for a medical manual, and 'leechcraft' for medicine, found early on in the literature and still sometimes used even today. They are discussed briefly on p. 33.

One insect product which has been extensively used, with identifiable effect, is 'Spanish fly', cantharidium. This is a fiercely irritating substance produced by the metallic green blister beetle *Lytta vesicatoria*, also known as cantharides. Hakbijl and de Groot (1997) found tiny fragments of of *L. vesicatoria* in a hut used by an expedition to Novaya Zemlya in 1596, and Hakbjil (1987) reported a container of ground-up cuticle from a wrecked Dutch East Indies ship. In the latter case remains of the bright green chafer *Cetonia aurata* were intermixed. This beetle, too, has according to Kirby and Spence (1859, 179) been employed medicinally. Hakbijl and de Groot (1997) review the many past medicinal uses of cantharides. The recovery of finely ground insects intended for medicinal use, like the detection of grain pests derived from flour (p. 344), will demand a modification of extraction techniques and cannot be done routinely. Fragments may be detected in 'squashes' for microfossils (p. 29), however.

Honey has widely accepted and apparently effective uses in medicine (see for example Molan n.d.), and must have been important in the past.

The use of the 'eyes' of crayfish as a cure-all medicine in western Europe in the past is described by Schmitt (1965). These 'eyes', in fact discoidal nodules of limy material laid down in the stomach, probably as a reserve of calcium which can be mobilised after moulting, may well preserve and can be added to the list of invertebrate curiosities which should not be overlooked.

Hopkin (1991) says that 'Woodlice ... have featured prominently throughout history in recipes' and also states that they were used as a cure for stomach aches and other minor ailments. Earthworms have also found use as medicine (Sabine 1983). The latter authors give a list of uses ranging from 'hair restorer to an aphrodisiac and even as treatment for haemorrhoids'. We may conceivably recover at least circumstantial evidence for such uses. Step (1927, 389) mentions that 'the ancients' used cuttlefish shell as an antacid, and it appears that dried woodlice have been used in the same way: again, we may hope for no more than circumstantial archaeological evidence.

A notable use of an invertebrate in medicine which, like leeches, is becoming fashionable again, is the application of fly maggots to clean infected wounds. The history of this practice and modern applications are reviewed by Sherman *et al.* (2000).

Invertebrates and other terrestrial resources

While rather few terrestrial invertebrates have been used directly by human beings, assemblages of invertebrates in archaeological deposits have proved invaluable as secondary evidence of the exploitation of a wide range of resources.

Invertebrates as secondary evidence of wild plant foods

Insects in particular have potential as indicators of the exploitation of wild plant foods, although no relevant cases have been encountered in the literature for Britain. Insects emerging from collected plant material might be detected; an obvious example would be nut weevils (*Curculio* spp.) emerging from, or eaten with, hazel nuts (*Corylus avellana*) or acorns (*Quercus* spp.). The writer has noted large numbers of beetles and bugs, including species found in medieval house floor layers, emerging from collected blackberries (*Rubus*). One such species is the capsid bug *Deraeocoris lutescens*, found year-by-year in blackberries from the writer's garden, and two of which were noted medieval floor deposits at the Magistrates' Court site, Hull (Hall *et al.* EAU 2000/25). Species associated with green plants collected for food might be found, although the difficulty of distinguishing between this and plants growing on or near the site would be considerable unless large numbers occurred in characteristic associations in house floors or cesspits. The aphids from a cesspit in York may - just conceivably - be such a case (p. 433).

Insects as evidence of exploitation of wood

It is suspected that a proportion of the wood-boring insects recovered from occupation sites emerged from collected firewood or from timber. Some bark beetles and epiphytic moss dwellers probably arrived in this way. Some of the woodland species from Anglo-Scandinavian 16-22 Coppergate (Kenward and Hall 1995) may have come with firewood, although most undoubtedly were brought in moss collected for various uses. The bark beetle *Leperisinus varius* has occasionally been found in archaeological deposits under circumstances leading to the suspicion that it emerged from logs, probably of ash (*Fraxinus*), intended for firewood. It is rather common in occupation deposits at York, for example in three deposits at the Queen's Hotel site (Kenward and Hall EAU 2000/14) and in deposits of the same date at 6-8 Pavement (Hall *et al.* 1983b, 185; Kenward EAU 2000/39). *L. varius* was found in 48 Anglo-Scandinavian contexts at 16-22 Coppergate (Kenward and Hall 1995); there were 275 records of ash wood from the site, so frequent importation would not be surprising. At Tanner Row, York (Hall and Kenward 1990, 346), a late second century deposit interpreted as part of a hearth gave (in addition to a rather mixed fauna) several specimens of *L. varius*, which it was suggested may well have emerged from logs (although ash timber had sometimes been used for structural purposes at the site). Several, again perhaps brought with wood, were found in the well at the villa site of Dalton Parlours, Collingham, described by Sudell (1990). Such an origin should not be automatically assumed: numerous *L. varius* in a 15th century pit at Morton Lane, Beverly (Kenward and Carrott PRS 2003/58) probably originated (with the abundant buds and bud scales recorded) from a tree or trees nearby, rather directly than from timber or firewood.

Invertebrates in moss

Accidental collection of corpses or living animals with moss was probably the means by which numerous insects and some other invertebrates were brought to occupation sites. Although very few insects feed on them, mats of moss provide habitats or hibernating sites for, or give temporary shelter to, many species. The litter collected in (and attached to) moss mats and clumps (polsters) also provides a trap and protection for invertebrate corpses, especially those of insects. Microfossils (e.g. testate amoebae) may have been imported in large numbers, too. Doubtless some species imported in moss became established, at least temporarily, on occupation sites.

Botanical analysis has revealed the use of moss on a huge scale at many sites; it was probably one of the basic raw materials until quite recently. The result of this massive importation must inevitably have been to bring in immense numbers of insects, and this must be kept in mind when considering the significance of the outdoor component of assemblages. At 16-22 Coppergate, York, for example, some of the Anglo-Scandinavian pits gave a substantial number of woodland insect species, undoubtedly imported in moss and including the small stag beetle Sinodendron cylindricum (Kenward and Hall 1995, 514-5, 576, fig. 183), while in a few cases it was suggested that landsnails had been imported in this way (op. cit., 545, 661). Such remains may be of use in reconstructing conditions at the source, although of course location and quantification of habitats detected in this way will be very difficult.

Invertebrates and hay

That invertebrates appear to act as indicators of hay (or similar cut vegetation) is mentioned in the discussion of stable manure (p. 397), and more specifically on p. 316. Hay and fodder more generally are considered in a series of papers edited by Charles *et al.* (1998). It is worth emphasising that three sets of insects (and other, less well-known invertebrates) are to be expected in hay or other plant fodder: those trapped when plants were cut (including immature stages in stems and pods, or attached to the plants), those which invaded hay in the field (e.g. various ground beetles and staphylinids), and those which invaded the dried hay in store (although most of these will have been components of the 'house fauna' found in low-grade buildings). Emphasis has been laid on hay insects in this review, because they are repeatedly observed in archaeological samples. However, other groups of invertebrates will certainly have been caught up in hay or leaf fodder; for example, brackish-water molluscs from the Flixborough site must have been imported, and saltmarsh hay is a possible source (Carrott EAU 2000/55). Leaf fodder may have been commonly used in the past, but no cases where insects suggest it have been found in the region, unless the various deposits rich in scale insects represent examples (p. 53). The problem of identifying fodder using beetles is discussed by Smith (1998).

Hay may not always have been fodder: it may have been employed to sweeten floors for human use, or for poor thatch, for example.

Invertebrates from peat, turf, and related resources

At some sites, the presence of a heathland or moorland component in the biota may merely reflect circumjacent vegetation, but in most cases such remains are regarded as indicative of the deliberate importation of raw materials, usually turf or peat but perhaps sometimes cut vegetation. These materials are more often recognised with certainty through plant remains or actual lumps of peat (which are not uncommon, Hall and Huntley 2007), but insects associated with bog, moor, heath or fen seem to have been brought to occupation sites rather regularly. Very often they have been recorded with fragments of acidophile plants, but it is not always clear how these had been imported (in peat, turf, moss, bundles of cut plants, the guts of grazing animals?). Of species regarded as belonging to this group, the froghopper *Ulopa reticulata* and the weevil *Micrelus ericae* are probably most frequently found, while the ground beetle *Bradycellus ruficollis* is also very frequent. More rarely recorded species in this category include the shieldbug *Rhacognathus punctatus*, the groundbugs *Macrodema micropterum* and *Scolopostethus decoratus*, the psyllid bug *Strophingia ericae*, the leaf beetle *Lochmaea suturalis*, and the weevil *Strophosomus sus*. These beetles and bugs are placed in the ecological category 'M' for the purpose of calculating assemblage statistics (see p. 63). There are also other species probably imported with these but less easily assigned: hydroporine water beetles and *Altica* species are very often found with them, for example, the former probably brought in peat. Various insects typical of, but not restricted to, acid terrain occur occasionally and include *Euaesthetus* and *Olophrum* species, *Syntomium* *aeneum*, and *Acidota crenata* (insect assemblages suggesting fen rather than bog peat have not been clearly recognised).

Helophorus tuberculatus is a very distinctive terrestrial `water beetle' (Hansen 1987, 102) which deserves mention here. It appears to be rare in Britain at the present day (Balfour-Browne 1958, 95; Kenward 1976b; 1978c; Booth 1981). It has now been recorded from Roman deposits in Carlisle, from Castle Street (Allison *et al.* 1991a, 23, also discussed by Kenward 1984c), and Old Grapes Lane (Kenward *et al.* AML 78/92); in York from Coppergate and Tanner Row (Hall and Kenward 1990; Kenward 1988b; Kenward and Hall 1995). Elsewhere, it has been found at the forts at Kirkham (Carrott *et al.* EAU 1995/02) and Ribchester (Large *et al.* EAU 1994/11). Two records were made from Anglo-Scandinavian deposits at 16-22 Coppergate, York (Kenward and Hall 1995), so it seems likely that the mechanism by which it entered archaeological deposits remained active. Clearly there is something of interest in the way this beetle occurs repeatedly: one explanation may be its importation in some material taken from its habitat, moorland turf, perhaps, but various other explanations could be put forward. Whatever the case, it must be suspected that it was very much more common in the past than it seems to be now, for reasons that are not obvious.

It is often uncertain whether insects were imported in peat, in cut living turf, or with cut vegetation, unless lumps of the material remain. Cases where insects seem to have been imported in peat in the modern English sense include, for the Roman period, the Roman wells at The Bedern and Skeldergate (Kenward *et al.* 1986b; Hall *et al.* 1980), and the rather larger quantities from Tanner Row and Rougier Street, York (Hall and Kenward 1990). These and other cases are considered in more detail in the next sections; the problem of interpreting peat fauna as local or imported is touched upon for a site in Iceland by Amorosi *et al.* (1994), and a similar difficulty was encountered by Kenward (2005b) for a site in Denmark. We need to investigate the sources of all this peat (it will be difficult, but some intelligent guesses should be possible) and refine the identification of peat in a decayed or burnt condition (we have no idea whether the latter is possible unless charred plant fragments have survived).

Charred peat has been found fairly often, in York at least (e.g. Hall *et al.* 1980 ; Hall and Kenward 1990), but whether peat was widely regarded as a fuel in Roman culture is uncertain. (Evidence for peat being used as fuel comes from the Roman salt producing site of Nordelph, Norfolk, Murphy 2002.) Peat deposits are very rare in southern Europe, so it is not likely to have been much known in the Mediterranean countries, but the value of peat may have been learned from native culture in central or north-west Europe, or it may have been burned by natives within the Roman economic system. Turf burning was described by Evans (1957, 81) as 'nowadays an index of isolation and self sufficiency'. In the Roman period it may perhaps have been a fuel for the lower classes rather than the Roman and Romanised.

Imported turf (again in the normal English sense of the living mat of plants at the soil surface) seems to have been the source of insects at a number of other sites, discussed below. Cases where cut vegetation may have been the source are often less clear.

Why was all this peat and turf brought into the towns? Possible uses (summarised by Hall CHP 16/2003, 19-23) include building and levelling; for roofing, as fuel, and as flooring in stables. There is archaeological evidence for the first two and hints of the third, while the occurrence of burned peat may indicate use as fuel or just disposal. Peat is common in stable manure deposits (p. 397), though here too it may have been on a disposal route rather than a primary import. The use of peat for many purposes is of course attested ethnologically (e.g. Fenton 1978; 1986), and continues today (causing the destruction of major ecological, archaeological and palaeoecological resources).

Hall (*loc. cit.*) has reviewed the evidence for turves in archaeological deposits using plant macrofossils: it would undoubtedly be productive to bring together this evidence with that from insect remains in a systematic way.

Acidophile insects at prehistoric sites

Some pre-Roman natural deposits include a heathland or moorland insect component (e.g. at various sites in the Humberhead Levels). This is hardly surprising when the deposits formed in such habitats, but acidophile organisms sometimes occur in less expected places. Hill (1993, 147), for example, found a small but clear heathland component in later Bronze Age riverine deposits at St George's Field, York. There were remains of *Strophingia ericae*, *Aphrodes trifasciatus*, *Bradycellus ruficollis*, and *Galeruca tanaceti*. Hill briefly discusses the history of heathland in the Vale of York, and suggests that his heathland community may have lived on naturally disturbed leached sandy soils close to the River Ouse. Tracing the development of heathland and acid bog in the region is a priority, and invertebrates will contribute substantially to the evidence from botanical research.

Peatland fauna at Roman sites

Peatland insects were noted in several samples from Roman deposits at the Tanner Row site, York (Hall and Kenward 1990, especially 341, 358, 412-4), *Macrodema micropterum* being (relatively) more abundant than at other sites. Peatland plants were rather more frequent than the insects, and peat itself was also present. The 4th century fills of the well at Skeldergate (Hall *et al.* 1980) included peat in recognisable lumps and remains of a range of peatland organisms (including insects and mites) were dispersed through the deposits (p. 169). In contrast, although acid peatland plants and tiny pieces of peat were identified from the early to mid third century fills of the well at The Bedern, York (Kenward *et al.* 1986b, 264), there were no obligate acidophile insects, emphasising the need to use more than one line of evidence.

Some sites in Roman Carlisle have provided abundant evidence for the use of peatland resources. At Lewthwaites Lane (Kenward *et al.* AML 77/92; 2000), there seems little doubt that acid turf or (less probably) peat was used for animal litter in at least one case, while some other deposits clearly identified on the basis of their invertebrates as peat/acid turf (see below) gave almost no indication of anything else, and seem more likely to have had a structural purpose. This site provided two deposits containing classic heath/moor groups which deserve fuller description. These assemblages of adult beetles and bugs were dominated by species likely to have occurred in related habitats in an area of heathland or (perhaps less probably) moorland. Particularly characteristic were *Macrodema micropterum*, *Ulopa reticulata*, *Bradycellus ruficollis*, *Olisthopus rotundatus*, and *Micrelus ericae*, but much of the remaining fauna would have been part of the same community, including *Lathrobium* sp., *Dyschirius globosus*, *Lesteva heeri*, *Euaesthetus bipunctatus*, *Altica* sp., *Pterostichus diligens* and others. Hardly any taxa which could not have been associated with these were present. Undoubtedly this material was predominantly surface heath/moor peaty soil (or much less probably, deeper peat). Beetle larvae were very abundant, and included numerous Elateridae (click beetles), mostly believed to be *Denticollis linearis* when the report was prepared. Subsequent work by A. Kroupa has shown that this was the most abundant species, but that there were almost as many *Actenicerus sjaelandicus*. These abundant elaterid larvae were very probably imported with the turf. The typical habitat of *A. sjaelandicus* appears to be moist soil in low-lying land such as peat moors, alder swamps, grassy meadows, and damp, moss-covered parts of forests (Freude *et al.* 1979; Glen 1950; Rudolph 1974). *Denticollis linearis* appears from the literature to be able to develop in peat as well as in dead wood, from which it is more familiar (Luff 1991, 228; Hansen 1966, 96).

The heath/moor component was also fairly substantial at the Old Grapes Lane A site, while there was some evidence from Old Grapes Lane B (Kenward *et al.* AML 78/92; 76/92; 2000) and the 'Lanes 2' sites (Kenward *et al.* EAU 1998/32), and also a few records from Annetwell Street, where this component was undoubtedly rarer (see Kenward EAU 1999/32 for data archive). The possibility that there was heathland vegetation at the present site of Carlisle, including the Lanes area, must be considered in view of the huge quantities of peat and/or turf which must have been freely available - transport over more than a few miles of so much material seems a little unlikely. Turf was certainly employed on a large scale for construction purposes, and `turves' have been found in Roman deposits at various sites, including Carlisle. Other uses for turf are for burning (if peaty enough), for horticulture or for animal bedding (for the latter see p. 397).

Other sites have produced insects from acid terrain, but with less clear evidence as to the means of introduction At North Cave, East Yorkshire, for example, small numbers of heathland insects in late 3rd -late 4th century ditch fills may have been imported but seem as likely to reflect vegetation developing on local soils (Carrott *et al.* EAU 1996/42; Allison *et al.* forthcoming a).

The insect remains interpreted as having originated in turf will, especially when combined with the record of plant remains, offer clues as to the nature of the areas from which the peat was collected. It may be very much harder to tie down the source in more precise geographical terms, however. Even where vegetation types are restricted at the present day, they may have had a different distribution in the past. Conventional wisdom seems to regard the heathy commons around York as a result of recent human despoliation, for example, although one might reasonably ask why, if this hypothesis is correct, resources from acid soils were available to be imported into the town on such a large scale in the past.

Possibly related to the importation of heathland soil is a record of the pine cone bug *Gastrodes grossipes* (originally recorded as '?', but there is no reason to doubt the identification) from late 2nd century Tanner Row, York (Hall and Kenward 1990, 346, 400). How this bug arrived in the town is not at all certain. One possibility (in addition to the obvious one of an origin in turf) is that it was brought with native pine (*Pinus sylvestris* L.) cones collected for some purpose, such as kindling (there were records of cones, as well as needles, from the site). Very much less probably it may have come with imported stone pine (*Pinus pinea* L.) cones, as a charred part seed of this species, whose cones are known to have been used ritually, was found at the site. *G. grossipes* has been found alive in appreciable numbers on Scots pine close to York (author, unpublished); as well as in the cones, it can be found under bark scales, suggesting timber as an alternative means of importation.

Turf from terrain other than heathland or moorland has occasionally been identified from Roman deposits on the basis of invertebrate remains. An origin in rather poor, damp grazing land where there were occasional pools was detected using the insect (and plant) remains from a layer of turves dated to the late first/early second century at the Castle Street site, Carlisle (Allison *et al.* 1991a, 28). Notable species supposed to have ben imported in the turf were *Aphodius* dung beetles, *Conomelus anceps* (a 'planthopper' bug found on rushes, *Juncus* spp.), *Megasternum obscurum* (a generalist decomposer beetle common in turf), and *Xantholinus linearis* (also very common in grassland litter). In this case, the turves were recognised in the field, but this is not always so. Another deposit (of early second century date) at Castle Street (op. cit., 34-5) gave an insect assemblage dominated by *Aphodius* species (dung beetles), with *A. prodromus* in particular very abundant, but in addition some *A. contaminatus*, *A. fimetarius* (recently split into two species; which was present is not known) and at least two other *Aphodius* species, a specimen of *Geotrupes spiniger*, and quite large numbers of aquatic and waterside beetles (*Helophorus* spp. and *Lesteva longoelytrata*). The only likely origin for such an assemblage is in turf from somewhat damp grazing land, with occasional pools, perhaps just in footprints; it may have come from an area very much like that used to obtain the earlier turves identified at the site. This deposit can thus be identified on entomological grounds as a layer of dumped turf, perhaps levelling; it was not examined for plant remains so contributory evidence is unavailable. Still in Carlisle, one Roman insect assemblage from Lewthwaites Lane suggested turf cut from a damp area (Kenward *et al.* AML 77/92; 2000), and several deposits at the Old Grapes Lane A appeared to include turf of one kind or another (Kenward *et al.* AML 78/92; 2000).

Heath/moor insects after the Roman period

Heathland/moorland insects, mostly Ulopa reticulata and Micrelus ericae, were recorded from a small number of Anglo-Scandinavian contexts at 16-22 Coppergate, York (Kenward and Hall 1995). In one case (*loc. cit.*, 611), it was specifically suggested that the insects had probably been imported in cut turf, and most of the species mentioned above as typical of such material were present. The means of importation of other heath/moor insects was less certain, although *Calluna vulgaris* remains were frequent at the site and they may have been brought with heather intended for various purposes. There was certainly no indication of an origin in peat and, on balance, turf was favoured as a likely source for many of the remains (*loc. cit.*, 724), suggesting one material which may have been used for roofing at the site. Ants from heathland were found at the nearby 6-8 Pavement (Lloyds Bank) site during the preliminary investigation (Buckland *et al.* 1974), but heath/moor insects were present only in traces in the main series of samples (Hall *et al.* 1983c, 221); inspection of the database for the site shows that most of the records were of *Strophosomus sus*. It is suggested on p. 378 that the finely comminuted 'outdoor' insects found in some house floors may have fallen from turf roofing, but the evidence so far is weak.

Records of peatland or heathland insects are rare after the Norman conquest. At Blanket Row in Hull, Carrott *et al.* (EAU 2001/12) noted *Hydroporus scalesianus*, and some other insects which were probably imported in peat (among them *Dyschirius ?globosus*, *Olophrum* sp., *Acidota crenata*, two *Euaesthetus* species and a larva of the click beetle *Actenicerus sjaelandicus*), from deposits dated to the first half of the 14th century; as in so many other cases, peatland plants and peat fragments were also present. The Magistrates' Courts site produced a few records of acidophiles, but no assemblage was rich in such species (Hall *et al.* EAU 2000/25).

At 63-64 Baxtergate, Whitby, Hall *et al.* (EAU 1993/26) found traces of heather-associated insects (Ulopa reticulata and Bradycellus ruficollis), presumably imported, in 13th-14th century occupation deposits. Fills of a 15th/16th century pit at the North Bridge site, Doncaster, yielded a more substantial heathland group, with rather numerous *Scolopostethus decoratus*, *Ulopa reticulata*, *Micrelus ericae*, *Bradycellus ruficollis* and *Strophosomus sus*, among others (Carrott *et al.* EAU 1997/16; Kenward *et al.* 2004a). It appeared likely that these had been imported in turf, perhaps for roofing.

Exploitation of freshwater resources

Perhaps the most important freshwater resource used in the past which may be detected through invertebrate remains is the water itself! Collecting water in buckets and other containers from rivers and wells would inevitably have caught the smaller swimming organisms, and occasionally larger ones such as beetles and corixid bugs. Where water was shallow or disturbed (e.g. by frequent extraction), live organisms and corpses would have been swirled up from the bottom mud. The final resting place of most these organisms would be wherever water was usually thrown after use: in sumps and drains, or on surfaces. A small proportion of them would be drunk or enter food, and so perhaps eventually be found in cesspits or stables (see p. 403 regarding the latter). Only rarely will it be possible to be sure of the means of entry of such artificially-transported organisms to the fossil record, for the numbers will generally be small and so indistinguishable from background fauna which has arrived naturally. (However, the author suspects that a large proportion of the aquatic organisms in occupation deposits, especially bryozoons and cladocera, but also many beetles and bugs, came with water.) A gully within one of the Anglo-Scandinavian plank-built structures at 16-22 Coppergate, York, provides a rare example where the resting eggs of cladocerans almost certainly came from waste water (Kenward and Hall 1995, 596). It seems possible that water flea remains at Swinegate and Coffee Yard, also in York, were brought in water (Carrott *et al.* EAU 1994/13; Robertson *et al.* EAU 1989/12), but importation in mud for flooring is also possible.

One potential means of introduction of freshwater organisms is in the guts of fish brought to sites as food. Cladocera and insects seem to be most likely to have such an origin, although molluscs may occur too (e.g. Frost and Brown 1967). No cases where this was suspected are known, however.

The importation of cut vegetation from wetlands would frequently have resulted in the introduction of a range of live and dead aquatic and wetland invertebrates; these are considered on p. 358.

The only significant invertebrate food resource from freshwater habitats in England is the freshwater mussels, which are also a source of pearls (e.g. Dakin 1913). Their valves are sometimes excavated in aquatic muds, indicating their availability for exploitation, but they also have been recorded from terrestrial occupation deposits. An example is provided by the 'surprisingly numerous' valves of *Unio* and *Anodonta* species in Anglo-Scandinavian deposits at 16-22 Coppergate, York (Kenward and Hall 1995, 757; O'Connor AML 4297), where exploitation as food is argued for the former, although the small size of the *Anodonta* valves was regarded by O'Connor as possibly indicative of their collection for some other use, perhaps as scoops. (Uses of *Unio* valves and resulting wear patterns are discussed by Cartwright 2003). Two *Anodonta* were recorded from Mount Grace (Evans AML 1826) but clearly do not stand as evidence of exploitation.

Pearl fishing was once a significant, if minor, industry (Dakin 1913; this author also reviews the occurrence of pearls in other molluscs, and outlines their history from classical times onward). The freshwater pearl mussel (*Margaritifera margaritifera*) occurred in much of the north of England (Step 1927), though it is now perhaps endangered. The biology of this remarkably long-lived mollusc is briefly reviewed by Fryer and Murphy (1991, 223), who also refer to a 17th century pearl fishery in the English Lake District. Pearls might be expected to survive under at least some ground conditions, but this reviewer is not aware of any British archaeological records (there are apparently some from the Middle East). Freshwater mussel shells may, of course, have been used as a source of mother-of-pearl for inlays and the like.

Crayfish (*Austropotamobius pallipes*) were no doubt occasionally exploited for food in the past and their remains might be found under exceptional circumstances; their use in folk medicine is mentioned on p. 313.

Exploitation of marine resources

The primary resources relevant here are of course the marine molluscs, and to a much smaller extent crustaceans. These were very widely eaten, but remains of marine organisms may stand as secondary evidence of the exploitation of other resources, for example fish and seaweed. Often remains of marine molluscs in archaeological deposits are not really studied, falling through the net on size (too large to be recovered in useful numbers from General Biological Analysis samples used for other macro-invertebrate remains), and means of collection (often recovered with hand-collected or bulk-sieved material which may be examined only by botanists and osteologists), or sheer lack of interest. They are often identified by non-specialists, who may not be aware that the common edible species are not the only shells likely to be found, and may be mentioned only by their common names in passing in 'structural' reports, or in bone reports. One gains the impression that idle speculation sometimes replaces sound reasoning where shellfish are concerned; fortunately there are some honourable exceptions, notably the work of Milner and Wynder (references below).

Because the records are diffuse and so often casual and incomplete, it has not been considered worthwhile to review the published data systematically; in particular, it would be absurd to attempt to discover all shellfish records given in standard 'excavation' reports. Sources are not mentioned unless they support a point. The need for a more thorough approach to the recovery and recording of shellfish is mentioned on p. 85.

Not all shellfish in archaeological deposit are necessarily human food. At sites near to the sea they may have been dropped by birds or even washed in by high seas. Trewin and Welsh (1976) illustrate *Mytilus* and *Littorina* shell fragments resulting from bird predation. These fragments could probably not easily be distinguished from those produced by human activity such as trampling. Oysters are less likely to have been imported by birds, since they are normally inaccessible to them, living at ELWS (extreme low water spring tides), and below, as well as being over-large for most shorebirds. It would also be possible to be sure that they had been used by humans through observation of the marks left by opening them (since, unlike other shellfish, they are traditionally eaten live and force is required to get to the unwilling animal!).

Step (1927, 395) mentions the use of squids and cuttlefish as bait - perhaps economically important but unlikely to leave evidence in archaeological deposits. Also on the topic of bait, Jackson and James (1979) report the impact of bait digging on a population of cockle (*Cerastoderma edule*), reminding us that changes in the abundance of a resource in the archaeological record may reflect unconnected activities.

The use of sea-shells to produce a high-quality lime (e.g. Murphy 2003) is worth mentioning here; maritime sites might produce evidence for this practice, which might also be detected via fragments of marine shell in mortar.

Despite popular perceptions, oysters rarely yield pearls of any value, stories of ostreophages making their fortune at the dinner table being apocryphal according to Dakin (1913), who also mentions that poor pearls occur in *Mytilus edulis*. Tacitus refers to pearls from the ocean in the context of Britain, these presumably being from oysters; he describes them as dusky and mottled (caused by sediment-rich water?) and implies that there was no organised fishery for them (Mattlingly 1960, 63). Mother-of-pearl is a material more reliably obtainable from shellfish. The documentary record of pearls (and mother of pearl) is quite good from 500 BC onwards, with archaeological records from Iran dating to the 4th century BC, and an example from Japan supposedly 5,500 years old, while there is evidence of pre-Columbian use of mother of pearl in South America (Joyce and Addison 1992).

Shellfish have substantial nutritional value, and are easy to obtain, sometimes on what is effectively an industrial scale (e.g. Horsey and Winder 1991). For many groups of people living within reach of the coast, they must have been an important fall-back ('famine') food, even if they were not particularly desired as everyday fare. They do have disadvantages, however. Their rapid decay means that they are a frequent source of food poisoning, and in addition some species, particularly mussels, sometimes accumulate planktonic dinoflagellate algae which are toxic to humans (reportedly *Gonyaulax tamarensis*), causing alarming symptoms and sometimes death (e.g. Nature editorial 1968; 1969; Clark 1968; Ingham 1968; McCollum *et al.* 1968).

The various shellfish are generally regarded as having very different gastronomic (as opposed to nutritional) value. Tradition places the oyster at the top of the list, though they were hugely abundant and common-folks' food until quite recently (Stott 2004; Yonge 1960). Mussels and cockles tend to be held in higher regard than winkles and whelks, and limpets are widely despised. But limpets are seen as a delicacy in southern Italy according to U. Albarella (in lit.), while J. Mulville (in. lit.) found them acceptable when poached out of their shells then sizzled in garlic- a warning against projecting our common attitudes on to past people. The wider case for limpets is argued in a brief article by Wickham-Jones (2003). It is not just the familiar shelled molluscs which have been eaten: Lovell (1884) reports that cuttlefish (*Sepia*) were formerly sold as food in England, and gives recipes.

Shellfish through time

There are probably large numbers of minor records of shellfish from sites in the north of England buried in archaeological reports which are not regarded as 'environmental' for bibliographic purposes. Unfortunately, the lack of any mention of shellfish cannot be taken as implying their absence, making it difficult to determine whether they had been exploited at all at many sites. Marine shell does not appear under any obvious head in the index of the report on the Rudston site (Stead 1980), for example, when an explicit statement as to their presence or absence at a site of this kind would be a matter of considerable interest. The present author cannot claim to be innocent of this kind of omission. The following survey is very selective. It would be unreasonable to mention all sites with shellfish, but the rare cases where fairly detailed studies have been made are noted. The presence of shellfish has often been mentioned in the chronological review, however.

Prehistoric: Records from prehistoric sites in Northern England are not abundant. Marine molluscs in Mesolithic and Bronze Age dune deposits at Low Hauxley, Amble-by-the-Sea, Northumberland, were probably naturally accumulated rather than representing human exploitation (Issitt *et al.* EAU 1995/16). Several routes were considered possible at this site, including conflation of thinly distributed material as dunes were blown out, deposition of seaweed by humans, or the throwing up of shells or seaweed by storms.

King (1963) and Brewster (1963) reported marine shells from the Iron Age site at Staple Howe, Knapton, near Malton, North Yorkshire. Assigned to 'Iron Age A' (550-350 BC) and 15 miles (24 km) from the coast, the site yielded an unusual assemblage of marine molluscs. Limpets (*Patella vulgata*) were the most abundant, with some *Cardium edule* and traces of other taxa (*Gibbula umbilicata* (= *umbilicalis*), *Littorina littorea* (as *littoea*) and *Tapes pallastra*. Some or all of these may have represented 'curios'. Some of the limpets and the winkle were water-worn and presumably taken as empty shells from the beach. It was suggested that the shells may have been collected during visits to the coast, possibly to obtain brine (although there surely would have been other reasons for such journeys).

Allen (1967) found clumps of *Littorina littorea* in a dark soil overlying bedrock, and in hearths of likely Iron Age or Romano-British age, at Tynemouth, suggesting that they had been dropped when their meat was eaten and subsequently trampled in; there seems to be no other similar evidence from the North of England.

Roman: Most Roman urban sites in the region have given at least a few shellfish, predominantly oysters; they are commonly noted at rural sites, too. Shellfish from Roman to medieval layers at the Tanner Row site, York, were considered by Hall *et al.* (1990, 407) and (in greater detail) by O'Connor (AML 4768). Ten or so marine mollusc taxa were recorded but oysters (*O. edulis*) were vastly more abundant than any other, among which only mussels (*M. edulis*) were at all common. This was not considered to be a result of bias in recovery or preservation. Measurement of representative groups suggested that a range of sizes of oyster up to very large ones was available, and consequently that they were being neither over-fished nor systematically exploited; this was in contrast to medieval material at the same site (see below). Oysters were seemingly exported to Rome from Britain in the later Roman period, so their transport across Britain was clearly practicable and the supply good (Yonge 1960).

Marine molluscs were recorded from the well and a few other Roman contexts at Skeldergate, York (Berry and Spencer 1980). Oysters (*Ostrea edulis*) were abundant, but otherwise there were only a few *Mytilus edulis* and a trace of *Patella vulgata*. Importation from the East coast was suggested, following Rackham (1976), who postulated that oyster fisheries formerly existed there, but offered no supporting evidence. There was little marine shell from the Church Street sewer system (Rackham *loc. cit.*), with a preponderance of oysters and mussels and a few limpets (again *P. vulgata*).

A small group of marine molluscs and a few fragments of crab shell, probably a mixture of human food and material dropped by seabirds, were recovered from deposits associated with use and abandonment of the signal tower at Filey Car Naze (Carrott *et al.* EAU 1994/07, Dobney *et al.* EAU 1996/26; 2001). The distribution of limpets (*Patella* spp.), most common in the occupation layers, rather surprisingly suggested that they were collected to be eaten. It was assumed that most of the shellfish were of local origin, but that the oysters must have come from further away, since it is argued by Winder (1992 and personal communication) that there were no oyster beds in the region, something which clearly is open to further research (p. 329). Shellfish reached sites further removed from the sea and rivers: Evans (AML 1771) reported small numbers of marine molluscs from the Roman villa at Winterton, North Lincolnshire, although it seems possible that they had not been systematically collected during excavation. Even rather remote Roman sites may have oysters: Jaques *et al.* (EAU 2000/70) found five poorly preserved oyster valves at a site north-east of High Catton.

Woodward (1983) gave a table of records of molluscs - almost entirely marine - from excavations of the defences of the Roman fort at South Shields. Only large species were represented, so the remains were presumably hand-collected. The most abundant were *Patella vulgata*, *Littorina littorea* and *Mytilus edulis*, with only traces of oyster. Presumably these molluscs had been collected for food and reflect what was available locally.

The fifth to the eighth centuries: Hand-collected marine molluscs from 7th-11th century deposits at Flixborough, North Lincolnshire, were reported by Carrott (EAU 2000/54). There were quite large quantities of shell, from all phases and context types, though primarily from mid 8th-early 9th and 10th century dumps. Oyster was predominant, with small amounts of periwinkle (*Littorina littorea*), common whelk (*Buccinum undatum*), red whelk (*Neptunea antiqua*, non-edible), mussel and cockle. Two-fifths of the oysters showed opening marks (it was suggested that such marks had been obliterated by fragmentation on other shells). Their size was consistent through time, so either they were selected for size, or conceivably cultivated. Oysters were clearly preferred to the other shellfish, some of which would probably have been much more easily obtained. A few oysters showed what seemed to be deliberately cut slots or holes, although their preservation condition left some doubt as to origin of these. Small amounts of shell, mostly fragmentary, were found in Bulk Sieving samples from Anglian deposits at Fishergate, York (Allison *et al.* 1996b).

Anglo-Scandinavian York: Shellfish are abundant in Anglo-Scandinavian deposits in York, most sites giving at least some, with oysters the most numerous. At 6-8 Pavement (Hall *et al.* 1983b, 180) mussel and oyster shells were numerous, although it was not clear whether they were thrown onto floors or derived from redeposited sediment used in levelling, and at 5-7 Coppergate there were smaller quantities. Enormous numbers of shellfish valves were recovered from Anglo-Scandinavian 16-22 Coppergate, mostly by hand collection (Kenward and Hall 1995, especially pp. 690 and 756-8; O'Connor AML 4297). Oysters were predominant (20 or more individuals from over 200 contexts). There were much smaller numbers of mussels and cockles (*Cerastoderma* sp.), and some records of periwinkles (*L. littorea*) and common whelks. Bulk-sieved assemblages gave an essentially similar picture, although the material was not systematically investigated. One context gave substantial numbers of a range of small marine molluscs, either from fish guts or from a catch of shellfish not sorted before it was brought to York (Kenward and Hall 1995, 756-7). Even allowing for possible under-representation of the smaller species and for decay of the shells of the much more easily collected mussels, oysters seem to have been by far the most heavily exploited shellfish. Clearly marine molluscs, especially oysters, were a significant resource in Viking-Age York, although no guess can be made as to their proportional contribution to diets. It is not known either how shellfish were brought to the town: presumably by ship, but were they fresh or at least sometimes preserved in some way?

Post-Conquest shellfish: Marine molluscs are almost always present in urban sites in the post-Conquest period, and often in rural ones too. O'Connor (AML 4768) reported material from Tanner Row, York, where deposits of 12th-13th century date yielded moderate numbers of oysters but few other marine shells; crabs were lacking in the medieval deposits, in contrast to the Roman layers. Measurement of the oyster shells showed that they were substantially smaller than in the Roman period at this site, and O'Connor suggested that this was a result of a reduction in the size of available oysters following intensive exploitation concentrating on individuals of at least a desired minimum size, so that few grew larger.

There are numerous mentions of shellfish from post-Conquest York in evaluation or assessment reports, and sometimes more detailed accounts e.g. from the Hungate area by Jaques *et al.* (EAU 2000/29).

For Beverley, Allison *et al.* (1996c) noted shellfish in small amounts from bulk-sieved samples from the Dominican Priory site, but they were sometimes more numerous; for example there were abundant Ostrea in a feature identified as a latrine or reredorter conduit. Small quantities of marine molluscs, mostly oysters, were recorded from the Preceptory of the Knights Hospitallers by Dobney *et al.* (EAU 1992/21). Occupation deposits at Blanket Row, Hull, yielded a few fragments of edible crab, *C. pagurus*, from deposits dated to the 14th-16th centuries (Carrott *et al.* EAU 2001/12), and at 54-7 High Street Jaques *et al.* (PRS 2003/01) found a single claw of ?*C. pagurus*.

Shellfish reached sites far removed from the sea, or even from a navigable river, in this period. Material from Wharram Percy, N. Yorkshire (Evans AML 1823) lacked dating but is assumed to have been broadly of the post-Conquest medieval period. There were only traces of marine molluscs (two *Ostrea edulis* and one *Littorina littorea*), but it is not clear whether this was a result of rarity at this isolated inland site, or selection of remains prior to submission for analysis. Material from Mount Grace, near Osmotherley, N. Yorkshire (Evans AML 1826) was again only dated as broadly 'medieval'. There were substantial numbers of marine shells, predominantly *O. edulis* but also some *Cerastoderma edule* and rare *Littorina littorea*, *Nucella lapillus*, *Buccinium undatum*, *Mytilus edulis* and *Arctica islandica*. Whether any but the first two of these was intentionally imported for food is not clear in view of their rarity.

Donaldson and Rackham (1985) and Rackham (1985) examined shellfish from deposits of Saxon to recent date at Holy Island Village, Northumberland. Winkles (*Littorina littorea*) were abundant throughout, with modest numbers of *Ostrea edulis* and *Patella vulgata* and traces of other species. There were traces of *Cancer pagurus* from early post medieval to recent deposits. *Cerastoderma edule* peaked in the recent deposits. Sieving produced a much better group of remains than hand collection. Oysters (*O. edulis*) were found in late or post medieval deposits at Tynemouth Priory by Allen (1967), leading to a brief discussion of their distribution in the past.

Early post-Conquest to post-medieval deposits at Barnard Castle (Allen AML 4144) gave assemblages of shellfish dominated by oyster (*O. edulis*), mussel (*M. edulis*) and cockle (*C. edule*), with traces of a few other species, but the proportions varied greatly through time. In the period AD 1095-1175 there were few marine shells, and all were oysters. Subsequently there was a period when all three taxa were present in appreciable numbers, although with rather more oysters and cockles; then mussels became dominant. After this (in the period 1479-1569) cockles were very much the most numerous shells, while in the post-medieval layers oysters and cockles were predominant. Allen explored the possibility that species composition in the collecting grounds was affected by silting in the Tees estuary, but accepts that these species might have exploited different facies (rocky, sandy) of the same stretch of coast. The varying proportions of species may therefore have reflected changing taste, particularly a decline in the status of oysters. In the same way, the rarity of limpets (*Patella* sp.), presumably reflects preference rather than availability. There were traces of crab shell, identified as '*Cancer* sp.' (it is assumed that 'crab species' was intended). Although the adjacent River Tees would probably have provided suitable habitats for them, freshwater bivalves do not seem to have been exploited at Barnard Castle, echoing the rarity of bones of freshwater fish. Molluscs from deposits at the Crown Court site, Newcastle, dated AD 1200 to post 1800 but predominantly from 1200 to 1500, were reported by Nicholson (1989a).

They included a rather wide range of species and were interpreted as food remains. Crab (*C. pagurus*) was found in a single context dated to the 13th or 14th centuries.

Post-Conquest shellfish from 16-22 Coppergate, York, have yet to be studied, although most were hand-collected oysters (assessment Carrott *et al.* EAU 1996/09; project design Dobney *et al.* EAU 1997/02); comparison with the pre-Conquest material may be instructive.

Post-medieval: While field observations suggest that shellfish are no less common in post-medieval deposits than in those of the previous centuries, there seem to be few formally recorded assemblages. There are some records from Newcastle: Rackham (AML 4788) recorded a small group of hand-collected marine molluscs (c. 100 shells) of 16th to 18th century date from the Blackfriars site. Only popular names were given: most were oysters, with a few 'cockles' and traces of other species. Rackham (1981) gave records of small numbers of molluscs from the Castle Ditch, together with *Cancer pagurus* claw fragments from the late 15th and late 16th centuries. Nicholson (1989a) reported Post-medieval shell from the Crown Courts site. A trace of crabshell ('probably ... *Cancer pagurus*') was found in Post-medieval layers at Queen Street (Nicholson 1988). At the Magistrates' Court site, Hull, oysters were present in modest numbers in deposits dating from the 14th to 19th centuries, and there were traces of a range of other mollusc taxa and some crab (Hall *et al.* EAU 2000/25; 2000/33).

Shellfish were present in substantial numbers at Blanket Row, Hull (Carrott *et al.* 2001/12, 37-9). A large proportion of the contexts yielding shell were determined to have a medium to high residual content, so this material was of limited value, only about a third of the recovered shell (by weight) being useable in analysis. Most of the recovered remains were oyster. Cockle was occasionally present in fairly large numbers, while mussel, common whelk, and red whelk were also present. There was, from characteristic 'V'- or 'W'-shaped notches in the margins of two-fifths of the valves, evidence of the oysters having been opened, and these remains are undoubtedly food. The average size of oyster valves remained fairly constant through time (although there were occasional significantly larger valves), and the general consistency in size was used to suggest that the oysters were from farmed rather than natural populations. The (subjectively) small average size of the oysters was perhaps an indication of over-exploitation. Likely sources were discussed. A few of the oyster valves from Blanket Row showed apparently deliberately cut, roughly rectangular, slots or holes, whose purpose was uncertain.

Where were the oyster fisheries?

The part(s) of the coast from which shellfish, and in particular oysters, were collected is a matter for speculation at present, although of interest in terms of understanding trading links. In the 19th century, fisheries were concentrated near the mouth of the Thames, with tens of millions of oysters sold through Billingsgate alone (Matthiessen 2001, 96; see also Stott 2004). But there seems to be no reason to suppose that oysters were not capable of thriving elsewhere. Matthiessen (*loc. cit.*, 88) points out that the distribution of *O. edulis* reaches north of the arctic circle in Norway, and describes it as 'not an estuarine species, preferring the relatively cool and saline waters of open bays and exposed shorelines'. This description appears to match a large proportion of the coasts of northern England - so were there really no oyster beds on most of the East coast, as Winder has suggested? A similar view was given by Allen (1967), who knew of no record of living oysters being found in the vicinity of the Tyne, citing the nearest beds as in the Forth (fished out by 1875) and at Holy Island (not commercially exploited). (The history of oyster fisheries in Scotland, including that in the Forth estuary, is reviewed by Millar 1961, but there appears to be no equivalent review for eastern England.) Rackham (1976) and Nicholson (1988), on the other hand, suggest that there may have been oyster beds in the North East. Hall *et al.* (PRS 2002/16), in their report on assessment of material from Bridge Street, Chester, consider possible sources of the abundant oysters at that site, mentioning Swansea Bay and Cornwall, as well as Sussex, though without leading to any conclusion.

There seems to be no sound reason to suppose that the present-day lack of oyster beds along much of our coasts reflects their absence in the past. The vulnerability of oysters to disease, predation and habitat change is well known, and overfishing combined with these may well have lead to the extinction of formerly productive beds. The historical decline of the oyster industry, which was already under way in the 19th century, is reviewed by Gross and Smyth (1946) and Matthiessen (2001), and in a more popular way be Stott (2004). Natural oyster beds are said to recover immensely slowly following damage, especially if the few remaining large adults continue to be collected (e.g. Orton 1946; Korringa 1946). Korringa emphasises the difficulty with which oyster beds re-establish once fished out, so lack of beds in the 20th century is poor evidence of the unsuitability of coastlines for them. The effect of the great flood of January 1953 on oysters is outlined by Waugh (1954), indicating their vulnerability to natural as well as human impact.

One way to deal with damage to shellfish stocks - whether by over-collecting or natural events - is culturing them. Oysters were certainly cultured in Italy in the Roman period, by suspending them on ropes, but there is no evidence that this was done in Roman Britain (Yonge 1960); there is no obvious reason why the molluscs should not have been farmed on at least sheltered parts of the east coast of northern England, but natural stocks may have been so abundant as to obviate the need for culturing.

Changes in shellfish exploitation through time

Mussels and cockles, as well as limpets, winkles and whelks, are easily collected by anyone and may have been often used as 'famine food' even if they were not normally considered worth eating. Unless cultured, oysters require specialised techniques such as a beam trawl to exploit them on a large scale since they mostly occur at and below the low water mark. O'Connor (AML 4297) remarks that if oysters were trawled and the catch brought to York unsorted, then most of the less frequent marine molluscs may have been brought with them. He also suggests that various species might have been imported incidentally with masses of mussels.

Studies of the proportions of marine molluscs may give clues as to taste or availability: O'Connor (AML 4297) notes the somewhat higher frequency of *Patella vulgata* (common limpet) and *Neptunea antiqua* (red whelk) in 9th century levels than in later ones at 16-22 Coppergate. If this was not a matter of taste, than there may have been proportionally greater exploitation (availability?) of rocky (rather than sandy or muddy) shores in the earlier period; could this be in turn related to increased silting?

At Roman Tanner Row, O'Connor (AML 4768) noted an apparent difference in exploitation of crabs between the Roman and medieval periods, for shell fragments identified as *Cancer pagurus* (common or edible crab) were rather abundant in Roman deposits but much rarer later. O'Connor pointed out that *C. pagurus* is a species of rocky shores, and suggested that it must have been carried overland from the East coast or brought by boat on the long journey round Spurn Head. The latter route he considered unlikely in view of the relative rarity of marine fish in Roman York. However, this line of argument is somewhat open to question; firstly, Spurn Head is probably not permanent, and was probably breached at various times (de Boer 1964), allowing easier access to the east coast; secondly, the literature suggests that *C. pagurus* has a rather wider habitat range than implied by O'Connor, occurring 'on mixed, coarse grounds, and offshore in muddy sand' according to Hayward *et al.* (1996), for example; thirdly, it is not known whether the Humber estuary would have been as heavily silted in the Roman period as at present, but a cleaner bed seems likely. The crab may thus have been more accessible in the past. Whether or not this was so, the contention that crabs would have been an expensive commodity away from the sea is a reasonable one, bearing in mind the difficulty of keeping them alive for long periods during transportation. On a related tack, O'Connor mentions the possibility that the inedible shellfish found in small numbers in archaeological deposits in York may have been a result of their accidental importation in seaweed used to protect live crabs in transit. The contrast of Roman and Medieval shellfish exploitation has been mentioned above.

Another aspect of changing exploitation through time is seasonality of use. Milner (2001) tested the reliability of determination of season of death for oysters (*O. edulis*) and (2002) examined seasonality of oyster shells in Danish kitchen middens; she gives many references to the study or archaeological marine shells. Similar studies in northern England might prove instructive.

In summary, work on marine molluscs (and other 'shellfish') from archaeological deposits in the north of England has, with a few notable exceptions, been patchy and undirected. More thought needs to be put into their analysis, building on the work of Winder (1992) and incorporating more recent methodological developments. Sampling policy and a research agenda for the future are urgently needed. Hand collection is wholly inadequate, and material should be extracted by site riddling and, to recover a truly representative range of small shells and fragments of larger ones, by bulk-sieving. The question of changing exploitation through time is clearly an important one. Other questions might be posed: what proportion of shellfish would have survived the trip to inland sites alive? Were shellfish smoked or brined for transport? May they even have been dried, as they are in warmer climates (e.g. Elmahi 1999, Henshilwood *et al.* 1994). Records of the association of valves and the decay of shell may provide information about depositional regimes, residuality and the success of transport.

Seaweed

Seaweed is well-documented as a resource from Roman times onwards, primarily for direct application in manuring agricultural land but also as human food, animal feed and bedding, for roofing, as fertiliser and as a source of alkali when burned, and in later periods for the production of salt, soda, potash and iodine, large quantities being processed for the soap and glass industries in particular (Chapman 1970; Clow and Clow 1947; Evans 1957, 218-224; Fenton 1978; 1986; Landsborough 1851; Newton 1951, 31 ff.; Stephenson 1973, 41-50). These authors do not mention seaweed processing in the north of England (and much of the coast is not very suitable for large seaweed crops), but local exploitation may have occurred at times. The early use of seaweeds and their value as a resource and routes to sites are discussed in an archaeological context by Bell (1981), who provides many useful references, and by Donaldson *et al.* (1981) and Amorosi *et al.* (1994). Bell collected modern seaweed and recorded the accompanying molluscs, barnacles, foraminifera, polychaetes and bryozoans. He suggests that utilisation of seaweed as a source of alkali might be detected through burnt shells, citing an eighteenth century site in the Scillies. He also mentions the burning of seaweed for fuel in Iceland, although Amorosi *et al.* (1994) suggest that seaweed was fodder for livestock at a site in Reykjavík.

The remains of a wide range of invertebrates are likely to have been imported in substantial quantities incidentally to the use of seaweed, for whatever purpose. These may include species associated with living seaweed, and those which invade wrack stranded on the shore. Mixed assemblages of organisms, especially molluscs and tube worms, unlikely to have had any direct use, may provide evidence of past exploitation. No such evidence has been encountered during this review, but it should be sought. In particular, areas of burning in the open, with mollusc remains of varied sizes, may represent ashing of seaweed (but note the use of shells in lime production mentioned above), and occasional seashells encountered in field walking may indicate manuring with wrack. In either case, sieving may produce a wider range of marine organisms which will conclusively demonstrate the use of seaweed. Newton (1951, 46-47) also notes the use of shelly sand and coralline algae for soil improvement, and the former would doubtless lead to the incidental importation of abundant and varied marine organisms, including small kinds. Records of the epizootic hydroid *Dynamena* (= *Sertularia*) *pumila* have been tentatively interpreted as an indicator of use of seaweed in manuring in Greenland (see taxonomic section), but no parallel examples are known from the North of England.

A characteristic suite of organisms, particularly flies and beetles, is associated with stranded wrack (Backlund 1945), and so may have been transported to occupation sites or to fields, or invaded seaweed on them. This was apparently the case for the farm midden at Reykjavík (Amorosi *et al.* 1994), where three species of 'wrack' beetles were found. Note, however, that some components of this fauna, now essentially restricted to the sea shore, managed to invade artificial habitats inland in the past (*Thoracochaeta zosterae*, p. 71 and *Ptenidium punctatum*, p. 300).

Exploitation of managed resources: agriculture and domestication

Invertebrates, like other organisms, were greatly affected by the rise of agriculture, which limited many habitats and vegetation types, favoured others, and created new ones. Thus, although only a tiny number have ever been deliberately cultured as a resource, invertebrates are potentially of enormous value in reconstructing agricultural land use. A particular example is the differentiation of primarily pastoral and arable landscapes using dung beetles (p. 61). Similarly, invertebrates can provide evidence concerning livestock, by determining the effect they had on landscapes or occupation sites, identifying the species present, and tracing their products through conversion stages (e.g. for wool, p. 363). In the case of the pig, lice may even prove be of use in tracing livestock improvement (p. 325). Woodland management is implicitly considered as an aspect of forest history, above; managed woodland merges into grazing land via wood-pasture, of course.

Managed landscapes: the rural environment

Introduction

Even before the rise of agriculture, there must have been some 'management' of natural habitats, perhaps not deliberate, as a result of exploitation. (This will be difficult to distinguish from the natural patchiness of woodland which is becoming accepted as the probable state even without human disturbances, p. 291). Like grazing by wild herbivores, localised human clearance of woodland may have favoured herbaceous and scrubby vegetation which provided a greater variety of foods, quantities of small wood for wicker and wattle, and so on. Such clearances, which may have increased ecological diversity significantly, might be detected in the record of insect remains, but preservation seems unlikely except in wetlands. An example from our region may be provided by Mesolithic insects from Seamer Carr. Here, there was evidence to suggest grassland on an island in the Vale of Pickering (Kenward and Large EAU 1997/30). Buckland and Edwards (1984) discuss the possible role of post-exploitation grazing of cleared areas, warning us that the continued presence of open-ground plants (and doubtless also of dung beetles, perhaps in large numbers locally) should not lead us to assume that human management was maintained. As human modification of landscape proceeded, there was progressively greater impact on the invertebrate fauna.

Evidence for management may be obtained from occupation sites as well as from deposits (such as those in ditches) set in agricultural land. There is abundant secondary evidence for land management in the form of invertebrates carried with material imported to settlements, or invading it when it arrived there. Grain and other foods, hay, and turf all fall in this category and are considered elsewhere in this review and, insect remains from rural sites of the Iron Age and later show little evidence of anything but farmland and wetlands.

Robinson has suggested that the ecological structure of beetle assemblages can be used to differentiate pastoral from arable landscapes (above, p. 61), essentially on the basis of the abundance of dung beetles. Buckland and

Sadler (1991), in using insect remains to determine whether a site in Iceland represented a farm settlement or a shieling, argued that the (relative) abundance of *Aphodius* dung beetles was one indication of the latter use. In several reports on Iron Age to medieval deposits in Yorkshire it has been argued that abundant dung beetles suggest grazing land (e.g. Hall *et al.* 1980 ; Jaques *et al.* EAU 2002/04; Kenward EAU 2001/49; Kenward *et al.* EAU 2002/12). Robinson's approach is probably appropriate in principle, but various difficulties can be foreseen. In particular, there will be a bias towards dung beetles where deposits formed in water-filled cuts or hollows from which livestock drank. In addition, water-filled cuts might trap dung beetles, which seem to land rather randomly on water surfaces as well as on the ground. They were recorded by Kenward (1976a) in his study of 'background fauna' and have been seen drowning on water surfaces (Kenward unpublished), although none were noted during a study of insects landing on water carried out by Lemdahl (1990). Thirdly, at least some dung beetles sometimes migrate in large numbers (Landin 1961; 1968; see Kenward 1983b for a specific example in our region), so we would predict that moderately large numbers might occasionally occur even at locations well removed from abundant dung. Lastly, and in opposition to what has just been stated, a recent student project failed to find more than traces of dung beetles in modern deposits formed in grazed areas.

In view of these problems, can we tell whether the surroundings of a particular site were used for grazing? The answer is probably 'yes, with caution', but more work needs to be done. One approach may be to look for species associated with grass turf (various chafers, click beetles, *Dascillus cervinus*, and others), or with arable weeds, in rural deposits, in addition to dung beetles. Similarly, it may be possible to test for the presence of perturbing concentrations of dung near the point of deposition using plant remains and by observing the presence of a full dung fauna rather than of the scarabaeoids alone.

There is much - if patchy - evidence from botanical studies for changing land use in parts of the region (e.g. for the Vale of Pickering, Cloutman 1988a-c; Day 1996, and for the Moors, Spratt and Simmons 1976; Innes 1999 summarised vegetation history in North East England as a whole), and some general views can be obtained from wider syntheses (e.g. Dark and Dark 1997 for the Roman period; Dark 2000 for the first millennium AD), but there has so far been little progress in using invertebrate remains (which would, of course, need to be integrated with other evidence). At present, only those parts of East Yorkshire fringing the Wolds have provided sufficient sites with preservation of invertebrate remains for synthesis to be potentially valuable. We may aim for the sort of flowing historical narrative presented by Gardiner *et al.* (2002) for the landscape of the Avon levels fringing the Severn Estuary or, based on fossil records of beetles from Britain as a whole, Dinnin and Sadler (1999).

Field systems and their special problems

We are concerned here with the physical arrangement of fields and their boundaries, and with their pattern of utilisation, and thus with a special aspect of the managed landscape. Fields were areas of high biological activity in many cases - encouraging rapid decay and leaving little evidence in the form of delicate biological remains. They also received much organic matter from occupation areas, and with it presumably abundant remains of plants and animals, some of which may have made a round journey from areas of production (woodland and other fields) to use areas (e.g. floors or byres) then out again. Caution is thus necessary! Arable fields seem unlikely to give preservation of most invertebrates in a way useful for reconstruction. Landsnails may provide a picture of general conditions and represent the main hope in many northern sites. However, the evidence available suggests that those molluscs are sporadically preserved, being dissolved by rainwater (Taylor 2001), as well as liable to vertical movement through active soils (Dimbleby and Evans 1974). In view of this no opportunities to study well-dated assemblages mollusc related to arable agriculture should be missed; they will doubtless mostly be found in ditches, although some information may come from ploughwash. Where there is waterlogging in ditches or buried soils, other invertebrates may give environmental evidence, for example of hedgerows, since the two frequently run side-by-side, and thus contribute to an overall picture of the landscape. However, the evidence in field boundary ditches, if it is there at all, will provide a biased view, since the ditch sides and the strips along them are likely to have been more strongly and diversely vegetated than the rest of the fields, especially if under arable cultivation, and to have been associated with hedgerows. The problem of the relationship of ditch fauna to surroundings needs to be resolved. The need for work on transfer rates of biological remains from occupation areas to ditches has been highlighted on p. 462. Parallel studies for fields and their ditches are equally to be encouraged.

Grazing land provides a slightly different set of problems. It may be on rather wetter soils, the soil is less disturbed, and there may consequently be organic preservation in 'buried soils', so that it may be possible to make useful reconstructions of pastureland using invertebrates (together with pedological and botanical evidence). Examples are provided by the buried soils at Skeldergate and Coney Street, York (p. 155). Secondary evidence may be obtained from turf imported to occupation sites (p. 316). However, dating of fossils is likely to be difficult in soils which may have existed for hundreds, or even thousands, of years.

Evidence for managed landscapes through time

Prehistoric sites

There are few invertebrate assemblages from prehistoric sites in the north of England which provide much evidence of managed landscapes, in contrast to several in the south, such as the Wilsford 'shaft' (Osborne 1969; 1989), which was surely set in a landscape of grazing land, the work of Robinson in the Thames Valley (e.g. Lambrick and Robinson 1979; Robinson 1991b; 2000c), and areas reconstructed using snail assemblages (see examples given in the taxonomic section).

The Neolithic

The sparse evidence for Neolithic landscapes is outlined in the chronological section and does not require repetition here.

Bronze Age

Jaques *et al.* (EAU 2000/61; EAU 2002/08) report the fauna of an Early Bronze Age pit at Low Farm, near Cottingham, north-west of Hull, East Riding of Yorkshire. The deposits formed in water, with many aquatics and abundant fauna which may have lived in a rather damp area with herbaceous vegetation and a range of fairly dry to damp litter. There were a few dung beetles, and indications of poor grassland, but it was not certain whether there was grazing land nearby. None of the fauna strongly suggested human structures or artificial accumulations of decaying matter, and there was only one beetle associated with trees or dead wood. The biological evidence overall suggested a landscape dominated by human activity, presumably through agriculture, and probably including grazing, but with no evidence for arable cultivation. The few other fragments of evidence are outlined in the chronological section.

Rural environments in the Iron Age

Recent sites revealed by surveys and watching briefs associated with pipelines and road development have provided much-needed information about land use in parts of Yorkshire. In West Yorkshire, Bronze Age, Iron Age and early Roman ditch fills at South Dyke and Grim's Ditch on the M1/A1 link road (Kenward and Large EAU 1999/02 and 2001b; 1999/03 and 2001a respectively) gave substantial insect assemblages. At Grim's Ditch, an assemblage from a ditch fill of later Bronze or early Iron Age included abundant aquatics, so deposition was undoubtedly in water, but probably without a well-developed aquatic or marginal flora, so perhaps open water was intermittent. There were a few dung beetles, and some indicators of grassland, suggesting on balance that the surroundings included grazing land. Synanthropes were very rare and species associated with trees lacking. A second assemblage, probably of Iron Age date, indicated more or less permanent water, with emergent vegetation and a muddy bottom. Terrestrial fauna evoked habitats typically found in field edges and along well-established drains in modern landscapes, perhaps with a little scrub willow or birch, but with predominantly herbaceous vegetation. Agriculture was probably primarily arable, though with some livestock. An assemblage from South Dyke placed in the later Iron Age by a radiocarbon date give rather little evidence of terrestrial conditions, but gave hints of grassland, though with rather few dung beetles.

The Teeside to Saltend Ethylene Pipeline project provided some useful data points. To the north of Hull, Jaques *et al.* (EAU 2002/06) examined samples from ditch fills and a hearth deposit, perhaps Iron Age or Romano-British, from Lawns Farm, Dunswell, north of Hull (TSEP420), but all were devoid of invertebrate remains. At Bolton Hall, Bolton (TSEP238), a sample from a pit or ditch terminal (probably the latter) with an Iron Age AMS date was rich in invertebrate remains (Jaques *et al.* EAU 2002/04). These suggested a shallow body of weedy, still or sluggish, water. The feature was apparently set in grazing land: the chafer *Phyllopertha horticola* was abundant, and other grassland species were recorded, while dung beetles were very numerous, being dominated by large numbers of *Aphodius contaminatus* and *A. sphacelatus*, with moderate to small numbers of a range of others. There was no biological evidence to suggest arable cultivation adjacent to the feature. A deposit at Carberry Hall Farm, East Yorkshire (Jaques *et al.* EAU 2002/05) contained abundant dung beetles and fauna indicating grassland and herbaceous vegetation, regarded as clear evidence of grazing land. The remaining evidence is even more fragmentary; see the chronological section.

Further sites giving evidence of pre-Roman landscapes are to be sought: they must exist in our area. Even where waterlogging is not found, the molluscs will provide some evidence for the progressive clearance of landscapes; again, little work has been carried out in the north, in contrast to the abundance of sites further south (see above, taxonomic section). The suggestion of Bush (1993) and Bush and Flenley (1987) concerning the possibility of naturally incomplete woodland cover in chalklands requires further investigation. Thus, in investigations of prehistoric land use we see another priority for the future.

Roman managed landscapes

This topic has been implicitly reviewed in the section on Roman rural sites (p. 177), and this section gives only a brief resumé and some comments. There is a small, but growing, body of information from invertebrates, primarily insects, concerning Roman landscapes.

In the south-east of the region, Carrott *et al.* (EAU 1993/13) examined Romano-British pit fills of mid-late 4th century date at Glebe Farm, Barton-upon-Humber, North Lincolnshire. The surroundings were probably farmland, but not intensively disturbed; there was little evidence for natural habitats, and the whole fauna would have been able to exploit semi-natural or artificial ones. Wells at Dragonby (Buckland 1996) and Winterton (Girling AML 3929), and ditch fills and Sandtoft (Samuels and Buckland 1978) gave no clear indication of the surrounding landscape.

A series of sites associated with pipelines in East Yorkshire has provided opportunities to examine small amounts of material from Roman rural sites, affording local insights into land use. The insect assemblage from the fill of a shallow timber-lined well at Hayton, near Pocklington, assessed by Jaques *et al.* (EAU 2000/35) appeared to consist largely of background fauna, and so were considered to reflect the wider landscape. There were some indications of mixed farming, and nothing to suggest woodland (although the likely under-representation of trees, p. 461, must be borne in mind). The fills of the well at Rudston (Buckland 1980), and the various cut fills at North Cave (Allison *et al.* EAU 1997/37; forthcoming) gave clear evidence of human impact on the landscape, but the predominant land use was not clear.

Invertebrate remains from the primary fill of a ditch situated near a trackway lying between field systems and associated with an early fourth century settlement at Stamford Bridge were reported by Large (EAU 1999/53). There were several larval cases of caddis flies (Trichoptera), and abundant water flea resting eggs, but the assemblage consisted chiefly of fragments of beetles greater than 1 mm in size, notably larger weevils, ground beetles and scarabaeids (dung beetles). There were hints of grazing and perhaps of cultivation. Non-standard extraction methods had been employed, using a coarse mesh, and this material represents a lost opportunity to extend the land-use map. Ditch fills at High Catton gave indications of grazing nearby (Kenward *et al.* EAU 2002/12); and hints of livestock came from Malmo Road, Hull (Carrott *et al.* EAU 1992/01). Together, these sites point to intensive use of land in the parts of East Yorkshire fringing the Wolds.

At 50 Piccadilly, York (Carrott *et al.* EAU 1992/08), samples from one of a series of 2nd-3rd century ditches gave a fauna consisted predominantly of species likely to be found in an area of rough grazing (the associated plants were annual and perennial weeds), but full analysis was not funded. The early Roman ditches at Tanner Row (Hall and Kenward 1990), and buried soils at Skeldergate and Coney Street (Hall *et al.* 1980 ; Kenward and Williams 1979) suggested grazing land. At West Lilling, in North Yorkshire, Hall *et al.* (EAU 2000/82) inferred local grazing from the numbers of dung beetles present in ditch fills.

In Northumberland, a fill of a Romano-British ditch terminal at the Flodden Hill rectilinear enclosure was examined (Kenward EAU 2001/49). Abundant water fleas and aquatic insects indicated deposition in water The immediate surroundings of the ditch supported a flora of perennial weeds, especially stinging nettles (*Urtica dioica* L.), but also docks and their relatives (*Rumex* and *Polygonum*), various crucifers, plantains (*Plantago*), clovers and vetches. The wider landscape appeared to include short herbaceous vegetation, including grassland, and dung beetles, probably indicated grazing land nearby. Much of the fauna consisted of species favoured by human modification of the natural landscape (i.e. 'semi-natural' environments, cf. Kenward and Allison 1994c). This impact may have been quite strong, leading to a generally open landscape, as no species associated with trees or shrubs were found in either sub-sample despite the presence of 'branch wood' in the sediment.

McCarthy (1995) reviewed a range of evidence, including that from invertebrates, concerning the impact of the Romans on vegetation near Carlisle, Cumbria. Assessment of material from Stanwix, Carlisle (Hall *et al.* EAU 1994/57; Usai EAU 1999/24), suggested that this was initially an area of rather damp grazing land, on which there was accumulation of organic matter interpreted as horse dung, possibly stable manure. The need to look at large sub-samples in order to make a clearer reconstruction was emphasised, but there was no further funding. Insect remains from the peaty basal fill of the ditch north of the turf wall at Appletree, near Birdoswald. suggested poor grazing land (Hall EAU 2000/46). Some of the sites in The Lanes area of Carlisle ('Lanes 1') may have been essentially rural in character, although strongly tied to the built-up centre. Old Grapes Lane A, in particular, gave an impression of an area which may have been primarily used for livestock penning (Kenward *et al.* AML 78/92; 2000) - perhaps for the numerous equines required by the nearby fort, see p. 173.

In West Yorkshire, Late Iron Age to early Roman ditch fills at South Dyke (on the M1/A1 link road) gave substantial insect assemblages (Kenward. and Large EAU 1999/02; 2001b), and one dated to the third century AD evoked a picture of the range of habitats typically found in field edges along well-established drains in modern landscapes. The ditch probably held permanent or nearly permanent water, with emergent vegetation and a muddy bottom. There was probably a little scrub willow or birch, but the vegetation on the banks, and probably beyond, was predominantly herbaceous. Land use was probably primarily arable, with suggestions of cultivation very close by, but there was perhaps some livestock.

There is a little evidence to suggest that the Romans worked to a formula in draining land when they took it over. Kenward *et al.* (AML 78/92) suggested that:

'There is a remarkable general similarity between groups of insects from `waterlogged' Roman surface deposits at... sites at Carlisle, York and, to a lesser extent, London. The material from [Old Grapes Lane A, OGLA] continues this trend, and indeed strengthens the impression that Roman activity brought about very similar conditions in many places. Sites at London (Copthall Avenue, de Moulins *et al.* 1990), York (Tanner Row and Rougier Street, Hall and Kenward 1990) and Carlisle (OGLA) have all revealed deposits associated with ditch systems and many broadly similar groups of insects have been recovered from these sites.... It would be very interesting to discover whether this apparently systematic ditching represented a continuation of widespread native agricultural systems or a Roman imposition. Roman agricultural writers give us clear evidence that field drainage was a common aspect of arable farming (White 1970, 146-50).'

Ditch digging may, of course, have simply been a rational response to a straightforward problem, attempts to divine traditional cultural patterns being a typical manifestation of our denigration of our ancestors' ability to tackle problems logically.

Later managed landscapes

There has been little investigation of the post-Roman countryside via invertebrates. At Waterton, North Lincolnshire, Carrott *et al.* (EAU 1996/40) suggested that the terrestrial environment around a ditch fill of later 15th to mid 16th century date included abundant herbaceous vegetation, with little indication of woody plants and weak evidence for grazing. At Bolton Hall, Bolton, East Yorkshire (Jaques *et al.* EAU 2002/04) dung beetles were notably absent in a deposit of probable medieval date, suggesting that livestock did not graze in the immediate vicinity (a strong contrast with the assemblage from an Iron Age deposit at the same site). Girling and Robinson (1989) were able to suggest a grassland-dominated environment with some trees at Cowick, on the basis of analyses of (presumably Post-medieval) fills of the 14th century moat. Hall *et al.* (EAU 2001/15) examined a ?15th century build-up at the St John's Coach Park, Clarence Street, York, which may have been a grazed soil (p. 236). In North Yorkshire, Girling and Robinson (AML 36/88) suggested that the surroundings of a putative mill pond (perhaps later a fishpond) of Saxon or later date at Wharram Percy had little or no woodland or scrub, with insufficient few dung beetles to stand as evidence that the area was intensively grazed.

Dung beetles contributed a large proportion of the fauna of late 15th-early 16th century watercourse fills at Speke Hall, Merseyside (Kenward and Tomlinson 1992), indicating that the surroundings were grazed. Dung beetles became proportionally and absolutely more abundant in the later levels, and the presence in one of the upper layers of numerous *Aphodius* which were apparently not fully hardened, and so must have died *in situ* soon after they emerged from the pupa, indicated that the ditch itself became fully terrestrialised and was grassed over. Biological remains from some 11/12th-16/17th century pond or moat fills at a Higher Lane, Fazakerley (Dobney *et al.* EAU 1995/22; Hall *et al.* EAU 1996/05) suggested that the area around the site may have been largely arable land with mature hedges or patches of trees; there was no evidence for the watering of stock. At Old Abbey Farm, Risley, Cheshire, regional evidence was not strong in the fills of the moat adjacent to the house platform, with dates from the early 15th to 18th or 19th centuries, but there was evidence for grazing in the 17-18th century layers (Kenward *et al.* EAU 1998/23).

Can invertebrates identify livestock species?

The obvious source of information as to which domesticates were kept on particular farms, in addition to the bones (which of course are liable to have been from beasts transported from holding to holding) is parasites of livestock (intestinal worms, lice and keds). Unfortunately, lice preserve only under rather good conditions, and tend only to be deposited under special conditions, so that they are very unlikely to occur more than sporadically in deposits associated with fields. Ked puparia are more robust, and easily recognised from fragments. If found in ditches far from known contemporaneous houses they may have derived from stock in adjacent fields. However, a much more likely source in most deposits is in waste from wool cleaning, which presumably may have been transported to be dumped, and the lighter fractions of which are liable to have blown around freely. The problem of identifying pig faeces from nematode eggs does not yet seem to have been resolved (p. 30), though records of *Oxyurus equi* (p. 425) and *Damalinia ovis* (p. 427) seem to be safe reasonably indicators of equines and sheep (or perhaps goats).

In addition to the identification of insect parasites, three other approaches to determining which livestock species were kept in particular areas seem worth pursuing: (a) recognition of vegetation types produced by sheep, rather than cow or horse, grazing using plant and insect remains; (b) recognition of the physical remains of dung, perhaps where it was deposited in damp environments such as ditch edges which favoured preservation; (c) recognition of mineral inclusions characteristic of dung (Canti 1997; 1999), and (d) identification of invertebrates associated with particular species' dung. The last approach may be possible using mites (Schelvis 1991b; 1994a), but, rather surprisingly, few beetles seem to be closely associated with the dung of any one species of mammal (Jessop 1986; Landin 1961; Skidmore 1991). Many deposits have been identified as horse (or at least equine) manure on grounds of texture as well as content of biological remains (p. 397), and, outside the area considered here, droppings of sheep or goat were investigated by Akeret *et al.* (1999).

Can dung beetles be used to indicate the kind of livestock kept? If earlier literature is taken literally, some species might be supposed to be primarily associated with one or a few domesticates, or with other mammals. However, deeper search of the recent literature quickly reveals numerous exceptions. This was the conclusion of Jaques *et al.* (EAU 2002/04) in discussing the abundant dung beetles from an Iron Age deposit at the site at Bolton Hall, East Yorkshire, mentioned above: 'Scarabaeid dung beetles were very abundant ... This dung fauna was dominated by *Aphodius contaminatus* (91) and *A. sphacelatus* (62), with small numbers of *A. prodromus* (4), *A. depressus*, *A. ?fimetarius* and *A. rufipes* (all 2), and single *A. ater*, *A. granarius*, *A. porcus*, *A.* sp., *Colobopterus fossor* and *Geotrupes* sp. ...[data concerning dung associations were then reviewed in a table, drawing particularly on Jessop (1986) and Landin (1961); the result was inconclusive] ... *A. contaminatus* is said to be particularly found in horse dung, but this is by no means exclusive, and it certainly occurs in cow dung (Landin 1961; Kenward unpublished). Landin (p. 193) points out that, in Sweden at least, autumnal species such as *A. contaminatus* are likely to feed on horse dung because cows are taken indoors early, placing a bias on records.'

As an aside it should be mentioned here that *Aphodius sphacelatus* may occasionally have been confused with *A. prodromus* in early reports from the EAU, characters useful for separating fossils having only recently been clarified, Jessop 1986). This illustrates the general problem of identifying many remains even of common species where they are fragmented or decayed. A preliminary check of material suggests that although *A. sphacelatus* may be commoner at rural sites (e.g. at Bolton Hall, Bolton, Jaques *et al.* EAU 2002/04, and Carberry Hall Farm, Jaques *et al.* EAU 2002/05), *A. prodromus* is the species in this pair normally encountered in urban deposits. Fortunately it seems that most of the identifications from urban sites will be correct, but that records from rural sites need confirmation.

Overall, its seems that *A. contaminatus*, *A. sphacelatus*, *A. prodromus* and *A. fimetarius* (though which of the species into which the last as recently been split is not known) were the common species in rural environments, in contrast to the relative abundance of *A. granarius* and *A. prodromus* in urban deposits. These are all very eurytopic species, found in most kinds of dung and also sometimes in decaying vegetation and rotten fungi. Thus we probably cannot tell which species of livestock was present in most cases; nevertheless these insects are still very useful in determining presence of livestock and thus indicating the broad trend of land use.

As a tailpiece to this discussion, the use of dung – especially cow dung – as fuel may be mentioned. Dried cattle dung was 'the fuel that gave most light' in the Northern Isles and was the fuel for poor folk still in the 19th century in places (Fenton 1978, 206-9). It had to be dried in the open, and would inevitably have been invaded by insects. Conceivably the use of dung may have been one route by which dung beetles (notably *Aphodius*) arrived on occupation sites?

Rural deposits are often barren of invertebrate remains, or contain only a few land snails or very decayed insects (numerous cases are mentioned in the chronological review, Part 3). Reconstruction of rural environments and land use has therefore been a priority for research, should opportunities arise. Fortunately, in the past few years a series of sites, often associated with pipelines, has produced a little more information for eastern Yorkshire at least, and we can begin to see the results of human manipulation of what must, in most of northern England, originally have been largely forest and swamp. Nevertheless, the enormous potential of invertebrates - especially insects and molluscs - in reconstructing managed landscapes in the North of England has barely begun to be tapped (for molluscs, a contrast to more southerly counties). Studies of land molluscs from rural sites in the North have almost always been unsatisfactory, small in scale, or of too specialised deposits to help much in landscape reconstruction; their deployment is a priority. Every opportunity to study invertebrate (and other biological material) material from well-dated rural deposits, both in and away from settlements, should be taken. It will be particularly important to integrate such work with analyses of plant remains.

Cereal production and utilisation: grain pests

While cereal production lies at the heart of any consideration of agriculture in lowland Britain since the Neolithic, the pests of stored grain sit a little uneasily within any topic. They are discussed here on the grounds that they (together with moulds and vertebrate pests) must in certain periods have been responsible for the loss of a substantial proportion of the grain crop, and so necessitated bringing larger areas under the plough, but they also have implications concerning diet, livestock, trade, and health, at least.

Cereal field fauna

A few 'wild' invertebrate species feed on cereals in the field in Britain (e.g. various aphids and the leaf beetle *Oulema melanopa*), but none appear to be restricted to them (Balachowsky and Mesnil 1935). An excess of grass-feeding and open-ground xerophile insect species (a characteristic ground beetle assemblage, for example) in a rural deposit such as a field ditch might, together with other evidence, indicate adjacent cereal cultivation. The range of taxa which may be found is indicated by Balachowsky and Mesnil (*loc. cit.* 745-1127); no evidence of assemblages containing associations of such species has yet been clearly recorded, but the presence of the 'turnip mud beetles' *Helophorus rufipes* and *H. porculus* at some sites (e.g. Hayton, East Yorkshire, Kenward unpublished; Bolton Hall, East Yorkshire, Jaques *et al.* EAU 2002/04), and of *H. nubilus* at numerous sites (it was common at Hayton), may offer a little evidence for cultivated land.

Grain pests

Archaeological grain pests were reviewed by Buckland (1990); many additional records have been made since then. The classic pests of stored grain are very common in Britain in deposits of Roman and post-Conquest date, unknown from the prehistoric period, and only doubtfully present in the fifth to early eleventh centuries. The lack of early records contrasts with the Middle East (e.g. Panagiotakopulu 2000) and mainland Europe (e.g. Bücher and Wolf 1997). Three abundant beetles are regarded as true grain-store pests: the saw-toothed grain beetle *Oryzaephilus surinamensis*, the rust-red grain beetle *Cryptolestes ferrugineus* and the grain weevil *Sitophilus granarius*. These are referred to as the 'three main grain pests' elsewhere in this review. A fourth species is important in the archaeological context: *Palorus ratzeburgi*, regarded as an indicator of foul grain and other rotting residues. It should be noted that the identification of *Cryptolestes* species is difficult, despite the impression given by the illustrations in Vogt (1967), and ideally should be confirmed by male genitalia (Lefkovitch 1959); this has rarely been possible, the site at Coney Street, York, being a notable exception (Kenward and Williams 1979, 92). It is, however, likely that the vast majority of fossils are of *C. ferrugineus*. A second species of grain weevil, *Sitophilus oryzae*, appears to have arrived very much later, probably as a result of the expansion of world trade (see p. 352). Other beetles found fairly often in archaeological deposits, and associated particularly with grain, include the cadelle, *Tenebroides mauritanicus*, *Alphitobius diaperinus*, and the red flour beetle *Tribolium castaneum*.

Although there has been some discussion of the status of *C. ferrugineus*, there no reason to suppose that the rest of these beetles are natives of Britain, as they are adapted to substantially warmer climates than that of Britain at any time in the Holocene. Some moths and mites were important in stored grain in the 20th century, but there are no records of them as fossils from the north of England; clearly they should be sought. We also need to recognise these species, and the native or introduced facultative beetle grain pest communities, for their value as indicators of stored grain in periods when, and at sites where, the classic grain beetles were absent.

No attempt is made here to review the biology of these pests, but it may usefully be noted that most are not reliably hardy in British winters, even in the south, and for those which are reasonably cold-hardy (e.g. *S. granarius*) there is a world of difference between surviving a season or two under test conditions, and surviving long-term under the rigours of real open-air habitats.

Information from grain pests

There are four principal aspects of grain pests in archaeology: as indicators of the *presence* of grain; as evidence of its *treatment* (and thus perhaps intended use); as *damagers* of grain, with obvious economic implications; and as evidence of grain *importation*. Pals and Hakbijl (1992, 297) list some of the negative impacts of grain pests, including reduced germination capacity, allergic and toxic effects on humans, transmission of parasites and pathogens, and noxious odours. There is an enormous literature of storage pests and their control.

Although some of the other pests can live happily in other stored products (and in warmer climes, in the wild), *Sitophilus granarius*, the grain weevil, is confined to cereal seeds and thus a very reliable indicator of grain. Even if the grain weevil is absent, large numbers of *Oryzaephilus* and *Cryptolestes* are likely to be from grain, especially if found together.

Detection of grain treatment methods from insect remains has yet to be considered in a routine way, but sieving can be used to remove smaller free-living insects, and this perhaps may be the reason why *Sitophilus granarius* is (apparently) prevalent in later periods (see below), since it is larger and lives much of its life inside grains. Milled insects are considered below (p. 344).

Determining the extent to which grain was damaged in the past by insects (and moulds) is extremely difficult, although under some circumstances estimates can be made (e.g. Carruthers AML 11/93; Kenward and Williams 1979, 72-3). Modern data may be helpful: Hurlock (1965), for example, gives estimates of the loss of weight of grain caused by infestations of *Sitophilus granarius*. There are 19th and 20th century records of astonishingly large infestations, causing much damage and perhaps illustrating what sometimes happened in the more distant past; an example was provided by Fitch (1879).

Estimating the relative abundance of the species by period and their detailed history is of more than purely entomological interest, since grain pests are regarded as indicators of a variety of aspects of the economy and of the conditions and success of storage. Unfortunately, a survey of their distribution in time and space has been inhibited by the fact that many evaluation and assessment reports deal with 'grain pests' as an ecological group without listing the species records. The sites entered to databases are too few to provide a statistically valid sample; had we made database records of grain pests at specific level for every evaluation the pattern would be much clearer, although still incomplete.

All of the grain pest were initially imported as aliens. There is some archaeological evidence from ships, e.g. Pals and Hakbijl (1992), who recorded *C. ferrugineus*, *O. surinamensis*, *P. ratzeburgi*, *Alphitophagus bifasciatus*, *Sitophilus granarius*, various other synanthropes, and (notably) *Tenebrio molitor* (p. 285). We do not know which beetles and other invertebrates invaded stored grain in the prehistoric period, although the author remembers being shown charred grain with 'dry decomposers' (including *Typhaea stercorea*) rather than grain pests from one prehistoric site, a record which may not have been published. There seems no reason to doubt that the Romans imported the typical grain pests, and probably many other species (p. 342). Any prehistoric records of these and other aliens should be examined with very great care; if genuine they would be of profound significance as evidence of early trade. We should also make every effort to recover bodies of prehistoric grain charred in storage in order to search for associated insects, and so determine which of the native species were the ecological precursors of the classic grain pests. If characteristic recurrent communities can be identified they may enable tentative identification of bulks of cereals even where the grain itself has completely decayed.

It should be mentioned here that it is now suspected that most grain pests in towns at least probably originated from stable manure, having been introduced in low-grade cereals and often perhaps continued to breed on the stable floor (Kenward and Hall 1997).

Milled insects

Beetles have potential for detecting milled (rather than whole) cereals, in cases where the cereal remains themselves have decayed badly, and minute fragments of insect are found. The lack of clear records of milled insects is almost certainly a consequence of the mesh size employed in recovery rather than of their absence. It is impracticable to use mesh smaller than 300 microns on a routine basis for the recovery of insects, but a rapid check for such remains might usefully be made using a small sub-sample when faecal layers are being examined. Present extraction techniques will almost inevitably lead to the loss of the small fragments involved. This could probably be overcome by slurrying samples rather than sieving prior to floatation by conventional paraffin extraction, or by using a paraffin/acetone mixture (Kenward 1974). Identification of such fragmented remains is probably feasible: there is a literature for identification of food contaminants which would assist greatly (e.g. Kurz and Harris 1962; Olsen *et al.* 1995).

There are some cases which may represent examples of milled remains. An Anglo-Scandinavian cesspit at 16-22 Coppergate, York (Hall *et al.* 1983b; Kenward and Hall 1995, 754-5) produced a minute and cleanly broken fragment of a mealworm beetle (*Tenebrio* sp.), which had just possibly been milled and eaten with flour. Hall *et al.* (EAU 2000/80) noted that the remains of a *T. obscurus* from a 10th-11th century deposit at a site to the rear of Spurriergate, York, were so fragmented as to suggest the possibility that they had been milled, though they warned that some other process (such as consumption by a horse) might have the same effect. An attempt to recover milled insects from a drain at a site at Kingswood, Hull, was unsuccessful (Carrott and Kenward unpublished).

Charred grain pests

Grain pests are not just recorded from the sites favoured with anoxic waterlogging: there are occasional records of charred grain beetles, for example from deposits of charred grain at Malton, North Yorkshire (Buckland 1982b) and Droitwich, Worcestershire (Osborne 1977). There are remarkably few records of charred grain pests bearing in mind the vast quantity of charred grains and chaff present in archaeological deposits. Other insects are common in stored grain, of course, and may have originated with it. In our region, charred insects (not classic grain pests, but *Atomaria* sp. and *Aglenus brunneus*, quite likely to invade stored grain but equally to have entered further along the taphonomic pathway) were found with charred grain on land to the rear of 7-15 Spurriergate, York (Hall *et al.* EAU 2000/80). Charred insects associated with grain may have been overlooked at other sites, because they were not recognised by workers primarily concerned with charred seeds, or because they were not recovered in the paraffin flots examined by entomologists, or because they broke up during sieving (p. 116). Charred grain showing damage caused by insects is discussed on p. 94.

Grain pests through time

This is not the place for detailed analysis, but it is worth noting the possible significance of variations in the pattern of abundance, a few illustrative examples of which are given in Table 1. There do seem to be substantial variations, which probably have archaeological significance. *O. surinamensis* was perhaps able to exploit a rather wider range of conditions than the other species, and has several times been noted in much greater numbers than usual, for example in a second century Roman floor at Castle Street, Carlisle, where 80% of the assemblage was this species (Allison *et al.* 1991a, 34) and in a second century pit fill at the nearby Annetwell Street site (Kenward and Large EAU 1986/20). *P. ratzeburgi* in unusual numbers might indicate well-decayed and moist residues, but to get to this state they will have probably passed through a succession in which the other species had been able to build up populations. Abundant *S. granarius* without many individuals of the other species may suggest clean and well-dried grain in good condition which had not been stored long enough to degrade to the state which favours the remaining pests. Although *S. granarius* is predominant in samples from a number of medieval and post-medieval sites (see Table 1 and below), similar cases have yet to be recorded for the Roman period in the North. Annetwell Street provided two assemblages with more *S. granarius* than any of the other typical species (Kenward EAU 1999/32), perhaps suggesting clean grain, but the total numbers recovered were fairly small (tens). There were no such cases at Tanner Row or Ribchester. The data in Table 1, representing a brief foray into the easily available data, strongly suggest that a fuller review, and more especially collection of further data, would reveal archaeologically significant patterns. This would be an ideal topic for a student dissertation.

Table 1. Abundances of the four principal grain pests in assemblages from various sites, expressed as ratios to the abundance of Sitophilus granarius. From unpublished databases where no reference is cited in the text. Os - Oryzaephilus surinamensis; Cf - Cryptolestes ferrugineus; Sg - Sitophilus granarius; Pr - Palorus ratzeburgi. R - Roman; lm - late medieval; pm - Post-medieval.

Site	Date	Os	Cf	Sg	Pr
Coney Street, York	R	6.6	5.3	1.0	0.6
Skeldergate Well, York	R	7.5	1.5	1.0	0.5
Tanner Row, York	R	4.0	2.0	1.0	0.5
Annetwell Street, Carlisle	R	2.7	3.0	1.0	0.3

Castle Street, Carlisle	R	6.3	3.7	1.0	0.7
Old Grapes Lane, Carlisle	R	15.0	7.0	1.0	1.0
Lanes 2 sites, Carlisle	R	8.5	5.4	1.0	1.1
Ribchester, Lancashire	R	2.0	1.7	1.0	0.3
The Bedern, York	lm-pm	1.0	0.0	1.0	0.0
Coffee Yard, York	pm	0.4	0.0	1.0	0.0

The Roman period

Grain pests are common in Roman deposits, and indeed almost ubiquitous in samples from the larger settlements and from military sites other than the most ephemeral, their absence rather than presence being a matter for note. Even the tiny group of 19 beetles from South Shields fort (Osborne 1994) included three species of grain beetles, for example. Four species are predominant, their abundances often being in the following order: *Oryzaephilus surinamensis*, *Cryptolestes ferrugineus*, *Sitophilus granarius*, *Palorus ratzeburgi*.

As mentioned above, the grain pests (with the conceivable exception of *Cryptolestes ferrugineus*, although evaluation of both ancient and modern records is complicated by difficulties of identification) are not native to the British Isles, and there is no reason to doubt that they were Roman introductions. They appear to have been brought in supplies by the military, probably at the very earliest stage. The grain pests were present in late first century deposits at Coney Street, York (Kenward and Williams 1979), and at Castle Street, Carlisle (Allison *et al.* 1991a; 1991b), and they appeared early at the fort at Ribchester, Lancashire (Buxton *et al.* 2000a-d; Carrott *et al.* 2000; Large *et al.* EAU 1994/11). Refinement of information about the arrival of these species at individual sites is desirable, requiring careful collaboration of excavator and entomologist.

In the early years of work on Roman insect remains, it was thought probable that the immense numbers of grain pests recorded from most sites indicated serious problems in storing grain for human consumption (e.g. Hall *et al.* 1980; R. Hall and Kenward 1976; Kenward and Williams 1979), and even that there was necessarily grain *in situ* (e.g. Robinson AML 2444). The passage of time, collection of more data, and increasingly effective integration of evidence from plant and invertebrate macrofossils, have brought about a revision of this view. The immense population of insects at Coney Street certainly represented stored grain, and may have pointed indirectly to storage problems in the major granaries, but the latter case is not yet proven. Convincing evidence might be a large dump of one kind of cereal heavily infested by insects. (Grain pests are not the only source of damage to stored cereals, of course, and moulds may have been more significant. Cereals with a high moisture content soon degrade in store - see, for example, Karunakaran *et al.* 2001, who recorded serious damage in days rather than months in experiments.)

The grain at Coney Street may have been stored under poor conditions because it was intended for use as horse (or other equine) feed. For other sites the evidence for storage is much less clear, and we now tend to believe that most grain pests were from stable manure rather than (or in addition to) representing a ‘background’ of insects emigrating from infested food stores (Kenward and Hall 1997, see also p. 342). Indeed, these insects must have been so numerous that their corpses were regularly trampled and blown throughout occupation sites and beyond (as was suggested to be possible for woodworm, *Anobium punctatum*, in Anglo-Scandinavian York, Kenward and Large 1998b). Grain pests are so abundant in Roman deposits that the exceptions are of more interest than the typical cases, but the sites at Castle Street (Allison *et al.* 1991a; b, Annetwell Street (Allison *et al.* forthcoming b; Kenward EAU 1999/32; Kenward and Large EAU 1986/20; Large and Kenward EAU 1987/14-16; 1988/15-19) and The Lanes (Kenward *et al.* AML 76-78/92; EAU 1998/32), Carlisle, and Rougier Street and Tanner Row, York (Hall and Kenward 1990) are particularly impressive for the presence of these insects in a large number of contexts, often representing a substantial proportion of the fauna.

The fills of the well at Skeldergate, York (Hall *et al.* 1980) may represent a case where grain pests did not originate in stable manure. The fills, which were a series of dumps of 4th century date, contained large numbers of grain pests and some rarer stored-products taxa. It was argued on the basis of the vertical distribution of these remains that a bulk of spoiled grain was amongst the first dumps and subsequently became mixed into later fills as they were tipped in, up to the water line (p. 128-9). The rather similarly-constructed well at The Bedern, York, contained fills of early to mid third century date, again with abundant grain pests (Kenward *et al.* 1986b). It is hard to be sure, but in this case, too, spoiled grain may have been an independent dump, rather than being introduced in stable manure, although the latter may have been present too. All of the grain beetles at the Tanner Row site (Hall and Kenward 1990) may have originated in stable manure, and it seems possible that occasionally they actually bred in the stable floor in spilled grain, their numbers sometimes being very large (e.g. in some late 2nd century dumps, op. cit., 353).

The massive layer of burned and unburned grain at the Rougier Street site, dated to the late 2nd century, did not contain abundant grain pests, although there were a few grains with holes rather like those caused by insects, and one grain with rather more convincing evidence of *Sitophilus* damage in the form of a small (?oviposition) hole and a large (?exit) one (Hall *et al.* 1990, 411). This bulk of grain seems likely to have been accidentally burned and may have been more typical of the level of infestation for the period than that inferred from the deposit of grain beetles at Coney Street. A case where damage to insects appears more clearly demonstrable is provided by Carruthers (AML 11/93). Charred grain from the granary at the Roman fort at Ambleside, Cumbria, in about 50% of cases showed characteristic holing. This damage may have been caused by *Sitophilus granarius* attacking the endosperm (Robinson AML 11/93). Outside our area, Osborne (1977) recorded numerous unidentified charred larvae and pupae in grain from Roman Droitwich, providing clear evidence of infestation. This matter of 'normal' levels of infestation is an important one, requiring careful studies in future, and integration of work by palaeobotanists and entomologists.

The sites discussed so far have mostly been important commercial or military centres, although some of the Lanes, Carlisle, material may represent rural fringes. Similarly, assessment by Allison *et al.* (EAU 1991/05) of samples from Roman deposits at the Adams Hydraulics III site, York, apparently on the fringes of the settled area, produced *Oryzaephilus surinamensis*, *Cryptolestes* sp. and *Sitophilus granarius*.

Grain pests are recorded from sites far removed from Roman urban centres, too, though somewhat less consistently present in smaller settlements (the nature of the deposits giving preservation may reduce the chance of their recovery, p. 461). *Sitophilus granarius* and *Oryzaephilus surinamensis* were found in fills of Romano-British ditches at Sandtoft, North Lincolnshire, by Samuels and Buckland (1978). An assemblage dated to after the Roman conquest, apparently during the first century, from the fill of a broad erosion cone associated with a wicker-lined pit or well at Dragonby, North Lincolnshire produced a single *S. granarius* (Buckland 1996), while Girling (AML 3929) reported a single *Oryzaephilus surinamensis* from near the bottom of a waterhole or wood-lined well of 3rd or early 4th century date at Winterton, North Lincolnshire. Only single fossils of *Cryptolestes ?ferrugineus* and *Oryzaephilus* sp. were found in the fills of a Roman timber-lined well at Hayton, East Yorkshire (Jaques *et al.* EAU 2000/35; Kenward, unpublished).

Records such as these, where only traces of grain pests were found, must be treated with extreme caution in view of the possibility of contamination of some kind (see p. 476). We might reasonably ask why, if we assume that the remains were not contaminants, are such small numbers found at so many sites? On balance their occurrence is perhaps rather too frequent to evoke contamination (although this seems more probable for records from the 5th to 11th centuries, see below). The typical pests may not have reached some sites, but when brought in small numbers may not have gained a foothold, or have soon died out because overall populations were unsustainably small, leaving rare individuals in the fossil record by chance. Studies of charred grain may give clearer evidence. A late 4th century charred grain deposit in a flue in an industrial area at the Staniwells Farm site, Hibaldstow, North Lincolnshire (Allison *et al.* EAU 1990/05), for example, gave no evidence of insect damage, although this limited evidence obviously cannot be taken to be representative.

In addition to the four typical grain pests, some other stored-products species which were also probably introduced by the Romans have been found: *Tenebroides mauritanicus* (as adults or larvae), for example from Skeldergate, Coney Street (Kenward and Williams 1979), Ribchester (Carrott *et al.* 2000; Large *et al.* EAU 1994/11), Castle Street and The Lanes, Carlisle (Allison *et al.* 1991a-b; Kenward *et al.* EAU 1998/32), and Lincoln (Carrott *et al.* EAU 1995/10); *Alphitobius diaperinus*, e.g. from Papcastle, Cumbria (Kenward and Allison AML 145/88; EAU 1995/01), Carlisle (Kenward *et al.* AML 78/92; 2000; and Tanner Row (Hall *et al.* 1990) and the Bedern well (Kenward *et al.* 1986b), York; and *Tribolium castaneum* from the Skeldergate well, Tanner Row, Castle Street, and Lincoln. It will be interesting to attempt to determine whether other familiar beetles, such as *Tenebrio* and *Blaps* species, were brought at this time too, rather than being natives.

Records of grain pests in the 5th to early 11th centuries

Grain pests seem definitely not to have been present in more than traces from the end of the Roman period until after the Norman Conquest, and in fact may have been wholly absent. It is postulated that this was a consequence of a radically different grain storage and distribution system, with the abandonment of centralisation.

We have almost no evidence from the 5th-8th centuries; such deposits of this date as have contained insects have lacked grain pests (p. 197).

In almost every case, assemblages of insects of the Anglo-Scandinavian period have lacked grain pests. Small number of remains have been found in samples from deposits dated to this period: in York, single individuals of *Sitophilus granarius*, *Oryzaephilus* sp. and *Cryptolestes* sp. from 6-8 Pavement, York (Hall *et al.* 1983b, 185; Kenward EAU 2000/39), a few from 16-22 Coppergate (Kenward and Hall 1975), and a single *O. surinamensis* from a pit fill of uncertain date, possibly Anglo-Scandinavian, at Walmgate (Philip Buckland ARCUS 208). At Castle Street, Carlisle, Allison *et al.* (1991a, 48-9) found traces of grain beetles (*Oryzaephilus surinamensis* and *Cryptolestes ferrugineus*) in an Anglian deposit which probably included material cleared from a building.

These records are all suspect in some way, with contamination in the laboratory as a likely source, while residuality of Roman remains, intrusion by later material and incorrect context dating are also possible. For the Pavement site it was suggested that they were contaminants from samples from Roman Coney Street, material from which was processed at the same time. At Castle Street it appeared quite likely that they had been redeposited from the Roman layers, in which there were immensely abundant, while at 16-22 Coppergate residuality, contamination in processing, later intrusion, and incorrect dating are all possible (Kenward and Hall 1995, 760-761). This last site offers a cautionary lesson - early in analysis grain pests were found in a rather large number of contexts dated during excavation as Anglo-Scandinavian, but a (blind) request for a more careful evaluation of dating moved almost all of them to the post-Conquest period and revealed others to have been cut by later features! The Walmgate pit fill included Anglo-Scandinavian artefacts but there were strong hints that they may have been redeposited (p. 211).

It may be thought that a degree of special pleading is being applied in the unwillingness to accept these records as authentic, but the dangers of this are more than outweighed by the seriousness of incorrectly assuming that they were contemporaneous. The reviewer has an open mind on this subject but cannot accept the evidence which is available. Why are they never at all common in these deposits if they were present in the pre-Conquest period? The doubt over these records of grain pests illustrates a more general problem of low-level contamination in archaeological assemblages, which needs to be addressed and which may have lead to publication of a number of misguided records; the subject is discussed on p. 476; for the present purpose a record of *Oryzaephilus* sp. from a sample from an early Holocene wetland deposit at Church Moss, Davenham, illustrates the depth of the problem (author, unpublished).

It will be informative to trace the disappearance of the grain pests at the end of the Roman period, for they (and some other synanthropes) will probably serve as an excellent indicator of the timing and geographical pattern of social decline. Dobney *et al.* (1998), for example, argue that grain pests contribute to a picture of continued economic organisation in late 4th century Lincoln. Similarly, if records of grain pests from Anglian or Anglo-Scandinavian deposits can be authenticated they would be of considerable historical significance. It is suggested that they would indicate bulk importation, or continuity of centralised and thus a substantial degree of social or commercial organisation and probably continued trade in cereals with mainland Europe.

Grain pests after the Norman conquest

The date of the re-establishment of the grain pests in force is not yet certain, and tracing their return is a priority. It is not wholly impossible that they were present in Britain, but very localised, and were enabled to increase by Norman economic changes, but two other hypotheses are that they were brought with cereal imports associated with provisioning during the Norman military operations, or that they regained a foothold as a result of commercial imports after a new, centralised, control system for cereals was set up. The impression is that they re-appeared fairly rapidly after the Conquest, and became almost ubiquitous in larger settlements not long after. At 16-22 Coppergate, they seem to be present in the earliest post-Conquest layers, although full analysis is required to confirm this (see the assessment by Carrott *et al.* EAU 1996/09 and project design by Dobney *et al.* EAU 1997/02). However, at nearby Spurriergate, a series of samples from 10th-12th century layers (some of which contained *Tipnus unicolor* in some numbers, *cf.* p. 378) was conspicuously devoid of grain pests, although stable manure, a likely source of such insects, seemed to be present (Hall *et al.* EAU 2000/80). Of course, if grain pests came from horse feed, their distribution in deposits may have been determined by local social factors.

There are numerous records for the post-Conquest period, and only some representative examples are given here; detailed review might prove rewarding in view of the shifts in species frequencies apparent from superficial reading, but would necessitate returning to stored material (where it still exists) in order to obtain quantification. At 44-45 Parliament Street, York (Carrott *et al.* EAU 1995/08; EAU 1996/15; Davis *et al.* 2002), grain beetles were present in several of the deposits of 11th to 13th century date, and quite abundant in some. The grain weevil *Sitophilus granarius* was more common in relation to *Oryzaephilus surinamensis* and *Cryptolestes ferrugineus* than in most Roman deposits. *S. granarius* develops inside grains and is particularly likely to be eaten in grain-based food. It was suggested that these remains of grain pests entered with faeces. There were two records of single individuals of *S. granarius* from cut fills (which may have received floor sweepings) associated with ?12th century landfill at the Dominican Priory, Beverley (Allison *et al.* AML 21/90; 1966c); no other grain pests were recorded. Again in Beverley, a fill of a pit dated to the 15th century at Morton Lane (Kenward and Carrott PRS 2003/58) produced *O. surinamensis* and *S. granarius* (these being absent from 12th century fills at the same site).

Grain pests were present in variable numbers in the late 13th and 14th century waterfront deposits at Chapel Lane Staith, Hull (Kenward 1979c), the single assemblage of mid-later 14th century date including enormous numbers of *O. surinamensis* and *S. granarius*. *C. ferrugineus* and *P. ratzeburgi* were conspicuously absent from this site, perhaps indicating a pattern see later elsewhere. *Sitophilus granarius* and *Oryzaephilus surinamensis* were both common at the Magistrates' Courts site in Hull (and other species again absent). *S. granarius* was present in more contexts than *O. surinamensis*, and usually proportionally more abundant than normal in Roman or early post-Conquest associations, which probably indicates well-cleaned grain intended for human consumption. *O. surinamensis* was very abundant in one deposit, which it was suggested may have included very spoiled grain, perhaps from horse feed or from spillage on stable floors. There are other records of grain pests from Hull, for example those of *S. granarius* and *O. surinamensis* from Blanket Row, although neither was abundant (Carrott *et al.* EAU 2001/12).

Fills of a late 14th century pit at 16-22 Coppergate, York, probably including dumps of stable manure, contained abundant grain pests and were notable for not only yielding *Oryzaephilus surinamensis* and *Sitophilus granarius* but, rather unusually in Post-Conquest groups, *Palorus ratzeburgi* and a larva of *Tenebroides mauritanicus*, suggesting that well-decayed grain may have been present somewhere along the taphonomic chain (Hall and Kenward EAU 1999/27).

Thirteenth to early 17th century pit fills at The Bedern, York, produced small numbers of grain pests throughout (never more than 'several' of any species); remarkably, only *Oryzaephilus surinamensis* and *Sitophilus granarius* were found although nearly 150 samples were examined, so *Cryptolestes ferrugineus* was presumably not favoured by local conditions or was absent at the source of the grain (there was a single record of '*Cryptolestes* sp.') (Hall *et al.* AML 56-58/93). Almost as remarkably, there were approximately equal numbers of *S. granarius* and *O. surinamensis*. In contrast, the ratios of *O. surinamensis*: *C. ferrugineus*: *S. granarius* at two other sites with large numbers of samples were, for Tanner Row, York (mostly Roman), 4:2:1, and for Annetwell Street, Carlisle, 3:3:1 (data from Table 1). The significance of such variations requires further investigation, but the high proportion of the primary pest *S. granarius* at The Bedern may suggest that the source of these insects was rather well-kept grain, perhaps for human consumption, rather than the poorly kept animal feed represented at the Roman sites, where rotting grain may have lain on stable floors for long periods. The pattern seen at The Bedern was observed in an even more exaggerated form in a series of assemblages from post-medieval floors at Coffee Yard, York (Robertson *et al.* EAU 1989/12): here, there were no *Cryptolestes*, and the ratio of *O. surinamensis* to *S. granarius* was 1:3. Again, grain for human consumption may have been the source.

Records of post-Conquest grain pests from evaluations and minor assessments are frequent, although frustratingly the species composition has always not been recorded and dating may be vague (e.g., for York, Carrott *et al.* EAU 1991/15; 1992/05; 1992/08; 1992/09; 1995/51; Kenward EAU 1986/14). Similarly, there are records from Gowthorpe, Finkle Street and Micklegate, Selby (Carrott *et al.* EAU 1993/08), where, although the date of many of the deposits was uncertain, most appeared to be of the later medieval period, and grain pests (unspecified) were noted from fills of the probable Kirk Dyke. There is a 'medieval' record of *O. surinamensis* from Scarborough (Hall *et al.* EAU 1996/35), and the three main grain pests were noted in a medieval cut fill at Rickergate, Carlisle, by Kenward (EAU 2002/13). Hull, too, has produced some records, from ?later medieval to post medieval deposits at High Street (Carrott *et al.* EAU 1994/49), 15th century pits at Mytongate (Miller *et al.* 1993), and from occupation or flood deposits and occupation layers dated to the 17th to 19th centuries at Tower Street (Carrott *et al.* EAU 1995/37). The last of these was of special interest as one layer (dated in the range AD 1680-1865) yielded grain weevil remains which were quite obviously not the usual *S. granarius*. Two other *Sitophilus* species are frequently imported to Britain: *S. oryzae* and *S. zeamais* (Aitken 1975). One of the abdomens from Tower Street contained female genital sclerites and could be identified as *S. oryzae* on the shape of the 'Y-shaped sclerite' (cf. figures given by Halstead 1963). These appeared to be the first specimens of *S. oryzae* recorded from archaeological deposits in Britain; their occurrence at what was then a major port is notable. A further record of *S. oryzae* – again confirmed by male genitalia – has since been made from a probable 19th century deposit in York (Kenward *et al.* unpublished).

Despite its name, *S. oryzae* is principally associated with wheat; in northern latitudes it is strictly confined to stored cereals, probably having originated in tropical or sub-tropical conditions (warmer than the likely home of *S. granarius*) and been brought to Europe quite late. It may have arrived in the 19th century as a result of the expansion of world trade, but occasional earlier introductions are possible. This is open to testing through archaeological investigations, which can elucidate the effects of trade in introducing aliens on one hand, and, on the other, provide evidence from records of aliens of trade into particular sites. These are excellent reasons for carrying out proper excavation and analysis of post-medieval deposits.

Records of grain pests from small settlements after the Norman Conquest appear rare, but such sites have yet to be studied adequately. Some 15th century primary ditch fills at 17-19 St Augustine's Gate, Hedon, produced *O. surinamensis* and *S. granarius* (Carrott *et al.* EAU 1993/04). These species were also found in fills of the 14th century moat at Cowick, East Yorkshire, by Girling and Robinson (1989). As grain pests (like other synanthropes) may provide an index of trade and status at isolated sites, care should be taken to investigate the insect fauna of such sites in sufficient detail for patterns to emerge. Where only one or a few samples are analysed, the results have little significance; for example Kenward *et al.* (AML 77/92; 2000) found no grain pests in the single ?12th-13th century sample from Lewthwaites Lane, Carlisle, in marked contrast to the Roman levels below and contemporaneous deposits at some other sites. In York, Jaques *et al.* (EAU 2000/53) did not find grain pests in assemblages which seem to have been from material resembling stable manure at the NCP Car Park site, Skeldergate. However, it was clearly not possible to assert that the beetles were absent in either case in view of the limited scale of analysis.

Grain pests present a range of problems, both practical (e.g. contaminants and reliable recognition of insect damage to charred grain, and of milled cereals) and theoretical (what type of storage regime and economic system would be predicted to be necessary for their survival?). There is also the question of whether horses were commonly fed grain in the period following the Norman Conquest: this is significant since most of the grain pests from other periods may have been from low-grade grain used for horse feed. As one of the groups of invertebrates most obviously relevant to archaeological issues, they particularly deserve careful, systematic and objective study.

Other pests of stored products

Among the numerous pests of stored products known today in addition to the typical grain pests (e.g. Munro 1966), a single species of bean weevil, *Bruchus rufimanus*, seems to be the only important one in archaeological deposits in the north of England (*cf* Winchester, where at least one of the smaller bruchids was found as well, Carrott *et al.* EAU 1996/20). Although fossil bruchids are often difficult to name, when remains are numerous and bear scales and hairs a confident identification can generally be made. Isolated fragments are particularly problematic, but remains of large Bruchus from occupation sites seem usually to be *B. rufimanus*.

B. rufimanus has been found at a significant number of sites in northern England, as well as outside this region (e.g. the records from Winchester, above, and Canterbury, Allison and Hall 2001). Kislev and Melamed (2000) recorded charred beans from Iron Age Israel hollowed by a bruchid, probably this species, and reviewed earlier records of such damage. There were numerous remains in a medieval moss-filled cess pit at Skeldergate, York (Kenward unpublished), and in such a case there can be little doubt that they entered after having been unknowingly (or of necessity) eaten in pulses. There were modest numbers of *B. rufimanus* and *B.* sp. (probably mostly *B. rufimanus*) from Anglo-Scandinavian 16-22 Coppergate, York, some under circumstances strongly suggesting that they had been eaten (Kenward and Hall 1995, 520, 760). Other records from York include modest numbers from 4-7 Pavement (Hall and Kenward EAU 2000/22). Bean weevils were found at the Magistrates' Courts site, Hull (Hall *et al.* EAU 2000/25), in a ?12th century pit fill associated with landfill at the

Dominican Priory site, Beverley (Allison *et al.* 1996c, 202), while a late 14th-15th century ?ditch fill at Cartergate, Grimsby, produced several, perhaps damaged by chewing (Carrott *et al.* EAU 1994/22).

Other origins are possible. Bruchids, not identified to species, from The Bedern, York, were found in company with a fauna suggesting the presence of stable manure, including weevils likely to have been imported in hay (Hall *et al.* AML 56/93, 10). Here the bruchids may have originated in hay from free-living populations on vetches and their relatives, or with beans used as horse feed. Many other records are probably simply of bruchids living in semi-natural environments locally (as was probably the case with *B. atomarius* and *B. loti* from Neolithic Runnymede, Robinson 1991b), emphasising the need to allow time to identify these insects whenever possible, even though it may not always be very easy. Bruchids are discussed further on p. 353.

A bark beetle, *Coccotrypes dactyliperda*, has been found in carbonised date stones in the Sultanate of Oman (Constantini and Audisio 2001), indicating an insect which might give secondary evidence of the importation of an exotic foodstuff into Britain; date stones have been recorded from a medieval pit fill in York (D. Williams unpublished).

Many insects regarded today as stored products pests (e.g. Hinton 1945) were, in the past, apparently normal components of the household commensal fauna. However, it is possible that in rare instances such species will be recognised as having infested stored materials, and such cases should not be overlooked.

Sitona clover weevils

Sitona species (some of which are called 'clover weevils') certainly occur in 'background fauna', where they may be common, but are often regarded as arriving in archaeological occupation deposits from hay, as are *Apion* species (many of which are also clover weevils) and various others (p. 354). However, at the Magistrates' Courts site in Hull, (Hall *et al.* EAU 2000/25), large numbers of these weevils (mainly *S. lineatus*) have been recorded in the absence of hay fauna, and some samples from Chapel Lane Staith (Kenward 1979c) and Blanket Row (Carrott *et al.* EAU 2001/12) contained rather more *Sitona* than might reasonably be expected by chance, so other explanations need to be considered.

The weevils may have had various sources: with legumes used for food—either for humans or horses; on other leguminous plants growing on sites (regarded as unlikely); bird droppings or pellets (in which they tend to be common at the present day, but for which there is no evidence from the sites in Hull); or they could conceivably be grain contaminants, originating on leguminous cereal field weeds, since they are large enough to make their removal from grain by sieving difficult. *Sitona* species, especially *S. lineatus*, are very migratory (Murray and Clements 1999), so it is not entirely impossible that the remains found in archaeological deposits have no special significance.

Sitona, and particularly *S. lineatus*, are sometimes minor pests on peas and beans (Morris 1997; Murray and Clements 1999), but unlike grain weevils and bean weevils, *Sitona* do not live inside seeds and so will not have emerged from stored food. However, they frequently enter houses with peas and beans brought green in the pod or freshly shelled into a container (author, unpublished). A test for association (Spearman's rank correlation) between *Sitona* and records for leguminous plants at the Magistrates' Courts site gave no evidence of a significant co-occurrence ($p = 0.461$), but this is inconclusive since there were so few records of legumes, which preserve poorly.

Some of the *Sitona* at the Magistrates' Courts site did not appear to have come from stable manure, for they occurred in assemblages lacking decomposers typical of such material. However, these assemblages may have represented stable manure which had been removed from the stable and buried before decomposer communities could develop. Those samples from floors in which *Sitona* was most abundant were notable for the marked abundance of plants representing grassland vegetation or other material which may have served as litter, and species association analysis showed that *Sitona* occurred especially with some taxa placed in 'house fauna', but also likely to occur in stored hay. To confuse the issue further, at the nearby Blanket Row site (Carrott *et al.* EAU 2001/12) rather large numbers of *Sitona* spp. occurred in what appeared to be stable manure associations, bringing us back to hypotheses concerning equine feedstuffs.

Insects from hay and other cut vegetation

The topic of 'hay' insects is closely tied with the study of stable manure, and perhaps to a lesser extent with flooring and roofing (although there are no authenticated cases of hay roofing from archaeological deposits in the area considered here). This section deals with principles and problems, illustrated by a few examples. Other cases are mentioned in the section dealing with stable manure (p. 397).

Insects associated with hay can be divided into two groups - those collected with the raw material (phytophages and those which crept into piles in fields for food or shelter) and invaders of stored, often mouldy, hay. Collected plant feeders include a range of weevils, a few other beetles, and some bugs, while the component of species colonising or sheltering in the field is likely to have been extremely diverse, including ground beetles and rove beetles. Freshly emerged weevils of the genera *Gymnetron* and *Apion* are considered excellent indicators of hay in urban assemblages (Kenward and Hall 1997), for they are most unlikely regularly to have entered deposits dominated by 'stable manure' fauna in any other way. Other indicators may be *Kateretes*, *Sitona* and *Hypera* species, but it is important to remember that these beetles may have lived at some sites, and certainly could have arrived as background fauna at many (and there is certainly a puzzle concerning *Sitona* spp. at some sites, see previous section). Particularly convincing are records of abundant bug nymphs, especially *Craspedolepta nervosa* (p. 54, 356), from various archaeological sites, again frequently in 'stable manure' associations. Outside the area considered here, the Deer Parks Farm site in Northern Ireland provided enormous numbers of immature and adult bugs believed to have been imported in cut vegetation (Allison *et al.* EAU 1999/08; 1999/10; Kenward *et al.* accepted). Occasional records of *Berytinus species* (stiltbugs) can probably be ascribed to an origin in hay, too (e.g. Kenward and Large EAU 1986/20; Large and Kenward EAU 1987/16; 1988/15).

For the weevils, an origin in hay (or other cut vegetation) is sometimes particularly clear, for example in some Roman deposits at Tanner Row, York (Hall and Kenward 1990, 360, 400). At this site there were considerable numbers of records of *Apion*, *Sitona* and *Gymnetron* species, sometimes in appreciable numbers and in several cases newly emerged, and *Hypera punctata* and *Kateretes rufilabris* were occasionally found with them. Some molluscs were perhaps also imported in hay: *Assiminea grayana* may conceivably have been brought in cut salt marsh vegetation, and there were various snails which may have been imported in conventional hay (*loc. cit.*, 403, 418).

Other cases are more suggestive than conclusive. Hay may have been the source of thermophilous bugs and other elements in the Roman Well at The Bedern, York (p. 157). A limited-scale investigation of Roman deposits at the Old Grapes Lane B site, Carlisle (Kenward *et al.* AML 76/92; 2000) gave *Mecinus pyraster* and *Gymnetron labile* (both associated with *Plantago* species - plantains). In this case the `hay' taxa might possibly have originated from weedy vegetation growing on the site, although on balance this was thought probably not to be the case. There were some rather clearer cases from Annetwell Street, Carlisle (Large and Kenward EAU 1987/16). At the 6-8 Pavement site (Anglo-Scandinavian, Hall *et al.* 1983; Kenward EAU 2000/39), *Apion* spp. were numerous, and *Sitona* rather often found. However, a substantial proportion of the former were probably

A. difficile (three were positively identified), and this weevil is believed to have been imported with *Genista tinctoria* intended for dyeing. On balance, the remainder of the 'hay weevils' at the site are considered likely to have had origin as background fauna rather than having been imported in hay. Records of 'hay weevils' from one layer at The Bedern, York (Hall *et al.* AML 57/93, 10), seem much less likely to have originated on the site and are more convincingly from hay, although the evidence that the layer included stable manure was not conclusive. Obviously each case must be taken on its merits, and integration of plant and insect evidence is essential.

Nymphs of the bug *Craspedolepta nervosa* (p. 54, 356) are found rather frequently, and seem certain to have been imported in cut vegetation in most cases. There were, for example, numerous records from Roman deposits at Castle Street, Carlisle, from an area just outside the fort, and probably from horse fodder (Allison *et al.* 1991a; b). The indicator value of a species such as this more than rewards the considerable effort required to make secure identifications.

The role of the garden chafer, *Phyllopertha horticola*, in relation to `hay' insects requires consideration in view of the remarkable frequency with which it occurs in archaeological deposits, being found far more often than its present-day distribution and usual abundance would suggest likely. The beetle still occasionally outbreaks locally, but was apparently much commoner in the 19th and early 20th centuries. It may have been a component of the local fauna in the surroundings of Roman Carlisle, sufficiently numerous to be a constant, and occasionally quite abundant, element of the `background fauna' of insects entering deposits by chance. Equally, however, corpses may have been brought in turf, and it has been found in samples where other insects strongly suggest that this was present (p. 316). Thirdly, this clumsy chafer may easily have been trapped when herbaceous vegetation was cut for hay. Its reported ubiquity and extreme abundance at some localities in some years in the 19th-20th centuries, typically in poor acid upland pasture (e.g. Bennett 1940; Ormerod 1898; Raw 1951; Taylor and Thompson 1928) would make accidental importation of quite large numbers in this way (and its arrival in flight) perfectly possible, although it is certainly no longer regularly present at most localities. P. horticola has been extensively studied in an agricultural context (e.g. Bennett 1940; Milne 1957-9; Milne and Laughlin 1957; Raw 1951).

Buckland (1996) states that *P. horticola* has been 'characteristic of the cleared landscape since the mid-Holocene'. Records suggest that it was at least locally numerous in the late Bronze Age: for example, Buckland (1981a) found several examples in samples from sediments associated with the 'raft' at Brigg, North Lincolnshire; Hill (1993) noted it frequently in later Bronze Age riverine deposits at St George's Field, York; and Kenward and Large (EAU 1999/03; 2001a) found two individuals in a Bronze Age ditch fill at Grim's Ditch, West Yorkshire. For the Iron Age, Girling (1986), reported specimens from around Lindow Man, probably derived from dry land some distance away, while Holdridge (1988) noted it in deposits around the Hasholme boat, and it has occurred in most larger assemblages from rural sites of this date examined by the present author (e.g. Jaques *et al.* EAU 2002/04; EAU 2002/05; EAU 2002/08).

P. horticola was found in numerous Roman urban contexts at Tanner Row, York, with 55 records, mostly single individuals but sometimes two or three (Hall and Kenward 1990). Rarely, larger numbers are found, for example in a second century pit at Annetwell street, Carlisle (Kenward and Large 1986/20), a 3 kg sub-sample of which gave five individuals. The implication of such records is great abundance in the background fauna or, more probably, frequent importation in cut vegetation (presumably hay) and turf. It is not infrequent in Carlisle; there were numerous records from Annetwell Street (Kenward EAU 1999/32) and The Lanes (Kenward *et al.* AML 76-78/92; Kenward *et al.* EAU 1998/32). It has been noted at Ribchester, Lancashire, by Large *et al.* (EAU 1994/11), occurring in 27 of 105 contexts as single individuals! Several specimens were found by Buckland (1996) in the fill of the erosion cone of a first century AD cut feature at Dragonby, North Lincolnshire, and Girling (AML 3929) recorded some from the Winterton Roman villa, while Sudell (1990) noted it from the well at Dalton Parlours villa. There was no reason to suppose *P. horticola* was of any but background origin in these rural sites.

There were 22 records of the chafer from Anglo-Scandinavian 16-22 Coppergate, York (Kenward and Hall 1995), suggesting that the beetle remained abundant into this period. It was also frequent at the Viking-Age site at Viborg, Denmark (Kenward CHP 2005/04; 2005b). Almost certainly its decline is very recent, the result of agricultural improvement and deliberate control.

Another small chafer, *Hoplia philanthus*, which bears beautiful characteristic oval metallic scales, was recorded from six sub-samples representing three contexts at the Roman fort at Kirkham, Lancashire (Carrott *et al.* EAU 1995/02). Highly fragmented remains suspected to have been of *H. philanthus* had occasionally been noted by the author from other Roman sites, particularly some in Carlisle, Cumbria (one specimen from Old Grapes Lane A, Carlisle, (Kenward *et al.* AML 78/92, can now be definitely identified, however), and there are Iron Age records of *H. philanthus* (with *P. horticola*) from Carberry Hall Farm, Bolton Hall and a site east of High Catton, East Yorkshire (Jaques *et al.* EAU 2002/05; EAU 2002/04; Kenward *et al.* EAU 2002/12). *H. philanthus* is a root-feeder in the larval stage, the adults occurring in May to July, reportedly sometimes in quite large numbers locally (Jessop 1986, 29). The occurrence of *H. philanthus* is interesting in relation to the very frequent records of *Phyllopertha horticola*. Both chafers may have arrived at sites in the ways suggested above, or sometimes even have been accidentally eaten by livestock grazing on the turf in which the beetles pass their immature stages and on which the adults often bumble about.

The recognition of field invaders of stacked or laying hay will probably be a matter for sample-by-sample interpretation, although some ground beetles, staphylinids, cryptophagids, lathridiids and others may prove characteristic. Invaders of the stored product may be particularly significant, although with an overlap with typical communities of houses and stables. Species such as *Typhaea stercorea* and *Crataraea suturalis* may have exploited stored hay, while others, such as the *Monotoma* species, perhaps entered as it began to moulder. Occasionally there has been a suspicion that a stored hay fauna has been predominant in stable manure groups, but no clear cases appear to be on record.

Much hay was probably cut from wetlands, such as the Ings along the Ouse and Derwent near York. However, wetland plants were probably imported for other reasons, such as flooring and thatching. In any case, it is possible that numerous aquatic organisms were brought with such plant material, trapped amongst or stuck onto the stems. This may be significant source of wetland invertebrates in occupation deposits.

Other fodder

A wide range of herbaceous and woody plants may have been used for fodder, with consequential importation of insects. Some of the records of scale insects (p. 52) may represent the importation of leafy branches for such a purpose, and heathland species (particularly the less mobile ones) may rarely have been brought with vegetation cut for fodder. There appear to be no cases where such an interpretation has been made with any confidence, however. Importation of heathland biota in peat and turf is discussed on p. 316.

Bees and beekeeping

Honey is a very valuable food, providing rapidly available energy as well as vitamins and minerals, which in the past may have made the difference between survival and extinction to some peoples (Bodenheimer 1951, 34-37). Wax, too was important, and doubtless found endless uses in the past (as it does now).

Records of honey bees (*Apis mellifera*) from British archaeological deposits, and various other aspects of the history of bees and beekeeping, have recently been reviewed by Kenward (2005a); a 15th century record from Morton Lane (Kenward and Carrott PRS 2003/58) post-dates that review. They have been found in small numbers at many sites, and remains of 'bees' which were probably *Apis*, but which were not specifically identified, have often been noted. These may well have strayed from elsewhere. However, Anglo-Scandinavian 16-22 Coppergate has provided deposits containing large numbers of honey bees (Kenward and Hall 1995, 706-8, 765-7), and there is little doubt that these represent the remains of a hive, deliberately or accidentally killed off during removal of the honey and wax, or possibly the victim of accident or inclement weather. Other Anglo-Scandinavian sites in York can be argued to produce more honey bees than might have arrived by accident, suggesting either beekeeping or the regular processing of honey, wax, or both (Hall and Kenward EAU 2004; Kenward, *loc. cit.*).

These bee remains may have simply been the corpses ejected from active urban hives, or they may have been refuse from the deliberate killing of a hive or hives to extract wax and honey (until the middle of the 19th century this seems to have been the normal way of dealing with hives in England). Other means of entry for bees are ingestion with food (having been contaminants in honey), or rejection prior to eating, ejection during the extraction of honey from combs (or in subsequent purification), extraction during purification of wax, and their presence in the waste from mead-making. In each of these cases the bees may have originated far from the final point of deposition. The superb preservation of some of the bees from 4-7 Parliament Street and 16-22 Coppergate might suggest a direct entry to the deposits from which they were recovered rather than a route involving processes such as heating and straining, though the effect of these processes has not been studied. The effect of the passage of bee corpses through the human gut also requires investigation, parallelling the work of Osborne (1983) on grain pests.

The association of the remains of bees at Coppergate with masses of *Genista tinctoria* (dyer's greenweed) was discussed by Kenward and Hall (op. cit.), and the widely-published 'skep' from the site is debunked by Kenward (1991).

It has been argued that lime (*Tilia cordata* Mill.) pollen in a Bronze Age beaker from Scotland, interpreted as the remains of mead, indicated probable importation from further south (Dickson 1978; Limbrey 1982). Honey residues have been identified chemically by Needham and Evans (1987).

Races of bees: It has been shown that the races of honey bees can be separated using the configuration of the wing veins, and that the remains from Coppergate (and medieval Oslo, Kenward 1988a) belong to the north-west European race (in fact the argument has run conversely, it having been established on the basis of the fossil record that the 'northern dark bee', known under various aliases, is indeed the ancestral form). References here include Dews (1985), Milner (1985), Ruttner *et al.* (1978; 1990) for morphological studies, and Cornuet and Garnery (1991), Arias and Sheppard (1996) and Pedersen (1996) for DNA analysis, the last indicating an early origin for the races, at 300-1300 kya, perhaps 670 kya, The history of beekeeping is reviewed by Crane (1983; see also Kenward 2005a; Limbrey 1982; Panagiotakopulu 2000, 95-103; Zeuner 1963b), and a reading of her book suggests a wide range of questions to be addressed, including determining whether *Apis mellifera* is truly a native of Britain, establishing when apiculture, rather than collection from wild colonies, developed here, identifying the material used for hives and, somewhat at a remove, using pollen and chemical analyses to attempt to identify honey residues.

Other bees: There have been one or two records of bees which were not *Apis*, always in small numbers. These were probably bumble bees or solitary bees, which might have minor ecological significance if found in larger quantities. Colonially-nesting 'solitary' bees such as *Andraena fulva*, for example, would stand as evidence of open sunny, but not too disturbed, ground if abundant as fossils.

Beeswax preserves and is easily recognised. Taken from the combs of honey bees, it is a valuable product with many uses, including candle-making, as an ingredient of sealing wax, waterproofing, sealing containers, lubricating, casting (lost-wax), polishing, and latterly in cosmetics and pharmaceuticals. Beeswax has a lengthening archaeological record, for example records from the Oseberg ship, Norway, quoted by Lewkowitsch (1914, 899), from an Etruscan cup (Garnier *et al.* 2002), and a 4000 year old beeswax figure from Australia (Wachman and Jones 2002). Lewkowitsch gives an analysis of the Oseberg wax. The use of beeswax for lost-wax moulding has been demonstrated for Egyptian objects as early as 600 BC (Noble 1975), though the practice is surely even older. Wax has been found in northern England both as tiny pieces and as obviously worked lumps (there were examples of both from Anglo-Scandinavian Coppergate, Kenward and Hall 1995, 765-6). It may be recovered in various ways: by trowelling (as was the wax ball at Coppergate, op. cit., 608, 766), or in Bulk Sieving or General Biological Analysis samples. 'Wax' films which form on the surface of samples in soak prior to sieving, and sometimes on insect material in spirit, were formerly ascribed to some polymerisation reaction (Kenward *et al.* 1980), but are now suspected in at least some cases to have formed when wax melted as samples were heated.

Identification of beeswax is by its pale colour, greasy appearance, and the characteristic and familiar smell evolved when a hot needle is touched against it. Chemical and spectroscopic methods of identification could be used (e.g. Charters *et al.* 1995; Evershed *et al.* 2003; Heron *et al.* 1994; Regert *et al.* 2001; 2002), but will generally be superfluous unless more advanced questions are being asked of the material, or traces in pottery are being investigated. At a simpler level, could we use pollen analysis of wax (or honey residues, or human faeces), to search for exotics indicating an overseas origin?

Sealing wax, a mixture of beeswax and resin (though later a mixture of shellac and rosin with turpentine and pigment), has also been recorded from archaeological deposits; Hall and Kenward (1990, 342, 361) note it from two late 2nd century Roman layers at the Tanner Row site, York.

Other sources of wax: Wax is produced in usable quantities by various insects in addition to bees, and that from bumble bees and some bugs has occasionally been exploited (Kirby and Spence 1859, 185-187; Lewkowitsch 1914). Such insects or their wax (which is chemically distinctive) might possibly be found in archaeological contexts. On a world scale, the best known seems to be 'Chinese wax', exuded by scale insects and (at least formerly) exploited in Western China (Lewkowitsch, *loc. cit.*, 931-2; Silliman 1871). Lewkowitsch (p. 934) also discusses 'psylla wax', from *Psylla alni*. Various waxes and resins exuded by insects - apparently always scale insects - have been used in the past and in some cases continue to be exploited today (e.g. MacVean 1994; Essig 1934).

Craft and industry

Invertebrates have some significance as producers of raw materials for craft and industry, principally wax and silk, (below) to a lesser extent dyes (below) and varnishes (p. 362). However, it is as secondary indicators of other raw materials that they are perhaps most important. Hall and Kenward (2003a) review the potential of bioarchaeological remains, including invertebrates, for indicating a variety of crafts and industries.

Invertebrates, dyes and dyeplants

The weevil *Apion difficile* is strongly associated with dyer's greenweed, *Genista tinctoria* in Britain (M. Morris 1990, 42). The beetle was first recorded from the 6-8 Pavement site (Hall *et al.* 1983b), leading to the tentative deduction that dye plants were used on the site before the remains of the plants themselves had been recorded (such plants have now been found as a result of further analysis, Hall 1996b; 1998). The weevil was probably quite common at 16-22 Coppergate, but identifications were confirmed for only nineteen contexts (Kenward and Hall 1995, 654, 772-3). Other insects may have been imported with the large quantities of a range of dyeplants obviously utilised in Anglo-Scandinavian York and doubtless elsewhere, notably clubmoss. However, the recognition of such imported insects may be difficult unless they are uncharacteristically abundant or alien. One species which may occur is the tiny staphylinid *Pycnoglypta lurida*, which was common in occupation deposits at a Viking-Age site in Denmark (Kenward CHP 2005/04; 2005b) and is a good candidate for importation with plant material, especially if it included moss.

Insects are themselves a source of dyes and other products. The strong red dye cochineal (kermes) was, and to an extent still is, obtained from various scale insects: *Kermes vermilio* (kermes proper, oak kermes), *Porphyrophora polonica* (Polish cochineal or kermes), *P. hamelii* (Ararat or Armenian cochineal), *Kerria lacca* (Indian lac), and in post-Colombian times, *Dactylopius coccus* (American cochineal) (e.g. Kurdian 1941; Morrison 1926; Taylor 1984; Wouters and Verhecken 1989). (All of these can be found under a variety of names in the literature, unfortunately, the old generic name *Coccus* being commonly used; the synonymy is confusing.) *P. polonica* has been exploited as far north as Poland (Cardon and Chatenet 1990, 354-384; Sandberg 1997, 61). The lac insect, source of the shellac once used to manufacture gramophone records, produces a scarlet dye (Celoria 1971, 23, Chadon and Chatenet 1990, 378-381). An article in the Burlington magazine for Connoisseurs (Anon 1904) grades these dyes in quality (the Eurpean kermes > American cochineal > lac), though there is at least a hint of snobbery present in this account! Other insect dyes are mentioned by Kirby and Spence (1859, 185). Latterly, from the 16th century on, the New World cactus-feeder *D. coccus*, a very rich source of the dye cochineal (Cardon and Chatenet loc. cit), was used almost exclusively. The production of cochineal became an important and jealously protected industry (Fleming 1983; land-use zonation Lee 1951). Initially controlled by the Spaniards, the trade apparently at least sometimes involved the importation of large quantities of dried insects to Europe (Sandberg1997, 44); these might rarely survive in archaeological waste deposits. The dyes themselves have been identified on archaeological textiles (e.g. Wouters and Verhecken 1989), in some cases from the North of England (e.g. Taylor 1983).

Lac, a resinous substance used to make varnish and shellac (thin flakes of lac), is obtained from the Asian scale insect *Laccifer* (or *Kerria*) *lacca*. Lac might be detected chemically, or remains of the producer bugs might be found in archaeological associations by extreme good fortune. Records of residues of insect products are mentioned by Sutton (1995, 272).

Some molluscs produce materials which can be used as dyes (e.g. Cardon and Chatenet 1990; Ruscillo 2005; Step 1927, 254; Thomas and Mannino 2001, 434-5). Although home-produced dyes were certainly used in Britain, the past centre of production of the mollusc-based dyes, notably Tyrrhenian purple, appears to have been the Mediterranean, where accumulations of broken shells are sometimes found (e.g. Minniti 2005; Ruscillo 2005). *Murex trunculus*, *M.* (= *Bolinus*) *brandaris* and *Thais haemastoma* are listed as the sources of shell purple dye in the Mediterranean by Reese (2005). Ancient dyeing methods are reviewed by Baker (1975). Only the dye itself, or dyed cloth, would have been exported to Britain, so these dyes would need to be identified chemically. Cardon and Chatenet (1990) give a list of European dye-producing whelks; among them, *Ocenebra erinacea* (sting winkle) and *Nucella lapillus* (the common dog whelk) are in British waters, and shells which may have been broken during dye extraction have been reported from Ireland (Henry 1952; Murray 1998).

There was probably at least limited local production of 'purple' in the British Isles at most times in the past, based on *N. lapillus* (Light 1995a, 148; Sandberg 1997). Bede mentions procurement of purple dye from shellfish. Murray in lit. (1998) suggests that *N. lapillus* shells found broken in Ireland may have been waste from dye production; according to Sandberg (*loc. cit.*) their use continued at least into the 17th century. Huge numbers of molluscs must be used to provide even small amounts of dye, so that it is quite likely that layers indicative of dye extraction would be recognised should they be excavated.

Silk

Silk is an insect product with a long and fascinating history of exploitation and intrigue. There are a fair number of records of the finished cloth and of yarn from the North of England, with a substantial quantity (over a fifth of the woven textiles, including a head-dress and unused off-cuts, as well as silk yarn) from 16-22 Coppergate, York (Walton 1989; Walton-Rogers 1997). Moths other than the traditional Chinese silkworm (*Bombyx mori*), some of them European, produce useful silk (see, e.g., Good 1995; Panagiotakopulu *et al.* 1997; Tazima 1984; Zeuner 1963a), and it has been implied that the source species can be identified. The larvae, pupae and cocoons of silk moths should be looked for, even though their recovery would be a remarkable chance. It is often stated (*contra* Zeuner *loc, cit.*) that silk moths were only brought to the west very recently, so any serendipitous records of *B. mori* would be of considerable importance. Were silkworms *really* unknown in the west? Silk in the Eastern Mediterranean in antiquity is considered by Panagiotakopulu (2000), much of what she writes being of wider relevance, and routes to York are discussed by Walton (1989).

Insects deposited by wool cleaning

Insects have contributed substantially to our knowledge of wool processing, revealing it to be a common and widespread activity. The contrast with the lack of records of raw wool fibre is quite surprising since wool certainly preserves under some circumstances and spun and woven wool is common.

There are numerous records of the very distinctive adults and puparia of sheep keds, *Melophagus ovinus* (which are flies, biology reviewed by Evans 1950 and Small 2005), or sheep lice, *Damalinia ovis*, or both, from the Anglo-Scandinavian period onwards. These remains are considered to have been deposited as a result of wool (or fleece) processing, and many of them are from deposits which were clearly domestic floors. Roman records are rarer, possibly because wool preparation was a specialist, perhaps primarily rural, activity in a centralised urban economy and rural deposits containing domestic waste are rare, but the sheep parasites were certainly present. A strong impression has developed that the remains of adult keds, which appear to have very weak cuticle, are in most cases recovered only because they remained within the extremely tough puparia until released during sample processing (something also suggested by Robinson 1981a, 204).

The following are some examples of records of *M. ovinus* and *D. ovis*; a systematic review would be useful. It is possible that these sheep parasites were overlooked during some early work, which tended to concentrate on the Coleoptera; the 6-8 Pavement site (Hall *et al.* 1983b) is a case in point, where re-investigation using the voucher samples might prove rewarding, especially since a return to the samples produced vegetative remains of dyeplants not recognised in the original study (see above).

For the **Roman** period, an adult and a puparium of *M. ovis* were recovered from a early-mid second century well fill at the Old Grapes Lane B site, Carlisle (Kenward *et al.* AML 76/92; 2000), in what appeared to be the remains of animal bedding dumped into water. Conceivably this was a rare case where sheep actually lived on the site, rather than the parasites originating from wool cleaning. Similarly, a single adult *Melophagus* head from the Tanner Row site, York (Hall and Kenward 1990, 349), found in what may have been a stable manure assemblage, was possibly from wool cleaning, but may just as well have been deposited when sheep were penned, killed or skinned.

There appear to be no records of sheep parasites dating to the **fifth to eighth centuries**, but few deposits with good preservation have been seen. By contrast with the earlier periods, keds were recorded very regularly in small numbers from **Anglo-Scandinavian** deposits at 16-22 Coppergate, York (Kenward and Hall 1995; catalogued by Walton Rogers 1997 and briefly discussed by Kenward 1997b), being found in over 200 contexts, and sheep lice were rather frequent too (more than 40 contexts). The remains were concentrated in floors, where larger numbers were sometimes observed (e.g. at least 100 *D. ovis* from one 3 kg sub-sample), but were present in various other features, perhaps largely as a result of the disposal of floor debris and of redeposition of earlier floor deposits during pit digging and house building (*op. cit.* fig. 194). One gully within a house produced substantial numbers of both lice and keds, as well as parasites of pigs and cats, but (although, on the evidence of cladoceran ephippia, water had been poured into it) there was no clear evidence that the gully functioned in wool or skin processing (*op. cit.* p. 596). It was noted (*op. cit.* p. 549) that these insects were patchily distributed within floors, but that is was not surprising as they were probably shed by intermittent episodes of wool-cleaning. The relatively robust *M. ovinus* in particular has been noted repeatedly elsewhere in Anglo-Scandinavian layers in York: for example, Carrott *et al.* (EAU 1992/03), recorded *M. ovinus* from 104-112 Walmgate during an evaluation exercise, Johnstone *et al.* (EAU 2000/04) and Jaques *et al.* (EAU 2000/29; 2001/26) found it (together with *?Damalinia* sp.) at 41-49 Walmgate, and at 4-7 Parliament Street both species were recorded (Hall and Kenward EAU 2000/22). On the other side of the River Ouse, at the Queen's Hotel site, many Anglo-Scandinavian deposits produced *M. ovinus*, and some *D. ovis* were also found (Kenward and Hall EAU 2000/14).

There are records of *Melophagus ovinus* from a few deposits dating to **after the Norman Conquest**. In York, a pit fill at the NCP car park site, Skeldergate with pottery dated up to 11th-12th century contained at least two adults (Jaques *et al.* EAU 2000/53). Some borehole samples, perhaps of immediately post-Conquest date, studied during an evaluation at 84 Piccadilly yielded a tentatively identified sheep ked in an apparently waterlain assemblage (Carrott *et al.* EAU 1991/16). Plants and other invertebrates from this core segment suggested the dumping of domestic waste. Carrott *et al.* (EAU 1992/05) found a *M. ovinus* puparium fragment in a borehole sample examined for evaluation of a 12-14th ?dump into the King's Pond at Palmer Lane; here a likely origin in floor sweepings was indicated by grain beetles and an assortment of decomposers, mostly indicating fairly dry material, together with single human and dog fleas (*Pulex irritans* and *Ctenocephalides canis*). There were further records from the Layerthorpe Bridge site (Hall *et al.* EAU 2000/64). At 14 Skeldergate, Allison *et al.* (EAU 1991/06) found *M. ovinus* with fullers' teasel and dyeplant seeds in a sample of deposits accumulating against a 13th century wall.

Several post-Conquest sites in Beverley have produced sheep parasites: the following list is not exhaustive. *Melophagus ovinus* adult and puparium fragments were present in 12-13th century pit fill and floor deposits, and (with *?Damalinia* sp. and textile-related plants) in the fills of a watercourse, at Keldgate (Carrott *et al.* EAU 1995/03; Jaques *et al.* 2001/35), and the fly was also found in 12th century floor silts and pit fills (perhaps formed before c. 1188) during evaluation at Champney Road (Carrott *et al.* EAU 1993/01). A puparium was found in a 13th century ditch fill at Lord Robert's Road by Carrott *et al.* (EAU 1999/07). Two 12th century cut fills at the Dominican Priory site gave *M. ovinus*, perhaps introduced in floor sweepings (Allison *et al.* 1996c). Keds in 15th century pit fills at Morton Lane (Kenward and Carrott PRS 2003/58) probably came from floor sweepings. A few *M. ovinus* were found at the Magistrates' Courts site, Hull (Hall *et al.* EAU 2000/25; 2000/33).

There are a few **later and post-medieval** records: A single *M. ovinus* was noted in a fill of a pit dated 14th/early 15th century at Morton Lane, Beverly (Kenward and Carrott PRS 2003/58); Hall *et al.* (EAU 1993/26) found ?*Melophagus ovinus* and *Damalinia* sp. together in 13-14th century occupation deposits at 63-64 Baxtergate, Whitby; Carrott *et al.* (EAU 2001/12) noted *M. ovinus* (together with human fleas and in one case a human louse, but in deposits which appeared to contain stable manure) from the first half of the 14th century at Blanket Row, Hull. Alldritt *et al.* (EAU 1991/01) found *Melophagus ovinus* and also unidentified *Damalinia* lice during evaluation of mid-later 14th century deposits at 17-21 Piccadilly, York (Reynard's Garage); and Carrott *et al.* (EAU 1993/04) found *M. ovinus* in both of the samples examined from 15th century primary ditch fills at 17-19 St Augustine's Gate, Hedon.

These sheep parasites appear generally to be telling a consistent story of wool processing, and so are of considerable indicator value. However, it is important to keep vigilant watch for cases where sheep may have been kept live or been slaughtered, and also to ensure that a careful identification is made of lice, since there are closely similar species associated with various other domesticates, and there is also a danger of confusing these and lice of (for example) birds. Similarly, there are keds associated with other species (such as deer, bats, and martins, Hutson 1984) and these might be confused with *M. ovinus*, so losing important information. So ideally we need range of evidence in recognising wool processing: in other words an indicator group or package (Hall and Kenward 2003a).

Tanning

The use of insects as an indicator of tanning was suggested in the 1970s (e.g. Buckland *et al.* 1974; Girling AML 2735), but only in 1997 was a convincing example discovered, on the basis of evidence from plants and invertebrates, and it was hypothesised that an indicator group might be recognisable (Hall and Kenward EAU 1999/27; Hall and Kenward 2003a; b). The argument revolves around the beetle *Trox scaber* in combination with bark sclereids. *T. scaber* is generally found in dry animal remains and in wood mould and nests in hollow trees at the present day (Britton 1956, 6; Palm 1959; Jessop 1986). Leatherdale (1955) cited a case where large numbers emerged from a birds' nest in a house. Hall *et al.* (1983b, 183) suggest that the range of habitats which it can exploit may be wider than suggested by the standard works, however.

T. scaber is very frequently recorded from urban sites (e.g. in 242 Anglo-Scandinavian contexts at 16-22 Coppergate), but generally in ones and twos. Occasionally several have been found together, suggesting breeding in larger numbers, for example in 14th-15th century urban deposits at 36A-40 High Street, Hull, where some were freshly emerged (Carrott *et al.* EAU 1994/01), and in one layer at 16-22 Coppergate (Kenward and Hall 1995), but it is not certain whether these records have special implications. In *contra*st to this general pattern, Hall *et al.* (EAU 2000/64) recorded rather large numbers of *T. scaber* from several Anglo-Scandinavian and medieval deposits at the Layerthorpe Bridge site, York. Large quantities of finely comminuted bark, and bark sclereids, were also present, and it was suggested that it and the beetle may have been associated with tanning in some way. Some other species may be associated with tanning, though certainly not exclusively. At Layerthorpe, one assemblage from a layer dated to the post-Conquest period (but perhaps of Anglo-Scandinavian date) gave an fauna in which much the most abundant beetle was *Trox scaber*, but the second most abundant beetle was *Acritus nigricornis* which, although often seen in archaeological occupation deposits, rarely occurs in such numbers. According to Kryzhanovskii and Reichardt (1976), *A. nigricornis* has sometimes been recorded in quantity under tan bark. It is also found in various kinds of decaying matter, and may have been attracted to skins, in the way postulated for *T. scaber*. Two other species may have also had connections with the tanning process: the maggot-predator *?Creophilus maxillosus*, and the histerid *Teretrius fabricii*, quite possibly imported with bark.

Further evidence that the *Trox scaber* at Layerthorpe had arrived by a different route from much of the fauna was offered by records of preservation. Most of the remains of *Trox* were in a poor preservational condition, and many were so decayed as to break up when manipulated with a fine paintbrush. In some cases the remains could be seen to have decayed substantially, having a characteristic surface texture and local patches of erosion. It is suggested that these remains had passed through the tan bath, and that the decay was the result of substances added to produce the active liquor, ash or lime perhaps being likely candidates.

Some other sites have given what might on re-investigation prove to be similar evidence. A nearby late medieval or early post medieval dump, presumably into the King's Fishpool, at the Palmer Lane site also produced unusually large numbers of *T. scaber* (Carrott et al. EAU 1992/05). There was much leather in the residue, and *T. scaber* may have lived in this or in material associated with its production. The beetle was also recorded as abundant in what appeared to be a dump of material taken from a floor, and containing much leather, in a late or post-medieval deposit at Palmer Lane (Carrott *et al.* EAU 1992/05). A pattern is thus suggested by the records from the fringes of the York fishpool. Outside the region reviewed, there is also a record of numerous *T. scaber* from the Chaucer House site, Southwark, where one sample (unfortunately of uncertain size) gave several tens of individuals (Kenward EAU 1990/10). Note, however, that Hall and Kenward (2003a; b) strongly warn against using abundance of *Trox scaber* alone as an indicator of tanning, pointing out that it is occasionally abundant in general occupation deposits, citing a late 14th century 'organic dump' from High Street, Kingston upon Hull (above) and an Anglo-Scandinavian layer at 16-22 Coppergate, an association with tanning being suspected in neither case. A record of *T. scaber*, apparently in appreciable numbers, by Jaques *et al.* (EAU 2000/29) was accompanied by an explicit judgement that it did not suggest tanning, as there was no confirmatory evidence and the *T. scaber* were preserved in the same condition as the rest of the fauna.

A fill of a putative 18th century tanning pit examined by Carrott *et al.* (PRS 2001/06) during evaluation of deposits at a site at Canalside/Witter Place was rich in very decayed bark, a likely component of tanning pit fills, but there were no insects indicative of skins.

Hall and Kenward (2003a) mention some other insects which may have been associated with tanning. One of these, the bark-boring longhorn beetle *Phymatodes testaceus* has now been found in modest numbers at a site which included a deposit rich in *T. scaber* adults and larvae, at Viborg, Denmark (Kenward CHP 2005/04; 2005b).

Other crafts and industries

Doubtless a range of other processes will eventually be detected through invertebrate remains, though the need to integrate with other evidence cannot be over-emphasised. Hall and Kenward (2003a) suggest a range of likely indicator groups for craft and industry. There are numerous minor possibilities: scale insects may stand as evidence of the use of willow (in particular) for basket-making, being shed with bark if it was stripped, for example. None of the records of these insects appear to have so originated, however. At an extreme, the lack of colonising decomposer insects in masses of well-preserved plant remains may indicate that the plants were used for some process which made them unsuitable as a habitat for these insects; dye bath residues might fall in this category, for example, and this was suspected in a few cases at the 16-22 Coppergate site.

Trade

Invertebrates offer evidence of trade of various kinds over short and long distances. Trade may be considered at several levels, but for the present purpose will be divided into regional trade (say, beyond a few hours' journey from a site but within the area of northern England and southern Scotland) and long-distance trade (beyond this, but particularly overseas). The local procurement of materials (roughly speaking, from areas within one day's round journey) is not considered in this section, but mentioned frequently in earlier ones (see especially p. 310 ff. and p. 332 ff.).

There is a problem of definition: trade is generally taken to imply an exchange system, but in some periods many resources were probably just collected, so transport may be more appropriate a term. Generally speaking, trade within a single geographical area may be difficult to detect using biological remains, since the fauna and flora were fairly uniform. Exceptions will be importation of materials not locally available; heathland, moorland, or chalkland resources will fall in this category for many sites, for example. Marine shellfish and crustaceans were obviously of necessity imported to most sites, but are considered on p. 323; marine invertebrates at inland sites are clear evidence of trade links unless it is believed that occupants of the sites always went to the sea shore and collected shellfish in person!

Trade over longer distances is perhaps more interesting to archaeologists and biologists alike. Invertebrates, particularly insects, offer evidence of importation of resources at some point in time, in that a good number of species are known or believed to be of alien origin (p. 468). In the Roman period, a range of insects seem to have been brought from overseas, initially in army supplies but doubtless later on in the course of trade as generally understood. (Direct evidence that aliens were carried in Roman ships is provided by Pals and Hakbijl (1992), see p. 284). This addition of species to the fauna appears to have been resumed after the Norman Conquest, and to have continued apace thereafter, eventually encompassing a range of Australasian insects. Surprisingly few species seem to have come from the New World; the movement seems to have been essentially in the opposite direction (Baker *et al.* 1993; Buckland 1988; Sadler 1991; Sadler and Skidmore 1995; Spence 1990). Tracing this process of introduction will be fascinating from the zoogeographical point of view, but there are important archaeological questions to be addressed too. The potential of systematic studies of alien importations can only be guessed at for the time being, but various areas of ecological and archaeological research can be envisaged.

A few invertebrates from archaeological sites clearly represent rare importations of species unable to become established. There is as yet nothing from the north of England to rival the clearly introduced longhorn *Hesperophanes fasciculatus* recorded at Alcester by Osborne (1971) and probably brought at an immature stage in furniture. Some species were doubtless brought deliberately, although there are no records for invertebrates to parallel the case of the garden dormouse in York (O'Connor 1986c), unless the edible snails *Helix aspera* or *H. pomatia* are accepted as introductions (p. 311). Some invertebrates were introduced dead, as in the case of the Red Sea cowrie *Cypraea pantherina* from the 16-22 Coppergate site (Kenward and Hall 1995, 781), which showed saw marks and probably had been used in manufacturing some form of personal decoration. The sponges recorded from a few sites (p. 20) may fall in this category, if they are not modern contaminants. Imported insects (and most other small invertebrates) are very unlikely to be found unless they became established at least locally and built up in numbers, although of course exceptional cases of recovery of primary imports may occur by chance (e.g. Osborne's longhorns, mentioned above).

Pearls, insect dyes, lac, silk and other invertebrate products were certainly traded internationally in various periods, and wax was probably of sufficient value to be imported. Documents referred to by Ruttner *et al.* (1990, 14-15) indicate that honey production in Eastern Europe was enormous in the medieval period and later, and that it was exported via Brugge and Hamburg at least. There may be documents referring to imports to Britain (the author has not attempted to research these). Dyeplants are suspected to have been imported to Anglo-Scandinavian sites, and the remains of alien natural-habitats insects may eventually confirm this. The possibility that some thermophilous bugs were imported into Roman York in hay has been entertained on p. 355, although a local origin under a warmer climatic regime now seems quite possible (Kenward 2004).

Many synanthropic insects were certainly or probably originally introduced to Great Britain in the course of direct or stepwise international trade. They are also believed to be useful as evidence of trade and exchange at the settlement level (see p. 468). A large number of garden, agricultural and forestry pests have been brought to these islands, too. (Most of the plants and animals exploited in agriculture, horticulture and gardening were originally imported, of course, but are not strictly relevant here except to the extent that many invertebrates are known to have been brought with them in recent times.) It remains for the importation of other groups of organisms to be traced; molluscs, spiders and earthworms, for example, certainly include aliens among their numbers.

Invertebrates from archaeological ships

There seem to be no records of biological remains from *within* ancient ships from our area (although deposits *associated* with boats have been described, e.g. by McGrail 1981; Wright and Churchill 1965). But should opportunity arise such material should be investigated in meticulous detail, for some important results have been obtained elsewhere, e.g. by Hakbijl (1987; see p. 100, 313), Lemdahl *et al.* (1995), and Pals and Hakbijl (1992; see p. 344). Deposits in and around boats should be sampled thoroughly (though the problem of establishing their temporal relationship to the boat is considerable). What may we have learned about contemporaneous environments and the contents of the boats from detailed analysis of the deposits associated with the various vessels from North Ferriby described by Wright and Wright (1947) and Wright and Churchill (1965), for example? Modern scientific literature tells us how common it is for insects, in particular, to be found in ships' cargoes (e.g. Aitken 1975 for beetles brought to Britain), and there are historical accounts too (e.g. those quoted by Roth and Willis 1960 for cockroaches).

Living conditions, including the urban environment

This section starts with a consideration of conditions within buildings, then reviews the evidence concerning the nature of open areas on occupation sites, and the effects of keeping livestock.

The fauna of intensive occupation

Although modern ecologists often tend to discuss the 'urban fauna' as though it were a discrete unit, this is very misleading, especially when the time dimension is introduced. There is a continuum from truly natural habitats to the most extreme urban 'concrete desert'. Much the same was true in the past, and the present author was in error to categorise certain kinds of insect associations as 'urban', although there is no harm in the use of phrases such as 'typical urban fauna' in some circumstances. It is much more helpful to think of a fauna of *intensive occupation* whatever the size of a settlement (Kenward and Allison 1994c), although of course even this is only one extreme of a range of occupation densities. (The sites in Carlisle examined for insect remains illustrate this well, with later Roman Annetwell Street at the urban extreme and the Lanes 1 sites at the other, p. 403).

This fauna of intensive occupation has some special characteristics, particularly in that many of the species appear to be rare in nature or even unable to survive away from people (i.e. they are strongly synanthropic). Such species are favoured by human transport between 'islands' of artificial habitat where there are accumulations of decaying matter, protected situations, and artificial heat. It is important to distinguish between 'pest' and 'domestic' species as now understood, and the much wider range of synanthropic taxa exploiting urban habitats in the past, and probably until very recently. Many of the insects in Roman or Anglo-Scandinavian houses would have been familiar to most people until the middle of the 20th century or later (the churchyard beetles, *Blaps*, and the mealworms, *Tenebrio*, for example). Aspects of this fauna strongly associated with people are discussed more fully elsewhere (p. 468).

Invertebrates and continuity of settlements

The question of continuity of settlements is of general interest, but of particular importance for two periods: the Iron Age-Roman transition, and the 'Dark Ages' following the collapse of direct Roman influence. This issue is discussed, with particular reference to later prehistory and the transition to Roman rule, by Dent (1988), and it is highlighted as an agenda issue by James and Millett (2001). Invertebrates, and especially synanthropic insects

(p. 468), may have a crucial role to play in addressing these issues. The disappearance of grain pests, presumably at the end of the Roman period, is indicative of substantial social change, but not of breaks in occupation. Assemblages of synanthropic 'decomposer' insects from dark age settlements would, however, be most informative: did the insects believed to be strongly dependent on artificial conditions survive, or did they die out when settlements dwindled away, to be replaced at least temporarily when new occupation foci arose by species present locally in natural habitats (Kenward 1997a)?

The nature and function of buildings

Many invertebrates, especially insects, are strongly associated with the range of habitats created by the construction, use, and decay of buildings of various kinds, and this makes them a powerful tool in archaeological reconstruction.

Invertebrates and construction materials

Insects have a considerable potential as a source of information about materials employed in constructing buildings. They can provide evidence of timber, wattle and basketwork, imported sediments for floors, and increasingly it appears, the nature of roofing materials. Turf and moss are discussed elsewhere (pp. 316 and 315). Timber beetles are a constant component of archaeological insect assemblages. Kenward and Hall (1995, 658) listed the insects associated with wood which were recorded from Anglo-Scandinavian deposits at 16-22 Coppergate, York: 20 species were considered particularly likely to have exploited structural timber or wattle. Some, notably the woodworm beetle *Anobium punctatum* (from 264 of 416 contexts for which insects were quantified), *Ptilinus pectinicornis* (56 contexts), and the powder-post beetle *Lyctus linearis* (97 contexts) were clearly established on the site, and some other species were quite frequent (e.g. *Grynobius planus*, from 17 contexts).

Anobium punctatum is almost always found when more than one or two samples from occupation deposits are analysed. There are prehistoric records (e.g. Smith *et al.* 1997; 2000 for the Iron Age), but it became common in the Roman period, when it is frequent at most sites and sometimes very abundant. At Tanner Row, York, for example, *A. punctatum* was present in a third of almost 300 samples, with ten or more individuals in sixteen (Hall and Kenward 1990), and large numbers were recorded from the fills of the well at Skeldergate (Hall *et al.* 1980 , 119). Anglo-Scandinavian deposits almost invariably contain the woodworm beetle, and it remained constant into the medieval (e.g. The Bedern, York, Hall *et al.* AML 56-58/93) and post-medieval (e.g. Coffee Yard, York, Robertson *et al.* EAU 1989/12) periods, despite the greatly restricted fauna generally present in the latter period.

A. punctatum and *L. linearis* are capable of causing considerable damage to timber, although not in proportion to the paranoia that has been generated by the pest control industry! They were, however, most unlikely to have caused appreciable damage to any but (ironically) the best-constructed and longest-lived buildings in the past, fungal decay of timbers at ground level probably being the factor limiting the life of most (Hall *et al.* 1983b, 190; Kenward and Hall 1995, 722-3). Even in long-lived Roman, medieval and post-medieval buildings, it is likely that insects caused relatively little structural damage. Woodworm takes many decades to cause serious damage in large timbers, and the death-watch beetle (*Xestobium rufovillosum*), cause of much alarm to modern building conservationists, damages timbers immensely slowly and would rarely have concerned people in the past, except superstitiously (the adults knock their heads against the inside of the pupal cell, producing what is said to be a disturbing sound in a silent room). The death-watch is recorded consistently but rather rarely from archaeological occupation deposits (there was only a single record from Anglo-Scandinavian Coppergate, for example). Subjectively it was relatively more abundant in later times, and it may rarely have found suitable large, old timbers in the earlier medieval period.

Roofs and walls of post-and-wattle buildings at Coppergate are discussed by Kenward and Hall (1995, 732-33). Brushwood at this site may have originated as part of roofs, and there were hints of the use of turf (see p. 316).

Insects give evidence of other structural materials in addition to timber. *Gracilia minuta* is a small longhorn beetle which bores in fine twigs, and is well known from wickerwork (Duffy 1953, 195; Hickin 1975, 241). It is fairly often recorded from archaeological sites, and when it occurs in large numbers, as in one Anglo-Scandinavian pit fill at 16-22 Coppergate, York (Kenward and Hall 1995, 520), it probably indicates the presence of material such as basketwork. At the Coppergate site it occurred in 17 contexts, suggesting that it was well established in the town. At the Dominican Priory site, Beverley, there were again rather more individuals in some pit fills than might arrive by accident, one sample giving five (Allison *et al.* AML 21/90; 1996c). Another longhorn beetle, the attractively-patterned *Phymatodes alni*, is so frequently found in occupation deposits (e.g. 29 contexts at Coppergate, Kenward and Hall op. cit.) that it, too, surely must have lived in basketwork or, more probably, in wattle or light roof supports.

A range of invertebrates, especially insects, doubtless lived in thatch, of whatever kind. Many of these would have been as, or more, common in a variety of other materials, however. One possible way of recognising roof fauna might be through the recovery of 'smoke-blackened' remains, parallelling the smoke-blackened thatch found in numerous buildings (Letts 1999). Letts and Smith (1999) and Smith *et al.* (1999) have investigated insects from such material and other aspects of thatch fauna are discussed by Smith (1995; 2000b) and Smith *et al.* 2005.

Conditions within buildings

One of the most effective uses of invertebrate remains, particularly the beetles, is in reconstructing conditions within buildings. Their value lies in the wide range of species capable of exploiting the many kinds of habitats created by human life, combined with the fact that the animals concerned are not deliberately exploited by humans. If a community of insects requiring a particular habitat is present in the deposits formed on a house floor, then it is very likely that the habitat existed in the house (the main exception to this is the possible importation of earlier material to make up floors, which should be detected through careful excavation in most cases). If fauna from within a house can be identified, then conditions within the building, and something of its construction and use, can be determined. This section deals with structures whose primary use appears to have been for human domestic or commercial occupation; animal houses, particularly stables, are considered on p. 397.

House fauna

An extremely distinctive group of species has been repeatedly detected in house floor deposits, and for convenience (and despite the dangers of circular argument) this group is termed 'house fauna'. The Anglo-Scandinavian period at 16-22 Coppergate has provided classic examples of house fauna assemblages *in situ*, leading to the definition (Kenward and Hall 1995; Carrott and Kenward 2001), although the group had been published earlier, especially in the Tanner Row report, Hall and Kenward 1990, 398-9). Hall and Kenward (1990, 398) and Kenward and Hall (1995, 662-7) list the species regarded as house fauna for Roman Tanner Row and Anglo-Scandinavian Coppergate respectively, and results of species association analysis for the 6-8 Pavement and 16-22 Coppergate sites showed that these insects occurred together far more frequently than is possible by chance (Hall *et al.* 1983b, 213; Kenward 1982). More detailed analyses have served only to strengthen the association (Carrott and Kenward 2001), which can also be identified statistically, though with variations, at various other sites (Kenward and Carrott 2006).

Unfortunately, it appears certain that house fauna communities developed in structures used to house livestock as well as those used primarily by people, so that it is essential to determine which kind of use is represented. This is generally not too difficult since there is a characteristic suite of organisms which signal stabling (Kenward and Hall 1997), although there are cases where uncertainty remains (as for some of the deposits at Tanner Row).

House fauna *in situ* and redeposited

House floor deposits may be encountered *in situ* or as dumps, including into pits; in the latter case, it may be necessary to disentangle very mixed communities including post-dumping decomposer successions. *Aglenus brunneus* must be seen as part of house fauna (Carrott and Kenward 2001), but may in some cases be a post-depositional burrower (p. 476).

The typical house fauna group has now been recorded from many sites of most periods from the Roman onwards in many places, ranging from urban centres to small isolated settlements such as that at Deer Park Farms, Co. Antrim, N. Ireland (Kenward and Allison 1994a; Allison *et al.* EAU 1999/08; 1999/10; Kenward *et al.* accepted). There is, however, a very variable representation, whether direct or indirect, of floors in the archaeological record of the north of England through time and at different kinds of sites, and there are few data for the prehistoric period or for Romano-British settlements proper.

As mentioned above, Anglo-Scandinavian 16-22 Coppergate provided large *in situ* house fauna groups which were significant in defining this species association. Some of the Roman groups from Tanner Row seem to have fallen from flooring during demolition (Hall and Kenward 1990, 341, 357), but most were undoubtedly in dumps, probably of stable manure. At various sites house floor deposits are only represented through floor sweepings dumped into pits and middens, as seems to have been the case for medieval and post-medieval deposits at the Dominican Priory site, Beverley (Allison *et al.* AML 21/90; 1996c) and The Bedern, York (Hall *et al.* AML 56/93; 58/93). Large quantities of house fauna, presumably from floor clearance but perhaps sometimes introduced as residual material in backfills, were observed in some pit fills at Coppergate (Kenward and Hall 1995); outside the area being considered here, particularly characteristic house fauna groups, undoubtedly representing floor sweepings, have been recorded from pit fills in Winchester (Carrott *et al.* EAU 1996/20). Both floors and pits at 1-9 Micklegate, York, contained house fauna, remains in the latter presumably having been cleaned from the former (Kenward and Hall EAU 2000/14). Dumped material from within buildings may occur in other kinds of deposits: most of the 14th century waterfront dumps at Chapel Lane Staith (Kenward 1979c), for example, gave some house fauna elements, but this component was particularly strongly represented in one of them. The single assemblage of mid-later 14th century date from this site included enormous numbers of grain pests and a substantial house fauna. There were also foul decomposers and species which may have originated in hay, so with hindsight it seems possible that this deposit included stable manure.

It is sometimes suggested that floor deposits will inevitably represent abandonment or low-grade use (e.g. Matthews 1993), but the present author emphatically does not agree: such a view is too coloured by modern attitudes. Obviously, if floor layers do not include the litter accumulating during use they cannot provide evidence for human activity and living conditions. However, in a culture where organic waste was produced in huge quantities, and where floors were damp, there would inevitably have been an accumulation of biological (and other) remains on floors, even if they were occasionally swept or scraped off. The arguments have been rehearsed elsewhere (Kenward and Hall 1995, 725). Hall *et al.* (1983b) offered a model of the way mineral and organic material may have accumulated on Anglo-Scandinavian floors, which clearly shows how much debris may build up. Work on invertebrates from floors would benefit greatly from integration with other approaches and studies of modern parallels such as that of Macphail *et al.* (2004).

House fauna through time

Evidence for conditions inside **Roman** domestic buildings is often negative; we know that the buildings existed, but the lack of organic preservation strongly suggests great cleanliness. This cannot be confirmed until dumps of certainly-identified domestic debris are discovered; those deposits seen so far which contain 'house fauna' are far more likely to represent stable manure, the human ectoparasites found in them perhaps being from the unfortunates who lived with (and guarded) the horses.

At Castle Street, Carlisle (Allison *et al.* 1991a; b) a series of buildings was excavated, with floors which on the evidence of the insect remains varied from quite clean to fairly foul, with grain pests, foul decomposer beetles, and house flies, perhaps in a stable, at one extreme, to a fauna limited to small quantities of 'house fauna' at the other. In some cases the grain pests were predominant, although whether this indicated grain storage is not certain, and the rooms may only have held stock fed on grain. Human fleas (*Pulex irritans*), or unidentified remains probably of this species, were frequently recorded in the floors at Castle Street.

House fauna has been seen at some Roman rural sites; for example at Kingswood, Hull, Carrott *et al.* (EAU 1997/17) examined Romano-British deposits interpreted as ditch fills or river-edge accumulation, recording house fauna whose restricted range was perhaps indicative of isolation (cf Kenward 1997a).

For the **Anglian** period, evidence is extremely rare. One layer in one of the distinctive 'bell-shaped' pits at The Bedern may possibly have comprised material dumped from inside a building (Kenward *et al.* 1986b); a daring interpretation might be that the material was rushes (and similar plants) strewn on a floor and swept out after a sufficient interval for insects to have bred in it and corpses to have accumulated. No relevant material was recovered from the extensive excavations at Anglian Fishergate, York (Allison *et al.* EAU 1989/02; 1996b). Investigation of occupation deposits of this period with preservation by anoxic waterlogging is a priority.

The principal evidence for conditions within **Anglo-Scandinavian** buildings comes from the 16-22 Coppergate site, York (Kenward and Hall 1995), with less clear data from the nearby 6-8 Pavement site (Hall *et al.* 1983b; Kenward EAU 2000/39). Although there were strong similarities in their fauna, with classic 'house fauna' groups from both (e.g. Hall *et al.* 1995, 548, 593), the floors of the earlier, post-and-wattle, and later, timber, buildings at Coppergate had some subtle differences, not surprising in view of the differences in the structures in the two periods. The Coppergate floors were reviewed in some detail in the chronological text in the site report, but the synthesis (*loc. cit.*, 725-36) is of rather more interest. It was argued strongly on the full range of evidence that the 'floors' at this site were (in the main) genuinely the product of normal occupation, and not deliberate dumps or representative of abnormal use. The gross condition of the floors of both periods, indicated by the predominance of house fauna, was generally best described as rather damp, but certainly not wet. There were, however, some occasions when insects indicating rather more foul conditions became established, perhaps as a result of particular activities. In some cases, flies indicating very unpleasant conditions, including the housefly *Musca domestica* and stable fly *Stomoxys calcitrans*, occurred in substantial numbers in the post-and-wattle buildings (*loc. cit.*, 548, 564). The range of insects recorded suggested that it was cosy and well-sheltered within the structures. It was argued that the floors of the Period 4B post and wattle buildings were certainly domestic, the evidence including the presence of both human fleas and lice (see p. 68). The relative rarity of lice in the Period 5B floors, together with other evidence, perhaps suggested that the floor deposits represented workshops, and it is possible that if these buildings had any domestic function, then the occupants lived on a first floor. Human fleas were frequently recorded and sometimes abundant in floors of both periods at Coppergate, representing a minor nuisance which would have been unavoidable in houses of this kind.

The identification of 'floors' at the Pavement site (Hall *et al.* 1983b) was far less clear because of the small lateral extent of the excavated trenches and, although many of the layers probably formed during occupation, some may have been make-up and others external layers. It appears that conditions in the Pavement structures were rather as at Coppergate, perhaps with a greater tendency towards episodes of foulness.

The floors of some buildings in both main Anglo-Scandinavian structural phases at Coppergate had been cut into. In Period 4B there were large pits, one with fills containing abundant bees. In Period 5B there were gulleys cut into floors, one of them apparently having been used to dispose of waste water (Kenward and Hall 1995, 559), and another perhaps having been covered (and colonised by subterranean species, the 'post-depositional invaders', discussed on p. 476). The function of these pits and gullies is far from clear.

Floors of post-and-wattle buildings of the Anglo-Scandinavian period were revealed by excavation at the Queen's Hotel site, Micklegate, York, although there was only limited sampling. Field observation and assessment (Dobney *et al.* EAU 1993/22) suggested that they had a character rather like those at Coppergate and Pavement, and this was confirmed by analysis of the insect assemblages, which were typically rich in house fauna (Kenward and Hall EAU 2000/14).

Investigation of the range of conditions and uses of floors of this period clearly has much potential, and even in York there cannot be said to have been more than a brave start; should further examples be revealed, a far more intensive sampling strategy should be adopted in order to allow for spatial analysis and more significant comparison through time in single buildings and between buildings (p. 440).

Rather few examples of invertebrates from floors dating to the medieval period after the Norman conquest appear in the literature. The best examples are provided by early 14th century deposits at the Magistrates' Court site, Hull (Hall *et al.* EAU 2000/25; 2000/33). Here, in general, the evidence (both direct and indirect, from what was interpreted as domestic ejectamenta) suggested that floors were kept fairly clean, with rushes and perhaps other materials used as litter. This provided habitat for the larvae of fleas, both those of humans (*Pulex irritans*) and of dogs (*Ctenocephalides canis*); the former were abundant and latter were rather common. Records of human lice (*Pediculus humanus*) suggest at least some of the buildings saw domestic occupation. The spider beetle *Tipnus unicolor* was a significant component of the fauna, perhaps an indicator of long-lived buildings which were rather damp but of at least moderately good quality (p. 378). In some cases it was not clear whether house fauna originated in domestic buildings or from stables (house fauna in the latter is discussed on p. 397).

Carrott *et al.* (EAU 1995/03) reported on evaluation of a 12-13th century floor at Keldgate, Beverley. Insect remains were very fragmented and not abundant, although they appeared to have undergone little chemical erosion; this may have been a result of trampling or short-term wetting and drying of the deposit at the time of deposition. The few beetles were a mixture of species likely to occur in a building and outdoor forms. There were remains of at least four lice, probably the human louse *Pediculus humanus* (identification could not be confirmed within the time constraints of an evaluation). The evidence of insect remains was thus consistent with the archaeological identification of this context as a floor, the lice strongly suggesting domestic occupation. The rather small number of domestic insects indicates that the structure was kept clean. However, it was suggested that a substantial proportion of the biological remains originated with the mineral sediment, perhaps at least partly as 'trample'. A second floor deposit at this site also included few insects, whose implications were even less clear.

There is some secondary evidence for conditions within buildings from what is believed to be material ejected from their floors. Some of the pit fills at The Bedern, York (Hall *et al.* AML 56-58/93) gave assemblages including small amounts of 'house fauna'. This may have been from stables in some cases, but in others was regarded as representing floor sweepings from rooms occupied by humans. There were small numbers of human fleas, and the spider beetle *Tipnus unicolor* (p. 378) was fairly common; conditions seem to have been rather clean.

There is a little evidence for conditions in medieval buildings from other localities in the north of England. Well fills of 12th-13th century date at the Old Grapes Lane A site in Carlisle (Kenward *et al.* AML 78/92; 2000) produced a classic house fauna group including the human louse and abundant *Aglenus brunneus*. In Whitby, the fauna of 13-14th century occupation deposits at 63-64 Baxtergate (Hall *et al.* EAU 1993/26) showed a strong human influence, and included some 'house fauna' groups. Human lice were present, and in one sample both adults and nymphs were abundant. *Melophagus ovinus* and *Damalinia* sp. were found together, and there were traces of heather-associated insects, adding up to a fauna which would not have been out of place in Anglo-Scandinavian or immediately post-conquest York. Fills of the 14th century moat of the manor house at Cowick, East Yorkshire (Girling and Robinson 1989) yielded what appeared to be a restricted house fauna, with *Anobium punctatum*, *Mycetaea hirta* and numerous *Tipnus unicolor*, suggesting an origin in a building of rather high quality.

Perhaps unexpectedly, substantial numbers of samples from occupation floors of the **Post-medieval** period have been examined, at least at the evaluation level. Many of them have proved barren, however, the North Bridge site in Doncaster providing examples (Carrott *et al.* EAU 1997/16; Hall *et al.* 2003c). There were some clear house fauna groups in pits of mid-late 14th to early 17th century date at The Bedern, York (Hall *et al.* AML 56-58/93), presumably introduced in floor sweepings and giving hints as to conditions indoors. These assemblages were notable for the importance of *Tipnus unicolor*, a species which appears to typify urban buildings in the post-medieval period (p. 378). Grain pests were also consistently present, with *Sitophilus granarius* more important than is usual in archaeological deposits in relation to the other grain pests (p. 342). At the nearby Coffee Yard site (Robertson *et al.* EAU 1989/12) there was a very restricted fauna in deposits of the late 14th to 16th centuries, again with *T. unicolor* as a conspicuous component, the only other particularly abundant species being *Sitophilus granarius*, *Aglenus brunneus*, *Oryzaephilus surinamensis*, *Ptinus fur* and *Anobium punctatum*. Here too, *S. granarius* was the most numerous grain pest, while *Cryptolestes ferrugineus* was absent. Conditions must have been very clean in the rooms represented by these remains. Evaluation at St Andrewgate, York (Carrott *et al.* EAU 1993/02) revealed a15th/16th century layer, probably a floor, with typical occupation site insects and a human flea; lack of funding meant that this was a lost opportunity to carry out detailed analysis of a rare late floor with good preservation.

The progressive restriction of the range of insects associated with houses over the past millennium is a fascinating story, which continues to the latter half of the present century, when most of the species found previously were eliminated by improvements in housing quality, especially by central heating and vacuum cleaners. It is to be hoped that it will be possible to amplify it through investigations of further sites, and to extend it back into the previous millennia. How early did the house fauna association develop, for example, and were elements of it imported aliens?

How open were buildings?

In theory the quantity and structure of outdoor background fauna in floor deposits might be expected to give clues as to how open structures were, following arguments presented by Kenward (1985a), but there is a huge problem in determining how outdoor remains entered structures. It was formerly considered that the presence of large numbers of certain waterside staphylinids was evidence of an open structure, the insects drifting in as they migrated in swarms, but (however improbable it may appear) these beetles now seem certain to have lived in the buildings (see e.g. Kenward and Hall 1995, 733).

The large quantity of highly comminuted outdoor remains found in some Anglo-Scandinavian floors at 16-22 Coppergate, York (Kenward and Hall 1995, 736) seem unlikely to be background fauna in the strict sense, and perhaps were imported in materials of some kind or had filtered from roofing (see below). Very restricted faunas in floors may, however, stand as evidence of a firmly closed structure (e.g. the wooden store building with abundant grain pests at Coney Street, York, Kenward and Williams 1979).

Invertebrates and the function of buildings

Invertebrates can provide information about the conditions within buildings, which clearly has implications for their probable function, as stables, or as primarily domestic or industrial for example. Other evidence may be obtained concerning a range of activities within structures. Various aspects of this are covered above and under other headings, particularly craft and industry (p. 361) and stabling (p. 397). This is an area of investigation where the integration of multiple lines of evidence is particularly important - illustrated at the site level by work at North Bridge, Doncaster, for example (Carrott *et al.* EAU 1997/16; Hall *et al.* 2003c), and at a more general level by the identification of stable manure (Kenward and Hall 1997).

Fragmentary 'outdoor' fauna in buildings

It has been suggested that the very fragmented remains of 'outdoor' insects found in floor deposits of some of the houses at 16-22 Coppergate, York, may have originated in predator droppings (Kenward and Hall 1995, 550-557, discussed 736), although other mechanisms were thought possible. The writer currently favours an origin in turf in roofs as the most probable, the cycles of changes in moisture status and the action of scavenging insects gradually reducing the corpses in turf to minute particles small enough to filter down as dust. If this explanation is correct, there should be parallel evidence from fragmenting plant remains, and we may have a much-needed tool in the difficult campaign (conceptually) to reconstruct ancient roofs. Other explanations should not be ruled out, however. Bats reduce insect cuticle to minute fragments (e.g. Swift *et al.* 1985, and author unpublished), and commensal rodents may do the same. Parallel assemblages with comminuted outdoor fauna have been observed in a Viking-Age workshop at Viborg, Denmark (Kenward CHP 2005/04; 2005b).

Tipnus unicolor: a spider beetle of archaeological distinction

The spider beetle *Tipnus unicolor* has a special place in a discussion of house fauna, both because it varies greatly in abundance through time and because it seems to be an indicator of a particular kind of building. *T. unicolor* is a member of the family Ptinidae, a group commonly called spider beetles because of the superficial resemblance of most of them to small arachnids. Its modern biology and place in archaeology were reviewed by Kenward *et al.* (EAU 1995/46; 2000c), whose account is summarised below. The 'white-marked spider beetle', *Ptinus fur*, is a second species which is extremely common in archaeological occupation deposits of all kinds and periods, while a third, the 'golden spider beetle' *Niptus hololeucus* (p. 280), may be a recent importation despite having occasionally been recorded from samples from earlier deposits. There are also records of *P. raptor* from 11th century occupation deposits at Viborg, Denmark (Kenward CHP 2005/04; 2005b).

T. unicolor is often present in insect death assemblages recovered from archaeological sites in Britain, occasionally forming a substantial proportion of the fauna (e.g. in the fills of the Roman well at Skeldergate, York, Hall *et al.* 1980; in deposits formed in a medieval building at Coffee Yard, York, Robertson *et al.* EAU 1989/12; in a medieval barrel-well at Worcester, Osborne 1981; at Shrewsbury Abbey, Smith 2002; and in deposits in a post-medieval high-status building at Drum Castle, Kenward *et al.* EAU 1995/46; 2004c). There are marked inter-period differences in its abundance, however, for *T. unicolor* is frequent in Roman and later medieval (post-Conquest) assemblages, but barely known from the intervening periods. This time distribution may have considerable importance in relation to changing urban conditions, and conversely the beetle may be a significant indicator species, though perhaps limited by difficulties of colonisation. The species is regarded as a typical component of 'house fauna'.

T. unicolor is rather common in Roman deposits in York. It was abundant from the mid second century onwards at Tanner Row (Hall and Kenward 1990 and unpublished database), and in the (probably 4th century) fills of the well at Skeldergate (Hall *et al.* 1980). These observations from Roman (and post-Conquest, see below) deposits contrast strongly with the rarity of *T. unicolor* at Anglo-Scandinavian sites, typified by 16-22 Coppergate, where there were insignificant numbers, and it was not always wholly certain they were not contaminants of some kind (although in one case the records suggest it lived at the site, Kenward and Hall 1995, 520). It was concluded that 'the beetle may have maintained a small, diffuse population in the town, but remained rare because there were few long-lived structures of the kind preferred by this species.' It appears that *T. unicolor* is generally a good indicator of long-lived high status buildings, and that the proportion of this species increases with general cleanliness; this is parallelled by the increasing importance of *Sitophilus granarius* in the 500 or so years up to the mid 20th century, discussed on p. 342. *T. unicolor* occasionally became established on more humble (and isolated) sites (e.g. at Deer Park Farms, Co. Antrim, Northern Ireland (Allison *et al.* EAU 1999/08; 1999/10; Kenward and Allison 1994a), where, however, the numbers were fairly small (less than 1% of the individuals); other components of the fauna at this site strongly suggest continuity over a very long period of time, perhaps providing the poorly-dispersing *T. unicolor* the opportunity to arrive and survive.

The beetle's fortunes were apparently restored dramatically following the Norman Conquest. An evaluation of a site behind Spurriergate, York, gave a record of abundant *T. unicolor* in deposits which appeared to have been formed very soon after the Conquest (Hall *et al.* EAU 2000/80; further work on the samples from these deposits is highly desirable). It is known from many sites of the later medieval and post-medieval periods, for example at 16-22 Coppergate (late 14th century: Hall and Kenward EAU 1999/27), c. 14th century 41-49 Walmgate (Jaques *et al.* EAU 2001/26) and Hungate (14th-15th century: Jaques *et al.* EAU 2000/29). It was well-represented in post-medieval deposits at Coffee Yard, York, where it was the most abundant beetle (17% of all individuals, Robertson *et al.* EAU 1989/12), and at nearby site at The Bedern, where it occurred regularly and sometimes in considerable numbers (5% of individuals, Hall *et al.* AML 56-58/93). It was by far the most abundant strongly synanthropic beetle recorded from post-medieval deposits at the North Bridge site, Doncaster (Carrott *et al.* EAU 1997/16; Hall *et al.* 2003c; Kenward *et al.* 2004a). Elsewhere in the region there are (for example) records from the Dominican Priory, Beverley (Allison *et al.* 1996c), where two were noted from a ?12th century pit fill, from Morton Lane, Beverley (Kenward and Carrott PRS 2003/58), and from Scarborough, where Hall *et al.* (EAU 1996/35) found it in medieval ?floor deposits at 23 Quay Street. Miller *et al.* (1993) noted it from 15th century pits at Mytongate, Hull, and it was present in rather large numbers from fills of the medieval moat at Cowick, East Yorkshire (Girling and Robinson 1989).

Remarkably, and in contrast to its abundance at York, early analyses of a very large number of Roman deposits in Carlisle and at Ribchester have given only two or three records of single individuals, although rather more were found in the 'Lanes 2' sites (Kenward *et al.* EAU 1998/32), perhaps hinting that it was under-recorded at other sites. A small number of samples from Papcastle also failed to produce the beetle. Why it should have become an important component of the urban fauna in York and not in all of these sites in the north-west demands explanation. Differences in climate seem most unlikely to be the cause since it was abundant at Drum Castle, Aberdeenshire (Kenward *et al.* EAU 1995/46; 2004c) and at the Irish Deer Park Farms site mentioned above, and is known in the wild in Scotland (see below). Perhaps some difference in supply routes to Yorkshire and to the North West meant that the beetle was carried frequently to the former, and thus able to establish, but only rarely to the latter; certainly it reached isolated settlements in Yorkshire (e.g. the villa at Dalton Parlours, Sudell 1990). The establishment of organisms in new areas is poorly understood, and by no means simple; the current state of knowledge is usefully summarised by Williamson (1996). The beetle managed to get to Iceland, where it seems to have exploited drier habitats, perhaps primarily human living quarters rather than stock buildings (Amorosi *et al.* 1994; Buckland *et al.* 1991).

Although widespread in distribution *T. unicolor* does not appear to be very common in nature and is chiefly found in association with man. Fowler (1890), summarizing records in the late 19th century, also regarded it as '...local and as a rule not common.' In Britain it appears to be commoner towards the North and there is evidence that it prefers fairly low temperatures (Howe 1955). In Scotland it occurs in the open at least as far north as Angus (Crowson, *in litt.*). In association with people, it has been found in vegetable refuse and sweepings from buildings (Lindroth 1931, 226-7), in mixed cereal and other debris, and grass seed spillage (O'Farrell and Butler 1948, 361). Although favoured by access to free water (Hunter *et al.* 1973) and found especially in damper situations in warehouses, where it may be one of the commoner spider beetles, it is not found in obviously wet or rotten material but in mouldy damp debris (O'Farrell and Butler, *loc. cit.*). It is hard to believe that the beetle would have lived in a cesspit, as suggested by Osborne (1981); specimens in such situations are considered by the present author to be likely to be strays from the closet above in the case of latrines, or introduced in floor sweepings, a view shared by Girling and Robinson (1989).

While the great majority of published modern records are indeed from indoors, *T. unicolor* certainly does occur in the open. Records from natural habitats are rare and mostly uninformative, offering no clear evidence as to its original habitat or way of life. Fowler (1890) gives '...in old wood etc., occasionally found in birds' nests'; and Joy (1932) '...among old wood'; Hinton (1941) records specimens taken from the nests of house martins (*Delichon urbica*); Linsley (1944) states that it occurs in the nests of house martins and other birds, and classifies it as having both bark and decomposing wood habitats and the nests and food caches of birds and mammals as its possible natural reservoir; Palm (1959) also refers to its occurrence in old birds' nests in hollow trees. Woodroffe (1953) failed to find it in his investigations of birds' nests as a source of pest species, however.

A modern and well authenticated record is given by Crowson (1972), who collected *T. unicolor* in hanging oak woods at Gledswood, Berwickshire. Crowson (*in litt.*) amplified this record and commented '...the species is one I have found in many open air sites in Scotland, but all of them fairly close to human occupation sites. Its basic requirement seems to be accumulations of dryish organic matter, protected from heavy rain soaking - commonly inside old hollow trees, under rock overhangs, etc.' Ironically, this unpublished record is probably one of the most useful indications as to its synanthropic habitats in the past - in fairly dry litter and rubbish in roof spaces, wall cavities, and the less disturbed corners of floors, of stables as well as domestic and store buildings, where it probably found many suitable slightly damp corners with a little litter. The beetle is doubtless primarily an omnivorous scavenger, although there are hints that it can exploit discrete, probably fairly dry, animal droppings (O'Farrell and Butler 1948, 361), and a review of its biology suggests that it is unlikely ever to be more than a minor pest, perhaps being best regarded as a commensal.

Niptus hololeucus*: the golden spider beetle*

Another 'house fauna' species, this spider beetle is rare in the archaeological record but nevertheless deserves discussion. There are records from Roman and other pre-modern deposits in Britain and Germany (Buckland 1976a; d; 1990; Koch 1970; 1971), but some of these appear to relate to contexts where there was clear evidence, or at least a distinct possibility, of recent contamination. The record given by Roeder (1899) is perhaps suspect, too, in view of its antiquity and subsequent nomenclatural changes. The beetle's biology and possible geographical origins are discussed by Howe and Burgess (1952) and Buckland (1976d). It is common today and particularly likely to occur as a contaminant in archaeological samples which have been stored poorly sealed (e.g. in polythene bags) since it is often found in the sort of building typically used for sample storage; the author has noted several such contaminants.

It may be that *N. hololeucus* was only brought to Britain in the past few hundred years, specimens from archaeological contexts being contaminants. Alternatively, as appears to have been the case for the grain pest taxa (p. 342), it may have been introduced on more than one occasion, starting in the Roman period, and only have become firmly established in modern, often permanently, heated buildings. This view is supported by a record from late 13th/early 14th century Kingston upon Thames, although the presence of *Pentarthum huttoni* (supposedly an Australasian species) suggests the possibility of later intrusion (Allison 2003). Records of numerous individuals from securely dated and sealed Roman deposits would allow the early introduction to be accepted, though whether or not it later became extinct rather than just very rare would be hard to establish. There are several records of *N. hololeucus* from deposits of mid 17th century or later date at The Bedern, York, where it was found in company with the bedbug, *Cimex lectularius*, and an unidentified cockroach, so it appears to have become well established by this stage. From Germany there are records of the golden spider beetle from the 15th-16th century (Cymorek and Koch 1969).

Clearly house fauna presents many problems for future research as well as being a very characteristic and significant association for interpretative purposes. Similarly, the reconstruction of conditions in, and use of, buildings offers stimulating challenges.

Open-air habitats on occupation sites

It is important to draw a distinction between conditions in open areas such as yards, gardens and streets, where people would normally be experiencing the environment directly as they went about their daily lives, and those in or those used exclusively for waste disposal or livestock penning, where rapid accumulation of organic matter might favour preservation but which people might avoid. This section deals primarily with the former; the latter are considered on p. 407.

Yards and other open areas: weeds, livestock and disturbance

Reconstruction of conditions and activities in yards and other open areas by any means presents considerable difficulties. Soils will have been disturbed, and any plant remains may have been imported for a variety of reasons and by various routes. Invertebrates may thus represent the best hope for ecological reconstruction. The deposits formed on the external surfaces themselves may be of little value in this respect (although they may be important for wider reconstruction where there is good preservation). In many cases there appears to have been much dumping, which introduced a wide variety of remains from elsewhere. Open areas were likely to be rather dry and well-drained, often disturbed by human activity or by livestock, particularly chickens and pigs, so that there was strong decay of biological remains, making preservation unlikely.

Remains of value in reconstructing surfaces are thus more likely to be found in pits and other cuts, although under some circumstances there may be surface preservation. The Anglo-Scandinavian material at 16-22 Coppergate (Kenward and Hall 1995) provides a good case in point, but while surface deposits contained larger numbers of well-preserved insect (and other delicate) remains than is the case at most sites, it was rarely clear whether they had originated *in situ*. Indeed, the presence of distinct house fauna assemblages here and there in surfaces strongly indicated dumping from within the nearby buildings, and botanical evidence showed that some layers were rich in dyeplant waste. It did appear, however, that the concentrations of fly puparia found here and there in surface layers had developed where they were found, indicating patches of very foul material, and rarely there were beetle communities suggesting rather longer-lived rotting matter. Certain insects associated with weeds were considered too abundant in the assemblages from the site as a whole to be present by accident (op. cit., 654), and it seems that some plants, particularly crucifers and nettles, were able to survive. Shells of snails, mainly the large garden snail *Helix aspersa*, were found rather often at Coppergate and although some were undoubtedly of modern origin (op. cit., 472, 526, etc.), others appeared to be ancient, supporting the hypothesis that disturbance did not completely sterilise the yard areas. In general, though, disturbance seems to have been intense, not least by the digging of pits and ditches and by dumping.

In many cases we are thrown back on cut fills as the only source of information about surface conditions. This means it is necessary to attempt to determine the likely origin of the various components of what are often very complex assemblages from the fills of wells, ditches and pits, a strong motivation to develop more powerful methods of analysis. Pits in some cases may be rather effective in sampling the fauna of the immediate surroundings (up to a few metres), though not quantitatively; if there is water in them, small or inept species may land on the surface by accident and be trapped, while larger walking insects may fall in and drown. The 'pitfall' effect appears to have operated for some Anglo-Scandinavian pits at 16-22 Coppergate (Kenward and Hall 1995, 567-8, 614, 627) and medieval wells at Annetwell Street (Large and Kenward EAU 1987/15). Wells, it is suspected, are likely to provide a very biased sample of invertebrates from adjacent surfaces through gradual accumulation (as opposed to dumping). If the well is in good condition, with its mouth properly protected, only flying insects and those tending to climb the barrier and fall in are likely to be preserved; if there is access at ground level, there will be a tendency for the larger ground-dwelling forms to be over-represented. This is not to say that wells should not be investigated, for they may provide the only good sample of the invertebrate fauna living at some sites (p. 464).

There is inherently a particularly strong bias against the existence of a fossil record for surfaces in cleaner, drier places in Roman (and other) towns. Preserved remains in such sites may often represent atypical circumstances; there is always a danger of misinterpretation consequent upon over-representation of foul conditions for taphonomic reasons. However, the earlier phases of Roman Carlisle have produced examples of surface preservation in what are interpreted as open areas. At Castle Street (Allison *et al.* 1991a; b), for example, there was a low background level of parasite eggs and occasional indications of foul conditions from populations of beetles and houseflies in deposits formed on external surfaces.

Sometimes Roman cut features have provided a sample of fauna (and, usually to a lesser extent, flora) of the surroundings when there is no surface preservation. The fills of the Roman well at Skeldergate, probably deposited in the fourth century, seem to have included debris from surrounding surfaces indicating a yard or garden which was run-down but not filthy, although these fills were clearly mixed (probably including various dumps and a component which entered during use), and therefore difficult to interpret (Hall *et al.* 1980). Early to mid third century dumps in the well at The Bedern seemed to have included material cleared from the adjacent rampart, although this conclusion seems a little less certain with hindsight (Kenward and Hall 1997 and chronological section). In many cases, however, Roman urban occupation appears to have lead to sterilisation of the surfaces, presumably as a result of low input of organic matter and organised cleaning and waste disposal; sites in the Fortress in York illustrate this well (p. 157), and the same phenomenon was observed at Carlisle in the later Roman phases (p. 158). We may find surface preservation in such areas only through rare events such as the deposition of clay layers (parallelling that at Coney Street, York, Kenward and Williams 1979).

For the Anglian period, some evidence concerning conditions in open areas near to the heart of York may be provided by the fills of the pit from which the Coppergate Anglian helmet was recovered and some further pits at The Bedern, and there is limited evidence from Fishergate, further out from the present centre of the city. Extensive investigations of the deposits at Fishergate (Allison *et al.* EAU 1989/02; 1996b) gave almost no evidence of preservation by anoxic waterlogging. It was suggested that this was a result of low input of organic matter, indicating cleanliness in what must have been a somewhat damp area in which organic accumulation might have been expected. The cut containing the Anglian helmet (Hall *et al.* 1992) appeared likely to have been a well, and the biota suggested open disturbed ground with annual and perennial weeds, plant litter, and perhaps dung. These remains may have been of Anglo-Scandinavian date, however. The 16-22 Coppergate site gave no biological remains which could be dated with certainty to the Anglian period, and certainly no organic accumulations of that date. This has been regarded as strongly suggesting that the area was at most used for horticulture and possibly essentially abandoned, but the Fishergate evidence rather perturbs this argument. The pits at The Bedern gave indications of damp weedy waste ground, but interpretation was rather problematic (Kenward *et al.* 1986; see also p. 197).

While the open areas at 16-22 Coppergate appear mostly to have been sterilised by intensive use during the **Anglo-Scandinavian** period (see above), there is a little evidence that at some stages there was development of more stable vegetation to the rear of the site, effectively in the same area as the helmet pit (Kenward and Hall 1995, pp. 614 and 625). The precise usage of this area between the rear of the tenements and the River Foss is uncertain, as is whether it was part of the tenements or was a separate property, but animals may possibly have been kept in it and maintained a short turf by grazing. The lowest and uppermost parts of the succession in one of the trenches at 6-8 Pavement, York (Hall *et al.* 1983b) were thought perhaps to have been external deposits on the evidence of the plant remains, but this was not clearly supported by the insects. In the assemblages as a whole from Pavement (listed by Kenward EAU 2000/39), there were rather few phytophages likely to have originated in yards and alleyways, other than crucifer and nettle feeders, and even these were present only in small numbers. Nothing suggested the presence of livestock at the site with any certainty.

There were frequently small numbers of parasite eggs in surface layers at 16-22 Coppergate (Kenward and Hall 1995), but these seem as likely to have been redeposited from earlier pit fills as to represent direct contamination; the presence of appreciable quantities of faecal concretions seems to support this. Indeed, the prevailing impression is that parasite eggs are rarely abundant except in pits, although there are numerous records of traces of eggs in surface deposits (for example at Coppergate, and in rubbish deposits of ?14th century date at High Street, Hull, Carrott *et al.* EAU 1994/49).

Was there cultivation in Anglo-Scandinavian towns? This topic has been reviewed for York by Hall and Kenward (2004). There was no evidence to indicate 'vegetable plots', although it is uncertain how visible these would be. There may have been a few fruit trees on the tenuous evidence of records of the small bark beetle *Scolytus rugulosus*.

Although there seems to have been a gradual trend **after the Norman Conquest** towards greater cleanliness in towns, yards continued to be used for waste disposal. Presumed yard deposits, cut by a series of pits, of 11th-13th century date at 44-5 Parliament Street, York (Carrott *et al.* EAU 1995/08; Carrott *et al.* EAU 1996/15; Davis *et al.* 2002) gave a mixture of typical urban insect species associated with decaying matter ranging from dry to very foul, with some aquatics and open-air species which may have lived on weeds on the site. There were indications of stable manure and other waste material. One pit fill indicated (from aquatic insects and *Daphnia* ephippia) temporary open water (or, with hindsight, perhaps waste water, see p. 321). Parasite eggs (mostly small numbers of *Trichuris*) suggested contamination by human faeces, perhaps as a primary component in some cases in view of evidence from plant remains. Yards at the Swinegate site also gave evidence of foul matter on surfaces (Carrott *et al.* EAU 1994/13).

The existence of 'open spaces' in the modern sense in towns of any period is not established. It was suggested that the 'hay' and dung component in the fills of the Roman well at The Bedern, York, reflected the vegetation of the nearby banks of the fortress walls, and a detailed reconstruction was ventured (Kenward *et al.* 1986b, 260-2), but this view is perhaps now less tenable (see above).

Pits and the conditions within them

Whatever the state of yard and other surfaces associated with occupation, there is clear evidence from a range of sites that pits cut into the yards often had extremely foul contents which were left exposed for long periods. These are considered in the section dealing with waste disposal (p. 407), but some aspects are mentioned here since pits were often close to houses and in areas which surely were used for a range of purposes; they were thus part of the immediate living environment of many people.

Many urban pit fills seem to have consisted of miscellaneous rubbish or backfill from surfaces nearby (e.g. some of those described by Kenward and Hall 1995, 580). Many other pits were clearly cesspits, in which conditions appear to have varied greatly between and within cuts. In some cases large populations of a wide range of insects developed, and these fills, although perhaps foul, may have been rather like compost. Others had a more specialised foul-matter fauna (again Coppergate has provided excellent examples). In addition to the beetles, most pit fills supported modest to large populations of immature flies. Remains of larvae and pupae of Nematocera have often been found, probably indicating very wet conditions, but insufficient attention has so far been paid to the identification of such remains. This is particularly reprehensible since, in addition to their value in ecological reconstruction, some of these flies have direct impact on humans through their nuisance value in biting or swarming. Many fly species are represented in pit fills by their puparia. Anglo-Scandinavian pits at Coppergate, for example, sometimes produced enormous numbers. The housefly (*Musca domestica*) was among the most abundant, indicating fermenting, dung-like material; in some cases it was accompanied by the stable fly *Stomoxys calcitrans*, and more rarely by *Muscina stabulans*, both requiring rather similar conditions. Even more foul fills are believed to be indicated by various Sphaeroceridae, among which *Thoracochaeta zosterae* probably represents an extreme of tolerance (see p. 71). Some of the pit fills at Coppergate were thought to be so foul that they could not be colonised by beetles, only a very restricted range of specialised flies being able to exploit them.

Where large populations of insects had been able to develop, it is likely that pit fills had been exposed for a considerable period, and thus acted as a source of infection by bacteria, viruses and parasitic worms. Such issues are discussed by Kenward and Large (1998b), who suggest that emigrating insects may have carried with them a range of pathogens (and other organisms: see for example Milliger *et al.* 1971).

That 'compost' and foul-matter fauna are recorded from pit fills is not surprising, although still interpretatively valuable. Rather less expected is a range of species associated with waterside mud. At Coppergate, waterside *Platystethus* species (particularly *P. degener* (often recorded as *P. cornutus* group) and *P. nitens*) were frequent and sometimes abundant in pits, presumably exploiting conditions chemically and physically resembling the organic-rich mud which seems to be their typical habitat today (Kenward and Hall 1995, e.g. 523; Hammond 1971); there were also various other related oxyteline rove beetles, and *Neobisnius* sp. often occurred with them; together these taxa have been tagged the 'oxyteline association'. This transfer to an artificial habitat parallels that by some other waterside oxytelines, such as *Carpelimus* species, which were able to thrive in house floors (p. 391). *P. degener/cornutus* group and *P. nitens* were each present in over a quarter of the assemblages from Coppergate, and in most of the larger ones. Clearly these species often gained a foothold in pit fills, or perhaps in the walls of the cuts where the fills were too liquid or unstable. The idea that the records of these *Platystethus* species were mainly of background fauna (Kenward 1978a, 7 and table 1) is perhaps appropriate in the case of floor and some other deposits, but is certainly not tenable for all pit fills. *P. nitens* was abundant in some contexts at the Blanket Row and Magistrates' Courts sites, Hull (Carrott *et al.* EAU 2001/12; Hall *et al.* EAU 2000/25; 2000/33), where it was presumably exploiting mud-like organic matter.

When analysis of pit fills is used to reconstruct conditions within the pit it is important to recognise that there may be considerable variation within and between fills and that time successions are represented. Various examples of such variation were observed at Coppergate, where a deliberate attempt was made to determine how representative single fills were of the contents of a pit as a whole (e.g. Kenward and Hall 1995, 514-21; 567, 576). A review of all layers is recommended, followed by detailed analysis where required. In addition, it may be that the current sampling strategy for pit fills, concentrating on obtaining pure samples of individual contexts, is inadequate since populations of insects are likely to have developed near the surface of layers which were exposed for long periods; it may be necessary to sample at context interfaces, too (see p. 440). Lastly, it should be remembered that where surface preservation is limited, pit fills may be the best, or only, source of evidence concerning surrounding living-surfaces, even though recovering this information will mean disentangling the fauna of the pit itself from that which has arrived from elsewhere.

Aquatic habitats on occupation sites

This section is concerned with the exploitation of aquatic habitats on true occupation sites by invertebrates, and not with riverside, ponds or defensive ditches, in which large numbers of a wide range of aquatics may occur. Invertebrates will be better than plants for detecting short-lived aquatic habitats, because insects in particular can invade in hours and days and many invertebrates can reproduce in days or weeks, while water plants invade much more slowly and typically take far longer to produce preservable remains (usually propagules). In addition, some invertebrates can withstand a great deal of disturbance, at a level which would inhibit the growth of plants and which would certainly prevent the development recognisable plant communities. Insects are also useful for detecting wet mud; a range of species adapted to it colonised occupation sites in the past, notably some *Platystethus* (*P. nitens*, and *P. cornutus* group, usually represented by *P. degener*). Organic-rich mud of various kinds, often in pits, probably supported the 'oxyteline association' in many cases (see above). Of the aquatic vertebrates, fish and mammals are hardly likely to have found suitable habitats in pits, drains and puddles, and the amphibians are so migratory and so nearly terrestrial as to be almost irrelevant.

Experience in mosquito control in warmer climates has shown the importance of very small bodies of water for invertebrates - discarded pots and tins, for example, can support populations of biting flies. Such habitats may have been present in early settlements, but it is suspected that the waste disposal system, and high value of any containers, would have made them of marginal importance. An exception may have been horse troughs, while hoof-prints provide another habitat for some species (e.g. Downes 1950).

Transported aquatics

Aquatic invertebrates, particularly insects, are found in small numbers in a very large proportion of assemblages from deposits of all kinds, and waterside species are typically present in at least traces. The presence of aquatic and aquatic-marginal species in occupation deposits does not necessarily prove that their habitats were present *in situ* or close by, since such species may be abundant in the insect background fauna (Kenward 1976a, 11; 1978a, 45), are common in clearly terrestrial deposits (e.g. at 16-22 Coppergate, Kenward and Hall 1995, 678-80), and are likely to be imported in water (e.g. perhaps at Coppergate, op. cit., 596, and Swinegate, Carrott *et al.* EAU 1994/13) or other material such as peat (e.g. the Roman well at Skeldergate, Hall *et al.* 1980), and dung and cut vegetation (Kenward and Hall 1997). These methods of introduction have been fairly well elucidated for insects, but aquatic and marshland snails are also likely to have been imported on occasion; records of such snails from Coppergate, York and the Dominican Priory, Beverley, seem to testify to this (Kenward and Hall 1995, 678-80; Allison *et al.* AML 21/90; 1996c). Aquatic insects were abundant, and *Daphnia* and ostracods present in appreciable numbers, in two samples from a fill of a pit dated 15th century at Morton Lane, Beverley (Kenward and Carrott PRS 2003/58), suggesting that the pit held water, but the possibility that waste water was directly or indirectly disposed of into it has to be entertained. A 12th-14th century floor deposit at Castle Street, Hull, contained numerous *Daphnia* ephippia and statoblasts of *Lophopus crystallinus*, presumably from spilled water or imported in waterlain sediment.

Aquatic insects often seem to be background fauna. *Helophorus* species in particular are well known as ready migrators (e.g. Kenward 1978a, 5), but most water beetles and bugs fly, and any small water body will soon be colonised by them when the weather is suitable for flight. *Helophorus* spp. are extremely common in archaeological deposits, and *Ochthebius* spp. (often *minimus*) and *Agabus bipustulatus* are very frequently noted (the first and last being recognisable at least tentatively from very tiny fragments of elytron). It would clearly be worthwhile to attempt to determine by analysis of the available records whether there is an obvious relationship between the (supposed) nearness of aquatic habitats and the numbers of aquatics in likely background components of archaeological assemblages, and work on death assemblages in relation to modern habitats would be useful.

It is not certain which insects were the typical colonisers of urban pits and pools, as opposed to accidental arrivals in background fauna (or in imported water or in the guts of animals, see p. 403), but the taxa just listed sometimes occur in more than ones and twos, perhaps suggesting that they managed to establish populations and indicating fairly long-lived bodies of water (e.g. in some pits at the rear of the 16-22 Coppergate site, Kenward and Hall 1995, 627). The quality of such water would not need to be too good for at least limited colonisation, although excessive organic pollution (e.g. by faeces or dyeplant waste) would not be tolerated by true water beetles and bugs (as opposed to foul-matter species tolerant of waterlogging). The immature stages of some flies may be excellent indicators of aquatic habitats, but most are too rarely identified for a useful body of evidence to have accumulated. It is not uncommon for remains of abundant immatures of nematoceran flies (the group including midges and mosquitos) to be found, and their identification is a priority. While some may be of species able to live in damp soil, others may be aquatic; records of biting forms would be an indication of a minor nuisance suffered by the human occupants of a site, and the recognition of malaria vectors would be noteworthy, even though not proof that the disease was endemic. Among other flies, there are frequent records of the respiratory processes of larvae of 'rat-tailed maggots' (almost always *Eristalis tenax*, it appears, F. Large, pers. comm.), and these are of some interest in that these insects are extremely tolerant of pollution, offering evidence of a type of habitat which is indicated by few other organisms and of considerable interest in building up a picture of human living conditions.

A special class of aquatic organisms encountered on occupation sites is the halobionts - those adapted to saline conditions. They are discussed on p. 297.

Daphnia ephippia (and some other water flea resting eggs) occur in many deposits (see p. 387), some of them apparently formed on surfaces. Quite probably some of these water fleas had colonised clean water in pits and puddles, but others were doubtless imported with water brought from rivers or wells. Others may have arrived in the guts of livestock (p. 321). A surprisingly large number of the deposits of medieval date from Swinegate (assessed by Carrott *et al.* EAU 1994/13) contained at least a few, and sometimes very many, resting eggs (ephippia) of Cladocera. At least three kinds were present, and a few deposits also contained water beetles in numbers subjectively a little too large for them to have arrived accidentally. It was considered possible that there was an area of wet ground near to the Swinegate sites, and that these aquatics originated in 'naturally' occurring pools, but their arrival in the faeces of livestock, having been ingested with drinking water from troughs or pools, was entertained, the rarity of aquatic marginal plants arguing for an origin of this kind rather than in imported wetland plants used for litter or fodder.

Some features on occupation sites were obviously intended to hold water, and so the presence of aquatic organisms is not surprising. Their remains will allow a variety of questions to be addressed, including determination of conditions in ditches and drains (how much of the time there was there open water, how polluted was it?), and evaluation of drinking water.

Waterside insects adapting to terrestrial habitats on occupation sites

Aquatic-marginal species present some special problems because (as mentioned above) some appear to have transferred to artificial habitats on occupation sites (e.g. *Carpelimus bilineatus*, *C. fuliginosus*, and *Neobisnius villosulus*, all of which seem to have been able to live in pits and house floors). Other waterside species (e.g. *Platystethus degener* and *P. nitens*) probably colonised damp mud in pits and ditches, and are sometimes numerous in deposits at intensive occupation sites (e.g. in York at 16-22 Coppergate, Kenward and Hall 1995; and at 5-7 Coppergate, Hall *et al.* 1983b, where they may have lived in muddy surface layers). Other than these, aquatic-marginal taxa were not at all common at Coppergate despite proximity of the River Foss (Kenward and Hall 1995), and they are generally rare in occupation deposits. Where they occur, an origin in the background fauna is often likely, and others were probably brought in cut vegetation, turf and peat.

Carpelimus (*Trogophloeus*) species present special interpretative problems. The problem of categorising *C. bilineatus* ecologically was first confronted in the report on Anglo-Scandinavian deposits at 6-8 Pavement, York (Hall *et al.* 1983b, 212-4), and discussed further by Kenward and Allison (1994c) and Kenward and Hall (1995). It appears to have been able to exploit accumulations of organic debris on occupation sites, and to have lived in large numbers in floors as well as pit fills. *C. fuliginosus*, rare now but often very abundant in the past, also seems to have lived in floors and in pit fills (e.g. in 182 samples, sometimes in large numbers, at Coppergate and occasionally numerous at Pavement, York, Kenward and Hall 1995; Hall *et al.* 1983b; Kenward EAU 2000/39). It was possibly a frequent component of stable manure communities in the past, as seems to have been the case in the Roman period at Tanner Row, York, where it was present in a substantial proportion of samples, and sometimes numerous (Hall and Kenward 1990, e.g. p. 351). The suspicion is growing that *C. rivularis*, rather similar to *C. bilineatus*, indicates more 'natural' waterside habitats, so it is important to distinguish these two even though separation is not always easy. *C. rivularis* has been definitely identified from a mid to late 4th century AD pit with a free-standing plank structure at its base at Glebe Farm, Humberside (Carrott *et al.* EAU 1993/13), where it was found together with a range of aquatics and species which would have been at home in muddy water margins, and from early Roman features interpreted as watercourses traversing grazing land at the Tanner Row site, York (Hall and Kenward 1990, 332), where it occurred in an assemblage regarded as representing natural flood or reed swamp debris.

In the *C. pusillus* group, *pusillus* itself may have been a common denizen of decomposing matter on occupation sites, living, for example in pits and stable manure, while gracilis may indicate cleaner semi-natural conditions (Hall and Kenward 1990, 352). The former species appears to be much the most abundant in occupation deposits, where it seems to have lived with *C. fuliginosus* and *C. bilineatus* in many cases. Examples are, for the Roman period, Hall and Kenward (*loc. cit.*, 351), and for the Anglo-Scandinavian, Kenward and Hall (1995, 729; data archive given by Hall and Kenward 2002). Of the other *Carpelimus* commonly found in archaeological deposits, *corticinus* and *elongatulus* seem to occur in association with cleaner mud by ditches, ponds, waterholes and abandoned pits.

Ditches, gullies and drains

A very heterogeneous group of features can be described as ditches, gullies and drains. It is sometimes hard to be sure whether to regard ditch fills as part of the (perhaps spreading) urban environment or as associated with rural precursors. The sites at Tanner Row, Rougier Street and Wellington Row, York provide good examples of this uncertainty (Hall and Kenward 1990; Carrott *et al.* EAU 1995/14). Similarly, at Castle Street, Hull (Carrott *et al.* EAU 1995/31), fills of an early medieval ditch apparently pre-dating urban occupation in that area gave weak evidence of the prevailing conditions. Ditches at Old Grapes Lane, Carlisle (Kenward *et al.* AML 78/92; 2000) were set in an occupied area, but are probably best regarded as rural.

Ditches and gullies of Anglo-Scandinavian date at 16-22 Coppergate, York, were certainly within occupied properties, and were presumably dug to provide drainage (they were not property boundaries), but seem to have been infilled with rubbish and soil from the surroundings. They gave no clear evidence of having been colonised by aquatic organisms, and were probably dry for most of the time. These were very minor cuts; at the opposite extreme was the ditch at 1-2 Tower Street, York (Carrott *et al.* EAU 1995/35), a major defensive structure associated with the castle. Here too, preliminary assessment suggested that the ditch did not hold permanent water, or if it did then it was not deep and that something, perhaps severe pollution, prevented the development of rich aquatic communities. There were certainly no layers with a biota resembling those seen in excavations of clearly waterlain deposits close to the Foss in nearby Piccadilly (Carrott *et al.* EAU 1991/16; 1992/08; 1992/09), silts presumably laid down in the King's Pool, whose creation appears to have been tied up with the construction of the Castle defences.

At Station Yard, Beverley (Carrott *et al.* EAU 1991/17), a series of fills of a large ditch thought by the excavator to be associated with the Preceptory of Holy Trinity were examined. It is hard to categorise this feature as urban or rural. Aquatic and aquatic-marginal insects and resting eggs of *Daphnia* indicated still or sluggish water, but there were also records of *Oulimnius ?tuberculatus* from two levels (at least four individuals), indicating clean flowing water and suggesting at least some inflow from a stream.

It appears that a creek may have traversed the Magistrates' Court site in Hull (Hall *et al.* EAU 2000/25; EAU 2000/33), for there was a large cut containing a characteristic range of salt-tolerant species. The halobiont insects recorded were *Bembidion irricolor*, *Cercyon depressus*, *Berosus affinis* (tolerant of brackish water but not confined to it), *Ochthebius viridis*, and *Carpelimus halophilus*. This cut, presumably originally natural, was eventually infilled with mixed waste.

A special case of the ditch is subterranean culverts and drains. The Roman sewer in York offers a spectacular example (p. 475), but there are a few lesser ones. At 54-7 High Street, Hull, Jaques *et al.* (PRS 2003/01) noted ostracods and members of the 'subterranean' beetle community (p. 482) in a medieval culvert fill; Carrott *et al.* (EAU 1991/16) reported the biota of the fill of a 19th century wooden drain at 84 Piccadilly, York (p. 258); and Kenward and Hall (1995) recorded the fills of what were perhaps covered drains in buildings at 16-22 Coppergate, York (p. 204).

Pits with aquatic fauna

The Anglo-Scandinavian pits at 16-22 Coppergate provide an excellent series ranging from those which appear to have been essentially dry, through those which were colonised by mud-dwellers, some which appear to have had limited colonisation of open water, to a few which were probably open for a very long period, and in which a rather rich aquatic fauna had developed (Kenward and Hall 1995). These pits convey various kinds of information about waste disposal, health and hygiene, but the last group is of particular interest. Why should pits be dug then abandoned? Were they in fact intended as wells, or were they sumps? Or was there an abrupt and unexpected end to a phase of occupation, so that pits dug for waste disposal (presumably primarily as latrines) were never used? If so, was this event (or events) a minor one, or was it one of the multifarious changes of control undergone by York in the Anglo-Scandinavian period (Brøndsted 1965) The pits concerned mostly belong to the period up to the Norman Conquest, so it is even possible that abandonment was related to that event (their dating cannot be precise) - an upheaval being quite possible as the nearby Castle was constructed, for example. Also in an urban context, 15th century fills of a very large pit at Morton Lane, Beverley, yielded a large and rich aquatic fauna, with insects, Cladocera and Ostracoda and (unless it received flood water or prodigious quantities of waste water) the pit seems to have been effectively a pond (Kenward and Carrott PRS 2003/58). This was surprising in view of the evidence for the dumping of organic waste into it: possible explanations are discussed on p. 251.

The 'helmet pit' at the Coppergate Development site, York (Tweddle 1992) was probably a truncated well of Anglian date, which it is suggested remained open until it was infilled in the Anglo-Scandinavian period; it provided useful evidence concerning the surroundings, but the aquatics seem at least as likely to have been background fauna or carried by floodwater as to have lived *in situ* (Hall *et al.* 1992).

In many cases the few aquatic insects recorded from pits at various sites appear to be strays, but sometimes, as at Coppergate, it appears that cuts held open water for long enough for a varied fauna to establish; however, plants very rarely managed to gain a foothold. Insects and cladocerans (water fleas) are the main invertebrates relevant here. The picture is complicated by the likely use of pits to dispose of water which had originally been taken from some other cut or from a natural feature. Some of the pits associated with ?12th century landfill at the Dominican Priory site, Beverley, contained rather more aquatics, especially cladoceran ephippia, than might be expected by accident (Allison *et al.* 1996c), but it was not clear that they held water rather than receiving waste. On the other hand, samples from several of the pits at North Cave (Allison *et al.* EAU 1997/37; forthcoming a) yielded abundant water fleas, and sometimes caddis cases, ostracods and aquatic insects, which as a group seem most likely to have colonised *in situ*. In this case, however, it is not certain that these were colonised while the site was in intensive use, so open water may not have been present during occupation, giving a very different view of the way the site was used. One of the pits at North Cave may have been a crude well, although the analyses suggested that the deposits sampled related to a prolonged period of natural infilling.

Fills of a mid to late 4th century pit at the Romano-British site at Glebe Farm, Barton-upon-Humber, North Lincolnshire, gave indications of clean water, mud, and some duckweed (*Lemna*) (Carrott *et al.* EAU 1993/13). This may have been a well, but there was no evidence of use for watering stock (dung beetles were not exceptionally abundant, for example).

The Anglian pits at The Bedern, York (Kenward *et al.* 1986b) represent a special case of aquatic habitats in cuts on an occupation site. Located in what had been the Roman fortress and close to the position of the Minster (and presumably to the early church), they probably were in an area of rather damp ground with weedy vegetation, showing some human influence. Aquatic fauna developed to varying degrees but in some layers was rather rich, suggesting that the pits were open for quite a long time (probably well over a year). Was drainage in this area impeded by the fortress wall and failure of the Roman sewer system, so that it was considered unsuitable for occupation, or was it a garden area?

Wells

Wells range from high-quality, often very deep, features, to mere sumps. The former are represented by elaborate constructions such as the Roman timber-lined wells in York (Skeldergate, Bedern); the supposed water-hole at North Cave (Allison *et al.* EAU 1997/37) perhaps represents the opposite extreme, with the timber-lined pit at Hayton, East Yorkshire (Jaques *et al.* EAU 2000/35) lying somewhere between. Clearly these cuts offer very different possibilities for colonising organisms, as well as for archaeological reconstruction of their surroundings. Deep wells of high quality do not present the most likely habitat for invertebrate colonisation, but some species might (literally and metaphorically) gain a foothold on the inner lining: it appears likely that the beetle *Lesteva longoelytrata* was able to establish itself in the Roman timber-lined well at Skeldergate, York

(Hall *et al.* 1980, 131), and at Hayton (Jaques *et al.*, loc.cit), for example. A few aquatic animals may be able to survive in deep wells, the immature stages of chironomid midges, and crustaceans such as Cladocera and Ostracoda, for example. The author has seen various insects and even vertebrates apparently living quite happily in a closed underground concrete water tank. However, their remains do not seem to have been documented from such archaeological features under circumstances suggesting breeding populations; there were *Daphnia* ephippia in the fills of the well at Skeldergate, for example, but they were recorded as 'rare'.

Shallow wells, which merge into water holes and spring-fed ponds, may contain a diverse living biota, and leave abundant remains in their fills. The large pit at North Cave, East Yorkshire, mentioned above, seems most likely to have been dug to obtain water, but when it fell into disuse (or before if used only on a small scale) it effectively became a small, rich pond which preserved a remarkable assemblage of invertebrates, particularly insects (Allison *et al.* EAU 1997/37; forthcoming a). An early-mid 2nd century well at the Old Grapes Lane B site, Carlisle (Kenward *et al.* AML 76/92; 2000), had been colonised by four kinds of Cladocera (represented by their ephippia) and aquatic beetles were quite numerous, although the forms represented were all highly migratory invaders of temporary water. Buckland (1996) described an insect assemblage dated to after the Roman conquest, apparently during the first century, from the fill of a broad erosion cone associated with a wicker-lined pit or well at Dragonby, North Lincolnshire. Abundant aquatics showed clearly that the hollow had been water-filled, with a rich aquatic vegetation. However, although Buckland suggested a use as a watering hole for livestock (a perfectly plausible interpretation), dung beetles were not exceptionally abundant. Girling (AML 3929) reported the fauna of a wood-lined waterhole or well of 3rd or early 4th century date at Winterton, North Lincolnshire, which included a few aquatics and waterside species, indicating damp conditions but not permanent open water, and perhaps suggested pastureland in the surroundings (although in this case only traces of dung beetles were recorded).

Jaques *et al.* (EAU 2000/35) reported the assessment of invertebrates from a timber-lined well at Hayton, east of Pocklington. Preservation of insects was generally superb, in strong contrast the lack of preservation of organic matter generally at the site. The species-rich assemblages represented a range of habitats, probably giving a good general view of the landscape in which the site was set, and appeared to have formed by slow accretion of background fauna, with a few aquatics and waterside species colonising the well itself. The rarity of ground beetles (Carabidae) or other ground-living insects, suggested that this structure did not act as a pitfall trap. Subsequent analysis (Kenward unpublished) supports the interpretation made during assessment.

Many shallow wells may have been intended primarily as sources of water for livestock, which may have been able to drink direct from them. If this was so, should we expect to recover the remains of dung beetles in large numbers? The Late Bronze Age well at Wilsford, Wiltshire (Osborne 1969; 1989) contained immense quantities of a variety of scarabaeid dung beetles, but other dung-feeders were rather rare. It seems very likely that livestock were concentrated around the mouth during the time the well was infilling, and the only convincing explanation for this is that they were being provided with water from it. The relatively large numbers of dung beetles at Wilsford may relate to the well's use over a very long period of time, whereas many shallow 'sumps' may have been ephemeral.

Many wells were eventually used for waste disposal, often for faeces (although it is possible that a large proportion of the wattle- or barrel-lined features interpreted as wells were always intended as latrines). As such they ceased to provide habitat for aquatic organisms, or at most presented only extremely polluted water. Both large Roman wells in York were backfilled with what appeared to be material from nearby surfaces (Hall *et al.* 1980; Kenward *et al.* 1986b). The infilling of the well at the Rudston villa is more problematic (Buckland 1980; see also p. 180). The general issue of interpretation of well fills is discussed on p. 464 - although they often present substantial challenges in this respect, they are the only source of delicate remains preserved by anoxic waterlogging at many sites, and thus take on special importance.

In summary, there are several problems to be addressed concerning aquatic deposits on occupation sites, but there is substantial potential for significant archaeological information to be obtained when these problems are solved. Apart from questions concerning the function of cuts, of the nature of water supplies, and means of disposal of waste water, water-filled cuts which can be shown to have infilled essentially naturally will provide a reasonably random sample of the surrounding fauna, and thus permit some degree of reconstruction of local conditions.

Conditions created by keeping livestock

Invertebrate remains, in combination with other evidence, offer excellent indications of the presence of livestock or their products on sites in the past. However, the evidence for animals other than horses (or mules or donkeys, Hyland 1990; White 1970, 288-301) is not entirely straightforward. Four principal kinds of evidence for the keeping of livestock may be provided by invertebrates: parasites of the animals themselves; the effect the beasts had on the soil, vegetation and water of places where they were kept; materials imported as food and bedding for them; and the dung and stable litter they generated. The remains of the vertebrates concerned are, of course, rarely useful since they may have been transported, although the presence of neonates (usually of pigs) is sometimes persuasive. Few examples of evidence from invertebrates for the presence on pre-Roman sites of livestock in northern England have been encountered, except where dung beetles indicate the presence of beasts at some unknown distance (the beetles may have exploited dung from other animals, however!). Exceptions are records of numerous dung beetles from Iron Age ditch fills at Carberry Hall Farm, NE of Wilberfoss (Jaques *et al.* EAU 2002/05) and Bolton Hall, Bolton, NE of Pocklington (Jaques *et al.* EAU 2002/04).

The 'watering holes' studied in the north of England have usually provided inconclusive or negative evidence, in contrast to the case of the enormous numbers of dung beetles from the Bronze Age Wilsford 'shaft' in Wiltshire (Osborne 1969; 1989), or the smaller, but still substantial, numbers found by Anderson (1989) in a ditch fill at Haughey's Fort, County Armagh, Northern Ireland. Dung beetles have sometimes been found in fairly large numbers in ditch fills from the North, however, for example at a site east of High Catton, East Yorkshire (Kenward *et al.* EAU 2002/12), in an enigmatic large pit or pond at the North Bridge site, Doncaster (Carrott *et al.* EAU 1997/16; Kenward *et al.* 2004a), and at the Flodden Hill rectilinear enclosure, Northumberland (Kenward EAU 2001/49).

There is rather little evidence to indicate that livestock were kept in towns from the most obvious sources: dung beetles and parasites. Dung beetles are very common in urban deposits, but some of the species concerned are known to be able to exploit rotting material other than dung (e.g. *Aphodius prodromus* and *A. granarius*, Landin 1961), and many of these beetles are highly migratory (Landin 1968; Kenward 1983b). The record of abundant *Aphodius* from an anomalous feature at St Saviourgate, York (Carrott *et al.* EAU 1998/14), is particularly puzzling. Most of the ectoparasites of domestic animals which have been recorded almost certainly came from wool, hides or skins, rather than directly from the live animals (e.g. Kenward and Hall 1995, 775-8; see p. 363). An enormous amount of evidence has now accumulated for the presence of manure from the stalling or penning of horses (Kenward and Hall 1997). This is hardly surprising in economies where horses (and in some cases donkeys, mules or cattle) were generally the prime means of transport after human feet. Clearly related to stabling of domestic animals is the identification, using insect and plant remains, of hay from many deposits (p. 355), and a large proportion of the grain pests recorded from archaeological sites probably originated from horse feed (p. 397).

Evidence for animals other than horses

Archaeological deposits containing dung or litter deposits from mammals other than horses (or, more accurately, equines) have not really been adequately investigated, although they may prove important. While horses were clearly very common in towns in some periods (the evidence is thin for the post-Roman to Anglo-Scandinavian periods), evidence of the keeping of pigs would obviously be valuable. There are significant sources of potential confusion: deposits containing gut contents, important as evidence of primary butchery; might be confused with dung or manure resulting from keeping the live animals; and when ectoparasites (normally lice) of animals other than sheep are found the possibility still exists that they originated from skins, or in the case of pigs from de-hairing after slaughter (p. 426).

Sometimes the evidence is a little clearer. One sample from a Roman deposit at the Old Grapes Lane A site, Carlisle, gave some evidence for the keeping of pigs, as there were `several' *Haematopinus apri*, the louse of European wild pigs (Kenward *et al.* AML 78/92; 2000). An additional hint that pigs were present at this site came from the relatively larger numbers of eggs of *Ascaris*, the maw-worm, in relation to *Trichuris*, the whipworm, than normal in deposits containing what is believed to be human excrement. (The ratio of *Trichuris* to *Ascaris* eggs has been said to have a role in differentiating faeces of pigs and humans, *Ascaris* being relatively more common in the former (p. 27), although this assertion requires objective testing. It is possible that this was a random effect of the rather small numbers of eggs observed, however. Measurements were of little assistance since unfortunately none of the contexts with a high proportion of *Ascaris* eggs contained sufficient well-preserved *Trichuris* to give significant data sets. One gave 15 eggs for which width measurements could be made, and it seems likely that these were *T. trichiura* (the species characteristic of *Homo sapiens*). There was very slight evidence from Anglo-Scandinavian 16-22 Coppergate for pig faeces, for two contexts with abundant parasite eggs gave larger numbers of *Ascaris* than *Trichuris* (Kenward and Hall 1995, 778-9). Again, measurements were not helpful, and there was no other confirmatory evidence. Pig lice (again *H. apri*) were present in small numbers. At 36A-40 High Street, Hull (evaluation, Carrott *et al.* EAU 1994/01), there was evidence suggesting litter, but no distinctive 'stable manure' fauna, and it was suggested that this may conceivably have resulted from keeping pigs (there were, however, no lice, and *Trichuris* eggs were too rare to be measured systematically). There were deposits at the 4-7 Parliament Street site in which the *Trichuris:Ascaris* ratio was low, and 1:1 in a single case (Hall and Kenward EAU 2000/22). The possibility that some medieval 'litter' deposits at Swinegate, York, originated through the keeping of animals other then horses - perhaps pigs - was entertained by Carrott *et al.* (EAU 1994/13) in their assessment report, but no further work to test this tentative hypothesis has yet been possible at this important site.

Outside the area being considered here, the Early Christian site at Deer Park Farms in County Antrim, Northern Ireland, has provided large numbers of lice of livestock, including species associated with pigs, sheep, goats, horses and cattle. Even in this case, however, it is not yet clear whether the animals were penned on site or the parasites resulted from slaughter, or the use of skins or wool (Allison *et al.* EAU 1999/08; 1999/10; Kenward *et al.* accepted).

There must be a strong suspicion that chickens were a major contributor to soil disturbance and lack of vegetation at most sites in the past, although direct evidence is perplexingly lacking (e.g. at 16-22 Coppergate, York, Kenward and Hall 1995, 779). In particular, there are few cases of what may have been 'lost' eggs from any site, and no parasites of fowl have yet been recorded from northern Britain. Ducks and geese were surely common as well, but again evidence is lacking. It is worth noting that the inadvertent implication of Buckland (1975b) that the beetle *Aglenus brunneus* is in some way indicative of the keeping of chickens is erroneous, though unfortunately repeated in textbooks.

Records of the principal lice of livestock from northern England are briefly reviewed on p. 425.

Penning of equines in the open

The accumulation of dung and litter in the open as a result of the penning of horses or other equines is less easy to recognise than might be hoped, although it must have been more common than stabling in view of the huge numbers of horses kept (see e.g. Hyland 1990 for the Roman period). Late first century assemblages from Lewthwaites Lane, Carlisle (Kenward *et al.* AML 77/92; 2000) gave the impression that dung and litter had been trampled into surfaces, rather than having been dumped, but this may have been deposited by livestock in the open or simply have been scatter from stabling nearby. Similarly, while there was some probable stable manure at Old Grapes Lane B (Kenward *et al.* AML 76/92; 2000), some layers may have formed in an open area such as a stockyard, and the evidence from the Old Grapes Lane A site suggests the possibility of penning (Kenward *et al.* AML 78/92; 2000). Still in Carlisle, evidence from Keay's and Law's Lanes strongly suggested the presence of dung, probably of horses, on the ground in the open, and many cut features seem to have been backfilled with soil from such surfaces (Kenward *et al.* EAU 1998/32)

Evaluation at the Cumbria College of Art, Stanwix, Carlisle (Hall *et al.* EAU 1994/57) revealed probable horse manure on an old ground surface underlying deposits interpreted as make-up for a Roman parade ground. The Roman fort at Ribchester produced much evidence of dumped stable manure, but there were a few cases where the deposition of dung in the open perhaps occurred (Buxton *et al.* 2000a-d; Carrott *et al.* 2000; Large *et al.* EAU 1994/11, 17, 30-33). Small numbers of grain beetles and other synanthropes in the buried soil at Skeldergate, York (Hall *et al.* 1980; Kenward EAU 2000/41) now seem quite likely to have been deposited in the dung of horses put out to graze after feeding in stables.

Very rarely, layers are found which appear to contain dumps of dung rather than stable manure. This was perhaps the case for one sample from Keldgate, Beverley (Carrott *et al.* EAU 1995/03), which contained finely comminuted plant remains, the small number of insects giving a subjective indication of dung. One layer in a large pit at the North Bridge site, Doncaster (Carrott *et al.* EAU 1997/16; Kenward *et al.* 2004a) produced huge numbers of dung beetles, leading to the conclusion that large herbivores (not necessarily horses) were corralled by it. Plant remains offered no indication for dung in the deposit, but dung, or perhaps spilled gut contents from butchery, on a nearby surface may have provided a habitat for the beetles. The dung-beetle rich deposit at St Saviourgate, York, may conceivably be of this kind (Carrott *et al.* EAU 1998/14).

Stable manure

Stable manure, probably almost always from equines, is now considered to be a very frequent component of archaeological deposits, especially of Roman and post-Conquest date, although in many cases it was overlooked in the past, particularly as a result of poorly integrated specialist studies (Kenward and Hall 1997). An 'indicator group' of organisms for stable manure is now recognised, as is the rich information which can be gained from this material (Hall and Kenward 1998). From the invertebrates, stable manure is typically recognised by the combination of grain pests (absent in some periods, of course, p. 343), 'hay' insects, house fauna from the stable, and decomposers associated with foul open textured matter. The combination of plant and insect evidence is the most compelling method of identification, however. Although hay may occasionally have been used for roofing, packing, or human bedding, it was doubtless generally intended for animal feed and so records of 'hay' insects are mentioned here; they are discussed further on p. 355.

Roman sites with stable manure

Stable manure is now very commonly recognised to be a component of deposits at Roman and post-Conquest intensive occupation sites, but evidence from the intermediate period and from prehistoric sites is very limited.

For Roman sites, stable manure was perhaps one of the major contributors to deposits where there is organic preservation and, indeed, by creating a water-retaining sponge, possibly the primary cause of preservation (Kenward and Hall forthcoming). Generally it appears to have been cleared from buildings, but in a few cases similar material may have accumulated *in situ* in the open (see above). Stable manure has rarely been found in what may have been a stable. Exceptions have been recorded at Castle Street and Old Grapes Lane A, Carlisle (Allison *et al.* 1991a-b; Kenward *et al.* AML 78/92; 2000), and perhaps at Vindolanda (Seaward 1976).

There can be little doubt that large quantities of stable manure were represented at the Tanner Row site, York (Hall *et al.* 1990, 400-404), and this site provided some very characteristic groups of 'stable manure' insects, including grain pests, 'hay' beetles, house fauna and decomposers associated with foul open-textured litter. These assemblages much more certainly represent stable manure when viewed with hindsight than was apparent at the time.

The identification of stable manure may be made with variable degrees of certainty. One group of insects from Lewthwaites Lane, Carlisle, for example, may have represented a stable manure deposit which had not been invaded by a foul matter community before burial (Kenward *et al.* AML 77/92; 2000). Late first/early second century material at this site gave some clearer indications, one group suggesting stable manure which included peat or turf as well as hay. At Kirkham fort, Lancashire (Carrott *et al.* EAU 1995/02), it was suspected that there was both stable manure and horse dung on surfaces. For Castle Street, Carlisle (Allison *et al.* 1991a), there were numerous records of exuviae (moulted larval skins) of the psyllid bug *Craspedolepta nervosa* (see p. 54, 356), representing strong evidence that cut vegetation, presumably hay, was present in many layers, either as the fresh material or introduced secondarily via stable manure or dung. Stable manure was weakly indicated in many samples from this site, but there were few characteristic groups like those from Tanner Row.

Other Roman sites from which stable manure has been identified with greater or lesser security include the fort at Papcastle (Kenward and Allison AML 145/88; EAU 1995/01), Old Grapes Lane B (Kenward *et al.* AML 76/92; 2000) and Keay's Lane and Law's Lane (Kenward *et al.* EAU 1998/32). Re-examination of the evidence from Blackfriars Street (Kenward 1990) suggests that much of the insect fauna may have originated in stable manure. The ditches at the fort at Ribchester, Lancashire, certainly had often received stable manure (Buxton *et al.* 2000a-d; Carrott *et al.* 2000; Large *et al.* EAU 1994/11), and provided some very characteristic assemblages. The extensive analyses of material from Annetwell Street (Kenward and Large EAU 1986/20; Large and Kenward EAU 1987/14-16; 1988/15-19; Allison *et al.* forthcoming b) were carried out before the components of stable manure were recognised; with hindsight it was widespread, as is clear from even cursory re-examination of the species lists (presented in updated format by Kenward EAU 1999/32).

In York, assessment by Carrott *et al.* (EAU 1993/14) of material from North Street revealed late 2nd century beetle groups which may have originated in stable manure, together with plants likely to have come from herbivore dung, including salt marsh taxa, and there was some evidence from the assessment of Roman material at nearby Wellington Row (Carrott *et al.* EAU 1995/14). At the Adams Hydraulics III site there was perhaps stable manure (Allison *et al.* 1991/05), while the fills of the well in The Bedern may also have included such material (see p. 156). Much of the peat and some of the turf detected on Roman (and later) occupation sites may have been used for animal bedding rather than for fuel or construction.

Horticultural uses might be regarded as modern, but P. C. Buckland has pointed out (pers. comm.) that peat or turves have been widely used in animal bedding, then returned to the land enriched with urine and faeces. The use of turves in this way has been demonstrated for the pre-Roman Iron Age in the Netherlands at least (Groenman-van Waateringe 1979a; b), and it was suggested by Troels-Smith (1984) that a similar process using manure containing the remains of leaf fodder occurred 6,000 years ago in a settlement in Switzerland. The Romans clearly appreciated the value of stable manure as a fertiliser (White 1970, 125 ff.), and all soils would increase in fertility with its application. For the Old Grapes Lane A site, Carlisle (Kenward *et al.* AML 78/92; 2000) it was thought possible that peat or turf was used in stables in the Roman period, the association of peat with likely stable manure containing hay at several other sites, notably Tanner Row, York (Hall *et al.* 1990), perhaps strengthening this hypothesis.

The presence of horse manure was apparently widely tolerated in the Roman period. Large *et al.* (EAU 1994/11; see also Buxton *et al.* 2000-d; Carrott *et al.* 2000) remarked on the contrast between abundant evidence for stable manure and lack of other kinds of identifiable organic waste at the Roman fort at Ribchester. While it may have been cleaned from the streets, it remained on many surfaces to be preserved in the archaeological record. Hall and Kenward (1990, 404) suggested that this was not so surprising in view of the importance of equines in daily life, citing the much greater tolerance of horse dung than of that of other mammals at the present day. One reason for tolerance may have been the inevitability of the material, for the volume produced must have been enormous (for a much more recent period, the twelve cartloads removed daily from Regent's Street in London in the 19th century, K. Smith (1974) may be cited).

Stable manure: post Roman to Norman conquest

On balance, there is no really satisfactory evidence for stable manure from this period. Of the deposits at the rear of 61-63 Saddler Street, Durham (Kenward 1979d), one, dated to the 10th-11th century, gave an assemblage which may perhaps have been stable manure, but the evidence was not clear. Similarly, some assemblages from the Anglo-Scandinavian sites at 6-8 Pavement, (Hall *et al.* 1983b; Kenward EAU 2000/39) and 16-22 Coppergate, York (Kenward and Hall 1995), had a character suggesting foul but open-textured matter like stable manure, with large numbers of (variously) *Ptenidium* sp., *Oxytelus sculptus*, *Carpelimus bilineatus*, *C. fuliginosus*, *C. pusillus* group, *Leptacinus* ?*pusillus*, *Typhaea stercorea*, *Monotoma bicolor* and *M. longicollis*, but this fauna may have been exploiting some other material such as dyebath waste. An extensive layer of pre-Conquest date at Eastgate, Beverley, may have consisted of stable manure, but the insects were only subjected to superficial examination (Kenward in McKenna 1992).

Re-examination of data for sites of this period using the combined evidence from plants and insects in the light of recent improvements in the understanding of stable manure (Kenward and Hall 1997) is required. The probable absence of grain pests in the 5th to mid-11th centuries may reduce the chance of recognising stable manure during rapid evaluation or assessment exercises unless full cognisance is taken of the botanical evidence. However, stable manure may only very rarely have been dumped on occupation sites in these times, either because it was too valuable as manure to be wasted, or because urban stabling needs large quantities of imported food in the form of hay and cereals, not easily available in a decentralised economy, so that animals were left outdoors in places where there was at least limited grazing or browse.

Stable manure: Norman conquest to late Medieval

Records of stable manure, often tentative because they result from evaluation exercises, are frequent for this period, and it is suspected that most sites with suitable preservation would give some evidence if plant and invertebrate groups from sufficient deposits were carefully examined. For York there are records of varying degrees of certainty (and with or without corroborative evidence from plant remains) from, among others: 11th-12th century pit fills at the NCP car park site, Skeldergate (Jaques *et al.* EAU 2000/53); a mid 13-early 14th century gully fill at 1-2 Tower Street (Castle Garage) (Carrott *et al.* EAU 1995/35); fills of a putative ditch at the Adams Hydraulics III site (Allison *et al.* EAU 1991/05); 12-14th century levelling/dump/buildup deposits at the Merchant Adventurers' Hall (Carrott *et al.* EAU 1996/44); fills of pits in yards at Parliament Street (Carrott *et al.* EAU 1996/15); from 12th-14th century surface deposits at Swinegate (Carrott *et al.* EAU 1994/13); from the basal fill of a timber lined pit of c. 14th century date at 41-49 Walmgate (Jaques *et al.* EAU 2001/26); from 13th century deposits at 14 Skeldergate (Allison *et al.* EAU 1991/06); and from the Hungate area (Jaques *et al.* EAU 2000/29). At Carmelite Street (Carrott *et al.* EAU 1991/15), there was evidence of hay, including *Craspedolepta nervosa* nymphs (see p. 54, 356).

For Hull, there were indications of stable manure from various deposits of early 14th century date at the Magistrates' Courts site (Hall *et al.* EAU 2000/25), although the evidence from plant remains was sometimes rather stronger at this site; it was suggested that if stables were represented they were usually cleared out frequently, preventing the build-up of a large decomposer fauna associated with foul matter (there were some more characteristic stable manure groups, however). At nearby Chapel Lane Staith (Kenward 1979c) an assemblage of mid-later 14th century date included enormous numbers of grain pests (*Oryzaephilus surinamensis* and *Sitophilus granarius* - *Cryptolestes ferrugineus* and *Palorus ratzeburgi* were absent from the site) together with a substantial house fauna. There were foul decomposers and insects which may have originated in hay, so this deposit may well have included stable manure.

There is some evidence from evaluations in Beverley: Carrott *et al.* (EAU 1995/03) recorded a 12-13th century deposit with organic matter resembling stable manure at Keldgate, while at a site in Flemingate, Dobney *et al.* (EAU 1995/48) recorded synanthropes, possibly with a stable manure component, in a small group of insects.

Other towns giving at least hints of stable manure in this period include Selby (later medieval deposits at Gowthorpe, Finkle Street and Micklegate, Carrott *et al.* EAU 1993/08), Grimsby (Cartergate, Carrott *et al.* EAU 1994/22), (with hindsight) Scarborough (24-6 The Bolts, Hall and Kenward EAU 1990/11), and (again with hindsight) Durham (11th-12th century layers at 61-63 Saddler Street, Kenward 1979d).

Post medieval sites with stable manure

Not very many identifications of stable manure have been made for the post-medieval period, but this is probably a result of the combination of rather rarer preservation and until recently a tendency to remove late deposits without proper sampling. The growth of evaluation excavations may help to rectify this problem, but funding may be inadequate to carry out proper confirmatory analyses. Deposits of this period giving at least hints of stable manure have been noted at the following: 17-19 Street Augustine's Gate, Hedon (15th century primary ditch fills with strong hints of stable manure from mouldering decomposers, house fauna, grain pests and some 'hay' weevils, Carrott *et al.* EAU 1993/04); North Bridge, Doncaster (Carrott *et al.* EAU 1997/16; Kenward *et al.* 2004a, hints of stable manure elements from a large 17th century pit); the Magistrates' Court site, Hull (Carrott *et al.* EAU 1995/17, an 18th century well fill); at 54-7 High Street, Hull (Jaques *et al.* PRS 2003/01, in 'pre-18th century' pit fills or dumps); and Carmelite Street, York (Carrott *et al.* EAU 1991/15, 16th dumps with some evidence of hay or straw and at least one layer with probable stable manure).

Stable manure and grain pests

It is worth mentioning here that it is now considered that most grain pests found in archaeological deposits probably came from horse feed and so do not stand as good evidence of problems in storing grain for human consumption. Grain pests are a characteristic component of deposits identified on a range of evidence as stable manure (Kenward and Hall 1997). Clearly either cereals were a normal part of the equine diet or, less probably, grain pests invaded residual grain in straw or chaff used for bedding or feed. High-quality grain clearly intended for human consumption is rare, and where found charred appears not to have been heavily infested with insects (p. 94).

Stable manure as a source of aquatic invertebrates

Aquatic and waterside invertebrates often occur in small numbers in terrestrial archaeological deposits. While the insects may frequently be regarded as 'background fauna' (p. 57), in some cases it appears possible that they were imported in some way, and this is likely to be the case for fossils of water fleas, bryozoan statoblasts and aquatic larvae. Buckets of water for domestic, craft or industrial use seem a likely source, but water was doubtless also brought in large quantities for livestock, and grazing or penned animals would obviously have drunk direct from whatever body of water was available to them, remains of aquatics subsequently being passed in faeces. The quantity of water required by an active animal is enormous. Hyland (1990, 96), for example, suggests that a horse may consume five gallons (23 litres) of water per day, and more in hot weather, while dry feeding increases consumption even further. Huge numbers of water fleas, insects and other invertebrates were surely drunk and voided in the faeces, while others would have been deposited when water was spilled. One case where water flea ephippia may have been deposited through watering of livestock is the Swinegate site, York (Carrott *et al.* EAU 1994/13), where water fleas occurred in a substantial number of deposits, and were abundant in a few, although deposition was clearly terrestrial. There were often hints of stable manure from the insect fauna. Awareness of the possibility of this route for aquatics to enter occupation deposits has lead to numerous cases where it was suspected, for example water fleas and aquatic insects in what seem to have been midden-like accumulations containing animal faeces at 4-7 Parliament Street, York (Hall and Kenward EAU 2000/22).

The importation of water is not the only likely source of aquatic and waterside invertebrates which is related to livestock. Numerous organisms may have been brought in hay from damp meadows, having either been collected live, or as corpses stuck onto stems during flooding. *Kateretes* species were probably often brought with hay, and it may have been one source of the donaciine ('reed') beetles occasionally found in occupation deposits. Many other wetland invertebrates may have been consumed by animals set out to graze at the margins of water.

Fly puparia as indicators where other insects rare

Fly puparia have much to offer archaeology (see the taxonomic section), and they will often be of great value in combination with the evidence from the beetles. However, flies have a particular importance in that they are sometimes able to exploit very small and short-lived habitats, and to survive in conditions so foul that other insects cannot breed. They thus may stand as evidence of small short-lived lumps of foul matter on surfaces where there was no widespread dumping. A particularly convincing case - albeit from outside northern England - is that of Drum Castle, Aberdeenshire (Kenward *et al.* EAU 1995/46; 2004c). A few Anglo-Scandinavian deposits at 16-22 Coppergate, York, gave such evidence (Kenward and Hall 1995). Pit fills often seem to have been colonised by flies then sealed before large beetle populations could develop; Coppergate provided some examples, and a case was noted at Keldgate, Beverley, by Carrott *et al.* (EAU 1995/03), but numerous other examples certainly exist unreported in the literature.

Mites as indicators of dung

That the mites (Acari) are an under-used resource in archaeology has been suggested above (p. 76). One specific area of potential is in the identification of dung, which has a characteristic mite fauna. Schelvis (1994a) discusses the value of these dung mites in archaeology. Investigation of British material would clearly be worthwhile, and mites may be useful as indicators of small amounts of, or rapidly-buried, dung.

Urban zonation

Invertebrate remains provide a powerful tool for examining spatial variation in activity and living conditions across towns (although ideally the full range of bioarchaeological techniques should obviously be applied, and integrated with 'conventional' archaeological data). Kenward (EAU 1999/43) undertook such a study of Roman Carlisle. The project was explicitly designed to test the hypothesis that there would be a detectable gradient in the insect remains from the fortress to rural fringes which reflected aspects of site function and environment. Data from four sites or groups of sites were analysed: within the fort, Annetwell Street; just outside the fort, and in an area believed to have largely been devoted to servicing it, Castle Street; sites designated 'Lanes 2' (Keay's Lane A-D and Law's Lane B-D), in an area which seems to have seen fairly intensive occupation; and The 'Lanes 1' sites (Old Grapes Lane A-B and Lewthwaite's Lane A), with substantially less intensive occupation, and perhaps an almost rural character.

Various methods of analysis were used, including (1) detailed inspection of the species lists context-by context and site-by site (carried out in the initial site-based projects); (2) examination of various summary statistics for the assemblages of adult beetles and bugs at the site level and broken down by feature type; (3) more detailed examination of the structure and distribution of species within certain ecological categories (e.g. the plant feeders, grain pests, house fauna, and species associated with foul matter); (4) analysis of the distribution of particular species; (5) analysis of species associations amongst selected beetles (and a few other insects) broadly following the methods described by Carrott and Kenward (2001); and (6) multivariate statistical methods: cluster analysis and multidimensional scaling, applied to main statistics and to records of species. Statistical tests of significance were applied to variations in statistics.

Some well-represented context types could be compared between the sites: layers; pit fills, drain, ditch and gulley fills, and floors. Limitations to the data were recognised: the numbers of contexts of any one type examined for each site was frequently small, there was uneven representation of context types across the sites; and the material had been recorded by four people over a long time period, during which methodology changed and of the range of organisms identified broadened, so that there was probably some variation in the standard of recording of certain groups between projects.

Comparison of main statistics at the site level in some cases showed clear trends, for example in the proportion of outdoor fauna from Lanes 1 through Lanes 2 to Castle Street and Annetwell Street, the presence of a substantially greater proportion of species associated with drier habitats at the latter site, interpreted as indicating lower tolerance of foul matter by the occupants, and a steady increase in the synanthropic component from Lanes 1, through Lanes 2 and Castle Street, to Annetwell Street (when grain pests are included), interpreted as reflecting increasing intensity of human utilisation of the sites. Comparison by deposit type produced similar results, giving clarification or amplification in some cases.

The species association analysis gave useful results too: although in very general terms taxa had similar relationships at each site, there were substantial differences in detail which are believed to reflect substantial differences in site environment and usage (Kenward and Carrott 2006). At Annetwell Street, for example, there was evidence of stable manure, but little to suggest that it persisted for long periods in a foul state so as to acquire a rich fauna, contrasting with the results for Castle Street, where associations suggested there was abundant stable manure, as well as filth in the open, perhaps dumped or scattered stable manure. At Lanes 2, a large part of the fauna seems to have lived in the open, with decaying matter on surfaces and a very limited weed flora. Stable manure probably existed locally, although there may more often have been accumulations of litter rather like it, but formed on open surfaces. There may have been little in the way of indoor habitats for insects, a limited house fauna perhaps arriving in poorly-stored feed grain. At Lanes 1, also, there was doubtless some stable manure, but there was rarely much in the insect assemblages to suggest the fauna of buildings, foul matter being allowed to lay in the open. Grain pests may have regularly arrived direct in horse dung here, as perhaps they did at Annetwell Street. No clear patterns emerged from analyses using clustering and multidimensional scaling.

A series of questions concerning the sites were specifically addressed in the study. The various analyses employed in the study strongly supported the initial hypothesis of gradation in land use, and consequently ecological conditions, across the four sites, but some surprising aspects emerged. Differences in human activity between the sites could be deduced, largely in terms of the way animals were kept, levels of cleanliness, and the evidence for human living quarters. In addition, there appears to have been a different level of exploitation of peatland or heathland resources at the sites. Variations in ecological conditions (and thus human living conditions) could be seen, with considerable variations in the amount of filth tolerated at the sites, variations perhaps related to the presence (or quality of) human living quarters. There were differences in the importance of (presumably temporary) aquatic habitats at the sites, always supposing that most of the aquatics were not imported, either in water for stock, or actually within the bodies of livestock, having been accidentally drunk. The vegetation of the sites could not be reconstructed from insects, not because of failure of the analyses, but rather because there appears to have been almost no vegetation at any of the areas studied. Many plant-associated insects were clearly imported in raw materials such as turf and hay. There may possibly have been rare, scattered, weeds, and there may have been over-grazed and trampled turf at the Lanes 1 sites, but the evidence is not very convincing. There was considerable problem of visibility of human living quarters at the sites. Much of the 'house fauna', which stood as clear evidence of deposition within buildings used by humans at Coppergate in York, may in Carlisle have been deposited in stable manure, or in spoiled grain and hay. It appeared that stabling could, cautiously, be differentiated from close-corralling and the keeping of stock in larger paddocks, with conventional stables at Castle Street, and to varying extents at the other sites; dung appears to have dropped onto the ground at Annetwell Street and the two sets of Lanes sites. Lanes 2 may have at least occasionally seen the penning of horses in the open, and Lanes 1 their confinement in larger paddocks.

Some information about land-use zonation emerged from a synthesis of data for Anglo-Scandinavian York (Hall and Kenward (2004). It seems that the area represented by the 16-22 Coppergate excavation was intensively used in all periods, and the Pavement site appears to have had a similar character to Period 4B at Coppergate. The site at 5-7 Coppergate probably represents a very disturbed and muddy yard and the small amount of material from All Saint's Church closely resembled that from 16-22 Coppergate. The deposits at 4-7 Parliament Street may have been unlike anything seen at 16-22 Coppergate (if it is accepted that the 'dumps' examined were really on surfaces and not fills of large unrecognised pits), appearing to have formed away from the houses on the street frontage, in an area where the foul conditions were tolerated; livestock may have been kept there. On the opposite side of the Ouse, 1-9 Micklegate gave assemblages essentially similar to that from 16-22 Coppergate, but the sites at 24-30 Tanner Row and 5 Rougier Street gave too little material for any meaningful comparison. The small amount of material from 2 Clifford Street appears to have differed from that seen at Micklegate, Coppergate and Pavement, even though it was very close to 16-22 Coppergate. Sites at 118-26 Walmgate (Kenward and Hall EAU 2000/20) and 41-9 Walmgate (Johnstone *et al.* EAU 2000/04), suggest a pattern, the Coppergate-Pavement area, and perhaps another area including1-9 Micklegate contrasting with more peripheral sites, perhaps with different roofing traditions on the botanical evidence, but also perhaps distinguished by the presence of livestock. The assemblages from 118-26 Walmgate were quite different from those from the town centre, lacking seething assemblages of house fauna like those seen at the other sites, so that the buildings may have been used in different ways. On somewhat limited evidence, it seems possible that conditions resembling those in an old-fashioned farmyard existed at 118-26 Walmgate, the buildings being byres or stables (pigs seem the most likely animals to be kept at a site such as this). The Walmgate area of York may thus at this period represent an early stage of urban settlement, with crowded small-holdings which would only later be subdivided into tenements.

Excavations in St Saviourgate gave evidence suggesting a fouler environment different from anything seen at Coppergate and Pavement, although perhaps not unlike 4-7 Parliament Street. Further east, there seem to have been very foul conditions along the banks of the Foss by what is now Layerthorpe Bridge. Anglo-Scandinavian deposits repeatedly gave very decayed bark and large numbers of the beetle *Trox scaber*, probably from waste from tanning (Hall and Kenward 2003a; b). This area thus probably was set aside for the less socially acceptable activities.

This kind of analysis of land use zonation clearly deserves further research using a full range of evidence; much more can be done in York and Carlisle. Beverley at least has been sufficiently well investigated (admittedly mostly through evaluations) for a similar exercise to be attempted.

Pollution and environmental control

An awareness of the need to avoid strewing living areas with filth (especially human faeces) seems to have developed early, and the value of organic waste as manure or raw material doubtless encouraged cleanliness indirectly. However, the pressures of urban life, particularly high population densities, lead to conditions that we now recognise as dangerous to health. Historical documents reveal various attempts to control filth through the law (e.g. Keene 1982), but these conspicuously failed at times if the archaeological evidence is being interpreted correctly. It is suspected that, while filth around houses and in the streets attracted municipal attention at most times, among most populations water pollution was more dimly appreciated until it reached the point where the water actually stank.

River pollution

There is rather little clear evidence from biological remains concerning early river pollution in the north of England from any source as yet. Determination of water quality is clearly an important objective, and one to which invertebrates, including molluscs, ostracods and insects (especially chironomid midge larvae, p. 68), will certainly contribute. In York, for example, Roman freshwater snails recorded in small numbers from the Tanner Row site included four taxa which indicated hard water, so that the River Ouse seems to have had a dissolved calcium content at or above 20 mg/l (Hall and Kenward 1990, 386; O'Connor AML 4768). O'Connor (AML 4297, and in Kenward and Hall 1995, 780) has suggested that an apparent change in the relative abundance of the bivalves *Unio tumidus* and *U. pictorum* through the Anglo-Scandinavian period at Coppergate, York, may possibly indicate degradation of water quality by pollution as York increased in size, the more pollution-tolerant *U. pictorum* becoming relatively more frequent.

Sewage and waste were perhaps not more than locally important causes of pollution, and effects of turbidity caused by clearance, agriculture and mining upstream may have been more significant. The Ouse/Humber system has been subjected to some research relevant here (Hudson-Edwards *et al.* 1999a, b; Longfield and Macklin 1999; Macklin *et al.* 2000; Taylor *et al* 2000).

The large number of sites related to the River Foss and the Kings Fishpool in York represent an opportunity to investigate pollution in the Foss basin; it undoubtedly occurred in view of the abundant evidence for rubbish dumping at the water margins (p. 411) and evidence for tanning and retting (Carrott *et al.* EAU 1997/25; see also p. 365), but the effect on, say, fish populations or the potability of water is unknown. Pollution-sensitive invertebrates should provide evidence, although any work on rivers is complicated by the transport of organisms from upstream, where water quality may be better.

'Riffle' beetles of the family Elmidae appear to be among the most useful quickly-recognisable invertebrate indicators of clean flowing water from ancient deposits (e.g. Dinnin 1997a; Greenwood and Smith 2005; Osborne 1996; Ponel 1997; Smith 2000a), although small numbers are sometimes found in clearly terrestrial deposits. This was the case at 16-22 Coppergate, York, Kenward and Hall 1995; these remains may have been introduced in imported water or cut waterside vegetation, or have been background fauna (as flying individuals or in trampled mud), and there is no good reason to suspect flooding. Several Elmidae ('riffle beetles') have become much rarer in the past millennia, to judge from archaeological records from rivers outside our area (e.g. Dinnin 1997a; Greenwood and Smith 2005; Howard *et al.* 1999; Osborne 1974; 1997a; 1997b; Smith 2000a). Hill (1993, 141) noted a group of elmids from later Bronze Age St George's Field, York, while Kenward and Hall (EAU 2000/14; 2004) recorded *Macronychus quadrituberculatus* from terrestrial deposits at the Queen's Hotel site, Mickelgate. This riverine species, apparently found on submerged wood, has very rarely been found in Britain (as far north as Lake Windermere), and is quite possibly extinct (Holland 1972). Its occurrence in York's rivers at so late a date is surprising, perhaps with the implication may be that there was sufficient post-Roman recovery in the River Ouse to enable these sensitive beetles to re-establish populations. These riffle beetles may have been adversely affected by pollution and increasing silt load in lowland rivers and, like some other insects, may prove to be useful indicators of the earlier stages of human damage to riverine ecosystems, although it will be necessary to evaluate the possibility of transport downstream from cleaner streams. Odd individuals of these elmids may have arrived as 'background fauna' - they have been observed in flight (e.g. Jäch 2003). Clearly further research using riverine sediments is required to address this significant aspect of past human impact.

The literature of water-quality estimation from modern invertebrates is large and much of it is relevant to palaeoecology. There is significant potential for further studies of river levels and water quality using invertebrate remains, with results relevant to both archaeology and biological conservation, and future opportunities to do so should not be allowed to pass without an attempt to obtain appropriate funding.

Waste disposal

Increasing population densities in growing settlements meant more waste, and soon rural manuring systems (reviewed by Guttmann *et al.* 2005) became irrelevant, either because quantities were unmanageable or because the direct link with farms was lost. In towns, pits and other cuts, middens, and waterfronts were used to dispose of material, although a good deal undoubtedly clearly just ended up on surfaces and contributed to the general accumulation. Pits for waste disposal are encountered primarily in towns - there were better uses for foul organic matter in the country, and easier ways of getting rid of it even if it is unwanted! The best-known groups of urban waste disposal pits in the north of England are probably those at 16-22 Coppergate (Kenward and Hall 1995), but samples from a large number of pits at The Bedern have also been studied (Hall *et al.* AML 56-58/93). However, in total, invertebrates from an enormous number of pits from numerous sites have been studied, and synthesis of the information is perhaps overdue (although the value of many of the data is restricted by their origin in evaluation and assessment exercises).

Whatever means of waste disposal was used, it had the implication of moving biological remains around, and often mixing remains from different sources, with implications for the interpretation of archaeological death assemblages.

Decomposer organisms

Decomposers are animals involved in the breakdown of organic matter of one kind or another. Most invertebrate groups include decomposer species. They are of immense value in archaeology since characteristic groups of species exploit different kinds of decaying matter, with different species associated with dry or moist litter, with birds' nests, with stable manure, with moist or dry corpses, with buried organic matter with dung, and so on. Various groups of decomposers, such as house fauna and those found in stable manure, are considered at length elsewhere in the review. Here we are drawing on evidence for the location, nature and condition of waste material The decomposer communities of occupation sites are part of a special kind of ecosystem, which is 'donor-controlled' - in other words it relies on input or organic matter from outside the system, and does not have any primary production (discussed for archaeological vertebrate communities by O'Connor 2000). Such systems are inherently unstable, unpredictable in their species composition, and liable to catastrophe, adding considerably to the challenge of interpreting them archaeologically.

Surface scattering and middens

Middens (excluding shell middens, which are a very different issue) seem rarely to be preserved in a recognisable form and may not have been used except in unusual circumstances. There is a problem of terminology, however, firstly because one archaeologist's 'spread' or 'surface accumulation' may be another's 'midden', and secondly because such surface dumps may have decayed rapidly. The present writer would certainly regard the large spreads of Anglo-Scandinavian dye-waste at 16-22 Coppergate (e.g. Kenward and Hall 1995, 551-2) as middens, for example, and many surface layers at the site included evidence of decomposing matter. Most sites where surface-laid deposits give preservation by anoxic waterlogging almost by definition offer evidence for disposal, whether deliberately or thoughtlessly, of waste onto surfaces. Such behaviour is often represented by 'general accumulation' of material from many sources. Waste was clearly dropped onto floors at Anglo-Scandinavian sites such as 6-8 Pavement and 16-22 Coppergate, York (Hall *et al.* 1983b, Kenward and Hall 1995, the latter arguing that 'floor deposits' at Coppergate were truly associated with occupation rather than abandonment, p. 725-6), and at some sites in Carlisle (e.g. Allison *et al.* 1991a-b). Informal random disposal on to external surfaces is perhaps less easy to recognise as preservation is likely to be reduced by factors such as drying, trampling and disturbance by chickens. But a good many external layers at

Coppergate gave evidence of disposal of a range of materials (see above), and deposits at 4-7 Pavement seem to have accumulated in the open in middens (Hall and Kenward EAU 2000/22). There is, however, a danger that levelling with re-excavated pit fill or other material may give the impression of primary disposal on surfaces. This should be recognisable during excavation in most cases.

Dog coprolites seem most likely to have formed from calcium-rich stools on surfaces or within surface deposits: they are frequent, and reasonably easily recognised by their texture and content (p. 112); Allison *et al.* (1996b) recorded numerous examples, some containing *Trichuris* eggs, from Anglian Fishergate, York, for example.

Pits

Pits are of course very common at sites of many kinds and periods, and are found at almost all intensive occupation sites where a useful sample of the deposits has been excavated. There is a strong bias in the chronological distribution of pits, since their use for waste disposal appears to have been positively correlated with settlement size (until density was too high to find places to dig them) and negatively correlated with the quality of organised waste disposal systems and with status (well-off people were not likely to dig pits in their backyards as a matter of course if there was a municipal refuse system or strong ordnances against informal disposal). Their primary function is often a matter for argument, and the writer has frequently heard the argument that no-one would go to the trouble of digging and lining a pit just to throw waste into it. This is clearly nonsense, at least for urban sites: privy-digging must have been an essential component of civilised life, and there is rarely the slightest hint of evidence for a 'primary' use even of rural pits before they were backfilled, often with a component of rubbish. (The author has not encountered any records of confirmed *storage* pits in the north during the course of this review. Clearly *industrial* pits have occasionally been recognised, however, for example at Walmgate, York, O'Connor 1984c.)

For some periods, pits were undoubtedly the normal means of disposal for faeces and a range of other waste, as witnessed, for example, by the enormous volume of material at 16-22 Coppergate and The Bedern, York (Kenward and Hall 1995; Hall *et al.* AML 56-58/93). Similar evidence has been found at many other sites, although full analysis has often been impossible within project constraints. At Coppergate, perhaps most of the pits gave evidence for human faeces, but a large proportion contained other kinds of material, including floor sweepings and dyeplant debris. In contrast, the reason why the pits at a rural site such as that at North Cave, East Yorkshire, were dug is far less clear, even though some contained what may have been refuse (Allison *et al.* EAU 1997/37; forthcoming a). It is possible that research excavations at rural sites may eventually cast light on primary uses of such pits (e.g. by very fine-scale sampling for micro- and macrofossils, and by analysis of thin sections), but often no more than guesses as to their function can yet be made. Many were probably dug to obtain sediment, others as temporary insertions of posts, others as sumps, but the range of reasons for digging holes is enormous - and the earth-moving power of livestock such as pigs and chickens (see Dobney *et al.* 2000a concerning the latter), and of children at play, should never be forgotten by archaeologists!.

There can be no doubt that many 'pits' in the widest sense were primarily dug for the disposal of faeces, and the position of many - often stone or brick lined - within or adjacent to buildings clearly indicates their function as garderobes. Good examples were encountered at The Bedern, York (Hall *et al.* AML 56-58/93), at North Beckside, Beverley (Carrott *et al.* EAU 1993/05) and Queen Street, Hull (McKenna 1993).

Kenward and Large (1998b), in a paper nominally concerned with the detection of the season of deposition of pit fills, modelled the development of insect populations in Anglo-Scandinavian pits at 16-22 Coppergate, and also considered the relationship of fill volumes of cesspits to human populations. They concluded that only a small number of people per tenement would be needed to produce the faeces recovered, although the assumptions made were deliberately provocative.

Waste in ditches and gullies

Some ditches doubtless acted as long-term drains for runoff or foul liquid waste, but very often they were eventually used to dump rubbish, perhaps sometimes through lax control but perhaps more often as a way of filling a redundant cut. The Anglo-Scandinavian ditches or gullies at 16-22 Coppergate were used as dumping places in all cases where analysis was carried out, and indeed there was little to indicate a primary drainage function (Kenward and Hall 1995). The ditches of the Roman fort at Ribchester, Lancashire, frequently included a component of dumped material, perhaps often stable manure, and probably deposited during levelling (Buxton *et al.* 2000a-d; Carrott *et al.* 2000; Large *et al.* EAU 1994/11). The ditches at Kirkham seem also to have received waste (Carrott *et al.* EAU 1995/02). At the Adams Hydraulics III site, York (Allison *et al.* 1991/05), fills of a putative Roman ditch of early 3rd century date included a probable stable manure group. The large ditch or creek at the Magistrates' Courts site in Hull seems to have received large quantities of waste from the adjacent houses ((Hall *et al.* EAU 2000/25; 2000/33). Even ditches associated with major structures may have been used for dumping; Carrott *et al.* (EAU 1995/35) found some evidence of waste disposal in fills of the Castle ditch at 1-2 Tower Street (Castle Garage), York, for example. On the other hand, assessment of insect remains from fills of the large medieval ditch fronting the city wall at Rickergate, Carlisle, gave no evidence that waste had been dumped (Kenward EAU 2002/13); perhaps there were well-enforced regulations banning this.

In some cases, all too few from the interpretative point of view, rural ditches seem to have been used for dumping, for example at 17-19 St Augustine's Gate, Hedon (Carrott *et al.* EAU 1993/04), where 15th century primary ditch fills yielded abundant synanthropes including house fauna, grain pests, and species associated with foul mouldering matter. The early ditches as the Tanner Row and Rougier Street sites, York (Hall and Kenward 1990) can perhaps be regarded as rural and they certainly received waste. In other cases the evidence is less clear, and occupation waste may have found its way into ditch fills accidentally, as may have been true for some ditches at the Iron Age and Roman-British site at North Cave, East Yorkshire (Allison *et al.* EAU 1997/37; forthcoming a). Debris in the Roman ditches at the Old Grapes Lane site, Carlisle, may have largely been of accidental origin, though a few layers seemed to have received dumps (Kenward *et al.* AML 78/92; 2000). Many rural ditches around occupation sites seem not to have been used for dumping at all, having infilled gradually and often apparently naturally, and this presents difficulties in reconstructing activity and living conditions at such sites, where there is no surface preservation (p. 462).

Landfill

The use of rubbish to build up land surfaces is not just a modern phenomenon. Much of the Roman sequence at Tanner Row, York, probably represents deliberate dumping of a range of material including stable manure and domestic waste, perhaps to raise levels prior to building (Hall and Kenward 1990). In some cases large insect populations probably developed *in situ*, but determining whether this was so or the fauna was imported with the dumped material was difficult. Thus the records of houseflies (*Musca domestica*) and stable flies (*Stomoxys calcitrans*) may indicate very foul conditions in the dump, but may equally define the state of stable floors. The combination of a good stratigraphic record with plant and invertebrate evidence may clarify this point in particular cases; it is an important one since we want to know conditions at the *source* of dumps (which may be the only deposits with adequately-preserved remains at some sites), as well as in the dumps themselves. Land around the Kings Fishpool, York, seems to have been raised by dumping (e.g. p. 411), although whether to create new space for occupation or just as a (perhaps illicit) means of waste disposal is uncertain.

Post-medieval to early modern land fills may provide better samples of the contemporaneous urban biota (including insect parasites) than occupation deposits, and thus offer the opportunity to trace the arrival and establishment of aliens (cockroaches, for example) as well as giving pointers to living conditions and activity at the source.

Waterfronts

Dumps in waterfronts may just represent convenient waste disposal, but sometimes such dumping was apparently well organised, with important implications concerning social structures or personal power. London and Lincoln offer classic cases of massive waterfront dumps, but some have been recognised in the region considered here and doubtless many more remain to be investigated since waterfront excavations have been fairly rare (although some of the cases cited in the previous section could be regarded as waterfronts in a general sense). Whether dumping was formal or casual, it is useful to determine whether waste was dumped into water or onto the bank; the two have considerably different implications for water pollution and contamination of drinking water, but material on banks would also have posed a threat of disease as a result of transmission of pathogens by flies and perhaps other organisms. From the interpretative point of view, if dumping was into water, the fauna represents a 'freezing' of the community at the source of the waste, while if material lay on the bank, there may have been further development of fauna, reducing the value of the deposits in reconstructing conditions at source. Mixing of dumps in water is always possible, and dumping of re-excavated waste may lead to reversed chronologies. These tricky taphonomic issues (discussed further on p. 304) are important and should not be ignored, since waterfronts may be the best locations for large-scale preservation by anoxic waterlogging in some places. At Lincoln, analyses of such dumps have generated significant hypotheses regarding late Roman life, for example (Dobney *et al.* 1998). Waterfront deposits at Chapel Lane Staith, Hull (Kenward 1979c), were notable since there was a clear marine influence and perhaps less chance of a typical synanthropic fauna developing *in situ*, so the fauna at the point of origin may have survived in a relatively unaltered state.

In the region considered here, dumping on waterfronts has been observed through analyses of deposits at Chapel Lane Staithe, Hull, mentioned above, where the late 13th and 14th century waterfront presumed to be the west bank of the River Hull gave some notable insect assemblages, with evidence of the kinds of material being dumped as well as indications of conditions in the river. There were dumps both in front of and behind the waterfront revetment. One deposit, for example, included enormous numbers of grain pests (*Oryzaephilus surinamensis* and *Sitophilus granarius*), a substantial house fauna, foul decomposers and species which may have originated in hay, and so probably included stable manure. Some of the samples contained abundant beetles associated with rotting seaweed, presumably exploiting salt-soaked organic waste in this case, and clearly post-disposal colonists. Excavations associated with the improvement of Layerthorpe Bridge, York, produced a range of evidence of dumping (Hall *et al.* EAU 2000/64). It seemed that there was tanning waste in many of the layers, while in some cases there were insects which seemed likely to have come from in or around occupied structures, and in others there were communities likely to have lived foul, waste, perhaps including stable manure. The ABC Cinema site, and others along the River Foss, in York have also yielded what appeared to be river- or lakeside dumps and it is unfortunate that it has not been possible to fund more detailed investigation of the material.

Further studies of waterfront dumps and waterside landfills are desirable for a variety of reasons in addition to those given above, for example they may provide rare evidence of normal water levels, episodes of flooding, and saline influence (*cf.* p. 297). They may also include material discharged from ships (and even the ships themselves!), offering the possibility of detecting trading links through alien biota. The numerous sites of this kind in York offer an excellent opportunity for a major programme of analysis and synthesis; the sites listed by York Archaeological Trust (1988) have since been augmented by further cases.

Health and hygiene

The topic of human health and hygiene is, inevitably, tied closely with those of waste disposal, living conditions and diet. The present section is concerned primarily with parasites and disease vectors. Busvine (1976) gives an extensive summary of the historical evidence regarding insects and disease, as well as a great deal of other relevant information; Cloudsley-Thompson (1976) covers similar ground. The likely importance of insects in the broad sweep of history is argued by Riley (1986), who ascribes a substantial part of the decline in human mortality rates in Europe from the 17th to 20th centuries to factors involving insects. Jones (1980a-b), in essentially popular articles, considers aspects of the history and archaeology of various parasites. Bouchet *et al.* (2003a; b;) review recent evidence of parasites from archaeological sites. A broad review of archaeological parasitology is given by Reinhard (1992), who emphasises applications, though again with a New World bias.

The enormous importance of invertebrates as disease causers and vectors on a world scale can hardly by over-emphasised. A closely-printed 30-page list of arthropod vectors given by The Royal College of Physicians (1961), and the list of causers in the same volume, serve to underline this. Numerous textbooks deal with medical aspects of invertebrates; some are mentioned on p. 313.

Five main groups of invertebrate parasites of humans have been recorded from archaeological deposits in the region: nematodes, fleas, lice and bedbugs. There have also been tentative identifications of a protozoon. A further group, the ticks, may affect humans but are considered as pests of livestock (p. 429). The eggs of flukes may eventually be convincingly identified (p. 23). The evidence of tapeworms is not clear (p. 23). Various mites affect humans, some causing dermatitis, others simply being skin-dwelling commensals; the species concerned all seem to be soft-bodied and their recovery here is perhaps unlikely.

Addyman (1989) reviewed the archaeology of public health in York.

Protozoon parasites

We have little direct evidence concerning protozoon (or viral and bacterial) diseases in Britain in the past, although there is some historical documentation for malaria. Plague, a bacterial disease, is extremely well documented, of course, and while much has been written on the subject (some references are given below), this is not the place to review it. Invertebrate plague vectors are briefly considered below.

Some of these diseases might conceivably be detected in archaeological human remains by DNA or other biochemical analysis. The bacterial causer of tuberculosis has been found through detection of lipids (e.g. Redman *et al.* 2002; Taylor *et al.* 2001). More relevant to the present review, DNA of the bacterial agents of trench fever (transmitted by fleas, lice and ticks Drancourt *et al.* 2005) and plague (Drancourt and Raoult 2002) have reportedly been found in ancient human dental pulp. There is also evidence from DNA for malaria (e.g. Abbott 2001; Bada et. al. 1999; de Castro and Singer 2005; Hume *et al.* 2003; Sallares and Gomzi 2001; Soren 2003); the disease was present in Britain in the past (e.g. Dobson 1980) and so evidence for it in the North of England may reasonably be sought.

Protozoon diseases may, more rarely, be detected through effects on skeletons (e.g. Toxoplasma, which may cause cerebral calcification, Markel and Voge 1976, 154-5). The organisms themselves may sometimes be preserved. Jones (AML 71/87) reported large counts of 'structures which closely resembled the oocysts of an intestinal coccidian ... probably *Eimeria* or *Isospora*' from a site in Chester. He suggested that they were of the right size for *Isospora belli* Wenyon, the causal agent of human coccidiosis, but considered closer identification to be unwise. Successes in recovering evidence for diseases of this kind are likely to be serendipitous rather than representing a reliable routine technique.

Nematode parasites of humans: *Trichuris* and *Ascaris*

The eggs of nematodes parasitic in human beings are found very frequently in archaeological deposits (p. 25). There are certainly considerable problems involved in determining how big infestations were and what proportion of the populace had worms, but infections were undoubtedly extremely common, perhaps almost universal at some places and periods. On a world scale, the range of nematodes known from archaeological deposits is becoming substantial (see above, taxonomic section). The eggs occur in anoxic sediments, in faecal concretions (i.e. those formed in faecal pit fills), and in coprolites (i.e. mineralised or desiccated discrete stools). Concretions and coprolites are discussed further on p. 116. These minute, pollen-sized, eggs (and concretions containing them) were certainly redeposited on a large scale, and care is required before yards and floors are assumed to have been faecally-contaminated and a source of infection because the parasites are present (re-excavated eggs would almost certainly be non-viable). The following are illustrative examples of records of eggs.

There do not appear to be any undoubtedly pre-Roman records of parasitic nematodes from the area considered in this review other than that from the Lindow II bog body (Jones 1986). This may be a result of a combination of low levels of infection, itself a result of efficient waste disposal, and low population densities, although it is notable that the only body examined for eggs *did* show a substantial infestation. The disposal of faeces away from the immediate dwelling area at most sites seems to be a more plausible explanation for the lack of records. Further investigation of parasites of the pre-Roman period is a priority.

There are some records of eggs of parasitic nematodes from the Roman period. For Carlisle, Kenward *et al.* (AML 77/92; 2000) noted them from Lewthwaites Lane. The Old Grapes Lane A site gave notable results (Kenward *et al.* AML 78/92; 2000), for *Ascaris* was sometimes rather better represented in relation to *Trichuris* than normal in assemblages of eggs from deposits containing what is believed to be human excrement. While it is possible that this was a non-significant result of the small numbers of eggs observed, a high relative count for *Ascaris* eggs has been associated with pig faeces (p. 27). Unfortunately none of the contexts with a high proportion of *Ascaris* eggs contained sufficient well-preserved *Trichuris* to allow measurements to be made, although even this may not have clarified matters (p. 30). At Castle Street, Allison *et al.* (1991a, 69-71) found that human gut nematodes were never abundant.

At Ribchester, Lancashire (Large *et al.* EAU 1994/11; see also Buxton *et al.* 2000a-d; Carrott *et al.* 2000) an extensive survey for parasite eggs gave only very limited evidence for contamination by human faeces, unless infection was rare. Buckland (1976a) discussed records of *Trichuris* and *Ascaris* from the Roman sewer at Church Street, York. There were traces of eggs of both genera in one sample from the Roman well at The Bedern (Kenward *et al.* 1986b), but they were too rare to suggest deliberate disposal of human faeces. Still in York, parasite eggs were present sporadically and generally in small numbers in Roman deposits at the Tanner Row site (Hall and Kenward 1990, 394). Some mid 2nd century drain fills gave food remains and abundant *Trichuris* and *Ascaris* and clearly contained a faecal component. Intestinal parasite eggs were abundant in lumps of faecal concretion from one late 3rd century layer, but it was considered to have been re-excavated from older deposits elsewhere. Some pit fill deposits dated to the fourth century and later contained abundant eggs of parasitic nematodes and also foodplant remains, and were undoubtedly rich in human faeces. Mid-late 2nd century ditch fills at Rougier Street mostly gave modest concentrations of *Trichuris trichiura* and *Ascaris* sp. (Hall and Kenward 1990, 379).

Anglian occupation deposits at Fishergate, York (Allison *et al.* 1996b) produced quite numerous objects identified as dog coprolites (or fragments of such), particularly in the earlier phases. Some proved to contain eggs of *Trichuris* and (more rarely) *Ascaris*, perhaps present as a result of dogs eating human faeces. A modest number of other deposits at Fishergate gave traces or small numbers of parasite eggs (*Trichuris*, *Ascaris*, or both), but only occasionally were the numbers sufficient to give acceptable evidence of the disposal of human faeces

Small numbers of *Trichuris*, and often also *Ascaris*, eggs were present in a large proportion of Anglo-Scandinavian deposits at Coppergate, York, and they were sometimes very abundant in pit fills which gave other evidence for faeces (Kenward and Hall 1975, 642, 696-7, 758-9). Eggs were sometimes recorded only in small numbers in what appear to have been faecal layers, perhaps as a result of low infection rates but equally possibly just a manifestation of their patchy distribution. Parasite eggs were occasionally found in large numbers in surface deposits, but this was probably a result of the redeposition of pit fills. The 'Lloyds Bank stool' from 6-8 Pavement, York (Jones 1983b) may have been a discrete mineralised human stool as argued by Jones, but conceivable was simply a lump of faecal concretion fortuitously having the right shape and size. It contained some *Ascaris* eggs, and large numbers of *Trichuris* with the correct dimensions of *T. trichiura* of humans.

For the period after the Norman conquest, there are numerous records of nematode parasite eggs. These were doubtless mainly of humans, but the constraints of evaluation projects preclude confirmatory measurements. Eleventh-13th century deposits at 44-5 Parliament Street, York, produced them, mostly small numbers of *Trichuris*, suggesting contamination by human faeces, perhaps as a primary component of some pit fills in view of evidence from plant remains (Carrott *et al.* EAU 1995/08; EAU 1996/15; Davis *et al.* 2002). Assessment of post-Conquest material from 16-22 Coppergate by Carrott *et al.* (EAU 1996/09) showed that many samples were rich in plant remains interpreted as indicating faecal material, often accompanied by rather characteristic insect assemblages and large numbers of parasite eggs. Carrott *et al.* (EAU 1996/44) reported *Trichuris* eggs in small to modest numbers in a series of 12th-14th century levelling/dump/buildup layers at the Merchant Adventurers' Hall, and well fills dated to the 14th-15th centuries at 22 Piccadilly gave some parasite eggs (assessment by Carrott *et al.* EAU 1995/53).

Although eggs of both *Ascaris* and *Trichuris* (*T. trichiura* on the basis of measurement) were recovered from over half of the samples from 12th-14th century deposits at the Dominican Priory site, Beverley, which were examined, they were present only in very small numbers (Allison *et al.* AML 21/90; 1996c), probably because they were of 'background' origin in most cases. The general matrix of one pit fill, which on the basis of the botanical evidence appeared likely to include faeces, also gave very small numbers; samples of concretion from this same layer contained rather more parasite eggs, however. Whether this was a taphonomic effect, or reflected variations in infection levels of individuals, can only be guessed.

The spread of nematode infections

Infection by the common nematode gut parasites occurs all too easily. Vast numbers of eggs are produced by both *Ascaris* and *Trichuris* (e.g. Markell and Voge 1976, 240, 261), and they remain infective for some time. The exposure of faeces in pits is attested by evidence from some sites (for example Anglo-Scandinavian Coppergate, York, Kenward and Hall 1995), and it is likely that eggs were dispersed by insects as a consequence (Kenward and Large 1998b). Infection by drinking water seems possible where wells were close to cesspits or contaminated ditches.

Insect parasites of humans

Several species of insects parasitic on humans have been recorded from archaeological deposits in the north of England, two of them, the human flea (*Pulex irritans*) and louse (*Pediculus humanus*), rather frequently. Busvine (1976) is a mine of information concerning the occurrence of, and attitudes towards, these insect parasites in the past, and literature from classical antiquity is reviewed by Beavis (1998).

In addition to these specific insect parasites of humans, the 'sheep tick' (*Ixodes ricinus*), which frequently attacks people, has been recorded from archaeological sites (p. 429).

Pulex irritans*: the human flea*

Fleas, including *P. irritans*, are capable of transmitting a variety of diseases, notably plague (brief review by Kenward and Hall 1995, 764; see also, for example, Benedictow 1992; Harwood and James 1979, 337; van der Hoeden 1964, 65; and with respect to the role of rodents, Twigg 1978), so their past occurrence may have at times represented more than a minor annoyance. That fleas afflicted past human populations may appear self-evident, part of the assumed wisdom of archaeology and historical fantasy literature. However, nothing is certain until proven, and there are doubts about where in the world the human flea came from and when it arrived in Europe (Yvinec *et al.* 2000), since the relatives of the human flea are found in the Americas (Buckland 1987; Buckland and Sadler 1989; Hopla 1980; Kenward and Allison 1994c; Traub 1985). Archaeological records are helping to elucidate a biogeographical puzzle with considerable implications for humans. There is now abundant evidence of the widespread occurrence of human fleas in Europe from the Iron Age onwards, with a few earlier records, and a very ancient origin in the Palearctic seems likely, perhaps initially on another host or having arrived by a route across Asia from the Americas (Kenward 1999; 2001a). When environmental archaeologists have the opportunity to examine insects from occupation deposits across Asia we may yet discover some interesting facts about past, perhaps very early, two-way human movement between Asia and North America from records of fleas!

Human fleas are very common in archaeological deposits and may be very abundant, for example in occupation deposits at the Early Christian rath site at Deer Park Farms, County Antrim, Northern Ireland (Allison *et al.* EAU 1999/08; 1999/10), in some Anglo-Scandinavian floor layers at 16-22 Coppergate, York (Kenward and Hall 1995), and in certain of the 14th century occupation deposits at the Magistrates' Courts site, Hull (Hall *et al.* EAU 2000/25; 2000/33). There are now many records of *P. irritans* from northern England following the first one from Anglo-Scandinavian York (6-8 Pavement, Hall *et al.* 1983b) and one noted at about the same time from 15th century Mytongate, Hull (Miller *et al.* 1993). The only known previous archaeological record was that from Dublin (Rothschild 1973). The earliest-dated european examples are from Neolithic Orkney (Elias 1994, 124) and from the Iron Age of the Isle of Man and The Netherlands (Allison *et al.* EAU 1990/07; Tomlinson *et al.* 2002; Hakbijl 1989). The insect will doubtless eventually be found in Iron Age (and perhaps earlier) sites in the north of England and elsewhere. The recent review of Yvinec *et al.* (2000), though valuable for various reasons, omits most of the known records.

The flea was apparently common in the **Roman** period, with numerous records. From Carlisle, for example, it has been noted from the Old Grapes Lane A and B sites (Kenward *et al.* AML 77/92; AML 78/92; 2000), and Castle Street (Allison *et al.* 1991a, several records of *P. irritans* and indeterminate remains probably of this species). There were numerous examples from the Roman fort at Ribchester (Buxton *et al.* 2001a-d; Carrott *et al.* 2000; Large *et al.* EAU 1994/11), where it was abundant in a few deposits. Records from York include a substantial number from Tanner Row (Hall and Kenward 1990, from 2nd-4th century layers, though particularly frequent in the late second century deposits associated with the second phase of timber buildings), and one from the Adams Hydraulics III site (Allison *et al.* 1991/05). Most of these records were from deposits associated with fairly dirty circumstances, and perhaps reflect people at the lower end of the social scale - particularly those spending their time in and around stables. The likely effect on the more fortunate part of the population remains to be discovered, but few are likely to have escaped the attentions of these highly mobile and persistent animals.

There are no well-authenticated records of human fleas from the **5th to 8th centuries** in the area considered here (although as noted above they were abundant in Early Christian deposits at a site in Ireland). This is not surprising bearing in mind the rarity of anoxic waterlogging at occupation sites of the period. A single specimen from Castle Street, Carlisle (Allison *et al.* 1991a) is supposedly of Anglian date, but suspect in that grain pests accompanied it (see p. 200).

From the **Anglo-Scandinavian** period, the single *P. irritans* from 6-8 Pavement, York has been mentioned above. Others may have been overlooked at this site. The flea occurred in nearly 200 contexts, sometimes in large numbers, in Anglo-Scandinavian deposits at 16-22 Coppergate (Kenward and Hall 1995, 698-703), and it has been noted frequently in deposits of the period at other sites, for example in floors at 41-49 Walmgate (Johnstone *et al.* EAU 2000/04), and at 1-9 Micklegate (Kenward and Hall EAU 2000/14). Indeed, it is rarely absent in urban deposits with good preservation of delicate remains from the 9th century onwards.

In the period **after the Norman Conquest**, fleas continued to occur regularly, records (mostly rather poorly provenanced since from evaluations) being exemplified by the following. From York, one was found in an apparently waterlain assemblage, perhaps immediately post-Conquest and probably introduced with dumped domestic waste, from 84 Piccadilly (Carrott *et al.* EAU 1991/16); from a borehole sample of ?earlier medieval date at 17-21 Piccadilly (Alldritt *et al.* EAU 1991/01); from a 12th-14th century buildup deposit, probably including stable manure, at the Merchant Adventurers' Hall (Carrott *et al.* EAU 1996/44); a single individual from a 12-14th ?dump into the King's Fishpool at Palmer Lane (Carrott *et al.* EAU 1992/05); and one, perhaps brought in stable manure, in a 16th century dump at Carmelite Street (Carrott *et al.* EAU 1991/15). There was a modest number of records of *P. irritans* or Siphonaptera sp. (probably *P. irritans*) from The Bedern, mostly from 14th century pit fills, with one from the 17th century (Hall *et al.* AML 56-58/93).

In Beverley, records include specimens from a pit fill associated with ?12th century landfill, perhaps dumped in floor sweepings, from the Dominican Priory (Allison *et al.* 1996c), from blanketing peat (which included some house fauna and other synanthropes) at Well Lane (Carrott *et al.* EAU 1999/04), from a 12-13th layer, perhaps including stable manure, at Keldgate (Carrott *et al.* EAU 1995/03, illustrating the general problem of whether *Pulex* is indicator of houses or often bred in other structures) and from 12th and 15th century pit fills at Morton Lane (Kenward and Carrott PRS 2003/58). There is a medieval record of *P. irritans* from Baxtergate, Whitby (Carrott *et al.* EAU 1992/04). At Blanket Row, Hull, several *P. irritans* occurred in probable stable manure associations (Carrott *et al* EAU 2001/12), and in the same town it was frequent at the Magistrates' Courts site (Hall *et al.* EAU 2000/25 ; EAU 2000/33), and found in a pre-18th century pit at 54-7 High Street by Jaques *et al.* (PRS 2003/01).

It has not been an aim in this review to produce a systematic database of records for species, only examples, so no analysis of the relationship of records of fleas (or any other invertebrates) to date or site/deposit type can be attempted. Such an exercise would undoubtedly be rewarding. The latest date for an archaeological record of *Pulex* in the region is uncertain, one from The Bedern (above) probably taking the honour, but the relative rarity of late records should not be taken as an indication of the decline of the flea, since the poorer preservation typical of later deposits may be a factor. The human flea still just survives in the north of England (e.g. a record from the University of York campus, Kenward unpublished), but is becoming a rarity.

Some rodent fleas may bite humans (for example when they are starved), and consequently transmit disease, typhus and plague being the most serious (Busvine 1976, 48-59). These parasites of commensal rodents are considered on p. 429. Similarly, as pet owners know to their cost, cat and dog fleas (p. 428) often attack humans.

Pediculus humanus*: the human louse*

What is perhaps most remarkable about the fossil record of this and other lice is that such soft, delicate creatures are represented at all, although it is suspected that they have often been lost to the record through decay even where a range of other insects have survived in good condition. The fossils are certainly easily destroyed by drying or rough handling in the laboratory. Bodenheimer (1951, 40) states that eating of lice picked from one's body, or those of relatives, is 'almost cosmopolitan', and there is a little evidence to support this, e.g. Fry (1976). Assuming that they pass the gut undamaged (as at least some other insects do, Osborne 1983), this may be one way in which lice became rapidly incorporated into sediments ideal for their preservation. Such a route would account for the mineralisation of pubic lice (*Pthirus pubis*) from some sites (e.g. Girling 1984; Kenward 1999; 2001a). However, lice are frequently found in such challenging environments as floor deposits.

The human louse is responsible for the spread of some dangerous pathogens of humans: *Borrelia recurrentis* (a spirochaete, causing relapsing fever), *Rickettsia prowazekii* (bacteria causing epidemic typhus), *Bartonella* (or *Rickettsia*) *quintana* (trench fever and various other conditions), and *Rickettsia mooseri* (endemic or flea-borne typhus) (e.g. van der Hoeden 1964, 65, 278; Harwood and James 1979, 137-137; Maunder 1983). It seems to have had a long and exclusive association with humans, perhaps having evolved as humans did (related lice occur on chimpanzees, Busvine 1976, 41). Archaeological records show that they have been in Britain at least since the Roman period. The rarity of occupation deposits of earlier date with good preservation by anoxic waterlogging is likely to frustrate our attempts to trace the records of lice (and fleas) back further, and every opportunity should be taken to sample and analyse in detail such material.

P. humanus is usually regarded as including two subspecies, *P. h. corporis* (the body louse) and *P. h. capitis* (the head louse), whose separate status has been argued to be sound (e.g. Busvine 1978). However, they interbreed freely (Maunder 1983) and it has been claimed that they can mutate one into the other over a few generations (Levene and Dobzhansky 1959), though it is not clear how well the experiments involved were controlled. Clay (1973) suggested that the forms should be 'considered as unstable environmental subspecies', adding that 'many specimens cannot be assigned to one or other of the subspecies.' This view has been supported by investigation of mtDNA from the two, which gives rather strong evidence that they are in fact conspecific, with gene flow between them (Leo *et al.* 2002). Indeed, Yong *et al.* (2003) suggest, again on nuclear and mitochondrial DNA evidence, that head and body 'forms' of *P. humanus* differentiated twice, once on humans in Africa, and again on hosts outside Africa. This story is complicated by the work of Reed *et al.* (2004), who suggest that there are two ancient lineages of head lice, which predate modern humans, having separated about 1.18 million years ago. Separation of these forms from archaeological material would generally be unreliable, unless exceptionally well-preserved remains were recovered (e.g. examples from Greenland, Sadler 1990, and Israel, Mumcuoglu *et al.* 2003). This is unfortunate, since head and body lice are likely to find their way into deposits under somewhat different circumstances. Head lice would easily be shed for various reasons, and be perhaps picked off by loved ones, or at least parents, as a matter of routine, but body lice would be most likely to leave the host on death, or less dramatically, when clothes were removed and they and the body thoroughly cleaned (a rare event in some periods, perhaps).

Pediculus stays on its host so records in archaeological deposits probably normally indicate areas where people either spent a lot of time or specifically cleaned themselves or their clothes. At Coppergate, their occurrence was used to suggest a more domestic function of period 4B post-and-wattle buildings when compared with the timber ones of period 5B. Lice can certainly be deposited outdoors: observation of large numbers of human lice in external layers at the Deer Park Farms site, with no evidence of an origin in floor sweepings (Allison *et al.* EAU 1999/08; 1999/10), suggests that they were shed in the open, in this case perhaps when clothes were cleaned or individuals were systematically de-loused.

There are a substantial number of records of human lice from **Roman** deposits. At Tanner Row, York (Hall and Kenward 1990) there were mid to late 2nd century records from organic-rich dump deposits, some apparently including stable manure. Whether this indicates a mixed origin, the layers including domestic sweepings as well as stable manure, or that the more unfortunate members of society shared accommodation with livestock is uncertain. One of the records, of two individuals, came from a deposit with abundant house fauna and strong evidence for hay but rather few grain pests, conceivably from a house floor or hay store rather than a stable. From Carlisle, Kenward *et al.* (AML 77/92; 2000) recorded a human louse from a late 1st/early 2nd century deposit (perhaps including stable manure) at Lewthwaites Lane, while Allison *et al.* (1991a) noted a single individual from a late 1st century pit fill at Castle Street. Records of *Pediculus* remains from boxwood combs from Roman Ribchester (Fell AML 87/91; Carrott *et al.* 2000) are notable, but the identification to subspecies on what appear to have been larval remains may appear over-optimistic.

Although there appear to be no **5th to 8th century** cases from Northern England, there is a more-or-less continuous fossil record for *P. humanus* from the **Anglo-Scandinavian** period onwards (many more records may have been lost through lack of time during evaluations, so material could not be sought carefully, or if found was not mounted for careful examination). It was noted from samples from more than 50 contexts at Anglo-Scandinavian Coppergate, York (Kenward and Hall 1995), usually as single specimens but sometimes in larger numbers (e.g. in a Period 4A pit fill, *loc. cit.* p. 537, and in the fill of a gully cut into the floor in one of the plank-built structures of period 5B, p. 596). The human louse was also found in several Anglo-Scandinavian assemblages from floors and pit fills at the Queen's Hotel site (Kenward and Hall EAU 2000/14), and in supposed surface accumulations at 4-7 Parliament Street (Hall and Kenward EAU 2000/22).

There are a few **post-Conquest medieval** records. The Magistrates' Courts site, Hull, yielded a number of records (Hall *et al.* EAU 2000/25; 2000/33), and one was found at 54-7 High Street by Jaques *et al.* (PRS 2003/01). Carrott *et al.* (EAU 1995/03) found at least four lice, almost certainly *Pediculus*, in a sample from a 12th-13th century floor at Keldgate, Beverley, but there was not time to confirm the identification within the constraints of the evaluation. At 63-64 Baxtergate, Whitby, Hall *et al.* (EAU 1993/26) found human lice together with 'house fauna' insect groups in 13th-14th century occupation deposits, one sample containing numerous individuals, both adults and nymphs. There appear to be no **post-medieval** records for the North of England, although there are a few from elsewhere (e.g. Girling 1984b).

In contrast to the flea, the human louse continues to thrive, not being amenable to control by cleanliness and easily spread by contact.

Pthirus pubis*: the pubic louse*

There a few records of pubic lice (*Pthirus pubis*) from archaeological sites, two coming from the North of England (Kenward *et al.* EAU 1998/32; Kenward 1999; 2001a). The first was from an early Roman pit fill at Keay's Lane, Carlisle. Although described as a 'secondary' fill, there can be little doubt from the insect assemblage that the layer incorporated stable manure and possibly other waste. The second record was from a deposit of medieval date at the same site, a pit fill which perhaps contained house floor cleanings. The Roman specimen was partly mineralised, and detail was obscured, but the medieval one was excellently preserved.

Kenward (1999) argued that pubic lice are by their nature perhaps unlikely to become incorporated into archaeological deposits. It is probable that most of the numerous human lice (*Pediculus humanus*) found in archaeological deposits are the subspecies capitis (although separation of the subspecies is extremely difficult in fossil material) which occurs in the head hair and is very likely to be shed in large numbers as a result of grooming. By contrast, pubic lice are only likely to be shed infrequently and in specialised areas. It is thus not so surprising that the only previous records of the pubic louse appear to be those of Girling (1984b) of a mineral-replaced fossil from eighteenth century deposits in the City of London, and Buckland *et al.* (1992) from 18th century Iceland. It does not appear to have been found elsewhere in Europe yet and should be sought.

Incidentally, despite statements to the contrary, there is clear evidence that crabs, normally regarded as effectively a venereal disease (Harwood and James 1979), can exceptionally invade the scalp (e.g. e.g. Burgess 1995; Burns 1987; Kremer and Ball 1997; Mueller 1973; Signore *et al.* 1989), suggesting a little caution in drawing conclusions about human behaviour from fossils.

Cimex lectularius*: the bed bug*

The British archaeological records and biology of *C. lectularius* were discussed by Kenward and Allison (1994c, 69) and Kenward and Hall (1995, 764-5), together with the intractable problem of separating two subspecies, one associated with humans and the other with doves, on the basis of fragmentary material. Its history is outlined by Busvine (1976, 33-34), although it should be noted that he lacked the benefit of archaeological records which seem to place it in Britain much earlier than the year 1583 suggested by documents. The bedbug perhaps needs buildings of quite high quality for long-term survival, and may have repeatedly been introduced (it is easily carried in furniture and household goods), only to die out.

For the north of England there are archaeological records of *Cimex* sp. from Roman Annetwell Street, Carlisle (Large and Kenward EAU 1988/15; 1988/17), discussed by Allison *et al.* (forthcoming b). In York, Anglo-Scandinavian deposits at 16-22 Coppergate yielded one from a mid 10th century cut fill at the rear of the site (Kenward and Hall 1995, 566, 764-5), and the genus is also known from The Bedern, where three occurred in a pit fill dated to the mid 17th century or later (Hall *et al.* AML 56/93, 32-3).

Biting flies

Various flies have a parasitic relationship with humans. Adults of considerable number of species suck blood. These include a variety of Nematocera, and there is a need to attempt to identify the numerous small nematoceran forms found in archaeological deposits, and determine whether they are blood-suckers. While they include the malarial mosquito, these mosquitoes and midges are generally more a nuisance than a health hazard in Britain, although scratching of reactions to the bites may have lead to secondary bacterial infections. The black-flies (Simuliidae) in particular can render areas virtually uninhabitable through their attacks in huge numbers. On the world scale, biting flies are very serious disease vectors (see for example Harwood and James 1979; K. Smith 1973).

The larger blood-suckers include members of the family Tabanidae (horse-flies, clegs and their relatives), which approach the victim perfectly silently and whose bites are suddenly painful but harmless unless they become septic. The stable-fly *Stomoxys calcitrans* is rather common in archaeological deposits (with records from 68 Anglo-Scandinavian contexts at 16-22 Coppergate, York for example, Kenward and Hall 1995, 491). It is implicated in disease transmission (summary given by Kenward and Hall loc. cit, 762).

Some flies are medically much more serious, namely those causing myiasis in humans and other vertebrates including livestock, boring through the flesh of the host. These are discussed on p. 67; there is a horrifying array of such species on the world scale (Zumpt 1965). There seem to be no archaeological records of the obligatory myiasis-causers, although they were probably common in the past. Their effects might be noticed on skeletons (Baker and Brothwell 1980, 185, illustrate a deer skull apparently modified by screw-worm, presumably the fly *Chrysomya* sp., but they were rejected as the cause of skull perforations by Brothwell *et al.* 1996), and the remains of the flies themselves may be found by good fortune. Their effect has been seen in archaeological leather (e.g. Chaplin 1965). Various species capable of facultative myiasis have been found in archaeological deposits (the house fly, *Musca domestica*, being among them), but there is no evidence that they actually caused the disease. The role of such flies in medicine is mentioned on p. 313.

Non-biting flies and disease

That non-biting flies such as the housefly *Musca domestica* distribute pathogens causing disease is generally understood at the present day (e.g. Lindsay and Scudder 1956).There is ample evidence from a great many sites that several species of flies likely to have carried disease (and to have been a direct nuisance to people through their persistent landing on food and skin) were immensely abundant in the past. For some sites there is little evidence to suggest that attempts were made to reduce their numbers by systematically covering likely breeding places. Records of fly puparia are discussed elsewhere (p. 68); the largest-scale survey for any site to date was that for Anglo-Scandinavian 16-22 Coppergate (Kenward and Hall 1995), although identifications were not as full as may now be achieved (p. 71). Kenward and Hall offered a brief summary of the range of pathogens spread by the species found at Coppergate; they include the causal agents of poliomyelitis and salmonellosis. Kenward and Large (1998b) argue that it is possible that flies may also distribute the eggs of whipworms, *Trichuris*, perhaps one reason why infection was so common in the past.

Parasites of domestic animals and commensal vertebrates

There is some overlap between parasites of humans and other mammals; species primarily associated with vertebrates other than humans are considered here.

Internal parasites of vertebrates other than humans

Attempts to identify internal parasites (and thus by implication dung or gut contents) of livestock from their eggs have been surprisingly unsuccessful, bearing in mind that heavy parasite loads are normal without regular medication. The position is complicated further by the apparent ease with which some pig and human parasites cross hosts. Eggs of parasites of livestock are normally recovered from ordinary sediments, but they may also occur in dog coprolites. Small numbers of what appeared to be dog coprolites were noted at 16-22 Coppergate, although they were mostly fragmentary and were barely considered in the report (Kenward and Hall 1995). There were also traces of likely canine coprolite in Roman deposits at the Tanner Row site (Hall and Kenward 1990, e.g. 353). There appear to be no records of the species of *Trichuris* primarily associated with canines, and the eggs found in dog coprolites may be a result of eating human faeces. This was suspected to have been the case at Anglian Fishergate, York (Allison *et al.* 1996b), where some of the numerous dog coprolites contained eggs of *Ascaris* and *Trichuris* (there was also one record of *Capillaria*, see below).

The tapeworm *Hymenolepis* has been considered in the archaeological context on p. 24 and there is nothing to add here.

Trichuris and *Ascaris*

Apart from the positive identification of dog faeces containing eggs of these genera (probably derived secondarily from human faeces), the evidence is poor and generally circumstantial. Records of large numbers of *Ascaris* in relation to *Trichuris* have been tentatively interpreted as indicative of pig faeces (p. 27), but in no case has the evidence been clear. There seem to be no published records of positive identification of any *Trichuris* species other than *T. trichiura* from the region considered here, although measurements (and the superficial appearance) of eggs from the Early Christian Deer Park Farms site in Northern Ireland strongly indicated the presence of T. ovis (Allison *et al.* EAU 1999/08; 1999/10). The range of additional *Trichuris* species which may be found is discussed briefly in the taxonomic section (p. 26).

Capillaria

A pit fill from Anglian Fishergate, York, gave a concretion which produced a single *Capillaria ?aerophila* and traces of *Trichuris* and *Ascaris*, the latter suggested to have been the result of a dog eating human faeces (Allison *et al.* 1996b). *C. aerophila* is a parasite of carnivores, including cats and dogs, occurring in the nasal cavity, trachea and bronchi. The eggs look very much like those of *Trichuris*, similarly having two polar plugs. The worm may infect humans, when it causes bronchitis-like symptoms, with slow recovery (van der Hoeden 1964, 590-591).

Oxyurus equi

Oxyurus equi, a nematode parasite of equines whose eggs resemble a *Trichuris* with a single polar plug, has only twice been recorded from archaeological deposits in the region, and very rarely elsewhere. Two eggs were found in an external blanketing soil deposit of early 2nd century date at Castle Street, Carlisle (Allison *et al.* 1991a, 69-70; Jones *et al.* 1988), and single egg was recovered from Roman Tanner Row, York, in one of a series of deposits which appeared to contain organic refuse of various origins (Hall and Kenward 1990, 354). *O. equi* has been recorded in much larger numbers from the Deer Park Farms site, County Antrim (Allison *et al.* EAU 1999/08; 1999/10), suggesting that the argument of Jones *et al.* (1988) that the number of eggs reaching deposits will inevitably be limited may be too pessimistic.

Ectoparasites of livestock and commensal vertebrates

A good number of species of lice of livestock have been found in archaeological deposits, together with some fleas of domestic animals and rats and mice and a single ectoparasitic fly, *Melophagus ovinus*. Lice are excellent and reliable indicators of the occurrence of their hosts, often being extremely conservative in their relationships, Busvine (1976, 40) observing that they will often starve to death rather than feed on a strange host, though lice can apparently survive for some while off-host (e.g. Crawford *et al.* 2001; Leeson 1941). Unfortunately the presence of lice is not an indicator of the presence of the live animal at the point of deposition, and indeed most records are of *Damalinia ovis*, like the sheep ked *Melophagus ovinus* probably almost always deposited as a result of wool preparation and considered more fully under that heading (p. 363). Other remains may have been brought on corpses or skins. Small-scale rapid investigations (evaluations and inadequate assessments) may produce a few remains, but lice not likely to be recovered in useful numbers unless careful analyses are carried out, with adequate time for the exacting process of identification. Although lice were only sought in a systematic way towards the end of the project, the Anglo-Scandinavian deposits at 16-22 Coppergate, York, produced one of the best ranges of species relevant here (Kenward and Hall 1995). The only group of comparable richness was that from the Deer Park Farms site, County Antrim, where lice were exceptionally abundant (Allison *et al.* EAU 1999/08; 1999/10; Kenward *et al.* accepted). The insects will doubtless be found at many sites when they are sought, for they have now been found at various excavations in Britain, mainland Europe, Iceland and Greenland.

Haematopinus apri: a pig louse

The louse *Haematopinus apri*, found on wild pigs but not on modern breeds of supposed oriental origin, is no longer found in Britain, having been replaced by *H. suis*. Its archaeological significance is discussed by Kenward and Allison (1994a). It is one of the very few insects *known* to have become extinct in Britain in the period between 0 AD and the 19th century. While it may have fallen from pigs kept on occupation sites, many lice may have been deposited from slaughtered pigs, for example when de-hairing the skins.

There are records from Roman and Anglo-Scandinavian sites. For the Roman period, one sample from Old Grapes Lane, Carlisle (Kenward *et al.* AML 78/92; 2000), gave `several' *H. apri*. A further hint that pigs were important at this site came from the eggs of nematode parasites of vertebrates (see p. 27). At 16-22 Coppergate, York, *H. apri* was recorded from eight Anglo-Scandinavian contexts, but only in small numbers, and offered only rather weak evidence for the presence of live pigs. There was a single record of three provisionally identified *H. apri* from Anglo-Scandinavian deposits at 1-9 Micklegate, York (Kenward and Hall EAU 2000/14). These records can be set in context by reference to the very large numbers recorded from one layer at the Early Christian site of Deer Park Farms, Co. Antrim, N. Ireland, and its overall frequency at the site (Allison *et al.* EAU 1999/08; 1999/10; Kenward and Allison 1994a); it seems that pigs were kept or their skins often processed at this small, isolated Irish site. Doubtless further records of this and (other lice) will be made now that they have been recognised.

Damalinia *spp.*

Several species in the genus *Damalinia* which are host-specific for particular domestic animals have now been recorded from archaeological deposits. These delicate lice appear to preserve poorly and are consequently difficult to identify, and it is sometimes uncertain whether remains are even of this genus. In some cases, where preservation is good, *Damalinia* remains can confidently be named to species, providing important evidence for their hosts, or products derived from the skin or hair of their hosts, on a site.

D. ovis is very much the most often recorded member of the genus in archaeological deposits and is sometimes numerous; it is considered to have been deposited as a result of wool cleaning in almost all cases and is discussed under craft (see p. 363 above).

A single *D. bovis* (of cattle) has been recorded from an accumulation of stable manure in a late 1st century building at Castle Street, Carlisle (Allison *et al.* 1991a), and another from a late first century ditchfill at Old Grapes Lane A (Kenward *et al.* AML 78/92; 2000); there may have been cattle *in situ* at the latter. A late or post-Roman pit at the Castle Car Park, York (Carrott *et al.* EAU 1995/32) gave a *D. ?bovis* in an odd assemblage including *Trichuris* eggs, mouldering-hay insects, some indicating fouler matter, and grassy plant detritus, but unfortunately this was an evaluation exercise with no funding for further work. From Anglo-Scandinavian York there are records from seven contexts at 16-22 Coppergate, and there is a record of *D. ?bovis* from a pit fill, probably of Anglo-Scandinavian date, at the Queens Hotel site (Dobney *et al.* EAU 1993/22), although no remains of this louse were reported by Kenward and Hall (EAU 200/14) in the analysis report. *D. bovis* has been found in a Neolithic byre in Switzerland (Nielsen *et al.* 2000).

Damalinia equi, potentially an indicator of the stabling of horses, has rarely been recorded (except at the Deer Park Farms site mentioned above, where it was rather common). There were only three records from Anglo-Scandinavian Coppergate (Kenward and Hall 1995, 698), and a single individual (in a layer probably rich in stable manure) from Roman Tanner Row (Hall and Kenward 1990, 349), despite the enormous number of analyses carried out for these sites. Similarly, there are few records of *D. caprae*, normally found on goats, Coppergate providing a single example (Kenward and Hall *op. cit.*); Schelvis and Koot (1995) suggest that *D. ovis* and *D. caprae* can be used to determine which caprovid was present, though further studies of modern host-transferability are perhaps desirable.

Other lice of livestock

Schelvis and Kloot (1995) found the lice *Solenopotes capillatus* and *Linognathus vituli* at an Iron Age farm in Holland, but these species appear not to have been found as fossils in Britain.

Felicola subrostratus: cat louse

This louse of cats has only once been recorded, from the fill of a gulley within a building of early/mid 11th century date at 16-22 Coppergate, York (Kenward and Hall 1995, 596). It came from a context which also gave a variety of other lice of humans and livestock, leaving a slight suspicion of cat skinning.

Ctenocephalides canis: the dog flea

There are a few records of dog fleas from archaeological deposits in the north of England, all from York or Hull. Hall and Kenward (1990, 341) reported two from late 2nd century deposits at Tanner Row, York, one in an assemblage containing house fauna, perhaps debris which fell from a raised floor during use or demolition, and the second from a cut fill with a rather mixed fauna. Carrott *et al.* (EAU 1992/05) found a single specimen at the Palmer Lane site, York, in what was probably a dump of a 12th-14th century date into the King's Fishpool; there were also grain beetles and an assortment of decomposers, mostly indicating fairly dry material so that an origin in floor sweepings seemed likely. A single individual was noted from 13th/14th century backfill deposits at the Swinegate, York, complex of sites by Carrott *et al.* (EAU 1994/13). Nearly 20 dog fleas (from seven contexts) were recorded from early 14th century occupation deposits at the Magistrates' Courts, site, Hull (Hall *et al.* EAU 2000/25; 2000/33), and Hall *et al.* (AML 56/93, 25) found one in a sample from a mid 15th-early 17th century 'peaty clay spread', possibly a trampled surface, at The Bedern, York. There is also a record from a 15th century pit fill at Morton Lane, Beverley (Kenward and Carrott PRS 2003/58). The only other record of numerous remains of *C. canis* seems to be from medieval Winchester (Carrott *et al.* EAU 1996/20), again in deposits interpreted as containing domestic sweepings.

Cat, bat and bird fleas

There appear to be no British records of cat fleas (*C. felis*) earlier than those of Girling (1984) for 18th century London. Until recently the only other record was from Schelvis (1994b), who found it in a shipwreck in Holland, also of 18th century date. This rarity is odd in view of its current abundance ('the most important ectoparasite of domestic cats and dogs worldwide', Rust and Dryden 1997), its range of alternative hosts, and the fact that it quickly builds up huge populations in the same way as *C. canis*. However, the archaeological record of the cat flea has been pushed back by Yvinec *et al.* (2000, with remains from 13th century Beauvais (Oise) and Rennes Ste-Anne (Ille-et-Vilaine), France), and into the 2nd millennium BC by Panagiotakopulu (2004b, with a record from Pharaonic Amarna). Possible reasons for its absence, concerned with human attitudes to cats, were suggested by Allison and Kenward (1990), but a late introduction is not impossible. The problem is discussed briefly by Yvinec *et al.* (2000), who also suggest that there may have be confusion with *C. canis* using conventional identification characters. A remote possibility is that the cat flea is a recent offshoot from the dog flea: DNA analysis might clarify this (recovery of DNA from mummified fleas has been claimed by Dittmar *et al.* (2003), but whether it survives in 'waterlogged' fossils has still to be established).

The near-absence of reliable records of fleas and lice associated with birds seems less explicable in view of the reasonable, but admittedly unproven, belief that chickens at least were kept at many sites, and given the huge amounts of bird bone found on many sites (the birds can hardly all have been plucked elsewhere). There appears only to be a single reliable European archaeological record of a bird flea, a tentative record of *Ceratophyllus gallinae* from Belgium (Schelvis 1998). The explanation may be taphonomic (the parasites being deposited on surfaces where preservation was unlikely), for bird lice and fleas surely must have been as abundant in the past as now. The number of species, especially of lice, parasitic on birds is large (Séguy 1944), many are very common, and they may be enormously abundant on the host. Even allowing for infrequent preservation of these delicate animals, the failure to find at least one pit with fills containing feathers and bird parasites resulting from food preparation seems surprising. The failure to recover any parasites of bats from archaeological deposits is also noteworthy. Bats are very commonly associated with human dwellings, and have a characteristic range of parasitic fleas, flies, bugs, mites and ticks, although quite remarkably bats have no associated lice. British bat parasites are reviewed by Hutson (1970), while Séguy (1944) probably remains most useful source for information concerning parasites of birds.

Rat and mouse fleas

Two species of fleas associated with rodents have been recorded from British archaeological deposits: *Nosopsyllus fasciatus* and *Ctenophthalmus nobilis*. Both were recorded from Anglo-Scandinavian Coppergate, York (Kenward and Hall 1995), and *C. nobilis* was found in Roman deposits at Tanner Row in the same city (Hall and Kenward 1990); there were also other records for these genera not identified to species at Coppergate, and for *Nosopsyllus* sp. from Tanner Row. Of these species, *N. fasciatus* at least has been shown to transmit human disease including plague (Harwood and James 1979, 333; K. Smith 1973, 521), but its role in this respect was probably minor. It is discussed in the archaeological context by Yvinec *et al.* (2000). The best known rodent flea is, of course, *Xenopsylla cheopis*, the rat flea primarily responsible for plague infections. There are no archaeological records from Britain or, apparently, elsewhere.

Ixodes ricinus: sheep tick

A single larval sheep tick was recovered from an Anglo-Scandinavian external layer at 16-22 Coppergate, York (Kenward and Hall 1995). This species sucks the blood of a wide range of warm-blooded vertebrates, and is by no means confined to sheep. It is particularly annoying when it bites humans since the rostrum is backwardly-barbed and typically remains in the skin if the animal is scratched off, and so may lead to a septic infection. *I. ricinus* was rather abundant at the Deer Park Farms site (reference above), but seems not to have been recorded as fossils elsewhere in the British Isles.

Parasites of wild vertebrates

There are almost no records of parasites of wild animals, (indeed, probably only one), although there is no reason why they should not occur where wild animals have been brought to occupation sites for preparation. Hall *et al.* (EAU 2001/51) found a thorax of the deer fly *Lipoptena cervi* in a sample from an evaluation borehole at the former Victoria House site, Micklegate, York. There was no clear dating evidence, but the plant and insect assemblages resembled many from Anglo-Scandinavian Coppergate (Kenward and Hall 1995), although with no distinctive character. This appears to be the first record of the species from archaeological deposits, and certainly the first from northern England. The fly is principally associated with roe deer (*Capreolus capreolus* (L.)) and red deer (*Cervus elaphas* L.), but sometimes found on other deer, or as strays on various species including humans (Hutson 1984). A likely origin is with deer carcasses or skins. *L. cervi* was also found (together with deer hairs) on the 5000 year-old ice-man mummy from the Austro-Italian border by Gothe and Schöl (1992).

Biting flies and myiasis

Myiasis has been discussed with respect to humans, above. It may be added that the effects on livestock may be considerable, leading to poor condition and even death (Zumpt 1965). Gasterophilids and oestrids are the important groups in Britain, Colebrook and Wall (2004) recording that the primary agent of cutaneous myiasis in northern Europe is the blowfly *Lucilia sericata*. Although non-biting, these flies may cause considerable distress to livestock simply by their presence (e.g. Chinery 1993, 208; Edwards and Heath 1964). The remains of the flies may eventually be found in archaeological deposits, but the most visible indication of these parasites is the holing of leather (p. 92, 423).

Biting flies of various kinds, particularly tabanids (clegs) and the stable fly (*Stomoxys calcitrans*), cause much irritation and even stampeding, as mentioned above, even non-biting flies searching for sweat are a constant annoyance to livestock, as to humans (e.g. Edwards and Heath 1964, 339 ff; see also Figuier 1869, figs I-III).

Stinging wasps

The familiar stinging paper wasps or 'yellowjackets', *Vespula* (and the very similar but tree-nesting *Dolichovespula*), are very common at the present day, and some of the species (notably *V. vulgaris* and *V. germanica*) are intimately involved with humans, sometimes causing much pain and annoyance. Many - often, surely, whole nests full - would be expected to have died or been deliberately killed in the past on sites where numerous insects are preserved by anoxic waterlogging. Records might particularly be expected in view of the habit of some wasps of robbing honeybee nests (e.g. Whitehead 2002).Yet there are apparently no good archaeological records of these insects, even at 16-22 Coppergate, York, where very large numbers of samples were investigated. The writer has only once found a specimen in an archaeological sample (Hall *et al.* EAU 2000/25), a damaged head, and even this may have been a recent contaminant. A second record, of an abdominal sclerite resembling *Vespula*, from an Anglo-Scandinavian context in York (Carrott *et al.* EAU 1998/14) is even more tentative. Members of a wide range of other groups of Hymenoptera are common enough in archaeological layers. Why do yellowjacket wasps not occur with them?

There are several possible reasons for the lack of fossil stinging wasps. The first, and most obvious, is differential preservation, wasp cuticle perhaps being significantly less resistant to decay than that of bees. This has been investigated by a project student (R. Lock, unpublished), whose results, although based on short-term experimentation, did not suggest that *Vespula* are preservationally exceptionally labile. Their remains certainly occur occasionally in modern deposits, although the pale areas are frequently lost, as is the case with many insects, such as ladybird beetles (Coccinellidae). Secondly, the synanthropic *Vespula* may have been present in Britain throughout the Flandrian but only developed the close association with humans latterly. Thirdly, they may not have been present in Britain, having invaded or been imported recently (though if this is the case, when they arrived may prove hard to establish as later and post-medieval archaeological insect assemblages are few and far between, and often poorly preserved). If these wasps are recent arrivals, old British (and presumably other Northern European) literary references to creatures of this general kind may relate to the less synanthropic *Vespula*, hornets (*Vespa*) or to *Dolichovespula* species. Certainly some species have arrived recently and become established, notably *Dolichovespula media* (Retzius) and *D. saxonica* (Fabricius) (Else 1992; 1993).

The classical sources do not appear to offer much help in solving this puzzle. Beavis (1988, 187-195) and Davies and Kathirithamby (1986) discuss these documents and, while it is clear that the ancient Greeks and Romans knew aggressive, stinging, colonial wasps or hornets, and that such insects came in two sizes (presumably *Crabro* and *Vespula*/*Dolichovespula*), and that they could be a nuisance to beekeepers, the accounts seem to be confused and contradictory, and may refer to non-synanthropic species.

If these 'pest' wasps are recent arrivals, either just in Britain or in Europe as a whole, it would be a matter of some interest to the wider biological community, and would pose some interesting questions about species which are extremely significant predators of a range of insects including pests. However, vary careful analysis of large volumes of archaeological samples, and further work on their taphonomy, is required before we can even cautiously use lack of records as an indication of absence. And conversely, even if remains are found, it will be necessary to establish that they cannot be intrusive, colonies having been formed underground in old burrows or other voids, or modern contaminants.

Invertebrates as ornaments and pets

Various invertebrates have been used for ornamental purposes, or even just been collected and transported as curios. Invertebrate dyes are mentioned on pages 361 and 362, and waxes and varnishes on pages 359 and 362.

Invertebrates have found (and of course continue to find) more direct decorative uses. Mollusc shells are often very attractive and will always have been liable to be picked up and carried round, if not actually collected or made into jewellery or ornaments. Oyster shells with what appear to be deliberately cut slots in them are occasionally recorded (e.g. Carrott *et al.* EAU 2001/12; Foreman 1992; Holden 1963; MacGregor 1982; Rogers 1993). It is not clear what these were for. Foreman (*op. cit.*) noted that 'The use of shells as amulets is widely recorded, but normally more exotic species than oyster are utilised.....In the medieval period, the shell was associated with pilgrim cults, notably that of St James of Compostella.'

Holing of shells cannot be taken as evidence of decorative use; holes may have been made by boring invertebrates or by abrasion. Light (2003) reviewed causes of holing and mentioned that holes in umbones of *Glycymeris glycymeris* can be worn, even holed, during life by the valves rubbing together. Large shells have often been applied to walls and paths as a decoration in the recent past; evidence of such use might be found archaeologically. Ancient fossils have sometimes been found in archaeological deposits, and in some cases may have been collected deliberately rather than arriving naturally; a few examples are mentioned in the taxonomic section. Oakley (1985) discusses decorative and symbolic uses of some groups of invertebrate fossils on a world scale, citing numerous examples from the Palaeolithic onwards, and records of fossil urchins from European archaeological sites are reviewed by Demnard and Neraudeau (2001). Large quantities of oyster shells were found in piles outside a Roman temple constructed built on a Bronze Age burial mound near Stanwick, Northamptonshire (G. Campbell, personal communication).

Coral is nowadays widely used decoratively, and may have been transported for such use in the past. No records of coral from NW European archaeological sites have been discovered, however.

Beetle jewellery and insect (mainly beetle, bug, butterfly and moth) art in the form of framed pictures or wings varnished into the surface of boxes and artefacts were commonly made in the past few centuries, and so might turn up in Post-medieval deposits: similar decorative objects may have been made earlier but seem most unlikely to have survived.

Another decorative use of a sort which invertebrates have found is as pets. Flea circuses are well-documented, as is the keeping of crickets in cages. Pet stick insects may be a recent fad, but the remains of such exotic animals might exceptionally occur at Roman or post-medieval high-status sites.

Pest control

Many invertebrates were pests in the past, and still are, although the modern and ancient concepts of pest were probably very different! Presumably the large populations of insects exploiting floors and rubbish were not perceived as pests, even if they were noticed at all. We have little evidence of whether or how people in the past went about trying to deal with those species which they *did* indeed consider to be pests, although there are documents and ethnographic parallels which are helpful. Various plants are supposed to have been used to control insects in the past (e.g. fleabane, *Pulicaria*), though both their actual use and their efficacy need to be verified. Excellent reviews by Panagiotakopulu (2000) and Panagiotakopulu *et al.* (1995), and the irresistible book by Busvine (1976) provide a route into the literature of early pest control, while White (1970, 189) mentions Roman methods for controlling grain pests.

Hakbijl (2002) discusses the possibility that ash was used as an as insecticide in the past. Certainly, ash-rich floor deposits tend to contain relatively few insect fossils, but this may be a result of lower availability of organic matter during use, and to more rapid decay after deposition, rather than of any insecticidal or repellent effect of the ash. The modern use of inert dusts, including sand, ash and lime, in pest control is discussed by (for example) Arthur (2001), Ebeling (1971); Fields and Korunic (2000), Golob (1997) and Golob and Webley (1980), though these reviews are primarily concerned with the tropics, where use of such materials has persisted. (The use of commercially-produced dusts is, however, becoming more widespread, particularly in view of their relatively low cost and the dangerous toxicity of chemical insecticides.) Mewis and Ulrichs (2001a-b) deal particularly with the effect of dust (diatomaceous earth) on *Sitophilus granarius*, noting the deleterious effect of rising moisture content; parallel research on *Oryzaephilus surinamensis* is reported by Arthur (2001). Ebeling (1971) mentions their use for human head and crab lice. Golob (1997) points out that research has shown that modern pest-control dusts are not anything like as effective at high humidity: what is the implication of this for their possible use in Britain? Would ash be better in damper climes? Anoxia is another possible method of pest control, suggested as the mechanism for pit storage (for which there is no evidence in our area): Bergh *et al.* 2003, for example, report the effects of anoxic treatment in the laboratory on dermestid beetles. Extracts of various plants have also been found effective in pest control experimentally (e.g. Jilani and Su 1983; Saim and Meloan 1986; Sighamony *et al.* 1986).

The archaeological evidence for pest control in the area under consideration here is very slight. The deliberate sealing of a layer rich in grain pests at the Roman site at Coney Street, York (R. Hall and Kenward 1976; Kenward and Williams 1979) may be one case of conscious pest prevention, while the postulated dumping of heavily infested grain into the well at Skeldergate in the fourth century (Hall *et al.* 1980) is perhaps another. The fine-toothed combs identified from many sites (and in at least one case containing lice, p. 419, and in another, from Holland, nits, p. 52) would have been of some use in dealing with ectoparasites. At another level, the construction of granaries, the use of sealed storage containers, the cleaning of streets and yards, the provision of sewers, the use of pits, latrines and other controllable disposal systems all represent pest control measures, although one suspects that suppression of smell or removal of filth from underfoot, rather than dealing with identified pests or pathogens, was usually the primary motivation where waste disposal was concerned. Many archaeological pits contain both organic matter (often faecal) and what appears to have been ash, and it may be suspected that the latter may have been seen as a way of sterilising the former; it would certainly have discouraged the breeding of insects. The alternation of organic and earthy fills seen in some pits presumably at least occasionally represents intermittent burial of foul waste. The writer has seen what appeared to be lime in layers in pits (no analyses have been carried out), and the possibility that quicklime or mortar were sometimes used as sterilising seals must be entertained. Many pits clearly remained open for some time without any form of effective treatment, however, as large insect populations developed (e.g. Kenward and Hall 1995; Kenward and Large 1998b).

As mentioned above, a particularly interesting aspect of the insecticidal effect of ash may be that it reduced insect populations in floors. Many archaeological floor deposits are rich in ash (or charcoal, presumably the visible residue from incompletely burned ash).Whether ash was raked out over floors because it was known to tend to discourage insects, or out of blind tradition originally rooted in such knowledge, or because it was perceived to 'sweeten' the floor or improve drainage, or simply to get rid of the large quantity of unwanted waste from the fire, is uncertain, and perhaps unknowable in most cases. It would be useful to attempt to correlate insect populations in archaeological floors with 'ashiness', though of course the effect of ash in promoting loss of remains by decay would have to be taken into account. From outside our area, floors at the Viborg Søndersø site in Denmark (Kenward CHP 2005/04; 2005b), where large populations of insects seem not to have developed, mostly appeared to have a very large ash content when processed. Subjectively, ashiness is correlated with rarity of insects, though this is greatly complicated by the fact that ash tends to be (a) commoner in later floors, which lie in more superficial deposits with poorer preservation and belong to periods which may have seen lower input of organic matter into floors, and (b) common in rooms with a supposed industrial use, where again organic input may have been low.

This discussion has considered only ancient pest control in relation to archaeology. There is another side to this coin: the control of pests in stored archaeological material. Dermestid beetles are particularly destructive to some kinds of museum specimens and would doubtless damage leather, for example. Timbers are not immune: Pitman *et al.* (1993) report damage to stored archaeological timbers by the wharf-borer *Nacerdes melanura* (a beetle) and discuss prevention measures.

Invertebrates and diet: further considerations

The relationship of invertebrates to diet has been considered above under a variety of headings; this section points to these and mentions a few further aspects. The use of marine invertebrates (especially molluscs and crustaceans) as food is discussed in the section dealing with wild terrestrial and marine resources (p. 310), while bees and honey are briefly considered on p. 358. Invertebrates can offer secondary evidence for diet, particularly from the remains of insects associated with food plants in the field or in storage. Grain pests are discussed on p. 342, although they may often be indicative of horse feed rather than of human food, and records of bean weevils (useful as indicators because beans do not preserve well) are mentioned on p. 353.

We should be sure not to overlook other invertebrate remains likely to have been introduced with food, especially those preserved in very pure 'cess' layers or in features suspected to have been used for storage. The group of aphids recorded from an Anglo-Scandinavian cesspit at 16-22 Coppergate, York (Hall *et al.* 1983a; Kenward and Hall 1995, 754-5) may represent an example of the former. It was suggested, very tentatively, that *Myzus cf. persicae* and *Brevicoryne brassicae*, both associated with crucifers, may have been introduced with some kind of 'greens'; these records were less useful as evidence of diet than as an indication of what might be done if funding permitted the routine identification of the aphids so often found in archaeological deposits. From the same sample, there was a minute and cleanly broken fragment of a mealworm beetle (*Tenebrio* sp.), which had just possibly been milled and eaten with flour (p. 344).

Numerous insects are pests of field crops, reducing the food available for humans, but very little is known of their status in the past, and their role is difficult to determine from archaeological evidence. Several of the species found as fossils in occupation deposits are at least minor pests of crops - the bean weevils, mentioned above, and various crucifer feeders including *Phyllotreta* and *Ceutorhynchus* species - but they may simply have exploited 'weeds' on sites or in the fields. The rather numerous crucifer feeders at 16-22 Coppergate, for example, almost certainly lived on weeds (Kenward and Hall 1995, 654, 737). The frequent remains of *Sitona* spp., often found on peas and beans, from occupation sites are also more likely to have originated from weeds, or from hay (p. 355), although at some sites in Hull other explanations may need to be sought (p. 354). Records of suites of such species with associations with field crops in primary cess deposits would stand as much better evidence of an origin in food, especially when the insects include freshly-emerged individuals. Balachowsky and Mesnil (1935-36) provide a comprehensive review of insect crop pests in NW Europe.

Other invertebrates may provide secondary evidence of diet. Assemblages of small molluscs and other marine organisms deposited in fish guts might be recovered (p. 99). Parasites of vertebrates (p. 424) usually, but not invariably (p. 363) stand as evidence for the presence of their hosts, but are not particularly useful as indicators of diet; bones are so much better!

Burials and funerary practices: invertebrates associated with corpses and inhumations

Invertebrates from inhumations should have potential as indicators of funerary practices, but the results of investigations of burials have so far been of limited value. This is a little surprising since the special conditions associated with burials might be expected to favour preservation either through rapid burial of a mass of organic matter or through the presence of metal salts from artefacts (see, for example, Janaway 1987). Parasite eggs have occasionally been sought but very rarely found (discussed by Jones 1979).

Certain insects, especially flies, rapidly invade corpses when they are exposed, and so can provide a measure of how long they were left before burial. This has long been recognised in the forensic context (e.g. Mégnin 1895), and there is a considerable literature of experimental work on decaying corpses (see for example the review of K. Smith 1986), though much of this has been carried out in North America (for example by Rodriguez and Bass 1983, who mention most of the more important studies), where of course a different suite of species is encountered. The primary aim of this kind of burial archaeoentomology, normally using flies and often without close identification of the remains, appears to have been to determine season of burial and length of pre-burial exposure (e.g. Gilbert and Bass 1967; Hincks 1966; Teskey and Turnbull 1979). It is important to remember that in temperate countries lack of insects associated with a corpse may indicate winter, rather than rapid, burial.

A very distinctive suite of species, including flies and beetles, is able to reach buried corpses. Outstanding in this respect in Britain is the beetle *Rhizophagus parallelocollis* which, however, is found in a range of habitats including compost heaps, under bark and in a variety of buried decaying materials; despite its occasional name 'graveyard beetle', it is firmly not an indicator of buried bodies. Useful references and notes on some species relevant here are given by Stafford (1971), while Dirrigl and Greenberg (1995) formulate some of the questions which may be asked of burial entomofauna. A recent review of burial taphonomy is given by Haglund and Sorg (1997).

It is important to remember that not all invertebrates found in graves may have any significant association with the body. Insects may have entered burials because they were on the corpse before burial, in backfill soil (as at the Magistrates' Courts site, Hull, see below), or because they were attracted to the decaying corpse or materials interred with it. Invertebrates entering with the corpse may give us interesting information. They fall into six groups: (a) ectoparasites, including nits; (b) endoparasites, usually nematodes; (c) invertebrates in materials buried with the body; (d) necrophages, and their parasites and predators, the range of which will have increased with length of pre-burial exposure; (e) omnivores which take advantage of the corpse and its biota; (f) adventitious species, which entered accidentally.

It is believed that a considerable number of grave fills have been investigated in some way for invertebrate remains, but with negative results which have not usually been put on record. Grave fills likely to be of medieval date at All Saints Church, York gave no more than traces of invertebrate cuticle (Carrott *et al.* EAU 1996/47), for example, while Hall *et al.* (EAU 1991/24; 1994) investigated cemetery deposits at the Jewbury site in York, but found no preservation of invertebrates by anoxic waterlogging. The Jewbury site did, however, provide quite large numbers of intriguing charred remains of what appeared to be fly or beetle larvae from a series of 'coffin stain' deposits (Hall *et al.* 1994; such remains are discussed on p. 116). These were the only preserved invertebrates and their origin is not at all obvious.

There have been some positive results. Some grave and coffin fills of 14th century date at the Magistrates' Courts site, Hull (Hall *et al.* EAU 2000/25), contained well-developed groups of beetles assigned to the 'post-depositional invader' group (discussed further on p. 476), some of which are also well-known from modern burials. *Coprophilus striatulus*, *Rhizophagus parallelocollis* and *Trechus micros* were all common in these deposits, and there were some *Quedius mesomelinus* and *Trichonyx sulcicollis*; all had undoubtedly been attracted to the buried corpses. (Most of the other remains from these burials were certainly redeposited from earlier occupation layers, however; they were not from plants used as packing, as speculated in the assessment report of Carrott *et al.* EAU 1995/17.) Buckland (1974, 306; 1979, 92-4) mentions insects from the coffin of Archbishop Greenfield in York Minster.

A Viking-Age burial in the Isle of Man yielded some Calliphora puparia, which Hincks (1966) regarded as indicative of burial in summer and exposure of the corpse for three weeks or so since adult flies seem to have left. Paul Buckland (pers. comm.) has recorded *R. paralellocollis*, *Q. mesomelinus* and *C. striatulus* from graves.

Girling (1986; AML 4725) investigated insects from around the Lindow II body. Only one beetle fragment was attributable to a species which was possibly attracted to the corpse, suggesting that it was immersed (although of course the unfortunate person may have been dumped into the bog in winter, when few species were active). Skidmore's (1986) study of the fly remains from Lindow II lead to a similar conclusion, and Dinnin and Skidmore (1995) failed to find a fauna related to the decomposition of flesh in association with the Lindow III burial. Girling (1985) suggested that fly puparia on a brooch from an Anglo-Saxon burial at Sewerby, East Yorkshire, indicated that the body had lain exposed for long enough to decay and become attractive to flies.

Outside our area, Girling (1981) found abundant *R. parallelocollis* in the grave of John Dygon in Canterbury, while arthropods including elements of the 'subterranean' beetle community, are reported by Hakbijl (2000) from 19th century burials in the Netherlands.

It might be imagined that eggs of intestinal parasites would be frequently recovered from the abdominal region of burials, but while eggs of the whipworm *Trichuris trichiura* (positively identified by measurements) were reported from Lindow II by Jones (1986, 137-8), this seems to be the only clear case on record from the region considered here. From other areas, eggs of intestinal parasites have been noted from bog bodies, e.g. by Szidat (1944; both *Trichuris* and *Ascaris*) and Helbaek (1958; *Trichuris* only), and from the Alpine ice man (Aspock *et al.* 2000) and various mummies (e.g. Cockburn *et al.* 1998).

These limited results from inhumations should certainly not be regarded as a reason to abandon sampling from graves, but they do suggest the need for a strategic approach using rapid survey of sample material. Bog bodies appear to be fairly common in the British Isles (see for example the gazetteer of Briggs and Turner 1986), and any further discoveries deserve careful attention, with a full range of analyses of both the body and the surrounding matrix following and improving upon the model established for 'Lindow Man' (Lindow II: Stead *et al.* 1986). The fills of sealed coffins should always be meticulously analysed, and any burial sites with even traces of waterlogging deserve careful sampling and assessment. Metal objects in inhumations may give local preservation (by a combination of toxicity and mineralisation), so sampling the sediment around them, and their incrustations, may be worthwhile. One connection between an invertebrate (the honey bee) and burials is the reported use of honey to preserve corpses (Crane 1983, 240), detectable through residue or pollen analysis perhaps.

The practicalities of studies of inhumation invertebrates are: there must be preservation, by 'waterlogging', mineralisation, or dehydration; large volumes of sediment from burials will need to be examined in order to find any preserved parasites or other species which were on or in the body on burial; insects from backfill can be recorded using normal General Biological Analysis samples; it is important to formulate questions before excavation so sampling can be appropriate; it would be worthwhile to examine samples from burial during the excavation process to establish if there is preservation of insects; in the rare cases where there is preservation, all the soil around a selection of bodies should be sampled, preferably in sectors so the location of any remains can be established; lastly, and most important, it should be accepted that work on burial invertebrates may only very occasionally produce information of much importance.

Environmental archaeology and nature conservation

Records of invertebrates from the past have substantial implications for modern efforts to conserve wildlife, a topic discussed by Robinson (1985). Information may be obtained concerning past abundance and distribution of species, the likely effects of future climate change, and human impact on habitats. The contribution to nature conservation and other ecological issues which may be made by Quaternary and archaeological palaeoecology is reviewed, albeit from a primarily botanical viewpoint, by Birks (1996) and Hayashida (2005) respectively.

Regional and topographic patterns in archaeological invertebrates

It is too soon to try to draw out geographical patterns in the records of invertebrates in the north of England at this stage. Too few sites have been examined and the regional cover is extremely patchy, especially if sites are broken down by period. Subjectively there is an impression that period and type of site is far more important than location in determining the nature of the invertebrate fauna. It is interesting to see where invertebrates have been (a) looked for, (b) found, and (c) studied in detail on a significant scale (Figures 1-9).

We have not enough evidence even to see whether marine molluscs are more in evidence in coastal and riverine sites than inland; subjectively, they are less constant in the more isolated and landlocked sites.

Apart from natural-habitats species presumed to be limited by temperature, only one species of insect has emerged from the review as appearing to have any regional pattern in its occurrence: the spider beetle *Tipnus unicolor* (p. 378), which seems to have been much rarer in Carlisle than in Yorkshire. It has not been part of the brief to carry out detailed analyses of databases, however; quite possibly other patterns would emerge if this were done. There are certainly temporal changes which require objective testing (e.g. in the abundances of *T. unicolor* and, both absolutely and relative to each other, of the principal grain pests, p. 342).

The distribution of sites is such that it is not even possible to make useful comments about preservation in different topographic zones in the north of England. There are low-lying sites near rivers with little preservation, and elevated ones with anoxic preservation. Insects have been found in deposits in areas with acid, neutral and calcareous soils. The only rule appears to be that deposits with a high organic content usually yield useful insect remains. The opposite does not hold true. Snails cannot be predicted to occur where there is a calcareous bedrock or drift under the soil.

It is important to remember that 'barren' sites are only known to be barren to the depth of excavation, often less than a metre where several metres of build-up exist. Curatorial policy and the nature of development in particular areas may thus bias the information which becomes available. In cases where only superficial levels were explored (as is commonly the case in evaluations), deeper deposits may have contained useful material and different states of preservation (e.g. waterlogging). While this may be guessed at in some cases, for some sites there is no information from other excavations to provide a guide. The best working assumption for the time being is that sites in some places (e.g. much of central York, Hull, Beverley, Scarborough, Selby and Carlisle) will almost always yield a wide range of well-preserved invertebrates, and that sites elsewhere may well do. This statement is not very helpful to curators, and in reality it is possible to make better predictions on a site-by-site basis after discussion. However, there is almost always a possibility that large invertebrate assemblages with value in archaeological interpretation may be found, with the implication that a contingency should be allowed, a degree of uncertainty which is highly unsatisfactory to commercial and public funders alike.

In summary, then, intra-regional pattern can only really be perceived in the distribution of the analyses which have been made, revealing large gaps and a general lack of work on invertebrates. No period or type of site is well enough studied for patterns to emerge within the subsets.

PART 5: TECHNIQUES OF STUDY: PROBLEMS AND FUTURE DEVELOPMENT

In this section, the emphasis is on discussion of current problems and potential for future development in practical and interpretative methods, particularly as highlighted by the review of evidence form northern England, but with regard to the wider study of invertebrate palaeoecology. A series of recommendations and research topics is outlined more succinctly in Section 6. The evolution of current methodology for the main groups is considered in the taxonomic section (p. 17). Different groups have different problems associated with their study in archaeology, but many problems are common to all classes of remains - assemblage formation, residuality, differential preservation, decay pathways, difficulties in identification, and lack of information about modern ecology, for example. Some of these have received a considerable amount of attention, although there is much left to be done. However, there has been insufficient emphasis on some basic issues such as optimisation of sampling strategies. There are particular problems associated with determining the best overall strategy in dealing with developer-funded sites, in ensuring that there is continued funding for fundamental research in this young and poorly-developed discipline, in obtaining resources for synthesis, and in setting up new large-scale excavation projects in which new methods and concepts can be tested and improved upon. These issues are considered in a somewhat piecemeal way here, starting with practical matters and concentrating on archaeological, rather than natural, sites.

First of all, though, have invertebrates been adequately exploited in archaeology? Clearly not. Too often they have not been used because they were assumed to be absent, seemed irrelevant, or were judged to be too expensive to study. Part of the problem of their neglect lies in the lack of literature expounding the ways that invertebrates may contribute to archaeology, and for this reason the present review includes a substantial amount of introductory and general matter which would not be appropriate in reviews of other classes of remains. In fact invertebrates have enormous potential in addressing a wide range of archaeological (and biological and climatological) issues, in many cases equal to or greater than any other biological materials.

It is worth reiterating that invertebrate remains of some kind are often present at sites where the excavator considers their preservation is unlikely; this is particularly true of material preserved by anoxic waterlogging (see p. 105), but also mineralisation, and to a very much smaller extent, charring and desiccation.

This review was largely written before the appearance of the English Heritage (2002) *Guidelines* to environmental archaeology. This document includes a great deal of useful information, and if its recommendations could be adopted widely, should overcome, at least to some extent, many of the problems discussed in the later sections of the present review. It remains to be seen whether it will in fact prove possible to persuade – or more fairly, *enable* – the commercial archaeology sector in particular to follow even the quite moderate recommendations of the *Guidelines* concerning evaluations (which are unfortunately not distinguished from assessments as clearly as in the present review) without some form of statutory coercion. The Institute of Field Archaeologists' (2001a; b) *Standard and guidance* for archaeological excavation and evaluation, and the ALGAO standards for Eastern England (Gurney 2003) provide important general background to standards but necessarily lack specific focus on the problems discussed here.

Practical methods

There is much scope for improvement in practical methods for all groups of invertebrates, at every level from project design to data presentation. Some issues relevant here are addressed in other sections; they include the problem of contamination (p. 476).

Expansion of the range of groups used

The first issue to be addressed is the range of invertebrates subjected to analysis, a topic discussed, often only by implication, at various points in the taxonomic section. Although remains of many groups of invertebrates in archaeological and natural deposits have received at least some attention, only the molluscs, adult beetles and some other insects, and (to a lesser extent) parasite eggs can be regarded as having become regular parts of the analytical package for archaeological projects, and even these are frequently not studied for financial reasons. Expansion of the range is desirable, even though there may be considerable practical problems (reviewed in the taxonomic section, p. 17) and financial implications. The mites and immature stages of flies are perhaps the groups deserving most attention, but cladocerans and ostracods are certainly under-utilised, and beetle larvae are a neglected but promising resource. Testate amoebae in deposits associated with human occupation may also reward further attention. The study of parasite eggs requires further research to determine how certainly *Trichuris* species may be identified, and to establish whether the many other egg types encountered (e.g. '*Hymenolepis*') can be reliably named.

Expanding the range of remains employed by archaeologists pre-supposes that funding can be obtained to develop the methodology, to train specialists, and to establish working reference collections (it is not practicable to rely on museum collections for routine analyses, though they often need to be consulted for critical identifications). It seems unjustifiable, however, to destroy irreplaceable archaeological evidence without sampling in detail and carrying out a full range of analyses. There are thus implications for the way the whole discipline of archaeology is organised and financed. Emphasising its role as human palaeoecology may make the relevance of environmental archaeology more apparent.

Sampling

The physical techniques employed in routine sampling are probably as refined as is practical within achievable funding. More effort might be made to clean the containers and instruments used to avoid contamination, and the use of site buckets to hold material before it is placed in storage tubs is to be strongly discouraged. Excavators need to be made aware that even minute levels of contamination may introduce remains which negate accurate interpretation or confound studies of important wider issues (e.g. the chronological distribution of grain pests and other aliens). More attention needs to be paid to clear and permanent labelling, and to the routine creation of a useful database of sample data for each site. The use of the same numerical range for context and samples numbers should be avoided since it frequently leads to confusion at later stages (e.g. on laboratory sheets and in storage media).

At a higher level, site sampling strategies are nowhere near sufficiently developed, and are rarely designed to address particular interpretative or research problems. The development and dissemination of a clear (but flexible) sampling strategy before excavation commences should be a normal part of any programme of excavation, but the present writer has never been called upon to provide one. Random sampling is quite inappropriate for most occupation site deposits: they are too complex, and most deposit type/period/spatial combinations too rare for a random strategy to provide a usefully representative sample (see, for example, the discussion of sampling at 16-22 Coppergate, York, by Kenward and Hall 1995; a rather different view is given by Orton 2000).

At the **feature and context** level, current strategies are probably not adequate. For cut fills, there is a need to consider where to sample; to date, there has been a tendency to collect material from the middle of the depth of each context, to obtain 'typical' material. This is patently not the only useful approach; information concerning conditions at interfaces between contexts is likely to complement considerably that from context centres. Sampling should, ideally, separately cover both the interfaces between and the body of contexts. This is because (in the case of a pit, for example) the body of each context will probably represent the dumped material, while the deposits across the interface will contain evidence of conditions during any hiatus between formation of the contexts (e.g. a period during which the pit filled with water, or when background fauna representing the local environment entered, or when insects were able to breed and emigrate, carrying disease organisms with them). Similarly, for floors, samples from different areas may reveal activity zones and produce evidence which, when combined with that from artefacts and the excavation record, will allow a substantial reconstruction of the way the insides of buildings were differentiated. Even at the context level, multiple sampling is undoubtedly needed in many cases, since for many deposits a single sample is simply not representative; even if a layer is uniform in general terms its content may be spatially heterogeneous at a more subtle level (this has usually been the case where two or more sub-samples have been examined). How much detail are we losing by studying single sub-samples of single samples from each context? For some classes of remains, the sampling or sub-sampling strategy needs to take account of very small-scale heterogeneity; this is particularly true of parasite eggs, for example, but other remains have patchy distributions, reflecting their occurrence in life. For the insects, recent work indicates that it may be more effective to record numerous small groups of remains rather than a small number of large assemblages (Carrott and Kenward unpublished).

At the site level, there will sometimes be a need for intensive sampling where (a) remains are rarely preserved and (b) features are heterogeneous. Intensive sampling of waterlogged deposits is very desirable, as so much information is locked up in them, though the problem of post-excavation costs, not least that of storage, remains. Only in rare cases can limited sampling strategies ('sampling' in the sense employed by statisticians) sensibly be implemented. This point was argued for the 16-22 Coppergate site by Kenward and Hall (1995, 454-455), on the basis that numerous samples were required in order to make meaningful comparison through time and space and between feature types. Hall *et al.* (1983b, 168-9) discuss the heterogeneity of deposits and the problem of the 'sample'. (Orton 2000 discusses wider issues of sampling in archaeology, although without addressing the problems of fine-scale heterogeneity on occupation sites where every context may effectively be unique.) An intensive approach to sampling is strongly supported by experience with sites with sporadic preservation but considerable archaeological significance, such as at Wellington Row, York (Carrott *et al.* EAU 1995/14), or with consistent sets of remains present in low concentration, such as at North Bridge, Doncaster (Carrott *et al.* EAU 1997/16; Hall *et al.* 2003c) and Coffee Yard, York (Robertson *et al.* EAU 1989/12). A more detailed set of recommendations regarding sampling strategies, with, in particular, copious illustration of examples, would be helpful.

Deposits rich in organic matter are still sometimes seen as a liability, for a variety of reasons. Commercial archaeology in particular seems ill-adapted to cope with preservation of 'soft' organic remains, in view of the cost of analysis. But some of the most important and detailed information available to archaeology is locked up in layers, often richly organic, with anoxic waterlogging; information concerning climate, human activity, diet, living conditions, past attitudes and constraints: clues to the reality of being alive hundreds or thousands of years ago. Perhaps the most important lesson learned during the past decades of work on plant and invertebrate macrofossils in the North of England, and one deserving constant reiteration, is that sampling during excavation should be very intensive, with rigorous selection at the post-excavation stage. Large scale studies are essential: the most detailed analysis of a single layer can give only limited information, but even the rapid examination of samples from several hundred deposits allows an overall picture of past conditions and activities on the site to be objectively synthesised. We are moving towards the possibility of statistical testing of hypotheses rather than making up good, but unsupported, stories! Another important lesson has been to realise the need for as constant as possible a presence on site of environmental expertise. The specialists can't be there all the time: an ideal compromise is a good site environmental assistant, someone with some experience in environmental archaeology, probably with a developing specialism, who can offer advice, carry out on-site processing, check labels and databases, and liaise with specialists.

Borehole samples and invertebrates

An aside concerning the value of samples from boreholes is apposite here. Such samples may become available as a result of ground-testing prior to development, be used to save excavation costs, or may be collected late in excavations when deeper deposits cannot be dug conventionally. Experience with such samples from a number of sites, mainly in York, has suggested that they are only 'better than nothing', for three main reasons: (a) poor dating and stratigraphic understanding; (b) the small amount of sediment per unit depth recovered; and (c) the problem of cross-contamination between sedimentary units. The borehole samples collected from the bottom of the excavated trenches at 6-8 Pavement proved of very limited value through lack of a clear archaeological context or dating, for example (Hall *et al.* 1985b), while a series of developer's cores from the Dundas Street/Garden Place area (e.g. Hall *et al.* EAU 1990/09; Carrott *et al.* EAU 1990/08) penetrated into the King's Pool area, but most of the material was barren or poor, though it gave some idea of what was below (unfortunately advice to use a trench to investigate deposits more fully could not be financed). Samples from boreholes at the former Victoria House site, Micklegate, York gave well-preserved remains, including the only British archaeological record of the deer fly *Lipoptena cervi*, but lack of clear dating meant that these remains were of little historical value (Hall *et al.* EAU 2001/51).

The absence of a meaningful archaeological context for most borehole material places great limits on its value, exacerbated by the problem of cross-contamination. There is also a possibility that boreholes may, unless plugged with clay or similar material, drain higher deposits with suspended water tables and accelerate decay of organic material.

A regional strategy for sampling?

It is perhaps too soon to develop strategies for sampling for invertebrates at the regional level, or to prioritise by site type or date. It is hoped that this review will serve to focus on some priorities (summarised in Part 6), but its main value will probably be to emphasise how sampling and analysis of invertebrates can address a wide range of critical archaeological issues. In the author's opinion, all categories of material, all kinds of sites, and all periods from the earliest prehistoric to the 20th century are in need of substantial further data collection before any can be regarded as of lower priority than any other.

Field recording and processing

The basis of successful environmental archaeology in the field is simply what would generally be recognised as good excavation practice - careful observation and meticulous recording. Accurate recording of the origin of samples in relation, for example, to wall lines and horizontal or lateral context boundaries is essential for meaningful interpretation of invertebrate (or indeed any other) remains.

Marine shell appears to have suffered particularly haphazard collection. Oyster shells are frequently recorded on site by 'finds' personnel and are then sometimes discarded. Although staff of the former EAU concurred with such treatment at times, it is now clear that all such material should be retained for laboratory examination; the presence of epiphytes and epizoonts on shells, and measurements of size and shape, and possibly microscopic, chemical and isotopic analysis, may provide important information (see p. 323). Measurement of valves on site followed by discarding is now considered inappropriate. Sieving is essential to collect representative samples of all the marine shell, since small ones and fragments may be of importance.

Insect burrows in, and galleries below the bark of, timber are often noted on site, but the wood may be discarded or by-pass the environmental archaeologists involved in a project. All such material should be at least briefly examined by an entomologist since identification is sometimes possible (p. 94). Some timbers, especially those bearing bark, may usefully be split open to recover any insects remaining in them; this is as true of occupation sites as natural ones. Timbers at natural sites have produced some remarkable remains, such as those from prehistoric deposits on the Humberhead levels (e.g. Boswijk and Whitehouse 2002; Buckland and Kenward 1973; Skidmore 1971).

Most of the remains considered here are too small to be extracted in the field, although rapid inspection to establish the extent of preservation could be carried out using simple equipment, provided a binocular microscope could be set up in a site hut. A transmission microscope, even if crude, could be used to establish quickly whether parasite eggs (and other microfossils) were present in deposits. Such information would be invaluable in allowing modification of sampling strategies, but presuppose the presence of a site environmentalist - ideal, but rare.

Processing on site to extract small remains for proper analysis would be too uncontrollable to be reliable; contamination would be a constant danger. However, bulk-sieving (sensu Dobney *et al.* 1992) is essentially a field method (although sometimes carried out in the laboratory), and is very much the best way to recover large invertebrate remains such as most shellfish and crab shell. Site riddling (sensu Dobney *et al.* 1992) will have some value in retrieving marine molluscs, but will retain only the larger remains.

Co-ordination of work on invertebrates with studies of sediments may be regarded as essentially a field issue: there are many cases where thin-sectioning, or even simply careful field description, would help to elucidate past events, particularly relating to flooding and periods of soil development (e.g. at Skeldergate, York, Hall *et al.* 1980).

In general, then, potential improvements in field methods relevant to invertebrates centre on more careful, thoughtful and thorough excavation and sampling in such a way as to make the best use of available resources.

Sample storage

Sample storage has been the cause of much difficulty and loss of valuable material over the years. Polythene bags have often proved inadequate in the face of storage and handling conditions, and samples sometimes dehydrate in them. Some sets of samples have been kept in inadequate conditions, some even outdoors, and have consequently degraded, and fauna and flora developed in the containers. There have been numerous cases where samples have become contaminated in store, sometimes by species important in archaeology (p. 476). The appropriate storage conditions are in tightly sealed rigid containers which are kept in cool, dark conditions. Samples need to be well-organised and catalogued for recovery. Not all samples can be kept, and a system of assessment is needed to permit discard of low-priority material and to justify retention in relation to the value of the individual samples and to research strategies. Very long-term storage of small vouchers for samples whose biota have been published is an area which has been largely ignored to date.

There is a pressing need for research into the most effective methods of short to medium and long-term storage of samples: long-term tests of the effectiveness of freeze-drying, freezing, saturation with de-ionised water, the use of preservatives, ideal storage containers and storage methods for the containers should be established.

Techniques of evaluation and assessment

The way in which the 'environmental' component of evaluations and assessments is carried out is still a matter of some controversy, and indeed the writer has changed his views significantly concerning both over the years. English Heritage (2002) offers important recommendations regarding these, although phrases such as 'In some cases an evaluation *might* be the only excavation undertaken' [my emphasis] do not resonate with experience in the north of England, where the evaluation is almost always the *only* excavation carried out, and the associated bioarchaeological work typically limited and almost never published.

In an ideal world samples would be assessed throughout each excavation, with feedback to the excavating team so that further sampling could be more clearly related to potential. The financial implications of doing this for General Biological Analysis samples are considerable, however, though processing and scanning of Bulk Sieved or Site Riddled samples as they are excavated has often proved practicable.

Evaluations

Recommendations regarding evaluations are given by Association for Environmental Archaeology (1995), and this document remains much the best summary of what is widely accepted as good practice. The Institute of Field Archaeologists (2001b). *Standard and Guidance for archaeological field evaluation* is also applicable.

Section 9 of AEA (1995) suggests that there should in an evaluation report be 'a clear statement of the presence/absence of each group of biological remains, its mode of preservation, and an estimate of its abundance; an appropriate measure of the taxonomic range of each biological group; if appropriate a summary table showing which classes of biological material were identified from each context, and their interpretative value'. The experience of preparing the present review has firmly convinced the writer that a further level of detail is essential if evaluation reports are to have much value outside the planning process (and they should, since archaeology is being destroyed): species lists *should* be made and included. These need not be meticulously complete, and may be at the level termed 'semi-quantitative rapid scanning' by Kenward (1992). However, a database should ideally be created which includes a record of the interpretatively significant taxa and their order of abundance. Had this been done for the several hundred evaluations which produced insects and whose reports were examined during the preparation of this review, it would be possible to arrive at a great deal of valuable synthesis, rather than at the somewhat subjective and unverifiable impressions frequently recorded herein. An attempt was made in the late 1990s to include lists in assessment and evaluation reports prepared in the EAU (e.g. Carrott *et al.* EAU 1997/25; EAU 1998/09), but this proved very time-consuming for invertebrates (several times longer required) and generally impossible without explicit provision within specifications.

A second recommendation which can be made forcefully on the basis of substantial experience is that sampling during evaluations should (within reason) be *intensive*, with rigorous selection before the processing and recording stages. In this way, an archive of material for future analysis and research will be accumulated without excessive cost, serving to compensate to some extent for the destruction - sometimes quite extensive - caused by the evaluation process and subsequent development work. Material shown to be useless can be discarded after evaluation, though caution is advised.

The standard of much developer-funded archaeology is, in the personal view of the writer, poor. This is not because of incompetence, but because the combination of competitive tendering and a lack of a mechanism for maintaining standards will always favour work which does no more than provide a cosmetic layer over the essentially commercially-orientated planning process. A clear lead in raising standards is essential, and should come in the form of agreement among curators combined with strong guidance from English Heritage, preferably with statutory support. Archaeology funded within PPG16 will be of almost no academic value if it merely meets the functional requirements of the planning process. Having said this, it is important to add that routine evaluation work can be made a great deal more interesting and useful if it is approached within a framework of research interests (see below) - such sites are useful as a source of many kinds of information, such as records of grain pests, and species of climatic significance, in space and time. This cannot be done where evaluation is carried out and reported in such a way that dating and context information is poor: and in the writer's opinion there has been a trend towards more trivial evaluation reports over the past few years as the competitive edge of developer-funded archaeology has bitten deeper.

Assessments

The way in which assessment of invertebrate (or indeed other) remains should best be carried out has yet to be agreed. A detailed scheme for assessment was put forward by Dobney *et al.* as early as 1992 (EAU 1992/23); intensive study at this stage was recommended. A great deal of subsequent experience has convinced the writer that for many sites, especially complex urban ones, the only effective way to determine the potential of the biological samples (General Biological Analysis samples, GBAs sensu Dobney *et al.* 1992), whether for plant macrofossils or invertebrates, is to process a large proportion of them. Preservation is very unpredictable, even when the whole unprocessed sample is examined visually prior to choosing material for assessment, and the presence of archaeologically or ecologically *significant* remains even more uncertain. Technician time to process 'test' samples (*sensu* Kenward *et al.* 1986a; 'pilot' samples of Kenward 1978a, 12) is reasonably cheap, and a very rapid examination of the resulting flots will reveal to the *experienced* eye which are particularly significant. Illustrations of the need for extensive assessment are provided by work on North Bridge, Doncaster (Carrott *et al.* EAU 1997/16; Hall *et al.*2003c) and the Magistrates' Courts site, Hull (Hall *et al.* EAU 2000/25). At the former, small-scale assessment give little indication of the value of an extensive study of the remains, and failed to detect most of the rare deposits with anoxic waterlogged preservation. Fortunately, the decision was made that the site should be used as a test-bed for extensive analysis, with valuable results. At the Hull site, assessment suggested that grave cuts contained remarkable evidence for funerary practise, but detailed study later showed that the fills were heavily contaminated by earlier deposits rich in remains. A fuller assessment of the numerous samples from the earlier material would certainly have made this obvious.

In addition to post-excavation assessment, *sensu* MAP2, a process of continuous assessment and prioritisation throughout the analytical phase of any major project is highly desirable, and this is especially important where there may be organic preservation. We need the ability to revise the programme in the light of discoveries: only a very small proportion of the samples can normally be examined in the initial assessment, and the nature of the biological remains in the rest may come as a surprise! Environmental archaeology is often routine, building up a picture from many unspectacular observations. However, the most spectacular finds will be often missed without large-scale processing. Just as it is not necessary to process a sample just because it was collected, its content does not have to bee recorded in detail just because it has been processed; a very rapid examination will often suffice.

As in the case of evaluations, representative assemblages should ideally be at least rapid-scan recorded during assessment and the results committed to a database, so that at least a minimum of accessible information is available for synthesis even if further analysis is either not considered worthwhile, or cannot be funded. In addition, a case can be made for research into the most effective methods of assessment for various kinds of sites and deposits.

Predicting the environmental archaeology potential of sites and deposits

Preparation of this review has suggested that the ability to approach excavation with a good idea of what bioarchaeological remains will be encountered would be enormously helpful in making the best use of resources. However, we are not yet able to predict the bioarchaeological potential of a large proportion of sites or deposits more than very crudely. There is a need to develop deposit models which have adequate reference to the diverse remains and means of preservation significant to environmental archaeology. This is not always easy, since biological preservation even by waterlogging is characterised by its unpredictability. Low-lying wet sites may give little, but a site on apparently well-drained soils may have local concentrations of excellent material (this is discussed on p. 105). Similarly, calcareous material may survive locally on acid soils, or be absent or badly preserved where the bedrock is calcareous. However, it is usually reasonably obvious whether a site will, in broad terms, have little or much potential for preservation, whether of delicate remains by anoxic waterlogging or of calcified remains, or of both. Charred preservation of invertebrates is too rare to concern us here (p. 116), and mineralisation appears very unpredictable, based on our current state of knowledge.

During excavation there is the need to predict usefulness of the deposits being trowelled (or removed mechanically). The recommended approach to sampling (Dobney *et al.* 1992) overcomes this to some extent, but on some sites sampling cannot for various reasons be so rigorous. Experience suggests that there is no easy-to-follow set of rules for excavators to follow. Experienced environmental archaeologists are often unable to make accurate predictions concerning preservation, and they will not necessarily agree as to the most appropriate sampling strategy under given archaeological circumstances. Nevertheless, their frequent presence on site would nevertheless ease matters considerably and certainly would reduce the number of 'lost opportunities'. The only 'rules' which can be offered are that richly organic deposits rarely fail to produce worthwhile remains preserved by anoxic waterlogging, while 'unpromising' deposits may or may not be useful, and land snails are often present in neutral and calcareous deposits. Even where sampling is intensive, decisions need to be made as to whether to sample particular features in special detail, for example by multiple sampling across the area of a floor, or by sampling interfaces of deposits as well as their body (p. 440).

Choice of samples for evaluation

Intensive sampling programmes have been recommended above, though in reality it is often only practicable during evaluation to collect samples considered to be representative of the range of deposits encountered. If numerous samples are collected, it is in most cases not possible to examine more than a proportion of them during evaluation (others may be employed later for research purposes), so sensible procedures for selection need to be established. This requires full archaeological information plus inspection of unprocessed samples in the laboratory. There is frequently a dilemma in deciding whether to process a range of sample types from a site, so as to obtain a reasonably good picture of variation, or to process the samples that seem most likely to contain useful remains, providing the most useful data for interpretation and synthesis. Usually the selection process is dominated by the need to chose fewer samples than are reasonably needed because of limited funding. The shortfall may be by an order of magnitude. This is exacerbated by the view in some quarters that the only purpose of evaluation is to determine whether there is any 'useful' material in the ground, and not to make any record of academic value. This view appears indefensible, since the buried heritage is being destroyed by the evaluation, and a proper record of all aspects should be made.

Sometimes it is quite clear that no analyses of the samples are justifiable. An example is provided by Carrott *et al.* (EAU 1991/14); various materials with no dating from St Leonard's Church, Malton, were all judged valueless for 'environmental' analysis of any kind when inspected, so none were processed. For most sites, however, it would be useful to have an agreed strategy for choice and an agreement as to reasonable levels of representation in relation to the volume of material excavated and the complexity of the deposits encountered.

In the mid-1990s the staff of the former EAU drafted what appeared to be quite rational rules for quantifying evaluation sampling and processing, but they led to recommendations with implications for what was regarded as excessive expenditure even at the sampling level. This still begs the question of *which* samples should be analysed, although this will be less of a problem where sufficient have been collected to provide adequate representation of all the kinds of deposit found.

Choice of samples for assessment

It is recommended that all bulk-sieved samples should be assessed, and this can be done fairly easily. Selection of GBA samples for assessment is rather different problem than for evaluation. Problems caused by assessing too few samples because of shortage of funds are common. It is hard to make an academically good case be made for funding for full analysis when even after assessment it is still uncertain what is present in most of the samples. It must be recognised that there is a high level of unpredictability associated with bioarchaeological materials. Ideally sub-samples from all non-duplicate well-provenanced General Biological Analysis samples would be processed for assessment (see above), and all bulk-sieved and hand-collected material would be seen. This said, some selection will almost always be necessary in the real world. Selection procedures must be based on archaeological information, and the aims stated in the project design. Large groups of samples cannot often be considered to be represented adequately by a small subset, especially in the case of complex occupation sites. The best solution lies in processing sub-samples from numerous samples, followed by very rapid examination of the product, then more detailed inspection and recording of selected material (still as part of the assessment). It is recommended that for all but the most 'uniform' sites at least 30-50% of General Biological Analysis samples are 'test' processed (*sensu* Kenward *et al.* 1986a) during assessment, the number of assemblages recorded being determined by the heterogeneity of the material extracted. The criteria used in selection should be properly stated. Phrases, used by the writer as much as by others, such as 'the selection of material for assessment was based on inspection in the laboratory and information provided by the excavator' (Carrott *et al.* EAU 1997/25, 2) do not bear closer analysis! Samples should be stated to be representative of a particular phase/feature type combination, and of particular parts of the lateral extent and vertical of the site, and to have relevance to particular projects (or wider) aims.

Estimating scale of analysis required on the basis of assessment data

Assessment of GBAs is almost always a 'sampling the samples' exercise; there is not sufficient funding for all samples to be processed using a 'test' sub-sample as originally envisaged by Kenward *et al.* (1986a). So after deciding which samples to process at assessment, and recording the material in them at some level, it is necessary, on the basis of the results, to predict in some way how much work will need to be done in the analysis stage, and on which samples. This process is inherently unreliable, because of the rather unpredictable content of samples and the even less predictable archaeological significance of the remains themselves. Large quantities of well-preserved remains do not guarantee exceptionally significant information, although such material is likely to be important at a more routine context-by-context reconstruction level or for synthesis. Conversely, a few fossils may open up new insights into the past, and certainly the consistent occurrence of a limited suite of remains, even if sparsely distributed and poorly preserved, may say much about the site (discussed on p. 464).

The minimum useful number of samples for examination in the main phase will be related to the archaeological heterogeneity of the site - in particular the number of phases, feature types and use areas. Since enough samples from each combination of these should be seen to judge whether there is archaeologically significant variation within and between them, even on this basis (rather than that of finding the unusual) the number of samples for assessment and analysis may be very large. This problem of representation of complex sites is outlined by Kenward and Hall (1995, 467) in relation to Anglo-Scandinavian Coppergate.

Quantifying the main phase, when only a limited proportion of samples has been examined, must be based on 'scaling up' from results of assessment. This seems to have first been done overtly in a systematic way for invertebrates (together with other remains) for the North Street, York, site (Carrott *et al.* EAU 1993/14). Subsequent attempts, using methods of varying complexity, some frankly baroque, include work on sites at Wellington Street and 22 Piccadilly, both in York (Carrott *et al.* EAU 1995/14; EAU 1995/53). In these cases, tables were produced (a) assigning priorities to the assemblages from the assessed sub-samples and (b) predicting the likely number of samples at each priority in the whole body of collected samples by extrapolation. From this extrapolation, resource requirements and costing were calculated. As no sites for which such estimates were made have proceeded to analysis, the efficacy of the approach cannot be judged. It is, however, immensely time-consuming to make the estimates and calculations, and recent work has tended to a more rule-of-thumb approach (e.g. Carrott *et al.* EAU 1996/09).

The consequences of small-scale assessment are well illustrated by the material from the site at Flixborough, North Lincolnshire (Dobney *et al.* EAU 1993/21), where there was a wide range of context types, principally of Anglo-Saxon date, on sharply-draining sands; no preservation of invertebrates other than a few molluscs was detected in assessment (and plant remains were very sparse), but it was recommended that a survey be made in the analysis phase since any assemblages present would be of exceptional importance given the close dating and unusual nature of the site. A fuller initial assessment would have been far more helpful to management of the project, even if it had only led to the conclusion that no work on invertebrates was justified (as indeed was proved by further work at a later stage, Hall, EAU 2000/56).

Even where this extrapolative process is carried out it may be necessary to review material at the main phase (by 'test' sub-samples) because assessment has highlighted the unpredictability of preservation of material or of its archaeological importance. This approach has been recommended in a number of cases but does not find favour because it implies uncertainty as to cost. It was used successfully in the Viborg Søndersø project (Kenward CHP 2005/04; 2005b).

Estimating amount of sediment to process for insect remains

The standard sub-sample size processed for assessment and evaluation in York was for many years 1 kg, and more rarely 2-3 kg. The 1 kg standard ('test' sub-sample for insects, Kenward *et al.* 1986a) was adopted to constrain cost, as increasing sample size often increases processing and recording time disproportionally. It was also a convenient compromise between the typical requirements of entomologists (needing relatively large sub-samples) and botanists (who generally require far less sediment to be processed). Latterly, as the number of evaluations of sites with low concentrations of remains grew, there has been a move towards larger sub-samples, typically 3-5 kg, where inspection of the sediment suggests this is necessary (and practicable) given the nature of the sediment.

An essential component of work on archaeological insect remains, whether during assessment *sensu stricto* or during the process of continuing review needed throughout the main phase of a project, is estimation of the minimum amount of sediment which must be processed to produce an assemblage likely to provide a useful 'interpretation' of conditions and human activity at the point of deposition. This is not as simple as might be thought. Although understood for many years, the problem was first overtly addressed in the assessment of material from Low Hauxley (Issitt *et al.* EAU 1995/16). In an attempt to estimate the amount of sediment which it would be necessary to process to recover an assemblage of adult beetles and bugs adequate for reliable interpretation, a multiplication factor was applied to the approximate minimum number of individuals (MNI) recorded during assessment.

It is not possible simply to estimate a minimum number of individuals (MNI) for the remains from the sub-sample processed during assessment, and multiply up to obtain the required sub-sample size. This is because minimum numbers do not double with a doubling of sample size; some of the new fossils will be 'lost' into individuals already recorded but not represented by the new parts recovered. A species may, for example, be recorded from a single head in the first sub-sample. A subsequent sub-sample of the same size may add a left elytron; two more sub-samples, a right elytron and a pronotum, but the MNI remains the same. For another species, the MNI may increase because ‘duplicate’ parts are found, and new species may be found. Thus some conversion factor must be applied. The following argument applies to deposits with a low concentration of fossils.

Empirical observations suggest that doubling sample size increases MNI by a factor of about 1.25 to 1.75 according to the nature of deposits. The proportional increase will depend on the degree of dispersion of the remains of each individual and on the concentration. It will be high if the concentration is low and the remains of each individual were dispersed in the past before the deposit was sealed; a large proportion of the additional fossils will represent new individuals. This will be the case in many natural deposits. It will also be high where the parts of individuals remain associated, since all will be recovered together, and subsequent sub-samples will add more whole new individuals. This may be the case in some undisturbed layers such as primary pit fills. The increase will be low where there has been a moderate degree of dispersion, so that the parts of each individual lie close to each other but are not usually included in the same sub-sample. The increase will also be low if the number of species is small (low diversity), so that new fossils will be of the same species as those already found, even if they may not be of the same individual. If the number of species in the deposit is large (high diversity), then the MNI will increase more rapidly, since parts of new taxa will be found, and these obviously must add to the MNI.

If a sub-sample of 1 kg yields an MNI of 20 individuals, then increasing sample size would, following this reasoning, have the effect shown in Table 2.

Table 2. MNI for beetles and bugs assuming various degrees of dispersion of their remains (see text).

Factor	Sub-sample size					
	1 kg	2 kg	4 kg	8 kg	16 kg	32 kg
1.25	20	25	31	39	49	61
1.5	20	30	45	68	101	152
1.75	20	35	61	107	187	327

For all of the fossiliferous deposits at the site at Low Hauxley, it was predicted that (a) the remains had been widely dispersed by bioturbation during deposition and (b) very many taxa would be present, derived from species-rich semi-natural or natural habitats in the vicinity at the time of deposition. The factor of 1.75 was thus adopted. Unfortunately, this could not be put to the test as no further work was carried out.

It was formerly assumed that most of the fossils present in a sub-sample were noted during assessment, so that the rough estimate of numbers in the flot was a good enough basis for calculation. Unfortunately it has not yet been possible to make objective tests of this kind of reasoning, although recent work where lists for assessment samples were entered to a database, for example on the Viborg Søndersø site in Denmark, suggests that the numbers noted in assessment are substantially below those actually present (Kenward CHP 2005/04; 2005b). Such empirical investigations would be ideally suited to a medium-length undergraduate project, and the problem is amenable to computer modelling. Both must be regarded as of high priority; the results would assist in the everyday business of project management, but (in combination with an estimate of diversity) could also be applied to determining the actual character of fossil assemblages, and thus something of their taphonomy.

This discussion has ignored the fundamental question of how many insects are needed for an objective deduction concerning their implications. The intuitive/experience-based minimum of around a hundred is clearly not universally applicable, and multiple small assemblages would be preferable to a single very large one. Assemblage size issues relevant here are considered for pollen by Lytle and Wahl (2005): there is much to be done in this area.

Extraction methods

The methods applied for extraction of insect (and most other arthropod) remains, and their problems, have been discussed on p. 47. In short, paraffin floatation is proving not to be entirely effective in extracting fossils, for reasons which are not yet clear. Since extraction of a large and representative set of fossils is a prerequisite for interpretation of archaeological assemblages, improvement of this most basic of techniques is a high priority. It would be an ideal subject for an extended student project (preliminary work was carried out by Shaw nd.).

Fly puparia may be rather poorly recovered by paraffin floatation, and an improved technique for their systematic recovery is desirable.

Extraction methods for other invertebrate remains deserve further investigation, particularly the concentration of parasite eggs and the cost-effective recovery of delicate mollusc remains without excessive damage. It would also be useful to determine the value of insect remains from bulk-sieving in ecological reconstruction (comparing the effect of using 1mm, 0.5 mm and 0.3 mm mesh), and to test the representativeness of hand-collected assemblages of shellfish as compared with material obtained by sieving. It would be very interesting to determine the value of remains retained by 0.25 rather than 0.3 mm sieve meshes; an investigation suited to a student project. Comparison of the value of the information obtained by processing and recording multiple small sub-samples rather than a single large one might also be revealing.

Recording methods

Early work on Quaternary, and then archaeological, insect remains at the University of Birmingham was carried out with the aim of identifying every fossil (though usually only of Coleoptera, and only the principal dorsal sclerites). This was the approach which was inherited by the next generation of entomologists working in archaeology, and in the initial stages it was undoubtedly an appropriate one. As larger numbers of samples from ever more sites were examined, the development of faster recording methods became necessary. This was made even more pressing by the gradual widening of the range of remains recorded, both in taxonomic and anatomical terms. Kenward *et al.* (1986a) described their rapid processing and recording methods, and these were evaluated by Kenward (1992).

Work at Tanner Row (Hall and Kenward 1990, e.g. 359) and Anglo-Scandinavian 16-22 Coppergate, York (Kenward and Hall 1995), and at many sites since, has amply justified the use of more rapid recording techniques to obtain a broad range of *archaeological* data, although the failure to identify all material as closely as possible has reduced the information for studies of other kinds, for example concerning past distributions of rarer species, particularly aliens and those of climatic significance.

The very rapid, somewhat subjective, recording method used for assessment and evaluations has proved to have one serious fault, for no database record has been created for large numbers of sites where no further analysis was carried out. It is strongly recommended that a listing and creation of a database of at least the more ecologically and historically significant taxa is incorporated into the requirements of specifications for evaluations and assessments in future. The time implications are too great for such a record to be created without explicit funding within the projects. The choice of which taxa are 'significant' is a matter to be addressed, although in most cases it will probably be obvious to experienced workers. It might be helpful to make available a list of common taxa and species associations which are regarded as particularly significant in interpretative terms, although of course that would not cover new discoveries.

Recording quality of preservation

Current methods employed for recording the preservational condition of invertebrate remains are reviewed on p. 122. Undoubtedly, further research is needed, both to refine recording and to relate the visually observable changes to the physical and chemical modification which has occurred to the fossils, and to events during deposition and subsequently, especially, of course, in relation to recent decay and the curation of the buried heritage.

Data presentation

There is a need to make readily available in reports a complete list of species with presence absence data or a count of the number of contexts in which they occurred, broken down by period/phase for quick reference, and to present summary assemblage statistics by phase and feature type. The best way to do this is in print. Beyond this, detailed species lists and statistics at the sub-sample assemblage level must be made available, with easy access for the foreseeable future.

The presentation of sample species lists is a vexatious matter and various methods have been explored. A single report (that for Late Glacial insects from St Bees, Cumbria, Coope and Joachim 1980) has presented data in the same way as a pollen diagram - perhaps appropriate for a continuous succession, but hard to create and use, expensive to present, and obviously unsuitable for most occupation site material. Osborne (1971) showed the list for a single assemblage in the form of a histogram. This is informative, but impractical for publication of most sites. (The same principle has been used in archive reports showing rank order and cumulative frequency curves produced by the EAU, e.g. those for 16-22 Coppergate, Kenward EAU 1984/03-05, 1884/08-14; 1985/08-15.) An appreciable number of publication reports give complete lists with numbers by sample assemblage. Unfortunately this is only practicable for a few samples, so that only the small, and therefore generally less useful, data sets appear in print. Three main approaches were taken to the problem of large data sets. The first was to give lists of the more abundant taxa for each sample (first ten ranks of abundance, FTRA or 'top ten' lists). This was the method suggested by Kenward (1978a), and subsequently employed in several reports (e.g. Hall and Kenward 1980; Hall *et al.* 1980 ; Kenward 1979d). Hall and Kenward (1980) discussed the difficulties of data presentation, outlining the scale of the problem involved in full publication and urging the 'top ten' approach.

The second approach was the use of microfiche, widely welcomed and adopted, for example, for the small group of samples from the Roman well in The Bedern, York, by Kenward *et al.* (1986). However, even this proved impracticable for larger data sets. Before the publication of the Bedern data, Hall *et al.* (1983b) had of necessity abandoned full publication in favour of 'top ten' lists on fiche for the data for over fifty assemblages from two Anglo-Scandinavian sites in York. But this approach was impossible for the data for over three hundred insect assemblages from two sites in the York Colonia (Hall and Kenward 1990), and in this case even nine sheets of microfiche allowed only publication of summary derived data for the plant and invertebrate assemblages, the full data remaining in archive form despite their potential value as a research resource.

Microfiche has not always proved easy to use - the writer has found data so stored to be effectively illegible in some cases.

The third approach to the problem of putting data on record was that latterly adopted in the former EAU. It also addressed the need to publish only a summary of the more important conclusions rather than the details of the deductive process as carried out at the context or feature level. A small number of copies of a technical report were produced, in which the material is discussed in full, context by context, setting the results of analyses of plant and invertebrate remains side by side (bone data have yet to be entirely successfully integrated into such a report, although Carrott *et al.* (EAU 1997/16) attempted to do so). Full species lists were given in appendices, together with assemblage statistics and other relevant data. Full data were also stored in a database (Paradox is used) and made available on application in electronic form. These technical reports and data archives are currently in process of being made available on the WWW. This is also the approach currently adopted in the Centre for Human Palaeoecology, University of York. The Archaeological Data Service (ADS) is available for those who cannot maintain their own websites in perpetuity. Recommendations concerning web data presentation and publishing are given by May (2006).

The publication text can be a narrative summary, illustrated by particularly significant examples only. Hall and Kenward (1990) and Kenward and Hall (1995) also presented summaries ('boxes') of principal components of the biota (e.g. 'house fauna', ectoparasites), including changes through time, using mixed tables, text and graphics. This approach is considered to be effective in communicating both the archaeological conclusions and the reasoning employed in arriving at them. For the Tanner Row site, a diagram of changes through time for various categories of the biota was presented using a crude scale (loc cit., figure 82) and the same scale was employed to show spatial variation as well as changes through time for the Coppergate site (Kenward and Hall 1995, e.g. figures 193-6). These methods of presentation are only offered as examples: there are many other ways of conveying essential information. The issue of data presentation was discussed with a vertebrate slant by O'Connor (1985b).

A problem arises where specialists of varying experience and egotism based in institutions with different publication cultures work on the same project: some contributors are wedded to full publication even though others are content to include only synthesis, and small data sets of only modest relevance may be published for one reason or another (e.g. for the Anglian deposits at Fishergate, York, Allison *et al.* 1996b).

In summary, there is much to be done to improve and refine the practical methods applied in studies of invertebrates in archaeology, some problems requiring the highest level of expertise, others addressable through simple projects suitable for undergraduate students.

Interpretative methods

A brief historical outline of the development of interpretative methods for insect assemblages has been given on p. 57, and an outline of approaches to mollusc assemblages on p. 84. There is a need for much further work in this area. Broadly it falls into four categories: (a) theoretical and empirical studies of death assemblage formation and other taphonomic issues; (b) development of a better understanding of the ecology of the species concerned, at the species and community level, and the application of ecological theory to interpretation; (c) development (or adoption) of improved statistical methods; and (d) integration with other evidence (from other biological, pedological, excavational, artefactual and other studies).

Taphonomic issues relevant to interpretation

The taphonomic problems associated with archaeological invertebrates are universal, and fundamentally identical to those encountered in conventional palaeontology (e.g. Dodd and Stanton 1990). Human behaviour adds a layer of complexity to archaeological material through, for example, the importation of a range of resources, but the underlying principles remain the same. However, somewhat different sets of problems exist for imported materials (particularly selected resources such as shellfish) as opposed to communities of invertebrates living at or near to the point of deposition. The following sections are rather more concerned with the latter than with the former.

Incorporation of invertebrate remains into forming deposits

It has been established that a simplistic assumption that there is a 1:1 relationship between nearby habitats and the corpses incorporated into a deposit is not workable (p. 57). It has also been demonstrated that remains in a deposit are not necessarily related to the immediately surrounding area. In addition, circumstances in the past may have conspired to reduce the representation of some habitats, as a result of differences in flight activity or other behavioural characteristics of the living animals in relation to habitat, and the preservational attributes of particular classes of depositional loci.

Death assemblages very rarely represent single communities, and usually several have become mixed. Hall *et al.* (1983, 194), for example, presented a tabular model of the way remains became incorporated into floor deposits, revealing the immense complexity. The problem of floors as areas of unpredictable accumulation was further discussed (op. cit, 204-5; see also the diagram given by Kenward 1985a). Other depositional environments will have been subject to various special factors in the formation of death assemblages. Kenward and Large (1998b) consider the development of insect communities and death assemblages in pit fills in some detail, for example. Materials as well as depositional situations require elucidation of their formation; Hall and Kenward (1998) represented this using a series of diagrams illustrating the way the many components of stable manure may be collected together and finally deposited.

In addition to the spatial relationships of the components of death assemblages, the temporal relationships require consideration. Few assemblages represent a moment in time; most are the result of the integration of successive communities at and around the point of deposition. Successions in invertebrate communities relevant to archaeology in natural or undisturbed artificial habitats have barely been examined, and on most archaeological sites the perturbing influence of human behaviour will have complicated matters further (by adding more waste to the fill of a pit, for example). Research into successions, whether undisturbed or perturbed, would be very time consuming, but is practicable. The biggest problem would lie in creating communities comparable to those found in past occupation sites, in view of the great changes of abundance in many species of insects, and no doubt of other, less well-known, invertebrates (Kenward and Allison 1994c; see also p. 279).

While the presence of background fauna will mean that components were added to death assemblages, there will also typically have been dispersal from the forming deposit. Successful reproduction would be likely to mean that adults left in search of new habitat, reducing representation of the autochthonous communities. This, too, is open to research.

Post-depositional decay of invertebrates

Preliminary results of studies of the changes to the structure of insect cuticle during decay are reported by Briggs *et al.* (1996) and Flannery *et al.* (2001), but little is understood of the processes involved, or of the differential loss of the various chemical constituents under different conditions. Why, for example, do fossils in some deposits remain robust yet become pale, while under other conditions they retain colouration despite being reduced to flexible films? Why do some groups of arthropods apparently decay so readily, when others are robust? (Notably poorly preserved are grasshoppers and woodlice, discussed on p. 50 and 42 respectively.) Almost nothing is known of the way the decay of invertebrates is related to conditions in the matrix, or of differential decay in different taxonomic groups (although empirical observations have given subjective impressions of which are likely to survive). There is a need for experimental work to examine rates of decay of a wide range of invertebrate remains at the macroscopic level under various conditions, and to relate the observations to chemical analysis and examination of sections using electron microscopy.

Another area for investigation is the use of experimental burial conditions, parallelling the research on artefacts and various biological remains (but not invertebrates) at the experimental earthwork at Wareham, Dorset (Evans and Limbrey 1974; Lawson *et al.* 2000).

Habitat visibility

Studies of modern deposits have proved crucial in improving our understanding of archaeological assemblages. There is a great need to continue this work. Emphasis is needed on the visibility of habitats, e.g. forest, trees and hedges, arable and grazing land, and human occupation in nearby cut features. We need to develop a better understanding of the bias likely to have been caused by the places in which remains are preserved, for example the degree to which aquatics or decomposers may be over-represented.

The visibility of trees and woodland

The problem of detecting trees from insect assemblages has been mentioned at various points in the text. Sometimes the plant macrofossil evidence strongly suggests the presence of trees, when insects give no sign of trees, or only traces of dead wood or scrub fauna. It may be that trees will only be revealed by insects when they were very close to, or even actually overhanging, deposits as they formed, because many woodland insects are believed not to migrate far (e.g. Southwood 1962). This hypothesis is strongly supported by the results of an early study in Kent (Kenward 1978a) and by recent work carried out in Yorkshire (Caswell 2001; Hill 1993; Peters 2001; Kenward 2006). Smith and Whitehouse (2005) examine this problem from another direction, discussing likely bias in woodland reconstructions from insects, perhaps resulting in under-estimation of the vegetational and structural diversity of past woodland environments. There are difficulties, too, in using 'woodland' or shade-loving snails since it appears that they may adopt more open habitats in cooler conditions. Further research is required, parallelling that for pollen (e.g. Bunting 2002; Davies and Tipping 2004).

The spatial relationship between the biota of activity areas and death assemblages in archaeological deposits

Many archaeological deposits have a clear relationship between human activity and the death assemblage they contain; this is true of many pit fills and floors, for example. However, in other cases this relationship is less clear, and for some sites the problem may be crucial (e.g. in relation to the detection of synanthropic fauna at isolated sites, Kenward 1997a, and in 'clean' towns). In rural occupation sites, in particular, it is common for preservation of the less durable invertebrate remains to be restricted to cut features, particularly peripheral ditches and sometimes wells. The transference of remains of organisms associated with structures and other activity areas to ditch fills is likely to have been a complex process, and in many cases few remains may have made the journey. It is possible that the rarity of decomposers, particularly synanthropic ones, and other species associated with human activity, in many ditch fills is a taphonomic effect rather than an accurate reflection of conditions at the site and the success of insect colonisation. This might lead to incorrect deductions about the character of a site, or an area of a site.

Transfer of material from occupation areas was undoubtedly normal in the past, but where waste ended up depended on the nature of the site. The occupants of rural sites perhaps almost always carried organic waste to the surrounding fields, in contrast to urban populations, whose waste (if not left where it fell) was dumped on the site in middens and pits, or was removed to disposal areas. Surface organic accumulations like those found at the Deer Park Farms site, Northern Ireland (Allison *et al.* EAU 1999/08; 1999/10; Kenward and Allison 1994a; Kenward *et al.* accepted) are, sadly, extremely rare on rural sites and may reflect exceptional circumstances.

Deposition in ditches on occupation sites

The transfer of insects to ditches (and similar localised areas with waterlogged preservation) at occupation sites has been modelled by Carrott and Kenward (unpublished). The calculations suggested that very few remains will have been incorporated in the fills unless there was deliberate dumping or there was intensive activity which generated large insect communities immediately adjacent to the ditch. This is to an extent supported by the archaeological record, although the evidence is not clear. A good example is offered by Roman-periods fills of a peripheral ditch at Brixwold, Midlothian (Carrott *et al.* 1997); the lower few contexts contained very few synanthropic species, and an upper one, with rather more, seemed to have received dumps rather than synanthropes having entered randomly. A single ditch deposit of Anglian date at Fishergate, York (Allison *et al.* EAU 1989/02; 1996a) gave a useful assemblage of insect remains, but supposedly contemporaneous occupation seems not to have resulted in the transfer of synanthropes to the ditch fill. (Alternatively, of course, the characteristic synanthropic fauna may not have developed to any great extent by the stage of occupation at the site represented by the fills.) One of a series of ditch fills associated with a 3rd-4th century Romano-British villa site at West Lilling (Site 169), gave a hint of an occupation-site synanthrope community, resembling to an extent those often seen in stable manure (Hall *et al.* EAU 2002/01). Studying Roman cut fills at a site along the route of the Leven-Brandesburton by-pass, Hall *et al.* (EAU 1994/15) suggested that the rarity of synanthropes might have been a result of under-representation (caused by mechanisms discussed above), periods of abandonment or low-grade use, or the failure of the typical synanthropes which would reveal artificial habitats to invade this remote site. Assessment of a site revealed by construction work on the M57 in Merseyside similarly indicated a lack of occupation-site synanthropes (as opposed to species favoured by human modification of vegetation) (Carrott *et al.* EAU 1994/17; Carrott and Kenward EAU 1994/24; Kenward and Large EAU 1997/20). The site at North Cave, East Yorkshire (Allison *et al.* EAU 1997/37; forthcoming a) represents another case where, against expectation, extensive analyses failed to discover more than traces of synanthropes in cut features, whose contemporaneity with intensive occupation must consequently be open to question. A small pond or ditch, perhaps of Roman date, on the route of the Chapel Haddlesey to Eggborough pipeline, West Yorkshire (Hall *et al.* EAU 1999/31) provides an example where there was a contrast between the plant remains, from which there were hints of human occupation, and the insects, which included no clear occupation-site synanthrope community.

Similarly, at a site at Risley, Cheshire (Carrott *et al.* EAU 1996/13; Kenward *et al.* EAU 1998/23), ditch fills contained rather small numbers of synanthropes despite their apparent association with occupation. At the Station Yard site, Beverley (Carrott *et al.* EAU 1991/17), a series of fills of a large ditch thought by the excavator to be associated with the Preceptory of Holy Trinity were examined. No strong synanthropes were recorded in the report (they were certainly not abundant), although the burrowing *Anommatus duodecimstriatus* was found and was perhaps intrusive. In this case it may be that nearby activities were not such as to encourage the development of large synanthropic decomposer faunas, but the possibility that there had simply been a low rate of transfer from activity areas to the point of deposition cannot be ruled out.

In some cases, the rarity of synanthropes seems particularly surprising. Pond sediments from the medieval rural site of Fazakerley, Merseyside, were examined by Hall *et al.* (EAU 1996/05) and illustrate the problem under discussion very well. The rarity of artefacts, the lack of strongly synanthropic insects (and of a plant assemblage typical of an occupation site), and the rarity of charcoal were somewhat surprising given the proximity of the pond to contemporaneous structures at some phases at least (Wright and Fletcher 1995). The explanation for this apparent anomaly was uncertain, but a feature interpreted as a ditch and bank lay between the pond and the nearby toft; if the two lay in separate properties, dumping of rubbish may have been inhibited, and if the ditch was accompanied by a hedge, this would have decreased the flow of material from the occupation area to the pond even further. A hedge close to the pond would, of course, have provided a protected place for tree and shrub growth and account for the remains of leaves and other debris recorded during analysis. Another consideration concerns the likely wind direction at times when insects are migrating in large numbers; gentle breezes on warm days, and particularly on humid evenings, are likely to be from the south-west, carrying insects migrating from habitats in a settlement preferentially to the NE. However, it remains possible that the rarity of synanthropic insects in the deposit reflected the fact that few such species had been able to invade this small and rather isolated farmstead, their place perhaps being taken by species more typical of semi-natural habitats. This problem of synanthrope rarity in ditch deposits forms close to apparent human occupation is not confined to the north of England, of course: an example from the Iron Age of East Anglia is provided by the ditch of the Wardy Hill ringwork, Ely (Clarke *et al.* 2003).

Although buildings and materials would provide habitats for many synanthropes, especially house fauna and storage pests, it seems likely that bulky organic waste only remained on small sites under exceptional circumstances. However, there may be cases where circumstances provide a sample of the synanthropic fauna, when a large quantity of material was transferred from activity areas to ditches. In such cases a remarkably good picture of local conditions can be built up even where preservation occurs principally in, or is restricted to, such features. An excellent illustration (albeit not from a small rural site) is provided by the ditches at the Roman fort at Ribchester (Buxton *et al.* 2000a-d; Carrott *et al.* 2000; Large *et al.* EAU 1994/11). These were perhaps used for disposal only because a major process of clearance was carried out during refurbishment by the military, who may have had little desire to favour local farmers with their manure. On a smaller scale, Carrott *et al.* (EAU 1993/04), in their study of 15th century primary ditch fill material from 17-19 St Augustine's Gate, Hedon, recorded an insect community interpreted as house fauna, perhaps from stable manure, including remains of the sheep ked *Melophagus* (most probably from inside a building, see p. 363). This component was presumably introduced by deliberate dumping. Similarly, ditch or riverside deposits at the Kingswood site, Hull, seem likely to have received dumps including synanthropes, whose limited diversity were tentatively suggested to indicated isolation of the settlement (Carrott *et al.* EAU 1997/17).

This problem of representation of occupation on rural sites requires further consideration. Modern empirical studies may be informative, although analogues will be hard to find. Development of the transference models for synanthropes produced by Carrott and Kenward (unpublished) would be helpful.

The special case of wells

Wells present substantial difficulties to excavators and bio-archaeologists alike, but may be the only place on a particular site where abundant and diverse remains are preserved. Interpretational problems centre on establishing how biological remains entered the fills. Properly constructed deep wells with a protective rim of some kind should receive limited input of insects during use. Only some background fauna and species given to climbing up vertical surfaces might be expected to enter such a well, although it is conceivable that bird droppings might occur in some cases. Even such insects as did fall in were perhaps likely to be removed in buckets of water, since (unless the depth of water below the bucket was very great) they would have been mixed into suspension for a time by currents created as water was withdrawn. Less carefully-made wells might be expected to accumulate very large numbers of insects which had accidentally fallen in (the 'pitfall trap' effect), and in a few cases this has been observed (the Roman well at Barnsley Park, Gloucestershire, may represent an example, Coope and Osborne 1968, as may the Wilsford Shaft, Osborne 1969; 1989). Such accumulations may represent disuse, when the well rim was lost or damaged, of course. What is perhaps surprising is how rarely wells (or indeed pits) yield assemblages of insects likely to have succumbed to the pitfall effect.

The infilling of wells is modelled by Greig (1988, fig. 2), who presents a useful diagram which emphasises the distinction between use and disuse phase fills and backfill dumps. Use-phase deposits in wells have rarely been convincingly demonstrated (an exception may be the fills of the timber-lined well at Hayton, East Yorkshire, Jaques *et al.* EAU 2000/35, where a small number of autochthonous species were suspected to be present together with a gradually-accreted 'background fauna', although even here there may have been mixing of use-phase accumulation with backfill). Normally, the material examined is quite clearly deliberate backfill, on stratigraphic, artefactual and biological grounds. If this dumped material contained contiguous spaces between its clasts (lumps of earth or masonry, for example), then small biological remains are likely to have gradually filtered down through the gaps, and the fossils in any layer may represent a long time span, and a period far later than the latest artefacts in the dumps (themselves, of course, likely to pre-date the act of dumping). These problems were discussed at length in the context of the Roman well at Skeldergate, York, by Hall *et al.* (1980 , 122-130). In this case, it was suggested that thin use-phase deposits may have existed, but that the fauna in them, and in the earliest backfills, would have been mixed into the later fills as they were dumped. Dumps in this well, and the one at The Bedern, York (Kenward *et al.* 1986b), seemed to be reasonably accurately datable, and not to have been liable to post-depositional infiltration by biological remains.

In other cases it is hard to establish which phase of occupation well fills relate to. Buckland (1980), in his interpretation of the insect assemblage from fills of the Roman well at Rudston villa, East Yorkshire, proceeded on the assumption that they related to the principal phase of occupation. However, the assemblage might best be interpreted as indicating at most low-grade occupation, or abandonment, of the villa, with agriculture continuing in the surroundings. Indeed, it might be argued that good-quality wells (requiring an enormous effort for construction and apparently capable of remaining in use for centuries) will very rarely have been simply abandoned during occupation, and that their fills will generally represent dumping during clearance, or abandonment episodes when the protective rim had been removed or had collapsed. Deep wells will thus perhaps hardly ever contain discrete, unmixed assemblages of recognisable use-phase material, unless a substantial amount of silting had somehow occurred, sealing biological remains so that they were not disturbed during subsequent infilling.

Wells of lower quality are progressively less clearly identifiable, and the crudest kinds are probably often mistaken for waste pits. On the other hand, not all features interpreted on excavational evidence as wells were necessarily such. Barrel 'wells' may often have been latrines, for example. Some of the Anglo-Scandinavian pits at 16-22 Coppergate, York, appear not to have been used for waste disposal and to have held open water for a considerable time, but it is not clear if these were wells (in the broad sense) or had just been abandoned (Kenward and Hall 1995). Cuts described as 'water holes' are particularly difficult to interpret. One such at the North Cave site (Allison *et al.* EAU 1997/37; forthcoming a) gave a rich fauna reflecting semi-natural habitats, for example, but there was no component to suggest the presence of humans or livestock. Features of this kind are considered in more detail on p. 393.

Whatever their special problems, wells and waterholes are often the only places where there is appreciable preservation by anoxic waterlogging, particularly on sites which are assumed to have been kept clean during occupation (Roman ones, for example) or are on sharply draining substrata (as at North Cave, mentioned above). Wells, especially the deeper ones, present an environment which has typically remained cool and wet, ideal for preservation of even very delicate remains. It might even be argued that the fact that deep wells lacked an autochthonous fauna (with rare exceptions such as the *Lesteva longoelytrata* at Skeldergate, Hall *et al.* 1980) is an advantage. Their interpretation thus must be tackled (as must first be their physically demanding excavation). Wells are often not excavated at all for pragmatic reasons, but far more reprehensible is the frequency with which they are partly excavated then abandoned. Excavation of the upper layers of wells at the Magistrates' Courts site, Hull, and at the Wellington Row site, York, for example, revealed early modern material which might have been an invaluable source of information about the fauna of the period, perhaps allowing the importation of new species and development of urban fauna to be tracked. The well at The Bedern mentioned above was also abandoned before it was completely excavated, for what can be argued to be justifiable practical reasons (safety, cost). The great difficulty of excavating wells is appreciated (Paccito 1980 gives an extensive discussion of the problems encountered during work on the Roman well at Rudston, for example). Nevertheless, in each case careful consideration should be given to the information which might be obtained and the problems of site reconstruction (and higher-level issues) which might be approached before calling off further attempts at excavation. Wells abandoned by recent and current excavations are quite likely never to be re-excavated, and may be destroyed by piling or pressure during the cycles of development likely to be suffered by many sites in future.

Time relationships of deposits with anoxic waterlogged preservation to occupation

The problem of relating the rare deposits with anoxic preservation to occupation at many sites has been alluded to at various points. In a nutshell, are records from many sites biased towards low-key, declining, occupation and abandonment? This problem was identified for (among others) Roman Papcastle (p. 158), Dalton Parlours (p. 191), Rudston (p. 180), and Romano-British sites at North Cave (p. 180) and on the route of the Leven-Brandesburton by-pass (p. 182). It is important to address this question when attempting reconstruction of living conditions and activity at sites, but also in relation to the spread of synanthropic insects to isolated sites, and the conclusions which may be drawn from their rarity (p. 461). No easy solutions can be offered, but meticulous excavation combined with intensive sampling and analysis at a small number of sites may be helpful. Of course, where the biota of deposits are dominated by remains clearly derived from human occupation (e.g. food plants, parasite eggs) we may be sure we are examining an occupation phase. It will probably always be impossible to know during excavation whether deposits are from occupation or post-occupation, and in any case the latter deposits may contain important archaeological information such as evidence of continued, non-occupation, use, sheltering by livestock, invasion by vegetation, or natural assemblages of insects containing climatic information. This sort of problem is usually only likely to be approachable in the context of 'research' excavations.

Arguments concerning the relationship of floor deposits to occupation, disuse or low-grade activity are rehearsed on p. 372.

Sites with thinly-distributed remains

Rich assemblages of remains are always welcome, but they are not necessarily packed with information concerning the questions most relevant to the contexts, feature, site or period under study. Conversely, a few fossils may open up new insights into the past, and certainly the consistent occurrence of a limited suite of remains, even if sparsely distributed and poorly preserved, may say much about the site (above; see also Hall *et al.* 2003c; see for example Carrott *et al.* EAU 1997/16; Robertson *et al.* EAU 1989/12).

Ecological issues in interpretation

Application of ecological methods and principles is of fundamental importance in interpretation of past ecologies and human living conditions from invertebrate remains. Specialised techniques, although still within the broad principles of palaeoecology as a whole, are required. For insects and molluscs, the groups relevant to archaeology which have received most attention in this respect, and developments to date have been summarised on p. 57 and 84 respectively. Here, some of the more promising current and most vital future developments are considered in a little more detail.

Insect species associations

The assemblages of insects recovered from archaeological occupation deposits cannot be directly matched to modern communities. This is partly because they represent a mixture of communities, but it is believed that a second, and more significant, factor is the existence in the past of living communities of insects which do not occur today as a result of changing availability of artificial habitats and of the introduction of new species. We thus need to investigate past communities on the basis of the archaeological evidence. A crude first step in this direction was made by Kenward (1982); the resulting 'constellation diagrams' representing frequency of association of groups of species were reproduced by Hall *et al.* (1983b, 213). Subsequent research has greatly strengthened belief in the value of these species associations, for they are both recurring and visible using a wide range of statistical methods (Carrott and Kenward 2001). Analysis of associations at a range of sites has served to underline the value of the approach (e.g. Hall *et al.* EAU 2000/25; Kenward *et al.* EAU 2000/57; Kenward and Carrott 2006), including their application to studies of land-use zonation (Kenward EAU 1999/43; Kenward and Carrott 2006; see p. 407).

Some of these statistically-identified groups are believed to be associated with house floors, buried organic matter, foul decomposition facies including stable manure, dung in the open and very wet (often faecal) mud, pit fills, and open yard surfaces. Enhanced understanding of these and other groups seen at Roman and later medieval sites, including their relationship to past and present communities of insects, will enable the ecologically complex archaeological assemblages to be disentangled. This, it is hoped, would allow accurate interpretation of depositional circumstances, and, very importantly, would permit smaller groups of remains, more easily and economically recovered from archaeological deposits, to be interpreted by detecting statistically significant excesses of particular ecological groups (Carrott and Kenward 2001). From the ecological perspective, such work may eventually lead to an understanding of the adaptation of insect communities to human modification of habitats and to the introduction of new species, with implications for ecologists' predictions concerning both.

Species association analysis was applied to assemblages from the Magistrates' Courts site, Hull (Hall *et al.* EAU 2000/25), and this can be used to exemplify the kind of information which may be obtained from even fairly limited material. The implications at this site were not completely clear, but it was thought likely that one of the groups identified, together with a peripheral 'swarm', indicated a taphonomic pathway from foul mouldering matter, perhaps indoors, to wetter, fouler accumulations in the open. There was little to support the hypothesis that aquatics represented the watering of livestock or spillage or waste from domestic activity. Grain pests were statistically isolated, a strong contrast with some other sites (e.g. Tanner Row, York), suggesting that they were not primarily introduced as animal feed: indeed cereals may have arrived separately from the other materials indicated by the insects, and perhaps passed down the taphonomic pathway in isolation too. Grain in cereal thatch was a possible source, although there were no associations with any likely thatch beetles. House fauna taxa were weakly associated, again a strong contrast with most other sites. It was though likely that they had diverse origins, some being predominantly from fairly clean buildings, some from domestic floors, and others from hay or litter.

Work on modern associations is highly desirable but complicated by the fact that, as mentioned above, there may not be direct comparability between modern and ancient communities (some ancient habitats no longer exist, Kenward and Allison 1994c). The problem of ecological successions in relation to death assemblage formation has also been mentioned above (p. 456).

Ecological and activity-related groupings of insects and other invertebrates (and their relationship to plant associations and other evidence) require further investigation as a matter of priority; work to date can only be regarded as a tentative first step. This is of course closely related to work on indicator groups (below).

Statistical comparison of groups of samples is another related aspect of the multivariate treatment of archaeological data. Although earlier work to date had limited results (p. 63), different approaches which take account of the presence of background fauna and eurytopic species, and make use of species associations, may prove more successful, to judge from the results of an investigation of zonation in Roman Carlisle which made use of a range of sample statistics (p. 63 and Kenward EAU 1999/43).

Modern parallels

The need for work on modern insect communities has been mentioned above. Just as useful will be studies of the formation processes and death assemblages in modern depositional environments. Studies of processes and their effects will also be invaluable, even such simple projects as making a careful record of the damage left by opening oyster shells being worthwhile. Much could be done using undergraduate projects, or by collecting material produced during studies of other materials, e.g. many of the diverse experiments reported at the Association for Environmental Archaeology symposium on 'Experimentation and reconstruction' (D. Robinson 1990).

There has been a modest amount of work on modern parallels for ancient invertebrate assemblages. Of course, numerous valuable parallels can be found in ecological research which was not carried out within the archaeological ambit, and some of these are especially relevant to the past: the study of vegetated roofs in Switzerland by Kaupp *et al.* (2004), for example. Some work explicitly carried out as exercises in creating archaeological comparanda has been published. Bell (1981) examined organisms introduced in seaweed. Kenward (1975a) reported the insect death assemblage from a modern urban drain. Kenward (1976a) assessed the likely composition of modern urban 'background fauna'. Kenward (1978a) reported insect remains from a modern well and stream deposits. Kenward (1985a) examined deposition of background fauna in houses. Smith (1996a; b) studied the beetles in Hebridean 'blackhouses' in regard to indicators of thatch and other materials and the rate of extinction of synanthropes. Robinson examined modern death assemblages, producing data concerning their relationship to local habitats (e.g. p. 58). Robinson (1997) compared modern beetle death assemblages in turf with Neolithic fauna from Silbury Hill. Markkula (1986) compared modern and subfossil mites in a mire, and Schelvis (1994a) studied mites in the dung of various livestock. Hellqvist (2004) reported a study of modern insect death assemblages in two wells and a stable floor in Sweden. H. Smith (1996) examined the deposition of molluscs in a Hebridean farmstead. Some other work on modern parallels in molluscs is mentioned on p. 84. There is probably much more, perhaps sometimes equally valuable, work languishing in student project reports and other archives. Among the latter, the author is aware of the following: Hill (1989) examined corpses in a decomposer system (a compost heap); Kenward (EAU 1984/06) examined dung beetles in grazing land turf (work which has occasionally been quoted in print); Chapman (2003) studied dung beetles in modern deposits in relation to local land use; Kenward *et al.* (EAU 1984/15) studied the death assemblages associated with modern turf roofs; Lancaster (1995) examined insect corpses associated with nettlebeds; Caswell (2001) and Peters (2001) (and also Kenward 2006) tested the visibility of woodland from insects in modern sediments; and Taylor (2001) studied rates of decay of mollusc shells in chalkland soils. Various other pieces of work have been carried out in an idle spirit of enquiry and never committed to paper, informing interpretation in an informal and utterly unscientific way! There is much which could be done here: one area which is particularly in need of investigation is the range of invertebrates (and plant remains) imported with water from various sources.

Indicator groups

The concept of 'indicator groups' which may include organisms of all kinds and which are characteristic of particular materials or depositional environments may prove valuable in a number of ways, particularly in aiding rapid recording of significant components of assemblages, and in focussing attention on formation processes and the complex pathways leading to the final death assemblage. The latter aspect is considered particularly by Hall and Kenward (1998) with respect to stable manure. Kenward and Hall (1997) take this concept further and suggest that the concept of 'indicator packages' encompassing all kinds of evidence, not just that from biological remains, is useful at least in developing hypotheses and theory about deposit formation. The practical value remains to be seen, but it would be useful to extend this kind of modelling to a much wider range of deposit types. Hall and Kenward (2003a) consider the extent to which indicator groups of plant and animal remains can be recognised for a range of domestic, craft and industrial activities, as well as some raw materials, and these are referred to where appropriate in this review.

Diversity indices and available species pools

An index of diversity can be used to do more than measure species richness in a sample. Assuming an approximately log-normal distribution of species' abundances in death assemblages (as opposed to living communities, vide Williamson and Gaston 2005), it is possible to estimate crudely the number of species in the local fauna, by back-calculating from the value of Fisher *et al.*'s (1943) alpha (see p. 58) for sample assemblages. This was done for the Oakwell Hall site by Kenward and Allison (EAU 1988/12), and for Late Devensian fauna at Davenham by Hughes *et al*. (2000), but similar reasoning was implied for beetle assemblages as early as 1970 by Coope (in Gaunt *et al.* 1970, 186): 'the [species recorded] are probably only a fraction of the total fauna. This conclusion is supported by the large number of species represented by single individuals.' It is possible to calculate how many taxa would be present in a group of remains of some arbitrary but very large size (say a million or more). This gives an indication of how quickly new taxa would be added by processing further material and is also of some use in estimating the richness of the fauna available at the time of deposition. This is an interesting way of looking at overall ecological richness in an area (a standard species list is not very helpful in this respect since it is so dependent on the number of fossils examined and vagaries of any particularly depositional situation). Systematic application of this simple method might prove edifying - providing a measure of species richness in the north and the south, in towns and at rural settlement, and through time. It could be applied particularly to the synanthropes at occupation sites (enhancing the statistics proposed by Kenward 1997a).

The calculation of a reasonably accurate estimate of the available fauna will probably not be simple, however. Firstly, the error of alpha is usually so large that the range obtained in the calculation is very great. Secondly (and presumably because the log-normal model of population structure is not wholly appropriate), in some cases the author (unpublished) has obtained estimates of numbers of beetle species in excess of the entire British fauna in this way! Further investigation of this concept will be worthwhile, for it may lead to methods for assessing the ecological richness in site catchments, which would be of considerable value in determining human impact, for example in tracing the development of more intensive agricultural practices or the degradation of woodland. Cumulative frequency graphs and estimates of equitability have been applied to some assemblages and both tools deserve further investigation, as does the use of a range of diversity indices.

Modelling populations

Much more can be done to model the way invertebrate populations developed on various substrata in the past, and such work would be of value to, and testable through, neoecology. Population (and associated death assemblage) development on a small scale was modelled by Kenward and Large (1998b) for insects in Anglo-Scandinavian pits at Coppergate, York. Models of population size and structure were offered, and the exercise clarified a number of issues concerning the interpretation of death assemblages in such deposits. These ideas need to be developed much further and related to observations of modern populations (which are very poorly studied). We usually have no idea of rates of development of communities, except subjectively from collectors' records and a limited amount of work, almost all on dung (e.g. Hanski and Cambefort 1991). We also need to model the balance of immigration plus population growth versus emigration, since the individuals which remain until death will be the only ones which can be preserved *in situ.* This is related to the issue of patchy habitats and metapopulations, well served in the recent ecological literature but apparently not yet served by a comprehensive review. The question of the relationship of death assemblages to living communities is considered briefly by Smith (1996b, 212) and Kenward and Large (1998b), and more remotely by Kenward (2006).

The same kind of reasoning can be applied on a larger scale to whole isolated sites, for which it also appears to be worthwhile to apply concepts from island biogeography, and trace the arrival (and in some cases extinction) of species at the 'island' of artificial habitat presented by human occupation.

Synanthropic insects

Synanthropic insects are those dependent upon, or favoured by, habitats created by human activity. Insect synanthropy is discussed, primarily with relevance to flies (and with much use of ponderous terminology), by Povolný (1971). Synanthropic insects have been introduced on p. 61, together with the scheme currently adopted for their classification and quantification in archaeological assemblages; note that this scheme only takes account of species associated with decaying matter (including dead wood) and stored materials on intensive occupation sites and ignores species favoured by disturbance of natural vegetation, and by agricultural or horticultural activity. Synanthropic insects (and doubtless synanthropes of other groups) have enormous importance in archaeology, for several reasons. Firstly, they are the characteristic species of most occupation sites. Secondly, some of them are rare or absent in nature, and thus they must somehow find their way to new artificial habitats on occupation sites, arguably giving a measure of the age, isolation, degree of occupation, and to an extent size, of settlements (Kenward 1997a), as well as of the intensity of human occupation. Many synanthropes are known, or suspected, to be aliens, and their history is therefore related to overseas contact (see next section).

We need to establish a clear understanding of which species are synanthropic, and indeed a more precise definition of the term itself would be helpful. The problem is best illustrated by examples. Kenward *et al.* (1986b, 273), writing of the fills of an Anglian pit at The Bedern, York, stated that 'true synanthropes are absent'. An inspection of the list of species revealed a substantial component of species now considered by the author to by synanthropic at some level, and a few which are typically synanthropic and not particularly common in nature; in fact, a 'house fauna' component (see p. 372) appears to have been present. Robinson (1991b, 325), studying a midden deposit at Runnymede, Egham, West London (a rare and important opportunity to examine the fauna of a large artificial accumulation of prehistoric foul midden material) suggested that synanthropes were absent. However, several species on his list are undoubtedly strongly favoured by human activity, even though they are not wholly dependent on artificial habitats. Smith (1996a, 216), illustrates this confusion well when he expresses the view that species able to persist after abandonment were 'not strict synanthropes'. The problem lies in primarily in terminology, and to a lesser extent in interpretation of the often rather vague habitat data given in the literature, and the impressions derived from personal experience. The writer has now erected ecological codes to define his judgement of the degree of synanthropy of a range of species (facultative, typical, strong, see p. 61), providing a starting point for future discussion, for example in relation to the ecological groups to which beetles are assigned by Koch (1989-96) in his review of the modern biology of the species. Species will doubtless be moved across the categories being erected for archaeological studies, and quite certainly will belong in different categories in different parts of their ranges. Careful examination of modern field data species-by-species will be needed; by detailed reading of many published records the writer has come to some conclusions which were quite surprising (to him) about the biology of species which, from the 'principal sources', would not be considered to be particularly strongly tied to humans.

Characterisation of the suite of 'natural habitats' species which facultatively invaded artificial habitats in the absence of the typical synanthropes is a priority (this 'facultative' synanthrope group is a very subjective one at present, but may be extremely important in understanding prehistoric, newly established and very isolated sites).

It is uncertain how quickly synanthropic species would become extinct following abandonment of a site. Some would clearly disappear almost immediately (fleas and lice for example), but work by Smith (1996a) suggests that some beetles may persist for a long time (decades) as artificial habitats for them persist after people have left or use has changed.

Synanthropes certainly have much potential as indicators of the intensity of human occupation and degree of modification of the environment. The trend towards restriction of faunas, eventually to a small group of characteristic synanthropes, seems to be documented in medieval and Post-medieval floors and related layers in the heart of York. At the Coffee Yard site, for example, only spider beetles and grain pests appear to have been at all common (Robertson *et al.* EAU 1989/12). This must surely reflect the nature and usage of buildings and overall conditions in towns.

The interpretative value of certain of the synanthropes is complicated by the apparent absence of many such species before the Roman period, and in some cases at times subsequently. Was the lack of such beetles a result of complete lack of intensive occupation habitats, or were they not brought because trade was rare, or were they unable to invade most settlements because habitats were widely separated when population density was low? Another problem is related to differences in waste disposal patterns in town and country (p. 407). For sites lacking surface preservation, it is uncertain how fully synanthropes in use areas will be represented in the rare features, such as ditches or wells, where preservation is possible. This is discussed on p. 462.

There are further aspects. At North Bridge, Doncaster (Carrott *et al.* EAU 1997/16; Hall *et al.* 2003c; Kenward *et al.* 2004a), analysis of the synanthropic component gave strong indications of the usage of the site. Synanthropes were relatively rare (half as abundant as at most of the occupation sites discussed by Kenward 1997a), and with a large facultative component. While dilution by natural or semi-natural fauna may have been part of the reason for this, it was considered that artificial decomposer habitats suitable for most synanthropes were rare at the site for much of the time. *Tipnus unicolor* (see p. 378) was rather common, suggesting long-lived buildings which, in view of the rarity of other 'house fauna' taxa, were probably kept rather clean. The conclusion from bioarchaeology was that the site was an industrial one, without domestic occupation, and this proved to be in accord with the evidence from the excavation record and finds analysis.

Seasonality

Seasonality is generally considered in terms of whole sites, for example their seasonal use as hunting stations. Insects may have some value in detecting sites with seasonal use. A possible explanation of the synanthrope-deficient invertebrate assemblages recorded at the North Cave site, East Yorkshire, is seasonal or other temporary use (Allison *et al.* EAU 1997/37; forthcoming a). Outside the region, one interpretation of the insects from the crannog at Buiston, Ayrshire, is that it was used seasonally or for only a few years at a time (Kenward *et al.* EAU 1994/42; 2000b-d), work on the Viborg Søndersø site in Denmark has produced a fauna deficient in synanthropes (Kenward CHP 2005/04; 2005b), and similar results may emerge from a detailed study of a site at Kaupang, Norway (Hall and Kenward CHP 2003/03); conversely, the rich synanthropic fauna at the Deer Park Farms site surely must stand as evidence of continuity of occupation (Allison *et al.* EAU 1999/08; 1999/10; Kenward 1997a, 145-146; Kenward and Allison 1994a; Kenward *et al.* accepted).

On a smaller scale, it may be possible to argue from insect assemblages the season of formation of particular deposits on year-round sites. This may be of some use, for example in estimating the health hazard presented by exposed faeces in cesspits (Kenward and Large 1998b). Similarly, it is just possible that marine invertebrates collected for food or bait may give information about seasonality in their exploitation. A further possibility is the use of isotopic methods to estimate the temperature at which individual invertebrates developed, and thus the season.

A matter related to seasonality is mentioned by Kenward and Large (1998b). The woodworm beetle *Anobium punctatum* occurred in a very large proportion of the analysed Anglo-Scandinavian pit fill deposits at 16-22 Coppergate, York. The beetle is migratory only for about two months per year, suggesting that it should occur in only perhaps a fifth of the rapidly-formed pit fills. Possible reasons for this anomaly were offered, including its presence throughout the year in dust (see p. 97), the widespread incorporation of floor sweepings, or an alarming level of laboratory contamination (discussed on p. 476).

Invertebrate biogeography - the ecological effects and interpretative potential of alien species

The potential importance of a biogeographical treatment of synanthropes, many of which are or may be aliens, at the level of site interpretation has been discussed above and on p. 468. Some other aspects of imported aliens require brief discussion.

Important in terms of impact on humans and natural communities alike are the ecological effects of the introduction of aliens (see for example Williamson 1996). The impact on the landscape and on native species is recognised for vertebrates (e.g. grey squirrels, rabbits, deer) and plants (e.g. sycamore, Japanese knotweed), as is the economic importance of some alien pest invertebrates. The effects of invaders on ordinary communities of invertebrates are barely known, yet some of the commonest beetle species in Britain today are known to be aliens, and it seems quite likely that a good number of familiar denizens of houses and artificial accumulations of decaying matter are also 'foreigners'. Archaeological assemblages thus have significant research potential in ecological studies of the impact of invading species on established communities, providing examples of fauna prior to the arrival of a particular alien, and the opportunity to document its spread and any accompanying changes in insect communities, perhaps using the species association technique (p. 464).

Another topic of interest is the timing of the importation of aliens. This is obviously related to the question of which species are aliens. Some probable or possible natives which found a niche at occupation sites are likely to have been so rare in nature, and to have lived in such obscure places and to disperse so poorly, that their distribution between occupation sites was almost certainly exclusively effected by human activity. They can thus usefully be considered with the aliens. The blind beetle *Aglenus brunneus* perhaps falls in this category (Kenward 1975b; Kenward and Allison 1994c). It should eventually be possible to trace the arrival of some of the aliens fairly closely. Clues are offered by evidence from sites such as Coney Street, York (Kenward and Williams 1979). This provided what is believed to be the earliest Roman urban insect assemblages seen in the north of England, yet the main grain pests were present, together with several other beetles more likely to be imported (from abroad or southern Britain) than of local origin. *Tipnus unicolor* was a notable absentee, however; perhaps it had not yet been imported or had not yet transferred from natural habitats in Britain (see p. 378). It appears that the grain pests arrived very early in the development of the Roman fort at Ribchester (Buxton *et al.* 2000a-d; Carrott *et al.* 2000; Large *et al.* EAU 1994/11), too. Observations such as these emphasise the need for particularly careful excavation and sampling of deposits representing periods of change; in this case we would ideally wish to examine deposits from the first few days of the construction of the fort!

Subjectively it appears that the range of synanthropes widened as the Roman period progressed, but it is too soon to draw any conclusions from the limited number of data points. The extinction of at least some of these species at the end of the Roman period seems possible (see for example Dobney *et al* 1998, and p. 279). The Viking age seemingly saw an upsurge of rich synanthropic insect communities, and species dependent upon humans were spread widely (e.g. to Iceland, Amorosi *et al.* 1992; 1994; Buckland 1988; Buckland *et al.* 1991; 1992; to Greenland , Buckland *et al.* 1994; Bocher 1987; McGovern *et al.* 1983; and to The Orkneys, Large *et al.* EAU 1993/29). This development appears not to have been reversed in Britain until the present day, although high-density occupation sites have an ever-decreasing range of species (Kenward and Allison 1994c, 70-72).

On a wider scale, the dispersal of these synanthropic, often pest, insects is reviewed by Buckland (1981b), with early records summarised by Panagiotakopulu (2000), while Buckland (1988), Buckland *et al.* (1995), Baker *et al.* (1993) and Spence (1990) discuss transport of Old World species (some of them doubtlessly previously introduced to Europe from further south and east) across the Atlantic. An important issue here is the mainly one-way (east to west) transport of insects; the abundant insects in post-Columbian occupation deposits in East coast America at least seem to be dominated by European synanthropes (Bain 1998), and agricultural pests also crossed the Atlantic early (Bain and LeSage 1998).

Archaeological records may show some species generally regarded as native or early introductions more probably to have been introduced recently, the pig louse *Haematopinus suis*, for example (p. 426). Conversely, archaeological records, if properly evaluated, may prove that supposed recent introductions have been here for much longer than thought. Human fleas, *Pulex irritans* from Iron Age sites were obviously not recently brought from America (p. 416). The snail *Candidula gigaxii* is widely regarded as medieval introduction (e.g. South 1974, 261), but there is no reason to doubt the Roman record from Roman Tanner Row, York (Hall and Kenward 1990, 359) unless hay was imported from overseas (which is just possible). At the same site, a shell of the slug *Deroceras caruanae* suggested that, *contra* various authorities, this species has been present in the British Isles for a long time (Hall and Kenward 1990, 366; O' Connor AML 4768). The black rat (*Rattus rattus*) is a classic case of an animal whose introduction has been pushed back into the Roman period by archaeological records (Rackham 1979; 1980a; O'Connor 1991), and it will be interesting to see whether its flea, the plague vector Xenopsylla cheopis, was brought here at the same time.

There are introduced species among most invertebrate groups, of course; alien and synanthropic molluscs, the group most likely to provide evidence in this respect, are discussed by Kerney (1966); other examples are mentioned in the taxonomic section.

There is a great deal to be discovered about the arrival and effects of imported synanthropes (and other aliens), and the value of the topic to both archaeology and ecology make it a priority area for future research.

Integration with other evidence

The full integration of evidence from invertebrates with that from a full range of other investigations is very important, though not necessarily easy (see for example Loveluck and Dobney 2001). In order to save space and avoid repetition it has not been possible to draw sufficient attention to the relationship of data concerning invertebrates and plant remains (in particular) throughout the text, though the advantages of integration have been noted here and there. The matter requires a little further consideration. Integration of evidence was emphasised early in the development of modern environmental archaeology in a preliminary and speculative account of evidence from the 6-8 Pavement site, York (Buckland *et al.* 1974). Buckland (1976a) went on to organise a multi-disciplinary study of the fills of the Roman sewer at Church Street, York, drawing on evidence from invertebrates, pollen, plant macrofossils, a range of insects, molluscs, ostracods, parasite eggs and sponge spicules, a study whose various interpretative problems do not detract from its value as an object lesson in integration.

Despite these early examples, and a succession of increasingly substantial later ones, far too many reports – and the present writer is certainly not innocent in this respect – are still produced without adequate integration. Plant-invertebrate integration has been successful where a botanist and an entomologist worked together in the same unit at York (witness many papers reviewed here, with Hall and Kenward 1980 ; 1990; and Kenward and Hall 1995 as particular examples), although has been limited by the time available for many projects. It has also worked well where one person worked on a wide range of material, as in the case of some sites investigated by Robinson in the south of England (e.g. Lambrick and Robinson 1979); in some of these cases integration was further enhanced by a strong involvement by the environmental archaeologist in the excavation process, something which is certainly desirable but usually obviated by considerations of time and cost.

Integration of bioarchaeological results where specialists were based in different institutions has rarely been as successful, even where there was a will to achieve it. Integration is apparently regarded by some workers as a chore rather than the intellectual target of a project, and it also depends on very good working relationships and adequate time. This weakness is in strong contrast to some recent work on natural deposits, such as Coope *et al.* (1997) and Walker *et al.* (1993a), and of course runs against the multi-authored trend of science in general. Incorporation of evidence from bone with that from plant and invertebrate remains has made frustratingly little progress, again despite the existence of a will to achieve it in some quarters. Project constraints rarely allow sufficient time to be devoted to the demanding and time-consuming (but often very intellectually satisfying) process of familiarisation with a range of evidence, hypothesis building, argument and collaborative writing inherent in good synthesis of evidence - yet most of the best ideas come from this.

Integration of 'environmental' reports by the archaeological author of a report rarely works very well and often fails to make good use of the biological evidence, however significant it may be. In some cases environmental evidence so used has been misinterpreted or over-stretched. There have been exceptions where close collaboration has been possible (the editor's contribution and good refereeing also being important); in the North, a notable example was the account of the Anglian helmet from Coppergate, York (Tweddle 1992), where a very high level of integration was achieved and the biological and sedimentological evidence made a major contribution to understanding the history of an important but enigmatic feature. The reports dealing with the Castle Street site, Carlisle, also made considerable progress towards integration (McCarthy 1991a; 1991b), although in this case distance and lack of time on the part of the specialists involved reduced the impact of the bioarchaeological results in the synthesis.

This discussion has so far been concerned with integration of results at the stage of writing up results and conclusions. Integration of work throughout projects is essential, of course, but a crucial stage is data analysis. Such collaboration is implicit when two or more specialists actually write together, but there is a need to take integrated data analysis further. This is emphasised by the concept of indicator groups and packages (Kenward and Hall 1997; Hall and Kenward 2003a), but is implicit in any statements about integration. Some attempts at more formal integration of data have been made. Hall *et al.* (1983b, 192-5), for example, explored correlations between plant and insect data in their study of the Anglo-Scandinavian site at 6-8 Pavement, York, although with little success so far as enhancement of interpretation was concerned. It is suggested that ongoing improvements in understanding of the way death assemblages formed, of the ecological significance of many species, and in the availability and ease of use of multivariate statistical programmes running on ever more powerful personal computers, will make integrated analysis far more likely to produce useful results in future. Time and the will of the specialists concerned seem likely to remain the limiting factors, however.

Bibliographies and databases as tools

Bibliographies and databases are an essential component of work on invertebrates (and other evidence) in archaeology. The number of relevant publications and volume of data on which it is necessary to maintain a grip are far too large to be managed in any other way. The three main components are (a) archaeological publications, (b) publications dealing with modern ecology (both principles and concerning species and communities) and taxonomy, and (c) archaeological records.

Archaeological publications in the British Isles are increasingly well served bibliographically (e.g. The CBA's British and Irish Archaeological Bibliography). Sites investigated bioarchaeologically are listed regularly in the invaluable Environmental Archaeology Bibliography, whose future maintenance and expansion will be crucial to the subject, particularly in facilitating synthesis. Publications dealing with Quaternary fossil insects and some other invertebrates, but not molluscs, are listed in the BugsCEP system (see below). New publications in Environmental Archaeology are regularly listed in the *Newsletter* of the Association for Environmental Archaeology.

Data concerning the modern aut- and syn-ecology of invertebrates, and details of their taxonomy and identification, are scattered in many thousands of articles and books. Synthetic treatments exist for few groups or species, and an acquaintance with the wider literature (and contacts with other workers, who for many species hold far more useful information in their minds and in notes than has ever appeared in print) is necessary. No individual can hope to keep abreast of the literature of nearly 200 years for any one group, let alone for the invertebrates as a whole. Bibliographies are thus invaluable. An early attempt to prepare a bibliography of references to modern data for beetles and bugs by species was made by Kenward (EAU 1984/11-14; 1985/16-20; 1986/15; now subsumed into a single unpublished data file). Sufficient information to be of some use – better than nothing, but *very* incomplete – was brought together, but further expansion was abandoned as other commitments grew. Subsequently, the BugsCEP package has been developed, initially under the direction of P. C. Buckland at the University of Sheffield (Buckland and Buckland 2006); it is currently available at http://www.bugscep.com/. This resource includes a summary of ecological data regarding each of the included species of Coleoptera, and is a valuable source of information. However, it is not comprehensive and in general relies on the 'standard works' rather than on the numerous individual sources concerning any given species. The two kinds of bibliography need to be brought together in the longer term, but this would be a monumental task. Conventional abstracting services do not list minor records of individual species or cover enough journals and other publications to be very useful in the present context. Bibliographies for rare species in Britain are given by Foster (2000) and Hyman and Parsons (1992; 1994).

BugsCEP also provides an invaluable database of published records of fossil beetles from archaeological sites. The bulk of records have not, however, been published. Most of the data for sites studied in the EAU are included in a database developed by J. Carrott and the author, and are available for distribution; they should be made accessible through the WWW in the near future. These sources have been extensively drawn on for the current review, and for Kenward (1997a) and current work on species associations, but much further analysis could usefully be carried out on them. Again, integration with the BugsCEP database is desirable in the longer term.

Data handling systems

Early analysis of species lists (e.g. for the Skeldergate Well and buried soil, and for 6-8 Pavement, York, Hall *et al.* 1980; 1983d) was carried out using cumbersome handwritten lists, at first employing a slide rule and subsequently using electromechanical, then electronic, calculators. Subsequent developments have moved in parallel with the increasing power and flexibility of desktop computers. The system currently used by the author was originally designed for PC using WINDOWS 95/98, and has been written by J. Carrott in consultation with HK and implemented in 1997. It is fully interactive for input, revision of the nomenclatural and ecological check list, and output. Species lists, main statistics, database files, and output for other analyses are produced by code under buttons in PARADOX, in some cases calling on PASCAL routines. The system deals with all the ecological codes in current use in at York (including those for synanthropes). It can be used for groups other than insects with a little additional work. Further development is desirable, but the system functions well and is designed to be more portable than any of the earlier ones (it *should* run under future platform upgrades, although problems have been encountered in transferring to upgrades of Windows and PARADOX). Desirable future developments include the provision of graphical output (especially rank order and cumulative frequency curves) and extension of the range of ecological codes used to include some of those used by other workers, those for the groups generated by investigation of species associations (Carrott and Kenward 2001; Kenward and Carrott 2006; and unpublished), and perhaps the categories of Koch (1989-96) discussed on p. 62.

The invaluable BugsCEP system (see above) also allows for input and analysis of species lists, but has not been tested by the present author beyond preliminary exploration. It is, however, likely that every worker will come to desire a system which takes account of their own interpretative predilections.

The problem of contamination

The interpretation of remains recovered from archaeological deposits depends on establishing their relationship to the formation of the deposit, both in space and time. Spatial relationships are considered elsewhere in the context of background fauna and imported and dumped materials (pp. 57 and 407 respectively). Contamination by substantially non-contemporaneous material is a much more serious problem, and is dealt with here.

Contamination during excavation, storage and processing

Contamination during sampling or processing by ancient or modern insects is rarely a great problem, but must be recognised as occurring regularly.

Providing standards of good practice are followed, only small numbers of *fossils* are likely to be transferred as a result of field or laboratory accidents, so interpretation is unlikely to suffer as communities rather than single species are used as indicators of past environments and human activity, single specimens generally not being regarded as significant. The exception is where rare individuals may have great importance, for example synanthropic species in prehistoric sites, recently introduced aliens, or grain pests outside the periods in which they are generally present. In such cases processing contamination is a serious problem which is extremely difficult to avoid. Experiments (unpublished) have shown that sieves and buckets used to process samples for insect recovery can retain a few fossils even when meticulously cleaned. The present writer is inclined to disregard odd specimens of significant species from samples processed in laboratories where other samples containing the same species have been processed. This includes grain pests at various periods in the EAU, and cold fauna at Birmingham when material reported by Buckland *et al.* (1974) was being sieved, for example. Cases where grain pests are suspected of being contaminants are discussed on p. 349. In general, mislabelling is regarded as a greater problem than gross contamination at any stage, except where samples are collected from under water in flooded trenches.

Modern individuals are generally very easily recognised by their freshness unless they have decayed in the ground or in very prolonged storage. Contamination by modern insects in the field during excavation and sieving is fairly common and indeed probably inevitable. Contamination of archaeological deposits by modern seeds is discussed by Keepax (1977). Flies, thrips, aphids, and beetles often find their way into samples even where great care has been taken to cut back to clean sediment. Flying insects are often extremely abundant. Most people are familiar with swarms of flies or aphids, but beetles may be abundant in flight and settle on excavations in large numbers, for example at Skipsea, East Yorkshire (Carrott *et al.* EAU 1994/37), where *Meligethes* sp., probably *aeneus*, were noted by the excavators flying in swarms during their work and were rather common in the samples as a result. This pollen beetle, often abundant on oilseed rape (Kirk-Spriggs 1996) may fly in immense numbers (e.g. at Bempton Cliffs, not far to the north of Skipsea, Kenward 1984d). Remains of *Helophorus* water beetles in archaeological samples sometimes seem suspiciously fresh. This genus includes some species observed to fly in large numbers, and often noted settling (Kenward 1978a, 5). Except during the coldest weather, most archaeological sites will be invaded by a few water beetles, attracted by short-lived pools after rain, or by open water where excavation penetrates the water table. A single *Sitophilus granarius* in a Romano-British deposit on the route of the Leven-Brandesburton by-pass (Hall *et al.* EAU 1994/15) may have been a processing contaminant (damaged sieves were found in the laboratory and samples from a site with grain pests were being processed concurrently) or originated in modern chicken feed in runs adjacent to the site (there were apparently modern *Cannabis sativa*, hemp, seeds, presumed to be from this source).

Other contaminants are recognisable by being known or suspected recent introductions. Several *Euophryum confine*, an Australasian weevil, were noted at The Bedern, York (Hall *et al.* AML 56-58/93) and this immensely common species has been found at other sites, probably originating in structural timbers or shoring boards. *Ptinus tectus*, another common species generally believed to be of Australasian origin, has also occurred in samples on several occasions. *P. tectus* and *Lithostygnus serripennis* were found in samples from 6-8 Pavement, York by Hall *et al.* (1983b, 185); there was also a breeding colony of nematoceran flies in one sample, together with a pselaphid beetle, and a thrips (*Aptinothrips rufus*). Pselaphid beetles and nematoceran flies (larvae, pupae and adults) were rather frequent in samples from the 16-22 Coppergate site (Kenward and Hall 1995, 472), and in this case it was not always certain whether they were ancient or modern (except in those cases where live or freshly dead whole individuals were recovered by processing!). A sample from a putative Iron Age clay at Park Grange Farm, Beverley (Alldritt *et al.* EAU 1991/35) contained a number of insect remains suspected to be of recent origin, but *Aridius bifasciatus* certainly was modern since it is undoubtedly another recent introduction from the Antipodes. The related *A. nodifer*, also a recent introduction, was noted, together with *Pentarthrum huttoni* (probably Australasian) in ?15th century deposits in Doncaster (Smith 1989). The suggestion that *P. huttoni* is in fact native (Buckland 1979) seems much less probable than an origin as a modern contaminant, perhaps just in dust. All of these Australasian beetles have been noted in samples by the author, but rarely reported since from their condition they were quite clearly modern.

Entry through cracks in surfaces left exposed for a long time during excavation may be a problem. The garden snail *Helix aspersa* was rather common in samples from 16-22 Coppergate, York, and the shells were in many cases undoubtedly of modern origin (Kenward and Hall 1995, 472). Many beetles and some other insects (e.g. earwigs) and (notably) woodlice creep into cracks for shelter, and may thus end up being collected in samples. Earthworms, too, may be present, and develop colonies in stored samples, either having been part of the modern fauna of the deposit *in situ* or having colonised exposed sediment.

A particular problem arises where samples are stored for a long time in polythene bags, as insects associated with the store often seem to have managed to enter the bags, presumably through splits or loosely-tied necks. Storage problems are considered further on p. 445.

It is thus important not to read too much into occasional records of rare or exotic species, especially those likely to find their way into deposits or samples by accident, and those which may be processing contaminants.

Ancient contamination: redeposition, residuality and intrusion

Ancient contamination by mixing of deposits, variously referred to as 'reworking', 'redeposition' or 'residuality' in the archaeological literature, is a topic afforded insufficient attention by environmental archaeologists, even those studying highly resistant remains such as bones and charred grains which seem inherently likely to survive redeposition and so become residual. This is a serious problem requiring much thought, even for workers dealing with easily decayed remains (Dobney *et al.* 1997). In addition, contamination through the life of deposits by later, intrusive, material is a frequent problem.

Lateral transfer

It is very important to distinguish redeposition or residuality in the generally accepted temporal sense from the lateral transference of essentially contemporaneous material, normally through importation of raw materials, re-arrangement of materials and deposits on a sites, or waste disposal. Such transportation may greatly enhance interpretation by giving information about the resource catchment of the site or by leading to the preservation of material which had initially been deposited in places on a site where it would have been destroyed or have decayed had it remained *in situ*. The turf detected at various sites, and the peat found at others (p. 316) are examples of the first phenomenon. Even more important are the cases where waste disposal has led to preservation. The fills of the Roman ditches at Ribchester (Buxton *et al.* 2000a-d; Carrott *et al.* 2000; Large *et al.* EAU 1994/11), the fills of wells at Skeldergate and The Bedern, York (Hall *et al.* 1980 ; Kenward *et al.* 1986b) and the extensive dumps at Tanner Row, York (Hall and Kenward 1990) and Highgate, Beverley (Hall and Kenward 1980) are excellent examples, where valuable information about what was happening nearby was obtained. The localised preservation of occupation debris in dumped material has been argued to be inherently more likely than *in situ* preservation by Hamilton (1956, 97), in his definition of areas of minimal and maximum growth. The operation of this principle is well illustrated by the sites mentioned above and by the detection of insect assemblages believed to have originated in dumped floor material in some of the Anglo-Scandinavian pits at 16-22 Coppergate, York (Kenward and Hall 1965). In this case there were perfectly preserved floors nearby; had these been destroyed or been too well drained for organic preservation, the pit fills would have provided the only remaining evidence of conditions and activities inside the houses.

Residuality

Residuality in the conventional sense of the transfer of material from earlier to (significantly) later deposits is another matter entirely, and presents a major problem, although perhaps not on the scale implied by Alvey (1996a) when he stepped back from detailed interpretation of molluscs from the Dragonby site on the grounds that 'individual features on such an intensively occupied settlement with locally varied conditions would, of course, be subjected to the problem of the re-deposition of shells from other habitats'! Residuality in resistant remains is now generally accepted to be a serious problem, after a long period of conscious or unconscious denial, and indeed very ancient derived fossils sometimes occur in archaeological deposits. Examples include the snail *Vertigo genesii* at Rougier Street, York, probably from the drift (Allison *et al.* 1990c, 382), and moderate numbers of 'hard-rock' fossils, mostly not recorded in databases, from many sites (a published example is provided by Donaldson and Rackham 1985, while *Gryphaea*, of Jurassic date, were noted by Hall *et al.* (PRS 2003/45) in samples from Roman ditch, pit and other fills at 66 Burringham Road, Scunthorpe).

Although there was never much doubt that resistant materials were frequently redeposited, the present writer tended in the 1970s to disregard the possibility of redeposition of delicate waterlogged remains (although the topic was considered by Kenward 1978a, 8). However, subsequent experience, particularly with the large-scale investigation of the deposits at 16-22 Coppergate, has forced acceptance of the possibility, and sometimes inevitability, of redeposition of all kind of remains on multi-phase sites with abundant and widespread preservation by anoxic waterlogging (e.g. Kenward and Hall 1995, 721). These authors (*op. cit.*, 759) state 'There is a growing suspicion that re-deposition of earlier 'waterlogged' remains into certain types of deposits was all too common at some sites.' The passage of time since this was originally written has not reduced this suspicion one iota. (See also Dobney *et al.* 1997.) In particular, work on grave fills at the Magistrates' Courts site, Hull, has given numerous examples of what is almost beyond doubt the redeposition of organic-rich deposits disturbed when graves were dug, although unfortunately this had not been apparent from the assessment (Hall *et al.* EAU 2000/25). And, of course, we see remains from imported peat, which may pre-date the deposit by millennia, at many sites (p. 316).

Redeposition may have taken place on any scale from trampling and dust-blow to bulk excavation and dumping of deep deposits of a much earlier date. On the smaller scale, Kenward and Large (1998b), observing that the woodworm beetle *Anobium punctatum* was present in a suspiciously large proportion of Anglo-Scandinavian pit fill deposits at Coppergate despite having a very short flight period, wondered whether this beetle, which is robust and recognisable from minute fragments, was so frequent because there had been constant small-scale redeposition. If this were the case, for how many other species of invertebrates (and plants) might it be true? (This is, of course, recognised in the concept of 'background fauna'.) It has already been accepted that there is a 'background' level for eggs of parasitic nematodes, at or below which records are insignificant (e.g. Jones 1985, 112-3; Kenward and Hall 1995, 759), and this has been assumed (perhaps not fully explicitly) to be the result of short-term scattering such as trampling, excavation of pits and other cuts, and scavenger action. The difficulty lies in determining at what concentration these eggs become significant indicators of faeces, assuming this is possible, and this is a problem which has not yet been tackled objectively. It is suspected that in some cases only the investigation of many replicates, or the use of thin sections to detect redeposited sediment clasts, may help to resolve the problem. Certainly, where numerous samples from many feature types are examined, clues as to background levels for particular classes of remains may emerge, as has been the case for parasite eggs.

Bulk redeposition may have occurred at the Coppergate site, but would generally be hard to detect. However, in one case, the evidence is a rather clearer, though still circumstantial. A single deposit of Phase 4b date contained large numbers of honey bees. Bees were present in small numbers only in most other layers at the site, except for quite large numbers in one Phase 5b layer. As these deposits were close to each other, and in an area where there was great disturbance in Phase 5b during the digging of 'cellars' to the timber buildings, it seems quite possible that the later bees were derived from the earlier deposit. This is unproven (AMS dating might help, although the time interval between the phases is quite small, a matter of decades), but worrying. It is possible that further excavation of early medieval towns will show bees frequently to be present (another huge concentration of them was found in a medieval deposit in Oslo, Kenward 1988a), but the suspicion of residuality at Coppergate cannot be dispelled. Perhaps the most important lesson to be drawn is the need for integration of the results of studies of datable artefacts, of stratigraphy, of lithology, and of biological remains in estimating the likelihood of residuality.

Ancient worm action may sometimes have moved older remains into newer deposits and newer ones into older, but it is suspected that the scale of natural movement of recognisable macrofossil remains is generally small. Although Evans (1972, 207 ff.) believed that it is an important factor in moving mollusc shells through active soils, it is suggested that for remains requiring good anoxic preservation (notably insects and mites) most fossils would decay rapidly in the kinds of soils in which there is an appreciable level of worm activity. There may, however, be cases where transport has occurred, and modern organisms certainly penetrate deep into soils, whether through bioturbation or their own burrowing activity.

Microfossils, including parasite eggs, may perhaps have been transported upwards (or perhaps more rarely, downwards) on a larger scale, and is it necessary to consider this possibility where sediments show signs of earthworm burrows. Disturbance and burial of archaeological deposits by earthworms has often been referred to; it is discussed further in the taxonomic section (p. 31).

A likely source of contamination of earlier deposits from later ones is passive movement of sediment down burrows, particularly those of mammals, and into small, perhaps archaeologically invisible, cuts and postholes. It is not easy to suggest a way of detecting this routinely. Evans (1972, 208) mentions the decay of tree roots as a factor for land snails, and similar processes certainly have occurred on occupation sites as posts decayed.

Residuality is thus a problem which must be addressed for invertebrate remains, as for other material. A possible approach would be through a large-scale study of a multi-period site using very large numbers of AMS dates; such a project should examine all kinds of biological remains, and contrast the residuality of the more robust remains with those preserved by anoxic waterlogging.

Post-depositional intrusion by active burrowing and migration through voids

In-ground contamination may occur actively. Intrusion from modern surfaces appears common, and not just down mammal burrows or through human activity. On many types of soil, superficial deposits tend not to have preservation of most classes of ancient remains, but fresh modern biological remains are commonly found in the top half-metre or so of stratigraphy. Some invertebrates may penetrate deeper, particularly earthworms, the beetles *Trechus micros* and *Rhizophagus parallelocollis*, and the snail *Cecilioides acicula*. The last of these is considered to be of recent introduction, and thus invariably to have penetrated from above (p. 483). Sometimes a large proportion of the remains found in archaeological deposits are believed to be of post-depositional origin. Allison *et al.* (EAU 1990/05), for example, considered most of the few insect remains from late 1st to late 4th century deposits at the Staniwells Farm site, Hibaldstow, North Lincolnshire, clearly to be modern contaminants; at this site the most abundant snail was *Cecilioides acicula*. This snail was also rather common in 7th-11th century deposits at Flixborough, North Lincolnshire, being found in 46 contexts (Carrott EAU 2000/55). The invertebrates recovered from prehistoric and medieval deposits at Church Farm, Lily Lane, Flamborough, East Yorkshire, were almost entirely restricted to earthworm egg capsules, probably intrusive, and *C. acicula* (Carrott *et al* EAU 1999/16). Fills of some Iron Age and Roman features at Burythorpe Church, North Yorkshire, and medieval cut features at Waterton, North Lincolnshire, gave almost no invertebrates other than *C. acicula* (Carrott *et al.* EAU 1995/50; 1996/40); a ditch fill at Sherburn, North Yorkshire, gave only numerous *Cecilioides acicula*, together with some other land snails, and a weevil head which may or may not have been ancient (Johnstone *et al.* EAU 2000/06); while at Cottam, on the Yorkshire Wolds, all the insect remains seemed to be modern and *Cecilioides acicula* was present (Carrott *et al.* EAU 1994/32; 1999). Similarly, the small numbers of insect remains noted at Aylesby, North Lincolnshire (Carrott *et al.* EAU 1994/51; 1995), Swine, East Yorkshire (Hall *et al.* EAU 2000/60), and Flixborough (on sharply-draining sands, Dobney *et al.* EAU 1993/21), were all suspected to be modern, having had insufficient time to decay completely after entering the sediments. Other species may be involved: Evans (AML 1829) mentioned that a specimen of *Arianta arbustorum* from Housesteads, Northumberland was probably modern since it still had the periostracum intact. Large numbers of such cases could doubtless be catalogued; it would be useful to study the records systematically to determine what kinds of deposits are most susceptible, and to what depths, and which species are typically involved.

The important point here is that we must accept that post-depositional intrusion, both active and passive, undoubtedly occurs, and has occurred through the life of some deposits. No conclusions should be based on remains which may conceivably have such an origin. The presence of intrusive elements should not lead to the total abandonment of analyses in all cases, however. Ancient and recent remains may be mixed, as appears likely to have been the case in deposits at the Anglian cemetery at Castledyke, Barton-on-Humber, North Lincolnshire (Carrott *et al.* EAU 1992/02). In that case, what appeared to be ancient groups of snails had been post-depositionally contaminated by quite large numbers of *Cecilioides acicula*. Even snails from such unpromising and easily-penetrated depositional environments as rock rubble are argued by Evans (1976) to have potential in some cases. The original and intrusive components of mixed assemblages may often be distinguishable by their preservational condition of ecological character.

The subterranean beetle community

The 'subterranean' beetle community - often referred to as post-depositional invaders - has been mentioned elsewhere, but deserves further consideration. *Trechus micros*, *Coprophilus striatulus*, *Quedius mesomelinus*, *Trichonyx sulcicollis*, perhaps some small euplectines, and *Rhizophagus parallelocollis* seem to be the typical components. In many cases these species probably entered post-depositionally and are thus not informative about the *original* conditions. They may be of interest as indicators of changing water content, however, as it is suspected that they will have invaded buried organic matter which was sufficiently well aerated to decay. This may have been in the past, the fossils having been stabilised by increased water content but, if fresh, these insects may be indicators of recent, perhaps ongoing, decay. Telling which may be difficult in borderline cases since even AMS dating will presumably be ineffective, the beetles ultimately having fed on ancient deposits! Some excellent examples of this community have been recorded from pit fills dated to the 4th century or later, and from some earlier deposits, at the Tanner Row site in York (Hall and Kenward 1990, 367-8, 345). The community is recurrent and widespread, although only weakly recognised by species association analysis (Carrott and Kenward 2001; Kenward and Carrott 2006); an excellent example from outside the area considered here is an 18th century pit fill from Berrington Street, Hereford (Kenward 1985b), while elements of it are reported by Hakbijl (2000) from 19th century burials in the Netherlands. Anglo-Scandinavian deposits at 16-22 Coppergate, York, provided a number of assemblages of this kind in what appeared to be temporarily dewatered pit fills and open-textured brushwood layers. Most appeared to be genuinely intrusive (e.g. Kenward and Hall 1995, 516, 521, 598). Further examples were provided by grave fills at the Magistrates' Court site, Hull (Hall *et al.* EAU 2000/25; see also p. 434). In some cases, however, some of these species may have lived a cavernicolous life (as perhaps they did in a covered gully in a house floor at Coppergate, *op. cit.*, 607, or in a culvert fill at 54-7 High Street, Hull, Jaques *et al.* PRS 2003/01), or invaded features during their use (for example it was postulated that *T. micros* may have accidentally entered tanning pits at the Layerthorpe Bridge site, York, by Hall *et al.* EAU 2000/64, 23).

The Roman sewer in Church Street, York (Buckland 1976a, 6-7) represents a notable case, where a modern fauna including Trechus micros, *Cercyon* sp., *Ptinella britannica*, *Quedius mesomelinus* and *Atheta deformis* had developed in the voids above the fills. Some of the other species of which remains were found in the fills were certainly of modern origin (*Metophthalmus serripennis* and *Pentarthrum huttoni*), the ant *Ponera punctatissima* may well have been, and the existence of the spider beetle *Niptus hololeucus* (found in two layers) in pre-early modern Britain has yet to be satisfactorily proven (p. 381). The presence of these species leaves one wondering how much of the remaining fauna was Roman, though much probably was. This site presented particularly difficult problems in determining the extent of post-depositional intrusion, and probably the only resolution of the argument lies in AMS dating of a selection of the fossils. Excavation and analysis of more fills of the Roman sewers beneath York with these questions in mind from the start might prove informative, although might equally lead only to wholesale rejection of the material as contaminated.

Suspected post-depositional fauna also occurred in pit fills of late 14th-early 15th century date at The Bedern, York (Hall *et al.* AML 56/93, 19-20; 58/93, 11). In each case *Coprophilus striatulus* was the dominant species in the group, with smaller numbers of *Trechus micros* and *Rhizophagus parallelocollis*, and sometimes *Trichonyx sulcicollis*.

Anommatus duodecimstriatus was another species found in the Church Street sewer which may have been a later active contaminant. It has also been found under suspicious circumstances at Town Street, Old Malton (Dobney *et al.* EAU 1994/20); also in waterlain ditch fill at Station Yard, Beverley (Carrott *et al.* EAU 1991/17), where there was no record of strong synanthropes in the report (they were certainly not abundant), and outside the region it was abundant and probably intrusive in a grave cut at 1 America Street, Southwark (Geary *et al.* PRS 2002/21). Carrott *et al.* (EAU 1991/18), reported *A. duodecimstriatus* from deposits by a Roman road at 12-20 Blossom Street, York; there were no other remains, so here too it was presumably intrusive. It is uncertain whether this species is a native or a rather recent arrival, though both the present writer and P. M. Hammond (personal communication) suspect that it may be a late introduction.

The blind burrowing beetle *Aglenus brunneus*, which is often abundant in archaeological deposits, presents a special case (Kenward 1975b; 1976c) since it almost certainly exploited accumulations of decaying organic matter as they formed, especially in protected situations such as house floors, but probably was also able to invade more deeply buried organic matter, co-existing with the ‘subterranean’ species listed above. The biology of *Rhizophagus parallelocollis* was discussed at length by Buckland (1979, 92-4). It, too, probably both lived in accumulating deposits and invaded deeply buried material (it is well known as a coloniser of buried bodies).

Elaterid (click beetle) larvae are sometimes suspected to have entered deposits some time after deposition; an example is provided by the abdominal apex of *Actenicerus sjaelandicus* from an undated ?posthole at Burythorpe Quarry, North Yorkshire (Carrott *et al.* EAU 1995/49). It is particularly important to try to distinguish post-depositional contaminant click beetles in view of their potential as indicators of buried soils and imported turf.

Detecting contaminants

These various kinds of contamination have been discussed at some length but, apart from very obvious cases, no simple rules can be offered for their recognition. Caution is therefore urged; the likely depositional regime should be recognised; the possibility of subsequent disturbance considered, variable preservation noted, and records of unusual species, or early ones of introduced species, evaluated with great care and put on record with appropriate reservations however great the temptation to publish spectacular results.

Standards and methods of reporting

The preparation of this review has necessitated the handling, and often detailed reading, of a very large number of reports. Inevitably this has impressed on the author the good and bad points of the documents under scrutiny, his own as well as those of others. This section deals briefly with some of the more common faults of reports of various kinds, then suggests (very briefly) some standards which might be adopted. A document produced by the Association for Environmental Archaeology (1995) provides substantial guidance for evaluations, including a standard for reporting which includes items of wider application. Guidelines outlining minimum standards for other kinds of site-based 'environmental' report are essential: EH's *Guidelines* (2002) go some way towards meeting this need.

The shortcomings of the reports reviewed lay in three main areas: investigations on too small a scale to be of substantial value; those with a lack of archaeological information (and consequently poor integration of biological and archaeological data); and those lacking sufficiently detail concerning the remains recovered. A fourth problem, inadequate or erroneous interpretation, is less serious providing species lists are available, and may be a matter for personal preference for some data sets. The first shortcoming is a consequence of poor funding in most cases, and this is mentioned elsewhere at various points in the text. Poor integration has often arisen because environmental archaeologists assume that the archaeologist commissioning their work will deal appropriately with the business of tying the various sets of results together. This is a dangerous assumption, partly because experience has shown that they rarely do, and even more importantly because all the environmental specialists working on a project should be closely involved in the integration process. The (usually 'mainstream' archaeologist) author of the site report is unlikely to be able to appreciate the significance of biological evidence, any more than the biologists can fully appreciate the subtleties of the excavation record and artefactual evidence. The most important ideas about the site and its wider importance may only emerge during the discussion, comparison and argument inherent in the process of integration. The lack of freely-available species lists is a further product of under-funding and must be corrected.

Environmental archaeology and neoecology

Neoecology (i.e. the study of modern ecology) is essential to environmental archaeology (e.g. Harris and Thomas 1991a), but the relationship is a two-way one. The importance of environmental archaeology as a stimulus to research in modern biology has been suggested by Kenward (1997a, 135). The study of the past highlights numerous ecological issues and presents an opportunity to study ecological processes (such as invasion by new species, the adaptation of communities to climatic and ecological change, and regional extinctions) over long time periods. The problems of identifying insect fossils have undoubtedly provided a stimulus to more careful taxonomic work including the examination of fine structures. Booth (1984), for example, produced an identification guide for the beetle genus *Tachyporus* based on previously under-used elytral characters typically preserved in fossils. Current trends towards thoughtful evaluation of the habitat requirements of insects have certainly been in part stimulated by the needs of palaeoentomology. The crossover between mainstream ecology and palaeoecology – including that of archaeological sites – should be maintained and extended.

PART 6: PRIORITIES FOR FUTURE RESEARCH

It was concluded in the main body of the review that so far as the invertebrates are concerned '...all categories of material, all kinds of sites, and all periods from the earliest prehistoric to the 20th century are in need of substantial further data collection before any can be regarded as of lower priority than any other.' Similarly, we know too little about any geographical or topographic area or topic. No aspect of invertebrates in archaeology or Quaternary palaeoecology should be neglected; the subject is still at the stage where almost any investigations may produce novel results. Research should not be confined to areas of archaeological interest, but should also take account of the research agendas of climatologists and ecologists. This said, in the real world of limited resources an attempt must be made to highlight areas which require special attention or which hold great promise. The following topics are regarded as requiring particular emphasis; they are discussed further in the *Review*.

Methodological and technological development

Integration into projects

Investigations of invertebrates (and other biological remains) should be designed, executed and reported in such a manner as to demonstrate that they are an integral part of archaeological projects and research agendas in addition to, or sometimes rather than, serving the agendas of bioarchaeologists, ecologists, geologists or climatologists. Equally, the relevance of 'specialist' agendas to archaeology need emphasis: climate studies, for example, seem to be inadequately acknowledged as investigating a major factor in human history.

Deposit formation, preservation and taphonomy

Depositional environments and their resulting sediment characteristics and suites of biological remains are still poorly understood. Issues requiring further investigation include:

1. The need to understand how the balance of insect immigration, reproduction and emigration affects the make up of an assemblage, especially for the highly mobile insects.

2. Determining whether the strongly oxidised fossils found in many deposits are actively decaying or somehow held at a point in the decay trajectory.

3. The need to investigate chemical aspects of the decay of invertebrate remains through modern deposits and laboratory experiments, with the aim of (a) understanding ground conditions permitting survival and (b) relating characteristics (such as patterns of change in colour and texture) that can easily be observed and recorded to degradation of particular structural components (e.g. proteins, chitin).

4. Studies of differential decay within groups (e.g. the insects, or even just the beetles) to determine whether extreme preservational conditions may change species composition radically; this is particularly relevant to later and post-medieval urban insect assemblages.

5. Methods for detecting transport and dispersal of invertebrate remains are needed; e.g. can paired ostracod or mollusc valves, associations of insect sclerites, or patterns of decay within assemblages, provide useful information?

6. The use of modern parallels to investigate the nature of any decay that occurs during deposit formation (when and how).

7. Modelling of waste disposal pathways and the development and decay of insect assemblages along them.

8. Investigation of the value of insect remains as indicators of the 'health' of organic archaeology – i.e. the preservational quality of the matrix – is a particularly promising field. Evidence suggesting recent decay should be followed up whenever possible.

A large-scale investigation of residuality in archaeological remains, including invertebrates, using AMS dating is a particularly high priority and, while rich and well-preserved material is inherently more informative, there is a need to develop approaches and techniques for analysis of sites where remains are thinly distributed and only a limited range of fossils is preserved.

Recovery and curation

Methods for evaluation and assessment of invertebrate remains should be improved and validated, in relation to both the smooth progress of development control and the recovery of academically-valuable information.

Research into the merits of sampling interfaces between, as well as the body of, contexts is required as well as thorough investigation of context heterogeneity and the appropriate sampling response to this.

Certain kinds of deposits with inherent interpretational problems should nevertheless be investigated if assessment can show in particular cases that those problems can be overcome: wells and waterfronts stand out in this respect.

Simple routine methods for concentrating parasite eggs should be developed. The effect of reagents on parasite eggs, especially in relation to identification using measurements, should also be investigated.

There is a need to find ways of economically recovering very small invertebrate remains (in the range 50-300 microns) such as milled grain pest fragments and insects ground up for medicinal use, which are currently lost but which may be of interpretative significance.

Research into the survival of organic remains in stored sediment samples is urgently required.

Identification and interpretation

Reference collections, criteria, and manuals need to be developed to aid the identification of certain groups:

1. Earthworm egg capsules, and earthworm setae: are the latter characteristic and are they preserved?

2. Eggs of intestinal parasites (e.g. capillarids; flukes, e.g. '*Fasciola*'-type eggs; tapeworms; *Trichuris* species). The use of image analysis for this group should be explored.

3. Cladoceran ephippia and carapaces.

4. Scale insects.

5. Fly puparia.

6. Fossil material of immature stages of Diptera other than puparia, with special reference to larvae and pupae of Nematocera (the group including midges and mosquitoes).

7. Mites, at least major groups and common species.

8. Residues of various kinds including honey, beeswax, lac, and invertebrates dyes.

Fundamental research is needed into the interpretation of insect assemblages via:

1. Species associations, especially their variation and its significance at the site and settlement level.

2. The representation of natural and semi-natural habitats in relation to distance from point of deposition, especially for aquatics, temporary terrestrial habitats, woodland and grazing land.

3. Investigation of the transfer of insects from (a) fields to ditches and (b) occupation areas to cut features; are local environments adequately represented in the fills of such cuts?

4. The detection of associations indicative of particular craft or industrial processes and as secondary evidence of resource exploitation e.g. turf, peat, hay, moss, water) also requires further study. Of particular interest is investigation of aquatic and grassland organisms in dung, especially of horses.

5. The use of modern insect-damaged grain, charred using a variety of methods, to determine whether evidence likely to be visible in archaeological material can be produced.

Some other groups need special attention with regard to interpretation:

1. For the *molluscs*, there is a pressing need to improve the ecological interpretation of terrestrial snails and to relate it to the habitats of the species concerned in different parts of their ranges; studies of communities of snails, both terrestrial and aquatic, in relation to local environment in northern England are long overdue.

2. Investigation of communities of *testate amoebae* in turf, soils and decaying matter may prove instructive; how do these fossils enter occupation deposits and are they of interpretative significance?

3. Studies of *ostracod* populations of small water bodies in relation to the archaeological record are needed.

New research techniques should be sought: Can DNA be recovered from particular groups of invertebrates from archaeological deposits, for example, and if so can it be used to address problems such as the origin and degree of isolation of insect of populations on occupation sites and the presence of disease organisms? Are other forms of ancient molecules related to invertebrates amenable to analysis?

Climatic and environmental change

Climate change

Tracing climatic change throughout the region is a high priority; a series of climatic histories of the past 10,000 years covering different areas across the region should be constructed using insect remains, relating them to regional/hemispheric evidence from physical techniques (ice and marine cores) and from botanical studies. Specific issues include:

2. The impact of sea level change on wetland and terrestrial environments.

3. Sites inundated by the sea should be located and investigated.

4. The interaction of climate with species distributions before human impact became a major factor, examining rates of invasion, causes of exclusion, and persistence in changing environments.

5. The supposed climatic changes associated with the adoption of agriculture in north west Europe.

6. The relationship between the cultural changes observed in the Late Mesolithic, later Bronze Age and late Bronze Age/ Iron Age Transition and climate and environment.

7. Tracing and understanding biological changes in the post-medieval period, where climatic change is rather well-documented and in which many species may have become restricted.

8. Dating the disappearance of now extinct (or extremely localised) ancient forest beetle species.

Environmental change

The reconstruction of *wetland history* and investigation of its exploitation and destruction by human activity requires detailed investigation using invertebrates as well as plant remains to build on the results of the various EH-sponsored surveys.

River changes: the process of alluviation and changing turbidity as revealed by invertebrates should be traced. Related to this is the problem of pollution by organic matter of human (waste disposal) and natural (e.g. decaying peat) origin and heavy metals, water quality being particularly important, especially in relation to land use and resources for centres of population.

Identification of *sources of water* used in large settlements should be attempted: was it from wells and pits, rivers, piped supplies, aqueducts?

Archaeological data can and should be used in studies of past *biological introductions and invasions* and their impact on 'native' invertebrate communities. This is important in interpreting past communities but also of relevance for biological conservation, biological control and the release of genetically-modified organisms. For later periods the impact of habitat exploitation and loss of species is of interest; or example:

1. The history of heaths and peatlands throughout the area around York remains problematic. This is important in relation to formulation of conservation policy.

2. The period of maximum species decline needs to be determined; was it very recent?

3. How did the increasing pace of technological change and growing population affect communities of plants and animals – in particular, when did today's rarities become rare? At what point did habitat fragmentation became critical?

Priorities pertaining to particular periods and areas

Time periods and events:

1. Any *pre-Flandrian* sites should be investigated thoroughly.

2. The hypothesis that grassland persisted through the Pre-Boreal and Boreal periods on the Yorkshire Wolds should be tested.

3. The elucidation of the development of *Mesolithic* and *Neolithic* landscapes clearly deserves to be regarded as of high priority. In this regard, well-stratified assemblages of molluscs and deposits with anoxic preservation in limestone and chalk areas should receive high priority.

4. The Vale of Pickering presents special opportunities for the Mesolithic and the waterlogged deposits in it are at least locally, and probably generally, in active decay and at risk from gravel extraction.

5. For all agricultural periods studies of rural landscape are needed, reconstructing natural history and determining the influence of human activity.

6. Pre-Roman Iron Age occupation sites with anoxic waterlogging or well-preserved land snail assemblages are very rare and of the highest priority and should always be investigated.

7. Was there Iron Age to Roman continuity of settlements? Did the Iron Age settlements ever create 'urban' conditions?

8. The detection of 'aliens' as evidence of early trade in pre-Roman sites, or evidence that would suggest that such species may in fact be native (if so, their changing status perhaps suggesting climatic or social change) is of particular interest.

9. Roman importation of organisms including a range of invertebrates should be traced; for the insects this will require particular attention to the very earliest Roman deposits at each settlement.

10. Roman rural sites, including agricultural land and deposits providing information concerning impact on the natural environment are of particular interest.

11. Forest, peatland, heath and marshland were important for the resources they provided for both the rural and urban population, and their distribution should be traced

12. For late Roman and immediately post-Roman periods questions still remain as to the continuity of settlement between the Roman period and the Dark Ages. Insects seem particularly likely to cast light on this question if sites with good preservation can be found.

13. Can we see the supposed AD 540 (536) event, in sediments, though effects on wild or synanthropic fauna, or via the effects of a 'Justinian Plague'?

The development of towns:

1. Insect remains (and doubtless mites) should be exploited as a source of information about the early development of the Anglo-Scandinavian towns in Britain, at present very poorly understood.

2. The evolution of urban living conditions may be traced through the insect fauna; with preliminary analysis suggests profound changes.

3. Why is there so little evidence of the keeping of livestock in towns?

4. Invertebrate remains should give evidence concerning trade, both local and international, and thus insights into the nature and origin of cultural traditions (e.g. in the 9th century, whether of native or Scandinavian origin).

5. For the medieval and post-medieval periods we may hope to observe changes in the range of materials exploited. When did the use of thatch and turf in roofing decline in various parts of the region, for example?

6. For post-medieval deposits in particular, where the documentary evidence is sometimes very good, correlation of archaeological data with historical records should provide useful insights, refining interpretation of both sources and revealing those aspects of life which were rarely if ever recorded in writing.

7. Comparison of land use, activity and ecological conditions within and between individual towns by time and in space would undoubtedly be very rewarding. For York the Roman and Anglo-Scandinavian periods hold promise. Beverley and Hull should also be amenable to similar investigations.

8. In York, sites associated with the River Foss and the King's Fishpool would also benefit form a more concerted approach.

For Anglo-Scandinavian York many questions arise, including the following:

1. Were the small tenements laid out essentially *de novo*, or did they develop organically from less subdivided holdings, perhaps farmsteads, whose ephemeral remains have yet to be discovered?

2. Did any occupation areas originate from existing Anglian or Saxon nuclei?

3. How representative is a site such as that at 16-22Coppergate of the town as a whole?

4. Was there functional zonation, as preliminary analysis suggests?

5. Were some areas of 'high status' and consequently poorly represented in the record?

6. Are variations in preservation primarily related to ground conditions or to organic input?

7. Were Roman buildings still in use?

8. Were some structures domestic, others purely workshops?

9. What roofing materials were used?

10. Was beekeeping an urban pastime?

11. What were the rivers and their fringes like?

12. What were the open spaces behind the streets like? Were they cultivated, or used to keep livestock, or primarily as dumping places?

Invertebrates of economic importance

1. Remains of moth and mite grain pests, and milled beetle fragments, should be sought.

2. The pattern of occurrence of grain pests (species by species) in time, space, and by site type should be traced.

3. The level of insect damage in charred grain from a wide range of sites should be determined; inspection for such damage should be a routine.

4. The range of insects exploiting grain prior to the arrival of the classic grain pests should be investigated.

5. We must attempt to evaluate the significance of trace amounts of grain pests in small settlements, and estimate local extinction rates of grain pests and other synanthropes, in individual settlements. Are they a useful measure of intensity of occupation and levels of economic integration?

6. Determining whether the honey bee *Apis mellifera* is truly a native of Britain is a matter of wide interest.

7. It will be useful to establish when apiculture, rather than collection from wild colonies, developed. The material used for beehives in various periods could also be investigated.

8. The past distribution of oysters should be investigated as a priority in order to understand more fully their exploitation and the impact this had on the local shellfish populations.

Table 3. Insects and intestinal parasites from archaeological sites in the north of England.

Site-based publications and reports including data concerning insects and nematode parasites (the two groups are presented together since most parasite reports are for sites where insects were at least sought). Some reports noting where a decision was made to reject material without analysis are included; unfortunately this is rarely explicit and often it is unclear whether lack of analysis was justifiable. Not all reports listed here are mentioned in the text; poorly-dated material in particular has generally not been discussed. Superceded, often archive-only, reports are listed in some cases to flag their nature but generally should not be consulted.

All sites where insects were explicitly sought are included (whether or not they were found), and some sites where insects were almost certainly present but not recorded have been added for illustrative purposes. Works purporting to be evaluations but which appear not to have dealt with invertebrate remains have not been systematically included (see text for further comment). If no group is mentioned under comments, the report deals primarily with Coleoptera (and usually also Hemiptera).

To simplify the referencing system, EAU and PRS reports have been listed using the author(s) and report number and are so referenced in the text. Site codes have not usually been included here to save space: they can be retrieved from the EAB. Kingston upon Hull is called Hull throughout.

Cross-references to 'data' or 'breakdown' in the 'comments' column are pointers within this table.

Abbreviations

***General:** anal - detailed analysis (full investigation of at least some assemblages); ass - assessment report; DE - data presented in another report; EAB No. - reference number in Environmental Archaeology Bibliography (see text); eval - evaluation report; incid - incidental mention; NS - not sought;   tech - technical report ('archive report' indicates early reports, usually on continuous computer stationary, which can only be consulted in the original at English Heritage or University of York); X - not relevant . 'Evaluation' and 'assessment' are used as defined by Association for Environmental Archaeology (1995), and do not necessarily follow the term used in the title of a report*

***Counties**: CHE - Cheshire; CLE - Cleveland; CoY - City of York; CUM - Cumbria; DUR - Durham; EYR - East Yorkshire; HAL - Halton; LAN - Lancashire; MER - Merseyside; NEL - North East Lincoln; NHM - Northumberland; NLN - North Lincolnshire; NYR - North Yorkshire; SYR - South Yorkshire; TaW - Tyne and Weir; WYR - West Yorkshire.*

***Periods**: AN - Anglian; AS - Anglo-Scandinavian; B - before; BA - Bronze Age; DV - Devensian; E - early; HO - Holocene; L - late; IA - Iron Age; LG - Late Glacial; MD - medieval; M - mid; MO - modern; MS - Mesolithic; nd - not dated in environmental report; NE - Neolithic; P -*

post; PL - Palaeolithic; PM - post-medieval; PH - 'prehistoric'; RB - Romano-British; RO - Roman; SX - Anglo-Saxon . Dates are centuries AD unless stated.

***Insects:** e - number of samples examined; m - method; L - species lists; M - macrofossil sample; N - non-standard record of some kind (e.g. from plant macrofossil analysis, or BS samples); NS - not sought; O - other methods (ie. not standard extraction, or incidental mention); R - rapid scan lists (sensu Kenward 1992); + - number of samples providing more than a trace of remains of arthropods (where listed, about 10 or more);U - analysed, or apparently so, but unlisted.; V - visual searching of sediment. Sometimes data from bulk-sieved samples have been used, signified by BS. In some cases it is likely that there were unreported barren samples.*

***Parasite eggs:** e - number of tests made, using Stoll or similar method, or squashes (s), see text; + - number with Trichuris, Ascaris or both (records of '?Hymenolepis' have been disregarded for this purpose).*

Reference	EAB No.	EAB name	Site	Location	County	Date	Comments	Insects			Parasites		
								m	e	+	m	e	+
Akeret *et al.* (PRS 2004/71)	10416	Station Farm Cottage PRS 2004/71	land at Station Farm Cottage, Souttergate	Hedon	EYR	12-13 and nd	eval; pit, ditch and post-hole fills	T	5	0	NS	X	X
Akeret *et al.* (PRS 2004/72)	10417	The Burrs (5) PRS 2004/72	5 The Burrs	Brough	EYR	RB	eval; ditch fill, surface deposits	T	3	0	NS	X	X
Akeret *et al.* (PRS 2004/76)	10421	Blaydes Staith PRS 2004/76	Blaydes Staith, High Street	Kingston upon Hull	EYR	14-15	eval; foreshore alluvium and dumping, ground raising	T	10	5	NS	X	X
Akeret *et al.* (PRS 2004/77)	10422	Hull High School (adj) PRS 2004/77	Hull High School, Tranby Croft	Anlaby	EYR	IA, ?RB	eval; ditch fills	T	5	0	NS	X	X
Akeret *et al.* (PRS 2004/87)	10431	Central Dry Dock PRS 2004/87	Hull Central Dry Dock, Humber Street	Kingston upon Hull	EYR	16-20	eval; various deposits	T	7	2	s	1	0
Akeret *et al.* (PRS 2005/10)	10452	Stonebow PRS 2005/10	former Henlys of York filling station, The Stonebow	York	CoY	12/13-15	ass; levelling, demolition,pit fill, alluvium	T	7	2	s	3	0
Akeret *et al.* (PRS 2005/103)	10532	Faverdale East PRS 2005/103	Faverdale East Business Park	Darlington	DHM	HO, RB	ass; various deposits, mostly cut fills	T	39	6	s	10	0
Akeret *et al.* (PRS 2005/105)	10533	North Rd Industrial Estate PRS 2005/105	North Road Industrial Estate	Berwick-upon-Tweed	NHM	IA, RB	ass; ditch and pit fills, dump, layer	T	9	1	NS	X	X
Akeret *et al.* (PRS 2005/14)	10455	Baldwin Ave PRS 2005/14	Baldwin Avenue, Bottesford	Scunthorpe	NLN	?13-14	anal; pit fill	T	1	0	NS	X	X
Akeret *et al.* (PRS 2005/21)	10461	North Rd Industrial Estate (adj) PRS 2005/21	land to the north of North Road Industrial Estate	Berwick-on-Tweed	NHM	?LBA	eval; ditch and cut fills	T	6	0	NS	X	X

Reference	EAB No.	EAB name	Site	Location	County	Date	Comments	Insects			Parasites		
								m	e	+	m	e	+
Akeret *et al.* (PRS 2005/61)	10497	High St (5) (Yarm) PRS 2005/61	5 High Street, Yarm	Stockton on Tees	CLV	12-14	eval; pit fills	T	4	0	NS	X	X
Akeret *et al.* (PRS 2005/63)	10498	Chowder Ness PRS 2005/63	intertidal peat exposure at Chowder Ness	Barton-upon-Humber	NLN	HO	ass; intertidal peat	T	1	1	NS	X	X
Akeret *et al.* (PRS 2005/87)	10520	Beverley Health Centre PRS 2005/87	Beverley Health Centre	Beverley	EYR	12, nd	eval; pit and ditch fills, layer	T	5	0	s	1	1
Akeret *et al.* (PRS 2005/89)	10522	Low Petergate (62-8) PRS 2005/89	62-68 Low Petergate	York	CoY	13/14, 14-15, ?17, 18-19	ass; pit fills, surface deposits	T	25	7	s	10	7
Akeret *et al.* (PRS 2005/93)	10525	Melton PRS 2005/93	alongside the A63	Melton	EYR	NE, EBA, LIA/RB, 'MD'	ass; various features, mainly pit and ditch fills	T	61	0	s	7	0
Alldritt *et al.* (EAU 1990/01)	143	Adams Hydraulics I EAU 90/01	Adams Hydraulics I	York	CoY	10-15/16	archive eval; pits, layers, ?river silts	T	16	3	NS	0	0
Alldritt *et al.* (EAU 1991/01)	5786	Piccadilly (17-21) EAU 91/01	17-21 Piccadilly (= Reynard"s Garage)	York	CoY	MD- L14	archive eval; boreholes, pits and unidentified, dating mostly poor	T	18	12	s	1	1
Alldritt *et al.* (EAU 1991/02)	7471	The Mount (89) EAU 91/02	89 The Mount	York	CoY	nd	archive eval; no archeology	T	7	0	NS	X	X
Alldritt *et al.* (EAU 1991/03)	3983	Ideal Laundry EAU 91/03	Trinity Lane (= Ideal Laundry site)	York	CoY	nd	archive eval; no archeology	T	6	0	NS	X	X
Alldritt *et al.* (EAU 1991/35)	5684	Park Grange Farm EAU 91/35	Park Grange Farm, Long Lane	Beverley	EYR	IA/RB	anal: peats, ?hillwash, pit, spring deposits, hollow fill	L	21	8	n/a	X	X
Allison *et al.* (AML 21/90))	2531	Dominican Friary (Beverley) AML 21/90	Dominican Friary	Beverley	EYR	?12-P14	tech anal; landfill, pit, conduit, floors, etc (see also Allison *et al.* 1996)	L	12	7	Stl	15	9
Allison *et al.* (AML 105/90)	5355	North Cave AML 105/90	North Cave	nr Beverley	EYR	RO	tech anal (see also Allison *et al.* forthcoming; EAU 97/37; data archive Carrott *et al.* EAU 1996/42)	n/a	X	X	n/a	X	X
Allison *et al.* (1991a; b)	1656	Castle St (Carlisle) 81-2	Castle Street	Carlisle	CUM	1-2, 8	anal; floors, external surfaces, some cuts (see also Jones and Hutchinson AML 59/88 for parasite data; Kenward and Morgan EAU 1985/22-24)	L	56	53	n/a	X	X
Allison *et al.* (1996a)	2985	Fishergate (46-54) 85-6 (Priory)	46-54 Fishergate	York	CoY	MD	pits and surface deposits, some directly associated with structures (see also Allison *et al.* EAU 1989/01; also BS samples, not enumerated).	T, L	49	7	P	56	7

Reference	EAB No.	EAB name	Site	Location	County	Date	Comments	Insects			Parasites		
								m	e	+	m	e	+
Allison *et al.* (1996b)	2984	Fishergate (46-54) 85-6 (Anglian)	46-54 Fishergate	York	CoY	AN	pits and surface deposits, some directly associated with structures (see also Allison *et al.* 1989a)	I	38	2	0	?	?
Allison *et al.* (1996c)	2534	Dominican Priory (Beverley) 86-9	Dominican Friary	Beverley	EYR	?12-P14	anal (See also Allison *et al.* AML 21/90 for data)	n/a	X	X	n/a	X	X
Allison *et al.* (EAU 1988/03)	5502	Oakwell Hall EAU 88/03	Oakwell Hall	Birstall	WYR	c. 1490-1550	archive tech; fills of structure built into moat bank (see Kenward and Allison EAU 1988/12 for lists)	X	X	X	X	X	X
Allison *et al.* (EAU 1989/01)	2993	Fishergate (46-54) EAU 89/01	46-54 Fishergate	York	CoY	MD	archive tech (see Allison *et al.* 1996a)	n/a	X	X	?	X	X
Allison *et al.* (EAU 1989/02)	2994	Fishergate (46-54) EAU 89/02	46-54 Fishergate	York	CoY	AN	archive tech (see Allison *et al.* 1996b)	n/a	X	X	?	X	X
Allison *et al.* (EAU 1989/03)	1669	Castle St (Carlisle) EAU 89/03	Castle Street	Carlisle	CUM	RO, AS	archive tech (see Allison et al. 1991a; b for breakdown)	n/a	X	X	n/a	X	X
Allison *et al.* (EAU 1990/02)	6888	St Georges Fields EAU 90/02	St George"s Fields	York	CoY	?	archive ass; no dating; various deposits	T	8	0	NS	X	X
Allison *et al.* (EAU 1990/05)	7080	Staniwells Farm EAU 90/05	Staniwells Farm	Hibaldstow	NLN	RO	archive anal based on BS samples only; mainly pit and ditch fills	BS	?	?	NS	X	X
Allison *et al.* (EAU 1991/05)	145	Adams Hydraulics III EAU 91/05	Adams Hydraulics III	York	CoY	RO-10/11	archive ass; RO build-up, and ?ditch and layers ?King"s Pool, MD pits	T	7	3	NS	X	X
Allison *et al.* (EAU 1991/06)	6576	Skeldergate (14) EAU 91/06	14 Skeldergate	York	CoY	13 +?	archive ass; boreholes, ?floor, stone drain, build-up, river silts	T	13	10	NS	X	X
Allison *et al.* (forthcoming a)	0	unpublished draft	North Cave	North Cave nr Beverley	EYR	IA RO	publication text of uncertain fate; anal: pit, ditch and other cut fills (see also Allison *et al.* AML 105/90; Carrott *et al.* EAU 1996/42)	L	32	21	?	X	X
Allison *et al.* (forthcoming)	0	unpublished draft	Annetwell Street	Carlisle	CUM	RO MD	publication text of uncertain fate; no copy found (see also Kenward and Large EAU 1986/20; Large and Kenward EAU 1987/14-16; 1988/15-19; see Jones and Hutchinson nd; Kenward EAU 1999/32 for breakdown)	n/a	X	X	n/a	X	X
Allison *et al.* (PRS 2005/109)	10537	Danes Moss PRS 2005/109	Danes Moss	Macclesfield	CHS	HO	anal; natural peats (see also Carrott PRS 2003/06).	L	7	7	NS	X	X
ASUD (ASUD 678)	5045	Milfield Basin ASUD 678	Milfield Basin	nr Wooler	NMD	NE-?IA	eval; various deposits including cuts (only traces of insects)	BS	25	0	NS	X	X

Reference	EAB No.	EAB name	Site	Location	County	Date	Comments	Insects			Parasites		
								m	e	+	m	e	+
Ashworth (1972)	10779	Red Moss	Red Moss	south of Horwich	LAN	LG	anal; natural hollow	L	15	15	n/a	X	X
ASUD (ASUD 791)	1179	Bridgegate ASUD 791	Bridgegate	Howden	EYR	MD	eval; cuts	BS	10	3	NS	X	X
Balfour-Browne (1954)	7132	Star Carr 49-50	Star Carr	Seamer nr Scarborough	NYR	MS	casual finds	O	X	X	n/a	X	X
Bastow (WYAS 801)	7917	Venn St (land off) WYAS 801	Land off Venn Street	Huddersfield	WYR	LMD PMD	incid; various deposits	BS	29	7	NS	X	X
Bateman *et al.* (2001a)	10780	Cove Farm Quarry	Cove Farm Quarry	Westwoodside, Isle of Axholme	SYR	LG	preliminary anal; peat	U	5	5	n/a	X	X
Bedford *et al.* (2004).	10806	Hawes Water	Hawes Water		LAN	LG	anal; research paper, Chironomidae	n/a	X	X	n/a	X	X
Blackburn (1952)	5230	Neasham (dating)	Neasham	nr Darlington	DHM	LG	a few invertebrates noted during botanical investigation	O	X	X	NS	X	X
Boswijk and Whitehouse (2002)	10781	Tyrham Hall Quarry	Tyrham Hall Quarry	Hatfield Moors	SYO		anal; buried forest; dendr 3618-3418 and 2921-2445	L	6	6	n/a	X	X
Brothwell *et al.* (EAU 1994/554)	957	Blue Bridge Ln 94 EAU 94/55	Blue Bridge Lane	York	CoY	nd	eval; no context information	T	9	0	NS	X	X
Brothwell *et al.* (EAU 1995/11)	7521	Thirsk Castle 94 EAU 95/11	Thirsk Castle	Thirsk	NYR	AS-PM	eval; various deposits	BS	7	0	NS	X	X
Buckland (1975b)	10815	Church St (York) 72-3 (First interim)	Church Street Sewer	York	CoY	RO	preliminary report	n/a	X	X	n/a	X	X
Buckland (1975b)	10777	Pavement (6-8) 72 (first interim)	6-8 Pavement	York	CoY	A/S	preliminary report	n/a	X	X	n/a	X	X
Buckland (1976a)	1946	Church St (York) 72-3	Church Street	York	CoY	RO	anal; fills of sewer	L	14	12	+	+	+
Buckland (1979)	7542	Thorne Moors	Thorne Moors	Thorne, nr Doncaster	SYR	BA	anal (see also Buckland and Kenward 1973) C14	L	6	6	n/a	X	X
Buckland (1980)	6260	Rudston Villa	picc..	Rudston	EYR	RO	anal: well fill	L	7	6	NS	X	X
Buckland (1981a)	1191	Brigg Raft 1888	Brigg raft	Brigg	NLN	LBA	anal: natural, associated with "raft" (see also Girling AML 3669, Perry 1981) C14	L	36	36	X	X	X
Buckland (1982a)	4991	Messingham 1	Messingham		NLN	LG or E PG	anal: natural deposits	L	6	6	n/a	X	X
Buckland (1982c)	4831	Malton 30 (reconsidered)	Malton	Malton	NYR	RO	anal: one sample of charred grain (= 'The Malton Burnt Grain')	L	1	1	n/a	X	X

Reference	EAB No.	EAB name	Site	Location	County	Date	Comments	Insects			Parasites		
								m	e	+	m	e	+
Buckland (1996)	2582	Dragonby 64-73	Dragonby	nr Scunthorpe	NLN	RO	anal: erosion cone fill	L	I	I	NS	X	X
Buckland (2001)	10782	West Moor	West Moor	Amthorpe	NLN	DV/LG	anal; peat	L	I	I	-		
Buckland and Johnson (1983)	10784	Thorne Moor (Curimopsis)	Thorne Moor	Thorne	SYR		Identification of modern and fossil byrrhids	n/a	X	X	n/a	X	X
Buckland and Kenward (1973)	7541	Thorne Moor	Thorne Moor	Thorne, nr Doncaster	SYR	BA	preliminary report (see also Buckland 1979) C14	n/a	X	X	n/a	X	X
Buckland *et al.* (1974)	5716	Pavement (6-8) 72 (preliminary)	6-8 Pavement	York	CoY	A/S	preliminary report (See Hall *et al.* 1983b)	n/a	X	X	n/a	X	X
Buckland *et al.* (1990)	2945	North Ferriby Boat No 2 78-80	North Ferriby	North Ferriby	EYR	BA	report not seen	?	?	?	NS	X	X
Buckland, Philip (ARCUS 208)	6890	St Georges School ARCUS 208	St George's School, Margaret Street, Walmgate	York	CoY	?AS or MD	eval; pitfill; report unclear as to number of samples with more than trace of insects	T	8	I	NS	X	X
Bush (1988)	8432	Willow Garth	Willow Garth	Where is it?	EYR	PH	incid	O	X	X	n/a	X	X
Bush and Ellis (1987)	10783	Willow Garth (b)	Willow Garth		EYR	PH	incid	O	X	X	n/a	X	X
Carrott *et al.* (PRS 2003/07)	9650	Tower St (Hull) PRS 2003/07	Tower Street	Kingston upon Hull	EYR	PM	eval: various deposits	T	6	2	NS	X	X
Carrott (EAU 1999/48)	3579	Hare and Hounds EAU 99/48	Hare and Hounds	Staxton	NYR	nd	ass; no data	T	I	0	NS	X	X
Carrott (EAU 2000/05)	6097	Redmires EAU 2000/05	Redmires abandonment	nr Sheffield	WYR	nd	eval; ditch fill	T	I	0	NS	X	X
Carrott (PRS 2001/01)	7336	Swinescaif Quarry PRS 2001/01	Swinescaif Quarry	South Cave	EYR	LBA/ EIA	eval; pit, ditch and grave fills	BS	26	0	-	X	X
Carrott (PRS 2002/35)	9629	Melton PRS 2002/35	Melton (A63)	nr Brough on Humber	EYR	nd	eval; ditch fills	BS	2	0	NS	X	X
Carrott (PRS 2002/43)	9637	OSA02EX07 (Transco Pipeline) PRS 2002/43	site OAS02EX07	nr Riplingham, W of Hull	EYR	LPH	eval; pit and ditch fills	T	2	0	NS	X	X
Carrott (PRS 2002/44)	9638	OSA02EX04 (Transco Pipeline) PRS 2002/44	site OAS02EX04	nr Cottingham	EYR	IA/RB	eval; ditch fill, hearth deposit	BS	3	0	NS	X	X
Carrott (PRS 2002/48)	9642	Alderley Edge/Nether Alderley By-pass PRS 2002/48	Gazetteer sites 9 and 29	Alderley Edge/Nether Alderley	CHS	nd	eval; borehole cores	O	X	X	NA	X	X
Carrott (PRS 2003/06)	9649	Danes Moss PRS 2003/06	Danes Moss	Macclesfield	CHS	HO	ass: peat (see also Allison *et al.* PRS 2005/109)	T	14	7	NA	X	X

Reference	EAB No.	EAB name	Site	Location	County	Date	Comments	Insects			Parasites		
								m	e	+	m	e	+
Carrott and Cousins (PRS 2003/44)	9684	Cleveland House PRS 2003/44	land adjacent to Cleveland House	Goldsborough	NYR	MD, mod	eval; ditch and cut fills	T	3	0	NS	X	X
Carrott and Cousins (PRS 2003/55)	9693	Elvington-Riccall Pipeline Site 3 PRS 2003/55	a site on the Elvington to Ricall pipeline	SE of York	NYR	RB	eval; ditch fills	T	2	0	NS	X	X
Carrott and Hall (EAU 1999/62)	29	A66 EAU 99/62	A66 between Greta Bridge and Stephen Bank and Carkin Moor to Scotch Corner	Greta Bridge - Scotch Corner	NYR	nd	eval; cut fills	T5+0	5	0	NS	X	X
Carrott and Hall (PRS 2003/08)	9651	Cottage Farm PRS 2003/08	Sewerby Cottage Farm	Bridlington	EYR	NE IA	eval: ditch, posthole and pit fills	BS	10	0	NS	X	X
Carrott and Hall (PRS 2003/15)	9658	Hob Moor Junior School PRS 2003/15	Hob Moor Junior School	York	CoY	?MD	eval; fill	T	1	0	NS	X	X
Carrott and Hall (PRS 2003/16)	9659	St Oswalds School PRS 2003/16	St Oswald's School, Fulford	York	CoY	RO MD	eval: ditch and cut fills	T	4	0	NS	X	X
Carrott and Jaques (EAU 2001/47)	4546	Little Wold Ln (off) EAU 2001/47	land off Little Wold Lane	South Cave	EYR	IA or RB	eval; ditch fills	T	2	0	NS	X	X
Carrott and Jaques (PRS 2002/40)	9634	Station Rd (off) PRS 2002/40	land off Station Road	Middleton-on-the-Wolds	EYR	MD, LMD	eval; ditch fills	T	4	0	NS	X	X
Carrott and Johnson (PRS 2003/84)	9722	Cottage Farm PRS 2003/84	Sewerby Cottage Farm (farmyard area)	Bridlington	EYR	NE	ass; cut fills, spreads	BS	8	0	NS	X	X
Carrott and Kenward (2001)	9745	Coppergate (16-22) (insect species association)	16-22 Coppergate	York	CoY	A/S	research (species associations)	n/a	X	X	n/a	X	X
Carrott and Kenward (EAU 1994/24)	5511	Ochre Brook EAU 94/24	Brook House Farm (further material)	Halewood	MER	PH	ass: ditch fills	T	2	1	s	2	0
Carrott and Large (EAU 1997/29)	8130	Welton Low Rd EAU 97/29	Welton Low Road	Elloughton, near Brough	EYR	RO	eval; ditch and ?ditch fills	T	2	0	NS	X	X
Carrott *et al.* (1995)	417	Aylesby 94	Aylesby	w of Grimbsby	NLN	IA, RB, 12-14	publication report; ditch, posthole and pit fills (see also Carrott *et al.* EAU 1994/51)	T	11	0	NS	X	X

Reference	EAB No.	EAB name	Site	Location	County	Date	Comments	Insects			Parasites		
								m	e	+	m	e	+
Carrott *et al.* (2000).	6111	Ribchester 80, 89-90	Ribchester	Preston - Clitheroe	LAN	RO	publication report (see Large *et al.* EAU 1994/11 for data)	n/a	X	X	n/a	X	X
Carrott *et al.* (EAU 1990/08)	3188	Garden Pl EAU 90/08	Garden Place	York	CoY	?PH-?MD	archive eval; mostly boreholes into area of King"s Pool; alluvium and accumulations in pool	T	52	14	NS	X	X
Carrott *et al.* (EAU 1991/10)	6578	Skeldergate (26-34) EAU 91/10	26-34 Skeldergate	York	CoY	LMD	archive eval; levelling/dump, ?occupation	T	2	0	NS	X	X
Carrott *et al.* (EAU 1991/11)	8004	Walmgate (41-9) - George St EAU 91/11	41-49 Walmgate/George Street	York	CoY	nd	archive eval; boreholes, ?natural and unidentified	T	13	8	NS	X	X
Carrott *et al.* (EAU 1991/12)	144	Adams Hydraulics II EAU 91/12	Adams Hydraulics II	York	CoY	?PH-18	archive eval; mostly boreholes, some layers	T	28	22	NS	X	X
Carrott *et al.* (EAU 1991/13)	2102	Coney St (13-17) EAU 91/13	13-17 Coney Street	York	CoY	nd	archive eval; no archaeology	T	4	0	NS	0	0
Carrott *et al.* (EAU 1991/14)	6931	St Leonards Church EAU 91/14	St Leonard"s Church	Malton	NYR	nd	archive eval; various materials	NS	0	0	NS	X	X
Carrott *et al.* (EAU 1991/15)	1557	Carmelite St EAU 91/15	Carmelite Street	York	CoY	?-16	archive eval; boreholes, MD surface, ?dumps, ?alluvium16th dumps	T	17	10	s	1	0
Carrott *et al.* (EAU 1991/16)	5793	Piccadilly (84) EAU 91/16	84 Piccadilly (= Fiat Garage site)	York	CoY	?AS-19	archive eval; boreholes, pond silts. layers, drain fills	T	12	9	NS	X	X
Carrott *et al.* (EAU 1991/17)	7147	Station Yd (Beverley) EAU 91/17	Station Yard	Beverley	EYR	?MD	archive eval; ditch fills, ? associated with Preceptory of Holy Trinity	T	5	5	NS	X	X
Carrott *et al.* (EAU 1991/18)	952	Blossom St (12-20) EAU 91/18	12-20 Blossom Street	York	CoY	RO-19	archive eval; various deposit types, mostly surface-lain	T	14	1	NS	X	X
Carrott *et al.* (EAU 1991/19)	4997	Methodist Church EAU 91/19	Methodist Church, St Saviourgate	York	CoY	nd	archive eval; cuts and surface layers	T	3	1	NS	X	X
Carrott *et al.* (EAU 1992/01)	4827	Malmo Rd EAU 92/01	Malmo Road	Hull	EYR	RB to MD	archive eval; RB ditch; MD cuts	T	6	1	s	1	0
Carrott *et al.* (EAU 1992/02)	1676	Castledyke 89-90 EAU 92/02	Castledyke	Barton-on-Humber	NLN	AN	archive; grave and pot fills	T	20	0	NS	X	X
Carrott *et al.* (EAU 1992/03)	7995	Walmgate (104-12) EAU 92/03	104-112 Walmgate	York	CoY	10-15	archive eval ; boreholes, mid 10-mid 11th pits	T	7	3	s	1	0
Carrott *et al.* (EAU 1992/04)	626	Baxtergate (Whitby) 92 EAU 92/04	Baxtergate	Whitby	NYR	MD	archive eval; floor make up or build-up	T	5	3	NS	X	X
Carrott *et al.* (EAU 1992/05)	5665	Palmer Ln 92 EAU 92/05	Palmer Lane	York	CoY	12/14, MD/PM	archive eval; boreholes; 12-14 ?dump, late MD/early PM dump	T	2	2	NS	X	X

Reference	EAB No.	EAB name	Site	Location	County	Date	Comments	Insects			Parasites		
								m	e	+	m	e	+
Carrott *et al.* (EAU 1992/06)	1621	Castle Car Park 92 EAU 92/06	Castle Car Park	York	CoY	?PH-?RO	archive eval; deposits of uncertain nature. (see also Carrott *et al.* EAU 1995/32)	T	7	0	NS	X	X
Carrott *et al.* (EAU 1992/08)	5791	Piccadilly (50) EAU 92/08	50 Piccadilly	York	CoY	2-3 11-15	archive eval; riverside dumps, reclamation, cut fills	T	10	9	NS	X	X
Carrott *et al.* (EAU 1992/09)	5788	Piccadilly (38) EAU 92/09	38 Piccadilly	York	CoY	RO-17	archive eval; mostly pond silts, but some dumps	T	9	8	NS	X	X
Carrott *et al.* (EAU 1992/10)	4909	Marygate (26-8) EAU 92/10	26-28 Marygate	York	CoY	3	archive eval; ?buried soil, pit and grave fills, spread	T	4	0	NS	X	X
Carrott *et al.* (EAU 1992/11)	6056	Rawcliffe Manor 92 EAU 92/11	Rawcliffe Manor, Manor Lane	York	CoY	RO MD	eval; various deposits	T	10	1	NS	X	X
Carrott *et al.* (EAU 1992/12)	160	Albion St 92 EAU 92/12	Albion Street	Driffield	EYR	RO MD	archive eval; RO pit and ditch, MD pit	T	4	0	NS	X	X
Carrott *et al.* (EAU 1992/13)	954	Blossom St (47) 91 EAU 92/13	47 Blossom Street	York	CoY	nd	archive eval; ?garden soils	T	2	0	NS	X	X
Carrott *et al.* (EAU 1993/01)	1770	Champney Rd 93 EAU 93/01	Champney Road	Beverley	EYR	12-15/16	archive eval; floor silts, pit fills	T	12	4	s	12	1
Carrott *et al.* (EAU 1993/02)	6823	St Andrewgate 93 EAU 93/02	St Andrewgate	York	CoY	15/16-17/18	archive eval; ?floor and ?build-up	T	2	1	s	2	0
Carrott *et al.* (EAU 1993/03)	844	Bishop Burton 93 EAU 93/03	Land off Bryan Mere	Bishop Burton	EYR	RO MD	archive eval; RO ditch fill, MD layers and ditch fill	T	3	0	NS	X	X
Carrott *et al.* (EAU 1993/04)	6845	St Augustines Gate (15-19) 93 EAU 93/04	17-19 St Augustine"s Gate	Hedon	EYR	15	anal; primary ditch fills	L	2	2	s	2	1
Carrott *et al.* (EAU 1993/05)	5350	North Beckside 93 EAU 93/05	North Beckside and Beckview Tilery	Beverley	EYR	13-17/18	archive eval; urban pit , garderobe and slot fills, layer, natural deposits	T	31	15	s	1	1
Carrott *et al.* (EAU 1993/06)	847	Bishop Wilton 93 EAU 93/06	Bishop Wilton	Bishop Wilton	EYR	LMD	archive eval; kiln floor (see also Carrott *et al.* EAU 1993/9)	T	1	0	NS	X	X
Carrott *et al.* (EAU 1993/07)	3042	Flemingate House 93 EAU 93/07	Flemingate House	Beverley	EYR	'MD'	archive eval ; floor, silt layers, slot and pit fills	T	3	1	s	3	2
Carrott *et al.* (EAU 1993/08)	6416	Selby (town centre) 93 EAU 93/08	north and west of Gowthorpe, Finkle Street and Micklegate	Selby	NYR	MD PM	archive eval; supposed natural deposits, fish pool, dumps, flood silt, ditch and pit fills	T	24	16	s	24	7
Carrott *et al.* (EAU 1993/09)	848	Bishop Wilton 93 EAU 93/09	Bishop Wilton	Bishop Wilton	EYR	LMD	archive eval; kiln floor (see also Carrott *et al.* EAU 1993/6)	T	4	0	NS	X	X

Reference	EAB No.	EAB name	Site	Location	County	Date	Comments	Insects			Parasites		
								m	e	+	m	e	+
Carrott *et al.* (EAU 1993/10)	224	All Saints School 93 EAU 93/10	All Saints School, Nunnery Lane	York	CoY	RO	archive eval; RO ditch or slot fills	T	2	0	s	2	0
Carrott *et al.* (EAU 1993/11)	5362	North Farm EAU 93/11	near Stamford Bridge	Stamford Bridge	NYR	RO	archive eval; ?ditch fills, deposits associated with roads, ?timber building	T	8	3	NS	X	X
Carrott *et al.* (EAU 1993/12)	2614	Duggleby Lodge EAU 93/12	Duggleby Lodge	nr Malton	NYR	?IA	archive eval; presumed pre-RO ditch fills	T	3	0	NS	X	X
Carrott *et al.* (EAU 1993/13)	3267	Glebe Farm 92 EAU 93/13	Glebe Farm	Barton-upon-Humber	NLN	RB M-L 4	archive anal: pit fills	L	2	2	s	1	0
Carrott *et al.* (EAU 1993/14)	5409	North St (York) 93 EAU 93/14	North Street	York	CoY	RO-MD	archive ass; riverfront deposits	T	29	19	NS	X	X
Carrott *et al.* (EAU 1993/32)	2690	Easingwold By-pass 93 EAU 93/32	Crankleys Lane (Easingwold by-pass)	nr Easingwold	NYR	IA MD	archive ass; various features	T	94	2	NS	X	X
Carrott *et al.* (EAU 1994/01)	3766	High St (36A-40) (Hull) EAU 94/01	34A-40 High Street	Hull	EYR	14-15	eval; urban dumps (see also Carrott *et al.* EAU 1994/49)	T	4	4	s	4	2
Carrott *et al.* (EAU 1994/05)	5352	North Bridge 93 EAU 94/05	North Bridge	Doncaster	SYR	13-18	ass; urban buildings and yards	T	15	3	s	1	1
Carrott *et al.* (EAU 1994/07)	1580	Carr Naze 93 EAU 94/07	Carr Naze	Filey	NYR	RO PR	ass; RO signal station, use and abandonment (see also Carrott *et al.* EAU 1995/15)	T	21	0	NS	X	X
Carrott *et al.* (EAU 1994/13)	432	Back Swinegate EAU 94/13	14, 18, 20 and 22 Back Swinegate/Little Stonegate	York	CoY	RO-16	ass; pre-RO, RO military, 11-14 urban occupation and yards	T	38	19	s	20	5
Carrott *et al.* (EAU 1994/13)	3359	Grape Ln (8) (York) EAU 94/13	8 Grape Lane	York	CoY	RO-PM	subsumed under Back Swinegate	n/a	X	X	n/a	X	X
Carrott *et al.* (EAU 1994/13)	7334	Swinegate (12-18) EAU 94/13	12-18 Swinegate	York	CoY	RO-PM	subsumed under Back Swinegate	n/a	X	X	n/a	X	X
Carrott *et al.* (EAU 1994/17)	1253	Brook House Farm (Merseyside) EAU 94/17	Brook House Farm and Ochre Brook	Merseyside	MER	PH RO	ass; ditches and other cuts, and some layers (see also Carrott *et al.* EAU 1997/24; Kenward 2000)	T	23	4	s	3	3
Carrott *et al.* (EAU 1994/22)	1601	Cartergate 94 EAU 94/22	Cartergate	Grimsby	NLN	13-17	eval; pit and ditch fills, and ?alluvium	T	8	4	s	6	0
Carrott *et al.* (EAU 1994/24)	1254	Brook House Farm (Merseyside) EAU 94/24	Brook House Farm and Ochre Brook	Merseyside	MER	PH RO	ass; ditch fills (see also Carrott *et al.* EAU 1994/17; Kenward 2000)	T	2	0	s	2	0
Carrott *et al.* (EAU 1994/25)	4370	Lawrence St (148) 93 EAU 94/25	148 Lawrence Street	York	CoY	11-13	ass; urban, cuts and layers associated with structures including leper hospital	T	8	0	s	6	0

Reference	EAB No.	EAB name	Site	Location	County	Date	Comments	Insects			Parasites		
								m	e	+	m	e	+
Carrott *et al.* (EAU 1994/31)	6901	St Helens Rd 94 EAU 94/31	St Helens Road, Dringhouses	York	CoY	PH MD	eval; ?Pleistocene layer, MD pit and ditch fills, layer	T	4	0	s	4	1
Carrott *et al.* (EAU 1994/32)	2213	Cottam 93 EAU 94/32	Cottam	nr Sledmere	EYR	AN	ass; AN rural hilltop settlement	T	28	0	NS	X	X
Carrott *et al.* (EAU 1994/34)	5358	North Duffield EAU 94/34	North Duffield Carrs between Selby and Holme on Spalding Moor	North Duffield	NYR	BA	ass; Bronze Age natural	T	8	5	n/a	X	X
Carrott *et al.* (EAU 1994/35)	3034	Flaxby 94 EAU 94/35	Flaxby	nr Knaresborough	NYR	IA/RB	eval; no context information	T	2	0	NS	X	X
Carrott *et al.* (EAU 1994/36)	2691	Easingwold By-pass 93 EAU 94/36	Crankleys Lane	nr Easingwold	NYR	nd	ass; mostly ditch and slot fills	T	12	1	NS	X	X
Carrott *et al.* (EAU 1994/37)	8553	Withow Gap EAU 94/37	Withow Gap	nr Skipsea	EYR	PH	ass; Flandrian gyttja and peats, and overlying clays	T	12	5	n/a	X	X
Carrott *et al.* (EAU 1994/41)	6013	RAF Catterick 94 EAU 94/41	RAF Catterick	Catterick	NYR	RO	ass; pit and ditch fills, layers and other cut and post features	T	16	0	s	1	0
Carrott *et al.* (EAU 1994/43)	2011	Clifton Moorgate 94 EAU 94/43	Clifton Moorgate	York	CoY	nd	eval; ditch and other cut fills (see also Carrott *et al.* EAU 1995/19)	T	7	0	s	7	0
Carrott *et al.* (EAU 1994/44)	8649	Yarm 94 EAU 94/44	Yarm	Yarm	CLV	MD	eval; ditch fills	T	5	5	s	5	0
Carrott *et al.* (EAU 1994/47)	6211	Rosemary Pl 94 EAU 94/47	Rosemary Place	York	CoY	MD	eval; boreholes penetrating supposed King"s Fishpool deposits	T	3	0	s	4	0
Carrott *et al.* (EAU 1994/49)	3767	High St (37) (Hull) EAU 94/49	37 High Street	Hull	EYR	?14- LMD	ass; floor, occupation rubbish, cesspit fills (see also Carrott *et al.* EAU 1994/1)	T	5	1	s	5	2
Carrott *et al.* (EAU 1994/50)	8133	Welton Rd 94 EAU 94/50	Welton Road	Brough	EYR	RO	ass; no context information (see also Issitt EAU 1995/9)	T	66	1	NS	X	X
Carrott *et al.* (EAU 1994/51)	418	Aylesby 94 EAU 94/51	Aylesby	w of Grimbsby	NLN	IA RB 12-14	tech; ditch and pit fills (see also Carrott *et al.* 1995)	T	3	0	NS	X	X
Carrott *et al.* (EAU 1995/02)	2570	Dowbridge Close 94 EAU 95/02	Dowbridge Close	Kirkham, nr Preston	LAN	RO	tech; fort, mainly ditches but a few other features	T	21	7	s	11	2
Carrott *et al.* (EAU 1995/06)	4379	Layerthorpe Bridge EAU 97/25	Leven-Brandesburton by-pass	between Leven and Brandesburton	EYR	IA ?RO EMD	eval; no context information (see also Dobney *et al.* 93/20; Hall *et al.* EAU 1994/15)	T	4	0	NS	X	X
Carrott *et al.* (EAU 1995/08)	5702	Parliament St (44-5) 94 EAU 95/08	44-5 Parliament Street	York	CoY	11-13	eval; urban yard surface and pit deposits (see also Carrott *et al.* EAU 1996/15)	T	7	7	s	7	6

Reference	EAB No.	EAB name	Site	Location	County	Date	Comments	Insects			Parasites		
								m	e	+	m	e	+
Carrott *et al.* (EAU 1995/14)	8120	Wellington Row 88-9 EAU 95/14	Wellington Row	York	CoY	RO PR MD	ass; wide range of deposit types	T	77	17	s	6	0
Carrott *et al.* (EAU 1995/15)	1582	Carr Naze 94 EAU 95/15	Carr Naze	Filey	NYR	RO PR	ass; RO signal station, use and abandonment (see also Carrott *et al.* EAU 1994/7)	T	9	0	s	??7	0
Carrott *et al.* (EAU 1995/17)	4793	Magistrates Courts (Hull) 94 EAU 95/17	Magistrates" Court site	Hull	EYR	14-20	ass; pre-pccupation, Friary and urban (see also Hall *et al.* EAU 2000/25)	T	32	22	s	32	3
Carrott *et al.* (EAU 1995/19)	2012	Clifton Moorgate 94 EAU 95/19	Clifton Moorgate	York	CoY	?RO	eval; spread (see also Carrott *et al.* EAU 1994/43)	T	1	0	NS	X	X
Carrott *et al.* (EAU 1995/20)	5109	Monkgate (50-2) (York) 95 EAU 95/20	50-52 Monkgate	York	CoY	RO MD	eval; RO and MD ditches; MD pit	T	4	1	s	4	1
Carrott *et al.* (EAU 1995/21)	5326	Norman Court 95 EAU 95/21	Norman Court, Grape Lane	York	CoY	11-16	eval; urban cuts and surface	T	5	0	s	5	0
Carrott *et al.* (EAU 1995/25)	8522	Winteringham 95 EAU 95/25	Winteringham	N of Scunthorpe	NLN	?BA; RO	eval, no context information	T	5	0	NS	X	X
Carrott *et al.* (EAU 1995/03)	4128	Keldgate 94 EAU 95/03	Keldgate	Beverley	EYR	12-13	eval; floors, pits and others	T	10	8	s	8	1
Carrott *et al.* (EAU 1995/31)	1670	Castle St (Hull) EAU 95/31	Castle Street	Hull	EYR	?early MD	eval; uncertain feature types	T	2	2	NS	X	X
Carrott *et al.* (EAU 1995/32)	1622	Castle Car Park 95 EAU 95/32	Castle Car Park	York	CoY	?RO-Mod	eval; various deposits (see also Carrott *et al.* EAU 1992/6)	T	8	3	s	4	1
Carrott *et al.* (EAU 1995/34)	5560	Old Manor House 95 EAU 95/34	Old Manor House, Baynard Castle	Cottingham, Hull	EYR	12-?14	eval ; pit/hollow and drain fills	T	3	0	s	2	0
Carrott *et al.* (EAU 1995/35)	7658	Tower St (1-2) (York) EAU 95/35	1-2 Tower Street (= Castle Garage)	York	CoY	12-18th	ass; ditch of castle bailey, gully and pit fills	T	14	2	s	14	6
Carrott *et al.* (EAU 1995/37)	7659	Tower St (Hull) 95 EAU 95/37	Tower Street	Hull	EYR	17th	eval; ditch and drain fills, ?flood deposits; occupation layers	T	4	4	s	1	0
Carrott *et al.* (EAU 1995/38)	7496	The Vivars EAU 95/38	The Vivars	Selby	NYR	?MD- PM	eval; silting of putative abbey fishpond	T	4	0	NS	X	X
Carrott *et al.* (EAU 1995/43)	22	A1 Leeming-Dishforth 95 EAU 95/43	A1 improvement	Leeming - Dishforth	NYR	PH	ass; various feature types	T	28	0	NS	X	X
Carrott *et al.* (EAU 1995/44)	7342	Tadcaster Rd (62) 95 EAU 95/44	62 Tadcaster Road	York	CoY	nd	eval; cut fills and ?natural	T	3	1	NS	X	X
Carrott *et al.* (EAU 1995/45)	3663	Healing 95 EAU 95/45	Healing	nr Grimsby	NLN	12-16	eval; pit and ditch fills	T	6	0	NS	X	X

Reference	EAB No.	EAB name	Site	Location	County	Date	Comments	Insects			Parasites		
								m	e	+	m	e	+
Carrott *et al.* (EAU 1995/49)	1389	Burythorpe Quarry 94 EAU 95/49	Burythorpe Quarry	S of Norton	NYR	no dates	eval; pit and ?ditch fills	T	4	0	NS	X	X
Carrott *et al.* (EAU 1995/50)	1388	Burythorpe Church 95 EAU 95/50	Burythorpe Church	S of Norton	NYR	IA; RO	eval; various features	T	5	0	NS	X	X
Carrott *et al.* (EAU 1995/51)	7033	St Saviourgate (9) 95 EAU 95/51	9 St Saviourgate	York	CoY	late MD	eval; pit and hollow fills	T	3	3	s	3	3
Carrott *et al.* (EAU 1995/53)	5787	Piccadilly (22) 87 EAU 95/53	22 Piccadilly (=ABC Cinema)	York	CoY	RO:14/15	ass; waterfront, various deposit types	T	40	30	s	40	18
Carrott *et al.* (EAU 1995/54)	5348	North Bar Within 95 EAU 95/54	37 North Bar Within	Beverley	EYR	B12-16/17	eval; mostly pit fills	T	10	0	NS	X	X
Carrott *et al.* (EAU 1996/01)	4977	Merchant Adventurers Hall EAU 96/01	Merchant Adventurers" Hall	York	CoY	14/15-17	eval; dumps (see also Carrott *et al.* EAU 1996/44)	T	4	0	NS	X	X
Carrott *et al.* (EAU 1996/09)	2169	Coppergate (16-22) EAU 96/09	16-22 Coppergate	York	CoY	PC	ass; post Norman conquest occupation deposits	T	184	182	s	51	32
Carrott *et al.* (EAU 1996/10)	8160	West Beck EAU 96/10	West Beck	Brigham, SE of Great Driffield	EYR	PH	ass; Flandrian	T	10	9	NS	X	X
Carrott *et al.* (EAU 1996/13)	5529	Old Abbey Farm EAU 96/13	Old Abbey Farm	Risley	Ches	MD and later	ass; moated farmhouse (see also Kenward *et al.* EAU 1998/23)	T	5	3	NS	X	X
Carrott *et al.* (EAU 1996/15)	10785	Parliament St (44-5) 94 EAU 96/15	44-5 Parliament Street	York	CoY	MD	research/anal, some notes on fauna (see also EAU 1995/8)	T	51	46	s	40	27
Carrott *et al.* (EAU 1996/17)	8129	Welton Low Rd EAU 96/17	Welton Low Road	Elloughton nr Brough, W of Hull	EYR	RO	eval; ditch fills	T	3	2	NS	X	X
Carrott *et al.* (EAU 1996/18)	6579	Skeldergate (47-51) EAU 96/18	47-51 Skeldergate	York	CoY	?MD	eval; ?pit, gully and boreholes	T	4	0	NS	X	X
Carrott *et al.* (EAU 1996/19)	999	Bootham School EAU 96/16	Bootham School	York	CoY	undated	eval; ?naturally accumulated soil	T	2	0	NS	X	X
Carrott *et al.* (EAU 1996/22)	5554	Old Hall (Hedon) EAU 96/22	Old Hall, Baxtergate	Hedon	EYR	MD, ?PM	eval; cut fills	T	2	1	NS	X	X
Carrott *et al.* (EAU 1996/25)	4326	Landress Ln EAU 96/25	Landress Lane	Beverley	EYR	12-15	eval; mostly pit fills, some occupation layers	T	4	1	NS	X	X
Carrott *et al.* (EAU 1996/27)	7185	Stockton West Moor EAU 96/27	Stockton West Moor and Rawcliffe Moor	York	CoY	no information	miscellaneous deposits	T	2	1	NS	X	X
Carrott *et al.* (EAU 1996/34)	7141	Starting Gate EAU 96/34	Starting Gate, Tadcaster Road	York	CoY	?RO	eval; ?natural	T	2	0	NS	X	X

Reference	EAB No.	EAB name	Site	Location	County	Date	Comments	Insects			Parasites		
								m	e	+	m	e	+
Carrott *et al.* (EAU 1996/36)	1919	Church Moss 95 EAU 96/36	Church Moss	Davenham	CHE	PH	ass; Late Devensian and Early Flandrian mire (see also Hughes *et al.* EAU 1998/26; Hughes *et al.* 2000)	T	32	25	poll	1	0
Carrott *et al.* (EAU 1996/37)	5627	The Outgang 96 EAU 96/37	The Outgang	Driffield	EYR	MD	ass; rural., mostly ditch and gully fills	T	1	1	NS	X	X
Carrott *et al.* (EAU 1996/40)	8079	Waterton EAU 96/40	Waterton	Waterton	NLN	c10-PM	gully, ditches, pit	T	4	1	NS	X	X
Carrott *et al.* (EAU 1996/42)	5356	North Cave EAU 96/42	North Cave	nr Beverley	EYR	IA RO	data archive for 1995 excavations (see also Allison *et al.* AML 105/90; forthcoming)	L	5	3	NS	X	X
Carrott *et al.* (EAU 1996/43)	3856	Holme Church Ln EAU 96/43	Holmechurch Lane	Beverley	EYR	14 18-19	ditches, pits	T	4	1	NS	X	X
Carrott *et al.* (EAU 1996/44)	4978	Merchant Adventurers Hall EAU 96/44	Merchant Adventurers" Hall	York	CoY	11/12-17/18	river/pond silts, build-up/levelling (see also Carrott *et al.* EAU 1996/1)	T	6	5	s	6	4
Carrott *et al.* (EAU 1996/45)	3165	Gadbrook Park EAU 96/45	Gadbrook Park	near Northwich	CHE	? RO	ditch fills	T	2	1	NS	X	X
Carrott *et al.* (EAU 1996/47)	221	All Saints (York) EAU 96/47	All Saints Church	York	CoY	A/S, MD	graves, layers (see also Hall *et al.* EAU 1998/30)	T	6	3	s	4	0
Carrott *et al.* (EAU 1996/50)	6074	Rectory Ln EAU 96/50	Rectory Lane, Beeford	ESE of Great Driffield	EYR	IA	eval; ditch fills	T	2	0	NS	X	X
Carrott *et al.* (EAU 1996/52)	4485	Ling Ln EAU 96/52	Ling Lane, Seamer Carr (= Long Lane)	Seamer nr Scarborough	NYR	MS	ass; natural peats	T	6	3	n/a	X	X
Carrott *et al.* (EAU 1996/55)	4232	Kingswood EAU 96/55	Kingswood	Hull	EYR	RB-16	ditch, ?ground surface, ?alluvium	T	5	0	s	4	0
Carrott *et al.* (EAU 1996/57)	3693	Hengate EAU 96/57	Hengate	Beverely	EYR	13-PM	eval; cut fills and surface deposits, no individual dating	T	5	0	s	2	0
Carrott *et al.* (EAU 1997/01)	2103	Coney St (3-7) EAU 97/01	3-7 Coney Street	York	CoY	nd	eval; surface deposits	T	2	0	NS	X	X
Carrott *et al.* (EAU 1997/11)	5006	Micklegate (61) EAU 97/11	61 Micklegate	York	CoY	RO	eval; no processing	NS	0	0	NS	X	X
Carrott *et al.* (EAU 1997/14)	6620	Smaws Quarry EAU 97/14	Smaws Quarry	near Tadcaster	NYR	nd	eval; ditch fills	T	2	0	NS	X	X
Carrott *et al.* (EAU 1997/16)	5353	North Bridge 93-4 EAU 97/16	North Bridge	Doncaster	SYR	?A/S 12/13-16/17	anal; cut fills and surface deposits	T, L	94	28	s	15	0

Reference	EAB No.	EAB name	Site	Location	County	Date	Comments	Insects			Parasites		
								m	e	+	m	e	+
Carrott *et al.* (EAU 1997/17)	3242	Gibraltar Farm EAU 97/17	Kingswood	Hull	EYR	RB MD	ass; various features	T	6	3	s	6	0
Carrott *et al.* (EAU 1997/18)	936	Blanket Row EAU 97/18	Blanket Row (Shaft 9)	Hull	EYR	PR MD LM PM	see Carrott *et al.* EAU 2001/12; 2001/48 for data	n/a	X	X	n/a	X	X
Carrott *et al.* (EAU 1997/21)	6319	Sammys Point EAU 97/21	Sammy's Point	Hull	EYR	17-?19	eval; surface deposits and earth closet (see also Carrott *et al.* EAU 1998/25)	T, BS	8	1	s	1	1
Carrott *et al.* (EAU 1997/22)	3930	Citadel Moat (South Barracks) EAU 97/22	Citadel Moat	Hull	EYR	PM	eval; moat fills	T	3	2	NS	X	X
Carrott *et al.* (EAU 1997/24)	7355	Tanner Row (47-55) EAU 97/24	47-55 Tanner Row	York	CoY	?9-modern	eval; layers, cut lining, cut fill; dating vague	BS	1	0	s	1	1
Carrott *et al.* (EAU 1997/25)	4379	Layerthorpe Bridge EAU 97/25	Layerthorpe Bridge and Peasholme Green	York	CoY	RO-early mod	ass; river deposits, dumps and associated deposits	T	30	27	NS	X	X
Carrott *et al.* (EAU 1997/31)	5053	Mill House Farm EAU 97/31	Mill House Farm, Kexby	near York	??	nd	ass; no context information	T	3	1	NS	X	X
Carrott *et al.* (EAU 1997/38)	4828	Malmo Rd EAU 97/38	Malmo Road	Hull	EYR	RB MD	eval; ditch fills	T	2	0	NS	X	X
Carrott *et al.* (EAU 1997/41)	7432	The Fox EAU 97/41	The Fox, Tadcaster Road	Dringhouses, York	CoY	RO	eval; ditch fills	T	2	0	NS	X	X
Carrott *et al.* (EAU 1997/45)	2954	Fetter Ln EAU 97/45	19 Fetter Lane	York	CoY	RO nd	eval; ashy deposit and unknown	T	2	0	NS	X	X
Carrott *et al.* (EAU 1997/46)	5215	Naburn Sewage Works EAU 97/46	Naburn Sewage Works	York	CoY	?RO PM	eval; ?RO ditch fill; PM flood deposits	T BS	4	0	NS	X	X
Carrott *et al.* (EAU 1997/48)	4993	Messingham EAU 97/48	Messingham	nr Scunthorpe	NLN	LG	peat	T	2	2	NS	X	X
Carrott *et al.* (EAU 1997/49)	8066	Water Ln EAU 97/49	Water Lane, Clifton	York	CoY	nd	eval; no context information; judged barren visually	NS	X	X	NS	X	X
Carrott *et al.* (EAU 1997/50)	4814	Main St (Spaunton) EAU 97/50	Main Street	Spaunton	N YR	'MD'; 12-14	eval; dump, pit/well fill	T	2	0	NS	X	XX
Carrott *et al.* (EAU 1997/51)	2433	Davygate (British Gas) EAU 97/51	British Gas, Davygate	York	CoY	?RO 11-15	eval; pit fills, dump	T	5	1	s	2	2
Carrott *et al.* (EAU 1997/52)	2224	County House EAU 97/52	County House, Monkgate	York	CoY	RO	eval; dump	T	1	0	NS	X	X
Carrott *et al.* (EAU 1998/02)	604	Barton St EAU 98/02	Barton Street	Barrow upon Humber	NLN	nd	eval; no context information; traces of snails	T	1	0	NS	X	X

Reference	EAB No.	EAB name	Site	Location	County	Date	Comments	Insects			Parasites		
								m	e	+	m	e	+
Carrott *et al.* (EAU 1998/04)	6248	Royal Chase EAU 98/04	Royal Chase, Tadcaster Road. Dringhouses	York	CoY	?RO, PM	eval; RO cut fill judged barren visually PM ?turfline	T	1	0	NS	X	X
Carrott *et al.* (EAU 1998/06)	3243	Gibraltar Farm EAU 98/06	adjacent to Gibraltar Farm, Kingswood	Hull	EYR	RB	ass; channel, gulley and pit fills; riverbank deposits	T	9	3	s	2	0
Carrott *et al.* (EAU 1998/07)	3078	Foredyke EAU 98/07	near junction of Foredyke and River Hull, Kingswood	Hull	EYR	11/13-17	ass; ditch fill, fills of garderobe and its outflow, ash spread	T	6	4	s	2	2
Carrott *et al.* (EAU 1998/08)	6611	Slingsby EAU 98/08	Slingsby, nr. Malton	Slingsby nr. Malton	NYR	13/14	eval; ditch fiill	T, BS	3	0	NS	X	X
Carrott *et al.* (EAU 1998/09)	2435	Davygate Centre EAU 98/09	former Davygate Centre	off Davygate	CoY	11/12-13	eval with insect lists	T, L	6	5	s	3	1
Carrott *et al.* (EAU 1998/10)	4082	Jack Taylor Ln EAU 98/10	Jack Taylor Lane	Beverley	EYR	12/13-16/18	eval; ?natural peat, "deposits", pit fills	T	6	6	s	5	3
Carrott *et al.* (EAU 1998/14)	7034	St Saviourgate (9) 95 EAU 98/14	St Saviourgate	York	CoY	early RO-16	ass; dumps, pit fills, cut fill	T	31	26	s	20	14
Carrott *et al.* (EAU 1998/15)	155	Ailcy Hill EAU 98/15	Ailcy Hill	Ripon	NYR	unclear	eval; cut fill	T	1	0	NS	X	X
Carrott *et al.* (EAU 1998/16)	2915	Feasegate (BHS store) EAU 98/16	BHS Store, Feasgate	York	CoY	11/12-12-13	ass; floor, pit fills, dumps	T	7	7	s	6	0
Carrott *et al.* (EAU 1998/17)	2964	Figham Common EAU 98/17	Figham Common	Beverley	EYR	late 12/ early 13- 13	eval; peat deposit, silt, ditch fills	T	5	2	NS	X	X
Carrott *et al.* (EAU 1998/18)	3664	Healing 98 EAU 98/18	Healing	nr. Grimsby	NLN	11-13	eval; ditch and slot fills; spread	T	4	1	NS	X	X
Carrott *et al.* (EAU 1998/20)	5620	Osgodby Ln EAU 98/20	Osgodby Lane	Scarborough	NYR	nd	eval; ridge and furrow feature; rejected on visual inspection	NS	0	0	NS	X	X
Carrott *et al.* (EAU 1998/21)	3086	Former Female Prison EAU 98/21	Former Female Prison	York	CoY	19	eval; "deposit"	T	1	0	s	4	0
Carrott *et al.* (EAU 1998/25)	6320	Sammys Point EAU 98/25	Sammy"s Point	Hull	EYR	17	ass; deposits pre-dating and associated. with construction of citadel (see also Carrott *et al.* EAU 1997/21)	T	6	5	NS	X	X
Carrott *et al.* (EAU 1998/27)	4539	Little Stonegate (9) EAU 98/27	9 Little Stonegate	York	CoY	13-17th and nd	ass; various deposits	T	5	0	s	1	1
Carrott *et al.* (EAU 1998/28)	864	Bishopthorpe Rd (292) EAU 98/28	292 Bishopthorpe Road	York	CoY	?RO-?PM	eval; various deposits	T	4	0	NS	X	X

Reference	EAB No.	EAB name	Site	Location	County	Date	Comments	Insects			Parasites		
								m	e	+	m	e	+
Carrott *et al.* (EAU 1998/29)	6417	Market Pl (Selby) EAU 98/29	"tree pits"	Selby	NYR	12-17th	ass with insect lists; occupation deposits	L	6	6	NS	X	X
Carrott *et al.* (EAU 1998/33)	3849	Holgate Rd (39) EAU 98/33	39 Holgate Road	York	CoY	?early PM	eval; ?dump, deposit	T	2	0	NS	X	X
Carrott *et al.* (EAU 1999/04)	8115	Well Ln (9-17) 98 EAU 99/04	9-17 Well Lane	Beverley	EYR	11-13	eval; 'peats'	T	6	6	NS	X	X
Carrott *et al.* (EAU 1999/07)	4657	Lord Roberts Rd EAU 99/07	Lord Robert's Road	Beverley	EYR	11/12-13/14	eval; 'loams', pit and ditch fills	T	5	5	NS	X	X
Carrott *et al.* (EAU 1999/12)	1655	Castle St (Blanket Row) EAU 99/12	Blanket Row (Stakis Casino)	Hull	EYR	PR MD PM MO	see Carrott *et al.* EAU 2001/12; 2001/48 for data	n/a	X	X	n/a	X	X
Carrott *et al.* (EAU 1999/16)	1910	Church Farm (Flamborough) EAU 99/16	Church Farm, Lily Lane	Flamborough	EYR	PH, 'MD'	eval; PH ditch fill, MD floor, ashy fill	T	3	0	NS	X	X
Carrott *et al.* (EAU 1999/29)	6024	Railway Station (York) EAU 99/29	York Railway Station	York	CoY	RO	eval; layers	T	2	0	NS	X	X
Carrott *et al.* (EAU 1999/56)	8413	Wigginton Rd EAU 99/56	A1237/B1363 junction, Wigginton Road, Clifton Moor	York	CoY	?RO	eval; cut fills	T	2	0	NS	X	X
Carrott *et al.* (EAU 2000/02)	6846	St Augustines Gate (9-11, rear) 99 EAU 2000/02	West side of St Augustine's Gate	Hedon	EYR	12-13	eval; pit, ground-raising	T	4	0	NS	X	X
Carrott *et al.* (EAU 2000/03)	580	Barrow Rd 99 EAU 2000/03	Barrow Road	Barton-upon-Humber	NLN	post-1066	ass; pits, ditches, cut	T	6	0	NS	X	X
Carrott *et al.* (EAU 2000/23)	5792	Piccadilly (58-60) EAU 2000/23	Ryedale Building, 58-60 Piccadilly	York	CoY	nd	eval; levelling deposits	T	3	3	NS	X	X
Carrott *et al.* (EAU 2000/45)	998	Bootham Engineering Works EAU 2000/45	Bootham Engineering Works, Lawrence Street	York	CoY	?late 15; nd	eval; ?kiln or oven fill; ditch fill	T	2	1	NS	X	X
Carrott *et al.* (EAU 2000/47)	7145	Station Rise EAU 2000/47	Railway HQ, Station Rise	York	CoY	MD	eval; cut fill, dump or dark earth	T	2	0	NS	X	X
Carrott *et al.* (EAU 2000/50)	953	Blossom St (28-40) 2000 EAU 2000/50	28-40 Blossom Street	York	CoY	RO, MD	eval; various deposits	T	7	0	NS	X	X
Carrott *et al.* (EAU 2001/01)	1299	Browns Yd EAU 2001/01	Brown's Yard (NGR: TA 0360 3770)	Beverley	EYR	nd	eval; ditch and feature fills	T	3	0	NS	X	X

Reference	EAB No.	EAB name	Site	Location	County	Date	Comments	Insects			Parasites		
								m	e	+	m	e	+
Carrott *et al.* (EAU 2001/12)	935	Blanket Row EAU 2001/12	Blanket Row	Hull	EYR	14-17	anal; various urban deposits (see also Carrott *et al.* EAU 1997/18; 1999/12; 2001/48; Johnstone *et al.* EAU 1999/01)	T	22	8	NS	X	X
Carrott *et al.* (EAU 2001/48)	10786	Blanket Row EAU 2001/48	Blanket Row	Hull	EYR	14-17	Publication draft (see also Carrott *et al.* EAU 1997/18; 1999/12; 2001/12; Johnstone *et al.* EAU 1999/01 for data)	n/a	X	X	n/a	X	X
Carrott *et al.* (EAU 95/04)	7451	The Lanes 79-82 EAU 95/04	Carlisle	Carlisle	CUM	RO; MD	assessment; superceded by Kenward *et al.* (EAU 1998/32)	n/a	X	X	n/a	X	X
Carrott *et al.* (PRS 2001/02)	537	Barmby-on-the-Marsh PRS 2001/02	Barmby-on-the-Marsh	SE of Selby	EYR	14-19	eval; silt, channel fill, floor	BS, T	3	1	NS	X	X
Carrott *et al.* (PRS 2001/04)	4915	Masonic Ln (off) PRS 2001/04	land off Masonic Lane	Thirsk	NYR	12	eval; ditch fills	T	2	0	NS	X	X
Carrott *et al.* (PRS 2001/06)	1492	Canalside/Witter Pl PRS 2001/06	Canalside/Witter Place	Chester	CHE	18	eval; ?canal upcast, ?tanning pit fills	T	3	1	s	3	1
Carrott *et al.* (PRS 2002/18)	4994	Metcalfe Ln PRS 2002/18	Metcalfe Lane, Osbaldwick	York	CoY	HO ?RO ?10-11	eval; ditch fills, ?tree hollow	T	4	0	NS	X	X
Carrott *et al.* (PRS 2002/24)	3790	High St/Long St (Rudston) PRS 2002/24	land at the junction of High Street and Long Street	Rudston	EYR	PH	Ass; ditch fill	T	1	0	NS	X	X
Carrott *et al.* (PRS 2002/46)	9640	OSA02EX02 (Transco Pipeline) PRS 2002/46	site OAS02EX02, Transco pipeline	nr Wawne, N of Hull	EYR	MD-PM	eval; fill, layers	T, BS	4	0	NS	X	X
Carrott *et al.* (PRS 2002/47)	9641	OSA02EX08 (Transco Pipeline) PRS 2002/47	site OAS02EX08, Transco pipeline	nr Elloughton, W of Hull	EYR	LIA/RB	eval; various deposits	T, BS	10	0	NS	X	X
Carrott *et al.* (PRS 2003/11)	9654	Homelands Farm PRS 2003/11	near Homelands Farm, Selby Road	Holme-on-Sapiding-Moor,	EYR	15-17 19	eval: ditch fills	T	3	0	NS	X	X
Carrott *et al.* (PRS 2003/12)	9655	East Ln PRS 2003/12	East Lane,	Sigglesthorne	EYR	IA MD	eval; ditch and slot fills	T	5	0	NS	X	X
Carrott *et al.* (PRS 2003/14)	9682	General Freight (off Ousegate) PRS 2003/41	General Freight, south of Ousegate	Selby	NYR	nd	eval; various deposits	T	6	0	NS	X	X
Carrott *et al.* (PRS 2003/83)	9721	Melton PRS 2003/83	pipeline, Melton Waste Water Treatment Works	Melton	EYR	Pre-RO, RO, modern	eval; cut fills, layer	T	7	0	NS	X	X
Carrott *et al.* (PRS 2004/11)	10358	Market Pl (Bedale) PRS 2004/11	the rear of 26 Market Place	Bedale	NYR	MS, MD	ass; detritus peats/silts and ditch fills	T	13	11	NS	X	X

Reference	EAB No.	EAB name	Site	Location	County	Date	Comments	Insects			Parasites		
								m	e	+	m	e	+
Carrott *et al.* (PRS 2004/35)	10387	Pentecostal Church PRS 2004/35	former Pentecostal Church, St Sepulchre Street	Scarborough	NYR	MD	eval; pit fills	T	2	2	NS	X	X
Carrott *et al.* (PRS 2004/41)	10391	Bradley St PRS 2004/41	Bradley Street	Castleford	WYR	RB	eval; ditch, gully and feature fills	T	4	0	NS	X	X
Carrott *et al.* (PRS 2004/42)	10392	Beetham Hilton Hotel PRS 2004/42	Beetham Hilton Hotel, Deansgate	Manchester	RO PR	RO	ass; various cut fills and layers	T	31	0	NS	X	X
Carrott *et al.* (PRS 2004/43)	10393	Skeldergate (64-74) PRS 2004/43	NCP car park, Skeldergate	York	CoY	12/13, 15/16	ass; feature types not evident from report	T	24	8	s	7	4
Carrott *et al.* (PRS 2004/53)	10400	Aldbrough PRS 2004/53	Aldbrough Gas Storage Project	Aldbrough	EYR	IA/RB	eval; pit and ditch fills	T	23	2	s	4	9
Carrott *et al.* (PRS 2004/67)	10413	Snuff Mill Ln/Priory Rd PRS 2004/67	Snuff Mill Lane	Cottingham	EYR	RB, ?RB	eval; ditch fills	T	4	0	NS	X	X
Carrott *et al.* (PRS 2005/13)	10454	Trinity Ln (20-4) PRS 2005/13	20-24 Trinity Lane	York	CoY	14-16	eval; depression fill	T	1	0	NS	X	X
Carrott *et al.* (PRS 2005/53)	10491	Driffield Terr (3) PRS 2005/53	3 Driffield Terrace	York	CoY	RO	eval; cremation, ditch and pit fills, inhumations	T	6	0	s	5	0
Carrott *et al.* (PRS 2005/59)	10495	St Helens Church (Skipwith) PRS 2005/59	St Helen's Church	Skipwith	NyR	8/10-?16	eval; various deposits	T	7	0	NS	X	X
Carrott *et al.* (PRS 2005/60)	10496	Terrys PRS 2005/60	Terry's chocolate factory	York	CoY	RO, ?MD	eval; ditch and cut fills	T	5	0	NS	X	X
Carrott *et al.* (PRS 2005/88)	10521	Chalmers Orchard PRS 2005/88	Chalmers Orchard, Newcastle Road	Chester-le-Street	DHM	?RO	eval; ditch fills	T	2	0	NS	X	X
Carruthers (AML 11/93)	257	Ambleside AML 11/93	Ambleside	Ambleside	CUM	RO	charred grain	n/a	X	X	n/a	X	X
Colledge (1981 AML 3347)	2338	Crown Car Park AML 3347	Crown Car Park	Nantwich	CHE	12 or later	qualitative beetle list; fill of ?castle ditch	X	X	X	X	X	X
Coope (1977)	10787	Low Wray Bay (insects)	Low Wray Bay	Windermere	CUM	LG	anal; natural deposits	L	20	17	n/a	X	X
Coope (1959)	9260	Farm Wood Quarry (insects)	Chelford	nr Alderley Edge	CHE	PH	natural Chelford Interstadial deposits (remains from various layers amalgamated)	L	1	1	n/a	X	X
Coope 1978	10789	St Bees (insects 2)	St Bees	Solway Firth	CUM	LG	preliminary; see Coope and Joachim (1980).	n/a	X	X	n/a	X	X

Reference	EAB No.	EAB name	Site	Location	County	Date	Comments	Insects			Parasites		
								m	e	+	m	e	+
Coope and Joachim (1980)	10788	St Bees (insects 3)	St Bees	Solway Firth	CUM	LG	anal; natural deposits	L	34	33	n/a	X	X
Cotton (2000 ASUD 709)	1944	Church St (Whitby) ASUD 709	Church Street	Whitby	NYR	MD-18	ass (plant macrofossils); incidental mention of insect remains	M	40	11	NS	X	X
Cowell *et al.* (1993)	3084	Formby Point Beach	Formby Point Beach	Formby	MER	NEO or EBA	preliminary; insects 'present'	O	X	X	n/a	X	X
Dainton *et al.* (EAU 1992/14)	6985	St Maurices Rd (2) 92 EAU 92/14	2 St Maurice's Road	York	CoY	RO	archive eval; ditch fills; coprolite	T	2	0	s	1	0
Dainton *et al.* (EAU 1992/15)	3266	Glebe Farm 92 EAU 92/15	Glebe Farm	Barton-upon-Humber	NLN	RO	archive eval; RB ditch, pit and other cut fills	T	11	2	NS	X	X
Dainton *et al.* (EAU 1992/16)	6057	Rawcliffe Manor 92 EAU 92/16	Rawcliffe Manor, Manor Lane	Rawcliffe, York	CoY	MD and undated	archive eval; pit and ditch fills (see also Carrott *et al.* 92/11, Dobney *et al.* EAU 1994/8)	T	13	1	NS	X	X
Dainton *et al.* (EAU 1992/17)	5407	North St (York) (b/holes) EAU 92/17	North Street	York	CoY	11-13	archive eval; boreholes (see also Carrott *et al.* 93/14)	T	7	6	NS	X	X
Davis (1961)	2434	Davygate 55-8	55-58 Davygate	York	CoY	RO	casual records	O	X	X	n/a	0	0
Dayton (1986)	4477	Lindow Moss	Lindow Moss	Wilmslow	CHE	IA	natural deposits; Chironomidae	O	X	X	n/a	X	X
de Rouffignac (1992)	3079	Foregate St (5-7) (Chester) (parasites)	5-7 Foregate Street	Chester	CHE	?	occupation deposits	n/a	X	X	+	+	+
Dinnin and Skidmore (1995)	10790	Lindow III (insects)	Lindow III	Wilmslow	CHE	IA	anal; natural peat around human corpse	L	9	9	n/a	X	X
Dinnin and Welsh (2001)	10791	Star Carr (Haxey)	Star Carr Farm	S of Seamer	NYR	LG	preliminary anal; peat	U	1	1	n/a	X	X
Dobney and Hall (EAU 1992/20)	5789	Piccadilly (41) EAU 92/20	41 Piccadilly	York	CoY	Ro, MD	archive eval; various features	T	4	0	s	1	0
Dobney *et al.* (EAU 1992/21)	4287	Knights Hospitallers EAU 92/21	Knights Hospitallers	Beverley	EYR	MD	anal; mid 13 floor	T	1	0	NS	X	X
Dobney *et al.* (EAU 1992/22)	3248	Gillygate (45-57) 92 EAU 92/22	Ankers Garage, 45-57 Gillygate	York	CoY	RO, MD	archive eval; RO ditchfills, MD buildup and backfills	T	8	0	NS	X	X
Dobney *et al.* (EAU 1993/19)	5588	Orchard Fields 92 EAU 93/19	Orchard Fields	Malton	NYR	RO	archive eval; various layers and cut fills	T	18	0	NS	X	X
Dobney *et al.* (EAU 1993/20)	4411	Leven-Brandesburton EAU 93/20	Leven-Brandesburton by-pass	Leven - Brandesburton	EYR	PH-RO	archive ass; ?Neolithic, BA pits; IA post hole, RO pit and ditch (see also Carrott *et al.* EAU 1995/6; Hall *et al.* EAU 1994/15)	T	8	2	NS	X	X

Reference	EAB No.	EAB name	Site	Location	County	Date	Comments	Insects			Parasites		
								m	e	+	m	e	+
Dobney *et al.* (EAU 1993/21)	3050	Flixborough 89 EAU 93/21	Flixborough	Flixborough	NLN	?RO-MD	archive ass; wide range of context types, principally Anglo-Saxon	T	59	0	NS	X	X
Dobney *et al.* (EAU 1993/22)	6000	Micklegate (1-9) 88-9 EAU 93/22	Queen's Hotel	York	CoY	RO-PM	archive ass; many feature types; surface and cut (mostly pit) deposits	T	25	15	NS	X	X
Dobney *et al.* (EAU 1994/08)	6058	Rawcliffe Manor EAU 94/08	Rawcliffe Manor, Manor Lane	nr York	CoY	14-15	ass; dumps and floors associated with buildings (see also Carrott *et al.* 92/11; Dainton *et al.* 92/16)	T	9	0	NS	X	X
Dobney *et al.* (EAU 1994/09)	3053	Flixborough 89 EAU 94/09	Flixborough	Flixborough	EYR	A/S, MD	integrated ass; see Dobney *et al.* 1993c)	X	X	X	X	X	X
Dobney *et al.* (EAU 1994/18)	3516	Hall Garth 80 EAU 94/18	Hall Garth	Beverley	EYR	MD to mod	tech; MD moat; see also Dobney *et al.* (EAU 1994/60)	BS	?	?	NS	X	X
Dobney *et al.* (EAU 1994/20)	7671	Town St 94 EAU 94/20	Town Street	Malton	NYR	nd	eval; vaguely identified deposits	T	5	0	NS	X	X
Dobney *et al.* (EAU 1995/22)	3802	Higher Ln (Fazakerley) 94 EAU 95/22	Higher Lane Fazakerley	Liverpool	MER	MD-PM	ass; ?pond fill; pits; ?byre floor (see also Hall *et al.* 1996)	T	6	1	NS	X	X
Dobney *et al.* (EAU 1995/48)	3041	Flemingate 95 EAU 95/48	95 Flemingate	Beverley	EYR	11-12	eval; pit fills	T	1	1	NS	X	X
Dobney *et al.* (EAU 1996/26)	1583	Carr Naze 93-4 EAU 96/26	Carr Naze	Filey	NYR	RO, PR	tech: various deposits associated with signal station (see also Carrott *et al.* EAU 1994/07; 1995/15)	BS	40	0	NS	X	X
Donaldson (1982)	2561	Doubstead 80	Doubstead	Scremerston, nr Berwick-upon-Tweed	NHU	RB	enclosure; passing mention of 'insects, mites, dung beetles and water fleas'	O	X	X	NS	X	X
Donaldson and Rackham (AML 2931)	5447	Norton Mill AML 2931	Norton Mill	Middlesbrough	CLV	modern	culvert and mill pond sediments	T	4	3	NS	X	X
Engleman and Robertson (EAU 1986/05)	2992	Fishergate (46-54) EAU 86/05	Fishergate	York	CoY	AS, MD	archive tech (see Allison *et al.* EAU 1989/01-02; 1996a; b for data)	n/a	X	X	n/a	X	X
Engleman *et al.* (EAU 1986/01)	3222	Tanner Row (24-30) EAU 86/01	Tanner Row	York	CoY	RO: MD	archive tech; see Hall and Kenward (1990) for data	n/a	X	X	n/a	X	X
Engleman *et al.* (EAU 1986/02)	3223	Tanner Row (24-30) EAU 86/02	Tanner Row	York	CoY	RO: MD	archive tech; see Hall and Kenward (1990) for data	n/a	X	X	n/a	X	X
Engleman *et al.* (EAU 1986/03)	3224	Tanner Row (24-30) EAU 86/03	Tanner Row	York	CoY	RO: MD	archive tech; see Hall and Kenward (1990) for data	n/a	X	X	n/a	X	X

Reference	EAB No.	EAB name	Site	Location	County	Date	Comments	Insects			Parasites		
								m	e	+	m	e	+
Engleman *et al.* (EAU 1986/04)	3225	Tanner Row (24-30) EAU 86/04	Tanner Row	York	CoY	RO: MD	archive tech; see Hall and Kenward (1990) for data	n/a	X	X	n/a	X	X
Engleman *et al.* (EAU 1987/03)	3227	Tanner Row (24-30) EAU 87/03	Tanner Row	York	CoY	RO: MD	archive tech; see Hall and Kenward (1990) for data	n/a	X	X	n/a	X	X
Engleman *et al.* (EAU 1987/04)	3228	Tanner Row (24-30) EAU 87/04	Tanner Row	York	CoY	RO: MD	archive tech; see Hall and Kenward (1990) for data	n/a	X	X	n/a	X	X
Fell (AML 87/91)	6112	Ribchester 80-90 AML 87/91	Ribchester	nr Preston	LAN	RO	lice from combs (see Fell 2000)	O	X	X	n/a	X	X
Fell (2000)	6111	Ribchester 80, 89-90	Ribchester	nr Preston	LAN	RO	lice from combs	O	X	X	n/a	X	X
Gaunt *et al.* (1970)	5647	Oxbow	Oxbow opencast quarry	Aire Valley	?WYR	PH (Upton Warren)	anal: natural silt	L (nq)	1	1	n/a	X	X
Gaunt *et al.* (1972)	10792	Austerfield	near Austerfield	S of Doncaster	SYR	PH (Ipswichian)	anal: natural silt	L	3	3	n/a	X	X
Geary *et al.* (PRS 2003/04)	9647	Mersey Crossing PRS 2003/04	Halton	nr Widnes	HAL	HO	ass; core samples	T	2	0	NS	X	X
Girling (1985)	6430	Sewerby 59	Sewerby		EYR	Anglo-Saxon	anal; puparia from brooch in burial	O	X	X	n/a	X	X
Girling (AML 3084)	1545	Carlisle AML 3084	(no site name)	Carlisle	CUM	RO	basket fill	T	1	1	X	X	X
Girling (AML 3669)	1190	Brigg Raft AML 3669	Brigg raft	Brigg	NLN	LBA	tech; 'raft' - insect-infested timber (see also Buckland 1981; Perry 1981)	O	X	X	n/a	X	X
Girling (AML 3929)	8536	Winterton AML 3929	Winterton	nr Scunthorpe	NLN	RO	tech; waterhole or well (relationship of this to material described by Robsinson nd is not clear)	L	2	2	NS	X	X
Girling (AML 4585)	727	Beeston Castle AML 4585	Beeston Castle	Chester/ Nantwich	CHE	nd	Charcoal with insect attack (see also Girling 1993)	O	X	X	n/a	X	X
Girling (AML 4725)	4476	Lindow Man AML 4725	Lindow Man	Wilmslow	CHE	PH:IA	anal; natural peat around human corpse (see also Dayton 1986; 1986 b; Jones 1986; Skidmore 1986)	L	10	8	n/a	X	X
Girling (1993)	712	Beeston Castle 68-85	Beeston Castle	Chester/ Nantwich	CHE	nd	Charcoal with insect attack (see also Girling 1985)	O	X	X	n/a	X	X
Girling and Robinson (AML 36/88)	8339	Wharram Percy AML 36/88	Wharram Percy	Wharram Percy	NYR	SX or MD	anal; putative mill pond	L	11	9	n/a	X	X

Reference	EAB No.	EAB name	Site	Location	County	Date	Comments	Insects			Parasites		
								m	e	+	m	e	+
Girling and Robinson (1989)	2245	Cowick 76	Cowick	nr Snaith	EYR	PR:MD	14 and later moat	T	6	6	NS	X	X
Hall (EAU 2000/46)	320	Appletree EAU 2000/46	Appletree	nr Birdoswald	CUM	RO	ass (botanical); turf wall, associated ditch	M	3	2	n/a	X	X
Hall (EAU 2000/56)	3049	Flixborough 89 EAU 2000/56	Flixborough	Flixborough	NLN	SX	plant report: numerous samples, no invertebrates	T, BS	many	0	n/a	X	X
Hall (EAU 2000/78)	1846	Cheviot Quarry EAU 2000/78	Cheviot Quarry, Milfield	Wooler	NHM	NE, BA	ass (botanical); various fills	M	35	0	NS	X	X
Hall (EAU 2001/17)	1740	Cawthorn Camps 2000 EAU 2001/17	Cawthorn Camps	nr Pickering	NYR	RO PRO	ass (botanical); various features	M	62	0	NS	X	X
Hall (EAU 2001/19)	8209	West Hull (Transco) pipeline EAU 2001/19	Transco W. Hull Gas Pipeline	nr Pickering	EYR	BA	anal (botanical); sediment from sockets of bronze axes	M	5	0	NS	X	X
Hall (PRS 2003/29)	9697	Wakemans House PRS 2003/29	rear of Wakeman's House, High Skellgate	Ripon	NYR	12/13	tech: pit fill	T	1	0	NS	X	X
Hall and Carrott (EAU 2001/36)	2755	Eastgate South (Driffield) EAU 2001/36	Eastgate South	Driffield	EYR	RB	eval; pit fills	T	2	0	NS	X	X
Hall and Carrott (PRS 2002/28)	10385	Heighington Ln West PRS 2002/28	site of the proposed Heighington Lane West Industrial Area	Newton Aycliffe	DRM	later IA	eval; ditch and pit fills	T	6	0	NS	X	X
Hall and Carrott (PRS 2002/45)	9639	OSA02EX05 (Transco Pipeline) PRS 2002/45	site OAS02EX05, Transco pipeline nr Little Weighton	W of Hull	EYR	LPH	eval; gully and pit fill	T	2	0	NS	X	X
Hall and Carrott (PRS 2003/02)	9646	Conistone PRS 2003/02	Conistone	nr Grassington	NYR	?MD	eval; below plough soil	T	1	0	NS	X	X
Hall and Carrott (PRS 2003/18)	9661	Green Acre Caravan Park PRS 2003/18	Green Acre caravan park, Lighthouse Road	Flamborough	EYR	IA and nd	eval; fills	T	4	0	NS	X	X
Hall and Carrott (PRS 2003/59)	9696	Hedon Cemetery (N of) PRS 2003/59	land north of Hedon cemetery	Hedon	EYR	13	eval; gully fill	T	1	0	NS	X	X
Hall and Dobney (EAU 1991/25)	8131	Welton Rd (rear 40-52) 91 EAU 91/25	Welton Road	Brough	EYR	?	report not found	-	?	?	n/a	X	X
Hall and Jaques (EAU 2001/22)	7435	The Gardens EAU 2001/22	The Gardens	Sprotborough	SYR	nd	eval; no information	T	1	0	NS	X	X
Hall and Kenward (1980)	3806	Highgate 77	Highgate	Beverley	EYR	11	anal; surface accumulation	L	17	8	NS	X	X

Reference	EAB No.	EAB name	Site	Location	County	Date	Comments	Insects			Parasites		
								m	e	+	m	e	+
Hall and Kenward (1983) in Richards (1993)	681	Bedern 73-6 (Foundry)	The Bedern	York	CoY	RO; PR; MD; PM; MO	anal; almost no information about invertebrates (there is no archive report for this material)	?	X	X	?	X	X
Hall and Kenward (1990)	3215	Tanner Row (24-30)	Tanner Row and Rougier Street	York	CoY	RO:PR:ME: MD	anal; various features See technical reports for assemblage details; Kenward and Allison AML 233/87; McKenna *et al.* AML 227/87)	L	294	217	P	293	130
Hall and Kenward (1992)	2175	Coppergate Helmet	Coppergate Development	York	CoY	PR:SE	anal; helmet pit (see also Hall *et al.* 1992)	T	2	0	NS	X	X
Hall and Kenward (2002)	10381	Coppergate (16-22) (Anglo-Scand) (data archive)	16-22 Coppergate	York	CoY	A/S	web data archive for all A/S analyses (see Kenward and Hall 1995 for breakdown)	n/a	X	X	n/a	X	X
Hall and Kenward (2003b)	9750	Coppergate (16-22) (leather-working)	16-22 Coppergate	York	CoY	A/S	publication (evaluation of evidence for tanning at Coppergate)	O	X	X	n/a	X	X
Hall and Kenward (CHP 2003/02)	9735	Roman Rd (Adel) CHP 2003/02	Adel	nr. Leeds	WYR	RO	ass: various deposits	T	5	5	NS	X	X
Hall and Kenward (CHP 2005/10)	10812	Sutton Common CHP 2005/10	Sutton Common	nr Askern	SYR	IA	anal; postholes, ditch and cut fills	T	96	4	NS	X	X
Hall and Kenward (CHP 2005/11)	10813	Sutton Common CHP 2005/11	Sutton Common	nr Askern	SYR	IA	anal; postholes, ditch and cut fills (see Hall and Kenward CHP 2005/10 for breakdown)	n/a	X	X	n/a	X	X
Hall and Kenward (EAU 1990/11)	7416	The Bolts (24-6) EAU 90/11	24-6 The Bolts	Scarborough	NYR	MD	archive tech; occupation deposit	T	1	1	s	1	0
Hall and Kenward (EAU 1991/26)	6316	Saltshouse Rd 91 EAU 91/26	Saltshouse Road	Hull	EYR	nd	archive eval; natural peat	T	1	1	NS	X	X
Hall and Kenward (EAU 1992/25)	6317	Saltwick EAU 92/25	Saltwick	nr Whitby	NYR	nd	archive ass; fill of stone-lined cistern	T	1	1	NS	X	X
Hall and Kenward (1994)	0	Saltwick	Saltwick	nr Whitby	NYR	nd	publication report (see Hall and Kenward EAU 1992/25 for breakdown)	n/a	X	X	n/a	X	X
Hall and Kenward (EAU 1997/33)	2170	Coppergate (16-22) EAU 97/33	16-22 Coppergate	York	CoY	A/S	data archive (see Kenward and Hall 1995 for breakdown)	n/a	X	X	n/a	X	X
Hall and Kenward (EAU 1999/27)	8666	Coppergate (16-22) (leather-working) EAU 99/27	16-22 Coppergate	York	CoY	late 14	anal; pit fills (see also Kenward and Hall 1995)	T	3	3	s	1	1

Reference	EAB No.	EAB name	Site	Location	County	Date	Comments	Insects			Parasites		
								m	e	+	m	e	+
Hall and Kenward (EAU 1999/30)	2127	Coppergate (16-22) (Period 3) EAU 99/30	16-22 Coppergate	York	CoY	A/S	anal; tech rep (not data) period 3, AD mid 9th-late 9th/early 10th (See Kenward and Hall 1995 for breakdown)	n/a	X	X	n/a	X	X
Hall and Kenward (EAU 1999/38)	2128	Coppergate (16-22) (Period 4A/B) EAU 99/38	16-22 Coppergate	York	CoY	A/S	anal; tech rep (not data) periods 4A and 4B, c. AD 930-975 (see Kenward and Hall 1995 for breakdown)	n/a	X	X	n/a	X	X
Hall and Kenward (EAU 1999/47)	2129	Coppergate (16-22) (Period 5A) EAU 99/47	16-22 Coppergate	York	CoY	A/S	anal; tech rep (not data) period 5A, AD 975 (see Kenward and Hall 1995 for breakdown)	n/a	X	X	n/a	X	X
Hall and Kenward (EAU 1999/49)	2130	Coppergate (16-22) (Period 5B) EAU 99/49	16-22 Coppergate	York	CoY	A/S	anal; tech rep (not data) period 5B, AD c. 975-early/mid 11th (see Kenward and Hall 1995 for breakdown)	n/a	X	X	n/a	X	X
Hall and Kenward (EAU 1999/54)	10386	St Pauls Green EAU 99/54	St Paul's Green	York	CoY	BA	ass; peat	T	1	1	n/a	X	X
Hall and Kenward (EAU 1999/63)	2131	Coppergate (16-22) (Period 5C) EAU 99/63	16-22 Coppergate	York	CoY	A/S	anal; tech rep (not data) period 5C, AD mid-later 11th (see Kenward and Hall 1995 for breakdown	n/a	X	X	n/a	X	X
Hall and Kenward (EAU 2000/09)	1741	Cawthorn Camps 99 EAU 2000/09	Cawthorn Camps	nr Pickering	NYR	RO	ass; various deposits, many 'turves'	T	2	0	NS	X	X
Hall and Kenward (EAU 2000/17)	2010	Clifford St (2) EAU 2000/17	2 Clifford Street	York	CoY	A/S (later 9th-mid 10th)	anal; surface dumps and layers	L	5	4	s	1	1
Hall and Kenward (EAU 2000/22)	5701	Parliament St (4-7) EAU 2000/22	4-7 Parliament Street (Littlewoods Store)	York	CoY	A/S	anal; layers/dumps, cut fill	L	4	4	s	4	4
Hall and Kenward (EAU 2001/07)	2100	Conesby Quarry Sidings EAU 2001/07	Conesby Quarry Sidings	nr Scunthorpe	NLN	nd	eval; borehole samples	O	5	2	s	4	0
Hall and Kenward (NAA 04/83)	4283	Wykeham NAA 04/83	Wykham	ENE of Seamer	NYR	LG, HO	ass; peats and silts	T	10	7	n/a	X	X
Hall and Large (EAU 1996/46)	5758	Penrith EAU 96/46	a site near Penrith	Penrith	CUM	early MD	cut fills	T	2	0	NS	X	X
Hall and Nicholson (EAU 1991/27)	4273	Kirmington Runway 91 EAU 91/27	Kirmington Runway	E of Grimsby	NLN	late BA /early IA	archive; pit fills	BS	8	0	NS	X	X

Reference	EAB No.	EAB name	Site	Location	County	Date	Comments	Insects			Parasites		
								m	e	+	m	e	+
Hall and Nicholson (EAU 1991/28)	6121	Riby 91 EAU 91/28	Riby	nr Grimsby	NLN	mid-late SX	archive eval; pit, posthole and ditch fills	BS	7	0	NS	X	X
Hall *et al.* (EAU 1996/29)	4435	Lime Tree Ln 93 EAU 96/29	Lime Tree Lane	Bilton, Hull	EYR	?MD	eval; date uncertain; ditch and pit fills	T	2	0	NS	X	X
Hall *et al.* (EAU 1997/26)	7037	St Sepulchre St EAU 97/26	St Sepulchre Street	Scarborough	NYR	'MD'	eval; watercourse fills (includes list of taxa)	T	2	2	NS	X	X
Hall *et al.* (PRS 2002/08)	5257	New Crane St PRS 2002/08	New Crane Street car park	Chester	CHE	PM	eval; sondage sample (?reclamation dumps)	T	1	1	NS	X	X
Hall *et al.* (1980)	6587	Skeldergate (58-9) 73-5 (buried soil)	58-59 Skeldergate	York	CoY	RO	Anal; buried soil (see also Kenward EAU 2000/41)	L	10	10	NS	X	X
Hall *et al.* (1980)	6588	Skeldergate (58-9) 73-5 (well fills)	58-59 Skeldergate	York	CoY	RO	Anal; well (see also Kenward EAU 2000/41)	L	13	13	NS	X	X
Hall *et al.* (1983)	2132	Coppergate (16-22) (bran)	16-22 Coppergate	York	CoY	A/S	research paper (see also Kenward and Hall 1995)	n/a	X	X	n/a	X	X
Hall *et al.* (1983)	2171	Coppergate (5-7) 74	5-7 Coppergate (= Hardings, Habitat, York Coffee House)	York	CoY	PR:SE	anal; ?yards	L	18	18	NS	X	X
Hall *et al.* (1983)	5715	Pavement (6-8) 72	6-8 Pavement (= Lloyds Bank)	York	CoY	PR:SE	anal; floors (see also Kenward EAU 2000/39))	L	53	53	NS	X	X
Hall *et al.* (1986 AML 4889)	698	Bedern/Aldwark AML 4889	The Bedern	York	CoY	Ro	anal; well	L	6	6	NS	X	X
Hall *et al.* (1986 AML 4889)	698	Bedern/Aldwark AML 4889	The Bedern	York	CoY	Ang	anal; pits	T	13	4	NS	X	X
Hall *et al.* (1986 AML 4889)	698	Bedern/Aldwark AML 4889	The Bedern	York	CoY	Ro	anal; surfaces	T	22	0	NS	X	X
Hall *et al.* (1992)	2175	Coppergate Helmet	Coppergate Development	York	CoY	PR:SE	anal; helmet pit (see also Hall and Kenward 1992)	T	2	2	s	1	0
Hall *et al.* (AML 56/93)	692	Bedern AML 56/93	The Bedern	York	CoY	13-17t/later	anal; mostly pits (see also Kenward and Robertson EAU 1988/20-22) Stoll = no of samples; many were replicated (numbers are for all reports)	L	147	95	stoll	147	many
Hall *et al.* (AML 57/93)	693	Bedern AML 57/93	The Bedern	York	CoY	13-17/later	anal; mostly pits (see also Kenward and Robertson EAU 1988/20-22; see Hall *et al.* AML 56/93 for breakdown)	n/a	X	X	n/a	X	X

Reference	EAB No.	EAB name	Site	Location	County	Date	Comments	Insects			Parasites		
								m	e	+	m	e	+
Hall *et al.* (AML 58/93)	694	Bedern AML 57/93	The Bedern	York	CoY	13-17/later	anal; mostly pits (see also Kenward and Robertson EAU 1988/20-22; see Hall *et al.* AML 56/93 for breakdown)	n/a	X	X	n/a	X	X
Hall *et al.* (1994)	4102	Jewbury 82-3	Jewbury	York	CoY	late 12-13	anal; mostly cemetary deposits (see also Hall *et al.* 1991; EAU 1991/24)	T	25	0	NS	X	X
Hall *et al.* (2003)	9177	North Bridge 93-4 (sparse remains)	North Bridge	Doncaster	SYR	PM	publication report (see Carrott *et al.* EAU 1997/16 for data)	n/a	X	X	n/a	X	X
Hall *et al.* (CHP 2003/01)	9736	Goodmanham (NE of) CHP 2003/01	N-E of Goodmanham (TSEP 907)	Goodmanham	EYR	LIA-4th	ass: various cut fills	T	14	0	NS	X	X
Hall *et al.* (EAU 1990/09)	2628	Dundas St EAU 90/09	Dundas Street	York	NYR	?MD	archive eval; boreholes in Kings Pool area	T	13	3	NS	X	X
Hall *et al.* (EAU 1991/23)	7335	Swinegate (20-4) EAU 91/23	20-4 Swinegate	York	CoY	nd	archive eval; no information	T	1	0	s	1	1
Hall *et al.* (EAU 1991/24)	4104	Jewbury 82-3 EAU 91/24	Jewbury	York	CoY	12-14/15	archive anal; mostly cemetery deposits (see also Hall *et al.* 1994)	T	17	0	NS	X	X
Hall *et al.* (EAU 1993/26)	625	Baxtergate (63-4) (Whitby) EAU 93/26	63-64 Baxtergate	Whitby	NYR	13-15	archive anal; occupation and marine or ditchfill deposits	L T	12	6	s	12	1
Hall *et al.* (EAU 1994/15)	4412	Leven-Brandesburton EAU 94/15	Leven-Brandesburton by-pass	between Leven and Brandesburton	EYR	PH: NE, BA, RB	tech; Neolithic and BA pits, RB pits, ditches, slots (see also Carrott *et al.* EAU 1995/6; Dobney *et al.* EAU 1993/20)	L	38	8	NS	X	X
Hall *et al.* (EAU 1994/57)	7108	Stanwix 94 EAU 94/57	Cumbria College of Art	Stanwix, Carlisle	CUM	RO	ass; putative soil below parade ground	T	4	3	s	2	0
Hall *et al.* (EAU 1995/40)	8675	York Minster Library EAU 95/40	York Minster Library	York	CoY	RO AN	eval; layers	T	5	0	NS	X	X
Hall *et al.* (EAU 1996/05)	3803	Higher Ln (Fazakerley) 94 EAU 96/05	Higher Lane	Fazakerley	MER	11/12-16/17	anal; pond fills; C14 dated	L	5	5	NS	X	X
Hall *et al.* (EAU 1996/35)	5974	Quay St (22A) EAU 96/35	22A Quay Street	Scarborough	EYR	'MD'	eval; dump, ?floor	T	2	1	NS	X	X
Hall *et al.* (EAU 1996/54)	5992	Queen St (Scarborough) EAU 96/54	Former Convent School, Queen Street	Scarborough	EYR	12	eval; old ground surface	T	1	0	NS	X	X
Hall *et al.* (EAU 1996/56)	2327	Crossgates Farm EAU 96/56	Crossgates Farm	Seamer	NYR	?RB	eval; boundary ditch fill	T	2	0	NS	X	X
Hall *et al.* (EAU 1997/40)	6493	Ship Inn (rear) EAU 97/40	West Cowick, nr Snaith	near Goole	EYR	15/16	eval; pit fill	T	2	0	NS	X	X

Reference	EAB No.	EAB name	Site	Location	County	Date	Comments	Insects			Parasites		
								m	e	+	m	e	+
Hall *et al.* (EAU 1998/30)	222	All Saints (York) EAU 98/30	All Saints Church, Pavement	York	CoY	A/S	anal; ?external accumulations (see also Carrott *et al.* EAU96/47)	L	3	3	s	4	0
Hall *et al.* (EAU 1999/13)	2121	Cooper Farm EAU 99/13	Cooper Farm	Long Riston	EYR	11-13	eval; ditch fills	T	2	0	NS	X	X
Hall *et al.* (EAU 1999/17)	8173	West End EAU 99/17	West End	Kilham	EYR	'MD'	eval; pit fills	T	1	0	NS	X	X
Hall *et al.* (EAU 1999/31)	1779	Chapel Haddlesey-Eggborough Pipeline EAU 99/31	Chapel Haddlesey to Eggborough pipeline		NYR	?RO	eval; pond or ditch	T	1	1	NS	X	X
Hall *et al.* (EAU 1999/59)	5431	Northgate (7) EAU 99/59	7 Northgate	Cottingham	EYR	post 1321	eval; moat, hearth and pit fills	T	3	1	NS	X	X
Hall *et al.* (EAU 2000/15)	6676	South Beckside 2000 EAU 2000/15	South Beckside	Beverley	EYR	12-19	eval; organic deposits, ditch fills	T	6	6	NS	X	X
Hall *et al.* (EAU 2000/19)	4794	Magistrates Courts (Hull) 99 EAU 2000/19	Magistrates' Courts site	Hull	EYR	14	ass; organic layers (see Hall *et al.* EAU 2000/25)	T	3	3	NS	X	X
Hall *et al.* (EAU 2000/25)	4790	Magistrates Courts (Hull) 94 & 99 EAU 2000/25	Magistrates' Courts site	Hull	EYR	14	anal; various deposits; urban occupation, Augustinian friary (see also Carrott *et al.* EAU 1995/17; Hall *et al.* EAU 2000/19; EAU 2000/33)	L	59	58	NS	X	X
Hall *et al.* (EAU 2000/27)	5283	Newbridge Quarry EAU 2000/27	Newbridge Quarry	Pickering	NYR	BA-IA	ass; post hole fills	BS	3	0	NS	X	X
Hall *et al.* (EAU 2000/28)	8659	Yearsley House EAU 2000/28	land immediately to the east of Yearsley House	York	CoY	MD or PM	eval; ditch fill; plough soil	T	3	0	NS	X	X
Hall *et al.* (EAU 2000/30)	3109	Foxtons Garage EAU 2000/30	Foxton's Garage	York	CoY	post 13-16	ass; deposits	T	4	0	s	4	0
Hall *et al.* (EAU 2000/33)	4791	Magistrates Courts (Hull) 94 & 99 EAU 2000/33	Magistrates' Courts site	Kingston-upon-Hull	EYR	14	anal (data); various feature types (see Hall *et al.* EAU 2000/25 for data)	n/a	X	X	n/a	X	X
Hall *et al.* (EAU 2000/34)	7045	St Thomas St (Scarborough) 99 EAU 2000/34	former convent school, St Thomas Street	Scarborough	NYR	RO	eval; ditch and cut fills	T	2	0	s	1	0
Hall *et al.* (EAU 2000/38)	5288	Newcastle Packet EAU 2000/38	Newcastle Packet, 13 Sandside	Scarborough	NYR	nd but ?MD	eval; ?dump	T	1	1	NS	X	X
Hall *et al.* (EAU 2000/48)	3961	Huntington South Moor EAU 2000/48	Huntington South Moor	York	CoY	?PM	eval; depression fill	T	1	0	NS	X	X

Reference	EAB No.	EAB name	Site	Location	County	Date	Comments	Insects			Parasites		
								m	e	+	m	e	+
Hall *et al.* (EAU 2000/49)	8412	Wigginton Rd (land off) EAU 2000/49	land off Wiggington Road	York	CoY	RO, ?19/20	eval; Ro ditch, ?19/20th ?hedge feature	T	3	0	NS	X	X
Hall *et al.* (EAU 2000/60)	1635	Castle Hill Farm EAU 2000/60	north-east of Castle Hill Farm, Swine (TSEP458)	nr Hull	EYR	?BA	ass; ditch fill	T	1	0	NS	X	X
Hall *et al.* (EAU 2000/64)	4378	Layerthorpe Bridge EAU 2000/64	Layerthorpe Bridge	York	CoY	RO-19	anal; river silts, fills, layers	L T	46	45	s	1	0
Hall *et al.* (EAU 2000/67)	982	Bolton Common EAU 2000/67	Bolton Common (TSEP 243)	NW of Pocklington	EYR	?IA	ass; ditch and post pit fills	T	3	2	NS	X	X
Hall *et al.* (EAU 2000/73)	3314	Goodmanham (NE of) EAU 2000/73	north-east of Goodmanham (TSEP 907).	nr Market Weighton	EYR	RO	ass; ditch, posthole, depression, slot and pit fills, spread	T	10	0	NS	X	X
Hall *et al.* (EAU 2000/80)	6804	Spurriergate 7-15 (rear of) EAU 2000/80	land to the rear of 7-15 Spurriergate	York	CoY	10-12	eval; layers, pit fills	T	9	9	s	9	6
Hall *et al.* (EAU 2000/82)	8210	West Lilling EAU 2000/82	near West Lilling	N of York	NYR	RO, MD	eval; ditch fills (see also Hall *et al.* EAU 2002/01) (BS to 300 ц?m with washover or paraffin floatation)	BS	13	2	NS	X	X
Hall *et al.* (EAU 2001/06)	4785	Magistrates Court (Beverley) EAU 2001/06	Magistrates' Court	Beverley	EYR	12-13	eval; layers, cut fills	T	5	3	NS	X	X
Hall *et al.* (EAU 2001/10)	5328	Normanby Park Steelworks EAU 2001/10	former Normanby Park Steelworks	north of Scunthorpe	NLN	MD-PM	eval; moat fills, moat platform deposit	T	4	3	NS	X	X
Hall *et al.* (EAU 2001/13)	5933	Presto Supermarket EAU 2001/13	former Presto supermarket, George Hudson Street	York	CoY	RO 11-12 ?14	eval; dumps, cut fills	T	6	0	s	2	1
Hall *et al.* (EAU 2001/15)	6916	St Johns Coach Park EAU 2001/15	St John's Coach Park, Clarence Street	York	CoY	?14-15	eval; 'build-up'	T	2	1	s	1	0
Hall *et al.* (EAU 2001/16)	8208	West Hull (Transco) pipeline EAU 2001/16	line of the Transco West Hull pipeline	Elloughton, nr Kingston-upon-Hull	EYR	nd	eval; ?peat (perhaps medieval)	T	1	0	NS	X	X
Hall *et al.* (EAU 2001/21)	8077	Waterside Rd EAU 2001/21	Waterside Road	Beverley	EYR	L12-16	eval; pit fills	BS	3	0	NS	X	X
Hall *et al.* (EAU 2001/25)	2222	County Hall (Beverley) EAU 2001/25	County Hall	Beverley	EYR	M12-M13	eval; rake-out, floor silt, pit fills	T	6	0	NS	X	X

Reference	EAB No.	EAB name	Site	Location	County	Date	Comments	Insects			Parasites		
								m	e	+	m	e	+
Hall *et al.* (EAU 2001/28)	1928	Church St (Burton Pidsea) EAU 2001/28	Church Street	Burton Pidsea	EYR	MD/PM	eval; pit and ditch fills	BS	2	0	NS	X	X
Hall *et al.* (EAU 2001/29)	624	Baxtergate (16) (Hedon) EAU 2001/29	16 Baxtergate	Hedon	EYR	L12-13	eval; channel and pit fills	T	2	1	NS	X	X
Hall *et al.* (EAU 2001/30)	5007	Micklegate (63-7) EAU 2001/30	63-67 Micklegate	York	CoY	?PM	eval; pit and gully fills	BS T	3	0	NS	X	X
Hall *et al.* (EAU 2001/37)	1964	Citadel Way EAU 2001/37	Citadel Way,	Hull	EYR	15-17	eval; ?buried soil, ground raising dump	T	2	1	NS	X	X
Hall *et al.* (EAU 2001/38)	4786	Magistrates Court (Brough) EAU 2001/38	Magistrates' Court	Brough	EYR	RB	eval; alluvial silts	T	2	2	NS	X	X
Hall *et al.* (EAU 2001/39)	8078	Waterside Rd EAU 2001/39	Waterside Road	Beverley	EYR	RB, 'MD'	eval; floor deposits, ditch fills	T	4	2	NS	X	X
Hall *et al.* (EAU 2001/40)	4372	Lawrence St (D C Cook) EAU 2001/40	former D. C. Cook site, Lawrence Street	York	CoY	10/11 11-16	eval; ?ditch backfill, post hole fill	T	2	0	NS	X	X
Hall *et al.* (EAU 2001/42)	7832	Union Terrace EAU 2001/42	Union Terrace	York	CoY	PM	eval; layer	T	1	0	NS	X	X
Hall *et al.* (EAU 2001/51)	7933	Victoria House EAU 2001/51	former Victoria House	Micklegate	York	nd	eval; borhole samples	T	6	5	NS	X	X
Hall *et al.* (EAU 2002/01)	8211	West Lilling EAU 2002/01	near West Lilling	N of York	NYR	RB	anal; ditch and cut fills (see also Hall *et al.* EAU 2000/82)	L, T	5	3	NS	X	X
Hall *et al.* (EAU 2002/02)	5141	Morton Ln EAU 2002/02	Morton Lane	Beverley	EYR	14/E15	ass; pit fills	T	2	2	NS	X	X
Hall *et al.* (EAU 2002/03)	7779	Trinity Ln EAU 2002/03	Trinity Lane	Beverley	EYR	13	eval; various (also released as PRS 2002/03)	T	5	0	NS	X	X
Hall *et al.* (PRS 2001/03)	1965	Citadel Way PRS 2001/03	land adjacent to Paragon BMW, Citadel Way	Hull	EYR	16-17	eval; turflines, moat fill	T	4	3	NS	X	X
Hall *et al.* (PRS 2001/05)	7682	West Hull (Transco) Pipeline PRS 2001/05	route of the Transco West Hull pipeline, Wawne	nr Hull	EYR	nd	eval; peats, pit and post-hole fills	T	4	0	NS	X	X
Hall *et al.* (PRS 2002/05)	2897	Far Ings PRS 2002/05	Far Ings	Barton	NLN	nd	eval; ?truncated marshland deposit	T	1	1	NS	X	X
Hall *et al.* (PRS 2002/10)	6677	South Beckside PRS 2002/10	South Beckside	Beverley	EYR	nd	note: no context type	T	1	1	NS	X	X

Reference	EAB No.	EAB name	Site	Location	County	Date	Comments	Insects			Parasites		
								m	e	+	m	e	+
Hall *et al.* (PRS 2002/14)	1777	Chapel Farm (rear) PRS 2002/14	land to the rear of Chapel Farm, 9 Runner End	Holme-on-Spalding-Moor	EYR	14-15	ass; ditch and pit fills	T	3	2	NS	X	X
Hall *et al.* (PRS 2002/16)	1172	Bridge St (Chester) PRS 2002/16	Bridge Street	Chester	CHE	PRO-20	ass; various deposits (T samples chosen from BS results so biased)	BS T	145	34	s	2	2
Hall *et al.* (PRS 2002/23)	5114	Monks Cross PRS 2002/23	Monks Cross	York	CoY	RO	ass; ditch fills	T	6	0	NS	X	X
Hall *et al.* (PRS 2002/27)	4971	Melton PRS 2002/27	site of the proposed waste water treatment works	Melton	EYR	IA, RO	ass; various features	T	22	5	NS	X	X
Hall *et al.* (PRS 2002/30)	9624	Grosvenor Park Rd (Deva Garage) PRS 2002/30	former Deva garage, 27 Grosvenor Park Road	Chester	CHE	PM	ass; various deposits	BS	15	14	NS	X	X
Hall *et al.* (PRS 2002/32)	9626	Low Farm PRS 2002/32	Low Farm	Cottingham	EYR	nd	eval; channel fill, burnt layer	T	3	0	NS	X	X
Hall *et al.* (PRS 2002/41)	9635	Elloughton (Transco Pipeline) PRS 2002/41	Elloughton	nr S Cave	EYR	LIA/RB	eval; various deposits	BS	7	0	NS	X	X
Hall *et al.* (PRS 2002/42)	9636	OSA02WB23 (Transco Pipeline) PRS 2002/42	site OAS02WB23, Transco pipeline	nr Skidby, Beverley/Hull	EYR	nd	eval; ?fire pit, peat	T	2	0	NS	X	X
Hall *et al.* (PRS 2003/03)	8754	Temple Point PRS 2003/03	Temple Point,	Colton (nr Leeds)	WYR	?	ass: various deposits	T	18	0	s	4	0
Hall *et al.* (PRS 2003/05)	9648	Magistrates Court (Brough) PRS 2003/05	site of the former Magistrates' Court	Brough	EYR	Ro MD PMD	eval; various deposits	T	7	0	NS	X	X
Hall *et al.* (PRS 2003/09)	9652	Airton PRS 2003/09	Airton	Malham - Hellifield	NYR	MD	eval; well fill	BS	1	0	NS	X	X
Hall *et al.* (PRS 2003/14)	9657	Guardian Glass PRS 2003/14	Guardian Glass site	Goole	EYR	?MS	eval: peat	T	1	1	s	1	0
Hall *et al.* (PRS 2003/19)	9662	Millfield Farm PRS 2003/19	Millfield Farm	Wheldrake	CoY	IA/RB RB MD	eval; ditch and grave fills	T	14	0	NS	X	X
Hall *et al.* (PRS 2003/20)	9663	Low Farm PRS 2003/20	Low Farm	Cottingham	EYR	IA or RB	eval; pit and ditch fills	T	2	0	NS	X	X
Hall *et al.* (PRS 2003/23)	9630	Island Wharf (Hull Marina) PRS 2002/36	Site R3, Island Wharf, Hull Marina	Kingston upon Hull	EYR	?17 18	eval; levelling, alluvial silt (non-standard methods)	T	2	2	NS	X	X
Hall *et al.* (PRS 2003/25)	8756	Low Petergate (62-8) PRS 2003/25	62-68 Low Petergate	York	CoY	14	eval; dump or accumulation layers	T	2	2	NS	X	X

Reference	EAB No.	EAB name	Site	Location	County	Date	Comments	Insects			Parasites		
								m	e	+	m	e	+
Hall *et al.* (PRS 2003/26)	9669	Rowdales PRS 2003/26	'Rowdales'	nr South Cave	EYR	IA	eval; pit and ditch fills	BS	2	0	NS	X	X
Hall *et al.* (PRS 2003/30)	9698	Winterton Landfill Site PRS 2003/30	Winterton Landfill site	nr Scunthorpe	NLN	RB	eval; various deposits	T	5	0	NS	X	X
Hall *et al.* (PRS 2003/32)	9673	Bedford Hotel PRS 2003/32	Bedford Hotel, 108-110 Bootham	York	CoY	RO	eval; ?ditch fill	T	1	0	NS	X	X
Hall *et al.* (PRS 2003/33)	9674	Lawrence St (D C Cook) PRS 2003/33	D C Cook, Lawrence Street	York	CoY	10, 14	eval; ?oven fills; barrel well and ditch fills	T	5	2	NS	X	X
Hall *et al.* (PRS 2003/42)	9683	The Spinney PRS 2003/42	The Spinney	Sherburn-in-Elmet	NYR	RO-15 and nd	eval; fills and surface deposits	T	8	5	NS	X	X
Hall *et al.* (PRS 2003/45)	9685	Burringham Rd (66) PRS 2003/45	66 Burringham Road	Scunthorpe	NLN	RO	ass: pit, ditch and other fills	T	30	0	NS	X	X
Hall *et al.* (PRS 2003/48)	9688	Keldgate Close PRS 2003/48	land north of Keldgate Close	Beverley	EYR	15/16-17	ass: pit fills	T	6	0	NS	X	X
Hall *et al.* (PRS 2003/69)	9707	Burn Ln PRS 2003/69	Burn Lane	Hexham	NHM	18/19	eval; tan pits	T	2	0	NS	X	X
Hall *et al.* (PRS 2003/70)	9708	Gillibrand Hall PRS 2003/70	Gillibrand Hall	Chorley	LAN	16	eval; linear feature fill	T	1	1	NS	X	X
Hall *et al.* (PRS 2003/71)	9709	St John St (6) PRS 2003/71	6 St John Street	Beverley	EYR	'early middle ages'	ass; layer	T	1	1	s	1	1
Hall *et al.* (PRS 2003/86)	9724	Monks Cross PRS 2003/86	Monks Cross	York	CoY	NE, ?RB	ass; various deposits	T	9	0	NS	X	X
Hall *et al.* (PRS 2003/87)	9725	Starting Gate PRS 2003/87	former Starting Gate public house, 40 Tadcaster Road	York	CoY	PR RO	ass; natural, hearth and ditch fills	T	5	0	NS	X	X
Hall *et al.* (PRS 2004/18)	10364	Morton Ln PRS 2004/18	69-73 Morton Lane	Beverley	EYR	MD	eval; cut fills, occupation layers	T	5	2	s	2	1
Hall *et al.* (PRS 2004/28)	10373	Heslington East PRS 2004/28	Heslington East	York	CoY	PH IA IA/RB RO ?AN ?MD	eval; mainly ditch and pit fills	T	20	7	NS	X	X
Hall *et al.* (PRS 2004/31)	10377	Citadel Way PRS 2004/31	Paragon BMW showroom, Citadel Way	Kingston-upon-Hull	EYR	PMD EMO	eval; turflines, moat fills, clay dumps	T	9	4	NS	X	X
Hall *et al.* (PRS 2004/32)	10378	Burnett House PRS 2004/32	Burnett House, Castle Street	Kingston-upon-Hull	EYR	LMD-PM	eval; ditch and pit fills, floor, dump	T	5	1	NS	X	X

Reference	EAB No.	EAB name	Site	Location	County	Date	Comments	Insects			Parasites		
								m	e	+	m	e	+
Hall *et al.* (PRS 2004/33)	10379	Newport Rd Quarry PRS 2004/33	Newport Road Quarry	North Cave	EYR	IA/RB	ass; pit and ditch fills	T	11	7	NS	X	X
Hall *et al.* (PRS 2004/45)	10395	Lathom PRS 2004/45	Lathom	Lathom	LAN	IA	anal; various deposit types	T	41	0	NS	X	X
Hall *et al.* (PRS 2004/48)	10397	Springfield PRS 2004/48	Springfield	Scarborough	NYR	13	ass; valley fill	T	1	1	NS	X	X
Hall *et al.* (PRS 2004/52)	10399	Newport Rd Quarry PRS 2004/52	Newport Road Quarry	North Cave	EYR	IA/RB RB	ass; pit and ditch fills, corn-drier fill, hedgeline fill	T	13	1	NS	X	X
Hall *et al.* (PRS 2004/57)	10403	Stamford Bridge PRS 2004/57	route of a water pipeline	nr Stamford Bridge	EYR	?BA RB	ass; pit, ditch and grave fills, firing pit, burnt mound	T	10	3	s	?	1
Hall *et al.* (PRS 2004/74)	10419	Welham Bridge PRS 2004/74	Welham Bridge	Welham Bridge	EYR	?5-6th 'MD'	eval; ?boat fill, moat, ditch and pit fills	T	9	1	NS	X	X
Hall *et al.* (PRS 2004/98)	10442	Catesby Business Park PRS 2004/98	Catesby Business Park, Balby Carr	nr Doncaster	SYR	?IA	ass; ditch, posthole and feature fills	T	10	7	NS	X	X
Hall, R. A. and Kenward (1976)	2101	Coney St (39-41) ((W H Smith)	Coney Street	York	CoY	RO	preliminary account; urban; adjacent to fortress (see also Kenward and Williams 1979)	n/a	X	X	n/a	X	X
Hamshaw-Thomas and Jaques (2000).	8132	Welton Rd 94	Welton Road	Brough	EYR	RO	publication report (see Carrott *et al.* EAU 1994/50; EAU 1998/24 for breakdown)	n/a	X	X	n/a	X	X
Hamshaw-Thomas *et al.* (EAU 1998/24)	8135	Welton Rd 94 EAU 98/24	Welton Road	Brough	EYR	?IA-PM	anal; various deposits (see also Hamshaw-Thomas *et al.* 2000)	T, BS	81	1	NS	X	X
Harmsworth (1968)	947	Blelham Tarn (cladocerans)	Blelham Tarn	Hawkshead - Ambleside	CUM	PH	detailed anal; late and post-glacial lake sediment; Chironomidae	O	X	X	n/a	X	X
Hill (1993)	10793	St Georges Field	St George's Field	York	CoY	LBA	thesis; riverine	L	9	9	n/a	X	X
Hill (1993)	10794	Thornton	Thornton	SW Pocklington	EYR	IA-RO-PR C14	thesis; lake muds, fen peat	L	7	7	n/a	X	X
Holden (1999)	7071	Stamford Bridge 98 HA	Stamford Bridge	Stamford Bridge	EYR	3	ass; ditch fill (botanical analysis)	M	10	4	n/a	X	X
Holdridge (1988)	3615	Hasholme Logboat 84	Hasholme	nr Holme on Spalding Moor	EYR	PH:IA	anal; associated with IA boat	L	2	2	X	X	X
Hughes *et al.* (2000)	1918	Church Moss 95	Church Moss Davenham	nr Northwich	CHE	LG HO	anal (publication) (see Hughes *et al.* (EAU 1998/26 for data)	n/a	X	X	n/a	X	X

Reference	EAB No.	EAB name	Site	Location	County	Date	Comments	Insects			Parasites		
								m	e	+	m	e	+
Hughes *et al.* (EAU 1998/26)	1920	Church Moss 95 EAU 98/26	Church Moss Davenham	nr Northwich	CHE	LG HO	anal tech (see also Hughes *et al.* 2000)	L	29	29	n/a	X	X
Huntley (DAER 31/96)	3531	Haltwhistle by-pass DEAR 31/96	A69 Haltwhistle bypass	Haltwhistle	NHU	HO	eval; palaeochannel	T	4	?	n/a	X	X
Issitt *et al.* (EAU 1995/09)	8134	Welton Rd 94 EAU 95/09	Welton Road	Brough	EYR	RO	eval; cut and ditch fills	T	4	0	NS	X	X
Issitt *et al.* (EAU 1995/16)	4680	Low Hauxley EAU 95/16	Low Hauxley	Low Hauxley, Amble-by-the-Sea	NHU	PH: ?MS, BA	ass; buried soil and waterlain peats (see also Issitt *et al.* 1995)	T	15	11	NS	X	X
Issitt *et al.* (EAU 1996/48)	3447	Grims Ditch (South) EAU 96/48	Grim's Ditch nr Swillington	nr Leeds	WYR	BA, early IA	ass; ditch fill (see also Kenward and Large EAU 1999/03; 2001a) (originally dated PR ?'dark age')	T	2	2	NS	X	X
Jaques and Carrott (EAU 2001/52)	5344	North Back Ln EAU 2001/52	land to the south of North Back Lane	Bridlington	EYR	nd	eval; layer, ditch fills	T	3	0	NS	X	X
Jaques and Carrott (PRS 2002/31)	9625	Snuff Mill Ln PRS 2002/31	Snuff Mill Lane	Cottingham	EYR	RB	eval; ditch fill	T	1	0	NS	X	X
Jaques and Carrott (PRS 2003/43)	8755	Clifton Garage PRS 2003/43	Clifton Garage, 84 Clifton	York	CoY	MD	eval; ditch and pit fills	BS	4	0	NS	X	X
Jaques and Hall (PRS 2003/28)	9671	Market Pl (Ripon) PRS 2003/28	8/9 and 10 The Market Place	Ripon	NYR	MD	tech: dump	T	1	0	NS	X	X
Jaques *et al.* (EAU 1999/06)	8676	York Minster Library EAU 99/06	York Minster Library	York	CoY	RO; MD	eval; RO layers, drain, gulley and scoop fills; MD layers	T	8	0	s	4	0
Jaques *et al.* (EAU 2000/06)	4367	Lawns Farm EAU 2000/62	Lawns Farm, Dunswell (TSEP420)	north of Hull	EYR	?IA/RB	anal; ditch fills, hearth (see also Jaques *et al.* EAU 2000/62)	T	4	0	NS	X	X
Jaques *et al.* (EAU 2000/29)	3950	Hungate area EAU 2000/29	Hungate area	York	CoY	10-15	eval; dumps, accumulations, pit fills	T	11	3	NS	X	X
Jaques *et al.* (EAU 2000/32)	2706	East Halton Skitter EAU 2000/32	East Halton Skitter	east of Barton upon Humber	NLN	mid 1-late 4	eval; mostly ditch fills	T	13	0	NS	X	X
Jaques *et al.* (EAU 2000/35)	3646	Hayton EAU 2000/35	Hayton	Hayton	EYR	RO	ass; well fill	T	5	5	NS	X	X
Jaques *et al.* (EAU 2000/37)	7472	The Mount (90) EAU 2000/37	90 The Mount	York	CoY	MD	eval; ditch fill	T	1	0	NS	X	X

Reference	EAB No.	EAB name	Site	Location	County	Date	Comments	Insects			Parasites		
								m	e	+	m	e	+
Jaques *et al.* (EAU 2000/43)	849	Bishop Wilton EAU 2000/43	Bishop Wilton	Bishop Wilton	NYR	?MD; nd	eval; pit and ditch fills	T	3	0	NS	X	X
Jaques *et al.* (EAU 2000/53)	5211	Skeldergate (64-74) EAU 2000/53	NCP Car Park, Skeldergate	York	CoY	11-14; 16/17	eval; pit fills and surface deposits	T	15	9	s	6	1
Jaques *et al.* (EAU 2000/59)	7411	Market Pl (8/9 & 10) (The Arcade) EAU 2000/59	The Arcade	Ripon	NYR	12-14/15	eval; urban cuts and layers	T	8	0	s	2	1
Jaques *et al.* (EAU 2000/61)	4674	Low Farm EAU 2000/61	Low Farm	Cottingham	EYR	BA, ?RB, RO	eval; pit and ditch fills, deposit	T	4	2	NS	X	X
Jaques *et al.* (EAU 2000/63)	5854	Poplar Farm EAU 2000/63	Poplar Farm (TSEP 905)	Dunswell	EYR	?BA	ass; layers; BS to 300μ? (see also Jaques *et al.* EAU 2002/07)	BS	2	0	NS	X	X
Jaques *et al.* (EAU 2000/65)	845	Bishop Burton/Dale Gate EAU 2000/65	south of Bishop Burton, east of Dale Gate (TSEP 373)	Bishop Burton	EYR	RB, PM,16/e17	ass; ditch, posthole and pit fills	T	5	0	NS	X	X
Jaques *et al.* (EAU 2000/66)	985	Bolton Hall EAU 2000/66	Bolton Hall (TSEP 238)	Bolton	EYR	?IA, nd	ass (superceded by Jaques *et al.* EAU 2002/04)	n/a	X	X	NS	X	X
Jaques *et al.* (EAU 2000/68)	3033	Flat Ln EAU 2002/10	Flat Lane, Barmby Moor (TSEP 254)	nr Pocklington	EYR	RB	ass (superceded by Jaques *et al.* EAU 2002/10)	n/a	X	X	NS	X	X
Jaques *et al.* (EAU 2000/69)	3315	Goodmanham Wold EAU 2000/69	Goodmanham Wold (TSEP 904).	NE Market Weighton	EYR	BA	ass; ?natural gully fill	T	1	0	NS	X	X
Jaques *et al.* (EAU 2000/70)	3740	High Catton (NE of) EAU 2000/70	north-east of High Catton (TSEP 218).	S of Stamford Bridge	EYR	RB	ass; ditch and oven or kiln fills (see also Jaques *et al.* EAU 2002/15)	T	3	0	NS	X	X
Jaques *et al.* (EAU 2000/71)	3738	High Catton (E of) EAU 2000/71	east of High Catton (TSEP 222)		EYR	4th	ass; RB ditch fills (see also Kenward *et al.* EAU 2002/12)	T	3	3	NS	X	X
Jaques *et al.* (EAU 2000/72)	1522	Carberry Hall Farm EAU 2000/72	Carberry Hall Farm (TSEP 908)	SE of Stamford Bridge	EYR	IA	ass; gully and pit fills (see also Jaques *et al.* EAU 2002/05)	T	4	1	NS	X	X
Jaques *et al.* (EAU 2000/74)	3185	Ganstead (S of) EAU 2000/74	south of Ganstead (TSEP 901)	NE of Hull	EYR	IA to MD	ass; (see technical report , Jaques *et al.* EAU 2002/09 for data)	n/a	X	X	NS	X	X
Jaques *et al.* (EAU 2001/02)	4881	Market Pl (Ripon) EAU 2001/02	Market Place	Ripon	NYR	nd	eval; layer	T	1	0	NS	X	X
Jaques *et al.* (EAU 2001/03)	5274	New School EAU 2001/03	New School, Priest Lane	Ripon	NYR	12/13, PM; 18	eval; ditch and pit fills	T	5	0	NS	X	X
Jaques *et al.* (EAU 2001/04)	7412	The Avenue (12-13) EAU 2001/04	12-13 The Avenue	Clifton	CoY	?RO	eval; deposit	T	1	0	NS	X	X

Reference	EAB No.	EAB name	Site	Location	County	Date	Comments	Insects			Parasites		
								m	e	+	m	e	+
Jaques *et al.* (EAU 2001/05)	1209	Britannia Car Park EAU 2001/05	York	York	CoY	14-15	eval; ditch fill	T	1	0	NS	X	X
Jaques *et al.* (EAU 2001/09)	7964	Wakemans House EAU 2001/09	Wakeman's House	Ripon	NYR	11/12	eval; pit fills	T	4	0	NS	X	X
Jaques *et al.* (EAU 2001/18)	850	Bishop Wilton EAU 2001/18	Bishop Wilton	Bishop Wilton	EYR	14/15, nd	eval; 'deposits'	T	2	0	NS	X	X
Jaques *et al.* (EAU 2001/26)	8002	Walmgate (41-9) EAU 2001/26	41-9 Walmgate	York	CoY	10/11-15	ass; floors, layers, pit fills (see also Johnstone *et al.* EAU 2000/04)	T	8	2	s	2	1
Jaques *et al.* (EAU 2001/34)	8081	Wath Quarry EAU 2001/34	Wath Quarry	Wath nr Hovingham	NYR	NE	ass; ditch and pit fills	T	3	0	NS	X	X
Jaques *et al.* (EAU 2001/35)	4127	Keldgate (by 52) EAU 2001/35	land behind and adjacent to 52 Keldgate	Beverley	EYR	B13/14 13/14 17	eval; pre-occupation; watercourse fill; ditch and cistern fills	T	7	3	NS	X	X
Jaques *et al.* (EAU 2001/44)	1967	City Arms EAU 2001/44	City Arms, Fawcett Street	York	CoY	nd	eval; cut fill	T	1	0	NS	X	X
Jaques *et al.* (EAU 2002/04)	986	Bolton Hall EAU 2002/04	Bolton Hall (TSEP 238)	Bolton	EYR	IA, MD/PM	anal; IA ditch fill, MD ?infilled meander (see also Jaques *et al.* EAU 2000/66)	T L	4	4	NS	X	X
Jaques *et al.* (EAU 2002/05)	1523	Carberry Hall Farm EAU 2002/05	Carberry Hall Farm (TSEP 908)	Wilberfoss - Fangfoss	EYR	IA	anal; pit and gully fills (see also Jaques *et al.* EAU 2000/72)	T L	6	1	NS	X	X
Jaques *et al.* (EAU 2002/07)	5855	Poplar Farm EAU 2002/07	Poplar Farm, Dunswell (TSEP905)	north of Hull	EYR	BA	anal; layer (see also Jaques *et al.* EAU 2000/63)	T	2	0	NS	X	X
Jaques *et al.* (EAU 2002/08)	4675	Low Farm EAU 2002/08	Low Farm, near Cottingham (TSEP418).	Cottingham	EYR	BA, RB	anal; pit and ditch fills (see also Jaques *et al.* EAU 2000/61)	T L	4	2	NS	X	X
Jaques *et al.* (EAU 2002/09)	3186	Ganstead (S of) EAU 2002/09	South of Ganstead (TSEP901)	NE of Hull	EYR	IA, RO	anal; ditch fills (see also Jaques *et al.* EAU 2000/74)	T	16	0	NS	X	X
Jaques *et al.* (EAU 2002/10)	3033	Flat Ln EAU 2002/10	Flat Lane, Barmby Moor (TSEP 254)	nr Pocklington	EYR	RB	anal; ditch fill (see also Jaques *et al.* EAU 2000/68)	T	1	0	NS	X	X
Jaques *et al.* (EAU 2002/15)	8693	High Catton (NE of) EAU 2002/15	north-east of High Catton (TSEP218)	NE High Catton	EYR	LRO	tech; pit and ditch fills (see also Jaques *et al.* EAU 200/70)	T BS	10	0	NS	X	X
Jaques *et al.* (PRS 2002/06)	675	Beckside North PRS 2002/06	Beckside North	Beverley	EYR	L12-E13 14-E17	eval; various occupation deposits	T	9	4	s	1	0
Jaques *et al.* (PRS 2002/07)	4812	Main St (Long Riston) PRS 2002/07	Main Street	Long Riston	EYR	13-14	eval; ditch fills	T	3	3	NS	X	X
Jaques *et al.* (PRS 2002/09)	8417	Wilbert Grove PRS 2002/09	Wilbert Grove	Beverley	EYR	L12-E13	eval; slot and pit fills	T	3	0	NS	X	X

Reference	EAB No.	EAB name	Site	Location	County	Date	Comments	Insects			Parasites		
								m	e	+	m	e	+
Jaques *et al.* (PRS 2002/12)	6824	St Andrewgate PRS 2002/12	St Andrewgate	York	CoY	E13-E17	ass; floors, pitfills, dumps	T	9	3	s	7	1
Jaques *et al.* (PRS 2002/29)	4813	Main St (Long Riston) PRS 2002/29	Main Street	Long Riston	EYR	EM, LM	eval; pit and pond fills	T	4	2	NS	X	X
Jaques *et al.* (PRS 2003/01	9645	High St (54-7) (Hull) PRS 2003/01	54-7 High Street	Kingston upon Hull	EYR	MD, pre-18, 18/19	eval: cesspit or dump layers; culvert fill, floor	T	5	5	NS	X	X
Jaques *et al.* (PRS 2003/51)	9690	Bridge Rd PRS 2003/51	Bridge Road	Brompton on Swale, NE of Catterick	NYR	RB	anal; pit fills, flue fills	T	7	0	NS	X	X
Jaques *et al.* (PRS 2003/63)	9703	Former Cathedral School (Ripon) PRS 2003/63	Former Cathedral School, Low St Agnesgate	Ripon	NYR	12	eval; pit fills	T	2	0	s	1	0
Jaques *et al.* (PRS 2003/75)	9713	Morton Ln (67-73) PRS 2003/75	69-73 Morton Lane	Beverley	EYR	'MD', ?16	eval; occupation deposits	T	3	0	NS	X	X
Jaques *et al.* (PRS 2004/08)	10352	Rosper Rd/Conoco Refinery PRS 2004/08	land between Rosper Road and the Conoco Humber Refinery	Immingham	NLN	RB	ass; ditch, well and pit fills	T	6	3	NS	X	X
Jaques *et al.* (PRS 2004/27)	10372	Wilbert Grove PRS 2004/27	Wilbert Grove	Beverley	EYR	LMD	eval; occupation deposits	T	2	0	NS	X	X
Jaques *et al.* (PRS 2004/29)	10374	Ainderby Steeple PRS 2004/29	Ainderby Steeple to Bullamore water pipeline renewal project	w. of Northallerton	NYR	RO, SX	eval; various features	T	6	0	NS	X	X
Jaques *et al.* (PRS 2004/37)	10346	Sprotborough Hall Gardens PRS 2004/37	Sprotbrough Hall Gardens	Sprotborough	SYR	MD, PM	anal; pit, ditch, well, culvert, post pipe fills, dumps	L T BS	13	2	s	4	1
Jaques *et al.* (PRS 2004/46)	10396	Bridge St (Chester) PRS 2004/46	25 Bridge Street	Chester	CHS	RO-MOD	anal; various deposit types (See also Hall *et al.* (PRS 2002/16)	L	5	5	s	8	2
Jaques *et al.* (PRS 2004/63)	10409	Hayton PRS 2004/63	Hayton	Hayton	EYR	2nd-4th, 12-14, PM	ass; various features	BS	12	0	NS	X	X
Jobey (1982)	2561	Doubstead 80	Doubstead Scremerston	nr Berwick-upon-Tweed	NHU	RO; RB	see Donaldson (1982)	n/a	X	X	NS	X	X
Johnson *et al.* (PRS 2003/56)	9694	High Green PRS 2003/56	former Mitchell's animal rendering plant, High Green	Bridlington	EYR	?MS/ENE	eval; layer	T	1	0	NS	X	X
Johnstone *et al.* (EAU 1998/37)	2955	Fetter Ln EAU 98/37	Fetter Lane	York	CoY	nd	eval; no information	BS	1	0	NS	X	X

Reference	EAB No.	EAB name	Site	Location	County	Date	Comments	Insects			Parasites		
								m	e	+	m	e	+
Johnstone *et al.* (EAU 1998/38)	2912	Fawcett St EAU 98/38	Fawcett Street	York	CoY	various	eval; samples rejected visually as barren	NS	X	X	NS	X	X
Johnstone *et al.* (EAU 1998/41)	1976	Clarence St EAU 98/41	Clarence Street	York	CoY	nd	eval; layer	T	1	0	NS	X	X
Johnstone *et al.* (EAU 1998/42)	2689	Easington EAU 98/42	Easington	south-east of Withernsea	EYR	?early SX	ass; pitfill	T1 BS 15	16	0	s	1	0
Johnstone *et al.* (EAU 1999/01)	937	Blanket Row EAU 99/01	Blanket Row	Hull	EYR		see Carrott *et al.* EAU 2001/12 for data)	n/a	X	X	n/a	X	X
Johnstone *et al.* (EAU 1999/18)	6494	Ship Inn (rear) EAU 99/18	West Cowick	nr Snaith	EYR	15/16	eval; flue pit fills, pre-kiln deposit	T	8	0	s	8	0
Johnstone *et al.* (EAU 1999/19)	8212	West Lilling EAU 99/19	Site 169 (Malton/York)	West Lilling	NYR	4th	eval; see Hall *et al.* EAU 2002/01 for breakdown	n/a	X	X	n/a	X	X
Johnstone *et al.* (EAU 1999/21)	4540	Little Stonegate (rear 3) EAU 99/21	Rear of 3 Little Stonegate (Methodist Chapel Cottage)	York	CoY	1-4th	ass; turf line, cut fills, surface accumulations	T	7	0	s	2	0
Johnstone *et al.* (EAU 1999/22)	2343	Crown Hotel 99 EAU 99/22	Crown Hotel	Boroughbridge	NYR	11/12-14	ass; ditch fills	T	3	0	NS	X	X
Johnstone *et al.* (EAU 2000/04)	8001	Walmgate (41-9) EAU 2000/04	41-49 Walmgate	York	CoY	A/S, late MD	ass/anal; A/S floors, layers, cut fill; late MD pit fill (see also Jaques *et al.* EAU 2001/26; Hall *et al.* PRS 2002/26)	L	8	8	s	8	1
Johnstone *et al.* (EAU 2000/06)	6487	Sherburn 99 EAU 2000/06	Sherburn	Malton - Scarborough	NYR	12/13	eval; ditch fill	T	1	0	NS	X	X
Jones (1983b)	5715	Pavement (6-8) 72	6-8 Pavement	York	CoY	A/S	coprolite	n/a	X	X	P	1	1
Jones (AML 4310)	690	Bedern AML 4310	The Bedern	York	CoY	RO	various deposits; see Hall *et al.* (1993 AML 56/93) for breakdown	n/a	X	X	n/a	X	X
Jones (AML 4599)	2178	Coppergate Helmet AML 4599	Coppergate Development ('helmet pit')	York	CoY	AN-A/S	pit	n/a	X	X	P	2	0
Jones (AML 4600)	258	Ambleside AML 4600	Ambleside	Ambleside	CUM	RO	pit	n/a	X	X	P	1	1
Jones (1986)	4477	Lindow Moss	Lindow Moss	Wilmslow	CHE	PH:IA	gut of bog body (see also Dayton 1986; Girling 1985; 1986a, b; Skidmore 1986)	n/a	X	X	s	1	1
Jones (AML 71/87)	3957	Hunters Walk AML 71/87	Hunter's Walk	Chester	CHE	nd	pitfill	n/a	X	X	P	3	3

Reference	EAB No.	EAB name	Site	Location	County	Date	Comments	Insects			Parasites		
								m	e	+	m	e	+
Jones (AML 237/87)	7831	Union Terrace 72 AML 237/87	21-7 Union Terrace	York	CoY	nd	pit fills	n/a	X	X	P	13	2
Jones (EAU 1986/34)	1829	Chester EAU 86/34	HW 79	Chester	CHE	MD	pit; concretion	n/a	X	X	P	1	1
Jones and Hutchinson (AML 59/88)	1664	Castle St (Carlisle) AML 59/88	Castle Street	Carlisle	CUM	RO	anal: various deposits (see also Allison *et al.* 1991a, b; Kenward and Morgan 1985a-c)	X	X	X	P	16	8
Jones and Hutchinson (nd)	10795	Annetwell St (parasites)	Annetwell Street	Carlisle	CUM	RO ?+PR	archive anal; various deposits	n/a	X	X	P	115	20
Jones and Nicholson (AML 229/87)	7358	Tanners Row AML 229/87	Tanners Row	Pontefract	SYR	MD	anal; pits	NS	X	X	P	10	5
Jones and O'Connor (EAU 1986/33)	5444	Norton (N Yorks) EAU 86/33	Norton on Derwent	Norton	NYR	RO	archive anal; pot fills	T	2	0	NS	X	X
Keepax (AML 2449)	721	Beeston Castle AML 2449	Beeston Castle	Chester/ Nantwich	CHE	MD	miscellaneous; traces of insects and molluscs	O	X	X	n/a	X	X
Kenward (1977)	6429	Sewer Ln 74	Sewer Lane	Hull	EYR	PR:MD	12/13 watercourse	X	X	X	NS	X	X
Kenward (1979c)	1782	Chapel Lane Staith 78	Chapel Lane Staithe	Hull	EYR	PR:MD	urban waste disposal at waterfront	T	13	13	NS	X	X
Kenward (1979d)	6302	Saddler St (61-3) 74	to rear of 61-63 Saddler Street	Durham	DUR	10-12	anal; urban occupation	L	5	5	NS	X	X
Kenward (1984a)	6605	Skipsea Withow Mere (b)	Skipsea Withow Mere	Skipsea	EYR	LG	incidental records	O	X	X	n/a	X	X
Kenward (1984b)	6605	Skipsea Withow Mere (b)	Skipsea Withow Mere	Skipsea	EYR	LG, HO	late-glacial and mid Flandrian; incidental records	O	X	X	n/a	X	X
Kenward (1987a)	6950	St Mary Bishophill Junior	St Mary Bishophill Junior	York	CoY	11	anal; putlog holes	L	4	2	n/a	X	X
Kenward (1990a)	898	Blackfriars St (Carlisle) 77-9	Blackfriars Street (between Blackfriars Street and West Walls)	Carlisle	CUM	RO	anal; urban/military occupation (see also Kenward AML 4823 for breakdown; 1986)	n/a	X	X	n/a	X	X
Kenward (1999b)	4120	Keays Ln C (pubic lice)	Keays Lane	Carlisle	CUM	RO, MD	research paper (public lice)	n/a	X	X	n/a	X	X
Kenward (2000)	1251	Brook House Farm (Merseyside) 93	Brook House Farm	Halewood	MER	PH RO	ass publication (see Carrott *et al.* EAU 1994/24; Kenward and Large EAU 1997/20 for data)	n/a	X	X	n/a	X	X

Reference	EAB No.	EAB name	Site	Location	County	Date	Comments	Insects			Parasites		
								m	e	+	m	e	+
Kenward (2005)	10778	Coppergate (16-22) (Anglo-Scand) (bees)	Review of British archaeological records of honeybees (Apis mellifera	Various sites	-	-	research systhesis	n/a	X	X	n/a	X	X
Kenward (AML 3540)	899	Blackfriars St (Carlisle) AML 3540	Blackfriars Street	Carlisle	CUM	RO	urban/military occupation (replaced by Kernward AML 4823; see also Kenward 1990)	n/a	X	X	NS	X	X
Kenward (AML 4823)	903	Blackfriars St (Carlisle) AML 4823	Blackfriars Street	Carlisle	CUM	RO	urban/military occupation; replaces Kenward (AML 3540; see also Kenward 1990)	L21+6	21	6	NS	X	X
Kenward (EAU 1986/14)	933	Blake St EAU 86/14	Blake Street (= City Garage)	York	CoY	RO-MD	archive anal; various RO deposits; MD well (see also Jones 1986/10; Hall *et al.* 1986/8)	T	37	2	NS	x	x
Kenward (EAU 1986/16)	189	Aldwark (adj 1-5) EAU 86/16	1-5 Aldwark	York	CoY	RO	archive tech (see also Kenward and Hall EAU 1986/17; Kenward and Robertson EAU 1988/20; Kenward *et al.* 1986)	T	6	0	NS	X	X
Kenward (EAU 1991/29)	6409	Seaton Beach 90 EAU 91/29	Seaton Beach	Hartlepool	DUR	nd	archive ass; natural clays, silts and peats	T	8	8	NS	X	X
Kenward (EAU 1998/01)	302	Annetwell St EAU 98/01	Annetwell Street	Carlisle	CUM	RO MD	data archive (see Allison *et al.* nd; superceded by Kenward EAU 1999/32)	n/a	X	X	n/a	X	X
Kenward (EAU 1999/32)	303	Annetwell St EAU 99/32	Annetwell Street	Carlisle	CUM	RO MD	archive tech (see Allison *et al.* nd; supecedes Kenward EAU 1998/01)	L	218	174	n/a	X	X
Kenward (EAU 1999/43)	10383	Carlisle sites (zonation) EAU 99/43	Carlisle	Carlisle	CUM	RO	synthesis of land use zonation	n/a	X	X	n/a	X	X
Kenward (EAU 2000/39)	5723	Pavement (6-8) EAU 2000/39	6-8 Pavement	York	CoY	A/S	data archive for insects (see Hall *et al.* 1983 for breakdown)	n/a	X	X	n/a	X	X
Kenward (EAU 2000/41)	6582	Skeldergate (58-9) 73-5 EAU 2000/41	58-59 Skeldergate	York	CoY	RO	data archive for insects from buried soil (see Hall *et al.* 1980)	L	3	3	NS	X	X
Kenward (EAU 2000/79)	3058	Flodden Hill EAU 2000/79	rectilinear enclosure, Flodden Hill	nr Milfield	NHM	RB	ass; ditch fill (see also Kenward EAU 2001/49)	T	1	1	NS	X	X
Kenward (EAU 2001/49)	3059	Flodden Hill EAU 2001/49	rectilinear enclosure, Flodden Hill	nr Milfield	NHM	RB	anal; ditch fills (see also Kenward EAU 2000/79)	L	1	1	NS	X	X
Kenward (EAU 2002/13)	10384	Rickergate EAU 2002/13	Rickergate	Carlisle	CUM	BRO RO MD	ass; pre-RO ?river channel; RO ditches, surface deposits; MD ditch, ?pit	T	10	8	NS	X	X

Reference	EAB No.	EAB name	Site	Location	County	Date	Comments	Insects			Parasites		
								m	e	+	m	e	+
Kenward and Allison (AML 233/87)	6227	Rougier St (5) AML 233/87	5 Rougier Street	York	CoY	RO:PR:ME:MD	tech; (for publication report see Hall *et al.* 1990)	L	45	26	n/a	X	X
Kenward and Allison (AML 145/88)	5674	Papcastle AML 145/88	Papcastle	nr Cockermouth	CUM	RO	tech; military (fort); no detailed lists see Kenward and Allison (1995) for breakdown	n/a	X	X	NS	X	X
Kenward and Allison (EAU 1988/12)	5503	Oakwell Hall EAU 88/12	Oakwell Hall	Birstall N of Huddersfield	WYR	c. 1490-1550	archive tech; fills of structure built into moat bank (see Allison *et al.* EAU 1988/03	T	4	4	NS	X	X
Kenward and Allison (EAU 1995/01)	5677	Papcastle EAU 95/01	Papcastle	nr Cockermouth	CUM	RO	military (fort) see also Kenward and Allison (AML 145/88)	T	13	9	NS	X	X
Kenward and Carrott (PRS 2002/49)	9643	Staithes PRS 2002/49	Staithes	Staithes	NYR	EBA	ass; deposits associated with timber structure	T	4	4	NS	X	X
Kenward and Carrott (PRS 2003/58)	9700	Morton Ln PRS 2003/58	Morton Lane	Beverley	EYR	12/13, 15th	anal; urban, pit fills	T L	12	6	n/a	X	X
Kenward and Hall (1995)	2126	Coppergate (16-22) (Anglo-Scand)	16-22 Coppergate	York	CoY	A/S	anal; urban, floors, external surfaces, pits, etc. (see also archive, Hall and Kenward 2002) (86 non-quantitative assemblages in addition)	L O	541	535	Stoll	+	+
Kenward and Hall (EAU 2000/14)	6001	Micklegate (1-9) 88-9 EAU 2000/14	Queen's Hotel site, 1-9 Micklegate	York	CoY	A/S	anal; floors, cut fills, layers	L	25	23	s	2	2
Kenward and Hall (EAU 2000/20)	7999	Walmgate (118-26) EAU 2000/20	118-126 Walmgate	York	CoY	A/S	anal; floors, layers, cut fills (also released as PRS2002/26)	L	23	21	P	21	13
Kenward and Large (1998b)	10382	Coppergate (16-22) (Anglo-Scand) (pits)	16-22 Coppergate	York	CoY	A/S	Research paper dealing with seasonality in cess-pit insects	n/a	X	X	n/a	X	X
Kenward and Large (20001b)	3451	Grims Ditch South (A1-M1 92-8)	South Dyke (A1-M1 link road)	A1-M1 link road	WYR	Late IA, RO	publication (see Kenward and Large EAU 1999/02 for data)	n/a	X	X	n/a	X	X
Kenward and Large (2001a)	3451	Grims Ditch South (A1-M1 92-8)	Grim's Ditch South	A1-M1 link road	WYR	BA, early IA	publication (see Issitt *et al.* EAU 1996/48; Kenward and Large EAU 1999/03 for data)	n/a	X	X	n/a	X	X
Kenward and Large (EAU 1986/20)	293	Annetwell St EAU 86/20	Annetwell Street	Carlisle	CUM	RO	archive tech (See also Allison *et al.* nd; Jones and Hutchinson nd; Kenward EAU 19 99/32)	n/a	X	X	n/a	X	X

Reference	EAB No.	EAB name	Site	Location	County	Date	Comments	Insects			Parasites		
								m	e	+	m	e	+
Kenward and Large (EAU 1997/20)	1255	Brook House Farm (Merseyside) EAU 97/20	Brook House Farm and Ochre Brook Halewood,	nr Liverpool	MER	PH RO	summary of Carrott *et al.* (EAU 94/17) and Carrott and Kenward (EAU 94/24) (see also Kenward 2000)	n/a	X	X	n/a	X	X
Kenward and Large (EAU 1997/30)	4486	Ling Ln EAU 97/30	Ling Lane, Seamer Carr	near Scarborough	NYR	MS	anal; probably lake shore (see also Carrott *et al.* EAU 1996/52; Osborne 1980)	L	1	1	NS	0	0
Kenward and Large (EAU 1999/02)	6685	South Dyke EAU 99/02	South Dyke (A1-M1 link road)	A1-M1 link road	WYR	LIA RO	anal; ditch fills (see Kenward and Large 2001a)	L	2	2	NS	0	0
Kenward and Large (EAU 1999/03)	3448	Grims Ditch (South) EAU 99/03	Grim's Ditch (A1-M1 link road)	A1-M1 link road	WYR	BA EIA	anal; ditch fills (see also Issitt *et al.* EAU 1996/48; Kenward Large 2001a)	L	2	2	NS	0	0
Kenward and Morgan (EAU 1985/22)	1666	Castle St (Carlisle) EAU 85/22	Castle Street	Carlisle	CUM	RO	archive tech (see Allison *et al.* 1991a; b; Jones and Hutchinson AML 59/88 for breakdown; see also Kenward and Morgan EAU 1985/23-24)	n/a	X	X	n/a	X	X
Kenward and Morgan (EAU 1985/23)	1667	Castle St (Carlisle) EAU 85/23	Castle Street	Carlisle	CUM	RO	archive tech (see Allison *et al.* 1991a; b; Jones and Hutchinson AML 59/88 for breakdown see also Kenward and Morgan EAU 1985/22; 24)	n/a	X	X	n/a	X	X
Kenward and Morgan (EAU 1985/24)	1668	Castle St (Carlisle) EAU 85/24	Castle Street	Carlisle	CUM	RO postRO	archive tech (see Allison *et al.* 1991a; b; Jones and Hutchinson AML 59/88 for breakdown see also Kenward and Morgan EAU 1985/22-23)	n/a	X	X	n/a	X	X
Kenward and Robertson (EAU 1988/20)	192	Aldwark (adj 1-5) EAU 88/20	1-5 Aldwark	York	CoY	RO	archive tech; see Kenward *et al.* (1986b)	n/a	X	X	n/a	X	X
Kenward and Robertson (EAU 1988/21)	695	Bedern EAU 88/21	The Bedern	York	CoY	-	archive tech; superceded by AML reports (see Hall *et al.* AML 56-58/93)	n/a	X	X	n/a	X	X
Kenward and Robertson (EAU 1988/22)	696	Bedern EAU 88/22	The Bedern	York	CoY	-	archive tech; superceded by AML reports (see Hall *et al.* 1992a-c)	n/a	X	X	n/a	X	X
Kenward and Tomlinson (1992)	6759	Speke Hall 81-2	Speke Hall	nr Liverpool	MER	PM	anal; watercourse below 16th century moated manor	O	+	+	NS	X	X

Reference	EAB No.	EAB name	Site	Location	County	Date	Comments	Insects			Parasites		
								m	e	+	m	e	+
Kenward and Williams (1979)	2104	Coney St (39-41) 74-5 (W H Smith)	39-41 Coney Street	York	CoY	RO	anal; soil horizon, store buildings; adjacent to fortress (see also Hall and Kenward 1976)	L	11	10	NS	X	X
Kenward *et al.* (AML 4822)	3750	High Ousegate (8) AML 4822	8 High Ousegate	York	CoY	LRO	anal; 470+80 ad (HAR 2708) layer	L	1	1	NS	X	X
Kenward *et al.* (1986b)	688	Bedern 76-81 (well fills)	The Bedern	York	CoY	RO AN	anal; well, pits (see also Hall *et al.* 1986 AML 4889 for breakdown)	n/a	X	X	n/a	X	X
Kenward *et al.* (AML 76/92)	7457	The Lanes AML 76/92	Old Grapes Lane B	Carlisle	CUM	RO	anal; urban fringes; surface deposits and well fills	L	8	8	s	8	2
Kenward *et al.* (AML 77/92)	7458	The Lanes AML 77/92	Lewthwaites Lane A	Carlisle	CUM	RO MD	anal; urban fringes; RO surface deposits and some cuts; MD pit	L	18	15	s	18	5
Kenward *et al.* (AML 78/92)	7459	The Lanes AML 78/92	Old Grapes Lane A	Carlisle	CUM	?PH RO-MD	anal; urban fringes; wide range of mostly RO feature types; MD well.	L	92	78	s	76	16
Kenward *et al.* (2000d)	8721	Southern Lanes 81-2	Old Grapes Lane A and B, Lewthwaites Lane	Carlisle	CUM	RO, MD	publication report; see Kenward *et al.* (1992a-c AML 76-78/92)	n/a	X	X	n/a	X	X
Kenward *et al.* (2004).	9178	North Bridge 93-4 (large pit)	North Bridge	Doncaster	SYR	PM	publication report (see Carrott *et al.* EAU 1997/16)	n/a	X	X	n/a	X	X
Kenward *et al.* (2004b)	9382	Old Abbey Farm 95	Old Abbey Farm	Risley	CHE	15-18/19	publication report (see Carrott *et al.* EAU 1996/13; Kenward *et al.* 1998/23 for data)	n/a	X	X	n/a	X	X
Kenward *et al.* (EAU 1998/23)	5530	Old Abbey Farm EAU 98/23	Old Abbey Farm	Risley	CHE	15-18/19	anal; moat fills (see also Carrott *et al.* EAU 1996/13; Kenward *et al.* 2004b)	L	5	5	NS	X	X
Kenward *et al.* (EAU 1998/32)	4121	Keays Ln EAU 98/32	Keay's Lane	Carlisle	CUM	RO MD	anal; suburban occupation; wide range of cut and surface feature types	L	92	76	s	47	10
Kenward *et al.* (EAU 1998/32)	4375	Laws Ln EAU 98/32	Law's Lane	Carlisle	CUM	RO MD	anal; suburban occupation; various cut and surface feature types	L	18	18	s	13	4
Kenward *et al.* (EAU 2001/46)	8377	Whitehall Shipyard EAU 2001/46	Whitehall Shipyard, Spital Bridge	Whitby	NYR	EM	eval; fills	T	3	2	NS	X	X
Kenward *et al.* (EAU 2002/12)	3739	High Catton (E of) EAU 2002/12	TSEP222	High Catton	EYR	RB	anal; ditch fills (see also Jaques *et al.* EAU 2000/71)	L	3	3	NS	X	X
Kenward *et al.* (PRS 2003/50)	8757	High Ousegate (28-9) PRS 2003/50	Waterstones bookshop, 28-29 High Ousegate	York	CoY	9-11	ass; pit fills, surface layers	T	7	7	s	7	6
Kenward *et al.* (PRS 2004/04)	10349	Lawrence St (D C Cook) PRS 2004/04	former D. C. Cook site, off Lawrence Street	York	CoY	MD (12-16)	anal; barrel well and ditch fills	L	2	2	NS	X	X

Reference	EAB No.	EAB name	Site	Location	County	Date	Comments	Insects			Parasites		
								m	e	+	m	e	+
Kenward (EAU 1984/03)	2155	Coppergate (16-22) EAU 84/03	16-22 Coppergate	York	CoY	A/S	archive report (see Hall and Kenward 2002; Kenward and Hall 1995)	n/a	X	X	n/a	X	X
Kenward, H. K. EAU 1984/04)	2156	Coppergate (16-22) EAU 84/04	16-22 Coppergate	York	CoY	A/S	archive report (see Hall and Kenward 2002; Kenward and Hall 1995)	n/a	X	X	n/a	X	X
Kenward (EAU 1984/05)	2157	Coppergate (16-22) EAU 84/05	16-22 Coppergate	York	CoY	A/S	archive report (see Hall and Kenward 2002; Kenward and Hall 1995)	n/a	X	X	n/a	X	X
Kenward (EAU 1984/08)	2158	Coppergate (16-22) EAU 84/08	16-22 Coppergate	York	CoY	A/S	archive report (see Hall and Kenward 2002; Kenward and Hall 1995)	n/a	X	X	n/a	X	X
Kenward (EAU 1984/09)	2159	Coppergate (16-22) EAU 84/09	16-22 Coppergate	York	CoY	A/S	archive report (see Hall and Kenward 2002; Kenward and Hall 1995)	n/a	X	X	n/a	X	X
Kenward (EAU 1984/10)	2160	Coppergate (16-22) EAU 84/10	16-22 Coppergate	York	CoY	A/S	archive report (see Hall and Kenward 2002; Kenward and Hall 1995)	n/a	X	X	n/a	X	X
Kenward (EAU 1985/09)	2162	Coppergate (16-22) EAU 85/09	16-22 Coppergate	York	CoY	A/S	archive report (see Hall and Kenward 2002; Kenward and Hall 1995)	n/a	X	X	n/a	X	X
Kenward (EAU 1985/10)	2163	Coppergate (16-22) EAU 85/10	16-22 Coppergate	York	CoY	A/S	archive report (see Hall and Kenward 2002; Kenward and Hall 1995)	n/a	X	X	n/a	X	X
Kenward (EAU 1985/11)	2164	Coppergate (16-22) EAU 85/11	16-22 Coppergate	York	CoY	A/S	archive report (see Hall and Kenward 2002; Kenward and Hall 1995)	n/a	X	X	n/a	X	X
Kenward (EAU 1985/12)	2165	Coppergate (16-22) EAU 85/12	16-22 Coppergate	York	CoY	A/S	archive report (see Hall and Kenward 2002; Kenward and Hall 1995)	n/a	X	X	n/a	X	X
Kenward (EAU 1985/13)	2166	Coppergate (16-22) EAU 85/13	16-22 Coppergate	York	CoY	A/S	archive report (see Hall and Kenward 2002; Kenward and Hall 1995)	n/a	X	X	n/a	X	X
Kenward (EAU 1985/14)	2167	Coppergate (16-22) EAU 85/14	16-22 Coppergate	York	CoY	A/S	archive report (see Hall and Kenward 2002; Kenward and Hall 1995)	n/a	X	X	n/a	X	X
Kenward (EAU 1985/15)	2168	Coppergate (16-22) EAU 85/15	16-22 Coppergate	York	CoY	A/S	archive report (see Hall and Kenward 2002; Kenward and Hall 1995)	n/a	X	X	n/a	X	X
Kenward (nd)	0	York Minster pits	York Minster	York	CoY	A/S	archive tech	L	2	2	NS	X	X
Kimmins (1954)	7103	Stanwick	Stanwick		NYR	IA	ditch fill; caddis	O	+	+	n/a	X	X
Langdon *et al.* (2004)	9755	Talkin Tarn	Talkin Tarn	Cumbria	CUM	HO	lake core: chironomids	O	+	+	n/a	X	X
Large (EAU 1997/27)	4854	Manor Ln EAU 97/27	Manor Lane, Rawcliffe	York	CoY	RO	eval; ditch fills	BS	1	0	NS	X	X
Large (EAU 1999/53)	7072	Stamford Bridge EAU 99/53	Stamford Bridge	Stamford Bridge	EYR	RO	ass; ditch fill	T	1	1	NS	X	X

Reference	EAB No.	EAB name	Site	Location	County	Date	Comments	Insects			Parasites		
								m	e	+	m	e	+
Large and Kenward (EAU 1987/14)	294	Annetwell St EAU 87/14	Annetwell Street	Carlisle	CUM	RO	archive tech (see Allison *et al.* nd; see also Kenward EAU 1999/32 for data)	n/a	X	X	n/a	X	X
Large and Kenward (EAU 1987/15)	295	Annetwell St EAU 87/15	Annetwell Street	Carlisle	CUM	RO	archive tech (see Allison *et al.* nd; see also Kenward EAU 1999/32 for data)	n/a	X	X	n/a	X	X
Large and Kenward (EAU 1987/16)	296	Annetwell St EAU 87/16	Annetwell Street	Carlisle	CUM	RO	archive tech (see Allison *et al.* nd; see also Kenward EAU 1999/32 for data)	n/a	X	X	n/a	X	X
Large and Kenward (EAU 1988/15)	297	Annetwell St EAU 88/15	Annetwell Street	Carlisle	CUM	RO	archive tech (see Allison *et al.* nd; see also Kenward EAU 1999/32 for data)	n/a	X	X	n/a	X	X
Large and Kenward (EAU 1988/16)	298	Annetwell St EAU 88/16	Annetwell Street	Carlisle	CUM	RO	archive tech (see Allison *et al.* nd; see also Kenward EAU 1999/32 for data)	n/a	X	X	n/a	X	X
Large and Kenward (EAU 1988/17)	299	Annetwell St EAU 88/17	Annetwell Street	Carlisle	CUM	RO	archive tech (see Allison *et al.* nd; see also Kenward EAU 1999/32 for data)	n/aX	Xn/a	XX			
Large and Kenward (EAU 1988/18)	300	Annetwell St EAU 88/18	Annetwell Street	Carlisle	CUM	RO	archive tech (see Allison *et al.* nd; see also Kenward EAU 1999/32 for data)	n/a	X	X	n/a	X	X
Large and Kenward (EAU 1988/19)	301	Annetwell St EAU 88/19	Annetwell Street	Carlisle	CUM	RO	archive tech (see Allison *et al.* nd; see also Kenward EAU 1999/32 for data)	n/a	X	X	n/a	X	X
Large *et al.* (EAU 1994/11)	6116	Ribchester 89 EAU 94/11	Ribchester	Ribchester nr. ??	LAN	RO	main; fort, surface deposits and pit and ditch fills	D	119	80	s	119	21
Large *et al.* (EAU 1998/40)	5794	Piccadilly (90) EAU 98/40	90 Piccadilly	York	CoY	nd	eval; deposit	T	1	1	s	1	0
Large *et al.* (EAU 1999/45)	5790	Piccadilly (41) EAU 99/45	41 Piccadilly	York	CoY	?RO MD PM, nd	ass; various deposits, dating vague where invertebrates recovered	T	7	4	s	2	0
Large *et al.* (EAU 1999/46)	4538	Little Stonegate (3) EAU 99/46	Primitive Methodist Chapel, 3 Little Stonegate	York	CoY	RO 10-12	ass; RO pit, MD layers	T	3	3	NS	X	X
Large *et al.* (EAU 1999/50)	7221	Storking Ln (land off) 99 EAU 99/50	Storking Lane,	Wilberfoss	EYR	nd	eval; ?silting in stream bed	T	7	7	NS	X	X
Large *et al.* (EAU 1999/57)	4427	Liberty Ln 99 EAU 99/57	Liberty Lane	Hull	EYR	14-18	ass; garderobe, ditch, barrel well and pit fills	T	5	4	NS	X	X

Reference	EAB No.	EAB name	Site	Location	County	Date	Comments	Insects			Parasites		
								m	e	+	m	e	+
LUAU (LUAU 8079)	4249	Kirkby Thore LUAU	Land at OS 8866, Kirkby Thore	NE Appleby	CUM	PR/MD	eval; well and ditch fills (botanical report, incidental mention of 'coleoptera' (sic))	M	10	4	NS	X	X
Mant *et al.* (PRS 2005/102)	10531	Castle Gate (Scott Ln) PRS 2005/102	Castle Gate (formerly Scott Lane)	Wetherby	WYR	PH, ?12, nd	ass; various features	O	12	0	NS	X	X
Mant *et al.* (PRS 2005/51)	10489	Back Side PRS 2005/51	Back Side	Duggleby	NYR	12/13-14/15	eval; pit, ditch and posthole fills, floor	T	5	0	NS	X	X
Mant *et al.* (PRS 2005/66)	10501	Skelton Crescent (adj) PRS 2005/66	land off Skelton Crescent	Market Weighton	EYR	16/17	eval; organic deposit	T	1	1	NS	X	X
Mant *et al.* (PRS 2005/97)	10529	Pocklington WWT Works PRS 2005/97	Pocklington Waste Water Treatment Works, Canal Lane	Pocklington	EYR	NE, BA/IA, RB	eval; pit and ditch fills	O	11	0	NS	X	X
McCobb *et al.* (2004).	9062	St Saviourgate (9) (invertebrate preservation)	St Saviourgate	York	CoY	MD	research paper, taphonomy, mineralisation	X	X	X	X	X	X
McKenna (EAU 1984/16)	3933	Lurk Ln 79-82 EAU 84/16	Lurk Lane	Beverley	EYR	9-15/16	no systematic work on insects (see also McKenna 1991)	O	?	?	X	X	X
McKenna (1991)	4727	Lurk Ln 79-82	Lurk Lane	Beverley	EYR	9-15/16	see McKenna (EAU 1984/16)	n/a	X	X	n/a	X	X
McKenna (1987)	3789	High St/Blackfriargate (Hull) 73-6	High Street and Blackfriargate	Hull	EYR	late 13-mid 14th	pit fills, layers, floors	NS	X	X	paras	?	present
McKenna (1992)	2743	Eastgate (Beverley) 83-6	Eastgate	Beverly	EYR	E12-L14	see McKenna (EAU 1988/30)	n/a	X	X	n/a	X	X
McKenna (EAU 1988/30)	2752	Eastgate (Beverley) 84 EAU 88/30	Eastgate	Beverley	EYR	12-14	cut fills and surface deposits; no systematic work on insects (see McKenna 1992)	O	?	?	P	69	34
McKenna *et al.* (AML 227/87)	6226	Rougier St (5) AML 227/87	Rougier Street	York	NYR (CoY)	RO-MD	various deposits (see also Hall and Kenward 1990b; Kenward and Allison 1987)	T	45	13	X	X	X
McKenna *et al.* (AML 37/88))	183	Aldwark (7-9) 85 AML 37/88	7-9 Aldwark	York	NYR (CoY)	RO A/S MD	anal; pit fills, layers, rampart deposits	NS	X	X	P	73	29
McKenna *et al.* (EAU 1987/28)	6229	Rougier St EAU 87/28	Rougier Street	York	NYR (CoY)	RO-MD	various deposits (see also McKenna *et al.* AML 227/87)	n/a	X	X	n/a	X	X
Miller *et al.* (1993)	5208	Mytongate 75	Mytongate	Hull	EYR	14-15	main: pitfills, hearth, ash layer	L	7	4	NS	X	X
Milles (EAU 1992/36)	8214	West Lodge EAU 92/36	West Lodge	Malton	NYR	nd	eval; ditch and trackway fills	T	3	0	NS	X	X

Reference	EAB No.	EAB name	Site	Location	County	Date	Comments	Insects			Parasites		
								m	e	+	m	e	+
Milles *et al.* (EAU 1992/39)	1686	Castlethorpe I EAU 92/39	Castlethorpe 1, Scawby Brook	Brigg	NLN	nd	eval; no archaeological information	T	1	1	NS	X	X
Milles *et al.* (EAU 1992/40)	1687	Castlethorpe II EAU 92/40	Castlethorpe 2	Brigg	NLN	PH	eval; ditch	T	1	0	NS	X	X
Milles *et al.* (EAU 1992/41)	3848	Holgate Cattle Dock EAU 92/41	Holgate Cattle Dock	York	CoY	nd	eval; no clear context information	T	5	0	NS	X	X
Murton *et al.* (2001)	10796	Yarborough Quarry	Yarborough Quarry	nr Scunthorpe	NLN	LG	anal; peat	L	2	2	NS	X	X
Nicholson and Kenward (EAU 1986/22)	5989	Queen St (Newcastle) EAU 86/22	Queen Street	Newcastle	TaW	nd	archive ass; dumps and a drain fill	T	25	15	NS	X	X
Nicholson and Kenward (EAU 1987/17)	2342	Crown Court EAU 87/17	Crown Court	Newcastle	TaW	nd	archive ass; no record of context types	T	13	13	NS	X	X
Nicholson *et al.* (AML 41/89)	2043	Coffee Yd AML 41/89	Coffee Yard	York	CoY	MD PM	anal; floors and associated deposits (see also Robertson *et al.* 1989 for insects)	n/a	X	X	P	32	4
Osborne (1980)	6404	Seamer Carr AML 3063	Seamer Carr	nr Scarborough	NYR	?MS	anal; peat	T	7	5	X	X	X
Osborne (1994)	6703	South Shields Fort	South Shields	South Shields	TaW	RO	pitfill	L	1	1	NS	X	X
Osborne (1995)	1250	Brook Farm NWWS 3	Kate's Pond, Brook Farm	E of Fleetwood	LAN	NE	anal; peat	L	2	2	NS	X	X
Pearson (1962)	6530	St Bees (insects 1)	St Bees	St Bees	CUM	LG, HO	anal; detritus muds, probably kettle hole	O	16	16	NS	X	X
Penny *et al.* (1969)	2509	Dimlington	Dimlington		EYR	DV	interstadial laminated silts and sands	O	+	+	n/a	X	X
Perry (1981)	1191	Brigg Raft 1888	Brigg 'raft'	Brigg	NLN	LBA	statistical anal; natural, associated with 'raft' (see also Buckland 1981; Perry 1981)	n/a	X	X	n/a	X	X
Phillips (1980)	6348	Scale Ln/Lowgate 74	Scale Lane/Lowgate	Hull	EYR	MD	anal; concretion	n/a	X	X	?	1	1
Rackham (2001)	1783	Chapel Lane Staithe 2000	Chapel Lane Staithe	Hull	EYR	15-18	ass; foreshore and alluvial deposits ('beetles' etc. noted)	BS	15	14	NS	X	X
Rackham and Scaife (2002)	1579	Carr Lodge Farm 2000 EAC 24/02	Carr Lodge Farm, Loversall,	Loversall, nr Doncaster	SYR	IA nd	eval; ditch fills, ?tree hole (insects and Cladocera noted)	BS	13	6	NS	X	X

Reference	EAB No.	EAB name	Site	Location	County	Date	Comments	Insects			Parasites		
								m	e	+	m	e	+
Robertson *et al.* (EAU 1989/12)	2044	Coffee Yd EAU 89/12	Coffee Yard	York	CoY	MD PM	archive anal; floors and associated deposits (see also Nicholson *et al.* AML 41/89)	L	61	21	n/a	X	X
Robinson (2000)	3087	Former Stock Market (Brigg) OAU	former Stock Market	Brigg	NLN	LBA	ass; palaeosol	T	2	2	NS	0	0
Robinson (AML 1786)	8530	Winterton AML 1786	Winterton	nr Scunthorpe	NLN	nd	handwritten notes; well and ditches (see also Girling 1983)	L	6	6	X	X	X
Robinson (AML 2444)	1531	Carlisle 75 AML 2444	no site name	Carlisle	CUM	RO	brief report	L	3	2	n/a	X	X
Robinson in Carruthers (AML 11/93)	257	Ambleside AML 11/93	RO fort granary	Ambleside	CUM	RO	note re holed grain in botanical report	O	X	X	n/a	X	X
Roeder (1899) (or 2000)	4836	Manchester 1899	New Police Station, Bridgewater Street	Manchester	GRM	RO	pitfill; casual records	O	X	X	n/a	X	X
Roper (1996)	10797	Thorne Moors (raised mire insects)	Thorne Moors	Doncaster	SYR	nd	anal; prehistoric peats	L	9	9	n/a	X	X
Roper and Whitehouse (1994)	7271	Sutton Common 87-93	Sutton Common	N of Doncaster	SYR	IA	ass; various deposits	L	9	6	n/a	X	X
Rowland *et al.* (EAU 2001/24)	6594	Skellgarths EAU 2001/24	Skellgarths	Ripon	NYR	12/13-17	eval; layers, cut fill	T	4	1	NS	X	X
Sadler (1985)	10799	Sandtoft (RB)	Sandtoft	Hatfield Chase	SYR	RO	anal; ditch and river channel fills	L	6	6	-		
Samuels and Buckland (1978)	10798	Sandtoft	Sandtoft	E of Hatfield	NLN	RB	anal; ditch fills (no lists)	?	+	+	n/a	X	X
Schmidl *et al.* (PRS 2006/47)	-	-	Park View School	Chester-le-Street	DUR	RO	eval; ditch and cut fills	T	4	4	s	1	0
Seaward (1976)	7949	Vindolanda 71-6	Vindolanda	Chesterholme	NHU	RO	fort; mention of insect identifications	O	+	+	n/a	X	X
Skidmore (1971)	10800	Askern	Askern	Askern	SYR	PH	bog oak	O	+	+	n/a	X	X
Skidmore (1986)	4477	Lindow Moss	Lindow Moss	Wilmslow	CHE	IA	Diptera (see also Dayton 1986; Girling 1985; 1986a, b; Jones 1986)	n/a	+	+	n/a	X	X
Smith (1989)	7252	Subscription Rooms (Doncaster)	Subscription Rooms	Doncaster	SYR	?15	anal; ?floor	L	2	2	NS	X	X
Sudell (1990)	2397	Dalton Parlours 76	Dalton Parlours	Collingham, nr Wetherby	WYR	IA RO	anal; well fill	L	1	1	NS	X	X

Reference	EAB No.	EAB name	Site	Location	County	Date	Comments	Insects			Parasites		
								m	e	+	m	e	+
Tomlinson (1987)	6829	St Annes Ln (Nantwich) 85	St Anne's Lane	Nantwich	CHE	RO	plank tank fil	O	+	+	P	I	I
Trechmann (1947)	2659	Durham Coast (submerged forest)	Submerged forest beds	Durham Coast	DUR	MS	casual observation of 'Coleoptera'	O	+	+	X	X	X
Wagner (1999)	8720	Skelfrey Beck (Hawling Rd) 89	Skelfrey beck	Market Weighton	EYR	PH	notes only	?	+	+	NS	X	X
Wagner and Pelling (SEF 9404)	8568	Wood Hall SEF 9404	Wood Hall	Womersley	NYR	13-18	anal; moat fill	L	3	3	X	X	X
Walker *et al.* (1993)	3354	Gransmoor	Gransmoor	NW of Skipsea	EYR	LDV	anal; natural deposits	L	69	69	n/a	X	X
Whitehouse (1993)	10802	Thorne Moors (Urwald)	Thorne Moors	Thorne	SYR	MHO	thesis; data not abstracted	n/a	+	+	NS	X	X
Whitehouse (1997a)	3946	Humberhead Levels (pine-associated insects)	Humberhead levels	Humberhead Levels	SYR	PH	Discussion of *Pinus* insects	n/a	+	+	n/a	X	X
Whitehouse (1997b)	10801	Thorne Moors (mid-Holocene)	Thorne Moors	Thorne	SYR	BA	anal; peat associated with charred wood	L	8	8	-		
Whitehouse (2000)	10258	Forest fires and insects	Hatfield Chase and Thorne Moor		SYR	NE BA	Insects associated with burnt forests	X	X	X	n/a	X	X
Whitehouse *et al.* (2001b)	10803	Lindholme Island	Lindholme Island	Hatfield Moors	SYR	MHO	preliminary anal; peats	O	7	7	n/a		
Wilkinson (1989)	2245	Cowick 76	Cowick	nr Snaith	EYR	MD PM	14th and later moat; caddis	O	X	X	n/a	X	X
Wilkinson and Clapham (1996)	10804	Birkwoods	Birkwoods, Dale Bottom	Lake District NY 298225	CUM	?BA-IA	note; incidental records of caddis cases	O	X	X	n/a	X	X
Worsley *et al.* (1983)	5504	Oakwood Quarry 78-80	Oakwood Quarry	Chelford	CHE	DV	anal; natural deposits	L	4	4	n/a	X	X

Table 4. Reports concerning terrestrial and freshwater molluscs.

NOTE: Molluscs were looked for but not found (or present in not more than traces) in a significant proportion of the samples from sites listed in the insect table, and only sites for which useful results (ie more than traces of shells) were recorded, or where non-marine molluscs are considered specifically, are listed here (in some cases molluscs may have been present, but not mentioned in the report). Inclusion in this list is somewhat inconsistent as it has been compiled over a long period. A few early reports of unprovenanced material or of a few shells have been included for illustrative purposes. Some reports could not be traced and are omitted.

Abbreviations: anal- analysis report; L - list; n/a - not applicable or not available; P - processed using standard methods for mollusca (Evans 1972); S - sieved (not 'test' processing); T - test sample; + - terrestrial or freshwater Mollusca probably present in useful quantities. Counties: CHE - Cheshire; CLE - Cleveland; CoY - City of York; CUM - Cumbria; DUR - Durham; EYR - East Yorkshire; HAL - Halton; HUM - Humberside; LAN - Lancashire; MER - Merseyside; NEL - North East Lincoln; NHM - Northumberland; NLN - North Lincolnshire; NYR - North Yorkshire; SYR - South Yorkshire; TaW - Tyne and Weir; WYR - West Yorkshire. Periods: AN - Anglian; AS - Anglo-Scandinavian/Anglo-Saxon; B - before; BA - Bronze Age; DV - Devensian; E - early; HO - Holocene; L - late; IA - Iron Age; LG - Late Glacial; MD - medieval; M - mid; MO - modern; MS - Mesolithic; nd - not dated in environmental report; NE - Neolithic; P - post; PL - Palaeolithic; PM - post-medieval; PH - 'prehistoric'; RB - Romano-British; RO - Roman; SX - Saxon. Dates are centuries AD unless stated.

Author, date	EAB No.	EAB Name	Site	Location	County	date	How collected	Comments
Alldritt *et al.* (EAU 1990/01)	143	Adams Hydraulics I EAU 90/01	Adams Hydraulics 1	York	CoY	10-15/16	sieved to 0.3 mm	archive eval; pits, layers, ?river silts; some molluscs
Allen (1986)	8190	West Heslerton 78-82	West Heslerton	Malton/ Scarborough	NYR	NE	-	*Cecilioides acicula* only
Allen (AML 4144)	552	Allen AML 4144	Barnard Castle	Barnard Castle	DUR	MD	hand coll and sieved	archive anal; molluscs
Allen (AML 4203)	8346	Wharram Percy AML 4203	Wharram Percy	Wharram Percy	NYR	MD	sieved to 0.5 mm	archive anal; molluscs
Allison *et al.* (1990a)	2531	Dominican Friary (Beverley) AML 21/90	Dominican Friary	Beverley	EYR	?12-post 14	various	archive tech (see also Allison *et al.* 1996)

Author, date	EAB No.	EAB Name	Site	Location	County	date	How collected	Comments
Allison *et al.* (EAU 1990/05)	7080	Staniwells Farm EAU 90/05	Staniwells Farm	Hibaldstow	EYR	RO	sieved to 1 mm	archiveanl; mainly pit and ditch fills; some molluscs
Alvey (1996a)	2582	Dragonby 64-73	Dragonby		NLN	RO	hand coll	analysis
Bisat (1932)	-	-	Humber shore at North Ferriby		EYR	DV, PG	hand coll	not systematic
Boylan (1966)	-	-	Skipsea, Barmston, North Ferriby		EYR	LG, HO	-	anal; freshwater and terrestrial
Brothwell *et al.* (EAU 1995/11)	7521	Thirsk Castle 94 EAU 95/11	Thirsk Castle	Thirsk	NYR	AS-PMD	BS	eval; various deposits; traces of molluscs only
Cameron (1976)	1946	Church St (York) 72-3	Church Street	York	CoY	RO	sieved to 0.3 mm	anal; freshwater and terrestrial.
Cameron (1980)	3736	Hibaldstow AML 3041	Hibaldstow	Hibaldstow	EYR	none	soil samples, no mesh size specified	anal; freshwater and terrestrial
Carrott (PRS 2003/52)	9691	Auchinleck Close PRS 2003/52	Auckinleck Close	Driffield	EYR	LIA/ ERO	BS 1mm, 0.3 mm w/o	ass; terrestrial
Carrott *et al.* (1999)	4967	Melton	Ladder settlement	Melton	EYR	EIA, RB	6 samples, 0.3 mm	anal; terrestrial
Carrott (EAU 2000/55)	3048	Flixborough 89 EAU 2000/55	Flixborough	nr Scunthorpe	NLN	7-11	BS (mesh size not stated)	anal; freshwater, estuarine and terrestrial.
Carrott (PRS 2003/22	9665	Micklefield PRS 2003/22	Micklefield		WYR	IA/RO	BS 1 mm	ass; pit, small number of snails
Carrott (PRS 2003/52)	9691	Auchinleck Close PRS 2003/52	Auchinleck Close	Driffield	EYR	IA/ERO	sieved 0.3 mm	ass; cut fills
Carrott (PRS 2001/01)	7336	Swinescaif Quarry PRS 2001/01	Swinescaif Quarry	South Cave	EYR	LBA/ EIA	BS (mesh size not stated)	eval; pit, ditch and grave fills
Carrott *et al.* (EAU 1993/32)	2690	Easingwold By-pass 93 EAU 93/32	Crankleys Lane (Easingwold by-pass)	nr Easingwold	NYR	IA; MD	sieved to 0.3 mm	archive ass; various features; aquatics from two medieval samples
Carrott *et al.* (EAU 1995/53)	5787	Piccadilly (22) 87 EAU 95/53	22 Piccadilly (=ABC Cinema)	York	CoY	RO;14/15	sieved to 0.3 mm	ass; waterfront, various deposit types

Author, date	EAB No.	EAB Name	Site	Location	County	date	How collected	Comments
Carrott *et al.* (EAU 1994/22)	1601	Cartergate 94 EAU 94/22	Cartergate	Grimsby	NLN	13-17	sieved to 0.3 mm	eval; pit and ditch fills, and ?alluvium; large snail species only
Carrott *et al.* (EAU 1994/25)	4370	Lawrence St (148) 93 EAU 94/25	148 Lawrence Street	York	CoY	11-13	sieved to 0.3 mm	ass; urban, cuts and layers associated with structures including leper hospital ; traces of snails
Carrott *et al.* (EAU 1994/32)	2213	Cottam 93 EAU 94/32	Cottam	nr Sledmere	EYR	AN	sieved to 0.3 mm BS	ass; Anglian rural hilltop settlement; some molluscs
Carrott *et al.* (EAU 1994/49)	3767	High St (37) (Hull) EAU 94/49	37 High Street	Hull	EYR	14-later MD	sieved to 0.3 mm	ass; floor, occupation rubbish, cesspit fills (see also Carrott *et al.* 1994a); a few snails
Carrott *et al.* (EAU 1994/51)	418	4128	Aylesby	nr Grimsby	NLN	IA/RB	sieved to 0.3 mm	tech; ditches and pits; some snails
Carrott *et al.* (EAU 1995/03)	4128	Keldgate 94 EAU 95/03	Keldgate	Beverley	EYR	12-13	sieved to 0.3 mm	eval; floors, pits and others, some molluscs
Carrott *et al.* (EAU 1995/14)	8120	Wellington Row 88-9 EAU 95/14	Wellington Row	York	CoY	RO;PR; MD	sieved to 0.3 mm BS	ass; (aka Leedham's Garage, Stakis Hotel, sometimes Rougier Street)
Carrott *et al.* (EAU 1995/15)	1582	Carr Naze 94 EAU 95/15	Carr Naze	Filey	NYR	RO;PR	sieved to 0.3 mm, and BS	ass; Roman signal station, use and abandonment (see also Carrott *et al.* 1994c); traces of molluscs
Carrott *et al.* (EAU 1995/17)	4793	Magistrates Courts (Hull) 94 EAU 95/17	Magistrates' Court site	Hull	EYR	14-20	sieved to 0.3 mm BS	ass; pre-occupation, Friary, urban; some molluscs
Carrott *et al.* (EAU 1995/38)	7496	The Vivars EAU 95/38	The Vivars	Selby	NYR	?MD-post MD	sieved to 0.3 mm	eval; silting of putative abbey fishpond, only trace of molluscs
Carrott *et al.* (EAU 1995/37)	7659	Tower St (Hull) 95 EAU 95/37	Tower Street	Hull	EYR	17	sieved to 0.3 mm	eval; ditch and drain fills, ?flood deposits; occupation layers, some molluscs

Author, date	EAB No.	EAB Name	Site	Location	County	date	How collected	Comments
Carrott *et al.* (EAU 1996/09)	2169	Coppergate (16-22) EAU 96/09	16-22 Coppergate	York	CoY	PC	sieved to 0.3 mm BS	ass; post Norman conquest occupation deposits; some molluscs
Carrott *et al.* (EAU 1996/10)	8160	West Beck EAU 96/10	West Beck	Brigham, SE of Great Driffield	EYR	PH	sieved to 0.3 mm	ass; Flandrian; some molluscs
Carrott *et al.* (EAU 1996/17)	8129	Welton Low Rd EAU 96/17	Welton Low Road	Elloughton nr Brough, W of Hull	EYR	RO	sieved to 0.3 mm	eval; ditch fills; traces molluscs
Carrott *et al.* (EAU 1996/18)	6579	Skeldergate (47-51) EAU 96/18	47-51 Skeldergate	York	CoY	?MD	sieved to 0.3 mm	eval; ?pit, gully and boreholes; trace molluscs
Carrott *et al.* (EAU 1996/37)	5627	The Outgang 96 EAU 96/37	The Outgang	Driffield	EYR	MD	sieved to 0.3 mm	ass; rural., mostly ditch and gully fills; trace molluscs
Carrott *et al.* (EAU 1993/06)	847	Bishop Wilton 93 EAU 93/06	Bishop Wilton	Bishop Wilton	EYR	?	sieved to 0.3 mm	archive eval; kiln floor; one mollusc (see also Carrott *et al.* 93/9)
Carrott *et al.* (EAU 1993/05)	5350	North Beckside 93 EAU 93/05	North Beckside and Beckview Tilery	Beverley	EYR	13-17/18	sieved to 0.3 mm	archive eval; urban pit , garderobe and slot fills, layer, natural deposits, trace molluscs
Carrott *et al.* (EAU 1993/08)	6416	Selby (town centre) 93 EAU 93/08	Gowthorpe, Finkle Street and Micklegate	Selby	NYR	MD	sieved to 0.3 mm	archive eval; supposed natural deposits, fish pool, dumps, flood silt, ditch and pit fills; useful mollusc groups check
Carrott *et al.* (EAU 1993/09)	848	Bishop Wilton 93 EAU 93/09	Bishop Wilton	Bishop Wilton	EYR	?	sieved to 0.3 mm	archive eval; kiln floor (see also Carrott *et al.* 93/6); trace molluscs
Carrott *et al.* (EAU 1993/13)	3267	Glebe Farm 92 EAU 93/13	Glebe Farm	Barton-upon-Humber	EYR	RB mid-late 4	sieved to 0.3 mm	archive analysis: pit fills; aquatic and damp ground snails
Carrott *et al.* (EAU 1993/14)	5409	North St (York) 93 EAU 93/14	North Street	York	CoY	RO-MD	sieved to 0.3 mm BS	archive ass; riverfront deposits; some fw molluscs
Carrott *et al.* (EAU 1990/08)	3188	Garden Pl EAU 90/08	Garden Place	York	CoY	?PH-?MD	sieved to 0.3 mm	archive eval; mostly boreholes; some molluscs

Author, date	EAB No.	EAB Name	Site	Location	County	date	How collected	Comments
Carrott *et al.* (EAU 1991/12)	144	Adams Hydraulics II EAU 91/12	Adams Hydraulics II	York	CoY	?PH-18	sieved to 0.3 mm	archive eval; mostly boreholes, some layers; a few molluscs only
Carrott *et al.* (EAU 1991/15)	1557	Carmelite St EAU 91/15	Carmelite Street	York	CoY	?-16	sieved to 0.3 mm	archive eval; boreholes, medieval surface, dumps, alluvium; some snails
Carrott *et al.* (EAU 1991/16)	5793	Piccadilly (84) EAU 91/16	84 Piccadilly (= Fiat Garage site)	York	CoY	?AS-19	sieved to 0.3 mm	archive eval; boreholes, pond silts. layers, drain fills; molluscs
Carrott *et al.* (EAU 1991/17)	7147	Station Yd (Beverley) EAU 91/17	Station Yard	Beverley	EYR	?MD	sieved to 0.3 mm	archive eval; ditch fills; molluscs
Carrott *et al.* (EAU 1992/08)	5791	Piccadilly (50) EAU 92/08	50 Piccadilly	York	CoY	2-3, 11-15	sieved to 0.3 mm	archive eval ; riverside dumps, reclamation, cut fills, some molluscs
Carrott *et al.* (EAU 1992/09)	5788	Piccadilly (38) EAU 92/09	38 Piccadilly	York	CoY	RO-17	sieved to 0.3 mm	archive eval; mostly pond silts, but some dumps, some aquatic molluscs
Carrott *et al.* (EAU 1992/10)	4909	Marygate (26-8) EAU 92/10	26-28 Marygate	York	CoY	3	sieved to 0.3 mm	archive eval; ?buried soil, pit and grave fills, spread, some land molluscs
Carrott *et al.* (EAU 1992/12)	160	Albion St 92 EAU 92/12	Albion Street	Driffield	EYR	RO, MD	sieved to 0.3 mm	archive eval; Rom pit and ditch, med pit; some snails but no insects
Carrott and Large (EAU 1997/29)	8130	Welton Low Rd EAU 97/29	Welton Low Road	Elloughton, near Brough	EYR	RO	GBA and BS	eval; lans and freshwater snails
Carrott *et al.* (EAU 1996/50)	6074	Rectory Ln EAU 96/50	Rectory Lane, Beeford	ESE of Great Driffield	EYR	IA	bulk-sieved and sieved to 0.3 mm	eval; ditch fills
Carrott *et al.* (EAU 1997/25)	4379	Layerthorpe Bridge EAU 97/25	Layerthorpe Bridge and Peasholme Green	York	CoY	RO-EMO	sieved to 0.3 mm	ass; river deposits, dumps, associated deposits; molluscs rare except in early modern
Carrott *et al.* (EAU 1997/01)	2103	Coney St (3-7) EAU 97/01	3-7 Coney Street	York	CoY	none	GBA	surface deposit, one with trace of aquatic molluscs

Author, date	EAB No.	EAB Name	Site	Location	County	date	How collected	Comments
Carrott *et al.* (EAU 1994/50)	8133	Welton Rd 94 EAU 94/50	Welton Road	Brough	EYR	RO	GBA	traces only
Carrott *et al.* (EAU 1997/14)	6620	Smaws Quarry EAU 97/14	Smaws Quarry	near Tadcaster	NYR	none	GBA	eval; ditch fills; some terrestrial snails
Carrott *et al.* (EAU 98/17)	2964	Figham Common EAU 98/17	Figham Common	Beverley	EYR	L12/E 13-13	GBA, hand coll	eval; peat deposit, silt, ditch fills
Carrott *et al.* (EAU 1994/07)	1580	Carr Naze 93 EAU 94/07	Carr Naze	Filey		RO	sieved to 0.3 mm	ass: traces molluscs
Carrott *et al.* (PRS 2002/24)	3790	High St/Long St (Rudston) PRS 2002/24	land at the junction of High Street and Long Street	Rudston	EYR	PH	sieved to 0.3 mm	Ass; ditch fill
Carrott (PRS 2003/35)	9676	Ferrybridge PRS 2003/35	Ferrybridge		WYR	NE BA IA RB	BS 1mm/300 microns	anal: various features
Carter (1997)	2392	Dale Ln 97 HA	Dale Lane, South Elmsall	NE Doncaster	WYR	?IA	sieved to 0.5 and 1 mm	anal; ditch and pit fills
Carter (2001)	659	Becca Banks (A1-M1) 92-8	Becca Banks		WYR	RB-13	sieved	anal: ditch fills
Castell (1963)	8426	Willerby Wold 58-60	Willerby Wold Long Barrow	near Filey	NYR	NE	?hand collected	large landsnails
Cowell *et al.* (1993)	3084	Formby Point Beach	Formby Point Beach	Formby	MER	NE or EBA	sieved to 0.3 mm	preliminary; molluscs present
Dainton *et al.* (EAU 1992/15)	3266	Glebe Farm 92 EAU 92/15	Glebe Farm	Barton-upon-Humber	NLN	RO	sieved to 0.3 mm	archive eval; RB ditch, pit and other cut fills, a few molluscs
Davis (1954)	7103	Stanwick	Stanwick		NYR	IA	not stated	ditch fills
Davis (1961)	2434	Davygate 55-8	Davygate	York	CoY	RO	?	Freshwater and terrestrial snails
Dobney *et al.* (EAU 1992/21)	4287	Knights Hospitallers EAU 92/21	Knights Hospitallers	Beverley	EYR	MD	sieved to 0.3 mm	anal; mid 13th floor
Dobney *et al.* (EAU 1993/19)	5588	Orchard Fields 92 EAU 93/19	Orchard Fields	Malton	NYR	RO	sieved to 0.3 mm	archive eval; various layers and cut fills; numerous molluscs
Dobney *et al.* (EAU 1994/18)	3516	Hall Garth 80 EAU 94/18	Hall Garth	Beverley	EYR	MD -mod	sieved to 1.0 mm	tech; medieval moat; large mollusc report

Author, date	EAB No.	EAB Name	Site	Location	County	date	How collected	Comments
Dobney *et al.* (EAU 1993/21)	3050	Flixborough 89 EAU 93/21	Flixborough	Flixborough	NLN	?RO-MD	sieved to 0.3 mm BS	archive ass; wide range of context types, principally Anglo-Saxon; some molluscs
Dobney *et al.* (EAU 1994/60)	3517	Hall Garth 80 EAU 94/60	Hall Garth	Beverely	EYR	pre-14-20	sieved to 1 mm, hand coll	ass; moat fills
Dobney *et al.* (EAU 1996/26)	1583	Carr Naze 93-4 EAU 96/26	Carr Naze	Filey	NYR	RO	BS, hand coll	tech: various deposits associated with signal station
Donaldson and Rackham (AML 2931)	5447	Norton Mill AML 2931	Norton Mill		CLE	modern	culvert and mill pond sediments	300 micron mesh
Evans (1969b)	1290	Brough-on-Humber 58-61	Brough-on-Humber		EYR	?RO	from 'soil samples'	small assemblage from one
Evans (AML 1826)	5158	Mount Grace Priory AML 1826	Mount Grace Priory	Osmotherley	NYR	'MD'	not specified; presumably hand collected	small numbers of large species
Evans (AML 1823)	8331	Wharram Percy AML 1823	Wharram Percy	Wharram Percy	NYR	none	hand collected	numerous records
Evans (1979)	8321	Wharram Percy Church 62-79	Wharram Percy	Wharram Percy	NYR	E 15-20	hand collected	large species (also trace of marine shell)
Evans (AML 1775)	1715	Catterick AML 1775	'Catterick'	Catterick	NYR	none	not specified	4 *L. peregra* only
Evans (AML 1834)	1716	Catterick AML 1834	Catterick	Catterick	NYR	none ?RO	not specified; presumably hand collected	2 individuals of large species
Evans (AML 1829)	3905	Housesteads AML 1829	Housesteads	Birkshaw (Hadrians Wall)	NHU	none ?RO	not specified; presumably hand collected	six individuals of large species
Evans (AML 1771)	8529	Winterton AML 1771	Winterton Roman villa	nr Scunthorpe	NLN	RO	not specified; presumably hand collected	three landsnails only
Evans (AML 1820)	719	Beeston Castle AML 1820	Beeston Castle	Beeston	CHE	none	not specified, presumably hand coll	small numbers of landsnails

Author, date	EAB No.	EAB Name	Site	Location	County	date	How collected	Comments
Evans (AML 1776)	717	Beeston Castle AML 1776	Beeston Castle	Chester/ Nantwich	CHE	‘MD’ ‘MD/ PMD’	not specified, presumably hand coll	small group of landsnails
Gale *et al.* (1985)	4252	Kirkhead Cave	Kirkhead Cave	Allithwaite, nr Grange over Sands	CUM	PH:UP	sieved to 0.063 mm	anal; long succession
Hall *et al.* (EAU 2000/25)	4790	Magistrates Courts (Hull) 94 & 99 EAU 2000/25	Magistrates’ Courts site	Kingston-upon-Hull	EYR	MD	various methods	anal
Hall and Carrott (EAU 2001/36)	2755	Eastgate South (Driffield) EAU 2001/36	Eastgate South	Driffield	EYR	RB	sieved to 0.3 mm	eval; pit fills
Hall *et al.* (EAU 1990/09)	2628	Dundas St EAU 90/09	Dundas Street	York	NYR	MD	sieved to 0.3 mm	archive eval; boreholes; molluscs
Hall and Nicholson (EAU 1991/27)	4273	Kirmington Runway 91 EAU 91/27	Kirmington Runway	??	EYR	LBA /EIA	BS	archive; pit fills
Hall and Kenward (1990)	6224	Rougier St (5) 81	Rougier Street	York	CoY	RO-MD	sieved to 0.3 mm; also BS	anal
Hall and Kenward (1990)	3215	General Accident Ext 83-4	General Accident (Tanner Row)	York	CoY	RO-MD	sieved to 0.3 mm; also BS	anal
Hall *et al.* (PRS 2002/41)	9635	Elloughton (Transco Pipeline) PRS 2002/41	Elloughton	nr South Cave	EYR	LIA/RB	BS 1mm/300mm	eval; various deposits
Hill (1993)	10794	Thornton	Thornton	nr Melbourne	EYR	IA-RO-PR-14	sieved to 0.3 mm	thesis; lake muds, fen peat
Huntley, J. P. (DEAR 03/96)	5821	Pits Plantation DEAR 3/96	Pits Plantation	Rudston	EYR	BA; RB	sieved to 0.5 mm	assess; various features
Issitt *et al.* (EAU 1995/16; 1995)	4680	Low Hauxley EAU 95/16	Low Hauxley	Low Hauxley, Amble-by-the-Sea	NHU	PH;?MS;BA	sieved to 0.3 mm BS	ass; buried soil and waterlain peats
Issitt *et al.* (EAU 1995/09)	8134	Welton Rd 94 EAU 95/09	Welton Road	Brough	EYR	RO	sieved to 0.3 mm	eval; cut and ditch fills; some molluscs

Author, date	EAB No.	EAB Name	Site	Location	County	date	How collected	Comments
Jaques *et al.* (EAU 2001/34)	8081	Wath Quarry EAU 2001/34	Wath Quarry	Wath	NYR	NE	sieved to 0.3	ass; ditch and pit fills
Keen *et al.* (1984)	4154	Kildale Hall 2	Kildale Hall	Kildale	NYR	LDV, EHO	'30 mesh sieve';	detailed analysis
Keepax (AML 2449)	721	Beeston Castle AML 2449	Beeston Castle	Beeston	CHE	MD	sieved to 0.425 mm	miscellaneous; traces of insects and molluscs
Kenward and Hall (1995)	2126	Coppergate (16-22) (Anglo-Scand)	16-22 Coppergate	York	CoY	AS	sieved to 0.3 mm BS	anal; some landsnails
McKenna (1991)	4727	Lurk Ln 79-82	79-82 Lurk Lane	Beverley	EYR	AN-MD	sieved to 1 mm	one assemblage (see also McKenna EAU 1984/16)
McMillan (1985).	6679	South Castle St 76-7	South Castle Street	Liverpool			not seen	
Milles *et al.* (EAU 1992/39)	1686	Castlethorpe I EAU 92/39	Castlethorpe 1, Scawby Brook	Brigg	NLN	none	sieved to 0.3 mm	archive eval; no archaeological information; primarily molluscs
Milles (1996)	1746	Caythorpe Pipeline	Gas pipeline	Caythorpe	EYR	PH: NE, BA	BS and as Evans (1972)	pub; almost no snails (see also Milles EAU 1992/34)
Milles (EAU 1992/34)	1745	Caythorpe Gas Pipeline EAU 92/34	Gas pipeline	Caythorpe	EYR	PH: NE, BA		(see Milles (1996)
Milles (EAU 1992/36)	8214	West Lodge EAU 92/36	West Lodge	Malton	NYR	-	No copy available	-
Milles *et al.* (EAU 1992/40)	1687	Castlethorpe II EAU 92/40	Castlethorpe 2	Brigg	NLN	PH	sieved to 0.3 mm	archive eval; ditch fill, molluscs only
Milles and Kenward (EAU 1992/42)	8215	West Lodge EAU 92/42	West Lodge	Malton	NYR	none	sieved to 0.3 mm	archive eval; ditch and trackway fills. primarily molluscs
Milles and O'Connor (1996)	1279	Brough St Giles (hospital) 88-90	St Giles by Brompton Bridge	between Catterick and Richmond	NYR	13-18	sieved	pub; freshwater and terrestrial
Milles, A. (AML 114/93)	2951	Ferrybridge Henge AML 114/93	Ferrybridge Henge	near Castleford	WYR	IA; RO	as Evans (1972)	anal; buried soil, ditch fill; useful assemblages in sequence
Milles (EAU 1992/38)	2950	Ferrybridge Henge 91 EAU 92/38	Ferrybridge Henge	near Castleford	WYR	NE BA IA	as Evans (1972)	see Milles 1993

Author, date	EAB No.	EAB Name	Site	Location	County	date	How collected	Comments
Nicholson (1989b)	2339	Crown Court 85-6	Crown Court, Quayside	Newcastle upon Tyne	T+W	early 14	-	one group from below a street surface
Norris *et al.* (1971)	8698	Burton Salmon 69	Burton Salmon	near Ferrybridge	WYR	7000-5000BP	full recovery	freshwater
Norris (1983)	6329	Sandal Castle 64-73	Sandal Castle	Weatherby-Leeds	WYR	12-17	hand collected	larger landsnails
O'Connor (AML 2449)	721	Beeston Castle AML 2449	Beeston Castle	Chester/ Nantwich	CHE	MD	not specified	a few snails
O'Connor (AML 1/86)	6887	St Georges Field AML 1/86	St George's Field	York	CoY	none	sieved to 1 mm	would be useful assemblage if dated
O'Connor (AML 4768)	3221	Tanner Row (24-30) AML 4768	General Accident Extension (=Tanner Row)	York	CoY	RO-MD	hand collected, bulk-sieved to 1mm	wide range of context types
O'Connor (AML 4735)	2153	Coppergate (16-22) AML 4735	16-22 Coppergate	York	CoY	AS	bulk-sieving to 1 or 2 mm; some from 0.3 mm	terrestrial and freshwater (see publication report, Kenward and Hall 1995)
O'Connor (AML 4709)	2223	County Hospital AML 4709	County Hospital ('Jewbury soft spot')	York	CoY	??PRO	sieved to 0.5 mm	from enigmatic depression
O'Connor (AML 4507)	2177	Coppergate Helmet AML 4507	Coppergate/ Piccadilly ('helmet pit')	York	CoY	AN/AS	>2 mm fraction	trace of landsnails
Rackham (AML 4788)	892	Blackfriars (Newcastle) AML 4788	Blackfriars	Newcastle	T+W	16-18	hand coll, sediment samples sieved to 0.85 mm	
Rackham (AML 4216)	889	Blackfriars (Newcastle) AML 4216	Blackfriars	Carlisle	CUM	MD	hand coll	traces only
Roeder (1899)	4836	Manchester 1899	near Collier Street	Manchester	GRM	RO	hand collected	marsh deposits
Spaul (1973)	6102	Rest Park 63	Rest Park	4 km E of Sherburn in Elmet	NYR	MD or PM?	not stated	moated manor; moat fill. All aquatics
Spencer (1988)	3615	Hasholme Logboat 84	Hasholme logboat	nr Holme-on-Spalding Moor	HUM	IA	-	fragmentary remains only

Author, date	EAB No.	EAB Name	Site	Location	County	date	How collected	Comments
Thew (AML 14/89)	3571	Hardendale Nab AML 14/89	Hardendale Nab	Shap	CUM	BA to RO or AS	0.5 mm mesh	anal
Thew and Wagner (1991)	3201	Garton Station 85-6	Garton Station and Kirkburn	nr Driffield	EYR	NE, BA, IA, AN	0.5 mm mesh	anal; ditches, graves. barrow
Thew and Woodall (1984)	6605	Skipsea Withow Mere (b)	Skipsea Withow Mere	Skipsea	EYR	PH	-	Late Glacial and Holocene natural deposits (see also Gilbertson 1984; Gilbertson *et al.* 1987)
Tooley *et al.* (1982)	6405	Seamer Carrs (Tees) (red deer)	Seamer Carr	Seamer	NYR	MS	sediment samples	7360±120 bp, sediment round deer skeleton
Trechmann (1947)	2659	Durham Coast (submerged forest)	Submerged forest beds	Durham Coast	DUR	MS	'washing'	freshwater and damp ground; species list only
Varley (1968).	538	Barmston Crannog 60-1	Barmston Crannog	Driffield/Bridlington	EYR		-	molluscs studied by Boylan 1966
Wagner (2004)	-	-	East Field and The Pit	Burton Agnes	EYR	IA	-	anal; ditch and pit fills
Wagner (2004)	-	-	Hangling Cliff	Kilham	EYR	IA	-	anal; ditch fills
Wagner (2004)	-	-	North Wood, Denby Farm and The Enclosure	Rudston	EYR	IA	-	anal; pit and ditch fills
Wagner and Pelling (SEF 9404)	8568	Wood Hall SEF 9404	Wood Hall	Womersley	NYR	13-18	0.3 mm mesh	anal; moat fill

REFERENCES

A. Conventional references

Abbott, A. (2001). Earliest malaria DNA found in Roman baby graveyard. *Nature* 412, 847.

Adam, W. (1960). *Faune de Belgique. Mollusques 1. Mollusques terrestres et dulcicoles.* Brussels: L'Institute Royal de Sciences Naturelles de Belgique.

Adams, C. G. (1981). *Foraminifera*, pp. 185-6 in McGrail, S. (ed.), The Brigg 'raft' and her prehistoric environment. *B. A. R. British Series* 89. Oxford.

Arobba, D. and Murialdo, G. (1996). Analysis of botanical remains of the first century B. C. found near the 'Pieve del Finale' (Finale Liguria, Italy). *Allionia* (Turin) 34, 55-61. [not seen in original]

Addyman, P. V. (1980). Eburacum, Jorvik, York. *Scientific American* 242, 76-86.

Addyman, P. V. (1989). The archaeology of public health at York, England. *World Archaeology* 21, 244-264.

Addyman, P. V. and Hall, R. A. (1991). Urban structures and defences. Lloyds Bank, Pavement and other sites, with a survey of defences north-east of the Ouse. *The Archaeology of York* 8 (3).

Addyman, P. V., Hood, J. S. R., Kenward, H. K., MacGregor, A. and Williams, D. (1976). Palaeoclimate in urban environmental archaeology at York, England: problems and potential. *World Archaeology* 8, 220-233.

Aitken, A. D. (1975). *Insect travellers* I*, Coleoptera.* London: HMSO.

Akeret, Ö., Haas, J. N., Leuzinger, U. and Jacomet, S. (1999). Plant macrofossils and pollen in goat/sheep faeces from the Neolithic lake-shore settlement Arbon Bleiche 3, Switzerland. *The Holocene* 9, 175-182.

Albarella, U. (2001) (ed.). *Environmental archaeology: meaning and purpose.* Dortrecht: Kluwer.

Albarella, U. and Mulville, J. (in litt. 2003). [Eating limpets in Italy, and limpets cooked with garlic]. Contribution to Zooarchaeology Newsgroup.

Alexander, K. N. A. (1998). The links between forest history and biodiversity: the invertebrate fauna of ancient pasture-woodlands in Britain and its conservation, pp. 73-80 in Kirby, K. J. and Watkins, C. (eds.), *The ecological history of European forests*. Wallingford, Oxfordshire: CAB International.

Allen, J. A. (1967). *Marine shells and fishbones*, p. 96 in Jobey, G., Excavations at Tynemouth Priory and Castle. *Archaeologia Aeliana* 4th series 45, 33-104.

Allen, M. (1986). *Molluscs*, Fiche M2/50 in Powlesland, D., Haughton, C. and Hanson, T., Excavations at Heslerton. *Archaeological Journal* 143, 53-173.

Allen, T. G. and Robinson, M. A. (1993). The prehistoric and Iron Age enclosed settlement at Mingies Ditch, Hardwick-with-Yelford, Oxon. *Thames Valley Landscapes: the Windrush Valley* 2. Oxford: Oxford University Committee for Archaeology.

Alley, R. B. (2000). Ice-core evidence of abrupt climate changes *Proceedings of the National Association for Science* 97, 1331-1334.

Alley, R. B., Mayewski, P. A., Sowers, T., Stuiver, M., Taylor, K. C. and Clark, P. U. (1997). Holocene climatic instability: a prominent, widespread event 8200 yr ago. *Geology* 25, 483-486.

Allison, E. P. (1979). Birds of a feather.... *Interim* 6 (3), 33-8. [Introduction to the study of bird remains from archaeological deposits.]

Allison, E. P. (2003). Insects from a late 13th/early 14th century hearth, [paging not clear in on-line version] in *Charter Quay, the spirit of change*. Wessex Archaeology 2003.

Allison, E., Carrott, J., Hall, A., Kenward, H., Large, F., McKenna, B. and Robertson, A. (forthcoming a). [Plant and invertebrate remains from Iron Age and Romano-British deposits at North Cave, East Yorkshire].

Allison, E. and Hall, A. (2001). *The plant and invertebrate remains*, pp. 334-338 in Hicks, M. and Hicks, A., St Gregory's Priory, Northgate, Canterbury excavations 1988-1991. *The Archaeology of Canterbury* New Series 2. Canterbury: Canterbury Archaeological Trust.

Allison, E. P. and Kenward, H. K. (1990). Hopping mad? Fleas from archaeological deposits. *Interim (Archaeology in York)* 15 (1), 27-33.

Allison, E. P. and Kenward, H. K. (1991). Those were lousy times! Lice from ancient York. *Interim (Archaeology in York)* 16 (2), 22-28.

Allison, E. P., Hall, A. R., Jones, A. K. G., Kenward, H. K., O'Connor, T. P. and Robertson, A. (1996a). *Report on plant and invertebrate remains*, Fiche 2:C1-G7 in Kemp, R. L. and Graves, C. P., The church and Gilbertine priory of St Andrew, Fishergate. *The Archaeology of York* 11 (2), 41-340 + xx + Fiche 2.York: Council for British Archaeology.

Allison, E. P., Hall, A. R., Jones, A. K. G., Kenward, H. K. and Robertson, A. (1996b). *Report on plant and invertebrate remains*, pp. 85-105 in Kemp, R. L, Anglian settlement at 46-54 Fishergate. *The Archaeology of York* 7 (1), 1-114 + v. York: Council for British Archaeology.

Allison, E. P., Hall, A. R., Jones, A. K. G., Kenward, H. K., O'Connor, T. P., Phipps, J. and Tomlinson, P. R. (1990c). *5 Rougier Street*, pp. 378-85 in Hall, A. R. and Kenward, H. K., Environmental evidence from the Colonia: General Accident and Rougier Street. *The Archaeology of York* 14 (6), 289-434 + Plates II-IX + Fiche 2-11. London: Council for British Archaeology.

Allison, E. P., Hall, A. R., Kenward, H. K., McKenna, W. J. B., Nicholson, C. M. and O'Connor, T. P. (1996c). *Environmental evidence*, pp. 195-212 and references pp. 267-73 in Foreman, M., Further excavation at the Dominican Priory, Beverley, 1986-89. *Sheffield Excavation Reports* 4. Sheffield.

Allison, E. P., Hutchinson, A., Jones, A. K. G., Kenward, H. K. and Morgan, L. M. (1991a). *pp. 849 passim and 65-72* in McCarthy, M. R., The structural sequence and environmental remains from Castle Street, Carlisle: excavations 1981-2. *Cumberland and Westmorland Antiquarian and Archaeological Society Research Series* 5 (fascicule 1).

Allison, E. P., Hutchinson, A., Kenward, H. K., Jones, A. K. G., and Morgan, L. M. (1991b). *passim* in volume and fiche in McCarthy, M. R., The Roman waterlogged remains and later features at Castle Street, Carlisle:

excavations 1981-2. *Cumberland and Westmorland Antiquarian and Archaeological Society Research Series* 5 (main volume).

Allison, E. P. and Kenward, H. K. (forthcoming). [The insect remains], in Caruana, I. (ed.), [Excavations at Annetwell Street, Carlisle].

Alvey, R. C. (1996a). *Land molluscs*, p. 170-171 in May, J., Dragonby. Report on excavations at an Iron Age and Romano-British settlement in North Lincolnshire. *Oxbow Monograph* 61. Oxford.

Alvey, R. C. (1996b). *Marine molluscs*, p. 171 in May, J. Dragonby. Report on excavations at an Iron Age and Romano-British settlement in North Lincolnshire. *Oxbow Monograph* 61. Oxford.

Ammann, B., Birks, H. J. B., Brooks, S. J., Eicher, U., von Grafenstein, U., Hofman, W., Lemdahl, G., Schwander, J.. Tobolski, K. and Wick, L. (2000). Quantification of biotic responses to rapid climatic changes around the Younger Dryas - a synthesis. *Palaeogeography, Palaeoclimatology, Palaeoecology* 159, 313-347.

Amorosi, T., Buckland, P. C., Olafsson, G., Sadler, J. P. and Skidmore, P. (1992). Site status and the palaeoecological record: a discussion of the results from Bessastadir, Iceland, pp. 169-191 in Morris, C. D. and Rackham, D. J. (eds.), *Norse and later settlement and subsistence in the North Atlantic*. Glasgow: Department of Archaeology, University of Glasgow.

Amorosi, T., Buckland, P. C., MagnússonN, K., McGovern, T. H. and Sadler, J. P. (1994). *An Archaeozoological Investigation of the Midden at Nesstofa, Reykjavík, Iceland*, pp. 69-79 in Luff, R. and Rowley-Conwy, P. (eds.), Whither Environmental Archaeology, 69-80. *Oxbow Monograph* 38. Oxford.

Amsden, A. F., & Boon, G. C. (1975). C. O. Waterhouse's list of insects from Silchester (With a note on early identifications of insects in archaeological contexts). *Journal of Archaeological Science* 2, 129-136.

Andersen, J. (1993). Beetle remains as indicators of the climate in the Quaternary. *Journal of Biogeography* 20, 557-562.

Anderson, D. E., Binney, H. A. and Smith, M. A. (1998). Evidence for abrupt climatic change in northern Scotland between 3900 and 3500 calendar years BP. *The Holocene* 8, 97-103.

Anderson, J. L. (1981). History and climate: some economic models. In Wigley, T. M. L., Ingram, M. J. and Farmer, G. (eds), Climate and history. Cambridge: University Press.

Anderson, R. (1989). Haughey's Fort: analysis of an insect death assemblage. *Emania* 6, 37-42.

Andersson, G. (1992). Arkeo-entomologiska undersökningar tid i Göteborg. *Entomologisk Tidskrift* 113, 7-14.

Angel, M. (1993). Marine planktonic ostracods. Keys and notes for the identification of the species. *Synopses of the British fauna (new series)* 48, 239 pp. Shrewsbury: Linnean Society etc.

Andreev, A. A., Tarasov, P. E., Ilyashuk, B. P., Ilyashuk, E. A., Cremer, H., Hermichen, W-D., Wischer, F. and Hubberten, H-W. (2005). Holocene environmental history recorded in Lake Lyadhej-To sediments, Polar Urals, Russia. *Palaeogeography, Palaeoclimatology, Palaeoecology* 223, 181-203.

Anon (1904). On oriental carpets. Article VI-the art of dyeing. *The Burlington Magazine for Connoiseurs* 4 (11), 143-147.

Anon [Kenward, H. and Robertson, A.] (1985). Cover illustration of *Circaea* 3 (1).

Arias, M. C. and Sheppard, W. S. (1996). Molecular phylogenetics of honey bee subspecies (Apis mellifera L.) inferred from mitochondrial DNA sequence. *Molecular Phylogenetics and Evolution* 5, 557-566.

Armour-Chelu, M. and Andrews, P. (1991). Bone dispersal by earthworms. *Symposia of the Zoological Society of London* 63, 301-3.

Armour-Chelu, M. and Andrews, P. (1994). Some effects of bioturbation by earthworms (Oligochaeta). *Journal of Archaeological Science* 21, 433-43.

Arobba, D. and Murialdo, G. (1996). Analysis of botanical remains of the first century B. C. found near the 'Pieve del Finale' (Finale Liguria, Italy). *Allionia* (Turin) 34, 55-61.

Arthur, D. R. (1963). *British Ticks*. London: Butterworth.

Arthur, F. H. (2001). Immediate and delayed mortality of *Oryzaephilus surinamensis* (L.) exposed on wheat treated with diatomaceous earth: effects of temperature, relative humidity, and exposure interval. *Journal of Stored Products Research* 37, 13-21.

Ashkenazi, S., Motro, U., Goren-Inbar, N., Biton, R. and Rabinovich, R. (2005). New morphometric parameters for assessment of body size in the fossil freshwater crab assemblage from the Acheulian site of Gesher Benot, Ya'aqov, Israel. *Journal of Archaeological Science* 32, 675-689.

Ashworth, A. C. (1972). A Late-glacial Insect Fauna from Red Moss, Lancashire, England. *Entomologica Scandinavica* 3, 211-224.

Ashworth, A. C. (2004). Quaternary Coleoptera of the United States and Canada. *Developments in Quaternary Science* 1, 505-517.

Ashworth, A. C., Buckland, P. C. and Sadler, J. P. (eds.) (1997). Studies in Quaternary entomology - and inordinate fondness for insects. *Quaternary Proceedings* 5. Chichester, UK: Wiley.

Aspock, H., Auer, H., Picher, O. and Platzer, W. (2000). Parasitological examination of the Iceman, pp. 127-136 in Bortenschlager, S. and Oeggl, K (eds.), *The iceman and his natural environment. Palaeobotanical results*. Vien and New York: Springer.

Association for Environmental Archaeology [Dobney, K., Ervynck, A., Hall, A., Jones, A., Kenward, H., Milles, A., Mulville, J., Payne, S. and Whittaker, K.] (1995). Environmental archaeology and archaeological evaluations. Recommendations concerning the environmental archaeology component of archaeological evaluations in England. *Working Papers of the Association for Environmental Archaeology* 2, 8 pp. York: Association for Environmental Archaeology.

Athersuch, J. Horne, D. J. and Whittaker, J. E. (1989). Marine and brackish water ostracods (superfamilies Cypridacea and Cytheracea). Keys and notes for the identification of the species. *Synopses of the British fauna (new series)* 43, 343 pp. + plates 1-7. Leiden etc.: E. J. Brill. Atkinson, T. C., Briffa, K. R. and Coope, G. R. (1987). Seasonal temperatures in Britain during the past 22,000 years, reconstructed using beetle remains. *Nature* (London), 325, 587-592.

Atkinson, T. C., Briffa, K. R., Coope, G. R., Joachim, M. J. and Perry, D. W. (1986). Climatic calibration of coleopteran data, pp. 851-858 in Berglund, B.E. (ed.), *Handbook of Holocene palaeoecology and palaeohydrology*. Chichester etc: Wiley.

Attenborough, D. (1984). *The living planet. A portrait of the earth.* London: Guild Publishing.

Attenborough, D. (1990). *The trials of life. A natural history of animal behaviour.* London: HarperCollins. Also a substantially enlarged edition (1992), Pleasantville, New York: Reader's Digest.

Baalam, N. D., Bell, M. G., David, A. E. U., Levitan, B., Macphail, R. I., Robinson, M. and Scaife, R. G. (1987). *Prehistoric and Romano-British sites at Westward Ho!, Devon. Archaeological and palaeoenvironmental surveys 1983 and 1984*, pp. 163-264 in Balaam, N. D., Levitan, B. and Straker, V. (eds), Studies in palaeoeconomy and environment in South West England. *BAR British Series* 181. Oxford.

Backlund, H. O. (1945). Wrack Fauna of Sweden and Finland ecology and chorology. *Opuscula Entomologica Supplementum* 5. Lund: Entomologiska Sällskapet.

Bada, J. L., Wang, X. S. and Hamilton, H. (1999). Preservation of key biomolecules in the fossil record: current knowledge and future challenges. *Philosophical Transactions of the Royal Society of London Biological Sciences* 354, 77-87.

Baillie, M. G. L. (1994). Dendrochronology raises questions about the nature of the AD 536 dust-veil event. *The Holocene* 4, 212-217.

Baillie, M. G. L. (1995). Patrick, Comets and Christianity. *Eemania* 13, 69-78.

Baillie, M. (1999). *Exodus to Arthur : Catastrophic Encounters With Comets*. London: Batsford.

Bain, A. (1998). A seventeenth-century beetle fauna from Colonial Boston. *Historical Archaeology* 32 (3), 38-48. [NB parts separately paged]

Bain, A. and LeSage, L. (1998). A late seventeenth century occurrence of *Phyllotreta striolata* (Coleoptera: Chrysomelidae) in North America. *Canadian Entomologist* 130, 715-719.

Bakels, C. C. (1997). The beginnings of manuring in western Europe. *Antiquity* 71, 442-445.

Baker, J. and Brothwell, D. (1980). *Animal diseases in archaeology.* London: Academic.

Baker, J. T. (1975). Tyrian purple: an ancient dye, a modern problem. *Conchologists Newsletter* 53, 428-434.

Baker, R. G., Schwert, D. P., Bettis III, E. A. and Chumbley, C. A. (1993). Impact of Euro-American settlement on a riparian landscape in northern Iowa, midwestern USA: an integrated approach based on historical evidence, floodplain sediments, fossil pollen, plant macrofossils and insects. *The Holocene* 3, 314-323.

Balachowsky, A. (1949). Coléoptères scolitides. *Faune De France* 50. Paris: Lechavalier.

Balachowsky, A. and Mesnil, L. (1935-36). *Les insectes nuisibles aux plantes cultivées* 1-2. Paris: Lechevalier.

Balfour-Brown, J. (1954). [insect remains], p. 95 in Clark, J. G. D., *Excavations at Star Carr. An early Mesolithic site at Seamer near Scarborough, Yorkshire.* Cambridge: University Press.

Balfour-Browne, F. (1958). *British water beetles* 3. London: Ray Society.

Ball, I. R. and Reynoldson, T. B. (1981). British planarians. Platyhelmithes: Tricladida. Keys and notes for the identification of the species. *Synopses of the British fauna (new series)* 19, 141 pp. Cambridge etc. : University Press.

Balogh, J. and Balogh, P. (1992). *The oribatid mite genera of the world* (2 volumes). Budapest: Hungarian Natural History Museum Press.

Barber, J. (2003). Developer funded archaeology. *Scottish Archaeological News* 42: 4-5.

Bar-Yosef Mayer, D. E. (ed.) (2005). *Archaeomalacology: molluscs in former environments of human behaviour*. Oxford: Oxbow.

Barker, P. (1977). *Techniques of archaeological excavation.* London: Batsford.

Barnard, P. C. (ed.). (1999). Identifying British insects and arachnids: an annotated bibliography of key works. Cambridge: Cambridge University Press. [reprinted 2005]

Barnes, H. (1956). Corrosion and shell composition in barnacles. *Nature, London* 177, 290.

Barnes, R. S. K. (1994). *The brackish-water fauna of northwestern Europe*. Cambridge: CUP.

Bassindale, R. (1964). British barnacles. *Synopses of the British fauna* 14. London: Linnean Society.

Bastow, M. (2000). *Macrobiological remains*, pp. 30-33 in O'Neill, R., Land off Venn Street, Huddersfield, West Yorkshire. *WYAS Report* 801. Wakefield.

Bateman, M. D., Buckland, P. C., Carpenter, R., Davies, S., Frederick, C. D., Gearey, B., Murton, J. B. and Whitehouse, N. J. (2001a). Cove Farm Quarry, Westwoodside (SK 737008), pp. 141-160 in Bateman, M. D., Buckland, P. C., Frederick, C. D. and Whitehouse, N. J. (eds.), *The Quaternary of East Yorkshire and North Lincolnshire. Field Guide.* London: Quaternary Research Association.

Bateman, M. D., Buckland, P. C., Frederick, C. D. and Whitehouse, N. J. (2001b). *The Quaternary of East Yorkshire and North Lincolnshire. Field Guide.* London: Quaternary research Association.

Bates, M. (1959). Insects in the diet. *American Scholar* 29, 43-52.

Bates, M. R., Bates, C. R, Gibbard, P. L., Macphail, R. I., Owen, F. J., Parfitt, A. S., Preece, R. C., Roberts, M. B., Robinson, J. E., Whittaker, J. E. and Wilkinson, K. N. (2000). Late Middle Pleistocene deposits at Norton Farm on the West Sussex coastal plain, southern England. *Journal of Quaternary Science* 15, 61-89.

Bathurst, R. R. (2005). Archaeological evidence of intestinal parasites from coastal shell middens. *Journal of Archaeological Science* 32, 115-123.

Battarbee, R. W. (1988). The use of diatom analysis in archaeology: a review. *Journal of Archaeological Science* 15, 621-644.

Battarbee, R, W., Mason, J., Renberg, I. and Talling, J. F. (eds.) (1990). Palaeolimnology and lake acidification. *Philosophical Transactions of the Royal Society of London* B, 223-445.

Bauch, H. A. and Weinelt, M. S. (1997). Surface water changes in the Norwegian sea during last deglacial and Holocene times. *Quaternary Science Reviews* 16, 1115-1124.

Bayford, E. G. (1903). Beetles in peat. *Naturalist* for 1903, 407-408.

Bayley, J. (1998). *Science in archaeology an agenda for the future*. London: English Heritage.

Beavis, I. C. 1988. *Insects and other invertebrates in classical antiquity*. Exeter: University of Exeter.

Bedford, A., Jones, R. T., Lang, B., Brooks, S. and Marshall, J. D. (2004). A Late-Glacial chironomid record from Hawes Water, northwest England. *Journal of Quaternary Science* 19, 281-290.

Beedham, G. E. (1972) *Identification of the British Mollusca*. Amersham: Hilton Educational Publications.

Beer, R. J. S. (1976). The relationship between *Trichuris trichiura* (Linnaeus 1758) of man and *Trichuris suis* (Schrank 1788) of the pig. *Research in Veterinary Science* 20, 47-54.

Begon, M., Harper, J. L. and Townsend, C. R. (1990). *Ecology: individuals, populations and communities*. Second edition. Boston (USA), London etc.: Blackwell Scientific Publications.

Behrensmeyer, A. K. (1978). Taphonomic and ecologic information from bone weathering. *Paleobiology* 4, 150-162.

Bell, A. (1922). On the Pleistocene and Later Tertiary British Insects. *Annual Report of the Yorkshire Philosophical Society* (1921), 41-51.

Bell, M. (1981). *Seaweed as a prehistoric resource*, pp. 117-126 in Brothwell, D. and Dimbleby, G. (eds.), Environmental aspects of coasts and islands. *Symposia of the Association for Environmental Archaeology* 1, *BAR International Series* 94.

Bell, M. (1989). Landsnails, pp. 99-103 in Ashbee, P., Bell, M. and Proudfoot, E., *Wilsford Shaft: excavations 1960-2*. London: HBMC.

Bell, M. G. (1990). Cultural landscapes: some thoughts stimulated by Bill Boyd's paper: *Towards a conceptual framework for environmental archaeology: environmental archaeology as a key to past geographies*. *Circaea* 7, 69-70.

Bell, M. G. and Walker, M. J. C. (1992). *Late Quaternary environmental change*. Harlow: Longman.

Bellman, H. (1988). A field guide to the grasshoppers and crickets of Britain and northern Europe. London: Collins.

Belshaw, R. (1989). A note on the recovery of *Thoracochaeta zosterae* (Haliday) (Diptera: Sphaeroceridae) from archaeological deposits. *Circaea* 6, 39-41.

Bending, J. (2005). An experimental approach to the disaggregation of samples from peat deposits. *Environmental Archaeology* 10, 83-90.

Benedictow, O. J. (1992). *Plague in the late medieval nordic countries.* Oslo: Middelalderforlaget.

Bennike, O. (1998). Fossil egg sacs of *Diaptomus* (Crustacea: Copepoda) in Late Quaternary lake sediments. *Journal of Paleolimnology* 19, 77-79.

Bennett, S. H. (1940). Experiments on the control of the chafer beetle, *Phyllopertha horticola* L. in grassland. Progress report.-1. *Report of the Agricultural and Horticultural Research Station, Bristol* (1939), 72-76.

Benson, R. B. (1976). [Identification of wasp galls], p. 47 in Cunliffe, B. (ed.), Iron Age sites in central southern England. *CBA Research Report* 16. London: CBA.

Benton, M. J. (1994). Palaeontological data and identifying mass extinctions. *Trends in Ecology and Evolution* 9, 181-185.

Bequaert, J. (1921). Insects as food. *Natural History* 21, 191-200.

Berenbaum, M. R. (1995). *Bugs in the system: Insects and their impact on human affairs*. Place of publication not given in original: Helix Books.

Beresford, G. (1981). Climatic change and its effect upon the settlement and desertion of medieval villages in Britain, pp. 30-39 in Smith, C. D. and Parry, M. L. (eds), *Consequences of climatic change.* Nottingham: Department of Geography, University of Nottingham.

Bergh, J.-E., Hansen, L. S., Jensen, K.-M. V., and Nielsen, P. V. (2003). The effect of anoxic treatment on the larvae of six species of dermestids (Coleoptera). *Journal of Applied Entomology* 127, 317-321.

Berry, M. F. and Spencer, P. J. (1980). *Marine molluscs*, p. 142. in Hall, A. R., Kenward, H. K. and Williams, D. Environmental evidence from Roman deposits in Skeldergate. *The Archaeology of York* 14 (3), 101-56. London: Council for British Archaeology.

Bird, J. B. (1943). Excavations in northern Chile. *Anthropological Papers of the American Museum of Natural History* 38 (4), 171-316.

Birks, H. J. B. (1996). Contributions of Quaternary palaeoecology to nature conservation. *Journal of Vegetation Science* 7, 89-98.

Birks, H. J. B. (2005). Mind the gap: how open were European primeval forests? *Trends in Ecology and Evolution* 20, 154-156.

Bishop, M. J. (1977). Approaches to the quantitative description of terrestrial mollusc populations and habitats. *Malacologia* 16, 61-66.

Bishop, M. J. (1981). Quantitative studies on some living British wetland mollusc fauns. *Biological Journal of the Linnean Society* 15, 299-326.

Blackburn, K. B. (1952). The dating of a deposit containing an elk skeleton found at Neasham near Darlington, County Durham. *New Phytologist* 51, 364-377.

Blackith, R. E. and Speight, M.C.D. (1974). Food and feeding habits of the frog *Rana temporaria* in bogland habitats in the west of Ireland. *Journal of Zoology* 172, 67-79.

Bland, K. P. and Sinclair, M. (1997). Beetles in toad faeces. *Entomologist's Record* 109, 205.

Blower, J. G. (1985). Millipedes. Keys and notes for the identification of the species. *Synopses of the British fauna (new series)* 35, 242 pp. London etc.: E. J. Brill/Dr W. Backhuys.

Böcher, J. (1997). *History of the Greenland insect fauna with emphasis on living and fossil beetles*, pp. 35-47 in Ashworth, A. C., Buckland, P. C. and Sadler, J. P. (eds.), Studies in Quaternary entomology - and inordinate fondness for insects. *Quaternary Proceedings* 5. Chichester, UK: Wiley.

Bodenheimer, F. S. (1951). *Insects as human food*. The Hague: Junk.

Bonsall, C., Macklin, M., Anderson, D. E. and Payton, R. W. (2002). Climate change and the adoption of agriculture in north-west Europe. *European Journal of Archaeology* 5, 9-13.

Booth, R. G. (1981). A second British colony of *Helophorus tuberculatus* Gyll. (Col., Hydrophilidae). *Entomologist's Monthly Magazine* 117, 26.

Booth, R. (1984). A provisional key to the British species of *Tachyporus* (Coleoptera, Staphylinidae) based on elytral chaetotaxy. *Circaea* 2, 15-19.

Boswijk, G. and Whitehouse, N. J. (2002). *Pinus* and *Prostomis*: a dendrochronological and palaeoentomological study of a mid-Holocene woodland in eastern England. *The Holocene* 12, 585-596.

Boswijk, G., Whitehouse, N. J., Smith, B. M. and Buckland, P. C. (2001). Thorne Moors (SE 7316), pp. 169-177 in Bateman, M. D., Buckland, P. C., Frederick, C. D. and Whitehouse, N. J. (eds.), *The Quaternary of East Yorkshire and North Lincolnshire. Field Guide*. London: Quaternary Research Association.

Bottrell, H. H. and Newsome, T.(1976). Body length, size of resting eggs and identification of the ephippia of *Ceriodaphnia megalops* and *Ceriodaphnia pulchella*. *Freshwater Biology* 6, 405-408.

Bouchet, F. (1995). Recovery of helminth eggs from archaeological excavations of the Grand Louvre (Paris, France). *Journal of Parasitology* 81, 785-787.

Bouchet, F., Guidon, N., Dittmar, K., Harter, S., Ferreira, L. F., Chaves, S. M., Reinhard, K. and Araujo, A. (2003a). Parasite remains in archaeological sites. *Memorias do Instituto Oswaldo Cruz* 98 (suppl. 1), 47-52.

Bouchet, F., Harter, S. and Le Bailly, M. (2003b). The state of the art of palaeoparasitological research in the Old World. *Memorias do Instituto Oswaldo Cruz* 98 (suppl. 1), 95-101.

Bouchet, F., Araujo, A., Harter, S., Chaves, S. M., Duarte, A. N., Monnier, J. L. and Ferreira, L. F. (2003c). *Toxocara canis* (Werner, 1782) eggs in the Pleistocene site of Menez-Dregan, France (300,000-500,000 years before present). *Memorias do Instituto Oswaldo Cruz* 98 (suppl. 1), 137-139.

Boulton, B. and Collingwood, C. A. (1975). Hymenoptera Formicidae. *Handbooks for the identification of British insects* 6 (3c). London: Royal Entomological Society.

Boycott, A. E. (1934). The habitats of land Mollusca in Britain. *Journal of Ecology* 22, 1-38.

Boycott, A. E. (1936). The habitats of fresh-water Mollusca in Britain. *Journal of Animal Ecology* 5, 117-186.

Boyd, W. E. (1990a). Towards a conceptual framework for environmental archaeology: environmental archaeology as a key to past geographies. *Circaea* 7, 63-69.

Boyd, W. E. (1990b). Reply to Bell, Jones, Thomas and Van der Veen. *Circaea* 7, 77- 79.

Boyd, P.D.A. (1981). The micropalaeontology and palaeoecology of medieval estuarine sediments from the Fleet and Thames in London, pp. 274-292 in Neale, J. W. and Brasier, M. D., *Microfossils from Recent and fossil shelf seas*. Chichester, England: Ellis Horwood.

Boyer, P. (1999). *The parasites*, pp. 344-346 in Connor, A. and Buckley, R. (eds.), Roman and medieval occupation in Causeway Lane, Leicester. *Leicester Archaeology Monograph* 5. Leicester: ULAS.

Boylan, P. J. (1966). New records of Holocene Mollusca from East Yorkshire. *The Naturalist* 899, 113-118.

Bradley, J. D., Tremewan, W. G. and Smith, A. (1973). *British tortricoid moths.* Cochylidae and Torticidae: Tortricinae. London: Ray Society.

Bradley, J. D., Tremewan, W. G. and Smith, A. (1979). *British tortricoid moths.* Torticidae: Olethreutinae. London: Ray Society.

Bradley, P. L. (1958). An assemblage of arthropod remains from a Roman occupation site at St. [*sic*] Albans. *Nature, London* 181, 435-436.

Bradshaw, R. H. W., Hannon, G. E. and Lister, A. (2003). A long-term perspective on ungulate-vegetation interactions. *Forest Ecology and Management* 181, 267-280.

Bradshaw, R. and Mitchell, F. J. G. (1999). The palaeoecological approach to reconstructing former grazing-vegetation interactions. *Forest Ecology and Management* 120, 3-12.

Brasier, M. D. (1981). Microfossil transport in the tidal Humber basin, pp. 314-322 in Neale, J. W. and Brasier, M. D., *Microfossils from Recent and fossil shelf seas*. Chichester, England: Ellis Horwood.

Brewster, T. C. M. (1963). *The excavation of Staple Howe.* Winteringham: East Riding Archaeological Research Committee.

Brian, M. V. (1977). *Ants. The New Naturalist* 59. London: Collins.

Brickley, M., Smith, W. and Smith, D. (2005). Ten years from *Whither Environmental Archaeology?*. The current state of environmental archaeology in Britain, pp. 6-10 in Brickley, M., Smith, D. and Smith, W. (eds.), *Fertile Ground. Papers in Honour of Susan Limbrey* (Symposia of the Association for Environmental Archaeology No. 22). Oxford: Oxbow Books.

Briggs, C. S. and Turner, R. C. (1986). A gazetteer of bog burials from Britain and Ireland, pp. 181-195 in Stead, I. M., Bourke, J. B. and Brothwell, D., *Lindow Man: the body in the bog.* London: British Museum.

Briggs, D. E. G. (1999). Molecular taphonomy of animal and plant cuticles: selective preservation and diagenesis. *Philosophical Transactions of the Royal Society London B* 354, 7-17.

Briggs, D. E. G. and Crowther, P. R. (1990). *Palaeobiology: a synthesis*. Oxford etc: Blackwell.

Briggs, D. E. G., Evershed, R. P. and Stankiewicz, B. A. (1996). The chitin files. Fossil cuticle, a complex chemical conundrum. *Ancient Biomolecules Initiative Newsletter* 3 (November 1996), 61-64.

Briggs, D. E. G. and Kear, A. J. (1993a). Fossilisation of soft tissue in the laboratory. *Science* 259, 1439-42.

Briggs, D. E. G. and Kear, A. J. (1993b). Decay and preservation of polychaetes: taphonomic threasholds in soft-bodied organisms. *Paleobiology* 19, 107-35.

Briggs, D. J., Gilbertson, D. D., and Harris, A. L. (1985). *Molluscan taphonomy in braided river environments: model development and application to the Summertown-Radley terrace gravels of the River Thames*, pp 67-89 and un-numbered figures in Fieller, N. R. J., Gilbertson, D. D. and Ralph, N. G. A., Palaeoenvironmental investigations: research design, methods and data analysis. *Symposia of the Association for Environmental Archaeology 5B, British Archaeological Reports International Series* 226.

Brimblecombe, P. (1982) *Early urban climate and atmosphere*, pp. 10-25] in Hall, A. R. and Kenward, H. K. (eds). Environmental archaeology in the urban context. *Council for British Archaeology Research Reports* 43.

Bristowe, W. S. (1958). *The world of spiders.* London: Collins.

Britton, E. B. (1956). Coleoptera Scarabaeoidea (Lucanidae, Trigidae, Geotrupidae, Scarabaeidae). *Handbooks for the identification of British Insects* 5 (11). London: Royal Entomological Society.

Brodin, Y.-W. (1990). Midge fauna development in acidified lakes in northern Europe. *Philosophical Transactions of the Royal Society, London* B 327, 295-298.

Brøndsted, J. (1965). *The Vikings*. Harmondsworth: Penguin.

Bronowski, J. (1973). *The ascent of man*. London: BBC.

Brook, E. J. (2005). Tiny bubbles tell all. *Science* 310, 1285-1287.

Brooks, S. J. (1997). *The response of* Chironomidae *(Insecta: Diptera) assemblages to Late-Glacial climatic change in Kråkenes Lake, Western Norway*, pp. 49-58 in Ashworth, A. C., Buckland, P. C. and Sadler, J. P. (eds.), Studies in Quaternary entomology - and inordinate fondness for insects. *Quaternary Proceedings* 5. Chichester, UK: Wiley.

Brooks, S. J. and Birks, H. J. B. (2000). Chironomid-inferred late-glacial and early-Holocene mean July air temperatures for Krakenes Lake, western Norway. *Journal of Palaeolimnology* 23, 77-89.

Brooks, S. J., Lowe, J. J., and Mayle, F. E. (1997a). The Late Devensian Lateglacial palaeoenvironmental records from Whitrig Big, SE Scotland. 2. Chironomidae (Insecta: Diptera) *Boreas* 26, 297-308

Brooks, S. J., Mayle, F. E. and Lowe, J. J. (1997b). Chironomid-based Lateglacial climatic reconstruction for southeast Scotland. *Journal of Quaternary Science* 12, 161-167. Brothwell, D. (1992). Bones and beyond bones: insects, stains and keratin remains. *Circaea* 9 (for 1991), 15-17.

Brothwell, D., Dobney, K. and Ervynck, A. (1996). On the cause of perforations in archaeological domestic cattle skulls. *International Journal of Osteoarchaeology* 6, 471-487.

Brumpt, E. (1936). *Précis de parasitologie* 1-2 (4th edn.). Paris: Masson. Brunton, C. H. and Curry, G. B. (1979). British brachiopods. Keys and notes for the identification of the species. *Synopses of the British fauna (new series)* 17, 64 pp. London etc.: Academic.

Bryant, V. B. Jr. (1974). Prehistoric diet in southwest Texas: the coprolite evidence. *American Antiquity* 39, 407-420. Bryce, D. (1962). Chironomidae (Diptera) from fresh water sediments with special reference to Malham Tarn (Yorks.). *Transactions of the Society of British Entomologists*, 15, 41-54.

Bryce, D. and Hobart, A. (1972). The biology and identification of the larvae of the Chironomidae (Diptera). *Entomologist's Gazette* 23, 175-217. Bucher, S. and Wolf, G. (1997). Ein Kornkafer - *Sitophilus granarius* (Linne) - aus einer banderkeramischen Grube bei Gottingen. *Archaeologisches Korrespondenzblatt* 27, 211-220.

Buckland, P. C. (1973). Environment and archaeology in the Vale of York. *South Yorkshire Studies in Archaeology and Natural History* 1, 6-16.

Buckland, P. C. (1974). Archaeology and environment in York. *Journal of Archaeological Science* 1, 303-316.

Buckland, P. C. (1975a). Synanthropy and the deathwatch: a discussion. *Naturalist* 100, 37-42.

Buckland, P. C. (1975b). *[Environmental analysis of the 6-8 Pavement site]*, p. 223 in Addyman, P. V., Excavations in York, 1972-1973. First interim report. *Antiquaries Journal* 54, 200-231.

Buckland, P. C. (1976a). The Environmental Evidence from the Church Street Roman Sewer System. *The Archaeology of York* 14 (1), 1-44. London: Council for British Archaeology.

Buckland, P. C. (1976b). The use of insect remains in the interpretation of archaeological environments, pp. 369-396 in Davidson, D. A. and Shackley, M. L. (eds.), *Geoarchaeology. Earth science and the past.* London: Duckworth.

Buckland, P. C. (1976d). *Niptus hololeucus* Fald. (Col., Ptinidae) from Roman deposits in York. *Entomologist's monthly Magazine* 111 (for 1975), 233-234.

Buckland, P. C. (1979). Thorne Moors: a palaeoecological study of a Bronze Age site (a contribution to the history of the British insect fauna). *University of Birmingham, Department of Geography Occasional Publications* 8. Birmingham.

Buckland, P. C. (1980). Insect remains from the well, pp. 162-8 in Stead, I. M., *Rudston Roman villa*. 179 pp. Leeds: Yorkshire Archaeological Society.

Buckland, P. C. (1981a). *Insect remains from beneath the Brigg 'raft'*, pp. 155-175 in McGrail, S. (ed), The Brigg 'Raft' and her prehistoric environment. *B. A. R. British Series* 89. Oxford.

Buckland, P. C. (1981b). The early dispersal of insect pests of stored products as indicated by archaeological records. *Journal of Stored Products Research* 17, 1-12.

Buckland, P. C. (1982a). The cover sands of north Lincolnshire and the Vale of York, pp. 143-178 in Adlam, B. H., Fenn, C. R. and Morris, L. (eds.), *Papers in earth studies*. Norwich: Geobooks.

Buckland, P. C. (1982b) The Malton burnt grain : a cautionary tale. *Yorkshire Archaeological Journal* 54, 53-61.

Buckland, P. C. (1984). North-west Lincolnshire 10,000 years ago, pp. 11-17 in Field, N. and White, A. (eds.), *A prospect of Lincolnshire.*. Lincoln: Newland.

Buckland, P. C. (1987). A tale of a flea. *Antenna* 11, 135-137.

Buckland, P. C. (1988). North Atlantic faunal connections - introduction or endemics? *Entomologica Scandinavica Supplement* 32, 7-29.

Buckland, P. C. (1990). Granaries stores and insects. The archaeology of insect synanthropy, pp. 69-81 in Fournier, B. D. and Sigaut, F. (eds.), *La préparation alimentaire des céréales*. Rapports présentés à la Table ronde, Ravello au Centre Universitaire pour les Biens culturels, avril 1988. PACT, Rixensart, Belgium.

Buckland, P. C., Beal, C. J. and Heal, S. V. E. (1990). Recent work on the archaeological and palaeoenvironmental context of the Ferriby boats, pp. 131-46 in Ellis, S. and Crowther, D. R. (eds), *Humber perspectives: a region through the ages*. Hull: University Press.

Buckland, P. C. (1996). *Insects*, pp. 165-170 in May, J., Dragonby. Report on excavations at an Iron Age and Romano-British settlement in North Lincolnshire. *Oxbow Monograph* 61. Oxford.

Buckland, P. C. (2001). West Moor, Armthorpe (SE 637058), pp. 99-102 in Bateman, M. D., Buckland, P. C., Frederick, C. D. and Whitehouse, N. J. (eds.), *The Quaternary of East Yorkshire and North Lincolnshire. Field Guide.* London: Quaternary Research Association.

Buckland, P. C., Amorosi, T., Barlow, L. K., Dugmore, A. J., Mayewski, P. A., McGovern, T. H., Olgivie, A. E. J., Sadler, J. P. and Skidmore, P. (1996). Bioarchaeological and climatological evidence for the fate of Norse farmers in medieval Greenland. *Antiquity* 70, 88-96.

Buckland, P. C., Ashworth, A. C. and Schwert, D. W. (1995). By-passing Ellis Island: insect immigration to North America, pp. 226-44 in Butlin, R. and Roberts, N., *Ecological change in historical time*. London etc.: Blackwell.

Buckland, P. C. and Coope, G. R. (1991). *A bibliography and literature review of Quaternary entomology*. Sheffield: J. R. Collis Publications.

Buckland, P. C., Coope, G. R. and Sadler, J. P. (compilers) (1997). *A biblography of Quaternary entomology*. Appendix to Ashworth, A. C., Buckland, P. C. and Sadler, J. P. (eds.), Studies in Quaternary entomology - and inordinate fondness for insects. *Quaternary Proceedings* 5. Chichester, UK: Wiley.

Buckland, P. C. and Dinnin, M.. H. (1993). *Holocene woodland, the fossil evidence*, pp. 6-20 in Kirby, K. J. and Drake, C. M. (eds.), Dead wood matters: the eccology and conservation of saproxylic invertebrates in Britain. Peterborough: English Nature.

Buckland, P. C. and Dinnin, M. H. (1997). The rise and fall of a wetland habitat: recent palaeoecological research on Thorne and Hatfield Moors. *Thorne and Hatfield Moors Papers* 4, 1-18.

Buckland, P., Dugmore, A. and Sadler, J. (1991). Faunal change or taphonomic problem? A comparison of modern and fossils insect faunas from South East Iceland, pp. 127-146 in Maizels, J. K. ans Caseldine, C. (eds), *Environmental change in Iceland: Past and present.* Netherlands: Kluwer.

Buckland, P. C. and Edwards, K. J. (1984). The longevity of pastoral episodes of clearance activity in pollen diagrams: the role of post-occupation grazing. *Journal of Biogeography* 11, 243 - 249.

Buckland, P. C., Greig, J. R. A. and Kenward, H. K. (1974). York: an early medieval site. *Antiquity* 48, 25-33.

Buckland, P. C., and Johnson, C. (1983). *Curimopsis nigrita* (Palm) (Coleoptera : Byrrhidae) from Thorne Moors, South Yorkshire. *Naturalist* (Hull) 108, 153-154.

Buckland, P. C. and Kenward, H. K. (1973) Thorne Moor : a palaeoecological study of a Bronze Age site. *Nature (London)* 241, 405-406.

Buckland, P. C. and Sadler, J. (1989). A biogeography of the human flea, *Pulex irritans* L. (Siphonaptera: Pulicidae). *Journal of Biogeography* 16, 115-120.

Buckland, P. and Sadler, J. (1991). Farm or shieling? An entomological approach. *Acta Archaeologia* 61, 93-96.

Buckland, P. C. and Sadler, J. P. (1997). Insects, pp. 105-8 in Edwards, K. J. and Ralston, I. B. M. (eds.), *Scotland. Environment and archaeology 8000 BC to Ad 1000*. Chichester: Wiley.

Buckland, P. C. and Wagner, P. E. (2001). Is there an insect signal for the 'Little Ice Age'? *Climatic Change* 48, 137-149.

Buckland, P. C., McGovern, T. H., Sadler, J. P. and Skidmore, P. (1994). Twig layers, floors and middens. Recent palaeoecological research in the Western Settlement, Greenland, pp. 132-143 in Ambrosiani, B. and Clarke, H. (eds.), *Developments around the Baltic and North Sea in the Viking Age* (Birka Studies 3, The Twelfth Viking Congress). Stockholm.

Buckland, P. C., Sadler, J. P. and Sveinbjarnardóttir, G. (1992). Palaeoecological investigations at Reykholt, Western Iceland, pp. 149-167 in Morris, C. D. and Rackham, D. J. (eds.), *Norse and later settlement and subsistence in the North Atlantic*. Glasgow: Department of Archaeology, University of Glasgow.

Buckland, P. C., Sveinbjarnardóttir, G., Savory, D., McGovern, T. H., Skidmore, P. and Andreasen, C. (1983). Norsemen at Nipaitsoq, Greenland. A palaeoecological investigation. *Norwegian Archaeological Review* 16, 86-98.

Buckland P.I. and Buckland P.C. (2006). Bugs Coleopteran Ecology Package (Versions: BugsCEP v7.63; Bugsdata v7.20; BugsMCR v2.02; BugStats v1.22). Available at www.bugscep.com (Accessed 21st October 2009).

Bukkens, S. G. F. (1997). The nutritional value of edible insects. *Ecology of Food and Nutrition* 36, 287-319.

Bullock, J. E., Kenward, R. E. and Hails, R. S. (eds.) (2002). *Dispersal ecology*. Oxford: Blackwell.

Bunting, M. J. (2002) Detecting woodland remnants in cultural landscapes: modern pollen deposition around small woodlands in northwest Scotland. *The Holocene* 12, 291-301.

Burgess, I. F. (1995). Human lice and their management. *Advances in Parasitology* 36, 271-342.

Burkhart, C. N., Gunning, W. and Burkhart, C. G. (2000). Scanning electron microscopic examination of the egg of the pubic louse (Anoplura: *Pthirus pubis*). *International Journal of Dermatology* 39, 201-202.

Burleigh, R. and Southgate, B. J. (1975). Insect infestation of stored Egyptian lentils in antiquity. *Journal of Archaeological Science* 2, 391-392.

Burman, J. and Schmitz, B. (2005). Periwinkle (*Littorina littorea*) intrashell ∂^{18}O and ∂^{13}C records from the mid-Holocene Limfjord region, Denmark: a new high-resolution palaeoenvironmental proxy approach. *The Holocene* 15, 567-575.

Burns, D. A. (1987). The treatment of *Pthirus pubis* infestation of the eyelashes. *British Journal of Dermatology* 117, 741-743.

Burns, D. A. and Sims, T. A. (1998). A closer look at *Pthirus pubis*. *Journal of Dermatology* 118, 497-503.

Burrows, R. D. (1965). *Microscopic diagnosis of the parasites of man.* New Haven and London: Yale University Press.

Burroughs, W. J. (2005). *Climate change in prehistory*. The end of the reign of chaos. Cambridge etc: Cambridge University Press.

Bush, M. B. (1988). Early Mesolithic disturbance: a force on the landscape. *Journal of Archaeological Science* 15, 453-462.

Bush, M. B. (1993). An 11 400 year palaeoecological history of a British chalk grassland. *Journal of Vegetation Science* 4, 47-66.

Bush, M. B. and Ellis, S. (1987). The sedimentological and vegetational history of Willow Garth, pp. 42-52 and references pp. 106-116 in Ellis, S. (ed.), *East Yorkshire - Field Guide*. Cambridge: Quaternary Research Association.

Bush, M. B. and Flenley, J. R. (1987). The age of the British chalk grasslands. *Nature, London* 329, 434-6.

Bush, M. B., Miller, M. C., De Oliveira, P. E., and Colinvaux, P. A. (2000). Two histories of environmental change and human disturbance in eastern lowland Amazonia. *The Holocene* 10, 543-553.

Busvine, J. R. (1976). *Insects, hygiene and history*. London: Althone Press.

Busvine, J. R. (1978). Evidence from double infestations for the specific status of human head lice and body lice (Anoplura). *Systematic Entomology* 3, 1-8.

Busvine, J. R. (1980). *Insects and hygiene*. London: Chapman and Hall.

Butzer, K.W. (1982). *Archaeology as human ecology*. Cambridge: University Press.

Buxton, K. and Howard-Davis, C. (2000). Bremetenacum. Excavations at Roman Ribchester 1980, 1989-1990. *Lancaster Imprints Series* 9. Lancaster: Lancaster University Archaeological Unit.

Buxton, K., Howard-Davis, C., Huntley, J., Stallibrass, S. and Kenward, H. (2000a). *Phase 1: The establishment of the Roman fort and settlement*, pp. 25-49 in Buxton, K. and Howard-Davis, C., Bremetenacum. Excavations at Roman Ribchester 1980, 1989-1990. *Lancaster Imprints Series* 9. Lancaster: Lancaster University Archaeological Unit.

Buxton, K., Howard-Davis, C., Huntley, J., Stallibrass, S. and Kenward, H. (2000b). Phase *2: Renewal of the fort, and rearrangement of the extramural area*, pp. 51-75 in Buxton, K. and Howard-Davis, C., Bremetenacum. Excavations at Roman Ribchester 1980, 1989-1990. *Lancaster Imprints Series* 9. Lancaster: Lancaster University Archaeological Unit.

Buxton, K., Howard-Davis, C., Huntley, J., Stallibrass, S. and Kenward, H. (2000c). *Phase 3: Demolition and rebuilding*, pp. 77-101 in Buxton, K. and Howard-Davis, C., Bremetenacum. Excavations at Roman Ribchester 1980, 1989-1990. *Lancaster Imprints Series* 9. Lancaster: Lancaster University Archaeological Unit.

Buxton, K., Howard-Davis, C., Huntley, J., Stallibrass, S. and Kenward, H. (2000d). *Phase 4: The military* Fabrica *and extramural annex*, pp. 103-126 in Buxton, K. and Howard-Davis, C., Bremetenacum. Excavations at Roman Ribchester 1980, 1989-1990. *Lancaster Imprints Series* 9. Lancaster: Lancaster University Archaeological Unit.

Cacares, C. E. (1998). Interspecific variation in the abundance, production, and emergence of *Daphnia* diapausing eggs. *Ecology* 79, 1699-1710.

Callen, E. O. (1965). Food habits of some pre-Columbian Mexican indians. *Economic botany* 19 (4), 335-343.

Cameron, R. A. D. and Killeen, I. J. (2001). *Land slugs and snails*, pp. 355-366 in Hawksworth, D. L. (ed.), The changing wildlife of Great Britain and Ireland. *Systematics Association Special Volume* 62. London and New York: Taylor and Francis.

Cameron, R. A. D. and Morgan-Huws D. I. (1975). Snail faunas in the early stages of a chalk grassland succession. *Biological Journal of the Linnean Society* 7, 215-229.

Cameron, R. A. D. and Redfern, M. (1976). British land snails. Mollusca: Gastropoda. Keys and notes for the identification of the species. *Synopses of the British fauna (new series)* 6, 64 pp. London and New York: Academic.

Canti, M. (1997). An investigation of microscopic calcareous sphaerulites from herbivore dungs. *Journal of Archaeological Science* 24, 219-231.

Canti, M. (1998). Origin of calcium carbonate granules found in buried soils and Quaternary deposits. *Boreas* 27, 275-288.

Canti, M. G. (1999). The production and preservation of faecal sphaerulites: animals, environment and taphonomy. *Journal of Archaeological Science* 26, 251-258.

Canti, M. G. (2003). Earthworm activity and archaeological stratigraphy: a review of products and processes. *Journal of Archaeological Science* 30, 135-148.

Canti, M. G. (2005). Wondering about worms: stones, soil and stratigraphy, pp. 30-42 in Brickley, M., Smith, D. and Smith, W. (eds.), *Fertile Ground. Papers in Honour of Susan Limbrey* (Symposia of the Association for Environmental Archaeology No. 22). Oxford: Oxbow Books.

Canti, M. G. and Piearce, T. G. (2003). Morphology and dynamics of calcium carbonate granules produced by different earthworm species. *Pedobiologia* 47, 511-521.

Capasso, L. and Di Tota, G. (1998). Lice buried under the ashes of Herculaneum. *The Lancet* 351, 992.

Cardon, D. and Chatenet, G. du. (1990). *Guide des teintures naturelles*. Lausanne: Delachaux et Niestlé.
Carrott, J., Fell, V., Large, F., Kenward, H. and Kent, P. (2000). *Insects and other invertebrate remains*, pp. 387-400 and Bibliography pp. 423-441 in Buxton, K. and Howard-Davis, C., Bremetenacum. Excavations at Roman Ribchester 1980, 1989-1990. *Lancaster Imprints Series* 9. Lancaster: Lancaster University Archaeological Unit.

Carrott, J., Hall, A., Issitt, M., Kenward, H., Large, F. and Milles, A. (1999). *Assessment of biological remains from COT93*, pp. 83-84 in Richards, J. D., Cottam: an Anglian and Anglo-Scandinavian settlement on the Yorkshire Wolds. *Archaeological Journal* 156, 1-110.

Carrott, J., Irving, B., Issitt, M., Jaques, D., Kenward, H., Large, F., McKenna, B. and Milles, A. (1995). *The biological remains*, pp. 31-34 in Steedman, K. and Foreman, M., Excavations at Aylesby, South Humberside, 1994. *Lincolnshire History and Archaeology* 30, 12-37.

Carrott, J., Issitt, M., Kenward, H., and Large, F. (1997). The invertebrate assemblage, pp. 396400 in Crone, A. and O'Sullivan, J., Excavation of a cropmark enclosure at Brixwold (Dalhousie Mains), Bonnyrigg, Midlothian. *Proceedings of the Society of Antiquaries of Scotland* 127, 387-405.

Carrott, J. and Kenward, H. (2001). Species associations among insect remains from urban archaeological deposits and their significance in reconstructing the past human environment. *Journal of Archaeological Science* 28, 887-905.

Carrott, J., Kenward, H. and Milles, A. (1999). *The molluscs*, pp. 58-61 in Bishop, M. C., An early Iron Age and Romano-British 'ladder' settlement at Melton, East Yorkshire. *Yorkshire Archaeological Journal* 71, 23-63.

Carruthers, W. J. (1991). Plant remains recovered from daub from a 16th century manor-house -Althrey Hall, near Wrexham, Clwyd, U. K. *Circaea* 8 (for 1990), 55-59.

Carruthers, W. J. (2000). Mineralised plant remains, pp. 72-84 in Goldberg, P., Ferring, C. R. and Holiday, V. (eds), *Animal husbandry in late prehistoric Wiltshire*. Salisbury: Wessex Archaeology.

Carter, S. (1986). Close sampling for terrestrial mollusca. *Circaea* 4, 15-16.

Carter, S. (1997). *Dale Lane, South Emsall* [Elmsall] *(SEL97). Analysis of the land snails.* Unpublished report, Headland Archaeology Ltd. Edinburgh.

Carter, S. P. (1990). The stratification and taphonomy of shells in calcareous soils: implications for land snail analysis in archaeology. *Journal of Archaeological Science* 17, 495-507.

Carter, S. (2001). *Land snails from Becca Banks*, pp. 239-240 in Roberts, I., Burgess, A. and Berg, D. (eds.), A new link to the past. The archaeological landscape of the M1-A1 link road. *Yorkshire Archaeology* 7. Leeds: West Yorkshire Archaeology Services.

Cartwright, C. (2003). Unusual use of freshwater mussel (Unio sp.) shells during the Early Bronze Age at Tell es-Sa'idiyeh, Jordan. *Environmental Archaeology* 8, 85-89.

Carver, M. O. H. (1996). On archaeological value. *Antiquity* 70, 45-56.

Carver, M. (2001). *The future of field archaeology*, in Z. Kobyli½ski (ed.) Quo vadis archaeologia? Whither European archaeology in the 21st century. *Proceedings of the European Science Foundation Exploratory Workshop, M•dralin near Warsaw, 12-13 October 2001: 118-32.* Warsaw: European Science Foundation, etc.

Carver, M. (2003). *Archaeological value and evaluation*. Mantova: Società Archaeologica Padana s.r.l.

Caseldine, A. (1987). *Charcoal patches from Meare Village East 1982*, pp. 223-226 in J. M. Coles, Meare Village East. The excavations of A. Bulleid and H. St. George Gray 1932-1956. *Somerset Levels Papers* 13.

Castell, C. P. (1963). *Appendix V. Land Mollusca*, p. 204 in Manby, T. G., Excavation of the Willerby Wold long barrow, East Riding of Yorkshire. *Proceedings of the Prehistoric Society* 29, 173-205.

Caswell, D. (2001). *How far do woodland insects move? Project 1*. Unpublished final year project, Department of Biology, University of York.

Catt, J. A. (1987a). Sewerby, pp. 53-57 and references pp. 106-116 in Ellis, S. (ed.), *East Yorkshire - Field Guide*. Cambridge: Quaternary Research Association.

Catt,. J. A. (1987b). Dimlington, pp. 82-98 and references pp. 106-116 in Ellis, S. (ed.), *East Yorkshire - Field Guide*. Cambridge: Quaternary Research Association.

Ceci, L. (1984). Shell midden deposits as coastal resources. *World Archaeology* 16, 62-74.

Celoria, F. (1971). Fifty early-19th-century dyestuffs. *Science and Archaeology* 7, 13-35. Chambers, F. M. (1993a) (ed.), *Climate change and human impact on the landscape*. London etc.

Chapman and Hall. Chambers, F. M. (1993b). Late-Quaternary climatic change and human impact: commentary and conclusions, pp. 247-259 in Chambers, F. M. (ed.), *Climate change and human impact on the landscape*. London etc.: Chapman and Hall.

Chapman, R. (2003). *Dung beetles as indicators of past land use*. Unpublished final year project report, Department of Biology, University of York.

Chaplin, R. E. (1965). Animals in archaeology. *Antiquity* 39, 204-211 + Plate XLIV. Chapman, V. J. (1970). *Seeweeds and their uses*. (2nd edn.) London: Methuen.

Charles, M., Halstead, P. and Jones, G. (1998). Fodder: archaeological, historical and ethnographic studies. *Environmental Archaeology* 1, i-ii + 1-126.

Charman, D. J. (1999). Testate amoebae and the fossil record: issues in biodiversity. *Journal of Biogeography* 26, 89-96.

Charman, D. J., Hendon, D. and Woodland, W. A. (2000). The identification of testate amoebae (Protozoa: Rhizopoda) in peats. *Quaternary Research Association Technical Guide* 9.

Charman, D. J., Roe, H. M. and Gehrels, R. W. (1998). The use of testate amoebae in studies of se-level change: a case study from the Taf estuary, south Wales, UK. *The Holocene* 8, 209-218.

Charters, S., Evershed, R. P., Blinkhorn, P. W. and Denham, V. (1995). Evidence for the mixing of fat and wax in archaeological ceramics. *Archaeometry* 37, 113-128.

Chinery, M. (1993). *Collins field guide. Insects of Britain and northern Europe*. Third edition. London: HarperCollins [*sic*]

Chivas, A. R., De Deckker, P. and Shelley, J. M. G. (1985). Strontium content of ostracods indicates lacustrine palaeosalinity. *Nature* 316, 251-253.

Chomko, S. A. and Gilbert, B. M. (1991). Bone refuse and insect remains: their potential for temporal resolution of the archaeological record. *American Antiquity* 56, 680-686.

Claassen, C. (1998). *Shells. Cambridge manuals in archaeology*. Cambridge: Cambridge University Press.

Clark, J. G. D. (1954). *Excavations at Star Carr: An early Mesolithic site at Seamer near Scarborough, Yorkshire.* Cambridge: University Press.

Clark, R. B. (1968). Biological causes and effects of paralytic shellfish poisoning. *The Lancet* October 5th 1968, 770-772.

Clark, D. L. (ed.) (1972). *Models in archaeology*. London: Methuen.

Clark, S. H. E. and Edwards, K. J. (2004). Elm bark beetle in Holocene peat deposits and the northwest European elm decline. *Journal of Quaternary Science* 19, 525-528.

Clarke, A., Davis, S., Evans, C., French, C., Gleed-Owen, C., Murphy, P. Robinson, M., Serjeantson, D., Stevens, C. and Wiltshire, P. (2003). *Environment* [sic] *setting, land-use and economic practices*, pp. 69-144 in Evans, C., Power and island communities: excavations at the Wardy Hill ring work, Coveney, Ely. *East Anglian Archaeology* 103, 69-144.

Clarke, K. J. (2003). Guide to the identification of soil protozoa - testate amoebae. *Freshwater Biological Association Special Publication* 12. Ambleside: FBA.

Clarke, M. R. (1962). Significance of cephalopod beaks. *Nature, London* 193, 560-561.

Clay, T. (1973). Phthiraptera, pp. 395-397 in Smith, K. G. V. (ed.), *Insects and other arthropods of medical importance*. London: British Museum (Natural History).

Cloudsley-Thompson, J. L. (1976). *Insects and history*. London: Weidenfeld and Nicolson.

Cloutman, E. W. (1988a). Palaeoenvironments in the Vale of Pickering. Part 1: Stratigraphy and palaeogeography of Seamer Carr, Star Carr and Flixton Carr. *Proceedings of the Prehistoric Society* 54, 1-19.

Cloutman, E. W. (1988b). Palaeoenvironments in the Vale of Pickering. Part 2: Environmental history at Seamer Carr. *Proceedings of the Prehistoric Society* 54, 21-36.

Cloutman, E. W. (1988c). Palaeoenvironments in the Vale of Pickering. Part 3: Environmental history at Star Carr. *Proceedings of the Prehistoric Society* 54, 37-58.

Clow, A. and Clow, N. L. (1947). The natural and economic history of kelp. *Annals of Science* 5, 297-316.

Clutton-Brock, J. (1982). *Appendix 1: The animal bone*, microfiche 44-54 in Perry, B. T., Excavations at Bramdean, Hampshire, 1973 to 1977. *Proceedings of the Hampshire Field Club and Archaeological Society* 38, 57-74.

Cobben, R. H. (1968). *Evolutionary trends in Heteroptera part 1. Eggs, architecture of the shell, gross embryology and eclosion*. Wageningen: Centre for Agricultural Publishing and Documentation.

Cockburn, A., Cockburn, E. and Reyman, T. A. (1998). *Mummies, disease and ancient cultures*. (2nd edition, abridged) Cambridge: CUP.

Cohn, S. (2002a). *The Black Death transformed: disease and culture in Early Renaissance Europe*. London: Arnold.

Cohn, S. K. (2002b). The Black death: end of a paradigm. The American Historical Review 107(3). Available at http://www.historycooperative.org/journals/ahr/107.3/ah0302000703.html

Colbourne, J. K., Crease, T. J., Weider, L. J., Hebert, P. D. N., Dufresne, F. and Hobaek, A. (1998). Phylogenetics and evolution of a circumarctic species complex (Cladocera: *Daphnia Pulex*). *Biological Journal of the Linnean Society* 65, 347-365.

Colebrook, E. and Wall, R. (2004). Ectoparasites of livestock in Europe and the Mediterranean region. *Veterinary Parasitology* 120, 251-274.

Coles, G. C., Hadley, P. J., Milnes, A. S., Green, L. E., Stosic, P. J. and Garnsworthy, P. C. (2003). Relationship between lice infestation and leather damage in cattle. *Veterinary Record* 153, 255-259.

Coleopterist, The. Available at http://www.coleopterist.org.uk/ (accessed 15 February 2007).

Colyer, C. N. and Hammond, C. O. (1968). *Flies of the British Isles*. Second edition. London: Warne.

Cong, S. and Ashworth, A. C. (1997). The use of correspondence analysis in the analysis of fossil beetle assemblages, pp. 79-82 in Ashworth, A. C., Buckland, P. C. and Sadler, J. P. (eds.), Studies in Quaternary entomology - and inordinate fondness for insects. *Quaternary Proceedings* 5. Chichester, UK: Wiley.

Constantini, L. and Audisio, P. (2000). Plant and insect remains from the Bronze Age site of Ra's al-Jinz (RJ-2), Sulanate of Oman. *Paleorient* 26, 143-156.

Cook, J. M. (1959). Bath-tubs in ancient Greece. *Greece and Rome* 6, 31-45.

Coope, G. R. (1959). A Late Pleistocene insect fauna from Chelford, Cheshire. *Proceedings of the Royal Society of London* B151, 70-86.

Coope, G. R. (1977). Fossil coleopteran assemblages as sensitive indicators of climatic changes during the Devensian (Last) cold stage. *Philosophical Transactions of the Royal Society of London* B280, 313-337.

Coope, G. R. (1978). Late-glacial deposits of Cumbria: St. Bees, p. 218 in Moseley, F. (ed.) *The Geology of the Lake District*. Leeds: Yorkshire Geological Society.

Coope, G. R. (1987). The Response of Late Quaternary insect communities to sudden climatic changes, pp. 421-438 in Gee, J. H. R. and Giller, P. S. (eds.), *Organisation of communities - past and present*. Oxford: Blackwell Scientific Publications.

Coope, G. R. (1991). The study of the 'nearly fossil'. *Antenna* 15, 158-163.

Coope, G. R. (1994). The response of insect faunas to glacial-interglacial climatic fluctuations. *Philosophical Transactions of the Royal Society, London* B 344, 19-26.

Coope, G. R. (1995). Insect faunas in ice age environments: why so little extinction?, pp. 55-74 in Lawton, J. H. and May, R. M. (eds.), *Extinction Rates*. Oxford: University Press.

Coope, G. R. (2000). The palaeoclimatological significance of Late Cenozoic Coleoptera: familiar species in very unfamiliar circumstances, pp. 303-315 in Culver, S. J. and Rawson, P. F. (eds.), *Biotic response to global change*. Cambridge: Cambridge University Press.

Coope, G. R. and Brophy, J. A. (1972). Late Glacial environmental changes indicated by a coleopteran succession from North Wales. *Boreas* 1, 97-142.

Coope, G. R., Gibbard, P. L., Hall, A. R., Preece, R. C., Robinson, J. E. and Sutcliffe, A. J. (1997). Climatic and environmental reconstructions based on fossil assemblages from the Middle Devensian (Weichselian) deposits of the River Thames at South Kensington, Central London, UK. *Quaternary Science Review* 16, 1163-1195.

Coope, G. R. and Joachim, M. J. (1980). Lateglacial environmental changes interpreted from fossil Coleoptera from St. Bees, Cumbria, N.W. England, pp. 55-68 in Lowe, J. J., Gray, J. M. and Robinson, J. E. (eds.), *Studies in the Lateglacial of North-West Europe*. Oxford: Pergamon.

Coope, G. R. and Lemdahl, G.(1995). Regional differences in the Lateglacial climate of northern Europe based on coleopteran analysis. *Journal of Quaternary Science* 10, 391-395.

Coope, G. R. and Lemdahl, G. (1996). Validations for the use of beetle remains as reliable indicators of Quaternary climates: a reply to the criticisms by Johan Andersen. *Journal of Biogeography* 23, 115-120.

Coope, G. R., Lemdahl, G., Lowe, J. J. and Walkling, A. (1998). Temperature gradients in northern Europe during the last glacial-Holocene transition (14-9 14C kyr BP) interpreted from coleopteran assemblages. *Journal of Quaternary Science* 13, 419-433.

Coope, G. R. and Osborne, P. J. (1968). Report on the Coleopterous Fauna of the Roman Well at Barnsley Park, Gloucestershire. *Transactions of the Bristol and Gloucestershire Archaeological Society* 86, 84-87.

Cooper, E. S., Bundy, D. A. P. and Henry, F. J. (1986). Chronic dysentery, stunting and whipworm infestation. *Lancet* 8501, 280-281.

Corbet, A. (1973). An illustrated introduction to the testate rhizopods in *Sphagnum* with special reference to the area around Malham Tarn, Yorkshire, *Field Studies* 3, 801-838.

Cornelius, P. F. S. (1995a). North-West European thecate hydroids and their medusae. Keys and notes for the identification of the species. Part 1. Laodiceidae to Haleciidae. *Synopses of the British fauna (new series)* 50 (1), 347 pp. Shrewsbury: Linnean Society etc.

Cornelius, P. F. S. (1995b). North-West European thecate hydroids and their medusae. Keys and notes for the identification of the species. Part 2. Sertulariidae to Campanulariidae. *Synopses of the British fauna (new series)* 50 (2), 386 pp. Shrewsbury: Linnean Society etc.

Cornuet, J. M. and Garnery, L. (1991). Mitochondrial DNA variability in honeybees and its phylogeographic implications. *Apidologie* 22, 627-642.

Costantini, L. and Audisio, P. (2000). Plant and insect remains from the Bronze Age site of Ras al-Jinz (RJ - 2), Sultanate of Oman. *Paleorient* 26, 143-156.

Cowell, R. W. and Innes, J. B. (1994). The wetlands of Merseyside. *North West Wetlands Survey* 1. *Lancaster Imprints* 2. Lancaster.

Cowell, R. W., Milles, A. and Roberts, G. (1993). Prehistoric footprints on Formby Point Beach, Merseyside. *North West Wetlands Annual Report* 1993, 43-8.

Crane, E. (1983). *The archaeology of bee-keeping*. London: Duckworth.

Cranston, P. S. (1982). A key to the larvae of the British Orthocladiinae (Chironomidae). *Freshwater Biological Association Scientific Publication* 45. Ambleside: FBA.

Cranston, P. S., Ramsdale, C. D., Snow, K. R. and White, G. B. (1987). Keys to the adults, male hypopygia, fourth-instar larvae and pupae of the British mosquitos (Culicidae) with notes on their ecology and medical importance. *Freshwater Biological Association Scientific Publication* 48, 152 pp. Ambleside: FBA.

Crawford, S., James, P. J. and Maddocks, S. (2001). Survival away from sheep and alternative methods of transmission of sheep lice (*Bovicola ovis*). *Veterinary Parasitology* 94, 205-216.

Criscione, C. D., Anderson, J. D., Sudimack, D., Peng, W., Jha, B., Williams-Blangero, S. and Anderson, T. J. C. (2007). Disentangling hybridization and host colonization in parasitic roundworms of humans and pigs. *Proceedings of the Royal Society B. Biological Sciences* 274, 2669-2677.

Crosskey, R. W. & Taylor, B. J. (1986). Fossil blackflies from Pleistocene interglacial deposits in Norfolk, England. *Systematic Entomology* 11, 401-412.

Crothers, J. and Crothers, M. (1983). A key to the crabs and crab-like animals of British inshore waters. *Field Studies* 5, 753-806.

Crowley, T. J. and Lowery, T. S. (2000). How warm was the medieval warm period? *Ambio* 29, 51-54.

Crowson, R. A. (1972). Records of Coleoptera from Gledswood, Leaderfoot, Berwickshire. *Entomologists' Monthly Magazine* 107 (for 1971), 148.

Crowson, R. A. (1981). *The biology of the Coleoptera*. London etc: Academic.

Cummins, R. H. (1994). Taphonomic processes in modern freshwater molluscan death assemblages: implications for the freshwater fossil record. *Palaeogeography, Palaeoclimatology, Palaeoecology* 108, 55-73.

Currie, D. C. and Walker, I. R. (1992). Recognition and palaeohydrologic significance of fossil black fly larvae, with a key to the Nearctic genera (Diptera: Simuliidae). *Journal of Paleolimnology* 7, 37-54.

Curry, A. R. (1979). The insects associated with the Manchester mummies, pp. 113-117 in David, A. R. (ed.), *The Manchester Museum mummy project*. Manchester: Manchester Museum.

Cymorek, S. and Koch, K. (1969). Über funde von Körperteilen des Messingkäfers *Niptus holoeucus* Fald. in Ablagerungen aus dem 15.-16. Jahrhundert (Neuss, Niederrhein) und Folgerungen daraus für die Ausbreitungsgeschichte der Art in Europa. Anzeiger für Schadlingskunde und Pflanzsschutz 42, 185-186.

Dainton, M. (1992). A quick, semi-quantitative method for recording nematode gut parasite eggs from archaeological deposits. *Circaea, the Journal of the Association for Environmental Archaeology* 9, 58-63.

Dakin, W. J. (1913). *Pearls*. Cambridge: University Press.

Dalfes, H. N., Kukla, G. and Weiss, H. (eds.) (1994). *Third millennium BC climate change and Old World collapse.* Berlin etc: Springer. Dansgaard, W. and many others (1993). Evidence for general instability of past climate from a 250-kyr ice-core record. *Nature* 364, 218-20.

Darby, H. C. and Versey, G. R. (1975). *Domesday gazetteer*. Cambridge: University Press.

Dark, K. and Dark, P. (1997). *The landscape of Roman Britain*. Stroud, Gloucestershire: Sutton.

Dark, P. (2000). *The environment of Britain in the first millennium A.D.* London.

Duckworth. Dark, P. (2004). New evidence for the antiquity of the intestinal parasite *Trichuris* (whipworm) in Europe. *Antiquity* 78, 676-681.

Darlington, A. and Hirons, M. J. D (1968). The pocket encyclopaedia of plant galls in colour. London: Blandford. Darwin, C. (1881). *The formation of vegetable mould through the action of worms, with observation of their habits*. London: Murray.

Davies, A. L. and Tipping, R. (2004). Sensing small scale human activity in the palaeoecological record: fine spatial resolution pollen analysis from Glen Affric, northern Scotland. *The Holocene* 14, 233-245.

Davies, L. (1968). A key to the British species of Simuliidae (Diptera) in the larval, pupal and adult stages. *Freshwater Biological Association Scientific Pulication* 24, 126 pp. Ambleside: Freshwater Biological Association.

Davies, M. and Kathirithamby, J. (1986). *Greek insects*. London: Duckworth. Davies, P. (1996). Subfossil Mollusca: improving environmental interpretation. *Circaea, the Journal of the Association for Environmental Archaeology* 12, 251-2.

Davies, P., Gale, C. H. and Lees, M. (1996). Quantitative study of modern wet-ground molluscan faunas from Bossington, Hampshire. *Journal of Biogeography* 23, 371-377.

Davies, P. and Griffiths, H. I. (2005). Molluscan and ostracod biostratigraphy of Holocene tufa in the Test Valley at Bossington, Hampshire, UK. *The Holocene* 15, 97-110.

Davies, P. and Grimes, C. J. (1999). Small scale variation of pasture molluscan faunas within a relict water meadow system at Wylye, Wiltshire, U. K.. *Journal of Biogeography* 26, 1057-1063.

Davies, P. and Wolski, C. (2001). Later Neolithic woodland regeneration in the long barrow ditch fills of the Avebury area: the molluscan evidence. *Oxford Journal of Archaeology* 20, 311-317.

Davis, A. G. (1954). Mollusca, pp. 58-9 in Wheeler, M., The Stanwick fortifications. *Reports of the Research Committee of the Society of Antiquaries of London* 17. Oxford: Society of Antiquaries.

Davis, A. G. (1961). [Mollusca and Coleoptera], p. 581 in Wenham, P., Excavations and discoveries within the Roman fortress in Davygate, York, 1955-8. *Yorkshire Archaeological Journal* 40, 507-87.

Davis, D. E. (1986). The scarcity of rats and the Black Death: an ecological history. *Journal of Interdisciplinary History* 16, 455-470.

Davis, M., Hall, A., Kenward, H. and Oxley, J. (2002). Preservation of urban archaeological deposits: monitoring and characterisation of archaeological deposits at Marks & Spencer, 44-45 Parliament Street, York. *Internet Archaeology* 11, 30,968 words + 32 images. Available at http://intarch.ac.uk/journal/issue11/oxley_toc.html

Davis, S. R. and Wilkinson, D. M. (2004). The conservation management value of testate amoebae as 'restoration' indicators: speculations based on two damaged raised mires in northwest England. *The Holocene* 14, 135-143.

Day, P. (1996). Devensian Late-Glacial and early Flandrian environmental history of the Vale of Pickering, Yorkshire, England. *Journal of Quaternary Science* 11, 9-24.

Dayton, J. A. (1986). Animal remains - the Cladocera and Chironomidae, pp. 93-98 in Stead, I. M., Bourke, J. B. and Brothwell, D., *Lindow Man: the body in the bog.* London: British Museum.

de Boer, G. (1964). Spurn Head: its history and evolution. *Transactions of the Institute of British Geographers* 34, 71-89.

de Castro, M. C. and Singer, B. H. (2005). Was malaria present in the Amazon before the European conquest? Available evidence and future research agenda. *Journal of Archaeological Science* 32, 337-340.

Deevey, E. S. (1969). Coaxing history to conduct experiments. *BioScience* 19, 40-43.

De Laubenfels, M. W. (1945). Sponge names. *Science* 101, 354-355.

de Moulins, D. [, Allison, E. P., Kenward, H. K., Preece, R., Robinson, E. and Rouffignac, C. de] (1990). *Environmental analysis*, pp. 85-115 and 126-152 in Maloney, C., The upper Walbrook valley in the Roman period. The archaeology of Roman London volume 1. *Council For British Archaeology Research Report* 69.

de Rouffignac, C. (1992). Parasite remains from excavations at 5-7 Foregate, Chester. *Worcester County Archaeological Service Report* 124.

DeFoliart, G. R. (1999). Insects as food: why the Western attitude is important. *Annual Review of Entomology* 44, 21-50.

Deith, M. R. (1983). Molluscan calendars: the use of growth-line analysis to establish seasonality of shellfish collection at the Mesolithic site of Morton, Fife. *Journal of Archaeological Science* 10, 423-440.

Deith, M. R. (1985). *Seasonality from shells: an evaluation of two techniques for seasonal dating of marine molluscs*, pp. 119-177 and un-numbered tables and figures in Fieller, N. R. J., Gilbertson, D. D. and Ralph, N. (eds.), Palaeobiological investigations. Research design, methods and data analysis. *Symposia of the Association for Environmental Archaeology* 5B, *British Archaeological Reports International Series* 226.

Delorme, L. D. (1990). *Freshwater ostracodes*, pp. 93-100 in Warner, B. G. (ed.), Methods in Quaternary ecology. *Geoscience Canada Reprint Series* 5. St John's Newfoundland: Geological Association of Canada.

Demnard, F. and Néraudeau, D. (2001). L'utilisation des oursins fossiles de la prehistoire à l'époque gallo-romaine. *Bulletin de la Société Préhistorique Française* 98, 693-715.

Denford, S. M. (1976). [Mites from Roman deposits at Tullie House] Carlisle. Unpublished typescript in possession of H. K. Kenward.

Denford, S. M. (1978). *Mites and their potential use in archaeology*, pp. 77-81 in Brothwell, D. R., Thomas, K. D. and Clutton-Brock, J. (eds.), Research problems in zooarchaeology. *Institute of Archaeology Occasional Publications* 3. London: Institute of Archaeology.

Denford, S. (1979). The mites, pp. 104-106 in Lambrick, G. and Robinson, M. A., Iron Age and Roman Riverside Settlements at Farmoor, Oxfordshire. *Council for British Archaeology Research Report* 32. London.

Denford, S.M. (1980). *Mites from selected contexts from the Roman well*, p. 139-141 in Hall, A. R., Kenward, H. K. and Williams, D. Environmental evidence from Roman deposits in Skeldergate. *The Archaeology of York* 14 (3), 101-56. London: Council for British Archaeology.

Dent, J. (1988). Some problems of continuity in rural settlement, pp. 94-100 in Manby, T. G. (ed.), *Archaeology in eastern Yorkshire*. Sheffield: Department of Archaeology and Prehistory, University of Sheffield.

Directorate of Ancient Monuments and Historic Buildings (1978). *The scientific treatment of material from rescue excavations*. London: H.M.S.O.

Desender, K. & Ervynck, A. (1992). Wat ruist daar door het struikgewas? De middeleeuwse loopkevers van het Heuvelterrein. In (N. Arts, Ed.), *Sporen onder de Kempische stad. Archeologie, ecologie en vroegste geschiednis van Eindhoven 1225-1500.* Eindhoven.

Deevey, E. S. (1969). Coaxing history to conduct experiments. *BioScience* 19, 40-43.

Dews, J. E. (1985). The significance of the wing veins in the assessment of honeybees for breeding purposes. *The Bee Breeder* 1, 3-11.

Dibb, J. R. (1947). The eco-taxonomic approach to the study of beetles. *The Naturalist* April-June 1947, 45-51.

Dibb, J. R. (1948). *A field book of beetles*. London and Hull: Brown.

Dickson, J. H. (1978). Bronze Age mead. *Antiquity* 52, 108-112.

Dickson, J. H., Dickson, C. A. and Breeze, D. J. (1979). Flour or bread in a Roman military ditch at Bearsden, Scotland. *Antquity* 53, 47-51 + Plate VIb.

Dimbleby, G. W. and Evans, J. G. (1974). Pollen and land-snail analysis of calcareous soils. *Journal of Archaeological Science* 1, 117-133.

DiMichele, W. A., Behrensmeyer, A. K., Olszewski, T. D., Labandeira, C. C., Pandolfi, J. M., Wing, S. L. and Bobe, R. (2004). Long-term stasis in ecological assemblages: evidence from the fossil record. *Annual Review of Ecology, Evolution and Systematics* 35, 285-322.

Dincauze, D. F. (2000). *Environmental archaeology principles and practice*. Cambridge: University Press.

Dinnin, M. (1997a). Holocene beetle assemblages from the Lower Trent floodplain at Bole Ings, Nottinghamshire, U. K. *Quaternary Proceedings* 5, 83-104.

Dinnin, M. (1997b). The palaeoenvironmental survey of West, Thorne and Hatfield Moors, pp. 157-189 in Van de Noort, R. and Ellis, S. (eds.) *Wetland heritage of the Humberhead Levels. An archaeological survey.* Hull: Humber Wetlands Project.

Dinnin, M. H. (1991). The sub-fossil occurrence of the greater silver water-beetle *Hydrophilus piceus* (l.) (Col: Hydrophilidae) at Shirley Pool, South Yorkshire. *The Naturalist* (Hull) 116, 57-9.

Dinnin, M. H. and Sadler, J. P. (1999). 10,000 years of change: the Holocene entomofauna of the British Isles. *Quaternary Proceedings* 7, 545-565.

Dinnin, M. H. and Skidmore, P. (1995). The insect assemblages associated with Lindow III and their environmental implications, pp. 29-38 in Turner, R. C. and Scaife, R. G. (eds.), Bog bodies. New discoveries and new perspectives. London: British Museum.

Dinnin, M. H. and Welsh, M. (2001). Star Carr (SE 744016), pp. 161-164 in Bateman, M. D., Buckland, P. C., Frederick, C. D. and Whitehouse, N. J. (eds.), *The Quaternary of East Yorkshire and North Lincolnshire. Field Guide*. London: Quaternary Research Association.

Dirrigl, F. J. and Greenberg, B. (1995). The utility of insect remains to assessing human burials: a Connecticut case history. *Archaeology of Eastern North America* 23, 1-7.

Dittmar, K., Mamat, U., Whiting, M., Goldmann, T., Reinhard, K. and Guillen, S. (2003). Techniques of DNA-studies on prehispanic ectoparasites (*Pulex* sp., Pulicidae, Siphonaptera) from animal mummies of the Chiribaya culture, Southern Peru. *Memorias do Instituto Oswoaldo Cruz* 98 (Suppl. 1), 53-58.

Dittmar, K. and Teegan, W. R. (2003). The presence of *Fasciola hepatica* (liver-fluke) in humans and cattle from a 4,500 year old archaeological site in the Saale-Unstrut Valley, Germany. *Memorias do Instituto Oswoaldo Cruz* 98 (Suppl. 1), 141-143.

Dobney, K., Hall, A. and Hill, M. (2000a). *Why did the chicken dig a hole? Some observations on the excavation of dust baths by domestic fowl and their implications for archaeology*, pp. 91-3 in Huntley, J. P. and Stallibrass, S. (eds.), Taphonomy and interpretation. *Symposia of the Association for Environmental Archaeology* 14. Oxford: Oxbow.

Dobney, K. *et al.* Flixborough publication Dobney, K., Hall, A. and Kenward, H. (1999). *It's all garbage... A review of bioarchaeology in the four English* Colonia *towns*, pp. 15-35 in Hurst, H. (ed.), The Coloniae of Roman Britain: New studies and a review. *Journal of Roman Archaeology Supplementary Series* 36.

Dobney, K., Hall, A. and Kenward, H. K. (2000b). The bioarchaeology of Anglian Yorkshire: present and future perspectives, pp. 133-140 in Geake, H. and Kenny, J. (eds.), *Early Deira. Archaeological studies of the East Riding in the fourth to ninth centuries AD*. Oxford: Oxbow.

Dobney, K., Hall, A. R., Kenward, H. K. and Milles, A. (1992 for 1991). A working classification of sample types for environmental archaeology. *Circaea, the Journal of the Association for Environmental Archaeology* 9, 24-6.

Dobney, K., Jaques, D, Carrott, J., Hall, A., Issitt, M. and Large, F. (2001). *Biological remains*, pp. 148-182 and *Bibliography* pp. 195-199 in Ottaway, P., Excavations on the site of the Roman signal station at Carr Naze, Filey, 1993-94. *The Archaeological Journal* 157 (for 2000), 79-199.

Dobney, K., Kenward, H., Ottaway, P. and Donel, L. (1998). Down, but not out: biological evidence for complex economic organisation in Lincoln in the late fourth century. *Antiquity* 72, 417-424.

Dobney, K., Kenward, H. and Roskams, S. (1997). All mixed up but somewhere to go? Confronting residuality in bioarchaeology, pp. 81-88 in De Boe, G. and Verhaege, F. (eds.), *Method and theory in historical archaeology*. Papers of the 'Medieval Europe Brugge 1997' Conference 10. *I. A. P. Rapporten* 10. Zellik.

Dobson, M. (1980). "Marsh fever" - the geography of malaria in England. *Journal of Historical Geography* 6, 357-389.

Dobson, R. M. and Satchell, J. E. (1956). *Eophila oculata* at Verulamium: a Roman earthworm population? *Nature* 177, 796-797.

Dodd, J. R. and Stanton, R. J. (1990). *Paleoecology concepts and applications.* New York etc: John Wiley and Sons.

Dolin, V. G. (1978). *Key to* Elateridae *larvae of the USSR.* Kiev. [in Russian)]

Dolling, W. R. (1991). *The Hemiptera*. Oxford etc: Oxford University Press.

Donaldson, A. (1982). *Botanical report*, pp. 18-19 in Jobey, G., The settlement and Doubstead and Roman-British settlement on the coastal plane between Tyne and Forth. *Archaeologia Aeliana* 5th series 10, 1-23.

Donaldson, A. M., Jones, A. K. G. and Rackham, D. J. (1980). *Barnard Castle, Co. Durham. A dinner in the Great Hall: report on the contents of a fifteenth-century drain*, pp. 76-96 in Austin, D., Barnard Castle, Co. Durham. Second interim report: excavations in the inner ward 1976-8: the later medieval period. *Journal of the British Archaeological Association* 133, 74-96.

Donaldson, A., Morris, C. and Rackham, J. (1981). The Birsay Bay project. Preliminary investigations into the past exploitation of the coastal environment at Birsay, mainland Orkney, pp. 65-86 in Brothwell, D. and Dimbleby, G. (eds), Environmental aspects of coasts and islands. *British Archaeological Reports International Series* 94. Oxford.

Donaldson, A. M. and Rackham, D. J. (1984). Environmental work in northern England, pp. 134151 in Keeley (H. C. M. (ed.), Environmental archaeology: a regional review. London: Department of the Environment.

Donaldson, A. M. and Rackham, D. J. (1985). *Analysis of soil samples*, pp. 80-83 in O'Sullivan, D. M., The excavation in Holy Island Village 1977. *Archaeologia Aeliana* 5th series 13, 27-116.

Donaldson, A. M., Jones, A. K. G. and Rackham, D. J. (1980). Barnard Castle, Co. Durham. Second Interim Report: Excavations in the Inner Ward, 1976-8: the Later Medieval Period. *Journal of the British Archaeological Association* 133, 74-96 plus pls. xxiv-xxi.

Dowdeswell, J. A, and White, J. W. C. (1995). Greenland ice core records and rapid climate-change. *Philosophical Transactions of the Royal Society of London Series A- Physical Sciences and Engineering* 352, 359-371.

Downes, J. A. (1950). Habits and life-cycle of *Culicoides nubeculosus* Mg. *Nature, London* 166, 510-511.

Drake, H. C. and Sheppard, T. (1910). Classified list of organic remains from the rocks of the East Riding of Yorkshire. *Proceedings of the Yorkshire Geological Society* 17 (1), 4-71.

Drancourt, M., Aboudharam, G., Signoli, M., Dutour, O., Raoult, D. (1998). Detection of 400-year-old *Yersinia pestis* DNA in human dental pulp: an approach to the diagnosis of ancient septicemia.. *Proceedings of the National Academy of Science USA* 95, 12637-12640.

Drancourt, M. and Raoult, D. (2002). Molecular insights into the history of plague. *Microbes and Infection* 4, 105-109.

Drancourt, M. and Raoult, D. (2004) Molecular detection of *Yersinia pestis* in dental pulp. *Microbiology* 150, 263-264.

Drancourt, M., Tran-Hung, L., Courtin, J., de Lumley, H. and Raoult, D. (2005). *Bartonella quintana* in a 4000-year-old human tooth. *Journal of Infectious Diseases* 191, 607-611.

Drewett, P., Bedwin, O., Freke, D. and Rudling, D. (1978). Rescue archaeology in Sussex, 1977. A fourth progress report on the Sussex Archaeological Field Unit. *Bulletin of the Institute of Archaeology, University of London* 15, 49-72.

Duffy, E. A. J. (1953). *A monograph of the immature stages of British and imported timber beetles (*Cerambycidae*)*. London: British Museum (Natural History).

Dufour, D. L. (1987). Insects as food: a case study from the northwest Amazon. *American Anthropologist* 89, 383-397.

Dumayne, L. and Barber, K. E. (1994). The impact of the Romans on the environment of northern England: pollen data from three sites close to Hadrian's Wall. *The Holocene* 4, 165-173.

Dumayne-Peaty, L. and Barber, K. (1997). Archaeological and environmental evidence for Roman impact on vegetation near Carlisle, Cumbria: a comment on McCarthy. *The Holocene* 7, 243-246.

Duncan, I. J., Titchener, F. and Briggs, D. E. G. (2003). Decay and disarticulation of the cockroach: implications for the preservation of the blattoids of Writhlington (Upper Carboniferous), UK. *Palaios* 18, 256-265.

Dury, G. H. (1981). Climate and settlement in late-medieval central England, pp. 40-55 in Smith, C. D. and Parry, M. L. (eds) *Consequences of climatic change.* Nottingham: Department of Geography, University of Nottingham.

Easton, E. H. (1964). *Centipedes of the British Isles.* London: Warne.

Ebbell, B. (1937). *The Papyrus Ebers. The greatest Egyptian medical document*. London and Copenhagen: Oxford University Press and Levin and Munksgaard.

Ebeling, W. (1971). Sorptive dusts for pest control. *Annual Review of Entomology* 16, 123-158.

Edington, J. M. and Hildrew, A. G. (1995). A key to the caseless caddis larvae of the British Isles, with notes on their ecology. *Freshwater Biological Association Scientific Publication* 53, 134 pp. Ambleside: FBA.

Edwards, C. A. (1987). The Quaternary deposits of Filey Bay, pp. 15-21 and references pp. 106116 in Ellis, S. (ed.), *East Yorkshire - Field Guide*. Cambridge: Quaternary Research Association.

Edwards, C. A. and Heath, G. W. (1964). *The principles of agricultural entomology*. London: Chapman and Hall.

Edwards, C. A. and Lofty, J. R. (1977). *Biology of earthworms*. London: Chapman and Hall.

Edwards, K. J. (1993). Models of mid-Holocene forest farming for north-west Europe, pp. 133-145 in Chambers, F. M. (ed.), *Climate change and human impact on the landscape*. London etc.: Chapman and Hall.

Elias, S. A. (1994). *Quaternary insects and their environments.* Washington: Smithsonian.

Elias, S. A. (1997). The mutual climatic range method of palaeoclimate reconstruction based on insect fossils: new applications and interhemispheric comparisons. *Quaternary Science Reviews* 16, 1217-1225.

Elias, S. A. (2001). Coleoptera and Trichoptera, pp. 67-80 in Smol, J. P., Birks, H. J. B. and Last, W. M. (eds.), *Tracking environmental change using lake sediments. Volume 4: Zoological indicators*. Dortrecht etc: Kluwer Academic Publishers.

Elliot, J.M. (1996). British freshwater Megaloptera and Neuroptera: a key with ecological notes. *Freshwater Biological Association Scientific Publication* 54. Ambleside: FBA.

Elliot, J. M., O'Connor, J. P. and O'Connor M. A. (1979). A key to the larvae of Sialidae (Insects: Megaloptera) occurring in the British Isles. *Freshwater Biology* 9, 511-514.

Ellis, A. E. (1926, reprinted 1969). *British snails*. Oxford: Clarendon.

Ellis, A. E. (1951). *British freshwater bivalves*. London: Academic Press.

Ellis, A. E. (1978). British freshwater bivalve Mollusca. Keys and notes for the identification of the species. *Synopses of the British fauna (new series)* 11, 109 pp. London etc: Academic.

Ellis, S., Fenwick, H., Lillie, M. and Van de Noort, R. (2001). *Wetland heritage of the Lincolnshire marsh. An archaeological survey*. Hull: Humber Wetlands Project.

ElMahi, A. T. [as ElMali on title page] (1999). Mollusc harvesting along the coasts of Oman: a supplementary diet. *Proceedings of the Seminar for Arabian Studies* 29, 45-53.

Elmslie, L. J. (1984). Edible snails, pp. 432-433 in Mason, I. L. (ed.), *Evolution of domesticated animals*. London: Longman.

Else, G. R. (1992). Further extension of the range of *Dolichovespula media* (Retzius) (Hym., Vespidae) in Britain in 1989 and 1990. *Entomologist's Monthly Magazine* 128, 43-46.

Else, G. R. (1993). *Dolichovespula saxonica* (F.) (Hym., Vespidae) in Hampshire, Surrey and Greater London in 1992. *Entomologist's Monthly Magazine* 129,168.

Elton, C. S. (1958). *The ecology of invasions by animals and plants*. London: Methuen.

Elton, C. S. (1966). *The pattern of animal communities*. London: Methuen.

Enckell, P. H. and Rundgren, S. (1988). Anthropochorous earthworms (Lumbricidae) as indicators of abandoned settlements in the Faeroe Islands. *Journal of Archaeological Science* 15, 439-451.

English Heritage (1991a). *Exploring our past.* London: Historic Buildings and Monuments Commission for England.

English Heritage (1991b). *Management of Archaeological Projects*. London: Historic Buildings and Monuments Commission for England. (MAP2)

English Heritage (2002). Environmental archaeology. A guide to the theory and practice of methods, from sampling and recovery to post-excavation. *Centre for Archaeology Guidelines* 2002/01. London: English Heritage.

EPICA community members (2004). Eight glacial cycles from an Antarctic ice core. *Nature* 429, 623-628.

Erickson, J. M. (1988). Fossil Oribatid mites as tools for Quaternary paleoecologists: preservation quality, quantities, and taphonomy. *Bulletin of the Buffalo Society of Natural Sciences* 33, 207-226.

Ervynck, A., Desender, K., Pieters, M. and Bungeneers, J. (1994). *Carabid beetles as palaeo-ecological indicators in archaeology*, pp. 261-266 in Desender, K., Dufrene, M., Luff, M. L. and Maelfait, J-P. (eds), Carabid beetles: ecology and evolution. *Series Entomologica* (Dordrecht) 51.

Erzinclioglu, Y. Z. and Phipps, J. (1983). [Report on dipterous puparia], pp. 180-1 in Hall, A. R., Kenward, H. K., Williams, D. and Greig, J. R. A., Environment and living conditions at two Anglo-Scandinavian sites. *The Archaeology of York* 14 (4), 157-240 plus Plate I and Fiche 1. London: Council for British Archaeology.

Essig, E. O. (1934). The value of insects to the California indians. *The Scientific Monthly* 38, 181-186.

Evans, A. C. and Guild, W. J. McL. (1947). Cocoons of some British Lumbricidae. *Annals and Magazine of Natural History* 1947, 714-719.

Evans E. E. (1957). *Irish folk ways*. London and New York: Routledge.

Evans, G. (1975). *The life of beetles*. London: George Allen and Unwin Ltd.

Evans, G. O., Sheals, J. G. and Macfarlane, D. (1961). *The terrestrial* Acari *of the British Isles* 1. London: British Museum (Natural History).

Evans, G. O. (1950). Studies on the bionomics of the sheep ked, *Melophagus ovinus*, L., in West Wales. *Bulletin of Entomological Research* 40, 459-478.

Evans, J. G. (1969a). Land and freshwater Mollusca in archaeology: chronological aspects. *World Archaeology* 1, 170-183.

Evans, J. G. (1969b). *The terrestrial mollusc shells*, p. 221 in Wacher, J., Excavation at Broughon-Humber. *Society of Antiquaries Research Report* 25.

Evans, J. G. (1969c). The exploitation of molluscs, 479-84 in Ucko, P. J. and Dimbleby, G. W. (eds.), *The domestication and exploitation of plants and animals*. London: Duckworth.

Evans, J. G. (1970). Interpretation of land snail faunas. *Institute of Archaeology University of London Bulletin* 8-9, 109-116.

Evans, J. G. (1971). Habitat change on the calcareous soils of Britain: the impact of Neolithic man, pp. 27-73 in Simpson, D. D. A. (ed.), Economy and settlement in Neolithic and early Bronze Age Britain and Europe. Leicester: University Press.

Evans, J. G. (1972). *Land snails in archaeology*. London and New York: Seminar.

Evans, J. G (1976). Subfossil land-snail faunas from rock-rubble habitats, pp. 397-399 in Davidson, D. A. and Shackley, M. L. (eds.), *Geoarchaeology. Earth science and the past*. London: Duckworth.

Evans, J. G. (1975a). *The environment of early man in the British Isles*. LOndon: Paul Elek.

Evans, J. G. (1979). *Molluscs*, pp. 136-7 in Andrews, D. D. and Milne, G. (eds.), Wharram. A study of settlement on the Yorkshire Wolds 1. Domestic settlement. 1: Areas 10 and 6. *Medieval Archaeology Monograph Series* 8.

Evans, J. G. (1991). An approach to the interpretation of dry-ground and wet-ground molluscan taxocenes from central-southern England, pp. 75-89 in Harris, D. R. and Thomas, K. D. (eds.), *Modelling ecological change: perspectives from neoecology, palaeoecology and environmental archaeology*. London: Institute of Archaeology.

Evans, J. G. (1993). Influence of human communities on the English chalklands from the Mesolithic to the Iron Age: the molluscan evidence, pp. 147-156 in Chambers, F. M. (ed.), *Climate change and human impact on the landscape*. London etc.: Chapman and Hall.

Evans, J. G., Davies, P., Mount, R, and Williams, D. (1992). *Molluscan taxocenes from Holocene overbank alluvium in central southern England*, pp. 65-74 in Needham, S. and Macklin, M. G. (eds), Alluvial archaeology in Britain. *Oxbow Monograph* 27. Oxford.

Evans, J. G. and Jones, H. (1981). Subfossil land-snail faunas from Grimes Graves and other Neolithic flint mines, pp. 104-111 in Mercer, R. J. (ed.), *Grimes Graves, Norfolk. Excavations 1971-72*. volume 1. London: HMSO.

Evans, J. G and Limbrey, S. (1974). The experimental earthwork on Morden Bog, Wareham, Dorset, England, 1963-1972. Report of the Experimental Earthworks Committee of the British Association for the Advancement of Science. *Proceedings of the Prehistoric Society* 40, 170-202.

Evans, J. and O'Connor, T. (1999). *Environmental archaeology. Principles and methods*. Stroud, Gloucestershire: Sutton.

Evans, J. G. and Simpson, D. A. (1991). Giants' Hill 2 long barrow, Skendleby, Lincolnshire. *Archaeologia* 109, 1-45.

Evans, J. G. and Smith, I. F. (1983). Excavations at Cherhill, North Wiltshire, 1967. *Proceedings of the Prehistoric Society* 49, 43-117.

Evans, J. G. and Williams, D. (1991). *Land mollusca from the M3 archaeological sites - a review*, pp. 113-142 in Fasham, P. J. and Whinney, R. J. B., Archaeology and the M3. *Hampshire Field Club and Archaeological Society Monograph* 7.

Evans, J. R., Kirby, J. R. and Long, A. J. (2001). The litho- and biostratigraphy of a late Holocene tidal channel in Romney Marsh, southern England. *Proceedings of the Geologists' Association* 112, 111-130.

Evershed, R. P., Bethell, P. H., Reynolds, P. J. and Walsh, N. J. (1997). 5'ß-Stigmastanol and related 5ß-Stanols as biomarkers of manuring: analysis of modern experimental material and assessment of the archaeological potential. *Journal of Archaeological Science* 24, 485-495.

Evershed, R. P., Dudd, S. N., Anderson-Stojanovic, V. R. and Gebhard, E. R. (2003). New evidence for the use of combed ware pottery vessels as beehives in ancient Greece. *Journal of Archaeological Science* 30, 1-12.

Eyre, M. D., Rushton, S. P., Luff, M. L. and Telfer, M. G. (2005). Investigating the relationships between the distribution of British ground beetle species (Coleoptera, Carabidae) and temperature, precipitation and altitude. *Journal of Biogeography* 32, 973-983.

Faulkner, C. T. (1991). Prehistoric diet and parasitic infection in Tennessee: evidence from the analysis of desiccated human paleofeces. *American Antiquity* 56, 687-700.

Faulkner, C. T., Patton, S. and Johnson, S. S. (1989). Prehistoric parasitism in Tennessee: evidence from the analysis of desiccated fecal material collected from Big Bone Cave, Van Buren County, Tennessee. *Journal of Parasitology* 75, 461-463.

Fell, V. (2000). The nit combs, pp. 398-400 in Buxton, K. and Howard-Davis, C., Bremetenacum. Excavations at Roman Ribchester 1980, 1989-1990. *Lancaster Imprints Series* 9. Lancaster: Lancaster University Archaeological Unit.

Fenton, A. (1978). *The Northern Isles: Orkney and Shetland*. Edinburgh: John Donald.

Fenton, A. (1986). *The shape of the past 2: essays in Scottish ethnology*. Edinburgh: John Donald.

Fenton-Thomas, C. (2003). Late prehistoric and early historic landscapes on the Yorkshire chalk. *British Archaeological Reports* 350. Oxford.

Ferreira, L. F., Araújo, A., Confalonieri, U. and Nuñez, L. (1984). The finding of eggs of *Diphyllobothrium* in human coprolites (4,000-1,950 B. C.) from Northern Chile. *Memorias do Instituto Oswaldo Cruz* 79, 175-180.

Fields, P. and Korunic, Z. (2000). The effect of grain moisture content and temperature on the efficacy of diatomaceous earths from different geograpical locations against stored-product beetles. *Journal of Stored Products Research* 36, 1-13.

Figuier, L. (1869). *The insect world; being a popular account of the orders of insects, together with a description of the habits and economy of some of the most interesting species.* London: Chapman and Hall.

Filippi, M. L., Lambert, P., Hunziker, J., Kubler, B. and Bernasconi, S. (1999). Climatic and anthropogenic influence on the stable isotope record from bulk carbonates and ostracodes in Lake Neuchatel, Switzerland. *Journal of Paleolimnology* 21, 19-34.

Fisher, M. J., Funnell, B. M. and West, R. G. (1969). Foraminifera and pollen from a marine interglacial deposit in the western North Sea. *Proceedings of the Yorkshire Geological Society* 37, 311-320.

Fisher, R. A., Corbet, A. S. and Williams, C. B. (1943). The relation between the number of species and the number of individuals in a random sample of an animal population. *Journal of Animal Ecology* 12, 42-58.

Fitch, E. A. (1879). Granary weevils: *Sitophilus granarius* and *S. oryzae*. *The Entomologist* 12, 41-50.

Fitter, R. S. R (1945). *London's natural history.* London: Collins.

Flannery, M. B., Stott, A. W., Briggs, D. E. G. and Evershed, R. P. (2001). Chitin in the fossil record: identification and quantification of D-glucosamine. *Organic Geochemistry* 32, 745-754.

Fleming, S. J. (1983) The tale of the cochineal: insect farming in the new world. *Archaeology* 36, 68-69.

Flemming, N. (2005). Submerged archaeological landscapes. Evidence of human migrations. *English Heritage Conservation Bulletin* 48 (Spring 2005), 20-22. London: English Heritage.

Flenley, J. R., Maloney, B. K., Ford, D. and Hallam, G. (1975). *Trapa natans* in the British Flandrian. *Nature* 257, 39-41.

Foreman, M. (1992). Object of bone, antler, and shell, pp. 163-74 in Evans, D. H. and Tomlinson, D. G., Excavations at 33-35 Eastgate, Beverley, 1983-86. *Sheffield Excavation Reports* 3. Sheffield.

Foster, G.N. (2000). *A review of the scarce and threatened Coleoptera of Great Britain Part 3 Aquatic Coleoptera*. Peterborough: Joint Nature Conservation Committee.

Fowler, W. W. (1887-1891). *The Coleoptera of the British Islands* 1-5. London: Lovell Reeve.

Fowler, W. W. and Donisthorpe, H. St J. (1913). *The Coleoptera of the British Islands* 6. London: Lovell Reeve.

Francis, D. R. (2001). Bryozoan statoblasts, pp. 105-123 in Smol, J. P., Birks, H. J. B. and Last, W. M. (eds.), *Tracking environmental change using lake sediments. Volume 4: Zoological indicators*. Dortrecht etc: Kluwer Academic Publishers.

Fraser, F. C. (1959). Mecoptera, Megaloptera, Neuroptera. *Handbooks for the identification of British insects* 1 (12-13). London: Royal Entomological Society.

Freeman, P. and Lane, R. P. (1985). Bibionid and scatopsid flies. Diptera: Bibionidae and Scatopsidea. *Handbooks for the identification of British insects* 9 (7). London: Royal Entomological Society.

Freude, H., Harde, K. W. and Lohse, G. A. (1964-1983) (eds.). *Die Käfer mitteleuropas* 1-11 and supplements. Krefeld: Goeke and Evers.

Frey, D. G. (1960). The ecological significance of Cladoceran remains in lake sediments. *Ecology* 41, 684-699.

Frey, D. G (1964). Remains of animals in Quaternary lake and bog sediments and their interpretation. *Archiv für Hydrobiologie. Beiheft (Internationale Vereinigung für theoretische und angewandte Limnologie*) 2 1-114 + Plates 1-2. Stuttgart.

Frey, D. G. (1976). Interpretation of Quarternary paleoecology from Cladocera and midges and prognosis regarding the workability of other organisms.. *Canadian Journal of Zoolology* 54, 2208-2226.

Frey, D. G. (1986). Cladocera analysis, pp. 667-692 in Berglund, B.E. (ed.), *Handbook of Holocene palaeoecology and palaeohydrology*. Chichester etc: Wiley.

Fritz, S. C., Engstrom, D. R. and Haskell, B. J. (1994). 'Little Ice Age' aridity in the North American Great Plains: a high-resolution reconstruction of salinity fluctuations from Devils Lake, North Dakota, USA. *The Holocene* 4, 69-73.

Frogley, M. R., Griffiths, H. I., and Heaton, T. H. E. (2001). Historical biogeography and Late Quaternary environmental change of Lake Pamvotis, Ioannina (north-west Greece): evidence from ostracods. *Journal of Biogeography* 28, 745-756.

Frost, W. E. and Brown, M. E. (1967). *The trout*. London: Collins. (*New Naturalist* 21.)

Fry, G. F. (1976). Analysis of prehistoric coprolites from Utah. *University of Utah Anthropological Papers* 97, 45 pp. Salt Lake City: University of Utah Press.

Fry, G. F. and Moore, J. G. (1969). *Enterobius vermicularis*: 10,000-year-old human infection. *Science* 166, 1620.

Fryer, G. (1972). Observations on the ephippia of certain macrothricid cladocerans. *Zoological Journal of the Linnean Society* 51, 79-96.

Fryer, G. (1977). The horse-trough ostracod *Heterocypris incongruens*. *The Naturalist* 122, 121-135.

Fryer, G. and Murphy, S. (1991). *A natural history of the lakes, tarns and streams of the English Lake District.* Ambleside, Cumbria: The Freshwater Biological Association.

Fryer, G. and Smyly, W. J. P. (1954). Some remarks on the resting stages of some freshwater cyclopoid and harpacticoid copepods. *Annals and Magazine of Natural History* series 12 vol. 7, 65-72 + Plate II.

Fuller, H. S. (1956). Veterinary and medical acarology. *Annual Review of Entomology* 1, 347-366.

Funnell, B. B. (1995). *Global sea-level and the (pen-)insularity of late Cenozoic Britain*, pp. 3-13 in Preece, R. C. (ed.), Island Britain: a Quaternary perspective. *Geological Society Special Publication* 96. London.

Gaillard, M-J. and Lemdahl, G. (1994). Early-Holocene coastal environments and climate in southeast Sweden: a reconstruction based on macrofossils from submarine deposits. *The Holocene* 4, 53-68.

Gale, S. H., Hunt, C. O. and Southgate, G. A. (1985). The stratigraphy of Kirkhead Cave, an Upper Paleolithic site in northern England. *Proceedings of the Prehistoric Society* 51, 283-304.

Gardiner, J., Allen, M. J.. Hamilton-Dyer, S., Laidlaw, M. and Scaife, R. G. (2002). Making the most of it: late prehistoric pastoralism in the Avon Levels, Severn Estuary. *Proceedings of the Prehistoric Society* 68, 1-39.

Garnier, N., Cren-Olive, C., Rolando, C. and Regert, M. (2002). Characterisation of archaeological beeswax by electron ionisation and electrospray ionisation mass spectrometry. *Analytical Chemistry* 74, 4868-4877.

Gaunt, G. D. (2001). Speeton Cliff (TA 147758), pp. 89-95 in Bateman, M. D., Buckland, P. C., Frederick, C. D. and Whitehouse, N. J. (eds.), *The Quaternary of East Yorkshire and North Lincolnshire.* Field Guide. London: Quaternary Research Association.

Gaunt, G. D. and Tooley, M. (1974). Evidence for Flandrian sea-level changes in the Humber estuary and adjacent areas. *Bulletin of the Geological Survey of Great Britain* 48, 25-41.

Gaunt, G. D., Coope, G. R. and Franks, J. W. (1970). Quaternary deposits at Oxbow opencast coal site in the Aire Valley, Yorkshire. *Proceedings of the Yorkshire Geological Society* 38, 175200 + Plate 11.

Gaunt, G. D., Coope, G. R., Osborne, P. J. and Franks, J. W. (1972). An interglacial deposit near Austerfield, southern Yorkshire. *Institute of Geological Sciences Report* 72/4. London: HMSO.

Gee, H. (2001). *Deep time.* London: Fourth Estate.

Gee, J. H. R. and Giller, P. S. (1991). Contemporary community ecology and environmental archaeology, pp. 1-12 in Harris, D. R. and Thomas, K. D. (eds.), *Modelling ecological change. Perspectives from neoecology, palaeoecology and environmental archaeology*. London: Institute of Archaeology.

Gehrels, W. R. and Newman, W. G. (2004). Salt marsh foraminifera in Ho Bugt, western Denmark, and their use as sea-level indicators. *Geografisk Tidsskrift, Danish Journal of Geography* 104, 97-106.

Gehrels, W. R., Roe, H. M. and Charman, D. J. (2001). Foraminifera, testate amoebae and diatoms as sea-level indicators in UK saltmarshes: a quantitative multiproxy approach. *Journal of Quaternary Science* 16, 201-220.

Getz, F. M. (1991). Black death and the silver lining. Meaning continuity and revolutionary change in histories of medieval plague. *Journal of the History of Biology* 24, 265-290.

Gilbert, M. B. and Bass, W. M. (1967) Seasonal dating of burials from the presence of fly pupae. *American Antiquity*, 32, 534-535.

Gilbert, M. T. P., Cucci, J., White, W., Lynnerup, N., Titball, R. W., Cooper, A. and Prentice, M. B. (2004). Absence of *Yersinia pestis*-specific DNA in human teeth from five European excavations of putative plague victims. *Microbiology* 150, 341-354.

Gilbertson, D. D., Late Quaternary Environments and Man in Holderness. *British Archaeological Reports British Series* 134. Oxford.

Gilbertson, D. D. and Hawkins, A. B. (1985). *Past and present distributions of* Hydrobia ulvae *(Pennant), Gastropoda, and* Macoma balthica *(L.), Bivalvia, along the southern shores of the Severn Estuary in relation to water pollution, field survey and laboratory methods*, pp. 167-178 + figures in Fieller, N. R. J., Gilbertson, D. D. and Ralph, N. G. A., Palaeobiological investigations. Research design, methods and data analysis. Symposia of the Association for Environmental archaeology No. 5B. *BAR International Series* 266. Oxford.

Gilbertson, D. D., Briggs, D. J., Blackham, A. M., Gale, S. J., Hall. A. R., Hunt, C. O. and Thew, N. M. (1987). The Late Quaternary lake margin sequence at Skipsea Withow Mere, pp. 58-68 and references pp. 106-116 in Ellis, S. (ed.), *East Yorkshire - Field Guide*. Cambridge: Quaternary Research Association.

Girling, M. (1977). Bird pellets from a Somerset Levels trackway. *The Naturalist* 102, 49-52.

Girling, M. A. (1979). Calcium carbonate-replaced arthropods from archaeological deposits. *Journal of Archaeological Science* 6, 309-320.

Girling, M. A. (1980). The fossil insect assemblage from the Baker Site. *Somerset Levels Papers* 6, 36-42.

Girling, M. A. (1981). *Beetle remains*, pp. 82-84 in Thorne, J. C., The burial of John Dygon, Abbott of St Augustine's, pp. 74-84 in Detsicas, A. (ed.), *Collectianae Historica: Essays in Memory of Stuart Rigold*. Maidstone: Kent Archaeological Society.

Girling, M. A. (n.d. but 1983). *Key to the Identification of Sub-Fossil Spider Remains*. London: Ancient Monuments Laboratory unpublished report.

Girling, M. A. (1984). Eighteenth century records of human lice (Pthiraptera, Anoplura) and fleas (Siphonaptera, Pulicidae) in the City of London. *Entomologist's Monthly Magazine* 120, 207-210.

Girling, M. A. (1985). *Fly puparia*, p. 31 and Fiche M1:A12 in Hirst, S. M., An Anglo-Saxon Inhumation Cemetery at Sewerby, East Yorkshire. *York University Archaeological Publications* 4. York: Department of Archaeology, University of York.

Girling, M. A. (1986). The insects associated with Lindow man, pp. 90-91 in Stead I M, Bourke, J B and Brothwell D., *Lindow Man: the body in the bog*. London: British Museum.

Girling, M. A. (1988). *The bark beetle* Scolytus scolytus *(*Fabricius*) and the possible role of elm disease in the early Neolithic*, pp. 34-38 in Jones, M. (ed.), Archaeology and the Flora of the British Isles. *Oxford University Committee for Archaeology Monograph* 14. Oxford.

Girling, M. (1993). *Insect attack in charcoal*, pp. 79-80 in Ellis, P. (ed.), Beeston Castle, Cheshire, a report on the excavations 1968-85 by Laurence Keen and Peter Hough. *HBMC Archaeological Report 23*. London: Historic Buildings and Monuments Commission for England.

Girling, M. A. and Greig, J. R. A. (1985). A first fossil record for *Scolytus scolytus* (F.) (elm bark beetle): its occurrence in elm decline deposits from London and the implications for Neolithic elm disease. *Journal of Archaeological Science* 12, 347-352.

Girling, M. A. and Robinson, M. (1989). [insect remains], pp. 49-50, 56-59 and *passim* in Hayfield,

C. and Greig, J. (eds.), Excavation and Salvage Work on a Moated Site at Cowick, South Humberside, 1976. *Yorkshire Archaeological Journal* 61, 47-70.

Glen, R. (1950). Larvae of the elaterid beetles of the tribe Lepturoidini. *Smithsonian Miscellaneous Collections* 111: number 11.

Godwin, H. (1975). *The history of the British flora*.Cambridge: University Press.

Goetze, G. (1939). Ein wichtiger Fund zur Frühgeschichte der deutschen Imkerei in Oldenburg. *Deutsche Imkerführer* 13, 106-7.

Goldie-Smith, E. K. and Thorpe, J. R. (1991). Eggs of British meniscus midges (Diptera: Dixidae) observed by scanning electron microscopy. *Freshwater Forum* 1, 215-224.

Golob, P. (1997). Current status and future perspectives for inert dusts for control of stored product insects. *Journal of Stored Products Research* 33, 69-79.

Golob, P. and Webley, D. J. (1980). The use of plants and minerals as traditional protectants of stored products. *Report of the Tropical Products Institute* G138, vi + 32 pp. London: Tropical products Institute.

Gonçalves, M. L. C., Araujo, A. and Ferreira, L. F. (2003). Human intestinal parasites in the past: new findings and a review. *Memorias do Instituto Oswaldo Cruz* 98 (suppl. 1), 103-118.

Good, G. L., Jones, R. H. and Ponsford, M. W. (1991). Waterfront archaeology. Proceedings of the third international conference on waterfront archaeology held at Bristol 23-26 September 1988. *CBA Research Report* 74. London.

Good, I. (1995). On the question of silk in pre-Han Eurasia. *Antiquity* 69, 959-968.

Gordon, D. and Ellis, C. (1985). Species composition parameters and life tables: their application to detect environmental change in fossil land molluscan [sic] assemblages, pp. 153-162 + figures in Fieller, N. R. J., Gilbertson, D. D. and Ralph, N. G. A. (eds.), Palaeoenvironmental investigations: research design, methods and data analysis. Symposium 5 of the Association for Environmental Archaeology. Oxford: BAR..

Gothe, R. and Schöl, H. (1992). Hirschlausfliegen (Diptera, Hippoboscidae: *Lipoptena cervi*) in den Beifunden der Leiche vom Hauslabjoch, pp. 299-306 in Höpfel, F., Platzer, W. and Spindler, K. (eds.), *Der Mann im Eis. Band 1. Bericht über das Internationale Symposium in Innsbruch, Wein*. Innsbruck.

Goulden, C. E. (1964a). Progressive changes in the Cladoceran and midge fauna during the ontogeny of Esthwaite Water. *Verhandlungen der Internationalen Vereinigung für theoretische und angewandte Limnologie* 15, 1000-1005.

Goulden, C. E. (1964b). The history of the cladoceran fauna of Esthwaite Water (England) and its limnological significance. *Archiv für Hydrobiologie* 60, 1-52.

Graham, A. (1971). British prosobranchs and other operculate gastropod molluscs. *Linnean Society of London Synopses of the British Fauna (New Series)* 2. London: Academic.

Green, F. J. (1979). Phosphatic mineralization of seeds from archaeological sites. *Journal of Archaeological Science* 6, 279-284.

Green, J. and Macquitty, M. (1987). Halicarid mites (Arachnida: Acari). Keys and notes for the identification of the species. *Synopses of the British fauna (new series)* 36, 178 pp. London etc.: E. J. Brill/Dr W. Backhuys.

Green, S. V. (1998). The bushman as entomologist. *Antenna* 22, 4-8.

Greenwood, M. and Smith, D. (2005). Changing fluvial conditions and landscapes in the Trent Valley: a review of paleoentomological evidence, pp. 53-67 in Brickley, M., Smith, D. and Smith, W. (eds.), *Fertile Ground. Papers in Honour of Susan Limbrey* (Symposia of the Association for Environmental Archaeology No. 22). Oxford: Oxbow Books.

Greenwood, M. T., Agnew, M. D. and Wood, P. J. (2003). The use of caddisfly fauna (Insecta: Trichoptera) to characterise the Late-glacial River Trent, England. *Journal of Quaternary Science* 18, 645-661.

Greig, J. R. A. (1981). The investigation of a medieval barrel-latrine from Worcester. *Journal of Archaeological Science* 8, 265-282.

Greig, J. (1988). The interpretation of some Roman well fills from the midlands of England, pp. 367-377 in Kuster, H., *Der prahistorische Mensch und seine Umwelt. Festschift fur Udelgard Korber-Grohne zum 65*. Geburtstag. Stuttgart: Konrad Theiss.

Greig, J. (2002). When the Romans departed.... evidence of landscape change from Mechley Roman fort, Edgbaston, Birmingham. *Acta Palaeobotanica* 42, 177-184.

Griffiths, H. I. and Evans, J. G. (1992). A simple notation scheme to describe time-averaged ostracod assemblages (Crustacea, Ostracoda) by their taxonomic composition. *Journal of Micropaleontology* 11, 31-35.

Griffiths, H. I. and Holmes, J. A. (2000). Non-marine ostracods and Quaternary palaeoenvironments. *Quaternary Research Association Technical Guide* 8. London.

Griffiths, H. I., Rouse, A. and Evans, J. G. (1993 for 1992). Processing freshwater ostracods from archaeological deposits, with a key to the valves of the major British general. *Circaea, the Journal of the Association for Environmental Archaeology* 10, 53-62.

Groenman-Van Waateringe, W. (1979a). *Nogle aspekter af jernalderens agerbrug i Holland og Nordvesttyskland*, pp. 75–86 in Thrane, H. (ed.), Fra jernalder til middelalder. *Skrifter fra Historisk Institut Odense Universitet* 27. Odense.

Groenman.Van Waateringe, W. (1979b). The origin of crop weed communities composed of summer annuals. *Plant Ecology* 41, 57-59.

Gross, F. and Smyth, J. C. (1946). The decline of oyster populations. *Nature, London* 157, 540-542.

Guerra, R. de M. S. N. de C., Gazeta, G. S., Amorim, M., Duarte, A. N. and Serra-Freire, N. M. (2003). Ecological analysis of Acari recovered from coprolites from archaeological site [*sic*] of northeast Brazil. *Memorias do Instituto Oswaldo Cruz* 98 (suppl. 1), 181-190.

Guerrero, R. D. (1983). The culture and use of *Perionyx excavatus* as a protein resource in the Philippines, pp. 309-313 in Satchell, J. E. (ed.), *Earthworm ecology from Darwin to vermiculture*. London and New York: Chapman and Hall.

Guiot, J., Nicault, A., Rathgeber, C., Edouard, J. L., Guibal, F., Pichard, G. and Till, C. (2005). Last-millennium summer-temperature variations in western Europe based on proxy data. *The Holocene* 15, 489-500.

Gullan, P. J. and Cranston, P. S. (2004). *The insects: an outline of entomology*. London: Blackwell.

Gurney, D. (2003). Standards for field archaeology in the East of England. *East Anglian Archaeology Occasional Paper* 14. Dereham: ALGAO East of England.

Guttmann, E. B., Simpson, I. A. and Davidson, D. A. (2005). Manuring practices in antiquity: a review of the evidence, pp. 68-76 in Brickley, M., Smith, D. and Smith, W. (eds.), *Fertile Ground. Papers in Honour of Susan Limbrey* (Symposia of the Association for Environmental Archaeology No. 22). Oxford: Oxbow Books.

Haarløv, N. (1967). Arthropoda (Acarina, Diptera) from subfossil layers in west Greenland. *Meddelelser om Grønland* 184 (3), 1-17 + plates I-VIII.

Haberle, S. G. and Chepstow, L. A. (2000). Can climate influence cultural development? A view through time. *Environment and History* 6, 349-369.

Helbaek, H. (1958). Grauballemandens sidste maaltid. Kuml 1958, 83-116.

Haglund, W. D. and Sorg, M. H. (1997). *Forensic taphonomy*. Andover and Boca Raton: CRC press.

Hakbijl, T. (1987). Insect remains: Unadulterated Cantharidium and tobacco from the West Indies, pp. 93-94 in Gawronski, J. H. G. (ed.), *Amsterdam project: Annual report of the VOC-ship 'Amsterdam' Foundation 1986*. Amsterdam.

Hakbijl, T. (1989). Insect remains from site Q, an Early Iron Age farm of the Assendelvers Polders project. *Helinium* 29, 77-102.

Hakbijl, T. (2000). *Arthropod remains as indicators for taphonomic processes: an assemblage from 19th century burials, Broerenkerk, Zwolle, the Netherlands*, pp. 95-96 in Huntley, J. P. and Stallibrass, S. (eds.), Taphonomy and interpretation*. Symposia of the Association for Environmental Archaeology* 14. Oxford: Oxbow.

Hakbijl, T. (2002). The traditional, historical and prehistoric use of ashes as an insecticide, with an experimental study on the insecticidal efficacy of washed ash. *Environmental Archaeology* 7, 13-22.

Hakbijl, T. and Groot, M. de (1997). *Insect remains from Willem Barents' 1596 arctic exploration preserved in "Het Behouden Huys", Novaya Zemlya - with notes on the medicinal use of cantharides*, pp. 129-134 in Ashworth, A. C., Buckland, P. C. and Sadler, J. P. (eds.), Studies in Quaternary entomology - and inordinate fondness for insects. *Quaternary Proceedings* 5. Chichester, UK: *Wiley*.

Hakbijl, T., Pals, J. P. and Troostheide, C. D. (1989). Plant and insect remains from the Late Neolithic well at Kolhorn. *Palaeohistoria* 31, 157-163.

Hakbijl, T. and Phipps, J. (1988). Mystery object identified. *Circaea* 5, 59-61.

Halkon, P., Millett, M., Easthaugh, E., Taylor, J. and Freeman, P. (2000). *The landscape archaeology of Hayton, East Yorkshire.* Hull: University of Hull.

Hall, A. R. (1981). ...The cockle of rebellion, insolence, sedition... *Interim* 8 (1), 5-8. [A popular article on corncockle in archaeological deposits.]

Hall, A. R. (1982). Seeing the wood for the trees. *Interim* 8 (3), 21-5. [A popular account of timber from excavations in York]

Hall, A. R. (1986). Of moss and men. *Interim* 11 (3), 36-41. [A popular account of mosses in archaeology.]

Hall, A. R. (1987). In pursuit of the uneatable. *Interim* 12 (2), 1-7. [A consideration of the archaeological evidence for vegetables.]

Hall, A. R. (1996a). *Charcoal from two samples associated with a medieval oven from a site at Appleton-le-Moors, N. Yorkshire*, pp. 10-11 in Allison, M. and Rahtz, P. (eds.), A medieval oven at Appleton le Moors. *The Ryedale Historian* 18, 6-11.

Hall, A. R. (1996b). *A survey of palaeobotanical evidence for dyeing and mordanting from British archaeological excavations*, pp. 635-40 in Turner, C. and Gibbard, P. (eds.), Quaternary stratigraphy and palaeoecology. *Quaternary Science Review* 15.

Hall, A. R. (1998). *Adding colour to the story: recognising remains of dyeplants in medieval archaeological deposits*, pp. 101-109 in Dewilde, M., Ervynck, A. and Wielemans, A. (eds.), Ypres and the medieval cloth industry in Flanders. *Archeologie in Vlaanderen Monografie* 2. Zellik: Instituut voor het Archeologisch Patrimonium.

Hall, A. R., Carrott, J. B., Kenward, H. K. and Richardson, J. E. (1994). Biological analyses of deposits, pp. 562-4 in Lilley, J. M., Stroud, G., Brothwell, D. R. and Williamson, M. H., The jewish burial ground at Jewbury. *The Archaeology of York* 12 (3), 295-578 + loose Figs. 187-89. York: Council for British Archaeology.

Hall, A. R. and Huntley, J. P. (2007). A review of the evidence for macrofossil plant remains from archaeological deposits in Northern England. *(English Heritage) Research Department Report Series* 87/2007.

Hall, A. R., Jones, A. K. G. and Kenward, H. K. (1983a). *Cereal bran and human faecal remains from archaeological deposits - some preliminary observations*, pp. 85-104 in Proudfoot, B. (ed.) Site, environment and economy. *Symposia of the Association for Environmental Archaeology 3, British Archaeological Reports International Series* 173.

Hall, A. R., Jones, A. K. G., Kenward, H. K. and O'Connor, T. P. (1992). *The environmental evidence*, pp. 875-80 in Tweddle, D., The Anglian helmet from Coppergate. *The Archaeology of York* 17 (8), 851-1201. London: Council for British Archaeology.

Hall, A., Issitt, M. and Large, F. (1996). *Evaluation of biological remains from excavations at The Former Convent School, Queen Street, Scarborough (site code: STS96)*, pp. 12-13 in Pearson, T., An archaeological excavation at The Former Convent School, Queen Street, Scarborough. *Scarborough Archaeological and Historical Society Interim Report* 24, 12 pp.

Hall, A. R. and Kenward, H. K. (1980). An interpretation of biological remains from Highgate, Beverley. *Journal of Archaeological Science* 7, 33-51.

Hall, A. R. and Kenward, H. K. (1990). Environmental evidence from the Colonia: General Accident and Rougier Street. *The Archaeology of York* 14 (6), 289-434 + Plates II-IX + Fiche 2-11. London: Council for British Archaeology.

Hall, A. R. and Kenward, H. K. (1992). [sediments from within the helmet], pp. 903-7 in Tweddle, D., The Anglian helmet from Coppergate. *The Archaeology of York* 17 (8), 851-1201. London: Council for British Archaeology.

Hall, A. R. and Kenward, H. K. (1993). [environmental evidence], pp. 157-159 and *passim* in Richards, J. D., The Bedern foundry. *The Archaeology of York* 10 (3), 149-210 + plates XXXIIXLVIII + fiche 1. London: Council for British Archaeology.

Hall, A. R. and Kenward, H. K. (1994). *Plant and invertebrate remains from a cistern on the foreshore at Saltwick, North Yorkshire,* pp. 60-1 in Marshall, G., Saltwick alum works. An archaeological interpretation. *Scarborough Archaeological and Historical Society Research Report* 11, vi + 61 pp. Scarborough: Scarborough Archaeological and Historical Society.

Hall, A. R. and Kenward, H. K. (1995). The dung thing? Stable manure in archaeological deposits. *Interim (Archaeology in York)* 21(3), 19-24.

Hall, A. and Kenward, H. (1998). Disentangling dung: pathways to stable manure. *Environmental Archaeology* 1, 123-126.

Hall, A. R. and Kenward, H. K. (2002). Data Archive for plant and invertebrate remains from Anglo-Scandinavian 16-22 Coppergate, York. Available at http://ads.ahds.ac.uk/catalogue/projArch/EAU/coppergate_2001

Hall, A. R. and Kenward, H. K. (2003a). *Can we identify biological indicator groups for craft, industry and other activities?*, pp. 114-30 in Murphy, P. and Wiltshire, P. E. J. (eds.), The environmental archaeology of industry. *Symposia of the Association for Environmental Archaeology* 20. Oxford: Oxbow.

Hall, A. R. and Kenward, H. K. (2003b). *Evidence for tanning from plant and insect remains*, pp. 3230-1 in Mould, Q., Carlisle, I. and Cameron, E., Craft, Industry and Everyday Life: Leather and Leatherworking in Anglo-Scandinavian and Medieval York. *Archaeology of York* 17 (16). York: York Archaeological Trust and Council for British Archaeology.

Hall, A. R. and Kenward, H. K. (2004). *Setting people in their environment: plant and animal remains from Anglo-Scandinavian York*, pp. 372-426 + references 507-521 in Hall, R. A., Rollason, D. W., Blackburn, M., Parsons, D. N., Fellows-Jensen, G., Hall, A. R., Kenward, H. K., O'Connor, T. P., Tweddle, D., Mainman, A. J. and Rogers, N. S. H., Aspects of Anglo-Scandinavian York. *The Archaeology of York* 8 (4), pp. 293-521 + xiv + separate map. York: Council for British Archaeology and York Archaeological Trust.

Hall, A. R. and Kenward, H. K. (2006). Development-driven archaeology: bane or boon for bioarchaeology? *Oxford Journal of Archaeology* 25, 213-224.

Hall, A. R., Kenward, H. K. and McComish, J. M. (2003c). Pattern in thinly-distributed plant and invertebrate macrofossils revealed by extensive analysis of occupation deposits at Low Fisher Gate, Doncaster, U. K. *Environmental Archaeology* 8, 129-144.

Hall, A. R., Kenward, H. K. and O'Connor, T. P. (1990). *Discussion and synthesis*, pp. 385-419 in Hall, A. R. and Kenward, H. K., Environmental evidence from the Colonia: General Accident and Rougier Street. *The Archaeology of York* 14 (6), 289-434 + Plates II-IX + Fiche 2-11. London: Council for British Archaeology.

Hall, A. R., Kenward, H. K. and Williams, D. (1980). Environmental evidence from Roman deposits in Skeldergate. *The Archaeology of York* 14 (3), 101-56. London: Council for British Archaeology.

Hall, A. R., Kenward, H. K., Williams, D. and Greig, J. R. A. (1983b). Environment and living conditions at two Anglo-Scandinavian sites. *The Archaeology of York* 14 (4), 157-240 plus Plate I and Fiche 1. London: Council for British Archaeology.

Hall, A. R. and Tomlinson, P. R. (1984). A dyeing art. *Interim* 10 (1), 21-5. [A popular account of dyeplants from Coppergate.]

Hall A. R. (2008) Environmental Archaeology Bibliography, Available at http://ads.ahds.ac.uk/catalogue/specColl/eab_eh_2004/index.cfm (Accessed October 2009).

Hall, D., Wells, C. E. and Huckerby, E. (1995). The wetlands of Greater Manchester. *North West Wetlands Survey* 2. *Lancaster Imprints* 3. Lancaster.

Hall, H. J. (1977). A paleoscatological study of diet and disease at Dirty Shame rockshelter, southeast Oregon. *Tebiwa: Miscellaneous Papers of the Idaho State University Museum of Natural History* 8, [0]-14. [first page not numbered] Hallam, A. and Wignall, P. B. 1997. *Mass Extinctions and Their Aftermath*. Oxford: University Press.

Hall, R. A. (1991). *The waterfronts of York*, pp. 177-184 in Good, G. L., Jones, R. H. and Ponsford, M. W. (eds.), Waterfront archaeology. Proceedings of the third international conference on waterfront archaeology held at Bristol 23-26 September 1988. *CBA Research Report* 74. London.

Hall, R. A. and Kenward, H. K. (1976). Biological evidence for the usage of Roman riverside warehouses at York. *Britannia* 7, 274-6.

Halstead, D. G. H. (1976). The separation of *Sitophilus oryzae* (L.) and *S. zeamais* Motschulsky (Col., Curculionidae), with a summary of their distribution. *Entomologist's Monthly Magazine* 99, 72-4.

Hamilton, J. R. C. (1956). Excavations at Jarlshof, Shetland. *Ministry of Works Archaeological Report* 1. Edinburgh.

Hammond, M. (2002). A preliminary survey of the water beetles of Hornsea Mere, East Yorkshire (England), including the rediscovery of *Hydroporus scalesianus* in Yorkshire. *Latissimus* 15, 1-3.

Hammond, P. M. (1971). Notes on British Staphylinidae 2. - On the British species of *Platystethus* Mannerheim, with one species new to Britain. *Entomologist's Monthly Magazine* 107, 93-111.

Hammond, P. M. (1974). Changes in the British coleopterous fauna, pp. 323-69 in Hawksworth, D. L. (ed.) *The changing flora and fauna of Britain*. Systematics Association Special Vol. 6. London: Academic Press.

Hamshaw-Thomas, J. Jaques, D., Carrott, J., Dobney, K., Hall, A., Issitt, M., Johnstone, C. and Large, F. (2000). The Environmental Evidence, and Appendix 8: Environmental Sample Archive, in Hunter-Mann, K., Darling, M. J. and Cool, H. E. M., Excavations on a Roman Extra-Mural Site at Brough-on-Humber, East Riding of Yorkshire, UK. *Internet Archaeology* 9. 100906 words, 509 images. Available at http://intarch.ac.uk/journal/issue9/brough_index.html

Hann, B. J. (1990). Cladocera, pp. 81-91 in Warner, B. G. (ed.), Methods in Quaternary ecology. *Geoscience Canada Reprint Series* 5. St John's Newfoundland: Geological Association of Canada.

Hanski, I. and Cambefort, Y. (eds.) (1991). *Dung beetle ecology*. Princeton: Princeton University Press.

Hansson, Å. (1955). Finns honungsbiet kvar i vilt tillstånd i Norden? *Nordisk Bitidskrift* 8, 123-126.

Hansen, M. (1987). The Hydrophiloidea (Coleoptera) of Fennoscandia and Denmark. *Fauna Entomologica Scandinavica* 18. Leiden/Copenhagen: Brill/Scandinavian Science Press.

Hansen, V. (1966). Biller 23. Smaeldere og pragtbiller. *Danmarks Fauna* 74. Kobenhavn: Gads.

Harde, K. W. and Hammond, P. M. (1984). *A field guide in colour to beetles*. London: Octopus Books.

Harding A. F. (ed.) (1982). *Climatic change in later prehistory*. Edinburgh: University Press.

Harding, J. P. (1954). Ostracods, p. 59 in Wheeler, M., The Stanwick fortifications. *Reports of the Research Committee of the Society of Antiquaries of London* 17. Oxford: Society of Antiquaries.

Harding, P. T. (1978). *A bibliography of the occurrence of certain woodland Coleoptera in Britain: with special reference to timber utilising species associated with old trees in pasture woodlands*. Abbots Ripton: Institute of Terrestrial Ecology.

Harding, P. and Rose, F. (1986). *Pasture-woodlands in lowland Britain. A review of their importance for wildlife conservation.* Abbots Ripton: Institute of Terrestrial Ecology.

Harding, P. T. and Sutton, S. L. (1985). *Woodlice in Britain and Ireland: distribution and habitat.* Huntingdon: Institute of Terrestrial Ecology [not seen in original]

Harland, R. (1974). *Appendix. Dinoflagellate cysts from the Stoneferry samples*, p. 41 in Gaunt, G. D. and Tooley, M. J., Evidence for Flandrian sea-level changes in the Humber Estuary and adjacent areas. *Bulletin of the Institute of Geological Sciences* 48, 25-41.

Harland, R. and Downie, C. (1969). The dinoflagellates of the interglacial deposits at Kirmington, Lincolnshire. *Proceedings of the Yorkshire Geological Society* 37, 231-237.

Harland, R. and Howe, J. A. (1995). Dinoflagellate cysts and Holocene oceanography of the northeastern Atlantic Ocean. *The Holocene* 5, 200-228.

Harmsworth, R. V. (1968). The developmental history of Blelham Tarn (England) as shown by animal microfossils, with special reference to Cladocera. *Ecological Monographs* 38, 223-41.

Harmsworth, R. V. and Whiteside, M. C. (1998). The relation of Cladocera remains in lake sediment to primary productivity of lakes. *Ecology* 49, 998-1000.

Harris, D. R. and Thomas, K. D. (eds.) (1991a). Modelling ecological change. Perspectives from neoecology, palaeoecology and environmental archaeology. London: Institute of Archaeology.

Harris, D. R. and Thomas, K. D. (1991b). Modelling ecological change in environmental archaeology, pp. 91-102 in Harris, D. R. and Thomas, K. D. (eds.), *Modelling ecological change. Perspectives from neoecology, palaeoecology and environmental archaeology*. London: Institute of Archaeology.

Harrison, F. W. (1988). Utilisation of freshwater sponges in palaeolimnological studies. *Palaeogeography, Palaeoclimatology, Palaeoecology* 62, 387-397.

Harrison, F. W. (1990). *Freshwater sponges*, pp. 75-80 in Warner, B. G. (ed.), Methods in Quaternary ecology. *Geoscience Canada Reprint Series* 5. St Hohn's Newfoundland: Geological Association of Canada.

Harrison, L. (1995). *The environmental remains. Invertebrate remains*, pp. 55-59 in Matthews, K. J., Excavations at Chester. The evolution of the heart of the city. Investigations at 3-15 Eastgate Street 1990/1. *Chester City Council Archaeological Service Excavation and Survey Reports* 8. Chester: Chester City Council.

Hart, M. (ed.) (1985). *Review of science-based archaeology 1985. The funding of research in science-based archaeology in universities and polytechnics*. Swindon: SERC.

Harwood, R. F. and James, M. T. (1979). *Entomology in human and animal health*. New York etc.: Macmillan.

Haselgrove, C., Armit, I., Champion, T., Creighton, J., Gwilt, A., Hill, J. D., Hunter, F. and Woodward, A. (2001). *Understanding the British Iron Age: an agenda for action*. Salisbury: Trust for Wessex Archaeology.

Haslett, S. K., Davies, P., Curr, R. H. F., Davies, C. F. C., King, C. P., Margetts, A. J. and Kennington, K. (1998). Evaluating late-Holocene relative se-level change in the Somerset Levels, southwest Britain. *The Holocene* 8, 197-207.

Haslett, S. K., Davies, P. and Strawbridge, F. (1997). Reconstructing Holocene sea-level change in the Severn Estuary and Somerset Levels: the foraminifera connection. *Archaeology in the Severn Estuary* 8, 29-40.

Haslett, S., Margetts, A. and Williams, H. (2000). *Foraminifera*, pp. 118-22 in Rippon, S., The Romano-British exploitation of coastal wetlands: survey and excavation on the North Somerset Levels. *Britannia* 31, 118-122.

Haughton, C. and Powlesland, D. (1999). *West Heslerton. The Anglian cemetery. Volume ii. Catalogue of the Anglian graves and associated assemblages*. Yedingham, North Yorkshire: Landscape Research Centre Ltd.

Hayashida, F. M. (2005). Archaeology, ecological history, and conservation. *Annual Review of Anthropology* 34, 43-65.

Hayfield, C. and Greig, J. (eds.) (1989). Excavation and salvage work on a moated site at Cowick, South Humberside, 1979. *Yorkshire Archaeological Journal* 61, 41-70.

Hayfield, C., Pouncett, J. and Wagner, P. (1995). Vessey Ponds: a 'prehistoric' water supply in East Yorkshire. *Proceedings of the Prehistoric Society* 61, 393-408.

Haynes, J. R. (1981). *Foraminifera*. London: Macmillan.

Hayward, P. J. (1985). Ctenostome bryozoans. Keys and notes for the identification of the species. *Synopses of the British fauna (new series)* 33, 169 pp. London etc.: E. J. Brill/Dr W. Backhuys.

Hayward, P. J. and Ryland, J. S. (1979). British acophoran bryozoans. Keys and notes for the identification of the species. *Synopses of the British fauna (new series)* 14, 169 pp. London etc.: Academic.

Hayward, P. J. and Ryland, J. S. (1985). Cyclostome bryozoans. Keys and notes for the identification of the species. *Synopses of the British fauna (new series)* 34, 147 pp. London etc.: E. J. Brill/Dr W. Backhuys.

Hayward, P. J., and Ryland, J. S. (eds). (1995). *Handbook of the marine faunas of North-West Europe*. Oxford: University Press.

Hayward, P., Nelson-Smith, T., and Shields, C. (1996). *Sea shore of Britain and Northern Europe.* London etc: HarperCollins. (*sic*)

Heath, A. C. G., Cooper, S. M., Cole, D. J. W. and Bishop, D. M. (1995). Evidence for the role of the sheep biting-louse *Bovicola ovis* in producing cockle, a sheep pelt defect. *Veterinary Parasitology* 59, 53-58.

Heaton, T. H. E., Holmes, J. A. and Bridgewater, N. D. (1995). Carbon and oxygen-isotope variations among lacustrine ostracods - implications for paleoclimatic studies. *The Holocene* 5, 428-434.

Heckenberger, M. J., Kuikuro, A., Kuikuro, U. T., Russell, J. C., Schmidt, M., Fausto, C. and Franchetto, B. (2003). Amazonia 1492: Pristine forest or cultural parkland? *Science* 301, 1710-1714.

Heiri, O. and Millet, L. (2005). Reconstruction of Late Glacial summer temperatures from chironomid assemblages in Lac Lautrey (Jura, France). *Journal of Quaternary Science* 20, 33-44.

Heizer, R. F. and Napton, L. K. (1969). Biological and cultural evidence from prehistoric human coprolites. *Science* 165, 563-568.

Helbaek, H. (1958). Grauballemandens sidste måltid. *Kuml* 1958, 83-116.

Hellqvist, M (1999). Insect assemblages from Iron Age wells in Central Sweden. *Norwegian Archaeological Review* 32, 1-17.

Hellqvist, M (2004). Studies of recently dead insects to understand insect remains in archaeological deposits. *Entomologisk Tidskrift* 125, 211-222.

Hellqvist, M. and Lemdahl, G. (1996). Insect assemblages and local environment in the medieval town of Uppsala, Sweden. *Journal of Archaeological Science* 23, 873-881.

Henderson, P. A. (1990). Freshwater ostracods. *Synopses of the British Fauna (new series)* 42. Oegstgeest, The Netherlands: Universal Book Services/Dr W. Backhuys for the Linnean Society of Lonon and the Estuarine and Brackish-waters Sciences Association.

Hendon, D. and Charman, D. J. (1977). The preparation of testate amoebae (Protozoa: Rhizopoda) samples from peat. *The Holocene* 7, 199-205.

Hendon, D., Charman, D. J. and Kent, M. (2001). Palaeohydrological records derived from testate amoebae analysis from peatlands in northern England: within-site variability, between-site comparability and palaeoclimatic implications. *The Holocene* 11, 127-148.

Hendon, D. J., Roe, H. M. and Gehrels, W. R. (1998). The use of testate amoebae in studies of sea-level change: a case study from the Taf Estuary, south Wales, UK. *The Holocene* 8, 209-218.

Henry, F. (1952). A wooden hut on Inishkea, Co. Mayo. *Journal of the Royal Society of Antiquaries of Ireland* 82, 163-177.

Henshilwood, C., Nilssen, P. and Parkington, J. (1994). Mussel drying and food storage in the late Holocene, SW Cape, South Africa. *Journal of Field Archaeology* 21, 103-109.

Heron, C., Nemcek, N., Bonfield, K. M., Dixon, D. and Ottaway, B. S. (1994). The chemistry of Neolithic beeswax. *Naturwissenschaften* 81, 266-269.

Heuer, D. E., Phillips, J. H., Rudersdorf, W. J. and Harley, J. P. (1975). Range extensions for *Coperia curticei*, *Ostertagia ostertagi*, *Setaria yehi* and *Trichuris ovis* in white-tailed deer from Kentucky. *Proceedings of the Helminthological Society of Washington* 42, 141-142.

Hewitt, G. M. (1999). Post-glacial colonisation of European biota. *Biological Journal of the Linnean Society* 68, 87-112

Hewitt, G. (2000). The genetic legacy of the Quaternary ice ages. *Nature 405*, 907-913.

Hey, G. and Lacey, M.. (2001). *Evaluation of archaeological decision-making processes and sampling strategies*. Kent: Kent County Council.

Hickin, E. E. (1967). *Caddis larvae*. London: Hutchinson.

Hickin, N. E. (1975). *The insect factor in wood decay.* (3rd edn, ed. and rev. R. Edwards) London: Associated Business Programmes.

Hickson, J. A., Johnson, A. L. A., Heaton, T. H. E. and Balson, P. S. (1999). The shell of the queen scallop *Aequipecten opercularis* (L.) as a promising tool for palaeoenvironmental reconstruction: evidence and reasons for equilibrium stable-isotope incorporation. *Palaeogeography, Palaeoclimatology, Palaeoecology* 154, 325-337.

Hill, M. (1989). *A study of the death assemblage of a decomposer ecosystem.* Undergraduate project in the year 1988/89. Department of Biology, University of York. 43 pp. + appendices.

Hill, M. J. (1993). *Insect death assemblages and the interpretation of woodland history: evidence from the Vale of York,* 253 pp. DPhil thesis, University of York.

Hill, M. J. (1994). Insect assemblages as evidence for past woodlands around York, pp. 45-54 in Hall, A. R. and Kenward, H. K. (eds.), Urban-rural connexions: perspectives from environmental archaeology. *Symposia of the Association for Environmental Archaeology* 12. *Oxbow Monographs* 47. Oxford.

Hillyard, P. D. (1996). Ticks of North-West Europe. Keys and notes for the identification of the species. *Synopses of the British fauna (new series)* 52, 178 pp. Shrewsbury: Linnean Society etc.

Hincks, W. D. (1949). Dermaptera and Orthoptera. *Handbooks for the identification of British insects* 1 (5). London: Royal Entomological Society.

Hincks, W. D. (1966). [*Diptera*], p. 70 in Bersu, G. and Wilson, D. M., Three Viking Graves in the Isle of Man. *Society for Medieval Archaeology Monograph* 1. London.

Hinton, H. E. (1941). The Ptinidae of economic importance. *Bulletin of Entomological Research* 31, 331-81.

Hinton, H. E. (1945). *A monograph of the beetles associated with stored products* 1. London: British Museum (Natural History).

Hinton, H. E. (1970). Insect eggshells. *Scientific American* 223, 84-91.

HMSO (1990). *Planning policy guidance note 16: Archaeology and Planning*. London: HMSO. ['PPG 16']

Hobley, B. and Milne, G. (1981). Waterfront archaeology in Britain and Northern Europe. *CBA Research Report* 41, 156 pp. London: Council for British Archaeology.

Hodge, P. J. and Jones, R. A. (1995). *New British beetles. Species not in Joy's practical handbook*. Reading: British Entomological and Natural History Society.

Hofmann, W. (1986). Chironomid analysis, pp. 715-727 in Berglund, B.E. (ed.), *Handbook of Holocene palaeoecology and palaeohydrology*. Chichester etc: Wiley.

Hofmann, W. (1987). Stratigraphy of Cladocera (Crustacea) and Chironomidae (Insecta: Diptera) in three sediment cores from the central Baltic Sea as related to paleo-salinity. *Internationale Revue der Gesamten Hydrobiologie* 72, 97-106.

Hofmann, W. (1988). The significance of chironomid analysis (Insecta: Diptera) for palaeolimnological research. *Palaeogeography, Palaeoclimatology, Palaeoecology* 62, 501-509.

Hoganson, J. W., Gunderson, M. and Ashworth, A. C. (1989). Fossil Beetle Analysis, pp. 211-226 in Dillehay, T. D., *Monte Verde, A Late Pleistocene Settlement in Chile, 1. Palaeoenvironment and site context*. Washington and London: Smithsonian Institute Press.

Holden, E. W. (1963). Excavations at the deserted medieval village of Hangleton, part 1. *Sussex Archaeological Collections* 101, 54-181.

Holden, T. (1999). *Assessment of the environmental samples from Stamford Bridge, East Riding of Yorkshire.* Unpublished report for Field Archaeology Services.

Holdridge, L. (1988). *The beetle remains*, pp. 88-89 and MF M1/08-09 in Millet, M. and McGrail, S., The archaeology of the Hasholme boat. *Archaeological Journal* 144 (for 1987), 69-155.

Holland, D. G. (1972). A key to the larvae, pupae and adults of the British species of Elminthidae. *Scientific Publications of the Freshwater Biological Association* 26. Ambleside: Freshwater Biological Association.

Holmes, J. A. (1992). Nonmarine ostracods as Quaternary paleoenvironmental indicators. P*rogress in Physical Geography* 16, 405-431.

Holmes, J. A. (1996). Trace-element and stable-isotope geochemistry of nonmarine ostracod shells in Quaternary palaeoenvironmental reconstruction. *Journal of Paleolimnology* 15, 223-235.

Holmes, J. A. (2001). Ostracoda, pp. 125-151 in Smol, J. P., Birks, H. J. B. and Last, W. M. (eds.), *Tracking environmental change using lake sediments. Volume 4: Zoological indicators*. Dortrecht etc: Kluwer Academic Publishers.

Holmes, J. A., Hales, P. E. and Street Perrott, F. A. (1992). Trace-element chemistry of nonmarine ostracods as a means of paleolimnological reconstruction - an example from the Quaternary of Kashmir, northern India. *Chemical Geology* 95, 177-186.

Holmes, J. A., Street Perrott, F. A., Ivanovich, M. and Perrott, R. A. (1995). A Late Quaternary paleolimnological record from Jamaica based on trace-element chemistry of ostracod shells. *Chemical Geology* 124, 143-160.

Holt, V. M. (1885). *Why not eat insects?* London: Field and Tuer. (Reprint Classey, Faringdon, Oxon.)

Holter, P. (1983). Effect of earthworms on the disappearance rate of cattle droppings, pp. 49-47 in Satchell, J. E. (ed.), *Earthworm ecology from Darwin to vermiculture*. London and New York: Chapman and Hall.

Holyoak, D. T. and Preece, R. C. (1985). Late Pleistocene deposits at Tattershall, Lincolnshire. *Philosophical Transactions of the Royal Society of London* B 311, 193-236.

Hopkin, S. (1991). A key to the woodlice of Britain and Ireland. *Field Studies* 7, 599-650. (also published as AIDGAP publication 204.)

Hopkins, D. W. (2000). Interfaces of soil biology with archaeological investigations. *Soil Biochemistry* 10, 483-510.

Hopla, C. E. (1980). A study of the host associations and zoogeography of *Pulex* spp., pp. 185207 in Traube, R. and Starcke, H. (eds.), *Fleas*. Rotterdam: Balkema.

Horne, P. D. (2002). First evidence for enterobiasis in ancient Egypt. *Journal of Parasitology* 88, 1019-1021.

Horsey, I. P. and Winder, J. M. (1991). *Late Saxon and Conquest-period oyster middens at Poole, Dorset*, pp. 102-104 in Good, G. L., Jones, R. H. and Ponsford, M. W. (eds.), Waterfront archaeology. Proceedings of the third international conference on waterfront archaeology held at Bristol 23-26 September 1988. *CBA Research Report* 74. London.

Horton, B. P. (1999). The contemporary distribution of intertidal foraminifera of Cowpen Marsh, Tees Estuary, UK: implications for studies of Holocene sea-level changes. *Palaeogeography, Palaeoclimatology, Palaeoecology Special Issue* 149, 127-149.

Horton, B. (2000). Foraminiferal analysis, pp. 12-15 in Archaeological Services University of Durham, *Whitby, North Yorkshire - CSW98, CSW99 and WS99 - plant macrofossil evaluation and Foraminiferal analysis*. ASUD Report 709. Durham.

Horton, B. P., Edwards, R. J. and Lloyd, J. M. (1999a). UK intertidal foraminiferal distributions: implications for sea-level studies. *Marine Micropaleontology* 36, 205-223.

Horton, B. P., Innes, J. B. and Shennan, I. (1999). Late Devensian and Holocene relative sea-level changes in Northumberland, England, pp. 35-47 in Bridgland, D. R., Horton, B. P. and Innes, J. B. (eds.), *The Quaternary of North-east England*. London: Quaternary Research Association.

Hosch, S. and Zibulski, P. (2003). The influence of inconsistent wet sieving procedures on the macroremain concentration in waterlogged sediments. *Journal of Archaeological Science* 30, 849-857.

House, M. R. and Farrow, G. E. (1968). Daily growth banding in the shell of cockle, *Cardium edule*. *Nature* 219, 1384-86.

Houghton, J. (1997). *Global warming. The complete briefing.* (Second edition.) Cambridge: University Press.

Howard, A. J., Keen, D. H., Mighall, T. M., Field, M. H., Coope, G. R., Griffiths, H. I. and Macklin, M. G. (2000). Early Holocene environments of the River Ure near Ripon, North Yorkshire, UK. *Proceedings of the Yorkshire Geological Society* 53, 31-42.

Howard, A. J., Smith, D. N., Garton, D., Hillam, J. and Pearce, M. (1999). Middle to late Holocene environments in the middle to lower Trent valley, pp. 165-178 in Brown, A. G. and Quine, T. A. (eds), *Fluvial Processes and Environmental Change*. Chichester etc: Wiley.

Howard, A. K. (1994). *Marine molluscs*, pp. 160-161 in Howe, A. K., Four millennia of Orkney prehistory excavations. *Monographs of the Society of Antiquaries of Scotland* 9. Edinburgh: SAS.

Howe, R. W. (1955). Studies on beetles of the family Ptinidae 12. - The biology of *Tipnus unicolor* Pill. and Mitt.. *Entomologists' Monthly Magazine* 91, 253-57.

Howe, R. W. and Burges, H. D. (1952). Studies on beetles of the family Ptinidae. VII.-The biology of five ptinid species found in stored products. *Bulletin of Entomological Research* 43, 153-186 + Plates VI-VII.

Hudson-Edwards, K., Macklin, M. and Taylor, M. P. (1999a). 2000 years of sediment-borne heavy metal storage in the Yorkshire Ouse basin, NE England, UK. *Hydrological Processes* 13, 1087-1102.

Hudson-Edwards, K., Macklin, M., Finlayson, R. and Passmore, D. G. (1999b). Mediaeval lead pollution in the River Ouse at York, England. *Journal of Archaeological Science* 26, 809-819.

Hughes, P. D. M., Kenward, H. K., Hall, A. R. and Large, F. D. (2000). A high-resolution record of mire development and climatic change spanning the Late glacial-Holocene boundary at Church Moss, Davenham (Cheshire, England). *Journal of Quaternary Science* 15, 697-724.

Hume, J. C. C., Lyons, E. J. and Day, K. P. (2003). Malaria in antiquity: a genetics perspective. *World Archaeology* 35, 180-192.

Hunt, C. O., Hall, A. R. and Gilbertson, D. D. (1884), The palaeobotany of the Late-Devensian sequence at Skipsea Withow Mere, pp. 81-108 in Gilbertson, D. D., Late Quaternary Environments and Man in Holderness. *British Archaeological Reports British Series* 134.

Hunter, F. A., Tulloch, J. B. M. and Lambourne, M. G. (1973). Insects and mites of maltings in the east Midlands of England. *Journal of Stored Products Research* 9, 119-41.

Hurlock, E. T. (1965). Some observations of the loss in weight caused by *Sitophilus granarius* (L.) (Coleoptera, Curculionidae) to wheat under constant experimental conditions. *Journal of Stored Products Research* 1, 193-195.

Hutchinson, G. E. (1957-1975). *Treatise on limnology* 1-3. London: Wiley/Chapman and Hall.

Hutson, A. M. (1970). Ectoparasites of British bats. *Mammal Review* 1, 143-150.

Hutson, A. M. (1984). Keds, flat-flies and bat-flies. Diptera, Hippoboscidae and Nycteribiidae. *Handbooks for the identification of British insects* 10 (7), 40 pp. London: Royal Entomological Society.

Hyland, A. (1990). *Equus: the horse in the Roman world.* London: Batsford.

Hyman, L. H. (1940). *The invertebrates: Protozoa through Ctenophora*. New York and London: McGraw-Hill.

Hyman, P. S. and Parsons, M. S. (1992). A review of the scarce and threatened Coleoptera of Great Britain. Part. 1. *UK Nature Conservation* 3. Peterborough: UK Joint Nature Conservation Committee.

Hyman, P. S. and Parsons, M. S. (1994). A review of the scarce and threatened Coleoptera of Great Britain. Part. 2. *UK Nature Conservation* 12. Peterborough: UK Joint Nature Conservation Committee.

Hynes, H. B. N. (1970). *The ecology of running waters.* Toronto: University Press.

Hyvärinen, H. and Alhonen, P. (1994). Holocene lake-level changes in the Fennoscandian treeline region, western Finnish Lapland: diatom and cladoceran evidene. *The Holocene* 4, 251-258.

Ilyashuk, E. A., Ilyashuk, B. P., Hammarlund, D. and Larocque, I. (2005). Holocene climatic and environmental changes inferred from midge records (Diptera: Chironomidae, Chaoboridae, Ceratopogonidae) at Lake Berkut, southern Kola Peninsula, Russia. *The Holocene* 15, 897-914.

Ingham, H. R. (1968). Distribution of toxin in molluscan shellfish following the occurrence of mussel toxicity in North-East England. *Nature* 220, 25-27.

Ingle, R. W. (1996). Shallow-water crabs. Keys and notes for the identification of the species. *Synopses of the British fauna (new series)* 25 (second edition), 243 pp. Shrewsbury: Linnean Society etc.

Ingram, H. R., Mason, J. and Wood, P. C. (1968). Distribution of toxin in molluscan shellfish following the occurrence of mussel toxicity in North-East England. *Nature, London* 220, 25-27.

Ingrouille, M. (1995). *Historical ecology of the British flora*. London etc: Chapman and Hall.

Iñiguez, A. M., Araújo, A., Ferreira, L. F. and Vicente, A. C. (2003a). Analysis of ancient DNA from coprolites: a perspective with random amplified polymorphic DNA-polymerase chain reaction approach. *Memorias do Instituto Oswaldo Cruz* 98 (suppl. 1), 63-65.

Iñiguez, A. M., Reinhard, K. J., Araújo, A., Ferreira, L. F. and Vicente, A. C. (2003b). *Enterobius vermicularis*: ancient DNA from North and South American human coprolites. *Memorias do Instituto Oswaldo Cruz* 98 (suppl. 1), 67-69.

Innes, J. B. (1999). Regional vegetational history, pp. 21-34 in Bridgland, D. R., Horton, B. P. and Innes, J. B. (eds.) *The Quaternary of North-East England*. London: Quaternary Research Association.

Innes, J. B. and Blackford, J. J. (2003). The ecology of late Mesolithic woodland disturbances: model testing with fungal spore assemblage data. *Journal of Archaeological Science* 30, 185-194.

Institute of Field Archaeologists (2001a). *Standard and guidance for archaeological excavation*. Reading: IFA.

Institute of Field Archaeologists (2001b). *Standard and guidance for archaeological field evaluation*. Reading: IFA.

Issitt, M., Kenward, H. and Milles, A. (1995). The invertebrate assemblage, p. 34 in Lancaster University Archaeological Unit [Drury, D., Howard-Davis, C. and Newman, R., (eds.)], Low Hauxley Northumberland archaeological evaluation. Unpublished report, LUAU.

Jäch, M. A. (2003). Observations on rheophilic water beetles swarming in Lower Austria in 2003 (Hydraenidae, Elmidae). *Latissimus* 17, 20-22.

Jackson, J. W. (1951). Animal remains and shells (*sic*), pp. 63-5 in Gilyard-Beer, R., *The Romano-British baths at Well.* Leeds: Roman Antiquities Committee of the Yorkshire Archaeological Society.

Jackson, M. J. and James, R. (1979). The influence of bait digging on cockle, *Cerastoderma edule*, populations in North Norfolk. *Journal of Applied Ecology* 16, 671-679.

Jaeger, E. C. (1978). *A source-book of biological names and terms* (third edition). Springfield, Illinois: Charles. C. Thomas.

James, S. and Millett, M. (eds.) (2001). Britains and Romans: advancing an archaeological agenda. *CBA Research Report* 125. York: Council for British Archaeology.

Janaway, R. C. (1987). The preservation of organic materials in association with metal artefacts deposited in inhumation graves, pp. 127-148 in Boddington, A., Garland, A. N. and Janaway, R. C. (eds.), *Death, decay and reconstruction. Approaches to archaeology and forensic science*. Manchester: University Press.

Jancke, O. (1938). De Anopluren Deutschlands. *De Tierwelt Deutschlands* 25, 43-78.

Jansen, J. and Over, H. J. (1962). Het voorkomen van parasieten in terpmateriaal uit Noordwest Duitsland. *Tijdschr. Diergeneesk.* 87, 1377-1379

Janus, H. (1965). *The young specialist looks at land and freshwater molluscs*. London and Toronto: Burke Books.

Jennings, S. (1992). A ceramic fish trap, pp. 66-69 in Gaimster, D. and Redknap, M. (eds.), *Everyday and exotic pottery from Europe c 650-1900*. Oxford: Oxbow.

Jeppesen, E., Leavitt, P., De Meester, L. and Jensen, J. P. (2001). Functional ecology and palaeolimnology: using cladoceran remains to reconstruct anthropogenic impact. *Trends in Ecology and Evolution* 16, 191-198.

Jessop, L. (1986). Dung beetles and chafers. Coleoptera: Scarabaeoidea. *Handbooks for the identification of British insects* 5 (11), 53 pp. London: Royal Entomological Society.

Jilani, G. and Su, H. C. F. (1983). Laboratory studies on several plant materials as insect repellents for protection of cereal grains. *Journal of Economic Entomology* 76, 154-157.

Johansson, B. M. (1990). Mollusker som miljöhistoriskt och kulturhistorisckt dokument, pp. 35-48 in Arrhenius, B. (ed.), *Laborativ Arkeologi* 4. Stockholm: Arkeologiska Forskningslaboratoriet Stockholms Universitet.

Johnson, B. (1958). Influence of parasitization on form determination in aphids. *Nature, London* 181, 205-206.

Johnson, C. G. (1969). *Migration and dispersal of insects by flight*. London: Methuen.

Jones, A. K. G. (1978). Environmental archaeology. *Interim* 5 (2), 32-35. [Popular introduction to bulk-sieving on site and laboratory sample processing.]

Jones, A. K. G. (1979). Parasite eggs and church archaeology. *Bulletin of the CBA Churches Committee* 11, 2-3.

Jones, A. K. G. (1980a). Mites and parasites. Part 1. *Interim* 6 (4), 9-16. [A popular account of the history of parasitic diseases.]

Jones, A. K. G. (1980b). Mites and parasites. Part 2. *Interim* 7 (1), 1-6. [A popular account of the history of parasitic diseases.]

Jones, A. K. G. (1980c). [Report on human remains from East Cottingwith and South Newbold, Yorks.] *CBA Group 4 Register for 1980*, 8.

Jones, A. K. G. (1981). The storage of organic samples, pp. 16-17 in A. Partington-Omar and A. J. White (eds.) *Archaeological Storage*. Society of Museum Archaeologists and Yorkshire and Humberside Federation of Museums and Art Galleries.

Jones, A. K. G. (1982a). *Bulk-sieving and the recovery of fish remains from urban archaeological sites*, pp. 79-85 in Hall, A. R. and Kenward, H. K. (eds). Environmental archaeology in the urban context. *Council for British Archaeology Research Reports* 43.

Jones, A. K. G. (1982b). *Human parasite remains: prospects for a quantitative approach*, pp. 66-70 in Hall, A. R. and Kenward, H. K. (eds). Environmental archaeology in the urban context. *Council for British Archaeology Research Reports* 43.

Jones, A. K. G. (1983a). A comparison of two on-site methods of wet-sieving large archaeological soil samples. *Science and Archaeology* 25, 9-12.

Jones, A. K. G. (1983b). *Report on a coprolite from 6-8 Pavement*, pp 225-9 in Hall, A. R., Kenward, H. K., Williams, D. and Greig, J. R. A., Environment and living conditions at two Anglo-Scandinavian sites. *The Archaeology of York* 14 (4), 157-240 plus Plate I and Fiche 1. London: Council for British Archaeology.

Jones, A. K. G. (1984b). Recent finds of intestinal parasite ova at York, England, pp. 229-33 in Haneveld, G. T. and Perizonius W. R. K. (eds.) *Proceedings of the Palaeopathology Association, 4th European Meeting, 15-19 September 1982*.

Jones, A. K. G. (1985). *Trichurid ova in archaeological deposits: their value as indicators of ancient faeces*, pp. 105-15 + figs. in Fieller, N. R. J., Gilbertson, D. D. and Ralph, N. (eds.), Palaeobiological investigations. Research design, methods and data analysis. *Symposia of the Association for Environmental Archaeology 5B, British Archaeological Reports International Series* 226.

Jones, A. K. G. (1986). Parasitological investigations on Lindow Man, pp. 136-9 in Stead, I. M., Bourke, J. B. and Brothwell, D., *Lindow Man: the body in the bog.* London: British Museum.

Jones, A. K. G. (1987a). Some fishy business at the University. *Interim* 12 (1), 29-36. [Fish in archaeology.]

Jones, A. K. G. (1987b). Intestinal parasite ova from archaeological deposits: evidence of widespread faecal contamination of 9th-12th century occupation layers, pp. 183-198 in Capecchi, V. and Rabino Massa, E. (eds.), *Palaeopathology Association. 5th European Meeting Siena 1984.*

Jones, A. K. G. (1988). Mix and mesh. *Interim* 13 (2), 11-16.

Jones, A. K. G. (1992). Coprolites and faecal material in archaeological deposits: a methodological approach, pp. 287-301 in Bernardi, M. (ed.), *Archeologia del Paesaggio*. Firenze: Edizioni all'Inegna del Giglio.

Jones, A. K. G. and Hutchinson, A. R. (1991). *The parasitological evidence*, *pp. 68-72* in McCarthy, M. R., The structural sequence and environmental remains from Castle Street, Carlisle: excavations 1981-2. *Cumberland and Westmorland Antiquarian and Archaeological Society Research Series* 5 (fascicule 1).

Jones, A. K. G., Hutchinson, A. R. and Nicholson, C. (1988). The worms of Roman horses and other finds of intestinal parasite eggs from unpromising deposits. *Antiquity* 62, 275-6.

Jones, A. K. G., Jones, J. J. M. and Spriggs, J. A. (1980). Marker Trial. *Rescue News* 21, March 1980, 9, *AEA Newsletter* 2, 5-6 and *Conservation News* 11, March 1980, 6-7.

Jones, A. M. and Baxter, J. M. (1987). Molluscs: Caudofoveata Solenogastres Polyplacophora and Scaphopoda. *Linnean Society of London Synopses of the British Fauna (New Series)* 37. London etc: Brill.

Jones, D. (1999). Evolutionary psychology. *Annual Review of Anthropology* 28, 553-575.

Jones, F. G. W. and Jones, M. G. (1974). *Pests of field crops* (2nd edition). London: Edward Arnold.

Jones, M. (1990). Comments on Boyd: *Towards a conceptual framework for environmental archaeology: environmental archaeology as a key to past geographies*. *Circaea* 7, 71-72.

Jones, M. D., Leng, M. J., Eastwood, W. J., Keen, D. H. and Turney, C. S. M. (2002). Interpreting stable-isotope records from freshwater snail-shell carbonate: a Holocene case study from Lake Golhisar, Turkey. *The Holocene* 12, 629-634.

Jope, E. M. (1952). Technical aids in archaeology. *Nature* 170, 909-910.

Jørgensen, G. (1986). Medieval plant remains from the settlements in Møllergade 6, pp. 45-84 in H. M. Jansen (ed.), *The Archaeology of Svendborg, Denmark. 4. The Analysis of Medieval Plant Remains, Textiles and Wood from Svendborg*. Odense: Odense University Press.

Joy, N. H. (1932). *A practical handbook of British beetles* 1-2. London: Witherby. (Reprinted 1976, Farningdon: Classey.)

Joyce, K. and Addison, S. (1993). *Pearls: ornament and obsession*. London: Simon and Schuster.

Judas, M., Dornieden, K. and Strothmann, U. (2002). Distribution patterns of carabid beetle species at the landscape level. *Journal of Biogeography* 29, 491-508.

Kai-Hong, L. (2001). Morphology and ultrastructure of the ephippia of some Cladocera (Crustacea). *Acta Zoologica Sinica* 47, 565-572.

Kansanen, P. H., Aho, J. and Paasivirta, L. (1984). Testing the benthic lake type concept based on chironomid associations in some Finnish lakes using multivariate methods. *Annales Zoologici Fennici* 21, 55-76.

Karppinen, E. and Koponen, M. (1973). The subfossil orobatid fauna of Piilonsuo, a bog in southern Finland. *Annales Entomologici Fennici* 29, 22-32.

Karppinen, E., Krivolutsky, D. A., Koponen, M., Kozlovskaja, L. S., Laskova, L. M. and Vitasaari, M. (1979). List of subfossil orobatid mites (Acarina, Orobatei) of northern Europe and Greenland. *Annales Entomologici Fennici* 45, 103-108.

Karunakaran, C., Muir, W. E., Jayas, D. S., White, N. D. G. and Abramson, D. (2001). Safe storage time of high moisture wheat. *Journal of Stored Products Research* 37, 303-312.

Kassai, T. (1999). *Veterinary parasitology*. Oxford etc: Butterworth Heinemann.

Kaupp, A., Brenneisen, S., Klausnitzer, B. and Nagel, P. (2004). Eco-faunistic characteristics of the beetle fauna of vegetated roofs (Insecta: Coleoptera). *Entomologische Blatter fur Biologie und Systematik der Kafer* 100, 47-83.

Keegan, W. F., Portell, R. W. and Slapcinsky, J. (2003). Changes in invertebrate taxa at two pre-Columbian sites in southwestern Jamaica, AD 800-1500. *Journal of Archaeological Science* 30, 1607-1617.

Keeley, H. C. M. (ed.) (1984). *Environmental Archaeology: a regional review. 1.* London: Department of the Environment.

Keeley, H. C. M. (ed) (1987). Environmental Archaeology. A regional review II. *English Heritage Occasional Papers* 1. London: English Heritage.

Keen, D. H. (1989). The molluscan fauna of a Flandrian tufa at Lower Beck, Malham, North Yorkshire. *Journal of Conchology* 33, 173-178.

Keen, D. H., Jones, R. L., Evans, R. A. and Robinson, J. E. (1988). Faunal and floral assemblages from Bingley Bog, West Yorkshire, and their significance for Late Devensian and early Flandrian environmental changes. *Proceedings of the Yorkshire Geological Society* 47, 125-138.

Keen, D. H., Jones, R. L., and Robinson, J. E. (1984). A late Devensian and early Flandrian fauna and flora from Kildale, North-East Yorkshire. *Proceedings of the Yorkshire Geological Society* 44, 385-397.

Keene, D. J. (1982). *Rubbish in medieval towns*, pp. 27-30 in Hall, A. R. and Kenward, H. K. (eds). Environmental archaeology in the urban context. *Council for British Archaeology Research Reports* 43.

Keepax, C. (1977). Contamination of archaeological deposits by seeds of modern origin with particular reference to the use of flotation machines. *Journal of Archaeological Science* 4, 221-229.

Kemp, R. L (1996). Anglian settlement at 46-54 Fishergate. *The Archaeology of York* 7 (1), 1-114 + v. York: Council for British Archaeology.

Kenward, H. K. (1974). Methods for palaeo-entomology on site and in the laboratory. *Science and Archaeology* 13, 16-24.

Kenward, H. K. (1975a). Pitfalls in the environmental interpretation of insect death assemblages. *Journal of Archaeological Science* 2, 85-94.

Kenward, H. K. (1975b). The biological and archaeological implications of the beetle *Aglenus brunneus* (Gyllenhal) in ancient faunas. *Journal of Archaeological Science* 2, 63-9.

Kenward, H. K. (1975c). Where there's muck there's beetles. *Interim* 2 (3), 25-31. [A popular introduction to archaeo-entomology.]

Kenward, H. K. (1976a). Reconstructing ancient ecological conditions from insect remains: some problems and an experimental approach. *Ecological Entomology* 1, 7-17.

Kenward, H. K. (1976b). *Helophorus tuberculatus* Gyll. (Col., Hydrophilidae) in the City of York. *Entomologist's Monthly Magazine* 111, 92.

Kenward, H. K. (1976c). Further archaeological records of *Aglenus brunneus* (Gyll.) in Britain and Ireland, including confirmation of its presence in the Roman period. *Journal of Archaeological Science* 3, 275-7.

Kenward, H. K. (1977). *A note on the insect remains from column sample IV*, pp. 33-4 in Armstrong, P., Excavations in Sewer Lane, Hull. *East Riding Archaeologist 3, Hull Old Town Report Series* 1, 1-82.

Kenward, H. K. (1978a). The analysis of archaeological insect assemblages: a new approach. *The Archaeology of York* 19 (1), 1-68 + plates I-IV. London: Council for British Archaeology.

Kenward, H. K. (1978b). *The value of insect remains as evidence of ecological conditions on archaeological sites*, pp. 25-38 in Brothwell, D. R., Thomas, K. D. and Clutton-Brock, J. (eds.), Research problems in zooarchaeology. *Institute of Archaeology Occasional Publications* 3. London: Institute of Archaeology.

Kenward, H. K. (1978c). Rediscovery of *Helophorus tuberculatus* (Gyll.) (Col., Hydrophilidae) in North Yorkshire. *Entomologist's Monthly Magazine* 113, 61.

Kenward, H. K. (1978d). *Oxytelus fulvipes* Er. (Col., Staphylinidae) in Yorkshire. *Entomologist's Monthly Magazine* 113, 80.

Kenward, H. K. (1979a). *Insect remains from `Oslogate 7'*, pp 134-7 in Schia, E. (ed.), Feltene `Oslogaten 3-7'. *De Arkeologiske Utgravninger I Gamlebyen Oslo* 2. Oslo: Universitetsforlaget.

Kenward, H. K. (1979b). *Megathrips lativentris* (Heeger) (Thysanoptera: Phlaeothripidae) from Bronze Age deposits at Thorne Moor, Yorkshire. *Entomologist's Monthly Magazine* 114, 25-26.

Kenward, H. K. (1979c). *The insect death assemblages*, pp 65-72 In Ayers, B. S. (ed.), Excavations at Chapel Lane Staith 1978. *East Riding Archaeologist 5, Hull Old Town Reports Series* 3.

Kenward, H. K. (1979d). *Five insect assemblages*, pp. 60-7 in Carver, M. O. H., Three Saxo-Norman tenements in Durham City. *Medieval Archaeology* 23, 1-80 and plates.

Kenward, H. K. (1980). *Oxytelus fulvipes* Er. (Col., Staphylinidae) abundant at Askham Bogs. *Entomologist's Monthly Magazine* 115, 180.

Kenward, H. K. (1982). *Insect communities and death assemblages, past and present*, pp. 71-8 in Hall, A. R. and Kenward, H. K. (eds). Environmental archaeology in the urban context. *Council for British Archaeology Research Reports* 43.

Kenward, H. K. (1983a). Colour patterns of Quaternary fossil insects. *Entomologist's Monthly Magazine* 119, 160.

Kenward, H. K. (1983b). Mass flight by *Aphodius contaminatus* (Herbst) (Col., Scarabaeidae). *Entomologist's Monthly Magazine* 119, 120.

Kenward, H. K. (1984a). *Insect assemblages*, p. 95 in Gilbertson, D. D., Late Quaternary Environments and Man in Holderness. *British Archaeological Reports British Series* 134.

Kenward, H. K. (1984b). *Insects*, pp. 220-1 in Gilbertson, D. D., Late Quaternary Environments and Man in Holderness. *British Archaeological Reports British Series* 134.

Kenward, H. K. (1984c). *Helophorus tuberculatus* Gyll. (Col., Hydrophilidae) from Roman Carlisle. *Entomologist's Monthly Magazine* 120, 225

Kenward, H. K. (1984d). Mass migration of *Meligethes aeneus* (Fabricius) (Col., Nitidulidae) at Bempton Cliffs, Yorkshire. *Entomologist's Monthly Magazine* 120, 236.

Kenward, H. K. (1985a). *Outdoors - indoors? The outdoor component of archaeological insect assemblages*, pp. 97-104 + figs. in Fieller, N. R. J., Gilbertson, D. D. and Ralph, N. (eds.), Palaeobiological investigations. Research design, methods and data analysis. *Symposia of the Association for Environmental Archaeology 5B, British Archaeological Reports International Series* 226.

Kenward, H. K. (1985b). *The insect fauna: Berrington Street site 4*. p. 96 and microfiche M9.B4-11 in Shoesmith, R, Hereford City Excavations. Volume 3: The Finds. *Council for British Archaeology Research Report* 56.

Kenward, H. K. (1987). *Insect remains from the putlog holes*, pp. 128-30 in Wenham, L. P., Hall, R. A., Briden, C. and Stocker, D. A., St. Mary Bishophill Junior and St. Mary Castlegate. *The Archaeology of York* 8 (2), 73-175 + plates IX-XXXII. London: Council for British Archaeology.

Kenward, H. K. (1988a). Insect remains, pp. 115-40 in Schia, E. (ed.), *De arkeologiske utgravninger i Gamlebyen, Oslo. Vol. 5 Mindets Tomt - Sondrefelt.* Øvre Ervik: Alvheim and Eide.

Kenward, H. K. (1988b). *Helophorus tuberculatus* Gyllenhal (Col. Hydrophilidae) from Roman York. *Entomologist's Monthly Magazine* 124, 90.

Kenward, H. K. (1990). *The insect remains (1981)*, pp. 317-8 and fiche 3/1-3/3 in McCarthy, M. R., A Roman, Anglian and medieval site at Blackfriars Street, Carlisle. *Cumberland and Westmorland Antiquarian and Archaeological Society Research Series* 4.

Kenward, H. K. (1991). Buzz, buzz, buzz, I wonder what it was. A skeptical view of the Coppergate `beehive'. *Interim (Archaeology in York)* 15 (4), 20-24.

Kenward, H. K. (1992). Rapid recording of archaeological insect remains - a reconsideration. *Circaea, the Journal of the Association for Environmental Archaeology* 9 (for 1991), 81-8.

Kenward, H. K. (1993a). Dead beetles can tell tales! Interpreting insect remains from archaeological sites. *Interim (Archaeology in York)* 17 (4), 15-21.

Kenward, H. K. (1993b). Dead beetles can tell (more) tales! *Interim (Archaeology in York)* 18 (1), 16-20.

Kenward, H. K. (1997a). Synanthropic decomposer insects and the size, remoteness and longevity of archaeological occupation sites: applying concepts from biogeography to past 'islands' of human occupation. *Quaternary Proceedings* 5, 135-151.

Kenward, H. K. (1997b). *Sheep parasites: keds and lice*, pp. 1715-17 in Walton-Rogers, P., Textile production at 16-22 Coppergate. *The Archaeology of York* 17 (11), 1687-1867 + i-vii. York: York Archaeological Trust and Council for British Archaeology.

Kenward, H. K. (1999). Pubic lice (*Pthirus pubis* L.) were present in Roman and Medieval Britain. *Antiquity* 73, 911-915.

Kenward, H. K. (2000). Insect assessment: inner enclosure ditch, p. 57 in Cowell, R. W. and Philpott, R. A., *Prehistoric, Romano-British and Medieval settlement in Lowland North West England*. Liverpool: National Museums and Galleries on Merseyside.

Kenward, H. (2001a). Pubic lice in Roman and medieval Britain. *Trends in Parasitology* 17, 167-168.

Kenward, H. (2001b). *Insects*, p. 80 in: Ewart, G., Dundrennan Abbey: archaeological investigation within the south range of a Cistercian house in Kirkcudbrightshire (Dumfries & Galloway), Scotland. *Scottish Archaeological Internet Reports* 1. Available at http://www.sair.org.uk/ (accessed October 2009)

Kenward, H. K. (2004). Do insect remains from historic-period archaeological occupation sites track climate change in Northern England? *Environmental Archaeology* 9, 47-59.

Kenward, H. K (2005a). Honeybees (*Apis mellifera* Linnaeus) from archaeological deposits in Britain, pp. 97-107 in Brickley, M., Smith, D. and Smith, W. (eds.), *Fertile Ground. Papers in Honour of Susan Limbrey* (Symposia of the Association for Environmental Archaeology No. 22). Oxford: Oxbow Books.

Kenward, H. (2005b). Insect and other invertebrate remains, pp. 215-237 in Iversen, M., Robinson, D., Hjermind, J. and Christensen, C. (eds.), *Viborg Søndersø 1018-1030. Arkæologi og naturvidenskab i et værkstedsområde fra vikingetid.* (= Jysk Arkæologisk Selskabs Skrifter). Højbjerg: Viborg Stiftsmuseum/Jysk Arkæologisk Selskab.

Kenward, H. (2006). The visibility of past trees and woodland: testing the value of insect remains. *Journal of Archaeological Science* 33, 1368-1380.

Kenward, H. K. (nd). Insect remains from two pits. Unpublished notes.

Kenward, H. K. and Allison, E. P. (1994a). *A preliminary view of the insect assemblages from the early Christian rath site at Deer Park Farms, Northern Ireland,* pp. 89-107 in Rackham, D. J. (ed.), Environment and economy in Anglo-Saxon England. *Council for British Archaeology Research Report* 89.

Kenward, H. K. and Allison, E. P. (1994b). *IV. Insects*, pp. 45-48 in Ayers, B. S., Excavations at Fishergate, Norwich, 1985. *East Anglian Archaeology* 68.

Kenward, H. K. and Allison, E. P. (1994c). *Rural origins of the urban insect fauna*, pp. 55-77 in Hall, A. R. and Kenward, H. K. (eds.), Urban-rural connexions: perspectives from environmental archaeology. *Symposia of the Association for Environmental Archaeology* 12. *Oxbow Monographs* 47. Oxford.

Kenward, H. K., Allison, E. P., Dainton, M. Kemenés, I. K. and Carrott, J. B. (2000). The insect and parasite remains, pp. 81-3 and bibliography pp. 145-147 in McCarthy, M. R. (ed.), *Roman and medieval Carlisle: The southern Lanes*. Department of Archaeological Sciences, University of Bradford, Research Report 1. Carlisle: Carlisle Archaeology Limited.

Kenward, H. K., Allison, E. P., Morgan, L. M., Jones, A. K. G. and Hutchinson, A. R. (1991). *Chapter 10. The insect and parasite remains*, pp. 65-72 in McCarthy, M. R., The structural sequence and environmental remains from Castle Street, Carlisle: excavations 1981-2. *Cumberland and Westmorland Antiquarian and Archaeological Society Research Series* 5 (fascicule 1).

Kenward, H. and Carrott, J. (2006). Insect species associations characterise past occupation sites. *Journal of Archaeological Science* 33, 1452-1473.

Kenward, H. K., Engleman, C., Robertson, A., and Large, F. (1986a). Rapid scanning of urban archaeological deposits for insect remains. *Circaea* 3, 163-72.

Kenward, H. K. and Hall, A. R. (1995). Biological evidence from Anglo-Scandinavian deposits at 16-22 Coppergate. *The Archaeology of York* 14 (7), 435-797 + xxii + loose figures. York: Council for British Archaeology.

Kenward, H. and Hall, A. (1997). Enhancing bioarchaeological interpretation using indicator groups: stable manure as a paradigm. *Journal of Archaeological Science* 24, 663-673.

Kenward, H. and Hall, A. (2000). Decay of delicate organic remains in shallow urban deposits: are we at a watershed? *Antiquity* 74, 519-525.

Kenward, H. and Hall, A. (2004a). Actively decaying or just poorly preserved? Can we tell when plant and invertebrate remains in urban archaeological deposits decayed? pp. 4-10 in Nixon, T. (ed.), *Preserving archaeological remains in situ? Proceedings of the 2nd [PARIS] conference 1214th September 2001*. London: Museum of London Archaeology Service.

Kenward, H. and Hall, A. (2004b). Beyond the foundations: decay of organic remains in archaeological deposits associated with timber buildings at Bryggen. pp. 138-141 in Christensson, A., Paszkowski, Z., Spriggs, J. and Verhoef, L. (eds.), *Safeguarding historic waterfront sites. Bryggen in Bergen as a case*. Szczecin: Stiftelsen Bryggen.

Kenward, H. K. and Hall, A. R. (2006). *Easily-decayed organic remains in urban archaeological deposits: value, threats, research directions and conservation*, pp. 183-198 in Brinkkemper, O., Deeben, J., van Doesburg, J., Hallewas, D. Theunissen, E. M. and Verlinde, A. D. (eds), Vakken in vlakken. Archeologische kennis in lagen. *Nederlandse Archeologische Rapporten* 32. Amersfoort.

Kenward, H., Hall, A. Allison, E. and Carrott, J. (accepted). Environment, activity and living conditions at DPF: evidence from plant and invertebrate remains, Chapter 28 in Lynn, C. J. and McDowell, J. A., The Excavation of a Raised Rath at Deer Park Farms, Glenarm, Co Antrim. Northern Ireland Archaeological Monograph.

Kenward, H. K., Hall, A. R. and Jones, A. K. G. (1980). A tested set of techniques for the extraction of plant and animal macrofossils from waterlogged archaeological deposits. *Science and Archaeology* 22, 3-15.

Kenward, H. K., Hall, A. R. and Jones, A. K. G. (1986b). Environmental evidence from a Roman well and Anglian pits in the legionary fortress. *The Archaeology of York* 14 (5), 241-88 + Fiche 2. London: Council for British Archaeology.

Kenward, H. K., Hall, A. R., Jones, A,. K. G. and O'Connor, T. P. (1984). *Environmental archaeology at York in retrospect and prospect*, pp. 152-79 in Keeley, H. C. M. (ed.), Environmental Archaeology. A regional review. *DAMHB Occasional Papers* 6. London: Department of the Environment.

Kenward, H. K., Hall, A. R. and McComish, J. M. (2004a). Archaeological implications of plant and invertebrate remains from fills of a massive post-medieval cut at Low Fisher Gate, Doncaster, UK. *Environmental Archaeology* 9, 61-74.

Kenward, H., Hill, M., Jaques, D., Kroupa, A. and Large, F. (2000b). Evidence from beetles and other insects, pp. 76-78 and bibliography pp. 300-320 in Crone, A. (ed.), *The history of a Scottish lowland crannog: excavations at Buiston, Ayrshire 1989-90*. STAR Monograph 4. Edinburgh: Scottish Trust for Archaeological Research.

Kenward, H., Hill, M., Jaques, D., Kroupa, A. and Large, F. (2000c). Evidence for living conditions on the crannog, pp. 99-101 and bibliography pp. 300-320 in Crone, A. (ed.), *The history of a Scottish lowland crannog: excavations at Buiston, Ayrshire 1989-90*. *STAR Monograph* 4. Edinburgh: Scottish Trust for Archaeological Research.

Kenward, H., Hill, M., Jaques, D., Kroupa, A. and Large, F. (2000d). Coleoptera analysis, pp. 230-247 in Crone, A. (ed.), *The history of a Scottish lowland crannog: excavations at Buiston, Ayrshire 1989-90*. *STAR Monograph* 4. Edinburgh: Scottish Trust for Archaeological Research.

Kenward, H., Hughes, P. and Hall, A. (2004b). Plant and invertebrate macrofossils, pp. 132-138, and bibliography pp. 177-184, in Heawood, R., Howard-Davis, C., Drury, D. and Krupa, M. (eds.), *Old Abbey Farm, Risley. Building survey and excavation at a medieval moated site*. Lancaster: Oxford Archaeology North.

Kenward, H. and Large, F. (1998a). Recording the preservational condition of archaeological insect fossils. *Environmental Archaeology* 2, 49-60.

Kenward, H. and Large, F. (1998b). Insects in urban waste pits in Viking York: another kind of seasonality. *Environmental Archaeology* 3, 35-53.

Kenward, H. and Large, F. (2001a). *The invertebrate remains* [from Grim's Ditch South], pp. 227231 in Roberts, I., Burgess, A. and Berg, D. (eds.), A new link to the past. The archaeological landscape of the M1-A1 link road. *Yorkshire Archaeology* 7. Leeds.

Kenward, H. and Large, F. (2001b). *The invertebrate remains* [from South Dyke], pp. 240-246 in Roberts, I., Burgess, A. and Berg, D. (eds.), A new link to the past. The archaeological landscape of the M1-A1 link road. *Yorkshire Archaeology* 7. Leeds.

Kenward, H., Large, F. and Skidmore, P. (2004c). *The insect remains*, pp. 444-446 in Greig, M. K., Excavations in the Laird's Hall, Drum Castle, Aberdeenshire. *Proceedings of the Society of Antiquities of Scotland* 134, 423-456.

Kenward, H. K. and O'Connor, T. P. (1991). Research priorities for bioarchaeology in York, Paper C.II in Ove Arup and Partners *et al., York development and archaeology study.* Manchester: Ove Arup.

Kenward, H. K. and Tomlinson, P. R. (1992). *Environmental analysis*, pp. 75-78 and 83-84 in D. Higgins, Speke Hall: excavations in the west range, 1981-82. *Journal of the Merseyside Archaeological Society* 8, 47-84.

Kenward, H. K. and Williams, D. (1979). Biological evidence from the Roman warehouses in Coney Street. *The Archaeology of York* 14 (2), 45-100. London: Council for British Archaeology.

Kenward, H. K., Williams, D., Spencer, P. J., Greig, J. R. A., Rackham, D. J. and Brinklow, D. (1978). *The environment of Anglo-Scandinavian York*, pp. 58-73 in Hall, R. A. (ed.), Viking-Age York and the North. *Council for British Archaeology Research Reports* 27.

Kerney, M. P. (1966). Snails and man in Britain. *Journal of Conchology* 26, 3-14.

Kerney, M. P. (1976). Two postglacial molluscan faunas from south-west England. *Journal of Conchology* 29, 71-73.

Kerney, M. P. (1977). A proposed zonation scheme for Late-glacial and Postglacial deposits using land Mollusca. *Journal of Archaeological Science* 4, 387-390.

Kerney, M. P. (1968). Britain's fauna of land mollusca and its relation to the post-glacial thermal optimum. *Symposia of the Zoological Society of London* 22, 273-291.

Kerney, M. P. (1981). *Gastropoda*, p. 184 in McGrail, S. (ed.), The Brigg 'raft' and her prehistoric environment. *B. A. R. British Series* 89. Oxford.

Kerney, M. P., Brown, E. H., Chandler, T. J., Carreck, J. N., Lambert, C. A., Levy, J. F. and Millman, A. P. (1964). The Late-Glacial and post-glacial history of the chalk escarpment near Brook, Kent. *Philosophical Transactions of the Royal Society London B* 248, 135-204.

Kerney, M. P. and Cameron, R. A. D. (1979). *A field guide to the snails of Britain and North-West Europe.* London etc: Collins.

Kerney, M. P., Gibbard, P. L., Hall, A. R. and Robinson, J. E. (1982). Middle Devensian river deposits beneath the `Upper Floodplain' terrace of the River Thames at Isleworth, West London. *Proceedings of the Geological Association* 93, 385-93.

Kerney, M. P., Preece, R. C. and Turner, C. (1980). Molluscan and plant biostratigraphy of some Late Devensian and Flandrian deposits in Kent. *Philosophical Transactions of the Royal Society London B* 291, 1-43.

Kettle, D. S. (1995). *Medical and veterinary entomology.* Second edition. Wallingford, Oxfordshire: CAB International.

Keys, D. (1999). *Catastrophe: an investigation into the origins of the modern world*. London: Century.

Kimmins, D. E. (1954). *Coleoptera*, p. 58 in Wheeler, M., The Stanwick fortifications, North Riding of Yorkshire. *Reports of the Research Committee of the Society of Antiquaries of London* 17. Oxford: Society of Antiquaries.

King, J. E. (1963). Report on the animal remains, pp. 136-7 in Brewster, T. C. M., *The excavation of Staple Howe.* Winteringham: East Riding Archaeological Research Committee.

King, P. E. (1974). British sea spiders. Arthropoda: Pycnogonida. Keys and notes for the identification of the species. *Synopses of the British fauna (new series)* 5, 68 pp. London: Academic.

King, P. E. and Crapp, G. B. (1971). Littoral pycnogonids of the British Isles. *Field Studies* 3, 455-480.

Kirby, W., and Spence, W. (1859). *An introduction to entomology or elements of the natural history of insects, etc.* London: Longman, Green, Longman and Roberts.

Kirk-Spriggs, A. H. (1996). Pollen beetles. Coleoptera: Kateretidae and Nitidulidae: Meligethinae. *Handbooks for the identification of British Insects* 5 (6a). London: Royal Entomological Society.

Kislev, M. E. and Melamed, Y. (2000). Ancient infested wheat and horsebean from Horbat Rosh Zayit, pp. 206-220 in Gal, A. and Alexandre, Y. (eds.) Horbat Rosh Zayit. *An Iron Age storage fort and village*. Jerusalem: Israel Antiquities Authority.

Klausnitzer, B. (1978). *Ordnung Coleoptera (Larven)*. Berlin: Akademie-Verlages.

Klausnitzer, B. (1991-1999). *Die Larven der Kafer mitteleuropas* 1-5. Krefeld: Goecke and Evers.

Kloet, G. S. and Hincks, W. D. (1964). *A check list of British insects. Second edition. Part 1: Small orders and Hemiptera*. London: Royal Entomological Society.

Kloet, G. S. and Hincks, W. D. (1972). *A check list of British insects. Part 2:Lepidoptera. Second edition* revised by J. D. Bradley, D. S. Fletcher and P. E. S. Whalley. London: Royal Entomological Society.

Kloet, G. S. and Hincks, W. D. (1975). *A check list of British insects. Part 5: Diptera and* Siphonaptera . Second edition revised by K. G. V. Smith London: Royal Entomological Society.

Kloet, G. S. and Hincks, W. D. (1977). *A check list of British Insects. Part 3. Coleoptera and Strepsiptera.* Second edition revised by R. D. Pope. London: Royal Entomological Society.

Kloet, G. S. and Hincks, W. D. (1978). *A check list of British insects. Part 4:* Hymenoptera. *Second edition.* London: Royal Entomological Society.

Knapp, R., Garton, J. and Sarnelle, O. (2001). The use of egg shells to infer the historical presence of copepods in alpine lakes. *Journal of Paleolimnology* 25, 539-543.

Knight, R. A. (1984). Morphological differences in *Trichuris ovis* associated with different host species. *Journal of Parasitology* 70, 842-843.

Knülle, W. (1957). Vorkommen und Indikationswert von Oribatiden (Acari : Oribatei) in postglazialen Ablagerungen. *Zoologischer Anzeiger* 159, 215-229.

Koch, K. (1970). Subfossile Käferreste aus römerzeitlichen und mittelalterlichen Ausgrabungen im Rheinland. *Entomologische Blätter* 66, 41-56.

Koch, K. (1971). Zur Untersuchung subfossiler Käferreste aus römerzeitlichen und mittelalterlichen Ausgrabungen im Rheinland. *Rheinische Ausgrabungen*. 10, 374-448 + plates 16-27.

Koch, K. (1989-1996). *Die Käfer mitteleuropas: Okologie* 1-8. Krefeld: Goecke and Evers.

Korhola, A. and Rautio, M. (2001). Cladocera and other branchiopod crustaceans, pp. 5-41 in Smol, J. P., Birks, H. J. B. and Last, W. M. (eds.), *Tracking environmental change using lake sediments. Volume 4: Zoological indicators*. Dortrecht etc: Kluwer Academic Publishers.

Koponen, M. and Nuorteva, M. (1973). Über subfossile Waldinsekten aus dem Moor Piilonsuo in Südfinnland. *Acta Entomoloigica Fennica* 29, 1-84.

Korinek, V., Sacherova, V. and Havel, L. (1997). Subgeneric differences in head shield and ephippia ultrastructure within the genus *Bosmina* Baird (Crustacea, Cladocera). *Hydrobiologia* 360, 13-23.

Korringa, P. (1946). A revival of natural oyster beds? *Nature, London* 158, 586-587.

Kramer, K., Groen, T. A. and van Wieren, S. E. (2003). The interacting effects of ungulates and fire on forest dynamics: analysis using the model FORSPACE. *Forest Ecology and Management* 181, 205-222.

Krebs, C. J. (1978). *Ecology: the experimental analysis of distribution and abundance* (Second edition). New York etc: Harper Row.

Kremer, M. and Ball, C. (1997). Why doesn't the crab-louse (*Phthirus pubis*) invade the scalp? *Annales de Dermatologie et de Venerologie* 124, 817-818.

Krivolutsky, D. A. and and Druk, A Y. (1986). Fossil orobatid mites. *Annual Review of Entomology* 31, 533-545.

Kryzhanovskii, O. L. and Reichardt, A. N. L. (1976). *Fauna S. S. S R. Zhestokrylye* 5(4). Leningrad: Nauka.

Kurdian, H. (1941). Kirmiz. *Journal of the American Oriental Society* 61, 105-107.

Kurek, J., Cwynar, L. C. and Spear, R. W. (2004). The 8200 cay yr BP cooling event in eastern North America and the utility of midge analysis for Holocene temperature reconstructions. *Quaternary Science Reviews* 23, 627-639.

Kurtz, O. L. and Harris, K. L. (1962). *Micro-analytical entomology for food sanitation control*. Washington DC: Association of Official Agricultural Chemists.

Lamb, H. H. (1972a). *The changing climate*. London: Methuen.

Lamb, H. H. (1972b).*Climate: present, past and future* 1. Fundamentals and climate now. London: Methuen.

Lamb, H. H. (1977). *Climate: present, past and future* 2. Climatic history and the future. London: Methuen.

Lamb, H. H. (1982). *Climate, history and the modern world*. London and New York: Methuen.

Lambeck, K. (1995). Late Devensian and Holocene shorelines of the British Isles and North Sea from models of glacio-hydro-isostatic rebound. *Journal of the Geological Society of London* 152, 437-448.

Lambrick, G. and Robinson, M. A. (1979). Iron Age and Roman Riverside Settlements at Farmoor, Oxfordshire. *Council for British Archaeology Research Report* 32. London.

Lancaster, S. (1994). *What are we doing to our beetles.* Unpublished placement Student project report.

Lancaster, S. (1995). *A study of the archaeological visibility of an insect community.* Dissertation in part fulfillment of the requirements for the degree of Batchelor of Science in Archaeology, Bradford University.

Landin, B.-O. (1961). Ecological studies on dung beetles. *Opuscula Entomologica Supplementum* 19, 1-228.

Landin, B-O. (1968). The diel flight activity of dung-beetles (Coleoptera Scarabaeidae). *Opuscula Entomologica Supplementum* 32, 1-172.

Landsborough, D. (1851). *A popular history of British seaweeds*. London: Reeve.

Lane, R. P. and Crosskey, R. W. (1993) (eds.). *Medical insects and arachnids.* London: Chapman and Hall.

Langdon, P. G., Barber, K. E. and Hughes, P. D. M. (2003). A 7500-year peat-based palaeoclimatic reconstruction and evidence for an 1100-year cyclicity in bog surface wetness from Temple Hill Moss, pentland Hills, southeast Scotland. *Quaternary Science Reviews* 22, 259-274.

Langdon, P. G., Barber, K. E. and Lomas-Clarke, S. E. (2004). Reconstructing climate and environmental change in northern England through chironomid and pollen analyses: evidence from Talkin Tarn, Cumbria. *Journal of Palaeolimnology* 32, 197-213.

Lapeere, H., Brochez, L., Vander Haeghen, Y., Mabilde, C., Vander Stichele, R., Leybaert, L. and Naeyaert, J-M. (2005). Method to measure force required to remove *Pediculus humanus capitis* (Phthiraptera: Pediculidae) eggs from human hair. *Journal of Medical Entomology* 42, 89-93.

Lawrence, J. M. (ed.) (2006). *Edible sea urchins: biology and ecology* (2nd edition). Amsterdam: Elsevier.

Lawson, T., Hopkins, D. W., Chudek, J. A., Janaway, R. C. and Bell, M. G. (2000). The experimental earthwork at Wareham, Dorset after 33 years: 3. Interaction of soil organisms with buried materials. *Journal of Archaeological Science* 27, 273-285.

Le Gross, A. E. (1958). How to begin the study of tardigrades. *Country-Side* (new series) 18 (8), 1-11.

Leach, B. F. (1979). Fish and crayfish from the Washpool midden site, New Zealand: their use in determining season of occupation and prehistoric catching methods. *Journal of Archaeological Science* 6, 109-126.

Leah, M. D., Wells, C. E., Appleby, C. and Huckerby, E. (1997). The wetlands of Cheshire. *North West Wetlands Survey* 4. *Lancaster Imprints* 5. Lancaster.

Leatherdale, D. (1955). House infestation by *Trox scaber* (L.) (Col., Trogidae) from a jackdaws' nest. *Entomologist's Monthly Magazine* 91, 266.

Lee, R. L. (1951). American cochineal in European commerce, 1526-1625. *The Journal of Modern History* 23, 205-224.

Leeson, H. S. (1941). The survival of unfed *Pediculus humanus corporis* de Geer (Anoplura) at different temperatures. *Bulletin of Entomological Research* 32, 49-51.

Lefkovitch, L. P. (1959). A revision of the European Laemophloeinae (Coleoptera: Cucujidae). *Transactions of the Royal Entomological Society of London* 111, 95-118.

Legg, G. and Jones, R. E. (1988). Pseudoscorpions (Arthropods: Arachnida). Keys and notes for the identification of the species. *Synopses of the British fauna (new series)* 40, 159 pp. London etc.: E. J. Brill/Dr W. Backhuys.

Lemdahl, G. (1990). Water-surfaces as insect traps and some consequences for palaeoentomology. *Quaternary Newsletter* 62, 26-29.

Lemdahl, G., Andersson, M. and Hedenas, L. (1995). Insect remains from a medieval vessel. *Entomologisk Tidskrift* 116, 169-174.

Leo, N. P., Campbell, H. J. H., Yang, X., Mumcuoglu, K. and Barker, S. C. (2002). Evidence from mitochondrial DNA that head lice and body lice of humans (Phthiraptera: Pediculidae) are conspecific. *Journal of Medical Entomology* 39, 662-666.

Le Quesne, W. J. and Payne, K. R. (1981). Cicadellidae (Typhlocybinae) with a check list of the British Auchenorhyncha (Hemiptera, Homoptera). *Handbooks for the Identification of British Insects* II (2c). London: Royal Entomological Society.

Lethieullier, S. (1735-6). Some account of a Roman tesselated pavement at Well four miles South East from Bedall in Hangwest Wapontake in the North Riding of Yorkshire. *Society of Antiquaries of London* i 101-2 (1735-53). [Not seen in original; given as quoted by Jackson 1951).]

Letts, J. B. (1999). *Smoke blackened thatch: a unique source of medieval plant remains from southern England.* London and Reading: English Heritage and University of Reading.

Letts, J. B. and Smith, D. N. (1999). Analysis of beetles in SBT [smoke blackened thatch], pp. 42-43 in Letts, J. B. (ed.), *Smoke blackened thatch: a unique source of medieval plant remains from southern England.* London and Reading: English Heritage and University of Reading.

Levene, H. and Dobzhansky, T. (1959). Possible genetic differences between the head louse and the body louse (*Pediculus humanus* L.). *The American Naturalist* 93, 347-353.

Levesque, A. J., Maylee, F. E., Walker, I. R. and Cwynar, L. C. (1993). The amphi-atlantic oscillation: a proposed late-glacial climatic event *Quaternary Science Reviews* 12, 629-643.

Lewis, T. (1965). The effects of an artificial windbreak on the aerial distribution of flying insects. *Annals of Applied Biology* 55, 505-512.

Lewis, T. (1969). The distribution of flying insects near a low hedgerow. *Journal of Applied Ecology* 6, 443-452.

Lewkowitsch, J. (1914). *Chemical technology and analysis of oils, fats and waxes*. London: Macmillan.

Light, J. (1995a). The marine molluscs, pp. 142-152 in Ratcliffe, J., Duckpool, Morwenstow, a Romano-British and early medieval industrial site and harbour. *Cornish Archaeology* 34, 81-171.

Light, J. (1995b). Duckpool, Morwenstow, Cornwall: the bias introduced by selective collection of the marine molluscs. *Cornish Archaeology* 34, 172-175.

Light, J. (2003). Dog cockle shells as occasional finds in Romano-British shell middens from Newquay, North Cornwall, UK. *Environmental Archaeology* 8, 51-59.

Limbrey, S. 1982. *The honeybee and woodland resources*, pp. 279-286 in Bell, M. and Limbrey, S. (eds.) Archaeological aspects of woodland ecology. *Association for Environmental archaeology Symposium* 2, *BAR International Series* 146. Oxford.

Limburg, P. A. and Weider, L. J. (2002). 'Ancient' DNA in the resting egg bank of a microcrustacean can serve as a palaeolimnological database. *Proceedings of the Royal Society of London Series B Biological Sciences* 269, 281-287.

Limondin, N. (1965). Late-Glacial and Holocene malacofaunas from archaeological sites in the Somme Valley (North France). *Journal of Archaeological Science* 22, 683-698.

Lincoln, R. J. (1979). *British marine Amphipoda:* Gammaridae. London: British Museum (Natural History).

Lindroth, C. H. (1931). *Die Insektenfauna Islands und ihre Probleme.* Uppsala: Almqvist and Wiksells.

Lindroth, C. H. (1960). *Catalogus Coleoptorum Fennoscandiae et Daniae*. Lund: Entomologiska Sallskapet.

Lindsay, D. R. and Scudder, H. I. (1956). Nonbiting flies and disease. *Annual Review of Entomology* 1, 323-346.

Linsley, E. G. (1944). Natural sources, habitats, and reservoirs of insects associated with stored food products. *Hilgardia* 16, No. 4, 187-222.

Lipton, P. (2005). Testing hypotheses: prediction and prejudice. *Science* 307, 219-221.

Lister, G. S., Kelts, K., Zao, C. K., Yu, J. Q. and Niessen, F. (1991). Lake Qinghai, China - closed-basin lake levels and the oxygen isotope record for ostracoda since the latest Pleistocene. *Palaeogeography, Palaeoclimatology, Palaeoecology* 84, 141-162.

Ljung, J-Å. (nd). *Destruction of archaeological remains in situ. An example from the central Swedish town of Nyköping*. Stockholm: Department of Archaeological Excavations.

Lloyd, M. and Ghelardi, R. J. (1964). A table for calculating the 'equitability' component of species diversity. *Journal of Animal Ecology* 33, 217-25.

Loader, N. J., Switsur, V. R. and Filed, E. M. (1995). High-resolution stable isotope analysis of tree rings: implications of 'microdendrochronology' for palaeoenvironmental research. *The Holocene* 5, 457-460.

Locker, B. (1953). Parasites of bison in northwestern U. S. A. *Journal of Parasitology* 38, 58-59.

Locket, G. H. and Millidge, A. F. (1951-1953). *British spiders* 1-2. London: Ray Society. (Reprinted Johnson Reprint Corportation, New York, 1968.)

Locket, G. H., Millidge, A. F. and Merrett, P. (1974). *British spiders* 3. London: Ray Society.

Lockwood, J. A., Nunamaker, R. E., Pfadt, R. E. and Debrey, L. D. (1990). Grasshopper Glacier: characterization of a vanishing biological resource. *American Entomologist* 36, 18-27.

Lockwood, J. A., Schell, S. P., Wangberg, J. K., Debrey, L. D., Debrey, W. G. and Bomar, C. R. (1992). Preserved insects and physical condition of Grasshopper Glacier, Carbon County, Montana, U.S.A. *Arctic and Alpine Research* 24, 229-232.

Lockwood, J. A., Thompson, C. D., Debrey, L. D., Love, L. D., Nunamaker, C. M., Pfadt, R.A. and Pfadt, R. E. (1991). Preserved grasshopper fauna of Knife Point Glacier, Fremont County, Wyoming, U.S.A. *Arctic and Alpine Research* 23, 108-114.

Löffler, H. (1986). Ostracod analysis, pp. 693-702 in Berglund, B.E. (ed.), *Handbook of Holocene palaeoecology and palaeohydrology*. Chichester etc: Wiley.

Lohse, G. A. and Lucht, W. H. (1989-1994). *Die Käfer mitteleuropas* 12-14. Krefeld: Goeke and Evers.

Long, A. J. (2003). Past and future se-level changes in Yorkshire, pp. 71-88 in Atherden, M. (ed.), *Global warming: a Yorkshire perspective*. York: PLACE Research Centre.

Long, A. J., Innes, J. B., Kirby, J. R., Lloyd, J. M., Rutherford, M. M., Shennan, I. and Tooley, M. J. (1998). Holocene sea-level change and coastal evolution in the Humber estuary: an assessment of rapid coastal change. *The Holocene* 8, 229-247.

Longfield, S. A. and Macklin, M. G. (1999). The influence of recent environmental change on flooding and sediment fluxes in the Yorkshire Ouse basin, northeast England. *Hydrological Processes* 13, 1051-1066.

Loreille, O. and Bouchet, F. (2003). Evolution of ascariasis in humans and pigs: a multi-disciplinary approach. *Memorias do Instituto Oswaldo Cruz* 98 (suppl. 1), 39-46.

Lotter, A. F., Birks, H. J. B., Eicher, U., Hofmann, W, Schwander, J. and Wick, L. (2000). Younger Dryas and Allerød summer temperatures at Gerzensee (Swuitserland) inferred from fossil pollen and cladoceran assemblages. *Palaeogeography, Palaeoclimatology, Palaeoecology* 159, 349-361.

Lovell, M. S. (1884). *The edible mollusks of Great Britain and Ireland, with recipes for cooking them.* [Second edition. With coloured illustrations.] London: Reeve.

Loveluck, C. and Dobney, K. (2001). A match made in heaven or a marriage of convenience? The problems and rewards of integrating palaeoecological and archaeological data, pp. 149-175 in Albarella, A. (ed.), *Environmental archaeology: meaning and purpose*. Dordrecht etc: Kluwer.

Lowe, J. J. and Walker, M. J. C. (1997a). *Reconstructing Quaternary environments.* Harlow: Longman.

Lowe, J. J. and Walker, J. C. (1997b). Temperature variations in NW Europe during the last glacial-interglacial transition (14-9 ^{14}C ka BP) based upon the analysis of coleopteran assemblages - the contribution of Professor G. R. Coope. *Quaternary Proceedings* 5, 65-175.

Loäek, V. (1986). Mollusca analysis, pp. 729-740 in Berglund, B.E. (ed.), *Handbook of Holocene palaeoecology and palaeohydrology*. Chichester etc: Wiley.

Lucht, W. H. (1987). Katalog. *Die Käfer mitteleuropas* K. Krefeld: Goeke and Evers.

Luff, M. L. (1991). Part IV - Beetle larvae. pp. 217-38 in Cooter, J. (ed.) *A coleopterist's handbook*. Feltham, Middlesex: The Amateur Entomologists' Society.

Luff, R. and Rowley-Conwy, P. (1994). Whither environmental archaeology? *Oxbow Monograph* 38. Oxford.

Lyman, R. L. (1994). *Vertebrate taphonomy*. Cambridge: University Press.

Lytle, D. E. and Wahl, E. R. (2005). Palaeoenvironmental reconstructions using the modern analogue technique: the effects of sample size and decision rules. *The Holocene* 15, 554-566.

Macan, T. T. (1963). *Freshwater biology.* London: Longmans.

Macan, T. T. (1973). A key to the adults of the British Trichoptera. *Freshwater Biological Association Scientific Publication* 28, 515 pp. + plates 1-5. Ambleside: Freshwater Biological Association.

Macan, T. T. and Cooper, R. D. (1977). A key to the British fresh- and brackish-water gastropods with notes on their ecology (fourth edition reprinted 1994). *Freshwater Biological Association Scientific Publication* 13, 46 pp. Ambleside: FBA.

MacArthur, R. H. (1957). On the relative abundance of bird species. *Proceedings of the National Academy of Science, Washington* 43, 293-5.

MacGregor, A. (1982). Anglo-Scandinavian finds from Lloyds Bank, Pavement, and other sites. *The Archaeology of York* 17 (3), 67-174. London: Council for British Archaeology.

Macklin, M. G., Taylor, M. P., Hudson-Edwards, K. A. and Howard, A. J. (2000). *Holocene environmental change in the Yorkshire Ouse basin and its influence on river dynamics sediment fluxes to the coastal zone*, pp. 87-96 in

Shennan, I. and Andres, J. E. (eds.) Holocene land-ocean interaction and enviromental change around the North Sea. *Geological Society Special Publication* 166. London: Geological Society.

MacPhail, R. I. (1994). *The reworking of urban stratigraphy by human and natural processes*, pp. 13-43 in in Hall, A. R. and Kenward, H. K. (eds.), Urban-rural connexions: perspectives from environmental archaeology. *Symposia of the Association for Environmental Archaeology* 12. *Oxbow Monographs* 47. Oxford.

MacPhail, R. I., Cruise, G. M., Allen, M. J., Linderholm, J. and Reynolds, P. (2004). Archaeological soil and pollen analysis of experimental floor deposits; with special reference to Butser Ancient Farm, Hampshire, UK. *Journal of Archaeological Science* 31, 175-191.

MacVean, C. M. (1994). Identification of Nij insects and their wax: deriving a sustainable industry from biological sources used by the Maya. *Proceedings of the International Meeting of the Society for Conservation Biology Association for Tropical Biology Guadalajara, Mexico*, 114.

Madsen, D. B. and Kirkman, J. E. (1988). Hunting hoppers. *American Antiquity* 53, 593-604.

Magny, M. and Haas, J. N. (2004). A major widespread climatic change around 5300 cal. yr BP at the time of the Alpine iceman. *Journal of Quaternary Science* 19, 423-430.

Maloney, B. K. (1984). Disease and the elm decline: a method of testing the hypothesis. *Circaea* 2, 91-96.

Manby, T. G. (1980). *Bronze Age settlement in eastern Yorkshire*, pp. 307-337 in Barrett, J. and Bradley, R. (eds.), Settlement and society in the British Later Bronze Age. *BAR British Series* 83 (ii). Oxford: BAR.

Manby, T. G. (1986). *The Bronze Age in western Yorkshire*, pp. 55-125 in Manby, T. G. and Turnbull, P. (eds.), Archaeology in the Pennines. *BAR British series* 158. Oxford: BAR.

Manby, T. G., Moorhouse, S. and Ottaway, P. (eds.) (2003). The archaeology of Yorkshire: an assessment at the beginning of the 21st century. *Yorkshire Archaeological Society Occasional Paper* 3. Leeds: YAS.

Mannino, M. A. and Thomas, K. D. (2001). Intensive Mesolithic exploitation of coastal resources? Evidence from a shell deposit on the Isle of Portland (southern England) for the impact of human foraging on populations of intertidal rock shore molluscs. *Journal of Archaeological Science* 28, 1101-1114.

Mannino, M. A. and Thomas, K. D. (2002). Depletion of a resource? The impact of prehistoric human foraging on intertidal mollusc communities and its significance for human settlement, mobility and dispersal. *World Archaeology* 33, 452-474.

Mannino, M. A., Spiro, B. F. and Thomas, K. D. (2003). Sampling shells for seasonality: oxygen isotope analysis on shell carbonates of the inter-tidal gastropod *Monodonta lineata* (da Costa) from populations across its modern range and from a Mesolithic site in southern Britain. *Journal of Archaeological Science* 30, 667-679.

Markell, E. K. and Voge, M. (1976). *Medical parasitology* (4th edition). Philadelphia: Saunders.

Markkula, I. (1986). Comparison of present and subfossil oribatid faunas in the surface peat of a drained pine mire. *Annales Entomologici Fennici* 52, 39-41.

Marra, M. J., Shulmeister, J. and Smith, E. G. C. (2006). Reconstructing temperature during the Last Glacial Maximum from Lyndon Stream, South Island, New Zealand using beetle fossils and maximum likelihood envelopes. *Quaternary Science Reviews* 25, 1841-1849.

Marra, M. J., Smith, E. G. C., Shulmeister, J. and Leschen, R. (2004). Late Quaternary climate change in the Atwatere Valley, South Island, New Zealand using a sine model with a maximum likelihood envelope on fossil beetle data. *Quaternary Science Reviews* 23, 1637-1650.

Marshall, J. A. and Haes, E. C. M. (1988). *Grasshoppers and allied insects of Great Britain and Ireland*. Colchester: Harley.

Martin, L. D. and West, D. L. (1995). The recognition and use of dermestid (Insect, Coleoptera) pupation chambers in palaeoecology. *Palaeogeography, Palaeoclimatology, Palaeoecology* 113, 303-310.

Martinez, E. M., Correia, J. A. S., Villela, E. V., Duarte, A. N., Ferreira, L. F. and Bello, A. R. (2003). Random amplified polymorphic DNA analysis of DNA extracted from *Trichuris trichiura* (Linnaeus, 1771) eggs and its prospective application to paleoparasitological studies. *Memorias do Instituto Oswaldo Cruz* 98 (suppl. 1), 59-62.

Massee, A. M. (1955). The county distribution of the British Hemiptera-Heteroptera, second edition. *Entomologist's Monthly Magazine* 91, 7-27.

Matsui, A., Kanehara, M. and Kanehara, M. (2003). Palaeoparasitology in Japan - discovery of toilet features. *Memorias do Instituto Oswaldo Cruz* 98 (suppl. 1), 127-136.

Matterne, V., Yvinec, J.-H. and Gemehl, D. (1998). Stockage des plantes alimentaires et infestation par les insects dans un grenier incendié de la fin de Iie siècle après J-C à Amiens (Somme). *Revue Archéologique de Picardie* 1998 (3/4), 93-122.

Matthews, K. 1993. A futile occupation? Archaeological meanings and occupation deposits, pp. 55-61 in Barber, J.W. (ed.), *Interpreting Stratigraphy. Proceedings of the 2nd Stratigraphy Conference, Edinburgh*. Edinburgh: AOC Scotland Ltd.

Matthiessen, G. C. (2001). *Oyster culture*. Oxford etc: Fishing News Books /Blackwell.

Mattingly, H. (1960). Tacitus *on Britain and Germany.* Harmondsworth: Penguin.

Matzke-Karasz, R., Horne, D. C., Janz, H., Griffiths, H. I., Hutchinson, W. F. and Preece, R. C. (2001). 5,000 year-old spermatozoa in Quaternary Ostracoda (Crustacea). *Naturwissenschaften* 88, 268-272.

Mauchline, J. (1984). Euphasiid, stomatopod and leptostracan crustaceans. Keys and notes for the identification of the species. *Synopses of the British fauna (new series)* 30, 91 pp. London etc.: E. J. Brill/Dr W. Backhuys.

Maunder, J. W. (1983). The appreciation of lice. *Proceedings of the Royal Institution of Great Britain* 55, 1-31.

Mauquoy, D., van Geel, B., Blaaw, M. and Plicht, J. van der (2002). Evidence from northwest European bogs shows 'little ice age' climatic changes driven by variations in solar activity. *The Holocene* 12, 1-6.

May, K. (2006). *MoRPHE technical guide 1: Digital archiving and digital dissemination*. English Heritage. Available at http://www.english-heritage.org.uk/upload/pdf/MoRPHE_Technical_Guide_1_Digital_Archiving_and_Dissemination.pdf (accessed 15 February 2007).

Mc Collum, J. P. K., Pearson, R. C. M., Ingham, H. R., Wood, P. C. and Dewar, H. A. (1968). An epidemic of mussel poisoning in North-East England. *The Lancet* October 5th 1968, 767-770.

McCarthy, M. R.(1991a). The structural sequence and environmental remains from Castle Street, Carlisle: excavations 1981-2. *Cumberland and Westmorland Antiquarian and Archaeological Society Research Series* 5 (fascicule 1).

McCarthy, M. R. (1991b). The Roman waterlogged remains and later features at Castle Street, Carlisle: excavations 1981-2. *Cumberland and Westmorland Antiquarian and Archaeological Society Research Series* 5 (main volume).

McCarthy, M. R. (1995). Archaeological and environmental evidence for the Roman impact on vegetation near Carlisle, Cumbria. *The Holocene* 5, 491-495.

McCarthy, M. R. (1997). Archaeological and environmental evidence for Roman impact on vegetation near Carlisle, Cumbria: a reply to Dumayne-Peaty and Barber. *The Holocene* 7, 245-6.

McCarthy, M. R. (2005). Social dynamics on the northern frontier of Roman Britain. *Oxford Journal of Archaeology* 24, 47-71.

McCarthy, M. R. (2000). Roman and medieval Carlisle: the Southern Lanes. *Department of Archaeological Sciences, University of Bradford Research Report* 1. Carlisle: Carlisle Archaeology Limited.

McCobb, L. M. E., Briggs, D. E. G., Carruthers, W. J. and Evershed, R. P. (2003). Phosphatisation of seeds and roots in a Late Bronze Age deposit at Potterne, Wiltshire, UK. *Journal of Archaeological Science* 30, 1269-1281.

McCobb, L. M. E., Briggs, D. E. G., Evershed, R. P., Hall, A. R. and Hall, R. A. (2001). Preservation of fossil seeds from a 10th Century AD cess pit at Coppergate, York. *Journal of Archaeological Science* 28, 929-940.

McCobb, L. M. E., Briggs, D. E. G., Hall, A. R. and Kenward, H. K. (2004). Preservation of invertebrates in 16th century cesspits at St Saviourgate, York. *Archaeometry*. 46, 157-169.

McGovern, T. H., Buckland, P. C., Savory, D., Sveinbjarnardottir, G., Andreason, C. and Skidmore, P. (1983). A study of the faunal and floral remains from two Norse farms in the Western Settlement, Greenland. *Arctic Anthropology* 20, 93-120.

McGrail, S. (ed.) (1981). The Brigg 'raft' and her prehistoric environment. *B. A. R. British Series* 89. Oxford.

McHugh, T. (1972). The time of the buffalo. New York: Knopf. [not seen in original]

McKenna, W. J. B (1993). *The plant macrofossils from Queen Street*, pp. 198-201 + fiche in Evans, D. H. (ed.), Excavations in Hull 1975-76, *East Riding Archaeologist* 4, *Hull Old Town Report Series* 2.

McKenna, W. J. B. (1987). *The environmental evidence*, pp. 255-261 in Armstong, P. and Ayers, B., Excavations in High Street and Blackfriargate. *East Riding Archaeologist* 8, *Hull Old Town Report Series* 5.

McKenna, W. J. B. (1991). *The plant, molluscan, insect and parasite remains*, pp. 209 - 215 in Armstrong, P., Tomlinson, D. and Evans, D. H., Excavations at Lurk Lane Beverley, 1979-82. *Sheffield Excavation Reports* 1.

McKenna, W. J. B. (1992). *The environmental evidence*, pp. 227-33 in Evans, D. H. and Tomlinson, D. G., Excavations at 33-5 Eastgate, Beverley, 1983-86. *Sheffield Excavation Reports* 3. Sheffield.

McKenna, W. J. B. (forthcoming). *Excavations in Hull 1975-6: Vicar Lane VL75. The plant macrofossils: archive.*

McKinney, M. L. and Lockwood, J. L. (1999). Biotic homogenization: a few winners replacing many losers in the next mass extinction. *Trends in Ecology and Evolution* 14, 450-453.

McMillan, N. (1985). *The mollusca*, pp. 148-50 in Davey, P. J. and McNeil, R., Excavations in South Castle Street, Liverpool, 1976 and 1977. *Journal of the Merseyside Archaeological Society* 4, 1-158.

McMillan, N. F. (1973). *British shells*. London: Warne.

Meese, D. A., Gow, A. J, Grootes, P., Mayewski, P. A., Ram, M., Stuiver, M., Taylor, K. C., Waddington, E. D. & Zielinski, G. A. (1994). The accumulation record from the GISP2 core as an indicator of climate-change throughout the Holocene. *Science* 266, 1680-1682

Mégnin, P. (1895). *La faune des cadavres. Application de l'entomologie à la médcine légale.* Paris: Massons Gauthier et Fils.

Mellars, P. (ed.) (1987). *Research priorities in archaeological science.* London: Council for British Archaeology.

Mellars, P. and Dark, P. (1998). *Star Carr in context*. Cambridge: The McDonald Institute for Archaeological Research.

Mellor, J. E. (1981). *Oysters, ostracods and leeches*, p. 172-173 in Mellor, J. E. and Pearce, T., The Austin Friars, Leicester. *Council for British Archaeology Research Report* 35. London: Leicestershire County Council and CBA.

Mewis, I. and Ulrichs, C. (2001a). Action of amorphous diatomaceous earth against different stages of the stored product pests *Tribolium confusum*, *Tenebrio molitor*, *Sitophilus granarius* and *Plodia interpunctata*. *Journal of Stored Products Research* 37, 153-164.

Mewis, I. and Ulrichs, C. (2001b). Effects of diatomaceous earth on water content of *Sitophilus granarius* (L.) (Col., Curculionidae) and its possible use in stored product protection. *Journal of Applied Entomology* 125, 351-360. [in German]

Meyrick (1976). Ostracods, pp. 31-32 in Buckland, P. C., The Environmental Evidence from the Church Street Roman Sewer System. *The Archaeology of York* 14 (1), 1-44. London: Council for British Archaeology.

Middleton, R., Wells, C. E. and Huckerby, E. (1995). The wetlands of North Lancashire. *North West Wetlands Survey* 3. *Lancaster Imprints* 4. Lancaster.

Millar, R. H. (1961). Scottish oyster investigations 1946-1958. *Marine Research* 3, 76 pp. Edinburgh: HMSO.

Miller, B. B. and Bajc, A. F. (1990). *Non-marine molluscs*, pp. 101-112 in Warner, B. G. (ed.), Methods in Quaternary ecology. *Geoscience Canada Reprint Series* 5. St John's Newfoundland: Geological Association of Canada.

Miller, B. B. and Tevesz, M. J. S. (2001). Freshwater molluscs, pp. 153-171 in Smol, J. P., Birks, H. J. B. and Last, W. M. (eds.), *Tracking environmental change using lake sediments. Volume 4: Zoological indicators*. Dortrecht etc: Kluwer Academic Publishers.

Miller, N., Williams, D. and Kenward, H. K. (1993). *Plant macrofossils and insect remains from Mytongate*, pp. 195-198 and Fiche 2 A7-C3 in Evans, D. H. (ed.), Excavations in Hull 1975-76, *East Riding Archaeologist* 4, *Hull Old Town Report Series* 2.

Miller, N. C. E. (1956). *The biology of the Heteroptera*. London: Leonard Hill.

Milles, A. (1996). *Molluscan analysis*, p. 81 in Abramson, P., Excavations along the Caythorpe gas pipeline, North Humberside. *Yorkshire Archaeological Journal* 68, 1-88.

Milles, A. (in press). Land use changes indicated by molluscan remains from the excavation of a trackway and ditch at West Henge, Malton, 1991. *Yorkshire Archaeological Journal.*

Milles, A. and O'Connor, T. (1996). *Molluscs*, pp. 224-225 in Cardwell P. Excavation of St Giles by Brompton Bridge, North Yorkshire. *Archaeological Journal* 152 (for 1995), 109-245.

Milliger, L. E., Stewart, K. W. and Silvey, J. K. G. (1971). The passive dispersal of viable algae, protozoans, and fungi by aquatic and terrestrial Coleoptera. *Annals of the Entomological Society of America* 64, 36-45.

Milne, A. (1957), Biology and ecology of the garden chafer *Phyllopertha horticola* (L.). 2. The cycle from egg to adult in the field. *Bulletin of Entomological Research* 47, 23-42.

Milne, A. (1958). Biology and ecology of the garden chafer *Phyllopertha horticola* (L.). IV. - The flight season: introduction and general aspects. *Bulletin of Entomological Research* 49, 685-699.

Milne, A. (1959). Biology and ecology of the garden chafer *Phyllopertha horticola* (L.). VI. - The flight season: reproductive state of females. *Bulletin of Entomological Research* 50, 467-486.

Milne, A. and Laughlin, R. (1957). Biology and ecology of the garden chafer *Phyllopertha horticola* (L.). 1. - The adult and egg production. *Bulletin of Entomological Research* 47, 7-22.

Milner, E. (1985). Biometry of the honeybee. *The Bee Breeder* 1, 2-3.

Milner, N. (2001). At the cutting edge: using thin sectioning to determine season of death of the European oyster, *Ostrea edulis*. *Journal of Archaeological Science* 28, 861-873.

Milner, N. (2002). Incremental growth of the european oyster *Ostrea edulis*. Seasonality information from Danish kitchenmiddens. *BAR International Series* 1057. Oxford: Archaeopress.

Ministry of Agriculture, Fisheries and Food (1977). Manual of veterinary parasitological laboratory techniques. *MAFF Technical Bulletin* 18. London: HMSO.

Minniti, C. (2005). Shells at the Bronze Age settlement of Coppa Nevigata (Apulia, Italy), pp. 71-81 in pp. 99-106 in Bar-Yosef Mayer, D. E. (ed.) *Archaeomalacology: molluscs in former environments of human behaviour*. Oxford: Oxbow.

Mitchell, G. F. (1957). Late-glacial finds of *Lepidurus arcticus* (Pallas) in the British Isles. *Nature* 180, 513.

Mitchell, F. J. G. (1990). The impact of grazing and human disturbance on the dynamics of woodland in S. W. Ireland. *Journal of Vegetation Science* 1, 245-254.

Mitchell, F. J. G. (2005). How open were European primeval forests? Hypothesis testing using palaeoecological data. *Journal of Ecology* 93, 168-177.

Moffett, L. and Smith, D. (1996). Insects and plants from a late medieval and early post-medieval tenement in Stone, Staffordshire, U. K. *Circaea, The Journal of the Association for Environmental Archaeology* 12, 157-175.

Molan, P. C. nd. *Use of honey in medicine: Bibliography*. Beekeeping in New Zealand. Available at http://www.beekeeping.co.nz/info/molan2.htm

Moore, J. W. (1950). Mesolithic sites in the neighbourhood of Flixton, north-east Yorkshire. *Proceedings of the Prehistoric Society* 16, 101-108.

Moore, P. D. (2005). Down to the woods yesterday. *Nature* 433, 588-599.

Moore-Scott, T., Price, E. and Rhodes, J. (1999). Tewkesbury Abbey lawn watching brief 1998. *Glevensis* 32, 29-34.

Morgan, A. V. and Morgan, A. (1990). *Beetles*, pp. 113-126 in Warner, B. G. (ed.), Methods in Quaternary ecology. *Geoscience Canada Reprint Series* 5. St John's Newfoundland: Geological Association of Canada.

Morgan, V. and Ommen, T. D. van (1997). Seasonality in late-Holocene climate from ice-core records. *The Holocene* 7, 351-354.

Morris, G. (1990). Animal bone and shell, pp. 178-190 in Ward, S., *Excavations at Chester: the lesser medieval religious houses*. Chester: Chester City Council Department of Leisure Services.

Morris, M. G. (1990). Orthocerous weevils. *Handbooks for the Identification of British insects* 5 (16). London: Royal Entomological Society.

Morris, M. G. (1997). Broad-nosed weevils. Coleoptera: Curculionidae (Entiminae). *Handbooks for the Identification of British insects* 5 (17a). London: Royal Entomological Society.

Morrison, H. (1926). Scale insects. *The Scientific Monthly* 22, 243-246.

Mortensen, T. (1927). *Handbook of the echinoderms of the British Isles*. London etc: Oxford UP.

Moulins, D. de [, Allison, E. P., Kenward, H. K., Preece, R., Robinson, E. and Rouffignac, C. de] (1990). *Environmental analysis*, pp. 85-115 and 126-152 in Maloney, C., The upper Walbrook valley in the Roman period. The archaeology of Roman London volume 1. *Council For British Archaeology Research Report* 69.

Mound, L. (1989). *Common insect pests of stored food products. A guide to their identification*. London: British Museum (Natural History).

Mound, L. A., Morison, G. D., Pitkin, B. R. and Palmer, J. M. (1976). Thysanoptera. *Handbooks for the identification of British insects* 1 (11). London: Royal Entomological Society.

Mourier, H., Winding, O., and Sunesen, E. (1977). *Collins guide to wild life in house and home.* London: Collins.

Mueller, J. A. (1973). Pubic lice from the scalp hair; a report of two cases. *Journal of Parasitology* 59, 943-944.

Müller, W. E. G., Batel, R., Schröder, H. C. and Müller, I. M. (2004). Traditional and modern biomedical prospecting: Part 1-the history. Sustainable exploitation of biodiversity (sponges and invertebrates) in the Adriatic Sea in Rovinj (Croatia). *Evidence-based Complementary and Alternative Medicine* 1, 71-82.

Mulvey, R. H. (1972). Identification of *Heterodera* cysts by terminal and cone top structures. *Canadian Journal of Zoology* 50, 1277-1292.

Mumcuoglu, K. Y., Zias, J., Tashis, M., Lavi, M. and Stiebel, G. D. (2003). Body louse remains found in textiles excavated at Masada, Israel. *Journal of Medical Entomology* 40, 585-587.

Mundy, S. P. (1980). A key to the British and European freshwater bryozoans. *Freshwater Biological Association Scientific Publication* 41. Ambleside: FBA.

Munro, J. W. (1966). *Pests of stored products.* London: Hutchinson.

Murphy, P. (1982). *Biological remains*, pp. 116-119 in Richmond, H., Taylor, R. and Wade-Marins, P., Nos. 28 34 Queen Street, Kings Lynn. *East Anglian Archaeology* 14, 108-124.

Murphy, P (2002). *Environmental evidence*, pp. 9-11, 15-18, 25-27 in Wallis, H., Roman Routeways across the fens: Morton, Tilney St Lawrence, Nordelph and Downham West. *East Anglian Archaeology Occasional Paper* 11. [not seen in original]

Murphy, P. (2003). *Charred shells as indicators of industrial activity*, pp. 135-140 in Murphy, P. and Wiltshire, P. E. J. (eds.), The environmental archaeology of industry. *Symposia of the Association for Environmental Archaeology* 20. Oxford: Oxbow.

Murphy, P. and Trow, S. (2005). Coastal change and the historic environment. Building the evidence base. *English Heritage Conservation Bulletin* 48 (Spring 2005), 8-12. London: English Heritage.

Murray, E. V. *In litt.* (1998). [*Nucella lapillus* broken shells, Ireland]. Copy retained by H. Kenward.

Murray, J. W. (1971). *An atlas of British recent nearshore foraminiferids*. London: Heinemann.

Murray, J. W. (1979). British nearshore foraminiferids. *Synopses of the British Fauna* 16. London etc: Academic.

Murray, P. and Clements, B. (1999). *Sitona* spp. (Coleoptera: Curculionidae) in grassland in England and the impact of root herbivory on white clover. *Antenna* 23, 221-227.

Murton, J. B., Bateman, M. D. and Dinnin, M. (2001). Yarborough Quarry (SE 936108), pp. 113-126 in Bateman, M. D., Buckland, P. C., Frederick, C. D. and Whitehouse, N. J. (eds.), *The Quaternary of East Yorkshire and North Lincolnshire. Field Guide*. London: Quaternary Research Association.

Nansen, P. and Jorgensen, R. J. (1977). Fund af parasitæg i arkælogisk materiale fra det vikingetidige Ribe. [Parasite eggs identified in material from archaeological excavations in Ribe (the viking age)] *Nordisk Veteninaer Medicin* 29, 263-266.

Nature editorial (1968). Mussels not for eating. *Nature* 220, 13.

Nature editorial (1969). Mussel eating hazards. *Nature* 222, 1225.

Naylor, E. (1972). *British marine isopods: keys and notes for the identification of the species*. London and New York: Academic.

Neale, J. W. (1983). The ostracods and uniformitarianism 1. The later record: recent, Pleistocene and Tertiary (Presidential Address 1981). *Proceedings of the Yorkshire Geological Society* 44, 305-326 + figures 1-7.

Needham, S. and Evans, J. (1987). Honey and dripping: Neolithic food residues from Runnymede Bridge. *Oxford Journal of Archaeology* 6, 21-28.

Nelson, B. C. (1972). Fleas from the archaeological site at Lovelock Cave, Nevada (Siphonaptera). *Journal of Medical Entomology* 9, 211-214.

New, T. R. (1974). Psocoptera. *Handbooks for the identification of British insects* 1 (7). London: Royal Entomological Society.

Newstead, R. (1901-3). *Monograph of the* Coccidae *of the British Isles* 1-2. London: Ray Society.

Newton, L. (1951). *Seaweed utilisation.* London: Sampson Low.

Nicholas, W. L. (1975). *The biology of free-living nematodes*. Oxford: Clarendon.

Nicholson, R. (1988). *The marine molluscs and crustaceans*, pp. 148-149 in O'Brien, C., Brown, L., Dixon, S. and Nicholson, R., The origins of the Newcastle Quayside. Excavations at Queen Street and Dog Bank. *Society of Antiquaries of Newcastle upon Tyne Monograph Series* 3.

Nicholson, R. (1989a). *The marine Mollusca and Crustacea*, pp. 196-198 in O'Brien, C., Bown, L., Dixon, S., Donel, L., Gidney, L. J., Huntley, J. P., Nicholson, R. and Wlton, P., Excavations at Newcastle Quayside: The Crown Court site. *Archaeologia Aeliana* 17, 141-205.

Nicholson, R. (1989b). *Non-marine molluscs*, pp. 198-199 in O'Brien, C., Bown, L., Dixon, S., Donel, L., Gidney, L. J., Huntley, J. P., Nicholson, R. and Wlton, P., Excavations at Newcastle Quayside: The Crown Court site. *Achaeologia Aeliana* 17, 141-205.

Nielsen, B. O., Mahler, V. and Rasmussen, P. (2000). An arthropod assemblage and the ecological conditions in a byre at the neolithic settlement of Weier, Switzerland. *Journal of Archaeological Science* 27, 209-218

Niemi, G. J. and McDonald, M. E. (2004). Applications of ecological indicators. *Annual Review of Ecology, Evolution and Systematics* 35, 89-111.

Nilssen, J. P. and Sandøy, S. (1990). Recent lake acidification and cladoceran dynamics: surface sediment and core analyses from lakes in Norway, Scotland and Sweden. *Philosophical Transactions of the Royal Society, London* B 327, 299-309.

Noble, J. V. (1975). The wax of the lost wax process. *American Journal of Archaeology* 79, 368-369.

Noe-Nygaard, B. (1982). The applicability of insect finds to the interpretation of archaeological sites. *PACT* 7, 239-245.

Nordenskiöld, E. (1901). Zur Kenntnis der Oribatidenfauna Finnlands. *Acta Societatis Pro Fauna et Flora Fennica* 21, 1-35.

Norris, A. (1983). Shell remains, p. 349 in Mays, P. and Butler, L., *Sandal Castle excavations 1964-1973*. Wakefield: Wakefield Historical Publications.

Norris, A., Bartley, D. D. and Gaunt, G. D. (1971). An account of the deposit of shell marl at Burton Salmon, West Yorkshire. *The Naturalist* 96, 57-63.

Norton, P. E. P. (1981). *Mollusca*, p. 183 in McGrail, S. (ed.), The Brigg 'raft' and her prehistoric environment. *B. A. R. British Series* 89. Oxford.

Nurse, F. R. (1950). Quinone tanning in the cocoon-shell of *Dendrocoelum lacteum*. *Nature, London* 165, 570.

Oakley, K. P. (1985). Decorative and symbolic uses of fossils: selected groups, mainly invertebrates. *Occasional Papers on Technology* 13. Oxford: Pitt Rivers Museum.

O'Brien, S, R,, Mayewski, P. A., Meeker, L. D., Meese, D. A., Twickler, M. S. and Whitlow, S. I. (1995). Complexity of Holocene climate as reconstructed from a Greenland ice core. *Science* 270, 1962-1964.

O'Connor, T. P. (1983). Not just the Sunday roast... *Interim* 9 (1), 25-6. [A popular account of archaeological bones as evidence of industrial activity.]

O'Connor, T. P. (1984a). Archaeogastronomy. *Interim* 10 (1), 26-7. [A popular account of ancient meat consumption.]

O'Connor, T. P. (1984b). Selected groups of bones from Skeldergate and Walmgate. *The Archaeology of York* 15 (1), 1-60, plates. I-II. London: Council for British Archaeology.

O'Connor, T. P. (1985a). Shell shock: or how I learned to love the humble whelk. *Interim* 10 (2), 29-32. [A popular account of molluscs from Coppergate]

O'Connor, T. P. (1985b). *On the presentation of results in environmental archaeology*, pp. 147-52 in Fieller, N. R. J., Gilbertson, D. D. and Ralph, N. (eds.), Palaeoenvironmental investigations. Research design, methods and data analysis. *Symposia of the Association for Environmental Archaeology 5A, British Archaeological Reports International Series* 258.

O'Connor, T. P. (1986a). Observations from a Roman rubbish heap. *Interim* 11 (3), 1-7.

O'Connor, T. P. (1986b). [molluscs], pp. 252 in Kenward, H. K., Hall, A. R. and Jones, A. K. G., Environmental evidence from a Roman well and Anglian pits in the legionary fortress. *The Archaeology of York* 14 (5), 241-88 + Fiche 2. London: Council for British Archaeology.

O'Connor, T. P. (1986c). The garden dormouse *Eliomys quercinus* from Roman York. *Journal of Zoology, London* 210, 620-2.

O'Connor, T. P. (1986d). What the Vikings left behind. *New Scientist* 1533, 42-7.

O'Connor, T. P. (1988). *Slums, puddles and ditches: are molluscs useful indicators?*, pp. 61-8 in Murphy, P. and French, C. (eds.), The exploitation of wetlands. *British Archaeological Reports, British Series* 186.

O'Connor, T. P. (1989a). The case of the absent rat. *Interim* 13 (4), 39-41.

O'Connor, T. P. (1989b). Bones from Anglo-Scandinavian levels at 16-22 Coppergate. *The Archaeology of York* 15 (3), 137-207 + Plates VII-XI. London: Council for British Archaeology.

O'Connor, T. P. (1990). Unlikely bones in improbable places. *Interim (Archaeology in York)* 14 (3), 22-5.

O'Connor, T. P. (1991). On the lack of bones of the ship rat *Rattus rattus* from Dark Age Yo*rk. Journal of Zoology, London* 224, 318-320.

O'Connor, T. P. (1994). *8th-11th century economy and environment in York,* pp. 136-147 in Rackham, D. J. (ed.), Environment and economy in Anglo-Saxon England. *Council for British Archaeology Research Report* 89.

O'Connor, T. P. (1998). Environmental archaeology: a matter of definition. *Environmental Archaeology* 2, 1-6.

O'Connor, T. P. (2000). Human refuse as a major ecological factor in medieval urban vertebrate communities, pp. 15-20 in Bailey, G., Charles, R. and Winder, N. (eds.), *Human ecodynamics*. Oxford: Oxbow.

O'Connor, T. P., Hall, A. R., Jones, A. K. G. and Kenward, H. K. (1984). Ten years of environmental archaeology at York, pp. 66-77 in Addyman, P. V. and Black, V. E. (eds.) *Archaeological papers from York presented to M. W. Barley*. York: York Archaeological Trust.

Oeding, P. (1990). The Black Death in Norway. *Tidsskrift for den Norske Laegeforening* 110, 2204-2208.

O'Farrell, A. F. and Butler, P. M. (1948). Insects and mites associated with the storage and manufacture of foodstuffs in Northern Ireland. *Economic Proceedings of the Royal Dublin Society* 3, 343-407.

Ogden, C. G. and Hedley, R. H. (1980). *An Atlas of Freshwater Testate Amoebae*. Oxford: British Museum (Natural History) and Oxford University Press.

Oldfield, F. (1993). Forward to the past: changing approaches to Quaternary palaeoecology, pp. 13-21 in Chambers, F. M. (ed.), *Climate change and human impact on the landscape*. London etc.: Chapman and Hall.

Oldfield, F. (2004). Some personal perspectives on the role of Quaternary science in global change studies. *Global and Planetary Change* 40, 3-9.

Oldfield F, Higgitt S R, Richardson N and Yates G. (1986). Pollen, charcoal, rhizopod and radiometric analyses, pp.82-5 in Stead I M, Bourke, J B and Brothwell D. (eds), *Lindow Man: the body in the bog*. London: British Museum

Oldfield, F., Higgitt, S. R., Richardson, N. and Yates, G. (1986). Pollen, charcoal, rhizopod and radiometric analyses, pp. 82-85 in Stead, I. M., Bourke, J. B. and Brothwell, D., *Lindow Man: the body in the bog.* London: British Museum.

Oldroyd, H. (1964). *The natural history of flies.* London: Weidenfeld and Nicolson.

Oliver, P. G. and Meechan, C. J. (1993). Woodlice. Keys and notes for the identification of the species. *Synopses of the British fauna (new series)* 49, 135 pp. Shrewsbury: Linnean Society etc.

Oliveros, E., Legrini, O., Hohl, M., Muller, T., Braun, A. M. and Elias, S. A. (1997). The mutual climatic range method of palaeoclimatic reconstruction based on insect fossils: new applications and interhemispheric comparisons. *Quaternary Science Reviews* 16, 1217-1225.

Olivier, A. (1996). *Frameworks for our past, a review of research frameworks, strategies and perceptions.* London: English Heritage.

Olsen, A. R., Sidebottom, T. H. and Knight, S. A. (1995). *Fundamentals of microanalytical entomology*. New York: CRC Press.

Ormerod, E. A, (1898). *Handbook of insects injurious to orchard and bush fruits with means of prevention and remedy*. London: Simpkin, Marshall, Hamilton, Kent and Co.

Orton, C. (2000). *Sampling in archaeology*. Cambridge: CUP.

Orton, J. H. (1946). Survival of oyster and other littoral populations. *Nature, London* 158, 586.

Osborne, P. J. (1969). An insect fauna of Late Bronze Age date from Wilsford, Wiltshire. *Journal of Animal Ecology* 38, 555-66.

Osborne, P. J. (1971). An insect fauna from the Roman site at Alcester, Warwickshire. *Britannia* 2, 156-165.

Osborne, P. J. (1972). Insect faunas of Late Devensian and Flandrian age from Church Stretton, Shropshire. *Philosophical Transactions of the Royal Society of London* B263, 327-367.

Osborne, P. J. (1974). An insect assemblage of Early Flandrian age from Lea Marston, Warwickshire, and its bearing on the contemporary climate and ecology. *Quaternary Research* 4, 471-486.

Osborne, P. J. (1977). Stored product beetles from a Roman site at Droitwich, England. *Journal of Stored Products Research* 13, 203-4.

Osborne, P. J. (1978). *Insect evidence for the effect of man on the lowland landscape*, pp. 32-34 in Limbrey, S. and Evans, J. G. (eds.), The effect of man on the landscape: Lowland zone. *CBA Research Report* 21.

Osborne, P. J. (1981). *Coleopterous fauna from Layer 1*, pp. 268-271 in Greig, J., The investigation of a medieval barrel-latrine from Worcester. *Journal of Archaeological Science* 8, 265-282.

Osborne, P. J. (1983). An insect fauna from a modern cesspit and its comparison with probable cesspit assemblages from archaeological sites. *Journal of Archaeological Science* 10, 453-463.

Osborne, P. J. (1989). Insects, pp. 96-99 in Ashbee *et al.*, *Wilsford Shaft: excavations 1960-2*. HBMC London: HBMC.

Osborne, P. J. (1994). The insects, p. 266 in Bidwell, P. and Speak, S., Excavations at South Shields Roman fort I. *Society of Antiquaries of Newcastle upon Tyne with Tyne and Wear Museums Monograph Series* 4. Newcastle upon Tyne.

Osborne, P. J. (1995). Arthropod analysis, pp. 157-159 in Middleton, R., Wells, C. E. and Huckerby, E., *The wetlands of North Lancashire. North West Wetlands Surveys 3*. Lancaster: Lancaster Imprints.

Osborne, P. J. (1996). An insect fauna of Roman date from Stourport, Worcestershire, U. K., and its environmental implications. *Circaea, The Journal of the Association for Environmental Archaeology* 12, 183-189.

Osborne, P. J. (1997a). Insects, man and climate in the British Holocene. *Quaternary Proceedings* 5, 193-198.

Osborne, P. J. (1997b). Insects, pp. 150-156 in Nayling, M. and Casledine, A., Excavations at Caldicot, Gwent: Bronze Age palaeochannels in the lower Nedern valley. *CBA Research Reports* 108. York: CBA.

Outeiro, A., Aguera, D. and Pajero, C. (1993). Use of ecological profiles and canonical correspondence analysis in a study of the relationship of terrestrial gastropods and environmental factors. *Journal of Conchology, London* 34, 363-375.

Paccito, A. L. (1980). Excavation, pp. 26-29 in Stead, I. M., *Rudston Roman villa*, 179 pp. Leeds: Yorkshire Archaeological Society.

Palacios-Fest, M. R. (1997). Continental ostracode paleoecology from the Hohokam Pueblo Blanco area, central Arizona. *Journal of Archaeological Science* 24, 965-983.

Palm, T. (1959). Die Holz- und Rinden-Käfer der süd- und mittelschwedischen Laubbäume. *Opuscula Entomologica Supplementum* 16.

Palm, T. (1972). Die skandinavischen Elateriden-Larven (Coleoptera). *Entomologica Scandinavica* 2, 1-63.

Pals, J. P. and Hakbijl, T. (1992). Weed and insect infestation of a grain cargo in a ship at the Roman fort of Laurium in Woerden. *Review of Palaeobotany and Palynology* 73, 287-300.

Panagiotakopulu, E. (2000). Archaeology and entomology in the eastern Mediterranean. Research into the history of insect synanthropy in Greece and Egypt. *BAR International Series* 836. Oxford.

Panagiotakopulu, E. (2004a). Dipterous remains and archaeological interpretation. *Journal of Archaeological Science* 31, 1675-1684.

Panagiotakopulu, E. (2004b). Pharaonic Egypt and the origins of plague. *Journal of Biogeography* 32, 269-275.

Panagiotakopulu, E., Buckland, P. C. and Day, P. M. (1995). Natural insecticides and insect repellents in antiquity: a review of the evidence. *Journal of Archaeological Science* 22, 705-710.

Panagiotakopulu, E., Buckland, P. C., Day, P., Doumas, C., Sarpaki, A. and Skidmore, P. (1997). A lepidopterous cocoon from Thera and evidence for silk in the Aegean Bronze Age. *Antiquity* 71, 420-429.

Parker, A. G., Goudie, A. S., Anderson, D. E., Robinson, M. A. and Bonsall, C. (2002). A review of the mid-Holocene elm decline in the British Isles. *Progress in Physical Geography* 26, 1-45.

Parry, M. L. (1978). *Climatic change, agriculture and settlement*. Folkestone: Dawson.

Payne, S. (1975). Partial recovery and sample bias, pp. 7-17 in Clason, A. T. (ed.), *Archaeozoological studies*. Amsterdam: Elsevier.

Peackock, E. R. (1977). Coleoptera Rhizophagidae. *Handbooks for the identification of British Insects* 5 (5a). London: Royal Entomological Society.

Peacock, E. R. (1993). Adults and larvae of hide, larder and carpet beetles and their relatives (Coleoptera: Dermestidae) and of derodontid beetles (Coleoptera: Derodontidae). *Handbooks for the identification of British Insects* 5 (3). London: Royal Entomological Society.

Pearce, F. (1989). *Climate and man from the ice ages to the global greenhouse*. London: Vision.

Pearce, F. (2005). Faltering currents trigger freeze fear. *New Scientist* 188 No. 2528, 3rd December 2005, 6-7.

Pearce, T. G., Oates, K. and Carruthers, W. J. (1990). A fossil earthworm embryo (Oligochaeta) from beneath a Late Bronze Age midden at Potterne, Wiltshire, UK. *Journal of Zoology (London)* 220, 537-42.

Pearson, R. G. (1962). The Coleoptera from a Late-Glacial deposit at St. Bees, West Cumberland. *Journal of Animal Ecology* 31, 129-150.

Pedersen, B. V. 1996. On the phylogenetic position of the Danish strain of the black honeybee (the Laeso bee), *Apis mellifera mellifera* L. (Hymenoptera: Apidae) inferred from mitochondrial DNA sequences. *Entomologica Scandinavica* 27, 241-250.

Pellett, P. L. (ed.) (1997). Minilivestock. *Ecology of Food and Nutrition* 36 (special issue) i-iv + 95-346 + colour plates I-XV.

Penney, D. N. (1993). Northern North Sea benthic Ostracoda: modern distribution and paelaeoenvironmental significance. *The Holocene* 3, 241-254.

Pennington, W. (1969). *The history of British vegetation*. London: English Universities Press.

Penny, L. F., Coope, G. R. and Catt, J. A. (1969). Age and insect fauna of the Dimlington silts, East Yorkshire. *Nature, London* 224, 65-67.

Perrin, R. M. S. (1956). Nature of "chalk heath" soils. *Nature* 178, 31-2.

Perry, D. W. (1981). *Cluster analysis of the insect remains from beneath the 'raft'*, pp. 176-181 in McGrail, S. (ed.), The Brigg 'raft' and her prehistoric environment. *B. A. R. British Series* 89. Oxford.

Perry, D.W., Buckland, P.C. and Snaesdottir, M., (1985). The application of numerical techniques to insect assemblages from the site of Stóraborg, Iceland. *Journal of Archaeological Science* 12, 335-45.

Petch, T. (1904). The published records of land and freshwater Mollusca of the East Riding with additions. *Transactions of the Hull Scientific and Field Naturalists' Club* 3 (2), 121-172. [Not seen in original.]

Peters, S. (2001). *How far do woodland insects move? Project 2*. Unpublished final year project, Department of Biology, University of York.

Peters, W. (1992). *A colour atlas of arthropods in clinical medicine*. London: Wolfe.

Petit, J. R. and many others (1999). Climate and atmospheric history of the past 420,000 years from the Vostok ice core, Antarctica. *Nature* 399, 429-436.

Phillips, D. and Heywood, B. (ed. M. O. H. Carver) (1995). *Excavations at York Minster* I. *From Roman fortress to Norman cathederal*. Part 2 *The finds*. London: HMSO.

Phillips, G. (1980). *The fauna*, pp. 77-85 in Armstrong, P., Excavations in Scale Lane/Lowgate 1974. *East Riding Archaeologist* 6, *Hull Old Town Report Series* 4.

Phillips, J. (1875). *Illustrations of the Geology of Yorkshire*. 3rd edn. London: John Murray.

Phillips, P. (1986). Towards a scientific approach [to archaeology] Nature 322, 112-113.

Phipps. J. (1983). Looking at puparia. *Circaea* 1, 13-29.

Phipps, J. (1986). The efficiency of paraffin flotation for the separation of dipterous and coleopterous material. *Circaea* 4 (1), 65-8.

Pike, A. W. (1967). The recovery of parasite eggs from ancient cesspit and latrine deposits: an approach to the study of early parasite infections, pp. 184-188 in Brothwell, D. R. and Sandison, A. T. (eds.), *Diseases in antiquity*. Illinois: Thomas.

Pike, A. W. (1968). Recovery of helminth eggs from archaeological excavations and their unsefulness in providing evidence for the purpose of an occupation. *Nature* 219, 303-304.

Pike, A. W. and Biddle, M. (1966). Parasite eggs in medieval Winchester. *Antiquity* 40, 293-6 and pl. xli.

Pincher, C. (1951). Imprint of a crustacean in an alloy casting. *Nature* 167, 490.

Pinder, L. C. V. and Morley, D. J. (1995). Chironomidae as indicators of water quality - with a comparison of the Chironomid faunas of a series of contrasting Cumbrian tarns, pp. 271-293 in Harrington, R. and Stork, N. E. (eds.), *Insects in a changing environment.* London etc.: Academic.

Pitkin, B. R. (1988). Lesser dung flies. Diptera: Sphaeroceridae. *Handbooks for the Identification of British Insects* 10 (5e). London: Royal Entomological Society.

Pitman, A. J., Jones, A. M. and Jones, E. B. G. (1993). The wharf-borer *Nacerdes melanura* L., a threat to stored archaeological timbers. *Studies in Conservation* 38, 274-284.

Plotnick, R. E. (1986). Taphonomy of a modern shrimp. Implications for the arthropod fossil record. *Palaios* 1, 286-293.

Plunkett, G. M., Whitehouse, N. J., Hall, V. A., Brown, D. M. and Baillie, M. G. L. (2004). A precisely-dated lake-level rise marked by diatomite formation in northeastern Ireland. *Journal of Quaternary Science* 19, 3-7.

Polcyn, I. (1996). Application of Cladocera analysis in archaeology. *Circaea, the Journal of the Association for Environmental Archaeology* 11, 41-48.

Ponel, P. (1997). Succession des assemblages de Coléoptères à Chalain 3, pp. 113-118 in Pétrequin, P. (ed.), *Les sites littoraux néolithiques de Clairvaux-les-Lacs et de Chalain (Jura), III, Chalain station 3, 3,3200-2900 av. J. -C., volume 1.* Paris: Editions de la Maison des Sciences de l'Homme.

Ponel, P., Orgeas, J., Samways, M. J., Andrieu-Ponel, V., De Beaulieu, J-L., Reille, M., Roche, P and Tatoni, T. (2003). 110000 years of Quaternary beetle diversity change. *Biodiversity and Conservation* 12, 2077-2089.

Povolný, D. (1971). Synanthropy, pp. 16-54 in Greenberg, B. *Flies and Disease* 2. Princetown: University Press.

Preece, R. C. (2001). Non-marine Mollusca and archaeology, pp. 135-145 in Brothwell, D. R. and Pollard, A. M. (eds.), *Handbook of archaeological sciences*. Chichester etc: Wiley.

Preece, R. C., Bennett, K. D. and Robinson, J.E. (1984). The biostratigraphy of an early Flandrian tufa at Inchrory, Glen Avon, Banffshire. *Scottish Journal of Geology* 20, 143-159.

Preece, R. C. and Robinson, J. E. (1984). Late Devensian and Flandrian environmental history of the Ancholme Valley, Lincolnshire: molluscan and ostracod evidence. *Journal of Biogeography* 11, 319-352.

Preucel, R. W. and Bauer, A. A. (2001). Archaeological pragmatics. *Norwegian Archaeological Review* 34, 85-96.

Putz, F. E. (1998). Halt the Homogeocene: a frightening future filled with too few species. *The Palmetto* 18, 7-10.

Quick, H. E. (1960). British slugs (Pulmonata: Testacellidae, Arionidae, Limacidae). *Bulletin of the British Museum (Natural History), Zoology* 6, 105-226 + plates 1-2.

Rackham, D. J. (1975). The study of animal bones. *Interim* 3 (1), 29-34. [A popular introduction.]

Rackham, D. J. (1976). *Marine molluscs*, p. 31 in Buckland, P. C., The environmental evidence from the Church Street Roman sewer system. *The Archaeology of York* 14 (1), 1-44. London: Council for British Archaeology.

Rackham, D. J. (1979). *Rattus rattus*: the introduction of the black rat into Britain. *Antiquity* 53, 112-120 + Plate XI.

Rackham, D. J. (1980a). [Note on black rat remains from the well], pp. 142-3 in Hall, A. R., Kenward, H. K. and Williams, D. Environmental evidence from Roman deposits in Skeldergate. *The Archaeology of York* 14 (3), 101-56. London: Council for British Archaeology.

Rackham, D. J. (1980b). *Bone and shell*, p. 70 in Clack, P. A. G., An excavation at Queen's Court, 2 North Bailey, Durham City. Rescue excavations in County Durham 1976-78. *Transactions of the Architectural and Archaeological Society of Durham and Northumberland* new series 5, 56-70.

Rackham, D. J. (1981). *The animal remains*, pp. 230-243 in Harbottle, B. and Ellison, M., An excavation in the Castle Ditch, Newcastle upon Tyne 1974-6. *Archaeologia Aeliana* 5th series 9, 75-250.

Rackham, D. J. (1985). *Molluscs and crustaceans*, pp. 89-91 in O'Sullivan, D. M., The excavation in Holy Island Village 1977. *Archaeologia Aeliana* 5th series 13, 27-116.

Rackham, D. J. (1990). *The vertebrate remains and the mollusc shells*, pp. 320-329 in McCarthy, M. R., A Roman, Anglian and medieval site at Blackfriars Street, Carlisle. *Cumberland and Westmorland Antiquarian and Archaeological Society Research Series* 4.

Rackham, D. J. and Scaife, R. G. (2002). *Carr Lodge Farm, Loversall, Doncaster CFL00. Environmental archaeology assessment*. Unpublished report, The Environmental Archaeology Consultancy EAC 24/02.

Rackham, O. (1994). Trees and woodland in Anglo-Saxon England: the documentary evidence, pp. 7-11 in Rackham, D. J. (ed.), Environment and economy in Anglo-Saxon England. *Council for British Archaeology Research Report* 89.

Rackham, O. (2003). *Ancient woodland, its history, vegetation and uses in England*. New Edition. Dalbeattie: Castlepoint Press.

Radies, D., Hasiotis, S. T., Preusser, F., Neubert, E. and Matter, A. (2005). Paleoclimatic significance of early Holocene faunal assemblages in wet interdune deposits of the Wahiba Sand Sea, Sultanate of Oman. *Journal of Arid Environments* 62, 109-125.

Ragge, D. R. (1965). *Grasshoppers, crickets and cockroaches of the British Isles.* London: Warne.

Ramos-Elorduy, J. and Moreno, J. M. P. (2002). Edible insects of Chiapas, Mexico. *Ecology of Food and Nutrition* 41, 271-299.

Ramos-Elorduy, J., Moreno, J. M. P., Prado, E. E., Perez, M. A., Otero, J. L. and de Guevara, O. L. (1997). Nutritional value of edible insects from the State of Oaxaca, Mexico. *Journal of Food Composition and Analysis* 10, 142-157.

Raoult, D., Aboudharam, G., Crubezy, E., Larrouy, G., Ludes, B. and Drancourt, M. (2000). Molecular identification by "suicide PCR" of *Yersinia pestis* as the agent of the medieval Black Death. *Proceedings of the National Academy of Science USA* 97, 12800-12803.

Raoult, D. and Drancourt, M. (2002). Cause of Black Death. *Lancet Infectious Diseases* 2, 459.

Rathje, W. L. and Schiffer, M. B. (1982). *Archaeology*. New York : Harcourt Brace Jovanovich.

Raw, F. (1951). The ecology of the garden chafer, *Phyllopertha horticola* (L.) with preliminary observations on control measures. *Bulletin of Entomological research* 42, 605-646 + Plates XXII-XXIII.

Redman, J. E., Stewart, M. I. and Gernaey, A. M. (2002). Ancient tuberculosis and lipid chemistry - odd bedfellows! *European Journal of Archaeology* 5, 112-120.

Reed, D., Smith, V. S., Hammond, S., Rogers, A. R. and Clayton, D. H. (2004). Genetic analysis of lice supports direct contact between modern and archaic humans. *PLoS Biology* 2, 1972-1983.

Rees, D. S. (2005). Whale bones and shell purple-dye at Motya (Western Sicily, Italy). *Oxford Journal of Archaeology* 24, 107-114.

Reinhard, K. J. (1990). Archaeoparasitology in North America. *American Journal of Physical Anthropology* 82, 145-163.

Reinhard, K. J. (1992). Parasitology as an interpretive tool in archaeology. *American Antiquity* 57, 231-245.

Reinhard, K., J., Hevly, R. H. and Anderson, G. A. (1987). Helminth remains from prehistoric indian coprolites on the Colorado plateau. *Journal of Parasitology* 73, 630-639.

Reinhard, K. and Urban, O. (2003). Diagnosing ancient Diphyllobothriaisis from Chinchorro mummies. *Memorias do Instituto Oswaldo Cruz* 98 (suppl. 1), 191-193.

Reiss, R. A., Ashworth, A. C. and Schwert, D. P. (1999). Molecular genetic evidence for the post-Pleistocene divergence of populations of the arctic-alpine ground beetle *Amara alpina* (Paykull) (Coleoptera: Carabidae). *Journal of Biogeography* 26, 785-794.

Renfrew and Bahn (1996). *Archaeology. Theories, methods and practice* (2nd edn.). London: Thames and Hudson.

Reyment, R. A. (1971). *Introduction to quantitative paleoecology*. Amsterdam etc: Elsevier. Reynolds, P. J. (nd). The nature of experiment in archaeology. Available at http://skcldv.demon.co.uk/iafexp.htm

Reynoldson, T. B. (1978). A key to the British species of freshwater triclads (Turbellaria, Paludicola). *Freshwater Biological Association Scientific Publication* 23 (2nd. edition), 32 pp. + plate. Ambleside: FBA.

Rhodes, F. H. T. (1957). Fossils and their environments. *Science News* 43, 67-77.

Ribera, I. and Vogler, A. P. (2004). Speciation of Iberian diving beetles in Pleistocene refugia (Coleoptera, Dytiscidae). *Molecular Ecology* 13, 179-193.

Richards, J. D. (1993). The Bedern foundry. *The Archaeology of York* 10 (3), 149-210 + Plates XXXIII-XLVIII. York: Council for British Archaeology.

Richards, O. W. and Davies, R. G. (1977). *Imms' general textbook of entomology* 1-2. Dordrecht: Kluwer.

Richardson, A. (2004). Granaries and garrisons in Roman forts. *Oxford Journal of Archaeology* 23, 429-442.

Riley, J. C. (1986). Insects and the European mortality decline. *The American Historical Review* 91, 833-858. Roberts, M. J. (1993). *The spiders of Great Britain and Ireland* 1-2. Colchester: Harley Books.

Roberts, M. J. (1995). *Spiders of Britain and Northern Europe*. London etc: HarperCollins.

Roberts, N. (1998). *The Holocene. An environmental history* (2nd edition). Oxford: Basil Blackwell.

Robinson, D. E. (ed.) (1990). *Experimentation and reconstruction in environmental archaeology.* Symposia of the Association for Environmental Archaeology No. 9. Roskilde, Denmark, 1988. Oxford: Oxbow Books.

Robinson, E. (1984). Ostracods, pp. 59-69 in Straker, V., Robinson, M. and Robinson, E., Biological investigations of waterlogged deposits in the Roman fortress ditch at Exeter. *Proceedings of the Devon Archaeological Society* 42, 59-69.

Robinson, J. E. (1980). The marine ostracod record from the Lateglacial period in Britain and NW Europe: a review. pp. 115-122 in Lowe, J. J., Gray, J. M. and Robinson, J. E. (eds.), *Studies in the Lateglacial of North-West Europe*. Oxford: Pergamon.

Robinson, J. E. (1990). The ostracod fauna of the middle Pleistocene interglacial deposits at Little Oakley, Essex. *Philosophical Transactions of the Royal Society of London B Biological Sciences* 328, 409-423.

Robinson, M. (1978). *The problem of hedges enclosing Roman and earlier fields*, pp. 155-158 in Bowen, H. C. and Fowler, P. J. (eds.), Early land allotment in the British Isles. A survey of recent work. *British Archaeological Reports* 48. Oxford.

Robinson, M. A. (1979). *Calcified seeds and arthropods*, pp. 23-24 in Parrington, M., Excavations at Stert Street, Abingdon, Oxon. *Oxoniensia* 44, 1-25.

Robinson, M. A. (1980). Archaeological Finds of Wasp Galls. *Journal of Archaeological Science* 7, 93-95.

Robinson, M. A. (1981a). *Waterlogged plant and invertebrate evidence*, pp. 199-206 and fiche 2 F12, Tables R-X in Palmer, N., A Beaker burial and medieval tenements in the Hamel, Oxford. *Oxoniensia* 45, 199-206 + fiche.

Robinson, M. (1981b). *The Iron Age to Early Saxon environment of the upper Thames terrace*, pp. 251-86 in Jones, M. and Dimbleby, G. (eds), The environment of man: the Iron Age to the Anglo-Saxon period. *British Archaeological Reports British Series* 87. Oxford.

Robinson, M. (1983). *Arable/pastoral ratios from insects?*, pp. 19-55 in Jones, M. (ed), Integrating the subsistence economy. *Symposia of the Association for Environmental Archaeology* 4, *British Archaeological Reports International Series* 181. Oxford.

Robinson, M. (1984). *Waterlogged plant and invertebrate evidence*, fiche 9:C1-9:E9 in Miles, D. (ed.), Archaeology at Barton Court Farm Abingdon, Oxon. *CBA Research Report* 50.

Robinson, M. (1985). Nature conservation and environmental archaeology, pp. 11-17 in Lambrick, G. (ed.), *Archaeology and nature conservation*. Oxford: University Department for External Studies.

Robinson, M. (1991a). *Calcium phosphate-replaced remains*, p. 75 in Fasham, P. J. and Whinney, R. J. B., Archaeology and the M3. *Hampshire Field Club and Archaeological Society Monograph* 7.

Robinson, M. (1991b). Chapter 17. The Neolithic and Late Bronze Age insect assemblages, pp. 277-327 in Needham, S., *Excavation and salvage at Runnymede Bridge, 1978: The Late Bronze Age waterfront site.* London: British Museum and English Heritage.

Robinson, M. (1997). *The insects*, pp. 36-47 in Whittle, A., Sacred mound, holy rings. Silbury Hill and the West Kennet palisade enclosures: a Later Neolithic complex in north Wiltshire. *Oxbow Monograph* 74. Oxford.

Robinson, M. (2000a). The insect remains, pp. 15-16 in Mitchell, N. and Bell, C., *Evidence for Late Bronze Age activity on the site of the former Stock Market at Brigg, North Lincolnshire*. Unpublished report, Oxford Archaeological Unit.

Robinson, M. (2000b). Coleopteran evidence for the elm decline, Neolithic activity in woodland, clearance and the use of the landscape, pp. 27-36 + references pp. 187-210 in Fairbairn, A. S. (ed.), *Plants in Neolithic Britain and beyond. Neolithic Studies Group Seminar Papers 5*. Oxford: Oxbow Books.

Robinson, M. (2000c). Middle Mesolithic to Late Bronze Age insect assemblages and an Early Neolithic assemblage of waterlogged macroscopic plant remains, pp. 146-167 in Needham, S. P., *The passage of the Thames. Holocene environment and settlement at Runnymede. Runnymede Bridge Research Excavations, Volume 1*. London: British Museum Press.

Robinson, M. (2001). Insects as palaeoenvironmental indicators, pp 121-133 in Brothwell, D. R. and Pollard, A. M. (eds.), *Handbook of archaeological sciences*. Chichester etc: Wiley.

Robinson, M. (2004). Mollusca and evidence for the extent of flooding, p. 367 in Hey, G. (ed.), *Yarnton: Saxon and medieval landscape and settlement*. Oxford: Oxford Archaeology.

Robinson, M., Dickson, J. H. and Greig, J. R. A. (1984). *Waterlogged plant and invertebrate evidence*, microfiche chapters VIII & IX in Miles, D. (ed.) Archaeology at Barton Court Farm, Abingdon, Oxon. *Council for British Archaeology Research Report* 50. London.

Robinson, W. H. (1996). *Urban entomology.* London etc.: Chapman and Hall.

Rodrigues, W. C. and Bass, W. M. (1983). Insect activity and its relationship to decay rates of human cadavers in East Tennessee. *Journal of Forensic Sciences* 28, 423-432.

Roe, H. M., Charman, D. J. and Gehrels, W. R. (2002). Fossil testate amoebae in coastal deposits in the UK: implications for studies of sea-level change. *Journal of Quaternary Science* 17, 411-429.

Roeder, C. (1899). Recent Roman discoveries in Deansgate and on Hunt's Bank, and Roman Manchester re-studied (1897-1900). *Tranactions of the Lancashire and Cheshire Antiquarian Society* 17, 147-189.

Regert, M., Colinart, S., Degrand, L. and Decavallas, O. (2001). Chemical alteration and use of beeswax through time: accelerated aging tests and analysis of archaeological samples from various environmental contexts. *Archaeometry* 43, 549-569.

Rogers, N. S. H. (1993). Anglian and other finds from Fishergate. *The Archaeology of York* 17 (9), 1203-1512. London: Council for British Archaeology.

Roger Tym and Partners (1995). *Review of the Implementation of PPG16, Archaeology and Planning*. English Heritage, London.

Rohling, E. J. and Pälike, H. (2005). Centennial-scale climate cooling with a sudden cold event around 8,200 years ago. *Nature* 434, 975-979.

Roper, T. (1996). Fossil insect evidence for the development of raised mire at Thorne Moors, near Doncaster. *Biodiversity and Conservation* 5, 503-521.

Roper, T. (1999). The beetles, pp. 290-297 in Parker Pearson, M and Sharples, N., *Between land and sea. Excavations at Dun Vulan, South Uist*. Sheffield: Sheffield Academic Press.

Rosen, P., Segerstrom, U., Erikson, L. and Renberg, I. (2003). Do diatom, chironomid, and pollen records consistently infer Holocene July air temperature? A comparison using sediment cores from four alpine lakes in northern Sweden. *Arctic Antarctic and Alpine Research* 35, 279-290.

Roth, L. M. and Willis, E. R. (1960). The biotic associations of cockroaches. *Smithsonian Miscellaneous Collections* 141, 470 pp.

Rothschild, M. (1973). Report on a female *Pulex irritans* in a tenth century Viking pit. *Proceedings of the Royal Entomological Society of London* 38, 29.

Rouse, A. J. and Evans J. G. (1994). Modern land mollusca from Maiden Castle, Dorset, and their relevance to the interpretation of subfossil archaeological assemblages. *Journal of Molluscan Studies* 60, 315-329.

Rowley, T. (1978). *Villages in the landscape*. London: Dent.

Rowley-Conwy, P. (1982). *Forest grazing and clearance in temperate Europe with special reference to Denmark: an archaeological view*. pp. 199-215 in Bell, M. and Limbrey, S. (eds.), Archaeological aspects of woodland ecology. Symposia of the Association for Environmental Archaeology 2. *BAR International Series* 146. Oxford: BAR.

Royal College of Physicians (1961). *The nomenclature of disease* (Eighth edition). London: HMSO.

Royal Commission on Historical Monuments (1962). *An inventory of the historical monuments in the City of York 1. Eburacum. Roman York*. London: Royal Commission on Historical Monuments.

Rudolph, K. (1974). Beitrag zur Kenntnis der Elateridenlarven der Fauna der DDR und der BRD (Eine morphologisch-taxonomische Studie). *Zoologische Jahrbücher zur Systematik der Tiere* 101: 1-151.

Ruiz, Z., Langdon, P. and Brown, T. (2003). *The potential of midge larvae for characterising urban and rural human activities*, p. 42 in Programmes, abstracts and list of participants, UK Archaeological Science 2003. Oxford.

Ruscillo, D. (2005). Reconstructing *Murex* royal purple and Biblical blue in the Aegean, pp. 99-106 in Bar-Yosef Mayer, D. E. (ed.) *Archaeomalacology: molluscs in former environments of human behaviour*. Oxford: Oxbow.

Russell, E. J. (1957). *The world of the soil*. London: Collins. (Also Fontana edition 1961.)

Rust, M. K. and Dryden, M. W. (1997). The biology, ecology, and management of the cat flea. *Annual Review of Entomology* 42, 451-473.

Rutter, J. G. and Duke, G. (1958). *Excavations at Crossgates near Scarborough 1947-56*. Scarborough: Scarborough and District Archaeological Society.

Ruttner, F. (1979). Ein Bienenkorb von der Nordseeküste aus prähistoricher Zeit, pp. 109-119 in Harnaj, V., Gnädinger, F. and Lögler, P. (eds.), *Bienenmuseum und Geschichte der Bienenzucht*. Bukarest: Apimondia-Verlag.

Ruttner, F. (1981). Ein Beinenkorb von der Nordküste aus prähistorischer Zeit, pp. 163-170 in Haarnagel, W. (ed.), *Feddersen Wierde*, 3. *Einzeluntersuchungen zur Feddersen Wierde*. 163 - 170. Wiesbaden: Steiner.

Ruttner, F., Milner, E. and Dews, J. E. 1990. *The dark European honey bee* Apis mellifera mellifera *Linnaeus 1758.* Derby: British Isles Bee Breeders Association.

Ruttner, F., Tassencourt, L. and Louveaux, J. (1978). Biometrical-statistical analyses of the geographic variability of *Apis mellifera* L.. *Apidologie* 9, 363-81.

Ryland, J. S. (1970). *Bryozoans*. London: Hutchinson University Library.

Ryland, J. S. and Hayward, P. J. (1977). British anascan bryozoans. Keys and notes for the identification of the species. *Synopses of the British fauna (new series)* 10, 188 pp. London etc.: Academic.

Sabine, J. R. (1983). Earthworms as a source of food and drugs, pp. 285-296 in Satchell, J. E. (ed.), *Earthworm ecology from Darwin to vermiculture*. London and New York: Chapman and Hall.

Sadler, J. P. (1985). *Late Holocene valley infill and flooding during the Late Roman period at Sandtoft, Hatfield Chase*. Unpublished dissertation for BSc (Hons) degree, Birmingham University.

Sadler, J. (1991). Beetles, boats and biogeography. Insect invaders of the North Atlantic. *Acta Archaeologica* 61, 199-211.

Sadler, J. P. (1990). Records of ectoparasites on humans and sheep from Viking-Age deposits in the former Western Settlement of Greenland. *Journal of Medical Entomology* 27, 628-631.

Sadler, J. P. and Jones, J. C. (1997). Chironomids as indicators of Holocene environmental changes in the British Isles. *Quaternary Proceedings* 5, 219-232.

Sadler, J. P. and Skidmore, P. (1995). *Introductions, extinctions or continuity? Faunal change in the North Atlantic islands*, pp. 206-225 in Butlin, R. A. and Roberts, N. (eds.), Ecological relations in historical times. Human impact and adaptation. *Institute of British Geographers Special Publication* 32. Oxford and Cambridge: Blackwell.

Saim, N. and Meloan, C. E. (1986). Compounds from leaves of bay (*Laurus nobilis* L.) as repellents for *Tribolium castaneum* (Herbst) when added to wheat flour. *Journal of Stored Products Research* 22, 141-144.

Salim, J., van Emden, H. F. and Nurullaho-lu, Z. Ü. (1996). What sex is your mummy? (Homoptera: Aphididae). *The Entomologist* 115, 185-190.

Salisbury, E. (1961). *Weeds and aliens*. London: Collins.

Sallares, R. and Gomzi, S. (2001). Biomolecular archaeology of malaria. *Ancient Biomolecules* 3, 195-213.

Salzman, L. F. (1997). *Building in England down to 1540*. Oxford: Oxford University Press.

Samuels, J. and Buckland, P. C. (1978). A Romano-British settlement at Sandtoft, South Humberside. *Yorkshire Archaeological Journal* 50, 65-75.

Samuels, R. (1965). Parasitological study of long-dried fecal samples, pp. 175-179 in Osborne, D., Katz, B. S. (eds.), Contributions to the Wetherill Mesa Archaeological Project. *Memoirs of the Society of American Archaeologists* 19, 175-179.

Sandars, E. (1939). *A butterfly book for the pocket*. London etc: Oxford University Press. [also later impressions]

Sandberg, G. (1997). *The red dyes. Cochineal, madder and murex purple.* Asheville, North Carolina Lark Books.

Sankey, J. H. P. and Savory, T. H. (1974). British harvestmen. Keys and notes for the identification of the species. *Synopses of the British fauna (new series)* 4, 76 pp. London and New York: Academic.

Sarmaja-Korjonen, K. (2003). Chydorid ephippia as indicators of environmental change biostratigraphical evidence from two lakes in southern Finland. *The Holocene* 13, 691-700.

Sars, G. O. (1890-1895). *An account of the Crustacea of Norway, with short descriptions and figures of all the species. Volume 1. Amphipoda*. Christiana and Copenhagen: Cammermayer. [reprinted 1966 by Unversitetsforlaget, Bergen and Oslo]

Savage, A. A. (1989). Adults of the British aquatic Hemiptera Heteroptera: a key with ecological notes. *Freshwater Biological Association Scientific Publication* 50, 173 pp. Ambleside: Freshwater Biological Association.

Sax, D. F. and Gaines, S. D. (2003). Species diversity: from global decreases to local increases. *Trends in Ecology and Evolution* 18, 561-566.

Schelvis, J. (1987). Some aspects of research on mites (Acari) in archaeological samples. *Palaeohistoria* 29, 211-218.

Schelvis, J. (1989). Mites (Acari) from the Late Neolithic well at Kolhorn (The Netherlands). *Palaeohistoria* 31, 165-171.

Schelvis, J. (1990a). Mites (Acari) in archaeology. *Experimental and Applied Entomology. Proceedings of the Netherlands Entomological Society* 1, 90-5.

Schelvis, J. (1990b). The reconstruction of local environments on the basis of remains of oribatid mites (Acari: Oribatida). *Journal of Archaeological Science* 17, 559-571.

Schelvis, J. (1991a). Lice and nits (*Pediculus humanus capitis*) from medieval combs excavated in the Netherlands. *Experimental and Applied Entomology, Proceedings of the Netherlands Entomological Society* 2, 14-15.

Schelvis, J. (1991b). Predatory mites (Acari; Gamasida) as specific dung indicators in archaeology. *Experimental and Applied Entomology. Proceedings of the Netherlands Entomological Society* 2, 8-13.

Schelvis, J. (1992). *Mites and archaeozoology. General methods; applications to Dutch sites*. PhD thesis, University of Groningen.

Schelvis, J. (1994a). Predatory mites (Acari; Gamasida) in excrements of five domestic animal species. *Pedobiologia* 38, 72-80.

Schelvis, J. (1994b). Caught between the teeth. A review of Dutch finds of archaeological remains of ectoparasites in combs. *Proceedings of the Section Experimental and Applied Entomology of the Netherlands Entomological Society* 5, 131-132.

Schelvis, J. (1997a). *Mites in the background. Use and origins of remains of mites (*Acari*) in Quaternary deposits*, pp. 233-236 in Ashworth, A. C., Buckland, P. C. and Sadler, J. P. (eds.), Studies in Quaternary entomology - and inordinate fondness for insects. *Quaternary Proceedings* 5. Chichester, UK: Wiley.

Schelvis, J. (1997b). Remains of mites (Acari) as palaeo-indicators: dwelling mounds and medieval reclamations in The Netherlands, pp. 175-180 in De Boe, G. and Verhaeghe, F. (eds.), *Environment and subsistence in medieval Europe. Papers of the 'Medieval Europe Brugge 1997' conference* 9. I. A. P. Rapporten 9. Zellik: I. A. P.

Schelvis, J. (1998). *Remains of sheep ectoparasites as indicators of wool processing in the past*, pp. 89-98 in Dewilde, M., Ervynck, A. and Wielemans, A. (eds.), Ypres and the medieval cloth industry in Flanders. *Archeologie in Vlaanderen Monografie* 2. Zellik: Instituut voor het Archeologisch Patrimonium.

Schelvis, J. (2000) *Remains of mites as indicators of human impact on past environments: dwelling mounds and marine incursions in the Netherlands*, pp. 71-74 in Nicholson, R. A. and O'Connor. T. P. (eds.), People as an agent of environmental change. *Symposia of the Association for Environmental Archaeology* 16. Oxford: Oxbow Books.

Schelvis, J. and Geel, B. Van (1989). A palaeoecological study of the mites (Acari) from a Lateglacial deposit at Usselo (The Netherlands). *Boreas* 18, 237-243.

Schelvis, J. and Koot, C. (1995). Sheep or goat? *Damalinia* deal with the dilemma. *Proceedings of the Section Experimental and Applied Entomology of the Netherlands Entomological Society* 6, 161-162.

Schilthuizen, M. (2005). The darting game in snails and slugs. *Trends in Ecology and Evolution* 20, 581-584.

Schmitt, W. L. (1965). *Crustaceans*. Ann Arbor: University of Michigan.

Schofield, A. J. (1987). The role of palaeoecology in understanding variations in regional survey data. *Circaea* 5, 33-42.

Schofield, J. E. and Bunting, M. J. (2005). Mid-Holocene presence of water chestnut (*Trapa natans* L.) in the meres of Holderness, East Yorkshire, UK. *The Holocene* 15, 687-697.

Schott, C. (1984). *Cerambyx cerdo* dans des bois fossiles. *Bulletin de la Societé Entomologique de Mulhouse* 19, 48.

Scott, S. and Duncan, C. (2001). *Biology of plagues: evidence from historical populations*. Cambridge: CUP.

Scourse, J. (1996). Trace fossils of talitrid sandhoppers in interglacial littoral calcareous sandstones, Cornwall, U.K. *Quaternary Science Reviews* 15, 607-615.

Scourfield, D. J. (1943). The Entomostraca of the bottom deposits of Windermere. *Proceedings of the Linnean Society of London* 154, 253-258.

Scourfield, D. J. and Harding, J. P. (1966). A key to the British species of freshwater Cladocera with notes on their ecology. *Freshwater Biological Association Scientific Publication* 5 (third edition reprinted 1994). Ambleside: FBA.

Seaward, M. R. D. (1976). *The Vindolanda environment*. Haltwhistle, Northumberland: Barcombe.

Séguy, E., (1944). Insectes ectoparasites (Mallophaga, Anopleures, Siphonaptera). *Faune de France* 43. Paris: Lechevalier.

Shackleton, N. J. (1973). Oxygen isotope analysis as a means of determining season of occupation of prehistoric midden sites. *Archaeometry* 15, 133-141.

Shaw, T. (n. d.) *An experiment investigating the efficiency of paraffin floatation for the extraction of insect remains.* Unpublished undergraduate project report lodged in the EAU.

Shennan, I. and Andrews, J. (eds.) (2000). Holocene land-ocean interaction and environmental change around the North Sea. *Geological Society Special Publication* 166. London: Geological Society.

Sherman, R. A., Hall, M. J. R. and Thomas, S. (2000). Medicinal maggots: an ancient remedy for some contemporary afflicaitons. *Annual Review of Entomology* 45, 55-81.

Sighamony, S., Anees, I., Chandrakala, T. and Osmani, Z. (1986). Efficacy of certain indigenous plant products against *Sitophilus oryzae* (L.) and *Rhyzopertha dominica* (F.). *Journal of Stored Products Research* 22, 21-23.

Signore, R. J., Love, J. and Boucree, M. C. (1989). Scalp infestation with *Phthirus pubis*. Archives of Dermatology 125, 133.

Silliman, B. (1871). The Chinese white wax insect. *The American Naturalist* 5, 683-685.

Simpson, G. (2001). *An introduction to the taxonomy of the sub-fossil remains of* Cladocera. Available at http://www.homepages.ucl.ac.uk/%7Eucfagls/thewaterflea/taxonomy/taxintro.htm

Sims, R. W. and Gerard, B. M. (1985). Earthworms: keys and notes for the identification and study of the species. *Synopses of the British Fauna* (New Series) 31. London etc: Brill/Backhuys.

Skidmore, P. (1971). The insect fauna of a bog oak found near Askern. *Naturalist* (Hull) no. 918 (for 1971), 111-112.

Skidmore, P. (1979). *On the immature stages of Palaearctic* Muscidae *with particular reference to taxonomic and biological aspects*. Unpublished thesis presented for the Degree of Master of Philisophy, University or York.

Skidmore, P. (1985). *The biology of the* Muscidae. The Hague: Junk.

Skidmore, P. (1986). The dipterous remains, p. 92 in Stead I M, Bourke, J B and Brothwell D. (eds), *Lindow Man: the body in the bog*. London: British Museum.

Skidmore, P. (1991). Insects of the British cow-dung community. *Field Studies Council Occasional Publication* 21. Shrewsbury: FSC.

Skidmore, P. (1995). *A dipterological perspective on the Holocene history of the North Atlantic area.* Unpublished PhD thesis, University of Sheffield.

Smaldon, G. Holthius, L. B. and Fransen, C. H. J. M. (1979). Coastal shrimps and prawns. Keys and notes for the identification of the species. *Synopses of the British fauna (new series)* 15 (second edition). London etc.: Academic.

Small, R. (2005). A review of *Melophagus ovinus* (L.), the sheep ked. *Veterinary Parasitology* 130, 141-155.

Smart, D., (1997). Archaeological evidence for cephalopods: taphonomic loss or unfortunate ignorance? *Circaea* 12, 249.

Smit, F. G. A. M. (1957). Siphonaptera. *Handbooks for the identification of British insects* 1 (16). London: Royal Entomological Society.

Smith, B. M. (2002). A palaeoecological study of raised mires in the Humberhead Levels. *British Archaeological Reports British Series* 336 (*Thorne and Hatfield Moors Monograph* 1). Oxford.

Smith, D. (1989). *An insect fauna from the Subscription Rooms (site DSR), Doncaster*, pp. 447-51 in Buckland, P. C., Magilton, J. R. and Hayfield, C., The archaeology of Doncaster 2. The medieval and later town. Part i. *British Archaeological Reports British Series* 202 (i). Oxford.

Smith, D. N. (1996a). Thatch, turves and floor deposits: a survey of Coleoptera in material from abandoned Hebridean blackhouses and the implications for their visibility in the archaeological record. *Journal of Archaeological Science* 23, 161-174.

Smith, D. N. (1996b). Hebridean blackhouses and a speculative history of the 'culture favoured' Coleoptera of the Hebrides, pp. 207-216 + references pp. 253-275 in Gilbertson, D., Kent, M. and Grattan, J. (eds.), *The Outer Hebrides. The last 14,000 years.* Sheffield: Sheffield Academic Press.

Smith, D. (1998). Beyond the barn beetles: difficulties in using some Coleoptera as indicators of stored fodder. *Environmental Archaeology* 1, 63-70.

Smith, D. N. (2000a). Disappearance of elmid 'riffle beetles' from lowland river systems - the impact of alluviation, pp. 75-80 in Nicholson, R. A. and O'Connor. T. P. (eds.), *People as an agent of environmental change*. Symposia of the Association for Environmental Archaeology 16. Oxford: Oxbow Books.

Smith, D. N. (2000b). *Detecting the nature of materials on farms from Coleoptera: a number of taphonomic problems*, pp. 71-83 in Huntley, J. P. and Stallibrass, S. (eds.), Taphonomy and interpretation. *Symposia of the Association for Environmental Archaeology* 14. Oxford: Oxbow.

Smith, D. N. (2002). Medieval and late medieval coleopterous faunas, pp. 159-162 in Baker, N. (ed.), *Shrewsbury Abbey, studies in the archaeology and history of an urban abbey*. Birmingham: Shropshire Archaeological and Historical Society Monograph 2.

Smith, D. N. and Howard, A. J. (2004). Identifying changing fluvial conditions in low gradient alluvial archaeological landscapes: can Coleoptera provide insights into changing discharge rates and floodplain evolution? *Journal of Archaeological Science* 31, 109-120.

Smith, D., Letts, J. and Cox, A. (1999). Coleoptera from late medieval smoke-blackened thatch (SBT): their archaeological implications. *Environmental Archaeology* 4, 9-17.

Smith, D., Letts, J. and Jones, M. (2005). Modern Coleoptera from non-cereal thatch: a poor analogue for roofing material from the archaeological record. *Environmental Archaeology* 10, 171-178.

Smith, D. N., Osborne, P. J. and Barrett, J. (1997). *Preliminary paleontological research at the Iron Age sites at Goldcliff, Gwent, Wales, 1991-199*3, pp. 255-267 in Ashworth, A. C., Buckland, P. C. and Sadler, J. P. (eds.), Studies in Quaternary entomology - and inordinate fondness for insects. *Quaternary Proceedings* 5. Chichester, UK: Wiley.

Smith, D. N., Osborne, P. J. and Barrett, J. (2000). *Beetles as indicators of past environments and human activity at Goldcliff*, p. 245-261 in Bell, M., Caseldine, A. and Neumann, H., Prehistoric intertidal archaeology in the Welsh Severn Estuary. *CBA Research Report* 120. York.

Smith, D, N., Roseff, R. and Butler, S. (2001). The sediments, pollen, plant macro-fossils and insects from a Bronze Age channel fill at Yoxall Bridge, Staffordshire. *Environmental Archaeology* 6, 1-12.

Smith, D. N. and Whitehouse, N. J (2005). Not seeing the trees for the woods: a paleoentomological perspective on Holocene woodland composition, pp. 136-161 in Brickley, M., Smith, D. and Smith, W. (eds.), *Fertile Ground. Papers in Honour of Susan Limbrey* (Symposia of the Association for Environmental Archaeology No. 22). Oxford: Oxbow Books.

Smith, H. (1996). An investigation of site formation processes on a traditional Hebridean farmstead using environmental and geoarchaeological techniques, pp. 195-206 + references pp. 253-275 in Gilbertson, D., Kent, M. and Grattan, J. (eds.), *The Outer Hebrides. The last 14,000 years.* Sheffield: Sheffield Academic Press.

Smith, K. G. V. (1973). *Insects and other arthropods of medical importance*. London: British Museum (Natural History).

Smith, K. G. V. (1974). Changes in the British dipterous fauna, pp. 371-391 in Hawksworth, D. L. (ed.), *The changing flora and fauna of Britain*. Systematics Association Special Vol. 6. London: Academic Press.

Smith, K. G. V. (1986). *A manual of forensic entomology.* London: British Museum (Natural History).

Smith, K. G. V. (1989). An introduction to the immature stages of British flies. *Handbooks for the identification of British insects* 10 (14), 280 pp. London: Royal Entomological Society.

Smith, M. (1951). *The British amphibians and reptiles*. London: Collins.

Smith, R. A. (1911). Lake dwellings in Holderness, Yorks, discovered by Thos. Boynton, Esq., F.S.A., 1880-1. *Archeologia* 62, 593-610.

Smith, W. G. (1894). *Man, the primeval savage: his haunts and relics from the hill-tops of Bedfordshire to Blackwall.* London: Edward Stanford. [not seen in original].

Smyly, W. J. P. (1957). A note on the number of eggs in the ephippium of Acantholebris curvirostris (O. F. Muller) (Cladocera, Macrothricidae). *Journal of the Queckett Microscopical Club* 4, 315-316.

Smyth, J. D. (1994). *Introduction to animal parasitology*. Third edition. Cambridge: University Press.

Snow, K. R. (1978). *Identification of larval ticks found on small mammals in Britain*. Reading: Mammal Society.

Solhoy, T. (2001). Oribatid mites, pp. 81-104 in Smol, J. P., Birks, H. J. B. and Last, W. M. (eds.), *Tracking environmental change using lake sediments. Volume 4: Zoological indicators*. Dortrecht etc: Kluwer Academic Publishers.

Soren, D. (2003). Can archaeologists excavate evidence of malaria? *World Archaeology* 35, 193-209.

Southwood, T. R. E. (1962). The migration of terrestrial arthropods in relation to habitat. *Biological Reviews* 37, 171-214.

Southwood, T. R. E. and Leston, D. (1959). *Land and water bugs of the British Isles*. London: Warne. [Also available as a CD from Pisces Conservation Ltd, Lymington, Hampshire.]

Sparks, B. W. (1961). The ecological interpretation of Quaternary non-marine Mollusca. *Proceedings of the Linnean Society of London* 172, 71-80.

Sparks, B. W. and West, R. G. (1972). *The ice age in Britain*. London: Methuen.

Spaul, E. A. (1973). *Soil sample from bottom of S. arm of inner moat*, p. 95 in Le Palourel, H. E. J., The moated sites of Yorkshire. *Society for Medieval Archaeology Monograph Series* 5. London: SMA.

Speight, M. (1970). *Research seminar on archaeology and related subjects. Archaeoentomology.* Unpublished document

Spence, J. R. (1990). Success of European carabid species in Western Canada: pre-adaptation for synanthropy?, pp. 129-141 in Stork, N. E. (ed.), *The role of gound beetles in ecological and environmental studies*. Andover: Intercept.

Spencer, P. J. (1976). The environmental spiral. *Interim* 3 (4), 14-9. [A popular introduction to molluscs in archaeology.]

Spencer, P. J. (1988). *The beetle remains*, pp. 89-90 in Millet, M. and McGrail, S., The archaeology of the Hasholme boat. *Archaeological Journal* 144 (for 1987), 69-155.

Spratt, D. A. and Simmons, I. G. (1976). Prehistoric activity and environment on the North York Moors. *Journal of Archaeological Science* 3, 193-210.

Stafford, F. (1971). Insects of a medieval burial. *Science and Archaeology* 7, 6-10.

Stallibrass, S. (1999). *Vertebrate and marine mollusc remains*, pp. 70-72 in Williams, A. and Wood, P., Excavations in Durham's Old Borough, 1995. *Archaeologia Aeliana* 5th series 27, 45-74.

Stallibrass, S. and Huntley, J. P. (1996). Slim evidence: a review of the faunal and botanical data from the Neolithic of Northern England. *Northern Archaeology* 13/14, 35-42.

Stankiewicz, B. A., Mastalerz, M., Hof, C. H. J., Bierstedt, A., Flannery, M. B., Briggs, D. E. and Evershed, R. P. (1998). Biodegradation of the chitin-protein complex in crustacean cuticle *Organic Geochemistry* 28, 67-76.

Stankiewicz, B. A., Briggs, D. E. G., Evershed, R. P. and Duncan, I. J. (1997). Chemical preservation of insect cuticle from the Pleistocene asphalt deposits of California, USA. *Geochimica et Cosmochimica Acta* 61, 2247-2252.

Stead, I. M., (1980). *Rudston Roman villa*. 179 pp. Leeds: Yorkshire Archaeological Society.

Stead, I. M., Bourke, J. B. and Brothwell, D. (1986). *Lindow Man: the body in the bog.* London: British Museum.

Stebbings, J. H. (1962). Endemic-exotic earthworm competition in the American midwest. *Nature, London* 196, 905-906.

Stein, J. K. (1983). Earthworm activity: a source of potential disturbance of archaeological sediments. *American Antiquity* 48, 277-289.

Step. E. (1927). *Shell life.* London: Warne.

Stephenson, W. A. (1973). *Seaweed in agriculture and horticulture* (2nd edition). Wakefield: EP Publishing.

Steward, J. H. (1938). Basin-plateau aboriginal sociopolitical groups. *Smithsonian Institution Bureau of American Ethnology Bulletin* 120, 346 pp. Washington: United States Government Printing Office.

Stott, R. (2004). *Oyster*. London: Reaktion Books.

Stroyan, H. L. G. (1984). Aphids - Pterocommatinae and Aphidinae (Aphidini). *Handbooks for the identification of British insects* 2 (6), 232 pp. London: Royal Entomological Society.

Strudwick, C. D. (1979). *A multivariate analysis of archaeological insect assemblages*. Unpublished M.Sc. dissertation, University of York, England.

Stubbs, A. and Chandler, P. (1978). A dipterist's handbook. *The Amateur Entomologist* 15, i-ix, 1-255.

Sudell, T. L. (1990). *The insects from Well 1*, pp. 267-271 in Wrathmell, S. and Nicholson, A. (eds.), Dalton Parlours: Iron Age settlement and Roman Villa Site. *Yorkshire Archaeology* 3. Wakefield: West Yorkshire Archaeology Service.

Sutton, M. Q. (1995). Archaeological aspects of insect use. *Journal of Archaeological Method and Theory* 2, 253-98.

Sutton, S. L. (1972). *Woodlice.* London: Ginn.

Svenning, J-C. (2002). A review of natural vegetation openness in north-western Europe. *Biological Conservation* 104, 133-148.

Swift, S. M., Racey, P. A. and Avery, M. I. (1985). Feeding ecology of *Pipistrellus pipistrellus* (Chiroptera: Vespertillionidae) during pregnancy and lactation. II. Diet. *Journal of Animal Ecology* 54, 217-225.

Szidat, L. (1944). Uber die Erhaltungsfähigkeit von Helmintheniern in vor- und frühgeschichlichen Moorleichen. *Zeitschrift für Parasitenkunde* 13, 265-274.

Taylor, D. M., Griffiths, H. I., Pedley, H. M. and Prince, I. (1994). Radiocarbon-dated Holocene pollen and ostracod sequences from barrage tufa-dammed fluvial systems in the White Peak, Derbyshire, UK. *The Holocene* 4, 356-364.

Taylor, G. M., Mays, S., Legge, A. J., Ho, T. B. L. and Young, D. B (2001). Genetic analysis of tuberculosis in human remains. *Ancient Biomolecules* 3, 267-280.

Taylor, G. W. (1983). Detection and identification of dyes on Anglo-Scandinavian textiles. *Studies in Conservation* 28, 153-160.

Taylor, G. W. (1984). Survey of the insect red dyes. *Dyes on Historical and Archaeological Textiles* 3, 22-25.

Taylor, G. W. (1987). New light on the insect red dyes of the ancient Middle East. *Textile History* 18, 143-146.

Taylor, E. L. (1955). Parasitic helminths in medieval remains. *Veterinary Record* 67, 216-218.

Taylor, J. E. (2001). *Rates of decay of mollusc shells in soils on the Yorkshire Wolds: why should preservation of calcareous fossils be so poor on the chalklands?* Unpublished BSc Biology final year project, University of York.

Taylor, M. P., Macklin, M. G. and Hudson-Edwards, K. (2000). River sedimentation and fluvial response to Holocene environmental change in the Yorkshire Ouse basin, northern England. *The Holocene* 10, 201-212.

Taylor, T. H. and Thompson, H. W. (1928). A garden chafer attack. *Annals of Applied Biology* 15, 258-263.

Tazima, Y. (1984). Silkworm moths, pp. 416-424 in Mason, I. L. (ed.), *Evolution of domesticated animals*. London: Longman.

Tebble, N. (1976). *British bivalve seashells*. Edinburgh: HMSO.

Teskey, H. H. and Turnbull, C. (1979) Diptera puparia from pre-historic graves. *Canadian Entomologist* 111, 527-528.

Thew, N. and Wagner, P. (1991). *The molluscan evidence from Garton station and Kirkburn*, pp. 148-151 in Stead, I., Iron Age cemeteries in East Yorkshire. *English Heritage Archaeological Report* 22.

Thew, N. M. and Woodall, D. (1984). *Late Devensian molluscan palaeoecology of Holderness*, pp. 109-157 in Gilbertson, D. D., Late Quaternary Environments and Man in Holderness. *British Archaeological Reports British Series* 134.

Thiéry, A., Brtek, J. and Gasc, C. (1995). Cyst morphology of European branchiopods (Crustacea, Anostraca, Notostraca, Spinicaudata, Laevicaudata). *Bulletin du Muséum National d'Histoire Naturalle* series 4 17, 107-139.

Thomas, C. (1983). Research objectives in British Archaeology. *CBA Occasional Paper*. London: CBA [series not numbered]

Thomas, K. (1978). *Part 3. The molluscs*, pp. 155-160 in Fenwick, V. (ed.), The Graveney boat: a tenth-century find from Kent, etc. *National Matitime Museum, Greenwich, Archaeological Series* 3, *BAR British Series* 53. Oxford.

Thomas, K. D. (1981). Coastal resources and the changing environment, pp. 49-64 in Brothwell, D. and Dimbleby, G. (eds.), Environmental aspects of coasts and islands. *Symposia of the Association for Environmental Archaeology* 1, *BAR International Series* 94.

Thomas, K. D. (1985). *Land snail analysis in archaeology: theory and practice*, pp. 131-156 and un-numbered tables and figures in Fieller, N. R. J., Gilbertson, D. D. and Ralph, N. (eds.), Palaeobiological investigations. Research design, methods and data analysis. *Symposia of the Association for Environmental Archaeology 5B. British Archaeological Reports International Series* 226.

Thomas, K. D. (1988). Invertebrate zooarchaeology, pp. 23-25 in Mellars, P. (ed.), *Research priorities in archaeological science.* London: Council for British Archaeology.

Thomas, K. D. (1989). Vegetation of the British chalklands in the Flandrian periods: a response to Bush. *Journal of Archaeological Science* 16, 549-553.

Thomas, K. D. (1990). What's in a name? Anyone can be an environmental archaeologist. *Circaea* 7, 72-76.

Thomas, K. D. and Mannino, M. A. (2001). The exploitation of invertebrates and invertebrate products, pp. 427-440 in Brothwell, D. R. and Pollard, A. M. (eds.), *Handbook of archaeological sciences*. Chichester etc: John Wiley.

Thompson, M. W. (1967). *Novgorod the Great: excavations at the medieval city 1951-62 by A. V. Artsikhovsky and B. A. Kolchin*. London: Evelyn, Adams & Mackay.

Thompson, T. E. and Brown, G. H. (1976). British opisthobranch molluscs. *Synopses of the British fauna (new series)* 8. London etc.: Academic.

Thorsen, T. A., Dale, B. and Nordberg, K. (1995). 'Blooms' of the toxic dinoflagellate *Gymnodinium catenatum* as evidence of climatic fluctuations in the late Holocene of southwestern Sweden, *The Holocene* 5, 435-446.

Tolonen, K. (1986). Rhizopod analysis, pp. 645-666 in Berglund, B. E. (ed.), *Handbook of Holocene palaeoecology and palaeohydrology*. Chichester etc: John Wiley.

Tomlinson, P. (1985). An aid to the identification of fossil buds, bud-scales and catkin-bracts of British trees and shrubs. *Circaea* 3, 45-130.

Tomlinson, P. R. (1987). *Plant remains*, pp. 291-5 in McNeil, R. and Roberts, A. F., A plank tank from Nantwich. *Britannia* 18, 287-95.

Tomlinson, P. R. (1993 for 1992). Design and implementation of a relational database for archaeological records from Great Britain and Ireland. *Circaea, the Journal of the Association for Environmental Archaeology* 10, 1-30.

Tomlinson, P. (1995). Using the Archaeobotanical Computer Database to survey the evidence for plant remains from Post-Roman deposits in the British Isles, pp. 317-34 in Kroll, H. and Pasternak, R. (eds.) *Res archaeobotanicae.* International Workgroup for Palaeoethnobotany. Proceeding of the ninth Symposium Kiel 1992. Kiel: published by the editors.

Tomlinson, P., Allison, E. P., Innes, J. B. and Kenward, H. K. (2002). *Environmental evidence from the prehistoric period*, pp. 231-247 in Freke, D., Excavations on St Patrick's Isle, Peel, Isle of Man, 1982-88. Prehistoric, Viking, medieval and later. *Centre for Manx Studies Monographs* 2. Liverpool: University Press.

Tomlinson, P. and Hall, A. (1985). Progress in palaeobotanical studies of dye plants 1983/4, pp. 28-9 in Dalrymple, H. E. (ed.) *Dyes on Historical and Archaeological Textiles. Summary of Talks. 3rd Meeting, York Archaeological Trust, September 1984*. Edinburgh: privately published.

Tomlinson, P. and Hall, A. (1996). A review of the archaeological evidence for food plants from the British Isles: an example of the use of the Archaeobotanical Computer Database (ABCD). *Internet Archaeology* 1. Available at http://intarch.ac.uk/journal/issue1/tomlinson_index.html

Tompa, A. S. (1976). A comparative study of the ultrastructure and mineralogy of calcified land snail eggs. *Journal of Morphology* 150, 861-871.

Tooley, M. J. (1974). Sea-level changs during the last 9000 years in North-West England. *The Geographical Journal* 140, 18-42 + foldout.

Tooley, M. J. (1990). *Sea-level and coastline changes during the last 5000 years*, pp. 1-16 in McGrail, S. (ed.), Maritime Celts, Frisians and Saxons. *CBA Research Reports* 71. London.

Tooley M. J., Rackham D. J. and Simmons I. G. (1982). A red deer (*Cervus elaphus* L.) skeleton from Seamer Carrs, Cleveland, England: provenance of the skeleton and palaeoecology of the site. *Journal of Archaeological Science* 9, 365-76.

Tooley, M. J. and Shennan, I. (eds.) (1987). Sea level changes. *IBG Special Publications* 20.

Torina, A., Dara, S., Marino, A. M. F., Sparagano, O. A. E., Vitale, F., Reale, S. and Caracappa, S. (2004). Study of gastrointestinal nematodes in Sicilian sheep and goats. *Annals of the New York Academy of Sciences* 1026, 187-194.

Traub, R. (1985). Coevolution of fleas and mammals, pp. 93-172 in Kim, K. C. (ed.), *Coevolution of parasitic arthropods and mammals*. Now York: Wiley and Sons.

Trechmann, C. T. (1947). The submerged forest beds of the Durham coast. *Proceedings of the Yorkshire Geological Society* 27, 23-32.

Trewin, N. H. and Welsh, W. (1976). Formation and composition of a graded estuarine shell bed. *Paaeogeography, Palaleoclimatiology, Palaeoecology* 19, 219-230.

Trigger, B. G. (1989). *A history of archaeological thought.* Cambridge: University Press.

Troels-Smith, J. (1984). Stall-feeding and field-manuring in Switzerland about 6000 years ago. *Tools and Tillage* 5, 13-25.

Trueman, C. N. G., Field, H. H., Dortch, J., Charles, B. and Wroe, S. (2005). Prolonged coexistence of humans and megafauna in Pleistocene Australia. *Proceedings of the National Academy of Sciences of the USA* 102, 8381-8385.

Turner, J. (1964). The anthropogenic factor in vegetational history. I. Tregaron and Whixall Mosses. *New Phytologist* 63, 73-90.

Tweddle, D. (1992). The Anglian helmet from Coppergate. *The Archaeology of York* 17 (8), 8511201 + unbound illustrations. London: Council for British Archaeology.

Twigg, G. I. (1978). The role of rodents in plague dissemination: a worldwide review. *Mammal Review* 8, 77-110.

Tyers, I. (1988). *Environmental evidence from Southwark and Lambeth*, pp. 443-477 in Hinton, P. (ed.), Excavations in Southwark 1973-76 and Lambeth 1973-79. *LAMAS/SAS Joint Publication* 3.

Usai, R. (2002). Northern Regional Review of Environmental Archaeology: Geoarchaeology in Northern England II: Site Review, Discussion, and Research Priorities. *Centre for Archaeology Report* 24/2002. English Heritage.

Usai, R. (2005). Geoarchaeology in Northern England I: The Landscape and Geography of Northern England. *Centre for Archaeology Repor*t 54/2005. English Heritage.

Van der Hoeden, J. (1964). *Zoonoses*. Amsterdam etc: Elsevier.

Van de Noort, R. and Davies, P. (1993). *Wetland heritage. An archaeological assessment of the Humber wetlands*. Hull: Humber Wetlands Project.

Van de Noort, R. and Ellis, S. (eds.) (1995). *Wetland heritage of Holderness. An archaeological survey*. Hull: Humber Wetlands Project.

Van de Noort, R. and Ellis, S. (eds.) (1997). *Wetland heritage of the Humberhead Levels. An archaeological survey. Hull: Humber Wetlands Project.*

Van de Noort, R. and Ellis, S. (eds.) (1998). *Wetland heritage of the Ancholme and lower Trent valleys. An archaeological survey*. Hull: Humber Wetlands Project.

Van de Noort, R. and Ellis, S. (eds.) (2000). *Wetland heritage of the Hull valley. An archaeological survey*. Hull: Humber Wetlands Project.

Van den Broek, E., (1977). De luzien (Anoplura en Mallophaga) van zoogdieren in Nederland. *Wetenschappelijke Mededelingen van de Koninklijke Nederlandse Natuurhistorische Vereniging* 121, 1-32.

Van Geel, B., Buurman, J., Brinkkemper, O., Schelvis, J., Aptroot, A., van Reenen, G. and Hakbikl, T. (2003). Environmental reconstruction of a Roman period settlement in Uitgeest (The Netherlands), with special reference to coprophilous fungi. *Journal of Archaeological Science* 30, 873-883.

Van Geel, B., Buurman, J. and Waterbolk, H. T. (1996). Archaeological and palaeoecological indications of an abrupt climate change in The Netherlands, and evidence for climatic teleconnections around 2650 BP. *Journal of Quaternary Science* 11, 451-460

Van der Veen, M. (1988). Carbonised grain from a Roman granary at South Shields, north-east England, pp. 353-365 in Küster, H., *Der prähistorische Mensch und seine Umwelt. Festschift für Udelgard Körber-Grohne zum 65*. Geburtstag. Stuttgart: Konrad Theiss.

Van der Veen, M. (1990). Commentary on Boyd's *Towards a conceptual framework for environmental archaeology: environmental archaeology as a key to past geographies*. *Circaea* 7, 76-77.

Van Nest, J. (2001). The good earthworm: how natural processes preserve upland Archaic archaeological sites of western Illinois, U. S. A. *Geoarchaeology* 17, 53-90.

Varley, W. T. (1968). Barmston and the Holderness crannogs. *East Riding Archaeologist* 1, 11-16.

Vellanoweth, R. L. (2001). AMS radiocarbon dating and shell bead chronologies: Middle Holocene trade and interaction in western North America. *Journal of Archaeological Science* 28, 941-950.

Vera, F. W. M. 2000. *Grazing ecology and forest history*. Wallingford: CABI.

Versey, H. C. (1938). The Speeton pre-glacial shell bed. *The Naturalist* for 1938, 227-229.

Vogt, H. (1967). Familie: Cucujidae, pp. 83-104 in Freude, H., Harde, K. W. and Lohse, G. A. (eds.). *Die Käfer mitteleuropas* 7. Krefeld: Goeke and Evers.

Volkart, H. D. (1967). Insektenfunde aus dem Areal der Station Seeberg, Burgäschisee-Süd. *Acta Bernensia* II. *Seeberg Burgäschisee-Süd* 4. *Chronologie und Umwelt*, 125-126 + plate. Bern: Verglag Stämpfli.

Von Grafenstein, U., Erlenkeuser, H., Müller, J., Jouzel, J., and Johnsen, S. (1998). The cold event 8200 years ago documented in oxygen isotope records of precipitation in Europe and Greenland. *Climate Dynamics* 14, 73-81.

Wacher, J. (1974). *The towns of Roman Britain*. London: Batsford.

Watchman, A. L. and Jones, R. (2002). An independent confirmation of the 4 ka antiquity of a beeswax figure in Western Arnhem Land, Northern Australia. *Archaeometry* 44, 145-153.

Waddington, C. (2003). A Mesolithic settlement site at Howick, Northumberland: a preliminary report. *Archaeologia Aeliana 5th series* 32, 1-12.

Wagner, P. E. (1997). Human impact or cooling climate? The 'Little Ice Age' and the beetle fauna of the British Isles, pp. 269-276 in Ashworth, A. C., Buckland, P. C. and Sadler, J. P. (eds.), Studies in Quaternary entomology - and inordinate fondness for insects. *Quaternary Proceedings* 5. Chichester, UK: *Wiley*.

Wagner, P. (1999). *The Skelfrey Beck section*, p. 170 in Halkon, P. and Millett, M. (eds.) Rural settlement and industry: studies in the Iron Age and Roman archaeology of lowland East Yorkshire. *Yorkshire Archaeological Report* 4.

Wagner, P. (2004). *The molluscan evidence*, pp. 82-89 in Rigby, V., Pots in pits: the British Museum East Yorkshire settlements project 1988-1992. *East Riding Archaeologist* 11, xv + 1-228.

Walker, G. (2004). Frozen time. *Nature* 429, 596-597.

Walker, I. R. (1987) Chironomidae (Diptera) in palaeoecology. *Quaternary Science Reviews* 6, 29-40.

Walker, I. R. (2001). Midges: Chironomidae and related Diptera, pp. 43-66 in Smol, J. P., Birks, H. J. B. and Last, W. M. (eds.), *Tracking environmental change using lake sediments. Volume 4: Zoological indicators*. Dortrecht etc: Kluwer Academic Publishers.

Walker, I. R. and Mathewes, R. W. (1989a). Chironomidae (Diptera) remains in surficial lake sediments from the Canadian Cordillera: analysis of the fauna across an altitudinal gradient. *Journal of Palaeolimnology* 2, 61-80.

Walker, I. R. and Mathewes, R. W. (1989b). Early postglacial chironomid succession in southwestern British Columbia, Canada, and its paleoenvironmental significance. *Journal of Palaeolimnology* 2 1-14.

Walker, I. R. and Paterson, C. G. (1985) Efficient separation of subfossil Chironomidae from lake sediments. *Hydrobiologia* 122, 189-192.

Walker, I. R., Mott, R, J. and Smol, J. P. (1991). Allerod-Younger Dryas lake temperatures from midge fossils in Atlantic Canada. *Science* 253, 1010-1012.

Walker, M. J. C, Coope, G. R. and Lowe, J. J. (1993a). The Devensian (Weichselian) lateglacial palaeoenvironmental record from Gransmoor, East Yorkshire, England. *Quaternary Science Review* 12, 659-680.

Walker, M. J. C., Griffiths, H. I., Ringwood, V. and Evans, J. G. (1993b). An early-Holocene pollen, mollusc and ostracod sequence from lake marl at Llangorse Lake, South Wales, UK. *The Holocene* 3, 138-149.

Wallace, I. D., Wallace, B. and Philipson, G. N. (2003). Keys to the case-bearing caddis larvae of Britain and Ireland. *Freshwater Biological Association Scientific Publication* 61. Ambleside: FBA.

Waller, M. P. and Hamilton, S. (2000). Vegetation history of the English chalklands: a mid-Holocene sequence from the Caburn, East Sussex. *Journal of Quaternary Science* 15, 253-272.

Walton, P. (1989). Textiles, cordage and raw fibre from 16-22 Coppergate. *The Archaeology of York* 17 (5), 283-454 + Plates XV-XXXIV + Fiche 1.

Walton Rogers, P. (1997). Textile production at 16-22 Coppergate. *The Archaeology of York* 17 (11), 1687-1867 + viii.

Wansard, G. (1996). A new approach to quantify past temperatures from the (MG/CA) ratio of lacustrine ostracod valves. *Comptes rendus de l'Academie des Sciences series II fascicule A Sciences de la Terre et des Planetes* 323, 493-500.

Ward, H. B. and Whipple, G. C. (1959). *Freshwater biology* (2nd edition). New York and London: Wiley.

Warner, B. G. (1990a). *Testate amoebae (Protozoa)*, pp. 65-74 in Warner, B. G. (ed.), Methods in Quaternary ecology. *Geoscience Canada Reprint Series* 5. St John's Newfoundland: Geological Association of Canada.

Warner, B. G. (1990b). *Other fossils*, pp. 149-162 in Warner, B. G. (ed.), Methods in Quaternary ecology. *Geoscience Canada Reprint Series* 5. St John's Newfoundland: Geological Association of Canada.

Waselkov, G. (1987). Shellfish gathering and shell midden archaeology. *Advances in Archaeological Method and Theory* 10, 93-210.

Waugh, G. D. (1954). Effect of floods on the oyster grounds of Great Britain. *Nature, London* 173, 68-69.

Webb, S. C., Hedges, R. E. M. and Robinson, M. (1998). The seaweed fly *Thoracochaeta zosterae* (Hal.) in inland archaeological contexts: $\partial^{13}C$ and $\partial^{15}N$ solves the problem. *Journal of Archaeological Science* 25, 1253-1257.

Webley, D. (1974). An early record of *Heterodera humuli* Filipjev in the United Kingdom. *Nematologica* 20, 262 + plate XXVII.

Welter-Schultes, F. W. (2001). Land snails from an ancient shipwreck: the need to detect wreck-independent finds in excavation analysis. *Journal of Archaeological Science* 28, 19-27.

West, R. G. (1969). Note on the pollen analysis from the Speeton Shell Bed. *Proceedings of the Geologists' Association* 80, 217-221.

White, I. M. and Hodkinson, I. D. (1982). Psylloidea (nymphal stages). Hemiptera, Homoptera. *Handbooks for the identification of British insects* 2 (5b). London: Royal Entomological Society.

White, J. H. (1953). Wind-borne dispersal of patato-root eelworm. *Nature, London* 172, 686-7.

White, K. D. (1970). *Roman Farming.* London: Thames and Hudson.

Whitehead, P. F. 2002. Honeybee predation by *Dolichovespula sylvestris* (Scopoli) (Hym., Vespidae) in Worcestershire. *Entomologist's Monthly Magazine* 138, 49.

Whitehouse, N. J. (1993). *A mid-Holocene forested site from Thorne Moors: the fossil insect evidence*. Unpublished MSc thesis, University of Sheffield.

Whitehouse, N. J. (1997a). *Insect faunas associated with* Pinus sylvestris *L. from the Mid-Holocene of the Humberhead Levels, Yorkshire, U. K.*, pp 293-303 in Ashworth, A. C., Buckland, P. C. and Sadler, J. P. (eds.), Studies in Quaternary entomology - and inordinate fondness for insects. *Quaternary Proceedings* 5. Chichester, UK: Wiley.

Whitehouse, N. J. (1997b). Silent witnesses: an 'Urwald' fossil insect assemblage from Thorne Moors. *Thorne and Hatfield Moors Papers* 4, 19-54.

Whitehouse, N. J. (1998). *The evolution of the Holocene wetland landscape of the Humberhead Levels from a fossil insect perspective.* Unpublished PhD thesis, University of Sheffield.

Whitehouse, N. J. (2000). Forest fires and insects: palaeoentomological research from a subfossil burnt forest. *Palaeogeography, Palaeoclimatology, Palaeoecology* 164, 231-246.

Whitehouse, N. J. (2004). Mire ontogeny, environmental and climate change inferred from fossil beetle assemblages from Hatfield Moors, eastern England. *The Holocene* 14, 79-93.

Whitehouse, N. J., Boswijk, G. and Buckland, P. C. (1997). Peatlands, Past, Present and Future: Some Comments from the Fossil Record, pp. 54-64 in Parkyn, L., Stoneman, R. E.and Ingram, H. A. P. (eds.), *Conserving Peatlands*. Oxford: CAB International.

Whitehouse, N. J., Buckland, P. C., Boswijk, G. and Smith, B. M. (2001a). Hatfield Moors (SE 7006), pp. 179-183 in Bateman, M. D., Buckland, P. C., Frederick, C. D. and Whitehouse, N. J. (eds.), *The Quaternary of East Yorkshire and North Lincolnshire. Field Guide*. London: Quaternary Research Association.

Whitehouse, N. J., Buckland, P. C., Wagner, P. and Smith, B. M. (2001b). Lindholme Island (SE 708063), pp. 185-193 in Bateman, M. D., Buckland, P. C., Frederick, C. D. and Whitehouse, N. J. (eds.), *The Quaternary of East Yorkshire and North Lincolnshire. Field Guide*. London: Quaternary Research Association.

Whitehouse, N. J. and Eversham, B. C. (2002). A fossil specimen of *Pterostichus angustatus* (Duftschmid) (Carabidae): implications for the importance of pine and fire habitats. *The Coleopterist* 11, 107-114.

Whiteside, M. C. and Swindoll, M. R. (1988). Guidelines and limitations to cladoceran palaeoecological interpretations. *Palaeogeography, Palaeoclimatology, Palaeoecology* 62, 405-412.

Whittaker, J. E. (1981). *Ostracoda*, p. 187 in McGrail, S. (ed.), The Brigg 'raft' and her prehistoric environment. *B.A.R. British Series* 89. Oxford.

Whyman, M. and Howard, A. (2005). *Archaeology and landscape in the Vale of York*. York: York Archaeological Trust.

Wickham-Jones, C. (2003). The tale of the limpet. *British Archaeology* 71, 23.

Wilkinson, B. J. (1981). Quaternary Sub-fossil Trichoptera Larvae from a Site in the English Lake District, pp. 409-419 in Moretti, G. P. (ed.), *Proceedings of the 3rd International Symposium on* Trichoptera*.* The Hague: Junk (*Series Entomologica,* 20).

Wilkinson, B. J. (1987). *Caddis Fly (*Trichoptera*) Remains*, pp. 247-248 in Balaam, N. D., Levitan, B. and Straker, V. (eds.), Studies in palaeoeconomy and environment in South West England. *British Archaeological Reports British Series* 181. Oxford.

Wilkinson, B. J.(1989) [caddis flies], in Hayfield, C. and Greig, J. (eds.), Excavation and Salvage Work on a Moated Site at Cowick, South Humberside, 1976. *Yorkshire Archaeological Journal* 61, 47-70.

Wilkinson, D. M. and Clapham, A. J. (1996). Subfossil Trichoptera larval cases from two British Holocene sites. *Entomologist's Gazette* 47, 277-278.

Williams, B. S. (1930). A new method of capturing Coleoptera in flight. *Entomologist's Monthly Magazine* 66, 253-255.

Williams, D. (1975). Archaeology goes to seed. *Interim* 2 (4), 27-33. [A popular introduction to plants in archaeology.]

Williams, D. J. (1985). The British and some other European Eriococcidae (Homoptera: Coccoidea). *Bulletin of the British Museum Natural History (Entomology)* 51, 347-393.

Williams, N. E. (1988). The use of caddisflies (Trichoptera) in paleoecology. *Palaeogeography, Palaeoclimatology, Palaeoecology* 62, 493-500. (also published in J.Gray (ed.) *Paleolimnology,* 493-500. Elsevier, Amsterdam.

Williams, N. E. (1989). Factors affecting the interpretation of caddisfly assemblages from Quaternary sediments. *Journal of Paleolimnology* 1, 241-248.

Williamson, M. (1996). *Biological invasions. Population and community biology series 15*. London etc: Chapman and Hall.

Williamson, M. and Gaston, K. J. (2005). The lognormal distribution is not an appropriate null hypothesis for the species-abundance distribution. *Journal of Animal Ecology* 74, 409-422.

Wilson, A. and Rackham, D. J. (1976). *Parasite eggs*, pp. 32-3 in Buckland, P. C., The environmental evidence from the Church Street Roman sewer system. *The Archaeology of York* 14 (1), 1-44. London: Council for British Archaeology.

Wilson, R. C. L., Drury, S. A. and Chapman, J. L. (2000). *The great ice age: climate change and life*. London and New York: Routledge.

Wilson, S. J. (1991). The correlation of the Speeton shell bed, Filey Bay, Yorkshire, to an oxygen isotope stage. *Proceedings of the Yorkshire Geological Society* 48, 223-226.

Winder, J. (1980). *The marine mollusca*, pp. 121-127 in Holdsworth, P., Excavations at Melbourne Street, Southampton, 1971-76. *Council for British Archaeology Research Report* 33.

Winder, J. M. (1992). *A study of the variation in oyster shells from archaeological sites and a discussion of oyster exploitation*. PhD. Thesis, University of Southampton, Department of Archaeology, 304pp. [Original not seen in its entirety.]

Witte, H. J. L., Coope, G. R., Lemdahl, G. and Lowe, J. J. (1998). Regression coefficients of thermal gradients in northwestern Europe during the last glacial-Holocene transition using beetle MCR data. *Journal of Quaternary Science* 13, 435-445.

Wood, J., Ferrell, R. and Dewitte-Avina, S. N. (2003). The temporal dynamics of the fourteenth-century Balck Death: new evidence from English ecclesiastical records. *Human Biology* 75, 427-448.

Wood, P. C. (1968). Dinoflagellate crop in the North Sea. *Nature, London* 220, 21.

Woodland, W. A., Charman, D. J. and Sims, P. C. (1998). Quantitative estimates of water tables and soil moisture in Holocene peatlands from testate amoebae. *The Holocene* 8, 261-273.

Woodroffe, G. E. (1953). An ecological study of the insects and mites in the nests of certain birds in Britain. *Bulletin of Entomological Research* 44, 739-72.

Woodward, T. (1983). Shell table, pp. 150-153 in Miket, R., *The Roman fort at South Shields: excavation of the defenses 1977-1981*. Tyne and Wear: Tyne and Wear County Council Museums.

Woodward, T. E. (1951). A case of persistent attacks on a human by *Lyctocoris campestris* (F.) (Hem. Anthocoridae). *Entomologist's Monthly Magazine* 87, 44.

Worsley, P., Coope, G. R., Good, T. R., Holyoak, D. T. & Robinson, J. E. (1983). A Pleistocene succession from beneath Chelford Sands at Oakwood Quarry, Chelford, Cheshire. *Geological Journal* 18, 307-324.

Wouters, J. and Verhecken, A. (1989). The coccid insect dyes: HPLC and computerised diode-array analysis of dyed yarns. *Studies in Conservation* 34, 189-200.

Wrathmell, S. (1990). *Discussion of Well 1 and its contents*, pp. 271-2 in Wrathmell, S. and Nicholson, A. (eds.), Dalton Parlours: Iron Age settlement and Roman Villa Site. *Yorkshire Archaeology* 3. Wakefield: West Yorkshire Archaeology Service.

Wright, E. V. and Churchill, D. M. (1965). The boats from North Ferriby, Yorkshire, England, with a review if the origins of the sewn boats of the Bronze Age. *Proceedings of the Prehistoric Society* 31, 1-24.

Wright, C. J. and Fletcher, M. (1995). *Higher Lane, Fazakerley, Merseyside. Assessment of evaluation and of excavation*. Lancaster University Archaeological Unit, Report to H.M. Prison Service, June 1995.

Wright, E. V. and Churchill, D. M. (1965). The boats from North Ferriby, Yorkshire, England, with a review of the origins of the sewn boats of the Bronze Age. *Proceedings of the Prehistoric Society* 31, 1-24.

Wright, E. V. and Wright, C. W. (1947). Prehistoric boats from North Ferriby, East Yorkshire. *Proceedings of the Prehistoric Society* 13, 114-138.

Wright, P. (2003). Preservation or destruction of plant remains by carbonisation? *Journal of Archaeological Science* 30, 577-583.

Wright, P. J. (2005). Flotation samples and some palaeoethnobotanical implications. *Journal of Archaeological Science* 32, 19-26.

Yong, Z., Fournier, P-E., Rydkina, E. and Raoult, D. (2003). The geographical segregation of human lice preceded that of *Pediculus humanus capitis* and *Pediculus humanus humanus*. *Comptes Rendus Biologies* 326, 565-574.

Yonge, C. M. (1960). *Oysters*. London: Collins.

York Archaeological Trust (1988). *The waterfronts of York*. York: YAT.

Yvinec, J. H., Ponel, P. and Beaucournu, J-C. (2000). Premieres apports archeoentomologiques de l'etude des Puces: aspects historiques et anthoplogiques (Siphonaptera). *Bulletin de la Societe Entomologique de France* 104, 419-425.

Zeuner, F. E. (1963a). The silk-moths, pp. 484-492 (+ references) in Zeuner, F. E., *A history of domesticated animals*. London: Hutchinson.

Zeuner, F. E. (1963b). The honey-bee, pp. 493-508 (+references) in Zeuner, F. E., *A history of domesticated animals*. London: Hutchinson.

Zumpt, F. (1965). *Myasis in man and animals in the Old World.* London: Butterworth.

B. References: EAU, CHP and PRS reports

Numbers in brackets, eg [91/2] have been added to early EAU reports post-hoc, so as to bring pre-1994 unpublished reports into line with *Reports from the EAU* and provide a stable reference system for these old reports. All these reports are referenced in the text using the report number because to use conventional year and letter references for (eg.) the Carrott *et al.* entries would be impossibly ponderous. Note, however, that the initial tags used in the references have been modified as follows for the purposes of automatic sorting: EAU full year / report number with leading zero if less than 10, so that, for example, ' 91/1' becomes 'EAU 1991/01'. Note also that sorting is literal, e.g. 'Carrott and ...' precedes 'Carrott EAU' and this in turn precedes 'Carrott *et al.*'.

Akeret *et al.* PRS 2005/64 Akeret, Ö., Mant, J., Jaques, D., Carrott, J. and Gardner, S. (2005). Evaluation of biological remains from excavations on land to the west of the Railway Hotel, 5 Middle Street South, Driffield, East Riding of Yorkshire (site code: DRH2005). *Palaeoecology Research Services Report* 2005/64.

Akeret *et al.* PRS 2004/72 Akeret, Ö., Mant, J., Jaques, D., Carrott, J. and Gardner, S. (2004). Evaluation of biological remains from excavations at 5 The Burrs, Brough, East Riding of Yorkshire (site code: TBB2004). *Palaeoecology Research Services Report* 2004/72.

Akeret *et al.* PRS 2004/76 Akeret, Ö., Allison, E., Carrott, J., Gardner, S., Jaques, D and Mant, J. (2004). Evaluation of biological remains from excavations at Blaydes Staith, High Street, Kingston upon Hull (site code: BLD2004). *Palaeoecology Research Services Report* 2004/76.

Akeret *et al.* PRS 2004/77 Akeret, Ö., Carrott, J., Mant, J., Jaques, D. and Gardner, S. (2004). Evaluation of biological remains from land adjacent to Hull High School, Tranby Croft, Anlaby, East Riding of Yorkshire (site code: TCA2004). *Palaeoecology Research Services Report* 2004/77.

Akeret *et al.* PRS 2004/87 Akeret, Ö., Allison, E., Mant, J., Carrott, J., Jaques, D. and Gardner, S. (2004). Evaluation of biological remains from excavations at Hull Central Dry Dock, Humber Street, Kingston upon Hull (site code: HDD2004). *Palaeoecology Research Services Report* 2004/87.

Akeret *et al.* PRS 2005/10 Akeret, Ö., Allison, E., Carrott, J., Jaques, D. and Mant, J. (2005). Assessment of biological remains from excavations on the site of the former Henlys of York filling station, The Stonebow, York (site code: YORYM 2004.148). *Palaeoecology Research Services Report* 2005/10.

Akeret *et al.* PRS 2005/14 Akeret, Ö., Carrott, J., Jaques, D. and Gardner, S. (2005). Technical report: biological remains from one sediment sample from excavations at Baldwin Avenue, Bottesford, Scunthorpe, North Lincolnshire (site code: BWA01). *Palaeoecology Research Services Report* 2005/14.

Akeret *et al.* PRS 2005/21 Akeret, Ö., Carrott, J. and Jaques, D. (2005). Evaluation of biological remains from excavations on land to the north of North Road Industrial Estate, Berwick-upon-Tweed, Northumberland (site code: NRB04). *Palaeoecology Research Services Report* 2005/21.

Akeret *et al.* PRS 2005/26 Akeret, Ö., Gardner, S. and Carrott, J. (2005). Assessment of plant macrofossil remains recovered from samples from deposits associated with a Neolithic trackway at Lindholme, Hatfield Moors, South Yorkshire. *Palaeoecology Research Services Report* 2005/26.

Akeret *et al.* PRS 2005/61 Akeret, Ö., Mant, J., Jaques, D., and Gardner, S. (2005). Evaluation of biological remains from excavations at 5 High Street, Yarm, Stockton on Tees (site code: YHS05). *Palaeoecology Research Services Report* 2005/61.

Akeret *et al.* PRS 2005/63 Akeret, Ö., Allison, E., Gardner, S. and Carrott, J. (2005). Assessment of biological remains recovered from a single sample from an intertidal peat exposure at Chowder Ness, North Lincolnshire. *Palaeoecology Research Services Report* 2005/63.

Akeret *et al.* PRS 2004/71 Akeret, Ö., Carrott, J., Mant, J., Jaques, D. and Gardner, S. (2004). Evaluation of biological remains from excavations on land at Station Farm Cottage, Souttergate, Hedon, East Riding of Yorkshire (site code: SFH2004). *Palaeoecology Research Services Report* 2004/71.

Akeret *et al.* PRS 2005/87 Akeret, Ö., Mant, J., Jaques, D., Carrott, J. and Gardner, S. (2005). Evaluation of biological remains from excavations at Beverley Health Centre, Beverley, East Riding of Yorkshire (site code: BHC2004). *Palaeoecology Research Services Report* 2005/87.

Akeret *et al.* PRS 2005/89 Akeret, Ö., Carrott, J., Mant, J., Jaques, D. and Gardner, S. (2005). Assessment of biological remains from sediment samples from excavations at 62-68 Low Petergate, York (site code: YORYM 2002.421). *Palaeoecology Research Services Report* 2005/89.

Akeret *et al.* PRS 2005/93 Akeret, Ö., Mant, J., Carrott, J. Jaques, D., Gardner, S. and Upex, B. (2005). Assessment of biological remains from excavations alongside the A63 at Melton, East Riding of Yorkshire (site code: OSA04EX03). *Palaeoecology Research Services Report* 2005/93.

Akeret *et al.* PRS 2005/103 Akeret, Ö., Mant, J., Carrott, J. Jaques, D., Gardner, S. and Upex, B. (2005). Assessment of biological remains from excavations at Faverdale East Business Park, Darlington, County Durham (site code: FAV04). *Palaeoecology Research Services Report* 2005/103.

Akeret *et al.* PRS 2005/105 Akeret, Ö., Mant, J., Carrott, J., Upex, B. and Jaques, D. (2005). Assessment of biological remains from further excavations at North Road Industrial Estate, Berwick-upon-Tweed, Northumberland (site code: NRB05). *Palaeoecology Research Services Report* 2005/105.

Alldritt *et al.* EAU 1991/01 Alldritt, D. M., Carrott, J. B., Hall, A. R. and Kenward, H. K. (1991). *Environmental evidence from 17-21 Piccadilly (Reynard's Garage) YAT/Yorkshire Museum sitecode 1990-1.29).* Prepared for York Archaeological Trust. [91/1]

Alldritt *et al.* EAU 1991/02 Alldritt, D., Carrott, J. B., Hall, A. R. and Kenward, H. K. (1991). *Environmental evidence from 89 The Mount (YAT/Yorkshire Museum sitecode: 1991.4).* Prepared for York Archaeological Trust. [91/2]

Alldritt *et al.* EAU 1991/03 Alldritt, D. M., Carrott, J. B., Hall, A. R., Kenward, H. K. and Nicholson, R. A. (1991). *Environmental evidence from excavations at the Ideal Laundry site, Trinity Lane, York (YAT/Yorkshire Museum sitecode 1991.5).* Prepared for York Archaeological Trust. [91/3]

Alldritt *et al.* EAU 1990/01 Alldritt, D., Carrott, J. B., Hall, A. R., Kenward, H. K. and Richardson, J. E. (1990). *Environmental evidence from Adams Hydraulics I (YAT/Yorkshire Museum sitecode: 90.13).* Prepared for York Archaeological Trust. [90/1]

Allen AML 4203 Allen, M. J. (1984). Land snails from Wharram Percy. *Ancient Monuments Laboratory Report* 4203.

Allen AML 4144 Allen, M. J. (1984). Mollusca from Barnard Castle. *Ancient Monuments Laboratory Report* 4144.

Alldritt *et al.* EAU 1991/35 Alldritt, D., Carrott, J. B., Hall, A. R. and Kenward, H. K. (1991). *Plant and invertebrate animal remains from Park Grange Farm, Long Lane, Beverley, N. Humberside*. Prepared for Humberside Archaeological Unit. [91/35]

Allison *et al.* EAU 1991/06 Allison, E. P., Carrott, J. B., Hall, A. R. and Kenward, H. K. (1991). *Environmental evidence from 14 Skeldergate (YAT/Yorkshire Museum sitecode: 1991.14).* Prepared for York Archaeological Trust. [91/6]

Allison *et al.* AML 21/90 Allison, E. P., Hall, A. R., Kenward, H. K., McKenna, W. J. B, Nicholson, C. M. and O'Connor, T. P. (1990). Environmental Evidence from the Dominican Friary, Beverley. *Ancient Monuments Laboratory Report* 21/90 (Includes data appendices 1-3).

Allison and Kenward EAU 1991/09 Allison, E. P. and Kenward, H. K. (1991). *Insect remains from St Kilda (SK89).* Prepared for J. Huntley, University of Durham. [91/9]

Allison *et al.* EAU 1989/02 Allison, E. P., Hall, A. R., Jones, A.K.G., Kenward, H. K. and Robertson, A. (1989). *Report on plant and invertebrate remains from Anglian deposits from excavations at 46-54 Fishergate, York (site code 1985-6.9).* Prepared for York Archaeological Trust. [89/2]

Allison *et al.* EAU 1989/03 Allison, E. P., Kenward, H. K., Large, F. and Morgan, L. (1989). *Insect remains from the Castle Street, Carlisle site.* Prepared for Carlisle Archaeological Unit. [89/3]

Allison *et al.* AML 105/90 Allison, E. P., Hall, A. R., Kenward, H. K., McKenna, B. and Robertson, A. (1990). Biological remains from excavations at North Cave, N. Humberside. *Ancient Monuments Laboratory Report* 105/90.

Allison *et al.* EAU 1990/02 Allison, E. P., Carrott, J. B., Hall, A. R., Kenward, H. K. and Richardson, J. E. (1990). *Environmental evidence from St George's Fields car park (1990 excavation).* Prepared for York Archaeological Trust. [90/2]

Allison *et al.* EAU 1990/05 Allison, E. P., Hall, A. R., Kenward, H. K. and O'Connor, T. P. (1990). *Environmental evidence from the Roman settlement, Staniwells Farm, Hibaldstow, Humberside, 1988.* Prepared for Humberside Unit. [90/5]

Allison *et al.* EAU 1990/07 Allison, E. P., Kenward, H. K., and Tomlinson, P. R. (1990). *Environmental analysis of samples from Area 86.53H, Peel Castle, Isle of Man.* Prepared for D. Freke, University of Liverpool. [90/7]

Allison *et al.* EAU 1991/05 Allison, E. P., Carrott, J. B., Hall, A. R. and Kenward, H. K. (1991). *Environmental evidence from Adams Hydraulics III (YAT/Yorkshire Museum sitecode 1991.13).* Prepared for York Archaeological Trust. [91/5]

Allison *et al.* EAU 1988/03 Allison, E. P., Hall, A. R. and Kenward, H. K. (1988). *Biological remains from Oakwell Hall, Birstall, West Yorkshire.* Prepared for J. Gilks. [88/3]

Allison *et al.* EAU 1997/37 Allison, E., Carrott, J., Hall, A., Kenward, H., Large, F., McKenna, B. and Robertson, A. (1997). Publication draft: Plant and invertebrate remains from Iron Age and Romano-British deposits at North Cave, East Yorkshire. *Reports from the Environmental Archaeology Unit, York* 97/37, 43 pp.

Allison *et al.* EAU 1999/08 Allison, E., Hall, A. and Kenward, H. (1999). Technical report. Living conditions and resource exploitation at the Early Christian rath at Deer Park Farms, Co. Antrim, N. Ireland: evidence from plants and invertebrates. Part 1: Text. *Reports from the Environmental Archaeology Unit, York* 99/8, 64 pp.

Allison *et al.* EAU 1999/10 Allison, E., Hall, A. and Kenward, H. (1999). Technical report. Living conditions and resource exploitation at the Early Christian rath at Deer Park Farms, Co. Antrim, N. Ireland: evidence from plants and invertebrates. Part 2:Tables. *Reports from the Environmental Archaeology Unit, York* 99/10, 144 pp.

Allison *et al.* PRS 2005/109 Allison, E., Carrott, J., Johnson, K. and Gardner, S. (2005). Technical report: Invertebrate remains from a watching brief at Danes Moss, Macclesfield, Cheshire (project code: 10142). *Palaeoecology Research Services Report* 2005/109.

Allison *et al.* EAU 1989/01 Allison, E. P., Hall, A. R., Jones, A.K.G., Kenward, H. K. and Robertson, A. (1989). *Report on plant and invertebrate remains from deposits associated with the Gilbertine Priory of St Andrew, from excavations at 46-54 Fishergate, York (site code 1985-6.9).* Prepared for York Archaeological Trust. [89/1]

ASUD 678 Archaeological Services University of Durham (2000). The Milfield Basin Archaeology Project, Northumberland: plant macrofossil, waterlogged wood and charcoal assessment. *ASUD Report* 678. Durham: ASUD.

ASUD 791 ASUD (Archaeological Services University of Durham) (2001). Bridgegate, Howden, HBG01: Plant macrofossil evaluation. *ASUD Report* 791.

Bailey *et al.* EAU 1994/10 Bailey, S., Carrott, J., Dobney, K., Hall, A., Jaques, D., Jones, A., Milles, A. and Turner, E. (1994). Assessment of biological remains from excavations at Mount Grace Priory, N. Yorkshire (MG89-92). *Reports from the Environmental Archaeology Unit, York* 94/10, 17 pp.

Bastow WYAS 801 Bastow, M. (2000). *Macrobiological remains*, pp. 30-33 in O'Neill, R., Land off Venn Street, Huddersfield, West Yorkshire. *WYAS Report* 801. Wakefield.

Brothwell *et al.* EAU 1994/55 Brothwell, D., Carrott, J., Dobney, K., Hall, A., Issitt, M., Jaques, D., Kenward, H. and Large, F. (1994). An evaluation of biological remains from excavations at Blue Bridge Lane, York (site code: 94.2288). *Reports from the Environmental Archaeology Unit, York* 94/55, 5 pp.

Brothwell *et al.* EAU 1995/11 Brothwell, D., Carrott, J., Dobney, K., Hall, A., Issitt, M., Jaques, D., Johnstone, C., Large, F., Milles, A. and Roberts, G. (1995). An evaluation of biological remains from excavations at Thirsk Castle, North Yorkshire (site code: TC94). *Reports from the Environmental Archaeology Unit, York* 95/11, 10 pp.

Buckland EAU 1997/47 Buckland, P. C. (1997). *The end of Norse Greenland: recent work at GUS*, pp. 7-8 in Jaques, D. and Dobney, K. (compilers) (1997), Centre for Palaeoecology Research Forum 1997: Synthesis. Abstracts from a one-day forum held at the Tempest Anderson Hall, York on 29th October 1997. *Reports from the Environmental Archaeology Unit, York* 97/47, 15 pp.

Buckland ARCUS 208 Buckland, Philip. (1995). *St George's School, Margaret Street, Walmgate, York. The insect remains*, unpaged appendix in Foster, P. and Symonds, J., An archaeological evaluation at St George's School, Margaret Street, Walmgate, York. *Arcus* no. 208.

Cameron AML 3041 Cameron, R. A. (1980). Hibaldstow: Mollusca. *Ancient Monuments Laboratory Report* 3041.

Canti AML 53/92 Canti, M. (1992). Research into natural and anthropogenic deposits from the excavations at Flixborough, Humberside. *Ancient Monuments Laboratory Report* 53/92.

Carrott and Hall PRS 2003/08 Carrott, J. and Hall, A. (2003). Evaluation of biological remains from further excavations at Sewerby Cottage Farm, Bridlington, East Riding of Yorkshire (site code: ERYMS1999/20). *Palaeoecology Research Services Report* 2003/08.

Carrott and Hall PRS 2003/15 Carrott, J. and Hall, A. (2003). Evaluation of biological remains from excavations at Hob Moor Junior School, York (site code: OSA02EV13). *Palaeoecology Research Services Report* 2003/15.

Carrott and Hall PRS 2003/16 Carrott, J. and Hall, A. (2003). Evaluation of biological remains from excavations at St Oswald's School, Fulford, York. *Palaeoecology Research Services Report* 2003/16.

Carrott and Jaques EAU 2001/47 Carrott, J. and Jaques, D. (2001). Notes on biological remains from excavations at land off Little Wold Lane, South Cave, Humberside (site code: KINCM 2000.223). *Reports from the Environmental Archaeology Unit, York* 2001/47, 3 pp.

Carrott and Jaques PRS 2002/40 Carrott, J. and Jaques, D. (2002). Evaluation of biological remains from excavations at land off Station Road, Middleton-on-the-Wolds, East Riding of Yorkshire (site code: ERYMS2002.47). *Palaeoecology Research Services Report* 2002/40.

Carrott and Hall EAU 1999/62 Carrott, J. and Hall, A. (1999). Evaluation of biological remains from A66 improvements (archaeological trial trenching), Greta Bridge to Stephen Bank and Carkin Moor to Scotch Corner, North Yorkshire (site code: ASS99). *Reports from the Environmental Archaeology Unit, York* 99/62, 5 pp.

Carrott and Johnson PRS 2003/84 Carrott, J. and Johnson, K. (2003). Assessment of biological remains from further excavations at Sewerby Cottage Farm (farmyard area), Bridlington, East Riding of Yorkshire (site code: OSA03EX02) *Palaeoecology Research Services Report* 2003/84.

Carrott and Cousins PRS 2003/44 Carrott, J. and Cousins, S. (2003). Evaluation of biological remains from excavations at land adjacent to Cleveland House, Goldsborough, North Yorkshire (site code: OSA03EV03). *Palaeoecology Research Services Report* 2003/44.

Carrott and Cousins PRS 2003/55 Carrott, J. and Cousins, S. (2003). Evaluation of biological remains from excavations at Site 3, a site on the Elvington to Ricall water pipeline, North Yorkshire (site code: ERP02). *Palaeoecology Research Services Report* 2003/55.

Carrott *et al.* EAU 1994/31 Carrott, J., Hall, A., Issitt, M., Kenward, H. and Large, F. (1994). Evaluation of biological remains from excavations at St Helens Road, Dringhouses, York (site code SHR 94). *Reports from the Environmental Archaeology Unit, York* 94/31, 4 pp.

Carrott and Kenward EAU 1998/36 Carrott, J. and Kenward, H. (1998): Multum in parvo: the significance of small archaeological insect assemblages, p. 10 in Jaques, D. and Dobney, K. (eds.), Research Forum 1998. Abstracts from a one-day forum held at the Tempest Anderson Hall, York on 28th October 1998. *Reports from the Environmental Archaeology Unit, York* 98/36, 13 pp.

Carrott and Large EAU 1997/29 Carrott, J. and Large, F. (1997). Evaluation of biological remains from excavations at Welton Low Road, Elloughton (site code: 1997.44). *Reports from the Environmental Archaeology Unit, York* 97/29, 4 pp.

Carrott EAU 1999/48 Carrott, J. (1999). Hare and Hounds, Staxton - environmental sample. Reports from the Environmental Archaeology Unit, York 99/48, 1 p.

Carrott EAU 2000/05 Carrott, J. (2000). Redmires abandonment: brief notes on biological remains from one sample. *Reports from the Environmental Archaeology Unit, York* 2000/05, 1 p.

Carrott EAU 2000/54 Carrott, J. (2000). Hand collected shell from excavations at Flixborough, North Lincolnshire (site code: FLX89). *Reports from the Environmental Archaeology Unit, York* 2000/54, 33 pp.

Carrott EAU 2000/55 Carrott, J. (2000). Mollusc remains (other than shellfish) recovered from bulk sediment samples from excavations at Flixborough, North Lincolnshire (site code: FLX89). *Reports from the Environmental Archaeology Unit, York* 2000/55, 13 pp.

Carrott et al. EAU 1990/08 Carrott, J., Hall, A. R., Kenward, H. K. and O'Connor, T. P. (1990). *Report on investigations of biological samples from boreholes and trenches at Garden Place, York* (YAT/Yorkshire Museum code 1989.6). Prepared for York Archaeological Trust. [90/8]

Carrott *et al.* EAU 1991/10 Carrott, J., Hall, A. R. and Kenward, H. K. (1991). *Environmental evidence from 26-34 Skeldergate (YAT/Yorkshire Museum sitecode 1991.1).* Prepared for York Archaeological Trust. [91/10]

Carrott *et al.* EAU 1991/11 Carrott, J. B., Hall, A. R. and Kenward, H. K. (1991). *Environmental evidence from 41-49 Walmgate/George St. (YAT/Yorkshire Museum sitecode: 90.26).* Prepared for York Archaeological Trust. [91/11]

Carrott *et al.* EAU 1991/12 Carrott, J. B., Hall, A. R. and Kenward, H. K. (1991). *Environmental evidence from Adams Hydraulics II (YAT/Yorkshire Museum sitecode: 90.13).* Prepared for York Archaeological Trust. [91/12]

Carrott *et al.* EAU 1991/13 Carrott, J. B., Hall, A. R. and Kenward, H. K. (1991). *Environmental evidence from 13-17 Coney Street (YAT/Yorkshire Museum sitecode: 1991.3).* Prepared for York Archaeological Trust. [91/13]

Carrott *et al.* EAU 1991/14 Carrott, J. B., Hall, A. R. and Kenward, H. K. (1991). *Environmental evidence from St Leonard's Church, Malton (YAT/Yorkshire Museum sitecode: 1991.5006).* Prepared for York Archaeological Trust. [91/14]

Carrott *et al.* EAU 1991/15 Carrott, J. B., Hall, A. R. and Kenward, H. K. (1991). *Assessment of biological remains from excavations at Carmelite Street, York (YAT/Yorkshire Museum sitecode: 1991.9).* Prepared for York Archaeological Trust. [91/15]

Carrott *et al.* EAU 1991/16 Carrott, J. B., Hall, A. R., Kenward, H. K. and Milles, A. (1991). *An evaluation of biological evidence from excavations at the Fiat Garage site, 84 Piccadilly, York (YAT site code 1991.16).* Prepared for York Archaeological Trust. [91/16]

Carrott *et al.* EAU 1991/17 Carrott, J. B., Hall, A. R., Kenward, H. K. and O'Connor, T. P. (1991). *Environmental evidence from Station Yard, Beverley (YAT/Yorkshire Museum sitecode 1991.5005).* Prepared for York Archaeological Trust. [91/17]

Carrott *et al.* EAU 1991/18 Carrott, J. B., Hall, A. R., Kenward, H. K. and Large, F. (1991). *Environmental evidence from excavations at 12-20 Blossom Street (YAT/Yorkshire Museum sitecode: 1991.11).* Prepared for York Archaeological Trust. [91/18]

Carrott *et al.* EAU 1991/19 Carrott, J. B., Hall, A. R., Kenward, H. K. and Nicholson, R. N. (1991). *An assessment of biological remains from excavations at the Methodist Church, St Saviourgate, York.* Prepared for MAP, Malton. [91/19]

Carrott *et al.* EAU 1992/01 Carrott, J. B., Dainton, M., Dobney, K. M., Hall, A. R., Kenward, H. K. and Milles, A. (1992). *Biological evidence from excavations at Malmo Road, Kingston-upon-Hull.* Prepared for Humberside Archaeological Unit. [EAU 92/1]

Carrott et al. EAU 1992/02 Carrott, J. B., Dobney, K. M., Hall, A. R. and Milles, A. (1992*). Investigation of plant and invertebrate remains from the Anglian cemetery at Castledyke, Barton-on-Humber, S. Humberside* (site code CS89-90). Prepared for Humberside Archaeological Unit. [EAU 92/2]

Carrott et al. EAU 1992/03 Carrott, J. B., Dobney, K. M., Hall, A. R. and Kenward, H. K. (1992). An evaluation of biological remains from excavations at 104-112 Walmgate, York (YAT site code 1991.21). Prepared for York Archaeological Trust. [EAU 92/3]

Carrott *et al.* EAU 1992/04 Carrott, J. B., Dobney, K. M., Hall, A. R. and Kenward, H. K. (1992). *An evaluation of biological remains from excavations in Baxtergate, Whitby (site code WHITBY 92).* Prepared for Malton Archaeological Projects. [EAU 92/4]

Carrott *et al.* EAU 1992/05 Carrott, J. B., Dobney, K. M., Hall, A. R., Kenward, H. K., Milles, A. and Nicholson, R. (1992). *Evaluation of biological remains from boreholes at Palmer Lane, York (YAT/Yorkshire Museum code 1992.3).* Prepared for York Archaeological Trust. [EAU 92/5]

Carrott *et al.* EAU 1992/06 Carrott, J. B., Dobney, K. M., Hall, A. R., and Kenward, H. K. (1992). *Environmental evidence from Castle Car Park, York (YAT/Yorkshire Museum site code: 1992.5).* Prepared for York Archaeological Trust. [EAU 92/6]

Carrott *et al.* EAU 1992/08 Carrott, J. B., Dobney, K. M., Hall, A. R., Kenward, H. K. and Milles, A. (1992). *An evaluation of environmental evidence from excavations at 50 Piccadilly, York (YAT/Yorkshire Museum site code: 1992.10).* Prepared for York Archaeological Trust. [EAU 92/8]

Carrott *et al.* EAU 1992/09 Carrott, J. B., Dobney, K. M., Hall, A. R., Kenward, H. K. and Milles, A. (1992). *An evaluation of environmental evidence from excavations at 38 Piccadilly, York (YAT/Yorkshire Museum site code: 1992.4).* Prepared for York Archaeological Trust. [EAU 92/9]

Carrott *et al.* EAU 1992/10 Carrott, J. B., Dobney, K. M., Hall, A. R., Kenward, H. K. and Milles, A. (1992). *Biological evidence from excavations at 26-28 Marygate, York (YAT/Yorkshire Museum site code 1992.11).* Prepared for York Archaeological Trust. [EAU 92/10]

Carrott et al. EAU 1992/11 Carrott, J. B., Dobney, K. M., Hall, A. R., Kenward, H. K. and Milles, A. (1992). Environmental evidence from a second trial excavation at Rawcliffe Manor, Manor Lane, Rawcliffe, York (Y.A.T./Yorkshire Museum sitecode: 1992.5007). Prepared for York Archaeological Trust. [EAU 92/11]

Carrott *et al.* EAU 1992/12 Carrott, J. B., Dobney, K. M., Hall, A. R., Kenward, H. K. and Milles, A. (1992). *An evaluation of the bioarchaeological value of some Roman and medieval deposits and bone from excavations in Albion Street, Driffield, North Humberside (site code DAD92).* Prepared for Humberside Archaeological Unit. [EAU 92/12]

Carrott *et al.* EAU 1992/13Carrott, J. B., Hall, A. R., and Kenward, H. K. (1992). *An evaluation of biological remains from excavations at 47 Blossom Street, York (YAT site code 1991.22).* Prepared for York Archaeological Trust. [EAU 92/13]

Carrott *et al.* EAU 1993/01 Carrott, J., Dobney, K., Hall, A., Issitt, M., Jaques, D., Kenward, H., Lancaster, S. and Milles, A. (1993). *Evaluation of biological remains from excavations in Champney Road, Beverley (site code BCR93).* 8 pp. Prepared for Humberside Archaeology Unit. [93/1]

Carrott *et al.* EAU 1993/02 Carrott, J., Dobney, K., Hall, A., Irving, B., Jaques, D. and Kenward, H. (1993). *Evaluation of biological remains from excavations at St Andrewgate, York (YAT/Yorkshire Museum sitecode 1993.16).* 8 pp. Prepared for York Archaeological Trust. [93/2]

Carrott *et al.* EAU 1993/03 Carrott, J., Dobney, K., Hall, A., Jaques, D., Kenward, H. and Manser, I. (1993). *An evaluation of biological remains from medieval and Roman deposits at Bishop Burton, N. Humberside (site code BBB93).* Prepared for Humberside Archaeology Unit. [93/3]

Carrott *et al.* EAU 1993/04 Carrott, J., Dobney, K., Hall, A., Jaques, D., Kenward, H. and Manser, I. (1993). *Biological remains from two medieval ditches at 17-19 St Augustine's Gate, Hedon, N. Humberside (site code HAG93).* Prepared for Humberside Archaeology Unit. [93/4]

Carrott et al. EAU 1993/05 Carrott, J., Dobney, K., Hall, A., Jaques, D., Manser, I. and Kenward, H. (1993). *An evaluation of biological remains from excavations of medieval deposits at North Beckside (site code NBS93) and Beckview Tilery (1827.1986 BLY)*. Prepared for Humberside Archaeology Unit. 93/5]

Carrott *et al.* EAU 1993/06 Carrott, J., Dobney, K., Hall, A., Jaques, D., Kenward, H. and Milles, A. (1993). *An evaluation of biological remains from excavations at Bishop Wilton, N. Humberside (site code VBW93).* Prepared for Humberside Archaeology Unit. [93/6]

Carrott *et al.* EAU 1993/07 Carrott, J., Dobney, K., Hall, A., Jaques, D., Kenward, H., Lancaster, S and Milles, A. (1993). *Evaluation of biological remains from excavations at Flemingate House, Beverley (site code FHB93).* 5 pp. [93/7]

Carrott et al. EAU 1993/08 Carrott, J., Dobney, K., Hall, A., Jaques, D., Kenward, H., Large, F. and Milles, A. (1993). An evaluation of biological remains from excavations on land to the rear of Gowthorpe, Finkle Street and Micklegate in Selby town centre (site code Selby 1993). Prepared for MAP Archaeological Consultancy Ltd. [93/8]

Carrott *et al.* EAU 1993/09 Carrott, J., Dobney, K., Hall, A., Jaques, D., Kenward, H., Large, F. and Milles, A. (1993). *Evaluation of biological remains from further samples from excavations at Bishop Wilton, N. Humberside (site code VBW93).* 3 pp. Prepared for Humberside Archaeology Unit. [93/9]

Carrott *et al.* EAU 1993/10 Carrott, J., Dobney, K., Hall, A., Jaques, D., Lancaster, S. and Kenward, H. K. (1993). *An evaluation of two samples for biological analysis and some bone from excavations at All Saints School, Nunnery lane, York (YAT/Yorkshire Museum site code 1993.13).* 2 pp. Prepared for York Archaeological Trust. [93/10]

Carrott *et al.* EAU 1993/11 Carrott, J., Hall, A., Kent, P. and Kenward, H. (1993). *The bioarchaeological value of deposits from excavations near Stamford Bridge, North Yorkshire.* Prepared for Ian Lawton. [93/11]

Carrott *et al.* EAU 1993/12 Carrott, J., Hall, A. and Kenward, H. (1993). *An examination of samples from excavations at Duggleby Lodge, North Yorkshire, for plant and animal remains.* Prepared for Ian Lawton. 1 page. [93/12]

Carrott *et al.* EAU 1993/13 Carrott, J., Hall, A., Kenward, H., Large, F. and Milles, A (1993). *Plant and invertebrate remains from two fill contexts from a Romano-British pit at Glebe Farm, Barton-upon-Humber, S. Humberside (site code GFA92).* Prepared for Humberside Archaeology Unit. [93/13]

Carrott *et al.* EAU 1993/14 Carrott, J., Hall, A. R., Issitt, M., Kenward, H. and Lancaster, S. (1993). *Assessment of biological remains from Roman to medieval riverside deposits at North Street, York (YAT/Yorkshire Museum code 93.1).* 24 pp. Prepared for York Archaeological Trust. [93/14]

Carrott *et al.* EAU 1993/32 Carrott, J., Dobney, K., Hall, A., Kenward, H., Jaques, D., Large, F. and Milles A, (1993). An assessment of environmental samples from excavations in Crankleys Lane, on the Easingwold by-pass (YAT/Yorkshire Museum sitecode 1993.5000). Prepared for York Archaeological Trust. [93/32]

Carrott *et al.* EAU 1994/01 Carrott, J., Dobney, K., Hall, A., Issitt, M., Jaques, D., Kenward, H., Large, F. and Milles, A. (1994). An evaluation of biological remains from excavations at 34A-40 High Street, Hull (site code HHS93). *Reports from the Environmental Archaeology Unit, York* 94/1, 6 pp.

Carrott *et al.* EAU 1994/05 Carrott, J., Hall, A., Kenward, H., Lancaster, S., Large, F. and Nicholson, C. (1994). A preliminary assessment of biological remains from excavations at North Bridge, Doncaster (site code DNB93). *Reports from the Environmental Archaeology Unit, York* 94/5, 12 pp.

Carrott *et al.* EAU 1994/07 Carrott, J., Dobney, K., Hall, A., Irving, B., Issitt, M., Jaques, D., Kenward, H., Lancaster, S., Large, F. and Milles, A. (1994). Assessment of biological remains from excavations at Carr Naze, Filey, N. Yorkshire (YAT/Yorkshire Museum sitecode 93.5002). *Reports from the Environmental Archaeology Unit, York* 94/7, 13 pp.

Carrott *et al.* EAU 1994/13 Carrott, J., Dobney, K., Hall, A., Jaques, D., Kenward, H., Lancaster, S. and Milles, A. (1994). Assessment of biological remains from excavations at 12-18 Swinegate, 8 Grape Lane, and 14, 18, 20 and 22 Back Swinegate/Little Stonegate, York (YAT/Yorkshire Museum sitecodes 1989-90.28 and 1990.1). *Reports from the Environmental Archaeology Unit, York* 94/13, 16 pp. + 53 pp. appendix.

Carrott *et al.* EAU 1994/17 Carrott, J., Issitt, M., Kenward, H. and Large, F. (1994). Assessment of insect and parasite egg remains from two sites on the M57 Merseyside Link Road - Brook House Farm (BHF34) and Ochre Brook (OB35). *Reports from the Environmental Archaeology Unit, York* 94/17, 9 pp.

Carrott *et al.* EAU 1994/22 Carrott, J., Hall, A., Hill, M., Issitt, M., Jaques, D., Kenward, H., Milles, A. and Nicholson, C. (1994). Evaluation of biological remains from excavations in Cartergate, Grimsby (site code CGG94). *Reports from the Environmental Archaeology Unit, York* 94/22, 7 pp.

Carrott and Kenward EAU 1994/24 Carrott, J. and Kenward, H. (1994). Assessment of insect and parasite egg remains from two additional samples from a site on the M57 Merseyside linkroad - Brook House Farm (BHF34 and BHF36). *Reports from the Environmental Archaeology Unit, York* 94/24, 5 pp.

Carrott *et al.* EAU 1994/25 Carrott, J., Dobney, K., Hall, A., Irving, B., Issitt, M., Jaques, D., Kenward, H., Large, F. and Milles, A. (1994). Assessment of biological remains from excavations at 148 Lawrence Street, York (site code 1993.11). *Reports from the Environmental Archaeology Unit, York* 94/25, 13 pp.

Carrott *et al.* EAU 1994/34 Carrott, J., Hall, A., Hill, M. and Kenward, H. (1994). Assessment of biological remains from Bronze Age deposits at North Duffield, North Yorkshire. *Reports from the Environmental Archaeology Unit, York* 94/34, 13 pp.

Carrott *et al.* EAU 1994/35 Carrott, J., Hall, A., Issitt, M., Large, F. and Milles, A. (1994). Evaluation of biological remains from excavations at Flaxby, North Yorkshire (site code FB94). *Reports from the Environmental Archaeology Unit, York* 94/35, 4 pp.

Carrott *et al.* EAU 1994/32 Carrott, J., Hall, A., Issitt, M., Kenward, H., Large, F. and Milles, A. (1994). An assessment of biological remains from excavations at the Anglian site at Cottam, North Humberside (site code COT93). *Reports from the Environmental Archaeology Unit, York* 94/32, 8 pp.

Carrott *et al.* EAU 1994/36 Carrott, J., Hall, A., Issitt, M., Kenward, H. and Large, F. (1994). Assessment of biological remains from further samples from excavations in Crankleys Lane, on the Easingwold by-pass (YAT/Yorkshire Museum sitecode 1993.5000). *Reports from the Environmental Archaeology Unit, York* 94/36, 6 pp.

Carrott *et al.* EAU 1994/37 Carrott, J., Hall, A., Hill, M., Issitt, M., Kenward, H., and Large, F. (1994). Assessment of biological remains from excavations at Withow Gap, Skipsea, Humberside (site code: CAS489). *Reports from the Environmental Archaeology Unit, York* 94/37, 13 pp.

Carrott *et al.* EAU 1994/41 Carrott, J., Dobney, K., Hall, A., Issitt, M., Kenward, H. and Large, F. (1994). Assessment of biological remains from excavations at RAF Catterick, North Yorkshire (sitecode: CAT94). *Reports from the Environmental Archaeology Unit, York* 94/41, 9 pp.

Carrott *et al.* EAU 1994/43 Carrott, J., Hall, A., Issitt, M., Kenward, H. and Large, F. (1994). An evaluation of biological remains from excavations at Clifton Moorgate, York (CLM94). *Reports from the Environmental Archaeology Unit, York* 94/43, 4 pp.

Carrott *et al.* EAU 1994/44 Carrott, J., Hall, A., Hill, M., Issitt, M., Kenward, H. and Large, F. (1994). Evaluation of biological remains from excavations at Yarm, Cleveland (sitecode: OCM 94). *Reports from the Environmental Archaeology Unit, York* 94/44, 5 pp.

Carrott *et al.* EAU 1994/47 Carrott, J., Hall, A., Issitt, M., Kenward, H. and Large, F. (1994). An evaluation of biological remains from a trial borehole at Rosemary Place, York (sitecode RP94). *Reports from the Environmental Archaeology Unit, York* 94/47, 3 pp.

Carrott *et al.* EAU 1994/49 Carrott, J., Hall, A., Irving, B., Issitt, M., Jaques, D., Kenward, H., Large, F. and Milles, A. (1994). Assessment of biological remains from excavations at 37 High Street, Hull (sitecode: HHS94). *Reports from the Environmental Archaeology Unit, York* 94/49, 7 pp.

Carrott *et al.* EAU 1994/50 Carrott, J., Dobney, K., Hall, A., Issitt, M., Jaques, D., Johnstone, C., Large, F. and Milles, A. (1994). Assessment of biological remains from excavations at Welton Road, Brough, North Humberside (site code: 1994.294). *Reports from the Environmental Archaeology Unit, York* 94/50, 6 pp.

Carrott *et al.* EAU 1994/51 Carrott, J., Irving, B., Issitt, M., Jaques, D., Kenward, H., Large, F., McKenna, B. and Milles, A. (1994). Biological remains from excavations at Aylesby, Humberside (Humber bank strategic works, sitecode: HBS94). *Reports from the Environmental Archaeology Unit, York* 94/51, 8 pp.

Carrott *et al.* EAU 1995/02 Carrott, J., Hall, A., Issitt, M., Kenward, H., Large, F. and McKenna, B. (1995). Plant and invertebrate remains from excavations at Dowbridge Close, Kirkham, Lancashire (site code: KD94). *Reports from the Environmental Archaeology Unit, York* 95/2, 15 pp. + 28 pp. appendix.

Carrott *et al.* EAU 1995/03 Carrott, J., Dobney, K., Hall, A., Issitt, M., Jaques, D., Johnstone, C., Kenward, H. and Large, F. (1995). An evaluation of biological remains from excavations at Keldgate, Beverley (site code: KEL94). *Reports from the Environmental Archaeology Unit, York* 95/3, 11 pp. + 1 p. appendix.

Carrott *et al.* EAU 1995/04 Carrott, J., Issitt, M., Kenward, H., Large, F. and McKenna, B. (1995). An assessment of insect remains from excavations at the Lanes, Carlisle (site code: CAR79-82). *Reports from the Environmental Archaeology Unit, York* 95/4, 42 pp.

Carrott *et al.* EAU 1995/06 Carrott, J., Hall, A., Issitt, M., Large, F. and McKenna, B. (1995). An evaluation of biological remains from excavations at a proposed site for a garage on the Leven-Brandesburton by-pass, North Humberside (site code: LV94). *Reports from the Environmental Archaeology Unit, York* 95/6, 3 pp.

Carrott *et al.* EAU 1995/08 Carrott, J., Dobney, K., Hall, A., Issitt, M., Jaques, D., Johnstone, C., Kenward, H. and Milles, A. (1995). An evaluation of biological remains from excavations at 44-45 Parliament Street, York (site code: 1994.3210). *Reports from the Environmental Archaeology Unit, York* 95/8, 11 pp.

Carrott *et al.* EAU 1995/10 Carrott, J., Issitt, M., Kenward, H., Large, F. McKenna, B. and Skidmore, P. (1995). Insect and other invertebrate remains from excavations at four sites in Lincoln (site codes: WN87, WNW88, WF89 and WO89): Technical report. *Reports from the Environmental Archaeology Unit, York* 95/10, 38 pp. + 19 pp. appendix.

Carrott *et al.* EAU 1995/14 Carrott, J., Dobney, K., Hall, A., Issitt, M., Jaques, D., Johnstone, C., Kenward, H., Large, F., McKenna, B. and Milles, A. (1995). Assessment of biological remains from excavations at Wellington Row, York (sitecode 1988-9.24). *Reports from the Environmental Archaeology Unit, York* 95/14, 17 pp. + 43 pp. appendix.

Carrott *et al.* EAU 1995/15 Carrott, J., Dobney, K., Hall, A., Issitt, M., Jaques, D., Johnstone, C., Kenward, H., Large, F., Milles, A. and Shaw, T. (1995). Assessment of biological remains from excavations at Carr Naze, Filey, N. Yorkshire (site code FCN 1994.1). *Reports from the Environmental Archaeology Unit, York* 95/15, 21 pp.

Carrott *et al.* EAU 1995/17 Carrott, J., Dobney, K., Hall, A., Irving, B., Issitt, M., Jaques, D., Kenward, H., Large, F., McKenna, B., Milles, A., Shaw, T. and Usai, R. (1995). Assessment of biological remains and sediments from excavations at the Magistrates' Court site, Hull (site code: HMC94). *Reports from the Environmental Archaeology Unit, York* 95/17, 17 pp. + 23 pp. appendix.

Carrott *et al.* EAU 1995/19 Carrott, J., Hall, A., Issitt, M., Large, F. McKenna, B. and Milles, A. (1995). A further evaluation of biological remains from excavations at Clifton Moorgate, York (site code: CLM94). *Reports from the Environmental Archaeology Unit, York* 95/19, 3 pp.

Carrott *et al.* EAU 1995/20 Carrott, J., Hall, A., Issitt, M., Large, F. McKenna, B. and Milles, A. (1995). Evaluation of biological remains from excavations at 50-52 Monkgate, York (site code: 1995.4). *Reports from the Environmental Archaeology Unit, York* 95/20, 4 pp.

Carrott *et al.* EAU 1995/21 Carrott, J., Hall, A., Irving, B., Issitt, M., Jaques, D., Kenward, H., Large, F., McKenna, B. and Milles, A. (1995). Evaluation of biological remains from excavations at Norman Court, Grape Lane, York (site code: 1995.5). *Reports from the Environmental Archaeology Unit, York* 95/21, 4 pp.

Carrott *et al.* EAU 1995/25 Carrott, J., Issitt, M., Jaques, D., Johnstone, C. and Large, F. (1995). Evaluation of biological remains from excavations at Winteringham, Humberside (site code: WEF95). *Reports from the Environmental Archaeology Unit, York* 95/25, 4 pp.

Carrott *et al.* EAU 1995/31 Carrott, J., Hall, A., Issitt, M., Kenward, H. and Large, F. (1995). Evaluation of biological remains from excavations at Castle Street, Hull (associated with upgrading works on the A63. Site codes: 1994.481 and 1994.483). *Reports from the Environmental Archaeology Unit, York* 95/31, 3 pp.

Carrott *et al.* EAU 1995/32 Carrott, J., Dobney, K., Hall, A., Issitt, M., Jaques, D., Kenward, H., Large, F., and Milles, A. (1995). An evaluation of biological remains from excavations at Castle Car Park, York (site code: 1995.58). *Reports from the Environmental Archaeology Unit, York* 95/32, 7 pp.

Carrott *et al.* EAU 1995/34 Carrott, J., Dobney, K., Hall, A., Issitt, M., Jaques, D., Large, F., and Milles, A. (1995). An evaluation of biological remains from excavations at the Old Manor House, Baynard Castle, Cottingham (site code COM95). *Reports from the Environmental Archaeology Unit, York* 95/34, 8 pp.

Carrott *et al.* EAU 1995/35 Carrott, J., Hall, A., Issitt, M. and Kenward, H. (1995). Assessment of biological remains from excavations at 1-2 Tower Street (Castle Garage), York (YAT/Yorkshire Museum sitecode 1981.3). *Reports from the Environmental Archaeology Unit, York* 95/35, 25 pp.

Carrott *et al.* EAU 1995/37 Carrott, J., Hall, A., Issitt, M., Jaques, D., Kenward, H., and Large, F. (1995). Evaluation of biological remains from excavations at Tower Street, Hull (site code HCT95). *Reports from the Environmental Archaeology Unit, York* 95/37, 6 pp.

Carrott *et al.* EAU 1995/38 Carrott, J., Hall, A., Issitt, M., Kenward, H., Large, F. and Milles, A. (1995). Evaluation of biological remains from excavations at Vivars, Selby, North Yorkshire. *Reports from the Environmental Archaeology Unit, York* 95/38, 4 pp.

Carrott *et al.* EAU 1995/43 Carrott, J. Issitt, M. and Large, F. (1995). An assessment of biological remains from excavations associated with improvements to the A1 between Leeming and Dishforth, North Yorkshire (site code: LEE95). *Reports from the Environmental Archaeology Unit, York* 95/43, 7 pp.

Carrott *et al.* EAU 1995/44 Carrott, J., Issitt, M., Jaques, D. and Large, F. (1995). Assessment of biological remains from excavations at 62 Tadcaster Road, York (site code: 1995.55). *Reports from the Environmental Archaeology Unit, York* 95/44, 4 pp.

Carrott *et al.* EAU 1995/45 Carrott, J., Hall, A., Jaques, D. and Large, F. (1995). An evaluation of biological remains from excavations at Healing, S. Humberside (site code: HEA95). *Reports from the Environmental Archaeology Unit, York* 95/45, 5 pp.

Carrott *et al.* EAU 1995/49 Carrott, J., Hall, A., Issitt, M. and Large, F. (1995). Evaluation of biological remains from excavations at Burythorpe Quarry, North Yorkshire (site code: BQ94). *Reports from the Environmental Archaeology Unit, York* 95/49, 4 pp.

Carrott *et al.* EAU 1995/50 Carrott, J., Hall, A., Issitt, M. and Large, F. (1995). Evaluation of biological remains from excavations at Burythorpe Church, North Yorkshire (site code: BC95). *Reports from the Environmental Archaeology Unit, York* 95/50, 6 pp.

Carrott *et al.* EAU 1995/51 Carrott, J., Dobney, K., Hall, A., Issitt, M., Jaques, D., Kenward, H., Large, F. and Shaw, T. (1995). An evaluation of biological remains from excavations in St Saviourgate, York (site code: 1995.434). *Reports from the Environmental Archaeology Unit, York* 95/51, 9 pp.

Carrott *et al.* EAU 1995/53 Carrott, J., Dobney, K., Hall, A., Issitt, M., Jaques, D., Kenward, H., Large, F., Milles, A. and Shaw, T. (1995). Assessment of biological remains from excavations at 22 Piccadilly (ABC Cinema), York (YAT/Yorkshire Museum sitecode 1987.21). *Reports from the Environmental Archaeology Unit, York* 95/53, 65 pp.

Carrott *et al.* EAU 1995/54 Carrott, J., Dobney, K., Issitt, M., Jaques, D. and Large, F. (1995). Evaluation of biological remains from excavations at 37 North Bar Within, Beverley, Humberside (site code: NBW95). *Reports from the Environmental Archaeology Unit, York* 95/54, 9 pp.

Carrott *et al.* EAU 1996/01 Carrott, J., Dobney, K., Issitt, M., Jaques, D. and Large, F. (1996). An evaluation of biological remains from excavations at Merchant Adventurers' Hall, York (site code: 1995.1). *Reports from the Environmental Archaeology Unit, York* 96/1, 5 pp.

Carrott *et al.* EAU 1996/09 Carrott, J., Hall, A., Issitt, M., Kenward, H. and Large, F. (1996). Plant and invertebrate remains from post-Conquest deposits at 16-22 Coppergate, York (site code 1976-81.7): assessment of bioarchaeological potential and draft project design. *Reports from the Environmental Archaeology Unit, York* 96/9, 20 pp. + 52 pp. tables.

Carrott *et al.* EAU 1996/10 Carrott, J., Dobney, K., Hall, A., Issitt, M., Jaques, D., Kenward, H. and Large, F. (1996). Palaeoecological potential of biological remains from Flandrian deposits by West Beck, Brigham, N. Humberside. *Reports from the Environmental Archaeology Unit, York* 96/10, 12 pp.

Carrott *et al.* EAU 1996/13 Carrott, J., Dobney, K., Hall, A., Issitt, M., Jaques, D., Kenward, H. and Large, F. (1996). Assessment of biological remains from excavations at Old Abbey Farm, Risley, Cheshire (site code: OAF 95). *Reports from the Environmental Archaeology Unit, York* 96/13, 12 pp.

Carrott *et al.* EAU 1996/15 Carrott, J., Hall, A., Issitt, M., Kenward, H., Large, F., Milles, A. and Usai, R. (1996). Suspected accelerated *in situ* decay of delicate bioarchaeological remains: a case study from medieval York. *Reports from the Environmental Archaeology Unit, York* 96/15, 71 pp. + 3 pp. Appendix.

Carrott *et al.* EAU 1996/17 Carrott, J., Hall, A., Issitt, M., Jaques, D., Kenward, H. and Large, F. (1996). Evaluation of biological remains from Welton Low Road, Elloughton, near Brough (sitecode WLE96). *Reports from the Environmental Archaeology Unit, York* 96/17, 5 pp.

Carrott *et al.* EAU 1996/18 Carrott, J., Hall, A., Issitt, M., Jaques, D., Kenward, H. and Large, F. (1996). Evaluation of biological remains from excavations at 47-51 Skeldergate, York (site codes: 1995.3017 and 1995.435). *Reports from the Environmental Archaeology Unit, York* 96/18, 6 pp.

Carrott *et al.* EAU 1996/19 Carrott, J., Hall, A., Issitt, M., Kenward, H. and Large, F. (1996). Evaluation of biological remains from excavations at Bootham School, York (site code: 1996.196). *Reports from the Environmental Archaeology Unit, York* 96/19, 3 pp.

Carrott *et al.* EAU 1996/20 Carrott, J., Hall, A., Issitt, M., Kenward, H. and Large, F. (1996). Medieval plant and invertebrate remains principally preserved by anoxic waterlogging at The Brooks, Winchester, Hampshire (site code: BRI and BRII): Technical Report. *Reports from the Environmental Archaeology Unit, York* 96/20, 32 pp.

Carrott *et al.* EAU 1996/22 Carrott, J., Hall, A., Issitt, M., Jaques, D. and Large, F. (1996). Evaluation of biological remains from Old Hall, Baxtergate, Hedon (sitecode HBX96). *Reports from the Environmental Archaeology Unit, York* 96/22, 6 pp.

Carrott *et al.* EAU 1996/25 Carrott, J., Hall, A., Issitt, M., Jaques, D., Kenward, H., Large, F. and Usai, R. (1996). Evaluation of biological remains from Landress Lane, Beverley (site code: LAB96). *Reports from the Environmental Archaeology Unit, York* 96/25, 7 pp.

Carrott *et al.* EAU 1996/27 Carrott, J., Hall, A., Issitt, M., Jaques, D., Kenward, H. and Large, F. (1996). Assessment of biological remains from excavations at Stockton West Moor and Rawcliffe Moor, York (site codes: YORYM 96.390 and 96.391). *Reports from the Environmental Archaeology Unit, York* 96/27, 11 pp.

Carrott *et al.* EAU 1996/34 Carrott, J., Hall, A., Issitt, M., Jaques, D. and Large, F. (1996). An evaluation of biological remains from excavations at Starting Gate, Tadcaster Road, York (site code: 1996.170). *Reports from the Environmental Archaeology Unit, York* 96/34, 4 pp.

Carrott *et al.* EAU 1996/36 Carrott, J., Hall, A., Kenward, H., Large, F. and Usai, R. (1996). Assessment of plant and invertebrate remains from Late Devensian and Early Flandrian mire deposits at Church Moss, Davenham, Cheshire (site code DV95). *Reports from the Environmental Archaeology Unit, York* 96/36, 26pp. + 5 pp. Appendices + 2 Figures.

Carrott *et al.* EAU 1996/37 Carrott, J., Hall, A., Issitt, M., Jaques, D., Kenward, H. and Large, F. (1996). Assessment of biological remains from The Outgang, Driffield (sitecode OGD96). *Reports from the Environmental Archaeology Unit, York* 96/37, 7 pp.

Carrott *et al.* EAU 1996/40 Carrott, J., Hall, A., Jaques, D., Kenward, H. and Large, F. (1996). An assessment of biological remains from excavations at Waterton, North Lincolnshire (site code: WGF96). *Reports from the Environmental Archaeology Unit, York* 96/40, 8 pp.30.9.96 (7.10.96)

Carrott *et al.* EAU 1996/42 Carrott, J., Hall, A., Kenward, H. and Large, F. (1996). Plant and invertebrate remains from the Iron Age and Roman site at North Cave, East Riding of Yorkshire (site code NC95): data archive. *Reports from the Environmental Archaeology Unit, York* 96/42, 20 pp.

Carrott *et al.* EAU 1996/43 Carrott, J., Hall, A., Issitt, M., Jaques, D., Kenward, H. and Large, F. (1996). Assessment of biological remains from excavations at Holmechurch Lane, Beverley (site code: HLB96). *Reports from the Environmental Archaeology Unit, York* 96/43, 8 pp.

Carrott *et al.* EAU 1996/44 Carrott, J., Dobney, K., Hall, A., Issitt, M., Jaques, D., Kenward, H. and Large, F. (1996). An assessment of biological remains from further excavations at Merchant Adventurers' Hall, York (site code: 1995.1). *Reports from the Environmental Archaeology Unit, York* 96/44, 9 pp. + 4 pp. appendix.

Carrott *et al.* EAU 1996/45 Carrott, J., Hall, A. and Kenward, H. (1996). Evaluation of plant and invertebrate remains from two ditch fills at Gadbrook Park, near Northwich, Cheshire (site code GAD96). *Reports from the Environmental Archaeology Unit, York* 96/45, 2 pp.

Carrott *et al.* EAU 1996/47 Carrott, J., Hall, A., Issitt, M., Kenward, H. and Large, F. (1996). Assessment of plant and invertebrate remains from excavations associated with renovations at All Saints Church, Pavement, York (site code 95.47). *Reports from the Environmental Archaeology Unit, York* 96/47, 8 pp.

Carrott *et al.* EAU 1996/50 Carrott, J., Hall, A., Issitt, M., Jacques, D. and Large, F. (1996). An evaluation of biological remains from excavations at Rectory Lane, Beeford (site code: RL96). *Reports from the Environmental Archaeology Unit, York* 96/50, 4 pp. + 1 p. Appendix.

Carrott *et al.* EAU 1996/52 Carrott, J., Kenward, H. and Issitt, M. (1996). Seamer Carr landfill extension: evaluation of the archaeological potential of insect remains. *Reports from the Environmental Archaeology Unit, York* 96/52, 5 pp.

Carrott *et al.* EAU 1996/55 Carrott, J., Dobney, K., Hall, A., Issitt, M., Jaques, D., Kenward, H., and Large, F. (1996). An evaluation of biological remains from excavations at Kingswood, Hull (site code: KWH96). *Reports from the Environmental Archaeology Unit, York* 96/55, 9 pp. + 2 pp. Appendix.

Carrott *et al.* EAU 1996/57 Carrott, J., Hall, A., Issitt, M., Jaques, D. and Large, F. (1996). Evaluation of biological remains from excavations in Hengate, Beverley, East Riding of Yorkshire (site code HGB96). *Reports from the Environmental Archaeology Unit, York* 96/57, 9 pp.

Carrott *et al.* EAU 1997/01 Carrott, J., Issitt, M., Jaques, D., and Large, F. (1997). Evaluation of biological remains from excavations at 3-7 Coney Street, York (site code: 1996.409). *Reports from the Environmental Archaeology Unit, York* 97/1, 3 pp. + 1 p. Appendix.

Carrott *et al.* EAU 1997/11 Carrott, J., Hall, A., Jaques, D. and Johnstone, C. (1997). Evaluation of the biological remains from 61 Micklegate, York (site code 1997.6). *Reports from the Environmental Archaeology Unit, York* 97/11, 4 pp.

Carrott *et al.* EAU 1997/14 Carrott, J., Hall, A., Issitt, M., Jaques, D., Johnstone, C. and Large, F. (1997). An evaluation of biological remains from excavations at Smaws Quarry (near Tadcaster), North Yorkshire (site code: SMAWS97). *Reports from the Environmental Archaeology Unit, York* 97/14, 4 pp.

Carrott *et al.* EAU 1997/16 Carrott, J., Dobney, K., Hall, A., Issitt, M., Jaques, D., Johnstone, C., Kenward, H., Large, F. and Skidmore, P. (1997). Technical Report: Environment, land use and activity at a medieval and post-medieval site at North Bridge, Doncaster, South Yorkshire. *Reports from the Environmental Archaeology Unit, York* 97/16, 64 pp. + 103 pp. appendix.

Carrott *et al.* EAU 1997/17 Carrott, J., Hall, A., Holt, M., Issitt, M., Jaques, D., Kenward, H. and Large, F. (1997). An evaluation of biological remains from further excavations at Kingswood, Hull (site code: KWH97). *Reports from the Environmental Archaeology Unit, York* 97/17, 7 pp. + 1 p. appendix.

Carrott *et al.* EAU 1997/18 Carrott, J., Hall, A., Issitt, M., Jaques, D., Johnstone, C., Kenward, H. and Large, F. (1997). An evaluation of biological remains from excavations at Blanket Row (Shaft 9), Hull (site code: BWH97). *Reports from the Environmental Archaeology Unit, York* 97/18, 8 pp.

Carrott *et al.* EAU 1997/21 Carrott, J., Hall, A., Issitt, M., Jaques, D., Kenward, H. and Large, F. (1997). Evaluation of biological remains from Sammy's Point, Hull (site code: SPH97). *Reports from the Environmental Archaeology Unit, York* 97/21, 7 pp.

Carrott *et al.* EAU 1997/22 Carrott, J., Hall, A., Issitt, M., Johnstone, C., Kenward, H. and Large, F. (1997). An evaluation of biological remains from excavations at Hull Citadel Moat (site code: SBH97). *Reports from the Environmental Archaeology Unit, York* 97/22, 6 pp.

Carrott *et al.* EAU 1997/24 Carrott, J., Hall, A., Johnstone, C., and Large, F. (1997). Evaluation of biological remains from excavations at 47-55 Tanner Row, York (site code: 1997.3). *Reports from the Environmental Archaeology Unit, York* 97/24, 7 pp.

Carrott *et al.* EAU 1997/25 Carrott, J., Dobney, K., Hall, A., Issitt, M., Jaques, D., Kenward, H., Large, F. and McKenna, B. (1997). Archaeological excavations at Layerthorpe Bridge and in Peasholme Green, York (site code: 1996-7.345): assessment of the interpretative potential of biological remains. *Reports from the Environmental Archaeology Unit, York* 97/25, 66 pp.

Carrott *et al.* EAU 1997/31 Carrott, J., Hall, A. and Large, F. (1997). Assessment of biological remains from excavations at Mill House Farm, Kexby, near York (site code 1997.61). *Reports from the Environmental Archaeology Unit, York* 97/31, 4 pp. + 1 p. appendix.

Carrott *et al.* EAU 1997/38 Carrott, J., Johnstone, C. and Large, F. (1997). Evaluation of biological remains from excavations at Malmo Road, Hull (1997 evaluation, site code: MAL97). *Reports from the Environmental Archaeology Unit, York* 97/38, 6 pp.

Carrott *et al.* EAU 1997/41 Carrott, J., Jaques, D., Johnstone, C., and Large, F. (1997). An evaluation of biological remains from excavations at The Fox, Tadcaster Road, Dringhouses, York (site code: 1997.70). *Reports from the Environmental Archaeology Unit, York* 97/41, 6 pp.

Carrott *et al.* EAU 1997/45 Carrott, J., Hughes, P., Johnstone, C. and Large, F. (1997). An evaluation of biological remains from excavations at 19 Fetter Lane, York (site code: 1997.96). *Reports from the Environmental Archaeology Unit, York* 97/45, 8 pp.

Carrott *et al.* EAU 1997/46 Carrott, J., Hughes, P. and Large, F. (1997). An evaluation of biological remains from excavations at Naburn Sewage Treatment Works, York (site code: 1997.81). *Reports from the Environmental Archaeology Unit, York* 97/46, 4 pp.

Carrott *et al.* EAU 1997/48 Carrott, J., Hughes, P., Kenward, H. and Large, F. (1997). An evaluation of biological remains from excavations at Messingham, North Lincolnshire (site code: BFM97). *Reports from the Environmental Archaeology Unit, York* 97/48, 5 pp.

Carrott *et al.* EAU 1997/49 Carrott, J., Hughes, P., Johnstone, C. and Large, F. (1997). Evaluation of biological remains from Water Lane, Clifton, York (site code 1997.95). *Reports from the Environmental Archaeology Unit, York* 97/49, 3 pp.

Carrott *et al.* EAU 1997/50 Carrott, J., Hughes, P., Johnstone, C., and Large, F. (1997). An evaluation of biological remains from excavations at Main Street, Spaunton, North Yorkshire (site code: 1997.93). *Reports from the Environmental Archaeology Unit, York* 97/50, 5pp.

Carrott *et al.* EAU 1997/51 Carrott, J., Hughes, P., Jaques, D., Kenward, H., Large, F. and Worthy, D. (1997). An evaluation of biological remains from excavations at British Gas, Davygate, York (site code: 1997.102). *Reports from the Environmental Archaeology Unit, York* 97/51, 12 pp.

Carrott *et al.* EAU 1997/52 Carrott, J., Hughes, P., Johnstone, C., Large, F. and Worthy, D. (1997). Evaluation of biological remains from County House, Monkgate, York (site code 1997.103). *Reports from the Environmental Archaeology Unit, York* 97/52, 7 pp.

Carrott *et al.* EAU 1998/02 Carrott, J., Hughes, P., Jaques, D., Johnstone, C. and Worthy, D. (1998). Evaluation of biological remains from Barton Street, Barrow upon Humber (Site code BRBD.1). *Reports from the Environmental Archaeology Unit, York* 98/2, 3 pp.

Carrott *et al.* EAU 1998/04 Carrott, J., Hall, A., Hughes, P., Jaques, D., Johnstone, C., and Worthy, D. (1998). An evaluation of biological remains from excavations at Royal Chase, Tadcaster Road, Dringhouses, York (site code: 1997.186). *Reports from the Environmental Archaeology Unit, York* 98/4, 5 pp.

Carrott *et al.* EAU 1998/06 Carrott, J., Hall, A., Hughes, P., Jaques, D., Johnstone, C., Kenward, H., Large, F., Usai, R. and Worthy, D. (1998). An assessment of biological remains from excavations at land adjacent to the former Gibraltar Farm, Kingswood, Kingston upon Hull (site code: GIB97). *Reports from the Environmental Archaeology Unit, York* 98/6, 13 pp.

Carrott *et al.* EAU 1998/07 Carrott, J., Hall, A., Hughes, P., Jaques, D., Johnstone, C., Kenward, H. and Worthy, D. (1998). An assessment of biological remains from excavations at land north of the junction of Foredyke and River Hull, Kingswood, Kingston upon Hull (site code: FOR97). *Reports from the Environmental Archaeology Unit, York* 98/7, 23 pp.

Carrott *et al.* EAU 1998/08 Carrott, J., Jaques, D. and Worthy, D. (1998). An evaluation of biological remains from excavations at Slingsby, North Yorkshire (site code: S97). *Reports from the Environmental Archaeology Unit, York* 98/8, 3 pp.

Carrott *et al.* EAU 1998/09 Carrott, J., Hall, A., Hughes, P., Jaques, D., Kenward, H. and Worthy, D. (1998). An assessment of biological remains from the former Davygate Centre, York (site code: 97.125). *Reports from the Environmental Archaeology Unit, York* 98/9, 18 pp.

Carrott *et al.* EAU 1998/10 Carrott, J., Hall, A., Hughes, P., Jaques, D., Johnstone, C., Kenward, H. and Worthy, D. (1998). Evaluation of biological remains from Jack Taylor Lane, Beverley, East Yorkshire (site code: BJT98). *Reports from the Environmental Archaeology Unit, York* 98/10, 23 pp.

Carrott *et al.* EAU 1998/14 Carrott, J., Hall, A., Hughes, P., Jaques, D., Johnstone, C., Kenward, H. and Worthy, D. (1998). Assessment of biological remains from excavations at St Saviourgate, York (site code 1995.434). *Reports from the Environmental Archaeology Unit, York* 98/14, 41 pp.

Carrott *et al.* EAU 1998/15 Carrott, J., Hughes, P., Johnstone, C., and Worthy, D. (1998). Evaluation of biological remains from Ailcy Hill, Ripon (site code HARGM:8947). *Reports from the Environmental Archaeology Unit, York* 98/15, 7 pp.

Carrott *et al.* EAU 1998/16 Carrott, J., Hughes, P., Jaques, D., Johnstone, C., Kenward, H. and Worthy, D. (1998). Assessment of biological remains from BHS store, Feasegate, York (site code YORYM1998.2). *Reports from the Environmental Archaeology Unit, York* 98/16, 20 pp.

Carrott *et al.* EAU 1998/17 Carrott, J., Hughes, P., Jaques, D., Johnstone, C., Kenward, H. and Worthy, D. (1998). Evaluation of biological remains from Figham Common, Beverley (site code FCB98). *Reports from the Environmental Archaeology Unit, York* 98/17, 8 pp.

Carrott *et al.* EAU 1998/18 Carrott, J., Hughes, P., Jaques, D., Johnstone, C., and Worthy, D. (1998). Evaluation of biological remains from Healing, nr. Grimsby, North Lincolnshire (site code HEA98). *Reports from the Environmental Archaeology Unit, York* 98/18, 6 pp.

Carrott *et al.* EAU 1998/20 Carrott, J. (1998). Evaluation of biological remains from Osgodby Lane, Scarborough, North Yorkshire. *Reports from the Environmental Archaeology Unit, York* 98/20, 4 pp.

Carrott *et al.* EAU 1998/21 Carrott, J., Fryer, K., Hall, A., Hughes, P., Jaques, D., Johnstone, C., and Worthy, D. (1998). Report on the biological remains from the Former Female Prison, York (site code 1998.32). *Reports from the Environmental Archaeology Unit, York* 98/21, 12 pp.

Carrott *et al.* EAU 1998/25 Carrott, J., Hall, A., Hughes, P., Jaques, D., Johnstone, C., Kenward, H. and Worthy, D. (1998). Assessment of biological remains from Sammy's Point, Hull (site code SPH98). *Reports from the Environmental Archaeology Unit, York* 98/25, 20 pp.

Carrott *et al.* EAU 1998/27 Carrott, J., Hall, A., Hughes, P., Jaques, D., Johnstone, C., and Worthy, D. (1998). Assessment of biological remains from 9 Little Stonegate, York (site code YORYM1997.102). *Reports from the Environmental Archaeology Unit, York* 98/27, 12 pp.

Carrott *et al.* EAU 1998/28 Carrott, J., Hall, A., Jaques, D. and Worthy, D. (1998). Evaluation of biological remains from 292 Bishopthorpe Road, York (site code YORYM 1998.162). *Reports from the Environmental Archaeology Unit, York* 98/28, 3 pp.

Carrott *et al.* EAU 1998/29 Carrott, J., Jaques, D., Kenward, H. and Worthy, D. (1998). Assessment of invertebrate remains from 'tree pits' in Selby (site code SDC97). *Reports from the Environmental Archaeology Unit, York* 98/29, *11 pp.*

Carrott *et al.* EAU 1998/33 Carrott, J., Hall, A., Jaques, D. and Worthy, D. (1998). Evaluation of biological remains from 39 Holgate Road, York (site code: 1998.332). *Reports from the Environmental Archaeology Unit, York* 98/33, 5 pp. + 2 pp. appendix.

Carrott *et al.* EAU 1999/04 Carrott, J., Hall, A., Jaques, D., Kenward, H., Large, F., Speight, H. and Worthy, D. (1999). Evaluation of bioarchaeological remains from 9-17 Well Lane, Beverley, East Yorkshire (site code: WLB98). *Reports from the Environmental Archaeology Unit, York* 99/4, 13 pp.

Carrott *et al.* EAU 1999/07 Carrott, J., Hall, A., Johnstone, C., Kenward, H., Large, F., Panter, I., Speight, H. and Worthy, D. (1999). Evaluation of bioarchaeological remains from Lord Robert's Road, Beverley, East Yorkshire (site code: LRB98). *Reports from the Environmental Archaeology Unit, York* 99/7, 16 pp. + 2 pp. appendix.

Carrott *et al.* EAU 1999/12 Carrott, J. Hall, A., Jaques, D., Kenward, H., Large, F. and Worthy, D. (1999). Evaluation of biological remains from excavations at Blanket Row (Stakis Casino), Hull (site code STK98). Reports from the Environmental Archaeology Unit, York 99/12, 10 pp.

Carrott *et al.* EAU 1999/16 Carrott, J. Hall, A. Johnstone, C., Large, F., Speight, H. and Worthy. D. (1999). Evaluation of bioarchaeological remains from Church Farm, Lily Lane, Flamborough, East Riding of Yorkshire (site code: LLF99). *Reports from the Environmental Archaeology Unit, York* 99/16, 8 pp.

Carrott *et al.* EAU 1999/29 Carrott, J. Jaques, D., Large, F., and Worthy, D. (1999). Evaluation of biological remains from York Railway Station (sitecode: YRS). *Reports from the Environmental Archaeology Unit, York* 99/29, 5 pp.

Carrott *et al.* EAU 1999/56 Carrott, J., Large, F. and Worthy, D. (1999). Evaluation of biological remains from proposed roundabout at A1237/B1363 junction, Wigginton Road, Clifton Moor, York (sitecode: YORYM 1999.955). Reports from the Environmental Archaeology Unit, York 99/56, 4 pp.

Carrott *et al.* EAU 2000/02 Carrott, J., Hall, A. and Jaques, D. (2000). Evaluation of biological remains from excavations on the west side of St Augustine's Gate, Hedon, East Riding of Yorkshire (site code: SAH99). *Reports from the Environmental Archaeology Unit, York* 2000/02, 5 pp.

Carrott *et al.* EAU 2000/03 Carrott, J., Hall, A. and Jaques, D. (2000). Assessment of biological remains from excavations at Barrow Road, Barton-upon-Humber, North Lincolnshire (site code: BOH99). *Reports from the Environmental Archaeology Unit, York* 2000/03, 5 pp.

Carrott *et al.* EAU 2000/23 Carrott, J., Hall, A., Jaques, D., Kenward, H. and Rowland, S. (2000). Evaluation of biological remains from an excavation at The Ryedale Building, 58-60 Piccadilly, York (site code: YORYM 2000.252). *Reports from the Environmental Archaeology Unit, York* 2000/23, 9 pp.

Carrott *et al.* EAU 2000/45 Carrott, J., Hall, A., Kenward, H. and Rowland, S. (2000). Evaluation of biological remains from excavations at Bootham Engineering Works, Lawrence Street, York (site code: YBE00). *Reports from the Environmental Archaeology Unit, York* 2000/45, 5 pp.

Carrott *et al.* EAU 2000/47 Carrott, J., Hall, A. and Jaques, D. (2000). Evaluation of biological remains from excavations at York Railway HQ, Station Rise, York (site code: YORYM 2000.506). *Reports from the Environmental Archaeology Unit, York* 2000/47, 6 pp.

Carrott *et al.* EAU 2000/50 Carrott, J., Hall, A. and Jaques, D. (2000). Evaluation of biological remains from excavations at 28-40 Blossom Street, York (site code: YORYM 2000.566). *Reports from the Environmental Archaeology Unit, York* 2000/50, 7 pp.

Carrott *et al.* EAU 2001/01 Carrott, J., Hall, A., Jaques, D. and Rowland, S. (2001). Evaluation of biological remains from excavations at Brown's Yard, Beverley (site code: 2001.259). *Reports from the Environmental Archaeology Unit, York* 2001/01, 4 pp.

Carrott *et al.* EAU 2001/12 Carrott, J., Hall, A., Jaques, D., Johnstone, C., Kenward, H., and Rowland, S. (2001). Technical Report: Plant and animal remains from excavations in Blanket Row, Kingston-upon-Hull (site codes BWH97-00). *Reports from the Environmental Archaeology Unit, York* 2001/12, 127 pp.

Carrott *et al.* PRS 2001/02 Carrott, J., Hall, A., Jaques, D. and Kenward, H. (2001). Evaluation of biological remains from excavations at Barmby-on-the-Marsh, East Riding of Yorkshire (site code: BOM2001). *Palaeoecology Research Services Report* 2001/02.

Carrott *et al.* PRS 2001/04 Carrott, J., Hall, A., Jaques, D. and Kenward, H. (2001). Evaluation of biological remains from excavations at land off Masonic Lane, Thirsk, North Yorkshire (site code: YORYM2000.2401). *Palaeoecology Research Services Report* 2001/04, 5 pp.

Carrott *et al.* PRS 2001/06 Carrott, J., Hall, A., Jaques, D. and Kenward, H. (2001). Evaluation of biological remains from excavations at Canalside/Witter Place, Chester (site code: CHE/SES01). *Palaeoecology Research Services Report* 2001/06, 9 pp.

Carrott *et al.* PRS 2001/44 Carrott, J., Jaques, D. and Cousins, S. (2003). Evaluation of biological remains from excavations at General Freight, south of Ousegate, Selby, North Yorkshire (site code: YORAT 2002.8). *Palaeoecology Research Services Report* 2003/41.

Carrott *et al.* PRS 2002/18 Carrott, J., Hall, A. and Kenward, H. (2002). Evaluation of biological remains from excavations at Metcalfe Lane, Osbaldwick, York (sitecode: YORYM2002.451). *Palaeoecology Research Services Reports* 2002/18, 3 pp.

Carrott *et al.* PRS 2002/24 Assessment of biological remains from a watching brief at land at the junction of High Street and Long Street, Rudston, East Riding of Yorkshire (site code: RU02). *Palaeoecology Research Services Reports* 2002/24, 3 pp.

Carrott *et al.* PRS 2002/46 Carrott, J., Jaques, D. and Hall, A. (2002). Evaluation of biological remains from excavations at site OAS02EX02 East Riding of Yorkshire (site code: OAS02EX02). *Palaeoecology Research Services Report* 2002/46.

Carrott *et al.* PRS 2002/47 Carrott, J., Jaques, D. and Hall, A. (2002). Evaluation of biological remains from excavations at site OAS02EX08, East Riding of Yorkshire (site code: OAS02EX08). *Palaeoecology Research Services Report* 2002/47.

Carrott *et al.* PRS 2003/07 Carrott, J., Hall, A., Kenward, H. and Jaques, D. (2003). Evaluation of biological remains from excavations at Tower Street, Kingston upon Hull. *Palaeoecology Research Services Report* 2003/07.

Carrott *et al.* PRS 2003/11 Carrott, J., Hall, A., Kenward, H. and Jaques, D. (2003). Evaluation of biological remains from excavations at a site near Homelands Farm, Selby Road, Holme-on-Saplding-Moor, East Riding of Yorkshire (site code: SRH2002). *Palaeoecology Research Services Report* 2003/11.

Carrott *et al.* PRS 2003/12 Carrott *et al.* PRS 2003/11 Carrott, J., Hall, A. and Jaques, D. (2003). Evaluation of biological remains from excavations at East Lane, Sigglesthorne, East Riding of Yorkshire (site code: BLS2002). *Palaeoecology Research Services Report* 2003/12.

Carrott *et al.* PRS 2003/83 Carrott, J., Hall, A., Jaques, D., Johnson, K. and Kenward, H. (2003). Evaluation of biological remains from excavations associated with a pipeline for the Melton Waste Water Treatment Works, at Low Common Lane, Melton, East Riding of Yorkshire (site code: BMP03). *Palaeoecology Research Services Report* 2003/83.

Carrott *et al.* PRS 2004/11 Carrott, J., Geary, B. R., Hall, A., Jaques, D., Johnson, K., Kenward, H. and Yates, K. T. (2004). Assessment of biological remains from excavations at a site to the rear of 26 Market Place, Bedale, North Yorkshire (site code: BED03). *Palaeoecology Research Services Report* 2004/11.

Carrott *et al.* PRS 2004/35 Carrott, J., Jaques, D., Hall, A., Kenward, H. and Johnson, K. (2004). Evaluation of biological remains from two pit fill samples recovered during excavations at the site of the former Pentecostal Church, St Sepulchre Street, Scarborough, North Yorkshire (site code: PC03 - 2003.516). *Palaeoecology Research Services Report* 2004/35.

Carrott *et al.* PRS 2004/36 Carrott, J., Hall, A., Jaques, D. and Johnson, K. (2004). Technical report: Biological remains from sites along the route of the Transco West Hull pipeline, East Riding of Yorkshire (site codes: OSA02EX02, OSA02EX04, OSA02EX05, OSA02EX07, OSA02EX08, OSA02WB23 and OSA01WB33). *Palaeoecology Research Services Report* 2004/36.

Carrott *et al.* PRS 2004/41 Carrott, J., Jaques, D. and Johnson, K. (2004). Evaluation of biological remains from excavations at Bradley Street, Castleford, West Yorkshire. *Palaeoecology Research Services Report* 2004/41.

Carrott *et al.* PRS 2004/42 Carrott, J., Hall, A., Jaques, D. and Johnson, K. (2004). Assessment of biological remains from excavations at the Beetham Hilton Hotel, Deansgate, Manchester (site code: DGM04). *Palaeoecology Research Services Report* 2004/42.

Carrott *et al.* PRS 2004/43 Carrott, J., Hall, A., Kenward, H., Mant, J. and Jaques, D. (2004). Assessment of biological remains from excavations at the NCP car park, Skeldergate, York (site code: YORYM 2003.282). *Palaeoecology Research Services Report* 2004/43.

Carrott *et al.* PRS 2004/53 Carrott, J., Jaques, D., Johnson, K. and Gardner, S. (2004). Evaluation of biological remains from excavations at the Aldbrough Gas Storage Project, Aldbrough, East Riding of Yorkshire (site code: AGS2004). *Palaeoecology Research Services Report* 2004/53.

Carrott *et al.* PRS 2004/67 Carrott, J., Jaques, D. and Gardner, S. (2004). Evaluation of biological remains from excavations at Snuff Mill Lane, Cottingham, East Riding of Yorkshire (site code: SMC2004). *Palaeoecology Research Services Report* 2004/67.

Carrott *et al.* PRS 2005/13 Carrott, J., Akeret, Ö. and Gardner, S. (2005). Evaluation of biological remains from excavations at 20-24 Trinity Lane, York (site code: OSA05EV01). *Palaeoecology Research Services Report* 2005/13.

Carrott *et al.* PRS 2005/53 Carrott, J., Mant, J., Akeret, Ö., Jaques, D. and Gardner, S. (2005). Evaluation of biological remains from excavations at 3 Driffield Terrace, York (site code: YORYM 2004.354). *Palaeoecology Research Services Report* 2005/53.

Carrott *et al.* PRS 2005/59 Carrott, J., Akeret, Ö., Jaques, D. and Gardner, S. (2005). Evaluation of biological remains from excavations at St Helen's Church, Skipwith, North Yorkshire (site code: YORYM 2004.18). *Palaeoecology Research Services Report* 2005/59.

Carrott *et al.* PRS 2005/60 Carrott, J., Akeret, Ö. and Gardner, S. (2005). Evaluation of biological remains from sediment samples from excavations at the Terry's chocolate factory, York (site code: YORYM 2005.505). *Palaeoecology Research Services Report* 2005/60.

Carrott *et al.* PRS 2005/88 Carrott, J., Mant, J. and Gardner, S. (2005). Evaluation of biological remains from Chalmers Orchard, Newcastle Road, Chester-le-Street, County Durham (site code: CLS05). *Palaeoecology Research Services Report* 2005/88.

Carrott PRS 2001/01 Carrott, J. (2001). Evaluation of biological remains from excavations at Swinescaif Quarry, South Cave, East Riding of Yorkshire (site code: SCQ2001). *Palaeoecology Research Services Report* 2001/01.

Carrott *et al.* EAU 2001/48 Carrott, J., Hall, A., Jaques, D., Johnstone, C., Kenward, H. and Rowland, S. (2001). Publication draft: Plant and animal remains from excavations in Blanket Row, Kingston-upon-Hull (site codes BWH97-00). *Reports from the Environmental Archaeology Unit, York* 2001/48, 43 pp.

Carrott PRS 2002/35 Carrott, J. (2002). Evaluation of biological remains from excavations at Melton (A63), East Riding of Yorkshire (site code: MTN02). *Palaeoecology Research Services Report* 2002/35.

Carrott PRS 2002/43 Carrott, J. (2002). Evaluation of biological remains from excavations at site OAS02EX07 East Riding of Yorkshire (site code: OAS02EX07). *Palaeoecology Research Services Report* 2002/43.

Carrott PRS 2002/44 Carrott, J. (2002). Evaluation of biological remains from excavations at site OAS02EX04 East Riding of Yorkshire (site code: OAS02EX04). *Palaeoecology Research Services Report* 2002/44.

Carrott PRS 2002/48 Carrott, J. (2002). Evaluation of the preservation of biological remains from deposits samples by coring at Gazetteer sites 9 and 29 as part of the A34 Alderley Edge and Nether Alderley bypass archaeological works, Cheshire. *Palaeoecology Research Services Report* 2002/48.

Carrott PRS 2003/06 Carrott, J. (2003). Assessment of the presence/absence and state of preservation of invertebrate remains from a watching brief at Danes Moss, Macclesfield, Cheshire (project code: 10142). *Palaeoecology Research Services Report* 2003/06.

Carrott PRS 2003/22 Carrott, J. (2003). Assessment of mollusc remains from excavations of a site at Micklefield, West Yorkshire (site code: MSW02). *Palaeoecology Research Services Report* 2003/22.

Carrott PRS 2003/35 Carrott, J. (2003). Technical report: mollusc remains from excavations at Ferrybridge, West Yorkshire (site code: FBH01). *Palaeoecology Research Services Report* 2003/35.

Carrott PRS 2003/52 Carrott, J. (2003). Assessment of mollusc remains from an evaluation at Auckinleck Close, Driffield, East Riding of Yorkshire (site code: ACD03). *Palaeoecology Research Services Report* 2003/52.

Carruthers AML 11/93 Carruthers, W. (1993). A charred grain deposit from Ambleside Roman fort, Cumbria. *Ancient Monuments Laboratory Report* 11/93.

Colledge AML 3347 Colledge, S. (1981). Report on the micro- and macroscopic plant remains from Crown Car Park, Nantwich (including a preliminary species list of the coleopteran remains). *Ancient Monuments Laboratory Report* 3347.

Cotton ASUD 709 Cotton, J. (2000). Plant macrofossil analysis, pp. 4-12 in Archaeological Services University of Durham, *Whitby, North Yorkshire - CSW98, CSW99 and WS99 plant macrofossil evaluation and Foraminiferal analysis*. ASUD Report 709. Durham.

Dainton *et al.* EAU 1992/14 Dainton, M., Dobney, K. and Hall, A. (1992). *An evaluation of biological remains from excavations at 2 St Maurice's Road, York (YAT/Yorkshire Museum site code 1992.12).* Prepared for York Archaeological Trust. [EAU 92/14]

Dainton *et al.* EAU 1992/15 Dainton, M., Dobney, K., Hall, A., Kenward, H. and Milles, A. (1992). *An evaluation of the bioarchaeological value of deposits from excavations at Glebe Farm, Barton-upon-Humber, S. Humberside, 1992.* Prepared for Humberside Archaeological Unit. [EAU 92/15]

Dainton *et al.* EAU 1992/16 Dainton, M., Frost, J., Hall, A. R. and Kenward, H. K. (1992). *Environmental evidence from Rawcliffe Manor, Manor Lane, Rawcliffe, York (YAT/Yorkshire Museum sitecode: 1992.5007).* Prepared for York Archaeological Trust. [EAU 92/16]

Dainton *et al.* EAU 1992/17 Dainton, M., Hall, A. R. and Kenward, H. K. (1992). *An evaluation of biological remains from boreholes at North Street, York (YAT site code 1992.1).* Prepared for York Archaeological Trust. [EAU 92/17]

Dobney *and Hall* EAU 1992/20 Dobney, K. and Hall, A. (1992). *An evaluation of biological remains from excavations at 41 Piccadilly, York (YAT/Yorkshire Museum site code 1992.18).* Prepared for York Archaeological Trust. [EAU 92/20]

Dobney *et al.* EAU 1992/21 Dobney, K., Hall, A. R. and Kent, P. (1992). *Biological remains from excavations on the site of the Preceptory of the Knights Hospitallers, Beverley, N. Humberside (site code BKH91-2).* Prepared for Humberside Archaeology Unit. [EAU 92/21]

Dobney *et al.* EAU 1992/22 Dobney, K., Hall, A. R. and Kenward, H. K. (1992). *An evaluation of biological remains from excavations at Ankers Garage, 45-57 Gillygate, York (YAT/Yorkshire Museum site code 1992.8).* Prepared for York Archaeological Trust. [EAU 92/22]

Dobney *et al.* EAU 1992/23 Dobney, K., Kenward, H. K., Hall, A. and Milles, A. (1992). *Post-excavation assessment of material for studies in environmental archaeology.* Prepared for Ancient Monuments Laboratory. [EAU 92/23]

Dobney *et* al. EAU 1993/19 Dobney, K., Hall, A., Kenward, H. and Milles, A. (1993). *Biological remains from excavations at the Orchard Fields site, Malton (site code OF92). 1. Samples for biological analysis and an infant burial.* Prepared for Malton Archaeological Projects. [93/19]

Dobney et al. EAU 1993/20 Dobney, K., Hall, A., Kenward, H. and Milles, A. (1993). *An assessment of `environmental' samples and bone from excavations on the route of the Leven-Brandesburton by-pass (site code LEV92).* Prepared for Humberside Archaeology Unit. [93/20]

Dobney et al. EAU 1993/21 Dobney, K., Hall, A., Kenward, H. and Milles, A. (1993). Material assessment of sediment samples (GBA and BS) from Flixborough. 12 pp. plus appendix 31 pp. Prepared for Humberside Archaeology Unit. [93/21]

Dobney *et al.* EAU 1993/22 Dobney, K., Hall, A., Kenward, H. and O'Connor, T. (1993). *Assessment of samples for biological analysis and of bone from excavations at the Queen's Hotel site, York (sitecode 1988-9.17).* Prepared for York Archaeological Trust. [93/22]

Dobney *et al.* EAU 1994/08 Dobney, K., Hall, A., Issitt, M., Kenward, H., Large, F., Lancaster, S. and Milles, A. (1994). Assessment of biological remains from excavations at Rawcliffe Manor, near York (Phase 6; YAT/Yorkshire Museum sitecode 93.5007). *Reports from the Environmental Archaeology Unit, York* 94/8, 5 pp.

Dobney *et al.* EAU 1994/09 Dobney, K., Hall, A., Kenward, H. and Milles, A. (1994). Integrated assessment of biological remains from excavations at Flixborough, S. Humberside. *Reports from the Environmental Archaeology Unit, York* 94/9, 15 pp.

Dobney *et al.* EAU 1994/18 Dobney, K., Hall, A., Jaques, D. and Milles, A. (1994). Assessment of biological remains from the medieval moat at Hall Garth, Beverley (site code BHG80). *Reports from the Environmental Archaeology Unit, York* 94/18, 7 pp.

Dobney *et al.* EAU 1994/20 Dobney, K., Hall, A., Issitt, M., Jaques, D., Kenward, H., Large, F. and Milles, A. (1994). An evaluation of biological remains from excavations at Town Street, Old Malton (site code OML94). *Reports from the Environmental Archaeology Unit, York* 94/20, 5 pp.

Dobney *et al.* EAU 1994/60 Dobney, K., Fitter, R., Hall, A., Irving, B., Jaques, D., Johnstone, C., Kenward, H., Milles, A. and Shaw, T. (1994). Technical report: Biological remains from the medieval moat at Hall Garth, Beverley, North Humberside. *Reports from the Environmental Archaeology Unit, York* 94/60, 46 pp. + 11 pp. appendices.

Dobney *et al.* EAU 1995/22 Dobney, K., Hall, A., Issitt, M., Jaques, D., Kenward, H. and Shaw, T. (1995). Assessment of plant and animal remains from deposits at Higher Lane, Fazakerley, Merseyside (site code FAZ94). *Reports from the Environmental Archaeology Unit, York* 95/22, 10 pp.

Dobney *et al.* EAU 1995/48 Dobney, K., Hall, A., Jaques, D., Kenward, H., Large, F. and Shaw, T. (1995). An evaluation of biological remains from excavations at Flemingate, Beverley (site code: FG95). *Reports from the Environmental Archaeology Unit, York* 95/48, 5 pp.

Dobney *et al.* EAU 1996/26 Dobney, K., Jaques, D., Carrott, J., Hall, A., Issitt, M. and Large, F. (1996). Biological remains from excavations at Carr Naze, Filey, N. Yorkshire: Technical Report. *Reports from the Environmental Archaeology Unit, York* 96/26, 71 pp. + 31 pp. Appendices.

Dobney *et* al. EAU 1997/02 Dobney, K., Hall, A. and Kenward, H. (1997). Environment and activity in the Coppergate area of York in the post-Conquest period: draft post-excavation project design. *Reports from the Environmental Archaeology Unit, York* 97/2, 32 pp.

Donaldson and Rackham AML 2931 Donaldson, A. and Rackham, D. J. (1979). Norton Mill, Cleveland; botanical report. *Ancient Monuments Laboratory Report* 2931.

Engleman and Robertson EAU 1986/05 Engleman, C. and Robertson, A. (1986). *Selected test samples from the Redfearn National Glass factory, York.* Deposited at York Archaeological Trust, Environmental Archaeology Unit, Ancient Monuments Laboratory. [86/5]

Engleman *et al.* EAU 1986/03 Engleman, C., Kenward, H. and Robertson, A. (1986). *Insect remains from the General Accident Extension site, York. Archive Report 3. A survey of deposits associated with the first Roman structural phase (Period 3).* Deposited at York Archaeological Trust, Environmental Archaeology Unit, Ancient Monuments Laboratory. [86/3]

Engleman *et al.* EAU 1986/04 Engleman, C., Kenward, H. and Robertson, A. (1986). *Insect remains from the General Accident Extension site, York. Archive Report 4. Samples from the late 2nd century to early 3rd century site-wide accumulation (Period 4).* Deposited at York Archaeological Trust, Environmental Archaeology Unit, Ancient Monuments Laboratory. [86/4]

Engleman *et al.* EAU 1986/01 Engleman, C., Kenward, H. and Robertson, A. (1986). *Insect remains from the General Accident Extension site, York. Archive Report 1. A survey of modern, medieval and `post-robbing' contexts.* Deposited at York Archaeological Trust, Environmental Archaeology Unit, Ancient Monuments Laboratory. [86/1]

Engleman *et al.* EAU 1986/02 Engleman, C., Kenward, H. and Robertson, A. (1986). *Insect remains from the General Accident Extension site, York. Archive Report 2. A survey of pre-occupation and initial usage deposits (Periods 1 and 2).* Deposited at York Archaeological Trust, Environmental Archaeology Unit, Ancient Monuments Laboratory. [86/2]

Engleman *et al.* EAU 1987/03 Engleman, C., Kenward, H. K., and Robertson, A. (1987). *Insect remains from the General Accident Extension site, York (YAT Code 1983-84.32). Archive Report 5. A survey of contexts associated with the second timber building range (later 2nd - early 3rd century) Period 5.* Deposited at York Archaeological Trust, Environmental Archaeology Unit and Ancient Monuments Laboratory. [87/3]

Engleman *et al.* EAU 1987/04 Engleman, C., Kenward, H. K., and Robertson, A. (1987). *Insect remains from the General Accident Extension site, York (YAT Code 1983-84.32). Archive Report 6. Samples from the later Roman deposits (late 2nd - 4th century) Periods 6-8.* Deposited at York Archaeological Trust, Environmental Archaeology Unit and Ancient Monuments Laboratory. [87/4]

Evans AML 1830 Evans J. G. I.d. of mollusca from Doncaster. *Ancient Monuments Laboratory Reports* 1830.

Evans AML 1776 Evans, J. G. (1975). Identification of mollusca from Beeston Castle. *Ancient Monuments Laboratory Report* 1776.

Evans AML 1826 Evans, J. G. (1975). I.d. of mollusca from Mount Grace Priory. *Ancient Monuments Laboratory Reports* 1826.

Evans AML 1820 Evans, J. G. (1975). Identification of mollusca from Beeston Castle. *Ancient Monuments Laboratory Report* 1820.

Evans AML 1775 Evans, J. G. (1975). [I.d. of mollusca from Catterick.] *Ancient Monuments Laboratory Report* 1775.

Evans AML 1829 Evans, J. G. (1975). I.d. of mollusca from Housesteads. *Ancient Monuments Laboratory Reports* 1829.

Evans AML 1775 Evans J. G. (1975). I.d. of mollusca from Catterick. *Ancient Monuments Laboratory Reports* 1775.

Evans AML 1834 Evans J. G. 1975. I.d. of mollusca from Catterick. *Ancient Monuments Laboratory Reports* 1834.

Evans AML 1771 Evans J. G. (1975). Identification of Mollusca from Winterton. *Ancient Monuments Laboratory Reports* 1771.

Evans AML 1823 Evans, J. G. (1975). Wharram Percy. Large shells collected during excavation. *Ancient Monuments Laboratory Reports* 1823.

Fell AML 87/91 Fell, V. (1991). Two Roman 'nit' combs from excavations at Ribchester (RBG80 and RB89), *Lancashire. Ancient Monuments Laboratory Report* 87/91.

Geary *et al.* PRS 2003/04 Geary, B. R., Read, J. M., Hall, A. and Carrott, J. (2003). Assessment of biological remains from core samples taken at the site of a proposed second crossing of the River Mersey, nr Widnes, Halton (site code: B4027A). *Palaeoecology Research Services Report* 2003/04.

Geary *et al.* PRS 2002/21 Geary, B. R., Kirkby, J., Dawes, O. J., Hall, A., Kenward, H. and Carrott, J. (2002). Assessment of biological remains from excavation on land to the rear of 1 America Street, London Borough of Southwark (site code: AMA01). *Palaeoecology Research Services Report* 2002/21.

Girling AML 2735 Girling, M. A. (1979). The entomological evidence for tanning from a post-medieval pit at Southwark. *Ancient Monuments Laboratory Report* OS 2735.

Girling AML 3084 Girling, M. A. (1980). Environmental analysis of the contents of a Roman basket from Carlisle. *Ancient Monuments Laboratory Report* 3084.

Girling AML 3669 Girling, M. A. (1982). Insect infestation in timbers of the Brigg raft. *Ancient Monuments Laboratory Report* 3669.

Girling AML 3929 Girling, M A. 1983. Insects from Winterton Roman villa, Humberside. *Ancient Monuments Laboratory Report* 3929.

Girling AML 4585 Girling, M A. (1985). Investigation of insect attack in charcoal from Beeston Castle. *Ancient Monuments Laboratory Report* 4585.

Girling AML 4725 Girling M A. 1986. Insects associated with Lindow Man. *Ancient Monuments Laboratory Report* 4725.

Girling and Kenward AML 46/86 Girling, M. A. and Kenward, H. K.(1986). Arthropod remains from archaeological sites in Southampton. *Ancient Monuments Laboratory Report* 46/86. [incorrectly attributed to Kenward and Girling on title page]

Girling and Robinson AML 36/88 Girling, M. and Robinson, M. (1988). The insect assemblages from the pond sediments at Site 30, Wharram Percy, Yorkshire. *Ancient Monuments Laboratory Report* 36/88.

Hall and Carrott EAU 2001/36 Hall, A., and Carrott, J. (2001). Evaluation of biological remains from excavations at Eastgate South, Driffield, East Riding of Yorkshire (site code: DES2001). *Reports from the Environmental Archaeology Unit, York* 2001/36, 4 pp.

Hall and Carrott PRS 2002/28 Hall, A. and Carrott, J. (2002). Evaluation of biological remains from excavations at the site of the proposed Heighington Lane West Industrial Area, Newton Aycliffe, County Durham (site code: HLW02). *Palaeoecology Research Services Report* 2002/28.

Hall and Carrott PRS 2002/45 Hall, A. and Carrott, J. (2002). Evaluation of biological remains from excavations at site OAS02EX05 East Riding of Yorkshire (site code: OAS02EX05). *Palaeoecology Research Services Report* 2002/45.

Hall and Carrott PRS 2003/02 Hall, A. and Carrott, J. (2003). Evaluation of biological remains from excavations at Conistone, North Yorkshire (site code CBP02). *Palaeoecology Research Services Report* 2003/02.

Hall and Carrott PRS 2003/18 Hall, A. and Carrott, J. (2003). Evaluation of biological remains from excavations at Green Acre caravan park, Lighthouse Road, Flamborough, East Riding of Yorkshire site code: GAF02). *Palaeoecology Research Services Report* 2003/18.

Hall and Carrott PRS 2003/59 Hall, A. and Carrott, J. (2003). Evaluation of biological remains from land north of Hedon cemetery, Hedon, East Riding of Yorkshire (site code: HEC2003). *Palaeoecology Research Services Report* 2003/59.

Hall and Dobney EAU 1991/25 Hall, A. R. and Dobney, K. (1991). *Report on animal and plant remains from excavations at Welton Road, Brough, N. Humberside.* Prepared for Humberside Archaeological Unit. [91/25]

Hall and Jaques EAU 2001/22 Hall, A. and Jaques, D. (2001). Notes on the biological remains from excavations at The Gardens, Sprotborough (site code: OSA01EV07)*. Reports from the Environmental Archaeology Unit, York* 2001/22, 3 pp.

Hall and Kenward CHP 2003/02 Hall, A.R. and Kenward, H.K. (2003). Assessment of plant and invertebrate remains from deposit associated with a Roman road at Adel near Leeds, West Yorkshire (site code ARR/02). *Reports from the Centre for Human Palaeoecology, University of York* 2003/02, 4pp.

Hall and Kenward CHP 2003/03 Hall, A. and Kenward, H. (2003). Assessment of plant and invertebrate macrofossil remains from excavations in 2002 at Kaupang, Norway. *Reports from the Centre for Human Palaeoecology, University of York* 2003/03, 26 pp.

Hall and Kenward CHP 2004/10 Hall, A. R. and Kenward, H. K. (2004). Plant and invertebrate remains from Viking Age deposits at Kaupang, Norway, 2002, in Barrett, J., Hall, A., Johnstone, C., Kenward, H., O'Connor, T. and Ashby, S., Plant and animal remains from Viking Age deposits at Kaupang, Norway. *Reports from the Centre for Human Palaeoecology, University of York* 2004/10, 144pp.

Hall and Kenward CHP 2005/10 Hall, A. and Kenward, H. (2005). Technical report: plant and invertebrate remains from Iron Age deposits at Sutton Common, South Yorkshire (site code SCOM02-03). Part 1. Text and publication tables. *Reports from the Centre for Human Palaeoecology, University of York* 2005/10, 39 pp.

Hall and Kenward CHP 2005/11 Hall, A. and Kenward, H. (2005). Technical report: plant and invertebrate remains from Iron Age deposits at Sutton Common, South Yorkshire (site code SCOM02-03). Part 2. Data archive tables. *Reports from the Centre for Human Palaeoecology, University of York* 2005/11, 58 pp.

Hall and Kenward EAU 1984/01 Hall, A. R. and Kenward, H. K. (1984). *A computer system for the preparation of statistics for the interpretation of archaeological insect assemblages.* Deposited at York Archaeological Trust, Environmental Archaeology Unit and Ancient Monuments Laboratory. [84/1]

Hall and Kenward EAU 1990/11 Hall, A. R. and Kenward, H. K. (1990). *Report on the analysis of richly organic medieval occupation sediment from excavations at 24-6, The Bolts, Scarborough, N. Yorkshire.* Prepared for T. Pearson, York Archaeological Trust. [90/11]

Hall and Kenward EAU 1991/26 Hall, A. R. and Kenward, H. K. (1991). *Report on a sample of peat from excavations at Saltshouse Road, Hull, 1991.* Prepared for Humberside Archaeological Unit. [91/26]

Hall and Kenward EAU 1992/25 Hall, A. R. and Kenward, H. K. (1992). *Plant and invertebrate remains from a cistern on the foreshore at Saltwick, N. Yorkshire.* Prepared for Gary Marshall, National Trust. [92/25]

Hall and Kenward EAU 1997/33 Hall, A. and Kenward, H. (1997). Data archive for biological samples from Anglo-Scandinavian 16-22 Coppergate, York (sitecode 1976-81.7). 1: Sample concordance. *Reports from the Environmental Archaeology Unit, York* 97/33, 30 pp.

Hall and Kenward EAU 1999/27 Hall, A. and Kenward, H. (1999). A consideration of the bioarchaeological evidence from plant and invertebrate remains for leather working in Anglo-Scandinavian and medieval York. *Reports from the Environmental Archaeology Unit, York* 99/27, 6 pp. + 2pp. appendices.

Hall and Kenward EAU 1999/30 Hall, A. and Kenward, H. (1999). Plant and invertebrate remains from Anglo-Scandinavian deposits at 16-22 Coppergate, York: technical report. Part 1: period 3. *Reports from the Environmental Archaeology Unit, York* 99/30, 74 pp.

Hall and Kenward EAU 1999/38 Hall, A. and Kenward, H. (1999). Plant and invertebrate remains from Anglo-Scandinavian deposits at 16-22 Coppergate, York: Technical Report.

Part 2: Periods 4A and 4B. *Reports from the Environmental Archaeology Unit, York* 99/38, 127 pp.

Hall and Kenward EAU 1999/47 Hall, A. and Kenward, H. (1999). Plant and invertebrate remains from Anglo-Scandinavian deposits at 16-22 Coppergate, York: Technical Report. Part 3: Period 5A. Reports from the Environmental Archaeology Unit, York 99/47, 39 pp.

Hall and Kenward EAU 1999/49 Hall, A. and Kenward, H. (2000). Plant and invertebrate remains from Anglo-Scandinavian deposits at 16-22 Coppergate, York: technical report. Part 4: Period 5B. *Reports from the Environmental Archaeology Unit, York* 99/49, 124 pp.

Hall and Kenward EAU 1999/54 Hall, A. and Kenward, H. (1999). *On some notable peat deposits at St Paul's Green, York*, p. 12 in Kenward, H. (compiler), Centre for Human Palaeoecology Research Forum 1999: Abstracts from a one-day forum held at the Tempest Anderson Hall, York on 17th November 1999. *Reports from the Environmental Archaeology Unit, York* 99/54, 18 pp.

Hall and Kenward EAU 1999/63 Hall, A. and Kenward, H. (2000). Plant and invertebrate remains from Anglo-Scandinavian deposits at 16-22 Coppergate, York: technical report. Part 4: Period 5B. *Reports from the Environmental Archaeology Unit, York* 99/63, 28 pp.

Hall and Kenward EAU 2000/09 Hall, A. and Kenward, H. (2000). Assessment of plant and invertebrate remains from excavations at Cawthorn Camps, N. Yorkshire, 1999 (site 645). *Reports from the Environmental Archaeology Unit, York* 2000/09, 8 pp.

Hall and Kenward EAU 2000/17 Hall, A. and Kenward, H. (2000). Technical report: Plant and invertebrate remains from Anglo-Scandinavian deposits at 2 Clifford Street, York (site code 99.256). *Reports from the Environmental Archaeology Unit, York* 2000/17, 24 pp.

Hall and Kenward EAU 2000/22 Hall, A. and Kenward, H. (2000). Technical Report: Plant and invertebrate remains from Anglo-Scandinavian deposits at 4-7 Parliament Street (Littlewoods Store), York (site code 99.946). *Reports from the Environmental Archaeology Unit, York* 2000/22, 31 pp.

Hall and Kenward EAU 2001/07 Hall, A., and Kenward, H. (2001). Evaluation of biological remains from borehole samples from Conesby Quarry Sidings, North Lincolnshire (site code: CQS2000). *Reports from the Environmental Archaeology Unit, York* 2001/07, 4 pp.

Hall and Kenward NAA 04/83 Hall, A. and Kenward, H. (2004). *Assessment of plant and invertebrate macrofossils from a further sequence of late Devensian/early Holocene deposits [at] Wykeham, North Yorkshire (site code WK04)*, Appendix 3 in Northern Archaeological Associates (compiler), Wykeham Quarry, Vale of Pickering. Proposed eastern extension. *NAA* 04/83.

Hall and Large EAU 1996/46 Hall, A. and Large, F. (1996). Assessment of biological remains from a site at Penrith. *Reports from the Environmental Archaeology Unit, York* 96/46, 3 pp.

Hall and Milles EAU 1993/27 Hall, A. and Milles, A. (1993). *Material assessment of hand-collected non-vertebrate remains from Flixborough.* 3 pp. Prepared for Humberside Archaeology Unit. [93/27]

Hall and Nicholson EAU 1991/27 Hall, A. R. and Nicholson, R. A. (1991). *Report on soil samples and bones from excavations at Kirmington Runway, 1991 (site code KRU 91).* Prepared for Humberside Archaeological Unit. [91/27]

Hall and Nicholson EAU 1991/28 Hall, A. R. and Nicholson, R. A. (1991). *Assessment of biological remains from bulk-sieved samples from Riby, Lincolnshire (RBY 91).* Prepared for Humberside Archaeological Unit. [91/28]

Hall and Tomlinson AML 6/96 Hall, A. R. and Tomlinson, P. (1996). User guide to the Environmental Archaeology Bibliography (EAB). *Ancient Monuments Laboratory Report* 6/96, 21 pp. + 3 3.5" disks.

Hall and Tomlinson EAU 1995/55 Hall, A. and Tomlinson. P. (1995). *The ABCD, a resource for palaeobotany*, p. 9 in Jaques, D. and Kenward, H. (compilers), Research Forum 1995: Current and future research in the EAU. Abstracts from a one-day forum held in Derwent College, University of York, on 18th October 1995. *Reports from the Environmental Archaeology Unit, York* 95/55, 19 pp.

Hall CHP 16/2003 Hall, A. R. (2003). Recognition and characterisation of turves in archaeological occupation deposits by means of macrofossil plant remains. *Centre for Archaeology Report* 16/2003. Portsmouth: English Heritage.

Hall EAU 2000/46 Hall, A. (2000). Assessment of plant and invertebrate remains from the Appletree section, Cumbria. *Reports from the Environmental Archaeology Unit, York* 2000/46, 5 pp.

Hall EAU 2000/56 Hall, A. (2000). Technical report: Plant remains from excavations at Flixborough, N. Lincolnshire (site code: FLX89). *Reports from the Environmental Archaeology Unit, York* 2000/56, 107 pp.

Hall EAU 2000/56 Hall, A. (2000). Technical report: Plant remains from excavations at Flixborough, N. Lincolnshire (site code: FLX89). *Reports from the Environmental Archaeology Unit, York* 2000/56, 107 pp.

Hall EAU 2000/78 Hall, A.. (2000). Assessment of plant remains from excavations at Cheviot Quarry, Milfield, Northumberland (site code 02-02-00). *Reports from the Environmental Archaeology Unit, York* 2000/78, 7pp.

Hall EAU 2001/17 Hall, A. (2001). Assessment of plant remains (mainly charcoal) from excavations at Cawthorn Camps, North Yorkshire, 2000 (site code CAS645) *Report from the Environmental Archaeology Unit, York* 2001/17, 11pp.

Hall EAU 2001/19 Hall, A. (2001). Notes on the examination of sediment from the sockets of five bronze axes collected along the course of the Transco W. Hull Gas Pipeline. *Reports from the Environmental Archaeology Unit, York* 2001/19, 2 pp.

Hall *et al.* AML 56/93 Hall, A. R., Kenward, H. K. and Robertson, A. (1993a). Investigation of medieval and post-medieval plant and invertebrate remains from Area X of the excavations in The Bedern (south-west), York (YAT/Yorkshire Museum sitecode 1973.81.13 X): Technical report. *Ancient Monuments Laboratory Report* 56/93.

Hall *et al.* AML 57/93 Hall, A. R., Kenward, H. K. and Robertson, A. (1993b). Investigation of medieval and post-medieval plant and invertebrate remains from Area IV of the excavations in The Bedern (north-east), York (YAT/Yorkshire Museum sitecode 1976-81.14 IV): Technical report. *Ancient Monuments Laboratory Report* 57/93.

Hall *et al.* AML 58/93 Hall, A. R., Kenward, H. K. and Robertson, A. (1993b). Investigation of medieval and post-medieval plant and invertebrate remains from Area II of the excavations in The Bedern (north-east), York (YAT/Yorkshire Museum sitecode 1976-81.14 II): Technical report. *Ancient Monuments Laboratory Report* 58/93.

Hall *et al.* CHP 2003/01 Hall, A., Jaques, D. and Carrott, J. (2003). Technical Report: Biological remains from a site north-east of Goodmanham, East Riding of Yorkshire (site code: TSEP907). *Reports from the Centre for Human Palaeoecology, University of York* 2003/01, 31pp.

Hall *et al.* EAU 1990/9 Hall, A. R., Kenward, H. K. and O'Connor, T. P. (1990). *Dundas Street 89.22 [Report on the borehole samples]* Prepared for D. Brinklow, York Archaeological Trust. [90/9]

Hall *et al.* EAU 1991/23 Hall, A. R., Carrott, J., Kenward, H. K. and Nicholson, R. A. (1991). *Biological analyses of sample from 20-4 Swinegate (YAT/Yorkshire Museum sitecode 1990.25).* Prepared for York Archaeological Trust. [91/23]

Hall *et al.* EAU 1991/24 Hall, A. R., Carrott, J., Kenward, H. K. and Richardson, J. (1991). *Report on biological analyses of deposits from excavations in Jewbury, York (YAT/Yorkshire Museum sitecode 1982-3.5).* Prepared for J. Lilley, York Archaeological Trust. [91/24]

Hall *et al.* EAU 1993/26 Hall, A., Jaques, D, Kenward, H. and Large, F. (1993). *Biological remains from excavations of medieval deposits at 63-64 Baxtergate, Whitby (site code WB2).* Prepared for Malton Archaeological Projects. 15 pp. + appendices 1-4. [93/26]

Hall *et al.* EAU 1994/15 Hall, A., Kenward, H., Hill, M., Large, F., Jaques, D., Dobney, K., Issitt, M. and Lancaster, S. (1994). Technical report: Biological remains from excavations on the Leven-Brandesburton by-pass, N. Humberside. *Reports from the Environmental Archaeology Unit, York* 94/15, 34 pp. + 24 pp. appendix.

Hall *et al.* EAU 1994/57 Hall, A., Kenward, H., Large, F. and Usai, R. (1994). Assessment of biological remains and sediments from Roman deposits at Cumbria College of Art, Stanwix, Carlisle (site code ARC94). *Reports from the Environmental Archaeology Unit, York* 94/57, 7 pp.

Hall *et al.* EAU 1995/40 Hall, A., Issitt, M., Jaques, D., Kenward, H. and Large, F. (1995). An evaluation of biological remains from excavations at York Minster Library (site code: YML95). *Reports from the Environmental Archaeology Unit, York* 95/40, 4 pp.

Hall *et al.* EAU 1996/05 Hall, A., Kenward, H. and Large, F. (1996). Biological remains from a medieval 'pond' at Higher Lane, Fazakerley, Merseyside (site code FAZ94). *Reports from the Environmental Archaeology Unit, York* 96/5, 30 pp.

Hall *et al.* EAU 1996/29 Hall, A., Jaques, D., Kenward, H. and Large, F. (1996). Assessment of biological remains from Lime Tree Lane, Bilton, Hull (sitecode BIL93). *Reports from the Environmental Archaeology Unit, York* 96/29, 8 pp.

Hall *et al.* EAU 1996/35 Hall, A., Issitt, M., Jaques, D. and Large, F. (1996). Evaluation of biological remains from 23A Quay Street, Scarborough (sitecode QS96). *Reports from the Environmental Archaeology Unit, York* 96/35, 4 pp.

Hall *et al.* EAU 1996/54 Hall, A., Issitt, M. and Large, F. (1996). Evaluation of biological remains from excavations at The Former Convent School, Queen Street, Scarborough (site code: STS96). *Reports from the Environmental Archaeology Unit, York* 96/54, 3 pp.

Hall *et al.* EAU 1996/56 Hall, A., Issitt, M., Jaques, D. and Large, F. (1996). Evaluation of biological remains from excavations at Crossgates Farm, Seamer, N. Yorkshire (site code CG96). *Reports from the Environmental Archaeology Unit, York* 96/56, 3 pp.

Hall *et al.* EAU 1997/26 Hall, A., Issitt, M., Kenward, H. and Large, F. (1997). Assessment of biological remains from excavations at St Sepulchre Street, Scarborough (site code: SP96). *Reports from the Environmental Archaeology Unit, York* 97/26, 4 pp. + 2 pp. appendix.

Hall *et al.* EAU 1997/40 Hall, A., Issitt, M. and Large, F. (1997). Evaluation of biological remains from excavations at West Cowick, East Yorkshire (site code: 1997.48). *Reports from the Environmental Archaeology Unit, York* 97/40, 3 pp.

Hall *et al.* EAU 1998/30 Hall, A., Kenward, H. and Carrott, J. (1998). Technical report: Plant and invertebrate remains from excavations associated with renovations at All Saints Church, Pavement, York (site code 95.47). *Reports from the Environmental Archaeology Unit, York* 98/30, *20 pp.*

Hall *et al.* EAU 1999/13 Hall, A., Johnstone, C., Large, F. and Worthy, D. (1999). Evaluation of bioarchaeological remains from Coopers Farm, Long Riston, East Riding of Yorkshire (site code: CFR99). *Reports from the Environmental Archaeology Unit, York* 99/13, 6 pp.

Hall *et al.* EAU 1999/17 Hall, A., Jaques, D., Large, F. and Worthy, D. (1999). Evaluation of biological remains from excavations at West End, Kilham, East Riding of Yorkshire (site code KINCM1998.87). *Reports from the Environmental Archaeology Unit, York* 99/17, 5 pp.

Hall *et al.* EAU 1999/31 Hall, A., Kenward, H., Large, F. and Worthy, D. (1999). Evaluation of bioarchaeological remains from a site on the Chapel Haddlesey to Eggborough pipeline (site code OSA99WB03). *Reports from the Environmental Archaeology Unit, York* 99/31, 4 pp.

Hall *et al.* EAU 1999/59 Hall, A., Carrott, J., Large, F. and Kenward, H. (1999). 7 Northgate, Cottingham (COT99): brief notes on biological remains from three samples. *Reports from the Environmental Archaeology Unit, York* 99/59, 2 pp.

Hall *et al.* EAU 2000/15 Hall, A., Carrott, J., Jaques, D., Kenward, H. and Rowland, S. (2000). Evaluation of biological remains from South Beckside, Beverley, East Riding of Yorkshire (site code: SBS2000). *Reports from the Environmental Archaeology Unit, York* 2000/15, 7 pp.

Hall *et al.* EAU 2000/19 Hall, A., Carrott, J., Jaques, D., Kenward, H. and Rowland, S. (2000). Assessment of biological remains from further excavations at Magistrates' Court, Hull (site code: MCH99). *Reports from the Environmental Archaeology Unit, York* 2000/19, 8 pp.

Hall *et al.* EAU 2000/25 Hall, A., Carrott, J., Jaques, D., Johnstone, C., Kenward, H., Large, F. and Usai, R. (2000). Technical report: Studies on biological remains and sediments from Periods 1 and 2 at the Magistrates' Courts site, Kingston-upon-Hull (site codes HMC 94 and MCH99). Part 1: Text. *Reports from the Environmental Archaeology Unit, York* 2000/25, 78 pp.

Hall *et al.* EAU 2000/27 Hall, A., Carrott, J. and Rowland, S. (2000). Assessment of biological remains from excavations at Newbridge Quarry, Pickering, North Yorkshire (site code NBQ99). *Reports from the Environmental Archaeology Unit, York* 2000/27, 5 pp.

Hall *et al.* EAU 2000/28 Hall, A., Kenward, H., Rowland, S. and Carrott, J (2000). Evaluation of biological remains from excavations at Yearsley House, York (site code YYH00). *Reports from the Environmental Archaeology Unit, York* 2000/28, 4 pp.

Hall *et al.* EAU 2000/30 Hall, A., Jaques, D., Kenward, H., Carrott, J. and Rowland, S. (2000). Assessment of biological remains from excavations at Foxton's Garage, York (site code: 2000.452). *Reports from the Environmental Archaeology Unit, York* 2000/30, 5 pp.

Hall *et al.* EAU 2000/33 Hall, A., Carrott, J., Jaques, D., Johnstone, C., Kenward, H., Large, F. and Usai, R. (2000). Technical report: Studies on biological remains and sediments from Periods 1 and 2 at the Magistrates' Courts site, Kingston-upon-Hull (site codes HMC 94 and MCH99). Part 2: Tables and figures. *Reports from the Environmental Archaeology Unit, York* 2000/33, 135 pp.

Hall *et al.* EAU 2000/34 Hall, A., Kenward, H., Rowland, S. and Carrott, J. (2000). Evaluation of biological remains from excavations at the former convent school, St Thomas Street, Scarborough (site code: STS99). *Reports from the Environmental Archaeology Unit, York* 2000/34, 4 pp.

Hall *et al.* EAU 2000/38 Hall, A., Kenward, H., Rowland, S., Jaques, D. and Carrott, J. (2000). Evaluation of biological remains from excavations at Newcastle Packet, 13 Sandside, Scarborough (site code: NP00). *Reports from the Environmental Archaeology Unit, York* 2000/38, 3 pp.

Hall *et al.* EAU 2000/48 Hall, A., Rowland, S. and Carrott, J. (2000). Evaluation of biological remains from excavations at Huntington South Moor, York (site code: YORYM 2000.574). *Reports from the Environmental Archaeology Unit, York* 2000/48, 3 pp.

Hall *et al.* EAU 2000/49 Hall, A., Kenward, H., Rowland, S. and Carrott, J. (2000). Evaluation of biological remains from excavations at land off Wiggington Road, York (site code: YORYM 2000.572). *Reports from the Environmental Archaeology Unit, York* 2000/49, 5 pp.

Hall *et al.* EAU 2000/60 Hall, A., Rowland, S., Kenward, H., and Carrott, J. (2000). Evaluation of biological remains from excavations north-east of Castle Hill Farm, Swine (site code: TSEP458). *Reports from the Environmental Archaeology Unit, York* 2000/60, 3 pp.

Hall *et al.* EAU 2000/64 Hall, A., Kenward, H., Jaques, D. and Carrott, J. (2000). Technical Report: Environment and industry at Layerthorpe Bridge, York (site code YORYM 1996.345). *Reports from the Environmental Archaeology Unit, York* 2000/64*, 117 pp.*

Hall *et al.* EAU 2000/67 Hall, A., Rowland, S., Kenward, H. and Carrott, J. (2000). Evaluation of biological remains from excavations at Bolton Common (site code: TSEP 243). *Reports from the Environmental Archaeology Unit, York* 2000/67, 5 pp.

Hall *et al.* EAU 2000/73 Hall, A., Rowland, S., Jaques, D. and Carrott, J. (2000). Evaluation of biological remains from excavations north-east of Goodmanham (site code: TSEP 907). *Reports from the Environmental Archaeology Unit, York* 2000/73, 13 pp.

Hall *et al.* EAU 2000/80 Hall, A., Rowland, S., Kenward, H., Jaques, D. and Carrott, J. (2000). Evaluation of biological remains from excavations on land to the rear of 7-15 Spurriergate, York (site code: 2000.584). *Reports from the Environmental Archaeology Unit, York* 2000/80, 13 pp.

Hall *et al.* EAU 2000/82 Hall, A., Jaques, D., Rowland, S., Kenward, H. and Carrott, J. (2000). Evaluation of biological remains from excavations near West Lilling, North Yorkshire (site code: OSA99EX03). *Reports from the Environmental Archaeology Unit, York* 2000/82, 9 pp.

Hall *et al.* EAU 2001/06 Hall, A., Jaques, D., Kenward, H., and Carrott, J. (2001). Evaluation of biological remains from excavations at Magistrates' Court, Beverley, East Yorkshire (site code: BMC2000). *Reports from the Environmental Archaeology Unit, York* 2001/06, 7 pp.

Hall *et al.* EAU 2001/10 Hall, A., Kenward, H., Jaques, D. and Carrott, J. (2001). Evaluation of biological remains from the former Normanby Park Steelworks, North Lincolnshire (site code: NPQ2000)*. Reports from the Environmental Archaeology Unit, York* 2001/10, 8 pp.

Hall *et al.* EAU 2001/13 Hall, A., Rowland, S., Kenward, H., Jaques, D., and Carrott, J. (2001). Evaluation of biological remains from excavations at the site of the former Presto supermarket, York (site code: 2000.624)*. Reports from the Environmental Archaeology Unit, York* 2001/13, 9 pp.

Hall *et al.* EAU 2001/15 Hall, A., Kenward, H., Jaques, D., and Carrott, J. (2001). Evaluation of biological remains from excavations at the St John's Coach Park, Clarence Street, York (site code: 2000.589). *Reports from the Environmental Archaeology Unit, York* 2001/15, 6 pp.

Hall *et al.* EAU 2001/16 Hall, A., Kenward, H., Jaques, D., and Carrott, J. (2001). Evaluation of biological remains from excavations at sites on the line of the Transco West Hull pipeline (site code: OSA01EV05). *Reports from the Environmental Archaeology Unit, York* 2001/16, 5 pp.

Hall *et al.* EAU 2001/21 Hall, A., Jaques, D. and Carrott, J. (2001). Evaluation of biological remains from Waterside Road, Beverley, East Yorkshire (site code: BWA2000). *Reports from the Environmental Archaeology Unit, York* 2001/21, 7 pp.

Hall *et al.* EAU 2001/25 Hall, A., Rowland, S., Carrott, J., and Jaques, D. (2001). Evaluation of biological remains from excavations at County Hall, Beverley, East Riding of Yorkshire (sitecode: CHB2001). *Reports from the Environmental Archaeology Unit, York* 2001/25, 9 pp.

Hall *et al.* EAU 2001/28 Hall, A., Kenward, H., and Carrott, J. (2001). Evaluation of biological remains from excavations at Church Street, Burton Pidsea, East Riding of Yorkshire (site code: CSB2001). *Reports from the Environmental Archaeology Unit, York* 2001/28, 3 pp.

Hall *et al.* EAU 2001/29 Hall, A., Kenward, H., Jaques, D., Rowland, S., and Carrott, J. (2001). Evaluation of biological remains from 16 Baxtergate, Hedon, East Riding of Yorkshire (site code: BAH2001). *Reports from the Environmental Archaeology Unit, York* 2001/29, 9 pp.

Hall *et al.* EAU 2001/30 Hall, A., Jaques, D., Rowland, S., and Carrott, J., (2001). Evaluation of biological remains from excavations at 63-67 Micklegate, York (site code: YMK01). *Reports from the Environmental Archaeology Unit, York* 2001/30, 6 pp.

Hall *et al.* EAU 2001/37 Hall, A., Rowland, S., Kenward, H. and Carrott, J. (2001). Evaluation of biological remains from excavations at Citadel Way, Kingston upon Hull (site code: BMW2001). *Reports from the Environmental Archaeology Unit, York* 2001/37, *4 pp.*

Hall *et al.* EAU 2001/38 Hall, A., Kenward, H., Rowland, S. and Carrott, J. (2001). Evaluation of biological remains from excavations at Magistrates' Court, Brough, East Riding of Yorkshire (site code: BRO2001). *Reports from the Environmental Archaeology Unit, York* 2001/38, *5 pp.*

Hall *et al.* EAU 2001/39 Hall, A., Kenward, H., Jaques, D., Rowland, S. and Carrott, J. (2001). Evaluation of biological remains from excavations at Waterside Road, Beverley, East Riding of Yorkshire (site code: WAT2001). *Reports from the Environmental Archaeology Unit, York* 2001/39, 6 pp.

Hall *et al.* EAU 2001/40 Hall, A., Jaques, D. and Carrott, J. (2001). Evaluation of biological remains from excavations at the former D. C. Cook site, Lawrence Street, York (site code: YORYM 2001.9444). *Reports from the Environmental Archaeology Unit, York* 2001/40, 5 pp.

Hall *et al.* EAU 2001/42 Hall, A., Jaques, D., Kenward, H. and Carrott, J. (2001). Evaluation of biological remains from excavations at Union Terrace, York (site code: 2001.4434). *Reports from the Environmental Archaeology Unit, York* 2001/42, 3 pp.

Hall *et al.* EAU 2001/51 Hall, A., Kenward, H., Rowland, S., Jaques, D. and Carrott, J. (2001). Evaluation of biological remains from borehole samples taken at the site of the former Victoria House, Micklegate, York (site code: 2001.10749). *Reports from the Environmental Archaeology Unit, York* 2001/51, 5 pp.

Hall *et al.* EAU 2002/01 Hall, A., Jaques, D., Rowland, S., Kenward, H. and Carrott, J. (2002). Technical report: Biological remains from excavations at a site near West Lilling, North Yorkshire (site codes: OSA99EX03 and BPTSEP169). *Reports from the Environmental Archaeology Unit, York* 2002/1, 34pp.

Hall *et al.* EAU 2002/02 Hall, A., Kenward, H. and Carrott, J. (2002). Assessment of biological remains from excavations at Morton Lane, Beverley, East Riding of Yorkshire (site code: MLA01). *Reports from the Environmental Archaeology Unit, York* 2002/02, 4pp. [also released as *Palaeoecology Research Services Report* 2002/01]

Hall *et al.* EAU 2002/03 Hall, A., Kenward, H., Jaques, D. and Carrott, J. (2002). Evaluation of biological remains from excavations at Trinity Lane, Beverley, East Riding of Yorkshire (site code: TRB2001). *Reports from the Environmental Archaeology Unit, York* 2002/03, 7pp. [also released as *Palaeoecology Research Services Report* 2002/03]

Hall *et al.* PRS 2001/03 Hall, A., Kenward, H., Jaques, D. and Carrott, J. (2001). Evaluation of biological remains from further excavations on land adjacent to Paragon BMW, Citadel Way, Kingston upon Hull (site code: BMW2001). *Palaeoecology Research Services Report* 2001/03, 4 pp.

Hall *et al.* PRS 2001/05 Hall, A., Kenward, H. and Carrott, J. (2001). Evaluation of biological remains from excavations associated with the Transco West Hull pipeline (site code OSA01EV05). *Palaeoecology Research Services Report* 2001/05, 3 pp.

Hall *et al.* PRS 2002/05 Hall, A., Kenward, H. and Carrott, J. (2002). Evaluation of biological remains from a sample recovered during a watching brief at Far Ings, Barton, North Lincolnshire (site code: FIB2001). *Palaeoecology Research Services Report* 2002/05, 4 pp.

Hall *et al.* PRS 2002/08 Hall, A., Wagner, P., Jaques, D. and Carrott, J. (2002). Evaluation of biological remains from excavations at New Crane Street car park, Chester (site code B3811C). *Palaeoecology Research Services Reports* 2002/08, 6 pp.

Hall *et al.* PRS 2002/10 Hall, A., Kenward, H. and Carrott, J. (2002). Short note: Biological remains from excavations at South Beckside, Beverley, East Riding of Yorkshire (site code: BSB00). *Palaeoecology Research Services Reports* 2002/10, 3 pp.

Hall *et al.* PRS 2002/14 Hall, A., Kenward, H. and Carrott, J. (2002). Assessment of biological remains from a watching brief on land to the rear of Chapel Farm, 9 Runner End, Holme-on-Spalding-Moor, East Riding of Yorkshire (site code: HRE02). *Palaeoecology Research Services Reports* 2002/14, 4 pp.

Hall *et al.* PRS 2002/16 Hall, A., Jaques, D., Carrott, J. and Kenward, H. (2002). Assessment of biological remains from excavations at Bridge Street, Chester (site code: CHE/25BS'01). *Palaeoecology Research Services Reports* 2002/16, 35 pp.

Hall *et al.* PRS 2002/23 Hall, A., Usai, R. and Carrott, J. (2002). Assessment of biological remains and sediments from excavations at Monks Cross, York (site code: YORYM2000.574). *Palaeoecology Research Services Report* 2002/23.

Hall *et al.* PRS 2002/27 Hall, A., Kenward, H., Jaques, D., Johnson, K. and Carrott, J. (2002). Assessment of biological remains from excavations at the site of the proposed waste water treatment works at Melton, East Riding of Yorkshire (site code MTW01). *Palaeoecology Research Services Report* 2002/27.

Hall *et al.* PRS 2002/30 Hall, A., Jaques, D., Johnson, K., Carrott, J. and Kenward, H. (2002) Assessment of biological remains from excavations at the site of the former Deva garage, 27 Grosvenor Park Road, Chester (site code: B3471A). *Palaeoecology Research Services Reports* 2002/30.

Hall *et al.* PRS 2002/32 Hall, A., Jaques, D. and Carrott, J. (2002). Evaluation of biological remains from excavations at Low Farm, Cottingham, East Riding of Yorkshire (site code: LFC2002). *Palaeoecology Research Services Report* 2002/32.

Hall *et al.* PRS 2002/41 Hall, A., Jaques, D. and Carrott, J. (2002). Evaluation of biological remains from excavations at Elloughton, East Riding of Yorkshire (site code: OSA01WB33). *Palaeoecology Research Services Report* 2002/41.

Hall *et al.* PRS 2002/42 Hall, A., Kenward, H. and Carrott, J. (2002). Evaluation of biological remains from excavations at site OAS02WB23 East Riding of Yorkshire (site code: OAS02WB23). *Palaeoecology Research Services Report* 2002/42.

Hall *et al.* PRS 2003/03 Hall, A., Johnson, K., Jaques, D. and Carrott, J. (2003). Assessment of biological remains from excavations at Temple Point, Colton (nr Leeds), West Yorkshire (site codeL D2001.85). *Palaeoecology Research Services Report* 2003/03.

Hall *et al.* PRS 2003/05 Hall, A., Kenward, H. and Carrott, J. (2003). Evaluation of biological remains from further excavations at the site of the former Magistrates' Court, Brough, East Riding of Yorkshire (site code BRO2002). *Palaeoecology Research Services Report* 2002/05.

Hall *et al.* PRS 2003/09 Hall, A., Jaques, D. and Carrott, J. (2003). Evaluation of biological remains from a watching brief at Airton, North Yorkshire (associated with the Mallam to Hellifield water pipeline) (site code OSA02WB23). *Palaeoecology Research Services Report* 2003/09.

Hall *et al.* PRS 2003/14 Hall, A., Kenward, H. and Carrott, J. (2003). Evaluation of biological remains from a watching brief at the Guardian Glass site, Goole, East Riding of Yorkshire (site code: GGG2002). *Palaeoecology Research Services Report* 2003/14.

Hall *et al.* PRS 2003/19 Hall, A., Jaques, D. and Carrott, J. (2003). Evaluation of biological remains from excavations at Millfield Farm, Wheldrake (nr York), North Yorkshire, a site on the Elvington to Ricall water pipeline (site code: ERP02). *Palaeoecology Research Services Report* 2003/19.

Hall *et al.* PRS 2003/20 Hall, A., Jaques, D. and Carrott, J. (2003). Evaluation of biological remains from further excavations at Low Farm, Cottingham, East Riding of Yorkshire (site code: LFC2002). *Palaeoecology Research Services Report* 2003/20.

Hall *et al.* PRS 2003/23 Hall, A., Jaques, D., Kenward, H. and Carrott, J. (2003). Evaluation of biological remains from further excavations at Site R3, Island Wharf, Hull Marina, Kingston upon Hull (site code: HUM2002). *Palaeoecology Research Services Reports* 2003/23.

Hall *et al.* PRS 2003/25 Hall, A., Kenward, H., Jaques, D. and Carrott, J. (2003). Evaluation of biological remains from excavations at 62-68 Low Petergate, York (site code: YORYM 2002.421). *Palaeoecology Research Services Report* 2003/25.

Hall *et al.* PRS 2003/26 Hall, A., Jaques, D. and Carrott, J. (2003). Evaluation of biological remains from excavations at 'Rowdales', nr South Cave, East Riding of Yorkshire (site code: RSC2002). *Palaeoecology Research Services Report* 2003/26.

Hall *et al.* PRS 2003/30 Hall, A., Jaques, D. and Carrott, J. (2003). Evaluation of biological remains from excavations at Winterton Landfill site, North Lincolnshire (site code: WLS2003). *Palaeoecology Research Services Report* 2003/30.

Hall *et al.* PRS 2003/32 Hall, A., Jaques, D. and Carrott, J. (2003). Evaluation of biological remains from excavations at Bedford Hotel, 108-110 Bootham, York (site code: YORYM 2003.250). *Palaeoecology Research Services Report* 2003/32.

Hall *et al.* PRS 2003/33 Hall, A., Kenward, H., Jaques, D. and Carrott, J. (2003). Evaluation of biological remains from excavations at D C Cook, Lawrence Street, York (site code: YORYM 2001.9444). *Palaeoecology Research Services Report* 2003/33.

Hall *et al.* PRS 2003/42 Hall, A., Kenward, H., Jaques, D. and Carrott, J. (2003). Evaluation of biological remains from excavations at The Spinney, Sherburn-in-Elmet, North Yorkshire (site code: YORYM2002.448). *Palaeoecology Research Services Report* 2003/42.

Hall *et al.* PRS 2003/45 Hall, A., Carrott, J. and Cousins, S. (2003). Assessment of biological remains from excavations at 66 Burringham Road, Scunthorpe, North Lincolnshire (site code: SCAE). *Palaeoecology Research Services Report* 2003/45.

Hall *et al.* PRS 2003/48 Hall, A., Jaques, D. Carrott, J. and Cousins, S. (2003). Assessment of biological remains from excavations on land northe of Keldgate Close, Beverley, East Riding of Yorkshire (site code: KCB2003). *Palaeoecology Research Services Report* 2003/48.

Hall *et al.* PRS 2003/69 Hall, A., Kenward, H., Carrott, J. and Johnson, K. (2003). Evaluation of biological remains from a watching brief at Burn Lane Hexham, Northumberland (site code: BLH03). *Palaeoecology Research Services Report* 2003/69.

Hall *et al.* PRS 2003/70 Hall, A., Kenward, H. and Carrott, J. (2003). Evaluation of plant and invertebrate remains from a deposit at Gillibrand Hall, Chorley, Lancashire (site code: B3423A). *Palaeoecology Research Services Report* 2003/70.

Hall *et al.* PRS 2003/71 Hall, A., Jaques, D., Kenward, H. and Carrott, J. (2003). Assessment of biological remains from excavations at 6 St John Street, Beverley, East Riding of Yorkshire (site code: SJB03). *Palaeoecology Research Services Report* 2003/71.

Hall *et al.* PRS 2003/86 Hall, A., Carrott, J. and Johnson, K. (2003). Assessment of biological remains from further excavations at Monks Cross, York (site code: YORYM2000.574). *Palaeoecology Research Services Report* 2003/86.

Hall *et al.* PRS 2003/87 Hall, A., Jaques, D., Johnson, K. and Carrott, J. (2003). Assessment of biological remains from excavations at the site of the former Starting Gate public house, 40 Tadcaster Road, York (site code: YORYM2003.303). *Palaeoecology Research Services Report* 2003/87.

Hall *et al.* PRS 2004/18 Hall, A., Jaques, D., Kenward, H., Carrott, J. and Johnson, K. (2003). Evaluation of biological remains from samples recovered during further excavations at 69-73 Morton Lane, Beverley, East Riding of Yorkshire (site code: MLB03). *Palaeoecology Research Services Report* 2004/18.

Hall *et al.* PRS 2004/23 Hall, A., Jaques, D., Kenward, H., Carrott, J. and Johnson, K. (2003). Assessment of biological remains from excavations at 14-16 and 48-50 Newmarket Street, Dublin, Republic of Ireland (site code: 02E1692). *Palaeoecology Research Services Report* 2004/23.

Hall *et al.* PRS 2004/28 Hall, A., Jaques, D., Kenward, H., Carrott, J. and Johnson, K. (2004). Evaluation of biological remains from excavations at Heslington East, York (site code: YORYM 2002.569). *Palaeoecology Research Services Report* 2004/28.

Hall *et al.* PRS 2004/31 Hall, A., Kenward, H., Jaques, D., Carrott, J. and Johnson, K. (2004). Evaluation of biological remains from further excavations at the Paragon BMW showroom, Citadel Way, Kingston-upon-Hull (site code: BMW2003). *Palaeoecology Research Services Report* 2004/31.

Hall et al. PRS 2004/32 Hall, A., Jaques, D., Kenward, H., Carrott, J. and Johnson, K. (2004). Evaluation of biological remains from excavations at Burnett House, Castle Street, Kingston-upon-Hull (site code: BHH04). *Palaeoecology Research Services Report* 2004/32.

Hall *et al.* PRS 2004/33 Hall, A., Jaques, D., Kenward, H., Carrott, J. and Johnson, K. (2003). Assessment of biological remains from excavations at Newport Road Quarry, North Cave, East Riding of Yorkshire: Phase 3 (site code: NCE2001). *Palaeoecology Research Services Report* 2004/33.

Hall *et al.* PRS 2004/45 Hall, A., Carrott, J. and Johnson, K. (2004). Technical report: biological remains from an Iron Age farmstead at Lathom, West Lancashire (site code: DFL57). *Palaeoecology Research Services Report* 2004/45.

Hall *et al.* PRS 2004/48 Hall, A., Kenward, H., Jaques, D., Carrott, J. and Gardner, S. (2004). Assessment of biological remains from a 13th century deposit at Springfield, Scarborough, North Yorkshire (site code: SP04). *Palaeoecology Research Services Report* 2004/48.

Hall *et al.* PRS 2004/52 Hall, A., Jaques, D., Kenward, H., Carrott, J., Johnson, K. and Gardner, S. (2004). Assessment of biological remains from excavations at Newport Road Quarry, North Cave, East Riding of Yorkshire: Phase 4 (site code: NCE2002). *Palaeoecology Research Services Report* 2004/52.

Hall *et al.* PRS 2004/57 Hall, A., Kenward, H., Mant, J., Jaques, D., Carrott, J. and Johnson, K. (2004). Assessment of biological remains from excavations along the route of a water pipeline near Stamford Bridge, East Riding of Yorkshire (site code: SBW03). *Palaeoecology Research Services Report* 2004/57.

Hall *et al.* PRS 2004/74 Hall, A., Geary, B. R., Kenward, H., Akeret, Ö., Carrott, J., Mant, J., Jaques, D. and Johnson, K. (2004). Evaluation of biological remains from excavations at Welham Bridge, East Riding of Yorkshire (site code: ERYMS 2004.19). *Palaeoecology Research Services Report* 2004/74.

Hall *et al.* PRS 2004/98 Hall, A., Kenward, H., Carrott, J., Mant, J. and Gardner, S. (2004). Assessment of plant and invertebrate macrofossils from deposits at a site at Catesby Business Park, Balby Carr, near Doncaster, South Yorkshire (site code: BCA04). *Palaeoecology Research Services Report* 2004/98.

Hall PRS 2003/29 Hall, A. (2003). Technical report: Plant remains from excavations to the rear of Wakeman's House, High Skellgate, Ripon (site code: HARGM 10486). *Palaeoecology Research Services Report* 2003/29.

Hamshaw-Thomas *et al.* EAU 1998/24 Hamshaw-Thomas, J. and Jaques, D., with contributions from Carrott, J., Dobney, K., Hall, A., Issitt, M., Johnstone, C. and Large, F. (1998). Technical report: Vertebrate and other biological remains from excavations at Welton Road, Brough, East Riding of Yorkshire. *Reports from the Environmental Archaeology Unit, York* 98/24, 22 pp. + 10 pp. appendices.

Hardy and Kenward EAU 1985/02 Hardy, E. A. and Kenward, H. K. (1985). *A data input and formatting system for archaeological insect remains.* Deposited at York Archaeological Trust, Environmental Archaeology Unit and Ancient Monuments Laboratory. [85/2]

Hughes, P. and Kenward, H. (1998). Assessment of plant and invertebrate macrofossils from Carse of Stirling (site code: AOC 1681). *Reports from the Environmental Archaeology Unit, York* 98/31, 5 pp.

Hughes *et al.* EAU 1998/26 Hughes, P., Kenward, H., Hall, A. and Large, F. (1998). Technical report: Reconstruction of Lateglacial and Early Postglacial mire succession and rates of climatic change from plant macrofossils, invertebrate remains and pollen at Church Moss, Davenham, Cheshire (site code: DV95). *Reports from the Environmental Archaeology Unit, York* 98/26, 95 pp.

Huntley and Milles DEAR 41/94 Huntley, J. P. and Milles, A. (1994). Melton, Humberside: MEL94. An assessment and evaluation of the environmental samples. *Durham Environmental Archaeology Report* 41/94.

Huntley DEAR 28/96 Huntley, J. P. (1996). Wood End, Mobberley, Morley Green, near manchester: WEM96. A palaeoenvironmental assessment. *Durham Environmental Archaeology Report* 28/96, unpaged

Huntley DEAR 03/96 Huntley, J. P. (1996). Pits Plantation, Rudston: PPR95. An assessment of the environmental samples. *Durham Environmental Archaeology Report* 3/96, 3 pp.

Huntley DEAR 31/96 Huntley, J. P. (1996). A69 Haltwhistle bypass: HALT96. An assessment of the environmental material. *Durham Environmental Archaeology Report* 31/96, unpaged.

Issitt *et al.* EAU 1995/09 Issitt, M., Kenward, H., Large, F. and Milles, A. (1995). An evaluation of biological remains from excavations at Welton Road, Brough, Humberside (site code: BRO 94). *Reports from the Environmental Archaeology Unit, York* 95/9, 3 pp.

Issitt *et al.* EAU 1995/16 Issitt, M., Kenward, H. and Milles, A. (1995). Invertebrate remains from excavations at Low Hauxley, Northumberland (site code: LH94): an assessment. *Reports from the Environmental Archaeology Unit, York* 95/16, 13 pp.

Issitt *et al.* EAU 1996/48 Issitt, M., Kenward, H. and Large, F. (1996). Assessment of invertebrate remains from excavations at M1/A1 Site 3, Grim's Ditch, Yorkshire (site code: AML96). *Reports from the Environmental Archaeology Unit, York* 96/48, 4 pp.

Jaques and Carrott EAU 2001/52 Jaques, D. and Carrott, J. (2001). Evaluation of biological remains from excavations at land to the south of North Back Lane, Bridlington, East Riding of Yorkshire (site code: NBL2001). *Reports from the Environmental Archaeology Unit, York* 2001/52, 6 pp.

Jaques and Carrott PRS 2002/25 Jaques, D. and Carrott, J. (2002). Shell and animal bone remains from Holy Trinity Church, Goodramgate, York (site code: OSA01WB06). *Palaeoecology Research Services Reports* 2002/25, 4 pp.

Jaques and Carrott PRS 2002/31 Jaques, D. and Carrott, J. (2002). Evaluation of biological remains from excavtions at Snuff mlll Lane, Cottingham, East Riding of Yorkshire (site code: SMC2002). *Palaeoecology Research Services Report* 2002/31, 3 pp.

Jaques and Carrott PRS 2003/43 Jaques, D. and Carrott, J. (2003) Evaluation of biological remains from excavations at Clifton Garage, 84 Clifton, York (site code: OSA03EV04). *Palaeoecology Research Services Report* 2003/43, 3 pp.

Jaques and Hall PRS 2003/28 Jaques, D. and Hall. A. (2003). Technical report: Biological remains from 8/9 and 10 The Market Place, Ripon, North Yorkshire (HARGM 10214). *Palaeoecology Research Services Report* 2003/28.

Jaques EAU 2000/21 Jaques, D. (2000). Notes on the vertebrate and shellfish remains from Friary Gardens, Richmond, North Yorkshire (site code RGF00). *Reports from the Environmental Archaeology Unit, York* 2000/21, 5 pp.

Jaques *et al.* EAU 2000/59 Jaques, D., Hall, A., Rowland, S. and Carrott, J. (2000). Evaluation of biological remains from excavations at The Arcade, Ripon, North Yorkshire (site code: HARGM 10214). *Reports from the Environmental Archaeology Unit, York* 2000/59, 9 pp.

Jaques *et al.* EAU 1996/21 Jaques, D., Kenward, H. and Usai, R. (1996). An evaluation of vertebrate remains and sediment from excavations at St Mary's Abbey Precinct wall, York (site code: 96.168). *Reports from the Environmental Archaeology Unit, York* 96/21, 4 pp.

Jaques *et al.* EAU 1999/06 Jaques, D., Large, F., Worthy, D., Hall, A. and Carrott, J. (1999). Assessment of biological remains from York Minster Library (sitecode: YML97). *Reports from the Environmental Archaeology Unit, York* 99/6, 10 pp.

Jaques *et al.* EAU 2000/29 Jaques, D., Carrott, J., Hall, A., Kenward, H., and Rowland, S. (2000). Evaluation of biological remains from excavations in the Hungate area, York (site codes YORYM2000.1-14). *Reports from the Environmental Archaeology Unit, York* 2000/29, 22 pp.

Jaques *et al.* EAU 2000/32 Jaques, D., Carrott, J., Hall, A., Kenward, H. and Rowland, S. (2000). Evaluation of biological remains from excavations at East Halton Skitter, North Lincolnshire (Humber link pipeline project site S26, site code: EHS00). *Reports from the Environmental Archaeology Unit, York* 2000/32, 14 pp.

Jaques *et al.* EAU 2000/35 Jaques, D., Kenward, H. and Johnstone, C. (2000). Assessment of biological remains from excavations at Hayton, East Riding of Yorkshire (site code KINCM1995.1020). *Reports from the Environmental Archaeology Unit, York* 2000/35, 7 pp.

Jaques *et al.* EAU 2000/37 Jaques, D., Carrott, J., Hall, A. and Rowland, S. (2000). Evaluation of biological remains from excavations at 90 The Mount, York (site code YORYM 2000.507). *Reports from the Environmental Archaeology Unit, York* 2000/37, 4 pp.

Jaques *et al.* EAU 2000/43Jaques, D., Carrott, J., Hall, A., and Rowland, S. (2000). Evaluation of biological remains from excavations at Bishop Wilton, North Yorkshire (site code: KINCM2000.108). *Reports from the Environmental Archaeology Unit, York* 2000/43 5 pp.

Jaques *et al.* EAU 2000/53 Jaques, D., Hall, A., Kenward, H., Rowland, S., Wang, T. and Carrott, J. (2000). Evaluation of biological remains from excavations at NCP car park site, Skeldergate, York (site code: YORYM 1999.844). *Reports from the Environmental Archaeology Unit, York* 2000/53, 17 pp.

Jaques *et al.* EAU 2000/61 Jaques, D., Hall, A., Kenward, H., Rowland, S. and Carrott, J. (2000). Evaluation of biological remains from excavations at Low Farm, north of Cottingham (site code: TSEP418). *Reports from the Environmental Archaeology Unit, York* 2000/61, 6 pp.

Jaques *et al.* EAU 2000/62 Jaques, D., Hall, A., Rowland, S. and Carrott, J. (2000). Evaluation of biological remains from excavations at Lawns Farm, Dunswell (site code: TSEP420). *Reports from the Environmental Archaeology Unit, York* 2000/62, 5 pp.

Jaques *et al.* EAU 2000/63 Jaques, D., Hall, A., Rowland, S. and Carrott, J. (2000). Evaluation of biological remains from excavations at Poplar Farm, Dunswell (site code: TSEP 905). *Reports from the Environmental Archaeology Unit, York* 2000/63, 5 pp.

Jaques *et al.* EAU 2000/65 Jaques, D., Hall, A., Rowland, S., and Carrott, J. (2000). Evaluation of biological remains from excavations south of Bishop Burton, east of Dale Gate (site code: TSEP 373). *Reports from the Environmental Archaeology Unit, York* 2000/65, 8 pp.

Jaques *et al.* EAU 2000/66 Jaques, D., Hall, A., Rowland, S., Kenward, H., and Carrott, J. (2000). Evaluation of biological remains from excavations at Bolton Hall, Bolton (site code: TSEP 238). *Reports from the Environmental Archaeology Unit, York* 2000/66, 7 pp.

Jaques *et al.* EAU 2000/68 Jaques, D., Hall, A., Rowland, S. and Carrott, J. (2000). Evaluation of biological remains from excavations at Flat Lane, Barmby Moor (site code: TSEP 254). *Reports from the Environmental Archaeology Unit, York* 2000/68, 5 pp.

Jaques *et al.* EAU 2000/69 Jaques, D., Hall, A., Rowland, S. and Carrott, J. (2000). Evaluation of biological remains from excavations at Goodmanham Wold (site code: TSEP 904). *Reports from the Environmental Archaeology Unit, York* 2000/69, 3 pp.

Jaques *et al.* EAU 2000/70 Jaques, D., Hall, A., Rowland, S. and Carrott, J. (2000). Evaluation of biological remains from excavations north-east of High Catton, East Riding of Yorkshire (site code: TSEP 218). *Reports from the Environmental Archaeology Unit, York* 2000/70, 6 pp.

Jaques *et al.* EAU 2000/71 Jaques, D., Hall, A., Kenward, H., Rowland, S. and Carrott, J. (2000). Evaluation of biological remains from excavations east of High Catton, East Riding of Yorkshire (site code: TSEP 222). *Reports from the Environmental Archaeology Unit, York* 2000/71, 7 pp.

Jaques *et al.* EAU 2000/72 Jaques, D., Hall, A., Kenward, H., Rowland, S. and Carrott, J. (2000). Evaluation of biological remains from excavations at Carberry Hall Farm (site code: TSEP 908). *Reports from the Environmental Archaeology Unit, York* 2000/72, 5 pp.

Jaques *et al.* EAU 2000/74 Jaques, D., Hall, A., Rowland, S., Kenward, H. and Carrott, J. (2000). Evaluation of biological remains from excavations south of Ganstead (site code: TSEP 901). *Reports from the Environmental Archaeology Unit, York* 2000/74, 8 pp.

Jaques *et al.* EAU 2001/02 Jaques, D., Hall, A., Rowland, S., and Carrott, J. (2001). Evaluation of biological remains from excavations at Market Place, Ripon, North Yorkshire (site code: HARGM 10427). *Reports from the Environmental Archaeology Unit, York* 2001/02, 5 pp.

Jaques *et al.* EAU 2001/03 Jaques, D., Hall, A., and Carrott, J. (2001). Evaluation of biological remains from excavations at New School, Priest Lane, Ripon, North Yorkshire (site code: HARGM 10330). *Reports from the Environmental Archaeology Unit, York* 2001/03, 7 pp.

Jaques *et al.* EAU 2001/04 Jaques, D., Hall, A., and Carrott, J. (2001). Evaluation of biological remains from excavations at 12-13 The Avenue, Clifton, York (site code: YORYM 2000.4287). *Reports from the Environmental Archaeology Unit, York* 2001/04, 3 pp. + 1 p. Appendix.

Jaques *et al.* EAU 2001/05 Jaques, D., Hall, A., and Carrott, J. (2001). Evaluation of biological remains from excavations at Britannia car park, York (site code: YBC00). *Reports from the Environmental Archaeology Unit, York* 2001/05, 3 pp.

Jaques *et al.* EAU 2001/09 Jaques, D., Hall, A., and Carrott, J. (2001). Evaluation of biological remains from excavations at Wakeman's House, Ripon, North Yorkshire (site code: HARGM 10486). *Reports from the Environmental Archaeology Unit, York* 2001/09, 7 pp.

Jaques *et al.* EAU 2001/18 Jaques, D., Hall, A. and Carrott, J. (2001). Evaluation of biological remains from excavations at Bishop Wilton, East Riding of Yorkshire (site code: KINCM 2000.108). *Reports from the Environmental Archaeology Unit, York* 2001/18, 5 pp.

Jaques *et al.* EAU 2001/26 Jaques, D., Hall, A., Kenward, H., Rowland, S., and Carrott, J. (2001). Assessment of biological remains from excavations at 41-9 Walmgate, York (site code: 1999.941). *Reports from the Environmental Archaeology Unit, York* 2001/26, 17 pp.

Jaques *et al.* EAU 2001/34 Jaques, D., Carrott, J., Hall, A. and Rowland, S. (2001). Assessment of biological remains from excavations at Wath Quarry, Wath, North Yorkshire (site code 07-08-00). *Reports from the Environmental Archaeology Unit, York,* 2001/34, 6 pp.

Jaques *et al.* EAU 2001/35 Jaques, D., Hall, A., Kenward, H., and Carrott, J. (2001). Evaluation of biological remains from excavations on land behind and adjacent to 52 Keldgate, Beverley, East Riding of Yorkshire (site code: KGB2001). *Reports from the Environmental Archaeology Unit, York* 2001/35, 11 pp.

Jaques *et al.* EAU 2001/44 Jaques, D., Hall, A. and Carrott, J. (2001). Evaluation of biological remains from excavations at City Arms, Fawcett Street, York (site code: 2001.10748). *Reports from the Environmental Archaeology Unit, York* 2001/44, 3 pp.

Jaques *et al.* EAU 2002/04 Jaques, D., Hall, A., Rowland, S., Kenward, H. and Carrott, J. (2002). Technical Report: Biological remains from a site at Bolton Hall, Bolton, East Riding of Yorkshire (site code: TSEP238). *Reports from the Environmental Archaeology Unit, York* 2002/4, 31 pp.

Jaques *et al.* EAU 2002/05 Jaques, D., Hall, A., Rowland, S., Kenward, H. and Carrott, J. (2002). Technical Report: Biological remains from a site at Carberry Hall Farm, East Riding of Yorkshire (site code: TSEP908). *Reports from the Environmental Archaeology Unit, York* 2002/5, 20pp.

Jaques *et al.* EAU 2002/06 Jaques, D., Hall, A., Rowland, S., and Carrott, J. (2002). Technical Report: Biological remains from a site at Lawns Farm, Dunswell, East Riding of Yorkshire (site code: TSEP420). *Reports from the Environmental Archaeology Unit, York* 2002/6, 5pp.

Jaques *et al.* EAU 2002/07 Jaques, D., Hall, A., Rowland, S., and Carrott, J. (2002). Technical Report: Biological remains from a site at Poplar Farm, Dunswell, East Riding of Yorkshire (site code: TSEP905). *Reports from the Environmental Archaeology Unit, York* 2002/7, 10pp.

Jaques *et al.* EAU 2002/08 Jaques, D., Hall, A., Rowland, S., Kenward, H. and Carrott, J. (2002). Technical Report: Biological remains from a site at Low Farm, near Cottingham, East Riding of Yorkshire (site code: TSEP418). *Reports from the Environmental Archaeology Unit, York* 2002/8, 15pp.

Jaques *et al.* EAU 2002/09 Jaques, D. Hall, A., Rowland, S., Kenward, H. and Carrott, J. (2002). Technical Report: Biological remains from a site south of Ganstead, East Riding of Yorkshire (site code: TSEP901). *Reports from the Environmental Archaeology Unit, York* 2002/9, 21pp. + 18pp. Appendix.

Jaques *et al.* EAU 2002/10 Jaques, D., Hall, A., Rowland, S. and Carrott, J. (2002). Technical Report: biological remains from excavations at Flat Lane, Barmby Moor (site code: TSEP 254). *Reports from the Environmental Archaeology Unit, York* 2002/10, 9pp. + 9pp. Appendix.

Jaques *et al.* EAU 2002/15 Jaques, D., Hall, A., Rowland, S. and Carrott, J. (2002). Technical report: Biological remains from a site north-east of High Catton, East Riding of Yorkshire (site code: TSEP218). *Reports from the Environmental Archaeology Unit, York* 2002/15, 19 pp. + 18 pp. appendix.

Jaques *et al.* PRS 2002/06 Jaques, D., Hall, A., Kenward, H. and Carrott, J. (2002). Evaluation of biological remains from excavations at Beckside North, Beverley, East Riding of Yorkshire (site code: BEC2001). *Palaeoecology Research Services Report* 2002/05, 9 pp.

Jaques *et al.* PRS 2002/07 Jaques, D., Hall, A., Kenward, H. and Carrott, J. (2002). Evaluation of bioarchaeological remains from excavations at Main Street, Long Riston, East Riding of Yorkshire (site code: MSR2001). *Palaeoecology Research Services Reports* 2002/07, 7 pp.

Jaques *et al.* PRS 2002/09 Jaques, D., Hall, A. and Carrott, J. (2002). Evaluation of biological remains from excavations at Wilbert Grove, Beverley, East Riding of Yorkshire (site code: WIB2002). *Palaeoecology Research Services Reports* 2002/09, 6 pp.

Jaques *et al.* PRS 2002/12 Jaques, D., Hall, A., Kenward, H. and Carrott, J. (2002). Assessment of biological remains from excavations at St Andrewgate, York (site code: 1995.89). *Palaeoecology Research Services Reports* 2002/12, 12 pp.

Jaques *et al.* PRS 2002/29 Jaques, D., Hall, A., Kenward, H. and Carrott, J. (2002). Evaluation of biological remains from further excavations at Main Street, Long Riston, East Riding of Yorkshire (site code: MSR2001). *Palaeoecology Research Services Report* 2002/29.

Jaques *et al.* PRS 2002/29 Jaques, D., Hall, A., Kenward, H. and Carrott, C. (2002). Evaluation of biological remains from further excavations at Main Street, Long Riston, East Riding of Yorkshire (site code: MSR2001). *Palaeoecology Research Services Report* 2002/29.

Jaques *et al.* PRS 2003/01 Jaques, D., Hall., A., Kenward, H. and Carrott, C. (2003). Evaluation of biological remains from excavations at 54-7 High Street, Kingston upon Hull (site code HSH2002). *Palaeoecology Research Services Report* 2003/01.

Jaques *et al.* PRS 2003/51 Jaques, D., Carrott, J. Hall, A. and Cousins, S. (2003). Technical report: biological remains from excavations at Bridge Road, Brompton on Swale, North Yorkshire (site code: BRB02). *Palaeoecology Research Services Report* 2003/51.

Jaques *et al.* PRS 2003/63 Jaques, D., Hall, A. and Carrott, J. (2003). Evaluation of biological remains from excavations at the Former Cathedral School, Low St Agnesgate, Ripon, North Yorkshire (site code: HARGM 12000) *Palaeoecology Research Services Report* 2003/63.

Jaques *et al.* PRS 2003/75 Jaques, D., Hall, A. and Carrott, J. (2003). Evaluation of biological remains from excavations at 69-73 Morton Lane, Beverley, East Riding of Yorkshire (site code: MLB03). *Palaeoecology Research Services Report* 2003/75.

Jaques *et al.* PRS 2004/08 Jaques, D., Hall, A., Kenward, H., Johnson, K. and Carrott, J. (2004). Assessment of biological remains from excavations on land between Rosper Road and the Conoco Humber Refinery, Immingham, North Lincolnshire (site Road and the Conoco Humber Refinery, Immingham, North Lincolnshire (site code: CHP2002). *Palaeoecology Research Services Report* 2004/08.

Jaques *et al.* PRS 2004/27 Jaques, D., Carrott, J. and Johnson, K. (2004). Evaluation of biological remains from excavations at Wilbert Grove, Beverley, East Riding of Yorkshire (site code: WIL2004). *Palaeoecology Research Services Report* 2004/27.

Jaques *et al.* PRS 2004/29 Jaques, D., Carrott, J. and Johnson, K. (2004). Evaluation of biological remains from excavations at two sites encountered during ground works for the Ainderby Steeple to Bullamore water pipeline renewal project, North Yorkshire (site code: ASB03). *Palaeoecology Research Services Report* 2004/29.

Jaques *et al.* PRS 2004/37 Jaques, D., Hall, A., Kenward, H., Carrott, J. and Johnson, K. (2004). Technical report: Plant, invertebrate and fish remains recovered from samples from Sprotbrough Hall Gardens, Sprotbrough, South Yorkshire (site code: OSA01EX03). *Palaeoecology Research Services Report* 2004/37.

Jaques *et al.* PRS 2004/46 Jaques, D., Hall, A., Kenward, H. and Carrott, J. (2004). Technical report: plant, invertebrate and fish remains from excavations at 25 Bridge Street, Chester (site code: CHE/25BS'01). *Palaeoecology Research Services Report* 2004/46.

Jaques *et al.* PRS 2004/63 Jaques, D., Hall, A., Mant, J. and Carrott, J. (2004). Assessment of biological remains from excavations at Hayton, East Riding of Yorkshire (site code: 06-01-02). *Palaeoecology Research Services Report* 2004/63.

Johnstone and Carrott EAU 1999/35 Johnstone, C. and Carrott, J. (1999). Notes on the biological remains from Rievaulx Abbey, North Yorkshire (site code 1999.165). *Reports from the Environmental Archaeology Unit, York* 99/35, 1 p.

Johnstone and Carrott EAU 1999/55 Johnstone, C. and Carrott, J. (1999). Evaluation of biological remains from St. William's College (cold store), York (site code 1999.4). *Reports from the Environmental Archaeology Unit, York* 99/55, 9 pp.

Johnson *et al.* (PRS 2003/56) Johnson, K., Carrott, J. and Jaques, D. (2003). Evaluation of biological remains from excavations at the former Mitchell's animal rendering plant, High Green, Bridlington, East Riding of Yorkshire (site code: HGB03) *Palaeoecology Research Services Report* 2003/56.

Johnstone *et al.* EAU 1998/37 Johnstone, C., Jaques, D., Large, F., and Carrott, J. (1998). Evaluation of biological remains from Fetter Lane, York (sitecode: 1998.692). *Reports from the Environmental Archaeology Unit, York* 98/37, 8 pp.

Johnstone *et al.* EAU 1998/38 Johnstone, C., Carrott, J. and Large, F. (1998). Evaluation of vertebrate remains from Fawcett Street, York (site code 1998.693). *Reports from the Environmental Archaeology Unit, York* 98/38, 4 pp.

Johnstone *et al.* EAU 1998/41 Johnstone, C., Hall, A., Worthy, D. and Carrott, J. (1998). Evaluation of biological remains from Clarence Street, York (sitecode: YC98). *Reports from the Environmental Archaeology Unit, York* 98/41, 3 pp.

Johnstone *et al.* EAU 1998/42 Johnstone, C., Carrott, J., Jaques, D., Large, F. and Worthy,

D. (1998). Assessment of vertebrate remains from Easington, East Riding of Yorkshire (site code EAS 98). *Reports from the Environmental Archaeology Unit, York* 98/42, 12 pp.

Johnstone *et al.* EAU 1999/01 Johnstone, C., Large, F., Jaques, D., Worthy, D., Hall, A., Carrott, J. and Kenward, H. (1999). Assessment of biological remains from Blanket Row, Hull (sitecode: BWH98). *Reports from the Environmental Archaeology Unit, York* 99/1, 35 pp.

Johnstone *et al.* EAU 1999/18 Johnstone, C., Hall, A., Worthy, D. and Carrott, J. (1999). Evaluation of biological remains from West Cowick, East Riding of Yorkshire (sitecode: 1998.88). *Reports from the Environmental Archaeology Unit, York* 99/18, 9 pp. + 1 p. appendix.

Johnstone *et al.* EAU 1999/19 Johnstone, C., Carrott, J., Hall, A., Kenward, H., Large, F. and Worthy, D. (1999). Assessment of biological remains from Site 169, West Lilling, North Yorkshire (site code BPTSEP169). *Reports from the Environmental Archaeology Unit, York* 99/19, 6 pp.

Johnstone *et al.* EAU 1999/21 Johnstone, C., Carrott, J., Hall, A., Large, F. and Worthy, D. (1999). Assessment of biological remains from Rear, 3 Little Stonegate (Methodist Chapel Cottage), York (site code 1998.705). *Reports from the Environmental Archaeology Unit, York* 99/21, 11 pp.

Johnstone *et al.* EAU 1999/22 Johnstone, C., Carrott, J., Hall, A., Large F. and Worthy, D. (1999). Assessment of biological remains from the Crown Hotel, Boroughbridge, North Yorkshire (site code HARGM:9553). *Reports from the Environmental Archaeology Unit, York* 99/22, 6 pp.

Johnstone *et al.* EAU 2000/04 Johnstone, C., Carrott, J., Hall, A., Kenward, H. and Worthy, D. (2000). Assessment of biological remains from 41-49 Walmgate, York (site code 1999.941). *Reports from the Environmental Archaeology Unit, York* 2000/04, 46 pp.

Johnstone *et al.* EAU 2000/06 Johnstone, C., Carrott, J., Hall, A. and Kenward, H. (2000). Notes on the biological remains from Sherburn, North Yorkshire (Site code 99EV08). *Reports from the Environmental Archaeology Unit, York* 2000/06, 2 pp.

Jones AML 273/87 Jones, A. K. G. (1987). Parasitological investigations on samples from 6-28/21-7 Union Terrace, York. *Ancient Monuments Laboratory Report* 273/87.

Jones AML 4310 Jones, A. K. G. (1984). Parasite ova from Roman levels at two sites within the fortress of Eboracum: two sites from the Bedern area of York. *Ancient Monuments Laboratory Report* 4310.

Jones AML 4599 Jones, A. K. G. (1985). Parasitological investigations on the 'Anglian helmet pit', Coppergate Development site (YAT site code 1982.22). *Ancient Monuments Laboratory Report* 4599.

Jones AML 4600 Jones, A. K. G. (1985). Parasitological investigations on the Roman pit. *Ancient Monuments Laboratory Report* 4600. [Ambleside]

Jones AML 71/87 Jones, A. K. G. (1987). Parasitological investigations on samples of organic sediment from Hunter's Walk, Chester. *Ancient Monuments Laboratory Report* 71/87.

Jones and Hutchinson AML 59/88 Jones, A. K. G. and Hutchinson, A. R. (1988). Parasitological investigations on samples of organic sediment from excavations at Castle Street, Carlisle, Cumbria. *Ancient Monuments Laboratory Report* 59/88.

Jones and Hutchinson (nd) Jones, A. K. G. and Hutchinson, A. R. (nd). *Parasitological investigations on samples of organic sediment and concretions from excavations at Annetwell Street, Carlisle*. Archive report lodged in EAU and Carlisle Archaeological Unit.

Jones and Nicholson AML 229/87 Jones, A. K. G. and Nicholson, C. (1987). Parasitological investigations on soil samples, coprolites and faecal concretions from the Tanners Row site, Pontefract. *Ancient Monuments Laboratory Report* 229/87.

Jones and O'Connor EAU 1986/33 Jones, A. K. G. and O'Connor, T. (1986). *Soil samples from two Roman pottery vessels from Norton, North Yorkshire.* [86/33]

Jones EAU 1986/10 Jones, A. K. G. (1986). *Parasitological investigations on soil and concretion samples from 9 Blake Street, York (YAT Code 1975-6.6)*. Deposited at Environmental Archaeology Unit and Ancient Monuments Laboratory. [86/10]

Jones EAU 1986/34 Jones, A. K. G. (1986). Parasitological investigations on a sample of concreted material adhering to fish bones from Chester. Deposited at Ancient Monuments Laboratory. [86/34]

Jones EAU 1989/04 Jones, A. K. G. (1989). *Parasite eggs and fish bones from 46-54 Fishergate: summary of results.* Prepared for York Archaeological Trust. [89/4]

Keepax AML 2449 Keepax C. A. [Keeley H., O'Connor T., Jones R. T.] (1978). Beeston Castle, Cheshire. Examination of biological remains. *Ancient Monuments Laboratory Report* 2449.

Kenward (nd) Kenward H. K. (nd.). Kenward, H. K. (forthcoming). Insect remains from two pits. Submitted to D. Phillips, York Minster Archaeology Group.

Kenward AML 195/87 Kenward, H. K. (1987b). Insect remains from Bridge Street, Ipswich. *Ancient Monuments Laboratory Report* 195/87.

Kenward AML 3540 Kenward, H. K. (1981). Insect remains from the Blackfriars Street site, (CAR 78 BLA). *Ancient Monuments Laboratory Report* 3540, 12 pp. [replaced by AML Report 4823, Kenward 1884].

Kenward AML 4823 Kenward, H. K. (1984c). Insect remains from the Blackfriars Street site, Carlisle (CAR 78, BLA). 4823.

Kenward and Allison AML 124/87 Kenward, H. K. and Allison, E. P. (1987b). Waterlogged insect remains from Southampton. *Ancient Monuments Laboratory Report* 124/87.

Kenward and Allison AML 145/88 Kenward, H. K. and Allison, E. P. (1988b). Insect remains from the Roman fort at Papcastle, Carlisle. *Ancient Monuments Laboratory Report* 145/88. [88/13]

Kenward and Allison AML 233/87 Kenward, H. K. and Allison, E. P. (1987a). Insect remains from 5 Rougier Street, York. *Ancient Monuments Laboratory Report* 233/87.

Kenward and Allison EAU 1988/12 Kenward, H. K. and Allison, E. P. (1988a). T*he insect remains from Oakwell Hall, Birstall, W. Yorks.* Prepared for J. Gilks. [88/12]

Kenward and Allison EAU 1995/01 Kenward, H. and Allison, E. (1995). Insect remains from the Roman fort at Papcastle, Cumbria. *Reports from the Environmental Archaeology Unit, York* 95/1, 11 pp. + 16 pp. appendix.

Kenward and Carrott EAU 2001/32 Kenward, H., and Carrott, J. (2001). Technical report: invertebrate remains from two samples from excavations at Broadgate, London (sitecode: BGA90)*. Reports from the Environmental Archaeology Unit, York* 2001/32, 10 pp.

Kenward and Carrott PRS 2002/49 Kenward, H. and Carrott, J. (2002). Assessment of invertebrate remains from excavation of a timber structure at Staithes, North Yorkshire (site code: SCL02). *Palaeoecology Research Services Report* 2002/49, 4 pp.

Kenward and Carrott PRS 2003/58 Kenward, H. and Carrott, J. (2003). Technical Report: The implications of invertebrates, mainly insects, from medieval and early post-medieval deposits at Morton Lane, Beverley, East Riding of Yorkshire. *Palaeoecology Research Services Report* 2003/58, 28 pp.

Kenward and Hall EAU 1986/17 Kenward, H. K. and Hall, A. R. (1986). *Annotated catalogue of `environmental' samples from 1-5 Aldwark, York (YAT Site Code 1976-7.15).* Deposited at York Archaeological Trust, Environmental Archaeology Unit and Ancient Monuments Laboratory. [86/17]

Kenward and Hall EAU 2000/14 Kenward, H. and Hall, A. (2000). Technical report: Plant and invertebrate remains from Anglo-Scandinavian deposits at the Queen's Hotel site, 1-9 Micklegate, York (site code 88-9.17). *Reports from the Environmental Archaeology Unit, York* 2000/14, 80 pp.

Kenward and Hall EAU 2000/20 Kenward, H. and Hall, A. (2000). Technical report: Plant and invertebrate remains from Anglo-Scandinavian deposits at 118-26 Walmgate, York (site code 78-9.8). *Reports from the Environmental Archaeology Unit, York* 2000/20, 67 pp. (also released as PRS 02/26)

Kenward and Large EAU 1986/20 Kenward, H. K. and Large, F. D. (1986). *Insect remains from the Annetwell Street site, Carlisle. Report 1. Selected samples from Level X.* Archive deposited at Environmental Archaeology Unit, Carlisle Archaeology Unit and Ancient Monuments Laboratory. [86/20]

Kenward and Large EAU 1997/20 Kenward, H.. and Large, F. (1997). Publication draft: Insect and parasite remains from two sites on the M57 Merseyside Link Road - Brook House Farm (BHF34) and Ochre Brook (OB35). *Reports from the Environmental Archaeology Unit, York* 97/20, 2 pp.

Kenward and Large EAU 1997/30 Kenward, H. and Large, F. (1997). Technical report. Insect remains from Seamer Carr landfill site: ecological reconstruction of a Mesolithic shore. *Reports from the Environmental Archaeology Unit, York* 97/30, 15 pp.

Kenward and Large EAU 1998/43 Kenward, H. and Large, F. (1998). Insect remains from the fills of two Roman wells at Gross Gerau, Hessen, Germany. *Reports from the Environmental Archaeology Unit, York* 98/43, 17 pp.

Kenward and Large EAU 1999/02 Kenward, H. and Large, F. (1999). Technical report: Habitat and land use reconstruction from Late Iron Age/Roman invertebrate remains at South Dyke (M1/A1 Site 21), West Yorkshire (site code: AML96). *Reports from the Environmental Archaeology Unit, York* 99/2, 16 pp.

Kenward and Large EAU 1999/03 Kenward, H. and Large, F. (1999). Technical report: Habitat and land use reconstruction from Iron Age invertebrate remains at Grim's Ditch (M1/A1 Site 3), West Yorkshire (site code: AML96). *Reports from the Environmental Archaeology Unit, York* 99/3, 14 pp.

Kenward and Large EAU 1999/05 Kenward, H. and Large, F. (1999). Insect remains from a Roman well at 'Salisweg', Hanau, Hessen, Germany (site code AH86 HU). *Reports from the Environmental Archaeology Unit, York* 99/5, 12 pp.

Kenward and Morgan EAU 1985/22 Kenward, H. K. and Morgan, L. (1985). *Insect remains from the Castle Street site, Carlisle. Archive report 1. Periods 2 and 3.* Deposited at Carlisle Archaeological Unit, Ancient Monuments Laboratory. [85/22]

Kenward and Morgan EAU 1985/23 Kenward, H. K. and Morgan, L. (1985). *Insect remains from the Castle Street site, Carlisle. Archive report 2. Periods 3/4-5.* Deposited at Carlisle Archaeological Unit, Ancient Monuments Laboratory. [85/23]

Kenward and Morgan EAU 1985/24 Kenward, H. K. and Morgan, L. (1985). *Insect remains from the Castle Street site, Carlisle. Archive report 3. Periods 6 to 11 and post-Roman.* Deposited at Carlisle Archaeological Unit, Ancient Monuments Laboratory. [85/24]

Kenward and Robertson EAU 1988/20 Kenward, H. K. and Robertson, A. (1988). *A supplement to the survey of insect remains from post-Roman deposits at 1-5 Aldwark, York.* Archive in Environmental Archaeology Unit, York Archaeological Trust, Ancient Monuments Laboratory. [88/20]

Kenward and Robertson EAU 1988/21 Kenward, H. K. and Robertson, A. (1988). *The insect remains from The Bedern, York. Report 1. A survey of samples from Area II of the Bedern.* Archive in Environmental Archaeology Unit, York Archaeological Trust, Ancient Monuments Laboratory. [88/21] Kenward and Robertson EAU 1988/22

Kenward, H. K. and Robertson, A. (1988). *The insect remains from The Bedern, York. Report 2. A survey of samples from Area IV of the Bedern.* Archive in Environmental Archaeology Unit, York Archaeological Trust, Ancient Monuments Laboratory. [88/22]

Kenward CHP 2005/04 Kenward, H. (2005). Technical report: Insect and other invertebrate remains from an early 11th century settlement at Viborg Søndersø, Denmark. *Reports from the Centre for Human Palaeoecology, University of York* 2005/04.124 pp.

Kenward EAU 1984/03 Kenward, H. K. (1984). *The insect remains from the 16-22 Coppergate, York, site. Archive report 1. Assemblages from floors in Anglo-Scandinavian workshop 1 (sample group 11).* Deposited at York Archaeological Trust, Environmental Archaeology Unit and Ancient Monuments Laboratory. [84/3]

Kenward EAU 1984/04 Kenward, H. K. (1984). *The insect remains from the 16-22 Coppergate, York, site. Archive report 2. Insect remains from pre-wattle phase pit ('Pit A', cut 27288) (sample group 1).* Deposited at York Archaeological Trust, Environmental Archaeology Unit and Ancient Monuments Laboratory. [84/4]

Kenward EAU 1984/05 Kenward, H. K. (1984). *The insect remains from the 16-22 Coppergate, York, site. Archive report 3. Insect remains from two mid 10th century pits (20991 and 20987), including a study of intra- and inter-contextual variation (sample group 10).* Deposited at York Archaeological Trust, Environmental Archaeology Unit and Ancient Monuments Laboratory. [84/5]

Kenward EAU 1984/06 Kenward, H. K. (1984). *Background studies for the interpretation of urban archaeological plant and animal remains. Archive report 2. Foul-matter insects in grazed turf soils.* Deposited at York Archaeological Trust, Environmental Archaeology Unit and Ancient Monuments Laboratory. [84/6]

Kenward EAU 1984/08 Kenward, H. K. (1984). *The insect remains from the 16-22 Coppergate, York, site. Archive report 4. Insect remains from floor and gulley deposits in Anglo-Scandinavian sunken building Structure 5 (sample group 22A).* Deposited at York Archaeological Trust, Environmental Archaeology Unit and Ancient Monuments Laboratory. [84/8]

Kenward EAU 1984/09 Kenward, H. K. (1984). *The insect remains from the 16-22 Coppergate, York, site. Archive report 5. Assemblages from post-occupation deposits in Anglo -Scandinavian Structure 5 (sample group 22B).* Deposited at York Archaeological Trust, Environmental Archaeology Unit and Ancient Monuments Laboratory. [84/9]

Kenward EAU 1984/10 Kenward, H. K. (1984). *The insect remains from the 16-22 Coppergate, York, site. Archive report 6. Assemblages from floors and a drain in Anglo-Scandinavian sunken building Structure 2 (sample group 21).* Deposited at York Archaeological Trust, Environmental Archaeology Unit and Ancient Monuments Laboratory. [84/10]

Kenward EAU 1984/11 Kenward, H. K. (1984). *A bibliography of British Coleoptera and Hemiptera. A data-base for archaeo-entomological interpretation, with some other material relevant to the study of fossil insect assemblages. Part 1. Introduction*. Deposited at York Archaeological Trust, Environmental Archaeology Unit and Ancient Monuments Laboratory. [84/11]

Kenward EAU 1984/12 Kenward, H. K. (1984). *A bibliography of British Coleoptera and Hemiptera. A data-base for archaeo-entomological interpretation, with some other material relevant to the study of fossil insect assemblages. Part 2.* Carabidae*: general to Pterostichus*. Deposited at York Archaeological Trust, Environmental Archaeology Unit and Ancient Monuments Laboratory. [84/12]

Kenward EAU 1984/13 Kenward, H. K. (1984). *A bibliography of British Coleoptera and Hemiptera. A data-base for archaeo-entomological interpretation, with some other material relevant to the study of fossil insect assemblages. Part 3.* Carabidae*:* Abax *to* Brachinus. Deposited at York Archaeological Trust, Environmental Archaeology Unit and Ancient Monuments Laboratory. [84/13]

Kenward EAU 1984/14 Kenward, H. K. (1984). *A bibliography of British Coleoptera and Hemiptera. A data-base for archaeo-entomological interpretation, with some other material relevant to the study of fossil insect assemblages. Part 4.* Haliplidae *to* Sphaeriidae. Deposited at York Archaeological Trust, Environmental Archaeology Unit and Ancient Monuments Laboratory. [84/14]

Kenward EAU 1985/08 Kenward, H. K. (1985). *The insect remains from the 16-22 Coppergate, York, site. Archive report 7. Insect remains from the Anglian Helmet Pit, Coppergate Development site (sample group 50).* Deposited at Ancient Monuments Laboratory, York Archaeological Trust. [85/8]

Kenward EAU 1985/09 Kenward, H. K. (1985). *The insect remains from the 16-22 Coppergate, York, site. Archive report 8. A survey of assemblages from post-occupation layers in Anglo-Scandinavian sunken building Structure 1 (sample group 20).* Deposited at Ancient Monuments Laboratory, York Archaeological Trust. [85/9]

Kenward EAU 1985/10 Kenward, H. K. (1985). *The insect remains from the 16-22 Coppergate, York, site. Archive report 9. A survey of wicker-phase floors in Tenement B, with detailed examination of selected samples (sample group 201).* Deposited at Ancient Monuments Laboratory, York Archaeological Trust. [85/10]

Kenward EAU 1985/11 Kenward, H. K. (1985). *The insect remains from the 16-22 Coppergate, York, site. Archive report 10. Samples from Anglo-Scandinavian Pit 27410 ('Pit B') (sample group 2).* Deposited at Ancient Monuments Laboratory, York Archaeological Trust. [85/11]

Kenward EAU 1985/12 Kenward, H. K. (1985). *The insect remains from the 16-22 Coppergate, York, site. Archive report 11. A survey of floor and post-occupation deposits of the wicker building phase of Tenement D (Sample group 208).* Deposited at Ancient Monuments Laboratory, York Archaeological Trust. [85/12]

Kenward EAU 1985/13 Kenward, H. K. (1985). *The insect remains from the 16-22 Coppergate, York, site. Archive report 12. A survey of pitfills dated to Period 3. Mid 9th century to ca. A. D. 925 (Sample group 212).* Deposited at Ancient Monuments Laboratory, York Archaeological Trust. [85/13]

Kenward EAU 1985/14 Kenward, H. K. (1985). *The insect remains from the 16-22 Coppergate, York, site. Archive report 13. A survey of pitfills dated to Periods 4 and 5 (ca. 925 to early/mid 11th century). (Sample group 213).* Deposited at Ancient Monuments Laboratory, York Archaeological Trust. [85/14]

Kenward EAU 1985/15 Kenward, H. K. (1985). *The insect remains from the 16-22 Coppergate, York, site. Archive report 14. Various Anglo-Scandinavian external surface deposits. (Sample group 214).* Deposited at Ancient Monuments Laboratory, York Archaeological Trust. [85/15]

Kenward EAU 1985/16 Kenward, H. K. (1985). *A bibliography of British Coleoptera and Hemiptera. A data-base for archaeo-entomological interpretation, with some other material relevant to the study of fossil insect assemblages. Part 5A.* Hydrophilidae *to* Hydraenidae. Deposited at Environmental Archaeology Unit and Ancient Monuments Laboratory. [85/16]

Kenward EAU 1985/17 Kenward, H. K. (1985). *A bibliography of British Coleoptera and Hemiptera. A data-base for archaeo-entomological interpretation, with some other material relevant to the study of fossil insect* *assemblages. Part 5B.* Ptiliidae *to* Scaphidiidae. Deposited at Environmental Archaeology Unit and Ancient Monuments Laboratory. [85/17]

Kenward EAU 1985/18 Kenward, H. K. (1985). *A bibliography of British Coleoptera and Hemiptera. A data-base for archaeo-entomological interpretation, with some other material relevant to the study of fossil insect assemblages. Part 6.* Staphylinidae *to* Paederinae. Deposited at Environmental Archaeology Unit and Ancient Monuments Laboratory. [85/18]

Kenward EAU 1985/19 Kenward, H. K. (1985). *A bibliography of British Coleoptera and Hemiptera. A data-base for archaeo-entomological interpretation, with some other material relevant to the study of fossil insect assemblages. Part 7.* Staphylinidae *to* Tachyporinae. Deposited at Environmental Archaeology Unit and Ancient Monuments Laboratory. [85/19]

Kenward EAU 1985/20 Kenward, H. K. (1985). *A bibliography of British Coleoptera and Hemiptera. A data-base for archaeo-entomological interpretation, with some other material relevant to the study of fossil insect assemblages. Part 8.* Staphylinidae *(*Aleocharinae*) to* Pselaphidae. Deposited at Environmental Archaeology Unit and Ancient Monuments Laboratory. [85/20]

Kenward EAU 1986/14 Kenward, H. K. (1986). *Insect remains from City Garage, Blake Street, York.* Deposited at York Archaeological Trust, Environmental Archaeology Unit and Ancient Monuments Laboratory. [86/14]

Kenward EAU 1986/15 Kenward, H. K. (1986). *A bibliography of British Coleoptera and Hemiptera. A database for Archaeo-entomological interpretation. Part 9,* Scarabaeoidea *to* Cantharidae. Deposited at Environmental Archaeology Unit, Ancient Monuments Laboratory. [86/15]

Kenward EAU 1986/16 Kenward, H. K. (1986). *Insect remains from post-Roman deposits at 1-5 Aldwark, York.* Deposited at York Archaeological Trust, Environmental Archaeology Unit and Ancient Monuments Laboratory. [86/16]

Kenward EAU 1988/11 Kenward, H. K. (1988). *A bibliography of Coleoptera and Hemiptera. User guide and programs.* Deposited at Environmental Archaeology Unit and Ancient Monuments Laboratory. [88/11] Kenward EAU 1990/10 Kenward, H. K. (1990). *Insect remains from various sites in Southwark.* Prepared for D. J. Rackham. [90/10]

Kenward EAU 1991/29 Kenward, H. K. (1991). *Short report on arthropod remains from Seaton Beach, Hartlepool HSF 90.* Prepared for Robin Daniels. [91/29]

Kenward EAU 1994/56 Kenward, H. (1994). Assessment of insect remains from bulk-sieved samples from the Brooks excavation, Winchester (site code BR). *Reports from the Environmental Archaeology Unit, York* 94/56, 6 pp.

Kenward EAU 1997/04 Kenward, H. (1997). Insect and other invertebrate remains from Dundrennan Abbey, near Kirkudbright, S. W. Scotland. *Reports from the Environmental Archaeology Unit, York* 97/4, 5 pp.

Kenward EAU 1997/09 Kenward, H. (1997). Insects associated with Roman scale armour from Carpow, Perthshire. *Reports from the Environmental Archaeology Unit, York* 97/9, 4 pp.

Kenward EAU 1999/32 Kenward, H. (1999). Data archive: Insect assemblages from Annetwell Street, Carlisle (revised edition). *Reports from the Environmental Archaeology Unit, York* 99/32, 126 pp.

Kenward EAU 1999/43 Kenward, H. (1999). Insect remains as indicators of zonation of land use and activity in Roman Carlisle, England. *Reports from the Environmental Archaeology Unit, York* 99/43, 88 pp.

Kenward EAU 2000/39 Kenward, H. (2000). Data archive: Insect assemblages from 6-8 Pavement (the Lloyds Bank site), York. *Reports from the Environmental Archaeology Unit, York* 2000/39, 25 pp.

Kenward EAU 2000/41 Kenward, H. (2000). Data archive: Insect assemblages from a Roman buried soil at 58-59 Skeldergate, York (site code 73-5.14). *Reports from the Environmental Archaeology Unit, York* 2000/41, 25 pp.

Kenward EAU 2000/79 Kenward, H. (2000). Assessment of insect remains from a sample from the Flodden Hill rectilinear enclosure. *Reports from the Environmental Archaeology Unit, York* 2000/79, 4 pp.

Kenward EAU 2001/49 Kenward, H. (2001). Insect remains from the Romano-British ditch terminal at the Flodden Hill Rectilinear Enclosure. *Reports from the Environmental Archaeology Unit, York* 2001/49, 15 pp.

Kenward EAU 2002/13 Kenward, H. (2002). Assessment of invertebrate remains from excavations in Rickergate, Carlisle (site code CAR98 RIC). *Reports from the Environmental Archaeology Unit, York* 2002/13, 6 pp.

Kenward *et al.* AML 4822 Kenward, H. K., Hall, A. R., Phipps, J. and Jones, A. K. G. (1985). Biological remains from Sample 6, from the 8 High Ousegate site, York. *Ancient Monuments Laboratory Report* 4822.

Kenward *et al.* AML 4889 Kenward, H. K., Hall, A. R. and Jones, A. K. G. (1986). Environmental evidence from Roman and Anglian deposits in The Bedern (north-east and south-west). *Ancient Monuments Laboratory Report* 4889.

Kenward *et al.* AML 76/92 Kenward, H. K., Dainton, M., Kemenes, I. K. and Carrott, J. B. (1992a). Evidence from insect remains and parasite eggs from the Old Grapes Lane B site, The Lanes, Carlisle: Technical report. *Ancient Monuments Laboratory Report* 76/92.

Kenward *et al.* AML 77/92 Kenward, H. K., Dainton, M., Kemenes, I. K. and Carrott, J. B. (1992b). Evidence from insect remains and parasite eggs from the Lewthwaites Lane A site, The Lanes, Carlisle: Technical report. *Ancient Monuments Laboratory Report* 77/92.

Kenward *et al.* AML 78/92 Kenward, H. K., Allison, E. P., Dainton, M., Kemenes, I. K. and Carrott, J. B. (1992c). Evidence from insect remains and parasite eggs from Old Grapes Lane A, The Lanes, Carlisle: Technical report. *Ancient Monuments Laboratory Report* 78/92.

Kenward *et al.* EAU 1984/15 Kenward, H. K., Hall, A. R. and Jones, A. K. G. (1984). *Background studies for the interpretation of urban archaeological plant and animal remains. Archive report 1. Turf roofs and urban archaeological build-up.* Deposited at York Archaeological Trust, Environmental Archaeology Unit and Ancient Monuments Laboratory. [84/15]

Kenward *et al.* EAU 1994/42 Kenward, H. K., Hill, M., Jaques, D., Kroupa, A. and Large, F. (1994). Insect remains from excavations at Buiston Crannog, Ayrshire, 1989: Technical report. *Reports from the Environmental Archaeology Unit, York* 94/42, 65 pp. + 61 pp. appendix.

Kenward *et al.* EAU 1995/46 Kenward, H., Large, F. and Skidmore, P. (1995). Insect remains from excavations at Drum Castle, Aberdeenshire: Technical report. *Reports from the Environmental Archaeology Unit, York* 95/46, 15 pp. + 8 pp. appendices.

Kenward *et al.* EAU 1995/55 Kenward, H., Large, F., Skidmore, P. and Schelvis, J. (1995). *Extending the range of macro-invertebrates*, p. 15 in Jaques, D. and Kenward, H. (compilers), Research Forum 1995: Current and future research in the EAU. Abstracts from a one-day forum held in Derwent College, University of York, on 18th October 1995. *Reports from the Environmental Archaeology Unit, York* 95/55, 19 pp.

Kenward *et al.* EAU 1996/06 Kenward, H., Large, F., Carrott, J. and Issitt, M. (1996). Invertebrate remains from excavations at Dalhousie Mains, Bonnyrigg, Midlothian (site code: 1140): Technical report. *Reports from the Environmental Archaeology Unit, York* 96/6, 20 pp.

Kenward *et al.* EAU 1998/23 Kenward, H., Hughes, P. and Hall, A. (1998). Technical report: Plant and invertebrate remains from fills of the moat at Old Abbey Farm, Risley, Cheshire (site code: OAF95). *Reports from the Environmental Archaeology Unit, York* 98/23, 35 pp. + 4 pp. appendix.

Kenward *et al.* EAU 1998/32 Kenward, H., Large, F. and Carrott, J. (1998). The archaeological significance of insect and other invertebrate remains from Keay's and Law's Lanes, The Lanes, Carlisle. Technical report. *Reports from the Environmental Archaeology Unit, York* 98/32, 126 pp.

Kenward *et al.* EAU 2000/57 Kenward, H., Hall, A. and Carrott, J. (2000). Environment, activity and living conditions at Deer Park Farms: evidence from plant and invertebrate remains. *Reports from the EAU, York* 2000/57, 82 pp.

Kenward *et al.* EAU 2001/46 Kenward, H., Jaques, D., Hall, A. and Carrott, J. (2001). Evaluation of biological remains from excavations at Whitehall Shipyard, Spital Bridge, Whitby, North Yorkshire (site code: WHITM 2001.12). *Reports from the Environmental Archaeology Unit, York* 2001/46, 4 pp.

Kenward *et al.* EAU 2002/12 Kenward, H., Hall, A., Jaques, D., Rowland, S. and Carrott, J. (2002). Technical report: Biological remains from a site east of High Catton, East Riding of Yorkshire (site code: TSEP222). *Reports from the Environmental Archaeology Unit, York* 2002/12, 33 pp. + 19 pp. Appendix.

Kenward *et al.* PRS 2003/50 Kenward, H., Hall, A., Jaques, D. Carrott, J. and Cousins, S. (2003). Assessment of biological remains from excavations at Waterstones bookshop, 28-29 High Ousegate, York (site code: 2002.475). *Palaeoecology Research Services Report* 2003/50.

Kenward *et al.* PRS 2004/04 Kenward, H., Hall, A., Jaques, D., Johnson, K. and Carrott, J. (2004). Technical report: Biological remains from excavations at the former D. C. Cook site, off Lawrence Street, York (site code: YORYM 2001.9444). *Palaeoecology Research Services Report* 2004/04.

Kroupa EAU 1993/03 Kroupa, A. S. (1993). *Beetle-larvae (especially* Elateridae *larvae) in archaeological sites.* Undergraduate project, Department of Biology, University of York.

Large and Kenward EAU 1987/14 Large, F. D. and Kenward, H. K. (1987). *Insect remains from the Annetwell Street site, Carlisle. Report 2. Samples from Level VI.* Deposited at Carlisle Archaeological Unit, Ancient Monuments Laboratory. [87/14]

Large and Kenward EAU 1987/15 Large, F. D. and Kenward, H. K. (1987). *Insect remains from the Annetwell Street site, Carlisle. Report 3. Samples from Level IV.* Deposited at Carlisle Archaeological Unit, Ancient Monuments Laboratory. [87/15]

Large and Kenward EAU 1987/16 Large, F. D. and Kenward, H. K. (1987). *Insect remains from the Annetwell Street site, Carlisle. Report 4. Period 3A structures.* Deposited at Carlisle Archaeological Unit, Ancient Monuments Laboratory. [87/16]

Large and Kenward EAU 1988/15 Large, F. D. and Kenward, H. K. (1988). *Insect remains from the Annetwell Street site, Carlisle. Report 5. Period 3 structures.* Deposited at Carlisle Archaeological Unit, Ancient Monuments Laboratory. [88/15]

Large and Kenward EAU 1988/16 Large, F. D. and Kenward, H. K. (1988). *Insect remains from the Annetwell Street site, Carlisle. Report 6. Samples from Period 3 roads.* Deposited at Carlisle Archaeological Unit, Ancient Monuments Laboratory. [88/16]

Large and Kenward EAU 1988/17 Large, F. D. and Kenward, H. K. (1988). *Insect remains from the Annetwell Street site, Carlisle. Report 7. Miscellaneous samples from Period Pre-3 to Period 4.* Deposited at Carlisle Archaeological Unit, Ancient Monuments Laboratory. [88/17]

Large and Kenward EAU 1988/18 Large, F. D. and Kenward, H. K. (1988). *Insect remains from the Annetwell Street site, Carlisle. Report 8. Level X structures.* Deposited at Carlisle Archaeological Unit, Ancient Monuments Laboratory. [88/18]

Large and Kenward EAU 1988/19 Large, F. D. and Kenward, H. K. (1988). *Insect remains from the Annetwell Street site, Carlisle. Report 9. Miscellaneous samples from Level VII, Level IX, Level X and Period 3.* Deposited at Carlisle Archaeological Unit, Ancient Monuments Laboratory. [88/19]

Large EAU 1997/27 Large, F. (1997). Evaluation of biological remains from excavations at Manor Lane, Rawcliffe, York (site code: 1997.43). *Reports from the Environmental Archaeology Unit, York* 97/27, 2 pp.

Large EAU 1999/53 Large, F. (1999). Assessment of invertebrate remains from Stamford Bridge, East Yorkshire (Site code: STB98). *Reports from the Environmental Archaeology Unit, York* 99/53, 3 pp.

Large *et al.* EAU 1993/29 Large, F. D., Kenward, H. K. and Hall, A. R. (1993). *Insect and other macrofossil remains associated with a copper alloy brooch from the Viking-Age boat burial at Scar, Sanday, Orkney, 1992: technical report*. Prepared for AOC (Scotland) Ltd. [93/29]

Large *et al.* EAU 1994/11 Large, F., Kenward, H., Carrott, J., Nicholson, C. and Kent, P. (1994). Insect and other invertebrate remains from the Roman fort at Ribchester, Lancashire (site code RB89): Technical report. *Reports from the Environmental Archaeology Unit, York* 94/11, 171 pp.

Large *et al.* EAU 1995/47 Large, F., Kenward, H. and Issitt, M. (1995). Assessment of invertebrate remains from excavations at Dahousie Mains, Bonnyrigg, Midlothian (site code: 1140). *Reports from the Environmental Archaeology Unit, York* 95/47, 9 pp.

Large *et al.* EAU 1998/40 Large, F., Hall, A., Kenward, H., Worthy, D. and Carrott, J. (1998). Evaluation of biological remains from 90 Piccadilly, York (sitecode: 1998.706). *Reports from the Environmental Archaeology Unit, York* 98/40, 3 pp.

Large *et al.* EAU 1999/45 Large, F., Hall, A., Johnstone, C., Worthy, D. and Carrott, J. (1999). Assessment of biological remains from 41 Piccadilly, York (sitecode: 1998.15). *Reports from the Environmental Archaeology Unit, York* 99/45, 11 pp.

Large *et al.* EAU 1999/46 Large, F., Hall, A., Johnstone, C., Worthy, D. and Carrott, J. (1999). Assessment of biological remains from the Primitive Methodist Chapel, 3 Little Stonegate, York (sitecode: 1999.95). *Reports from the Environmental Archaeology Unit, York* 99/46, 9 pp.

Large *et al.* EAU 1999/50 Large, F., Hall, A., Worthy, D. and Carrott, J. (1999). Evaluation of biological remains from Storking Lane, Wilberfoss, East Yorkshire (Site code: ERYMS 1999.8). Reports from the Environmental Archaeology Unit, York 99/50, 7 pp.

Large *et al.* EAU 1999/57 Large, F., Hall, A., Johnstone, C., Carrott, J. and Kenward, H. (1999). Assessment of biological remains from Liberty Lane, Hull, East Yorkshire (Site code: LLH99). Reports from the Environmental Archaeology Unit, York 99/57, 11 pp.

LUAU 8079 Lancaster University Archaeological Unit (LUAU) (2001). Macrofossils, p. 36 in *Land at OS 8866, Kirkby Thore, Cumbria*. Archaeological excavation. LUAU Report 20002001/(069)/AUA 8079. Lancaster.

Mant *et al.* PRS 2005/102 Mant, J., Akeret, Ö. and Carrott, J. (2005). Assessment of biological remains from excavations at Castle Gate (formerly Scott Lane), Wetherby, West Yorkshire (site code: SLW04). *Palaeoecology Research Services Report* 2005/102.

Mant *et al.* PRS 2005/51 Mant, J., Carrott, J. and Gardner, S. (2005). Evaluation of biological remains from excavations at Back Side, Duggleby, North Yorkshire (site code: 05-01-04). *Palaeoecology Research Services Report* 2005/51.

Mant *et al.* PRS 2005/66 Mant, J., Akeret, Ö., Carrott, J. and Gardner, S. (2005). Evaluation of biological remains from excavations on land off Skelton Crescent, Market Weighton, East Riding of Yorkshire (site code: 01-03-05). *Palaeoecology Research Services Report* 2005/66.

Mant *et al.* PRS 2005/97 Mant, J., Carrott, J. and Akeret, Ö. (2005). Evaluation of biological remains from excavations at Pocklington Waste Water Treatment Works, Canal Lane, Pocklington, East Riding of Yorkshire (site code: PSW04). *Palaeoecology Research Services Report* 2005/97.

McKenna EAU 84/16 McKenna, W. J. B. (1984). *Hull sites 1973-6 and Beverley Lurk Lane 1979-82: Environmental investigations.* Prepared for Humberside Archaeological Unit. [84/16]

McKenna EAU 1984/17 McKenna, W. J. B. (1984). *Excavations in Hull 1975-6: Queen Street. The plant macrofossils.* Prepared for Humberside Archaeological Unit. [84/17]

McKenna EAU 1984/18 McKenna, W. J. B. (1984). *Excavations in Hull 1975-6: Vicar Lane VL75. The plant macrofossils: archive.* [84/18]

McKenna EAU 1984/19 McKenna, W. J. B. (1984). *Excavations in High Street and Blackfriargate, Hull. The environmental evidence.*[84/19]

McKenna EAU 1988/30 McKenna W J B. (1988). *The environmental evidence from excavations at Eastgate, Beverley, North Humberside in 1984*. Unpublished report prepared for the Humberside Archaeology Unit. [88/30]

McKenna *et al.* AML 227/87 McKenna W J B, Hutchinson A R, Jones A K G and Nicholson C. (1988). Parasitological investigations on samples of organic sediment from excavations at Rougier Street, York (1981.12). *Ancient Monuments Laboratory Report* 227/87.

McKenna *et al.* AML 37/88 McKenna, W. J. B., Hutchinson, A. R. and Jones, A. K. G. (1988). Parasitological investigations on samples of sediment from excavations at 7-9 Aldwark, York (Y.A.T. site code 1985.5). *Ancient Monuments Laboratory Report* 37/88.

McKenna *et al.* EAU 1987/28 McKenna, W. J. B., Hutchinson, A. R., Jones, A. K. G. and Nicholson, C. (1987). *Parasitological investigations on samples of organic sediment from excavations at Rougier Street, York (1981.12).* Deposited at York Archaeological Trust, Environmental Archaeology Unit, Ancient Monuments Laboratory. [87/28]

Milles AML 114/93 Milles, A. (1993). *Mollusca from the excavations at Ferrybridge Henge 1991. Ancient Monuments Laboratory Report* 114/93.

Milles and Kenward EAU 1992/42 Milles, A. and Kenward, H. (1992). *An evaluation of the bioarchaeological potential of deposits from excavations at West Lodge, Malton 1992.* Prepared for Malton Archaeological Projects. [92/42]

Milles EAU 1992/34 Milles, A. (1992). *An evaluation of the bioarchaeological potential of deposits from excavations along the course of the Caythorpe Gas Pipeline 1992.* Prepared for Northern Archaeological Associates. [EAU 92/34]

Milles EAU 1992/36 Milles, A. (1992). *Molluscan remains from the excavations at West Lodge, Malton, 1991.* Prepared for MAP Archaeological Consultancy Ltd. [EAU 92/36]

Milles EAU 1992/37 Milles, A. (1992). *An evaluation of the biological potential of foreshore sediments at site Alpha H, Formby, Merseyside.* Prepared for Ron Cowell, Liverpool Museum. [EAU 92/37]

Milles EAU 1992/38 Milles, A. (1992). *Mollusca from the excavations at Ferrybridge Henge 1991.* Prepared for West Yorkshire Archaeology Unit. [EAU 92/38]

Milles *et al.* EAU 1992/39 Milles, A., Dainton, M., Hall, A. and Kenward, H. (1992). *An evaluation of the bioarchaeological potential of deposits from excavations at Castlethorpe 1, Scawby Brook, Brigg, S. Humberside, 1992.* Prepared for Humberside Archaeological Unit. [EAU 92/39]

Milles *et al.* EAU 1992/40 Milles, A., Dobney, K., Hall, A. and Kenward, H. (1992). *An evaluation of the bioarchaeological value of deposits from excavations a Castlethorpe 2, Brigg, South Humberside, 1992.* Prepared for Humberside Archaeological Unit. [EAU 92/40]

Milles et al. EAU 1992/41 Milles, A., Hill, M. and Hall, A. (1992). *An examination of deposits from excavations at Holgate Cattle Dock, York (YAT/Yorkshire Museum site code 1992.16).* Prepared for York Archaeological Trust. [EAU 92/41]

Murphy AML 109/93 Murphy, P. (1993). Cambridgeshire dykes project: Mollusca and other macrofossils. *Ancient Monuments Laboratory Reports Series* 109/93.

Murphy CAR 68/2001 Murphy, P. (2001). Review of molluscs and other non-insect invertebrates from archaeological sites in the West and East Midlands, and the East of England. *Centre for Archaeology Report* 68/2001. Portsmouth: English Heritage.

Nicholson and Hall AML 45/86 Nicholson, R. A. and Hall, A. R. (1986). The plant remains from excavations at Queen Street, Newcastle-upon-Tyne, 1984-85. *Ancient Monuments Laboratory Report* 45/86.

Nicholson and Kenward (EAU 1986/22) Nicholson, R. A. and Kenward, H. K. (1986). *A preliminary assessment of the insect remains from Queen Street, Newcastle Quayside, and recommendations for future work.* Prepared for Ancient Monuments Laboratory. [86/22]

Nicholson and Kenward (EAU 1987/17) Nicholson, R. A. and Kenward, H. K. (1987). *A preliminary assessment of the insect remains from excavations at Crown Court, Newcastle Quayside.* Submitted to Ancient Monuments Laboratory. [87/17]

Nicholson *et al.* AML 41/99 Nicholson, C., Douglas, B. and Jones, A. K. G. (1989). Parasitological investigations on soil samples and coprolites from Coffee Yard, York. *Ancient Monuments Laboratory Report* 41/89.

O'Connor AML 4507 O'Connor T P. (1985). Bones and mollusca from the Anglian Helmet Pit'. Coppergate/ Piccadilly Watching brief site, York. *Ancient Monuments Laboratory Report* 4507.

O'Connor AML 4709 O'Connor T P. (1985). A mollusc assemblage from the County Hospital site, York. *Ancient Monuments Laboratory Report* 4709.

O'Connor AML 4735 O'Connor, T. P. (1985). Terrestrial and freshwater mollusca from Anglo-Scandinavian levels at 16-22 Coppergate, York (1976-81.7). *Ancient Monuments Laboratory Report* 4735.

O'Connor AML 4768 O'Connor, T. P. (1986). Mollusca and other shell fragments from the General Accident Extension site. York (1983-4.32). *Ancient Monuments Laboratory Report* 4768.

O'Connor AML 4297 O'Connor, T. P. (1984b). Hand-collected molluscs from 16-22 Coppergate, York. 4297.

O'Connor AML 2449 O'Connor, T. P. (1978). Land-snails, unpaged in Keepax, K., Beeston Castle, Cheshire. Examination of biological remains. *Ancient Monuments Laboratory Report* 2449.

O'Connor AML 1/86 O'Connor, T. P. (1986). Preliminary report on a mollusc assemblage from St George's Fields, York. *Ancient Monuments Laboratory Report* 1/86.

O'Connor AML 190/88 O'Connor, T. P. (1988). Archaeological bone samples recovered by sieving: 46-54 Fishergate, York, as a case study. *Ancient Monuments Laboratory Report* 190/88.

O'Connor EAU 90/21 O'Connor, T. P. (1990). *An assessment of residues of bulk-sieved samples from the Queen's Hotel site (1988-9.17).* Prepared for York Archaeological Trust. [90/21]

Osborne AML 3063 Osborne, P. J. (1980). Seamer Carr, Yorkshire. Interim report on the insect fauna. *Ancient Monuments Laboratory Report* 3063.

Payne AML 55/92 Payne, S. (1992). Some notes on sampling and sieving for animal bones. *Ancient Monuments Laboratory Report* 55/92.

Rackham AML 4212 Rackham, D. J. (1984). Blackfriars, Carlisle. A report on the vertebrate remains and mollusc shell. *Ancient Monuments Laboratory Report* 4212.

Rackham AML 4788 Rackham, D. J. (1986). A report on selected groups of 16th-18th century bone and shell from excavations at Blackfriars, Newcastle. *Ancient Monuments Laboratory Report* 4788.

Rackham EAC Rackham D J. 2001. Chapel Lane Staithe - CLS00. Environmental archaeology assessment. *Environmental Archaeology Consultancy Report*.

Robertson *et al.* EAU 1989/12 Robertson, A., Tomlinson, P. and Kenward, H. K. (1989). *Plant and insect remains from Coffee Yard, York.* Prepared for York Archaeological Trust. [89/12]

Robinson CAR 9/2003 Robinson, M. (2003). English Heritage reviews of environmental archaeology: Midlands Region insects. *Centre for Archaeology Report* 9/2003. Portsmouth: English Heritage.

Robinson AML 1786 Robinson, M. (nd). Winterton (1972). *Ancient Monuments Laboratory Report* 1786.

Robinson AML 2444 Robinson, M. (nd). Carlisle 1975 insects (Lab. No. 755714). *Ancient Monument Laboratory Report* 2444, 4 pp.

Robinson CAR 39/2002 Robinson, M. (2002). English Heritage reviews of environmental archaeology: Southern Region insects. *Centre for Archaeology Report* 39/2002. Portsmouth: English Heritage.

Robinson AML 11/93 Robinson, M. (1993). [untitled contribution], p. 4 in Carruthers, W., A charred grain deposit from Ambleside Roman fort, Cumbria. *Ancient Monuments Laboratory Report* 11/93.

Roper and Whitehouse ARCUS 181 Roper, T. and Whitehouse, N. (1994). Sutton Common environmental analysis assessment report, pp. 1-8 + 2 un-numbered pages. ARCUS 181.

Rowland *et al.* EAU 2001/24 Rowland, S., Kenward, H., Jaques, D., Hall, A., and Carrott, J. (2001). Evaluation of biological remains from excavations at Skellgarths, Ripon, North Yorkshire (site code: HARGM 10426). *Reports from the Environmental Archaeology Unit, York* 2001/24, 8 pp.

Schmidl *et al.* PRS 2006/47 Schmidl, A., Allison, E., Jaques, D., Carrott, J. and Gardner, S. (2006). Evaluation of biological remains from excavations at Park View School, Chester-le-Street, County Durham (site code: PVC06). *Palaeoecology Research Services Report* 2006/47.

Skidmore EAU 2000/25 Skidmore, P. (with annotations by A. Hall and H. Kenward) (2000). Appendix 1: Report on selected remains of immature Diptera from the Magistrates' Courts site, Kingston-upon-Hull, pp. 73-75 in Hall, A., Carrott, J., Jaques, D., Johnstone, C., Kenward, H., Large, F. and Usai, R.., Technical report: Studies on biological remains and sediments from Periods 1 and 2 at the Magistrates' Courts site, Kingston-upon-Hull (site codes HMC 94 and MCH99). Part 1: Text. *Reports from the Environmental Archaeology Unit, York* 2000/25, 78 pp.

Skidmore EAU 1997/16 Skidmore, P. (1997). *Report on fly puparia from selected contexts from North Bridge, Doncaster*, p. A103 in Carrott, J., Dobney, K., Hall, A., Issitt, M., Jaques, D., Johnstone, C., Kenward, H., Large, F. and Skidmore, P., Technical Report: Environment, land use and activity at a medieval and post-medieval site at North Bridge, Doncaster, South Yorkshire. *Environmental Archaeology Unit, York* 97/16, 64 pp. + 103 pp. appendix.

Thew AML 14/89 Thew, N. (1989). The molluscan remains from a Bronze Age cairn at Hardendale Nab, Shap, Cumbria. *Ancient Monuments Laboratory Report* 14/89.

Tomlinson EAU 1995/52 Tomlinson. P. (1995). The Archaeobotanical Computer Database (ABCD): a guide for users (Interim Edition, September 1995). *Reports from the Environmental Archaeology Unit, York* 95/52, 11 pp.

Tomlinson EAU 1989/21 Tomlinson, P. R. (ed.) (1989). *Environmental analysis of samples from excavations at 6-28 and 21-7 Union Terrace, York.* Prepared for York Archaeological Trust. [89/21]

Tomlinson EAU 1995/27 Tomlinson, P. (1995). Environmental Archaeology Bibliography (EAB): a guide. *Reports from the Environmental Archaeology Unit, York* 95/27, 19 pp. Available via http://www.english_heritage.org.uk/server/show/nav.1518 (accessed 15 February 2007).

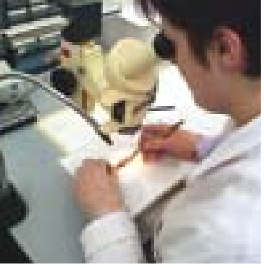
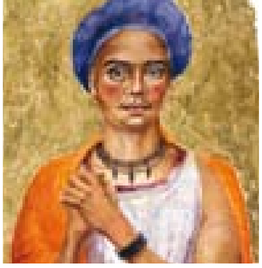
Usai EAU 1999/24 Usai, M. R. (1999). Textural pedofeatures and pre-Hadrian's Wall ploughed paleosols at Stanwix, Carlisle, Cumbria. *Reports from the Environmental Archaeology Unit, York* 99/24, 21 pp.

Usai CAR 54/2005 Usai, M. R. (2005). Geoarchaeology in northern England 1: The landscape and geography of northern England. *Centre for Archaeology Report* 54/2005.

Usai EAU 1999/26 Usai, M. R. (1999). Fetter Lane, York: dark earth? *Reports from the Environmental Archaeology Unit, York* 99/26, 3 pp. pp.

Usai EAU 2001/11 Usai, M. R. (2001). Station Rise, York: dark earth? *Reports from the Environmental Archaeology Unit, York* 2001/11, 3pp. pp.

Wagner and Pelling SEF 9404 Wagner, P. and Pelling, R. (1995). Environmental evidence from the moat at Wood Hall, Womersley, North Yorkshire. *Sheffield Environment Facility Project* 9404. Sheffield.



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