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English Heritage Reviews of Environmental Archaeology: Midlands Region Insects

Mark Robinson

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Keywords

Insect

Author's address

Mark Robinson: Oxford University Museum of Natural History, Parks Road, Oxford, OX1 3PW. Telephone: . Email:

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Author's address
Oxford University Museum of Natural History, Parks Road, Oxford, OX1 3PW

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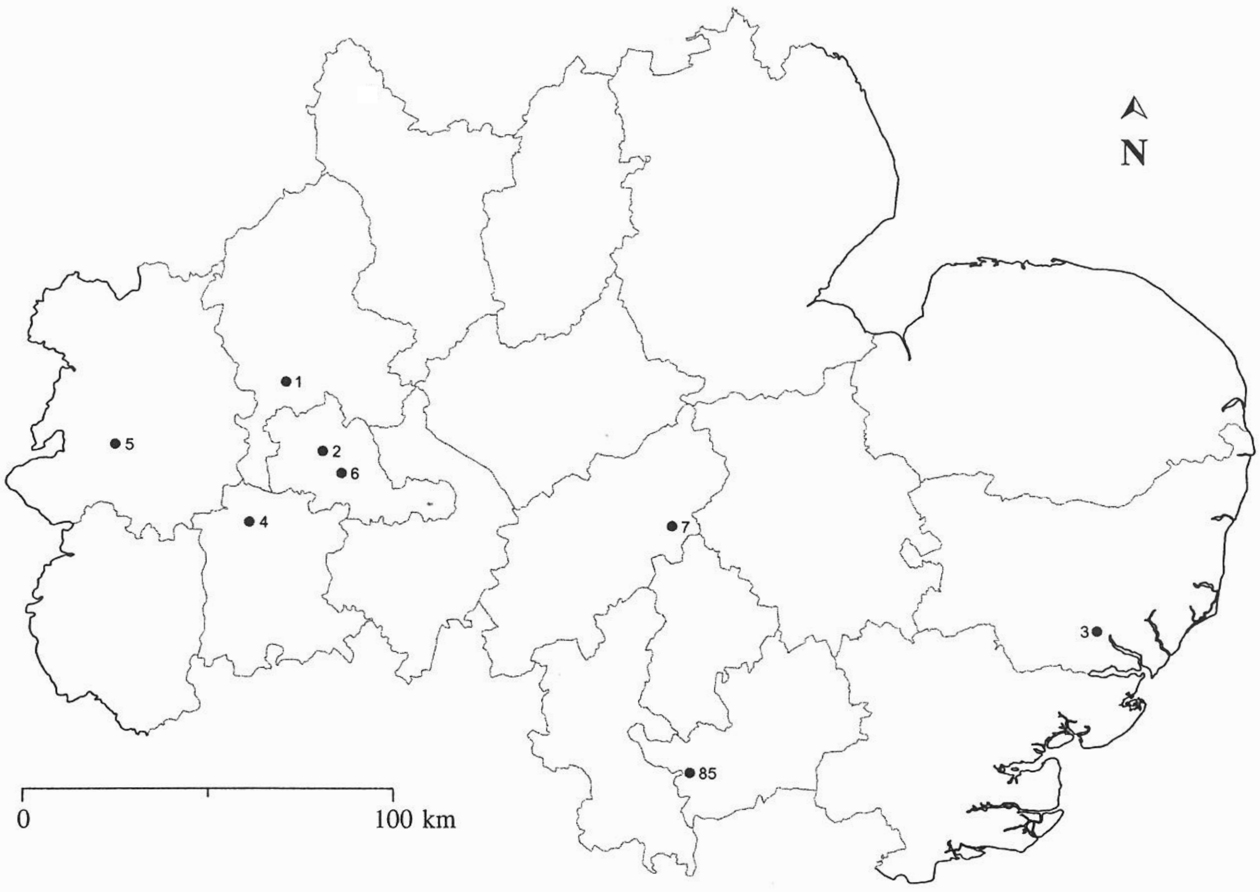

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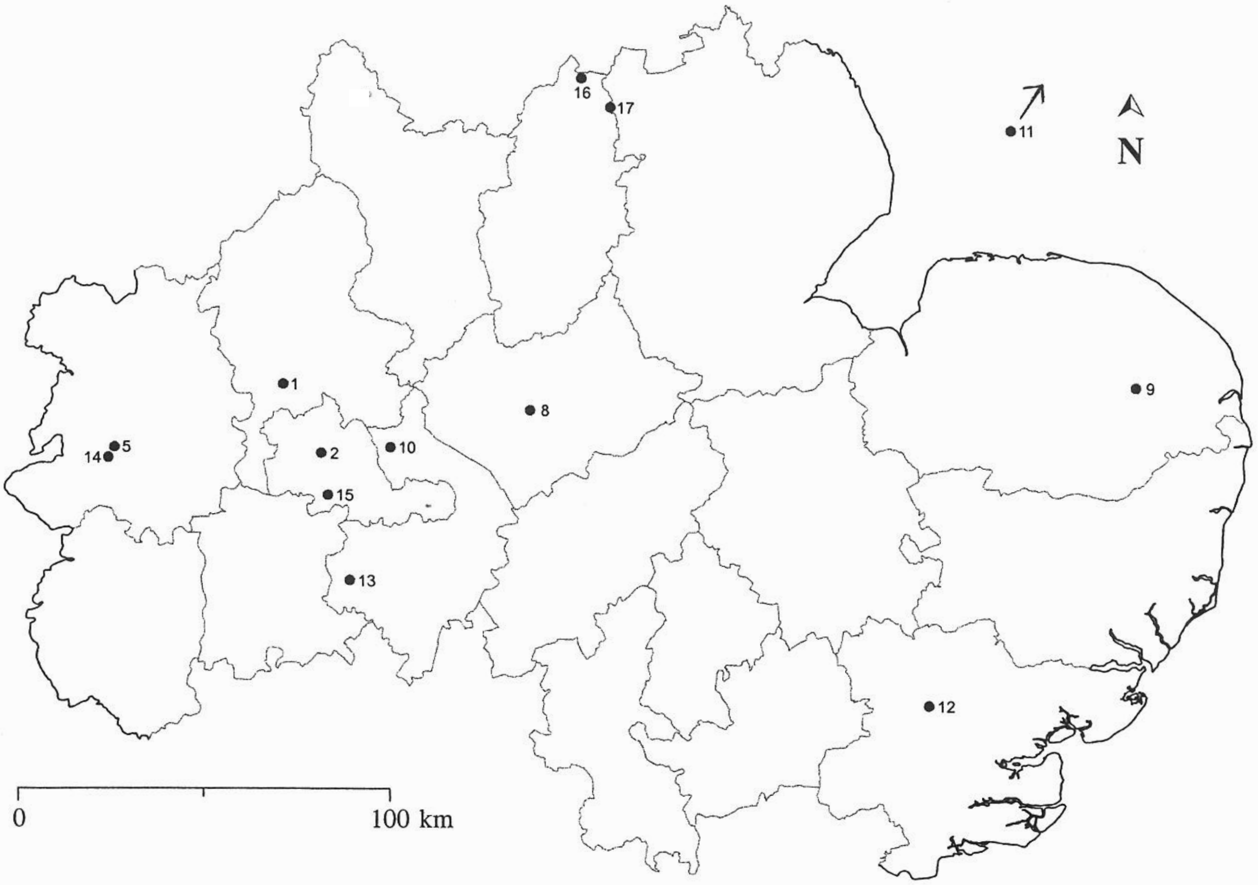

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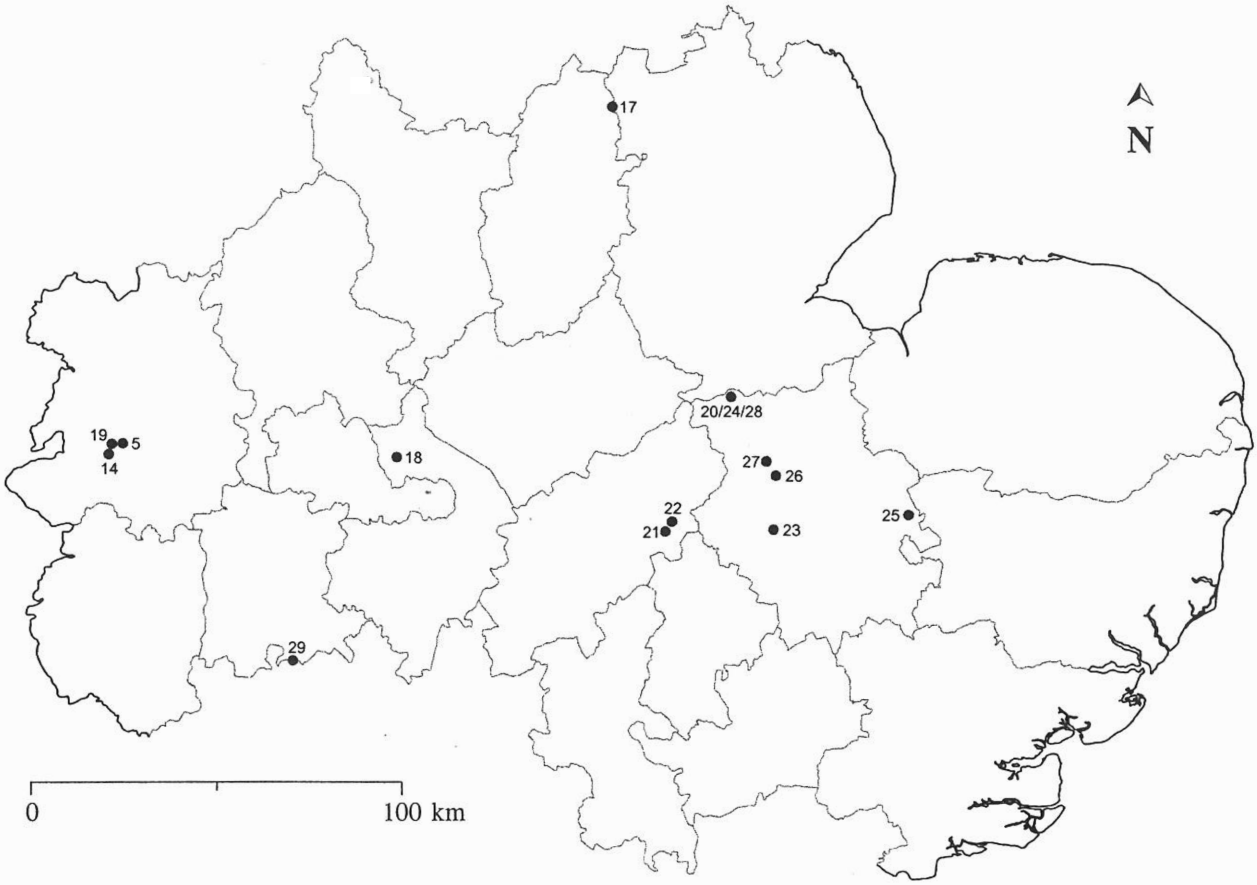

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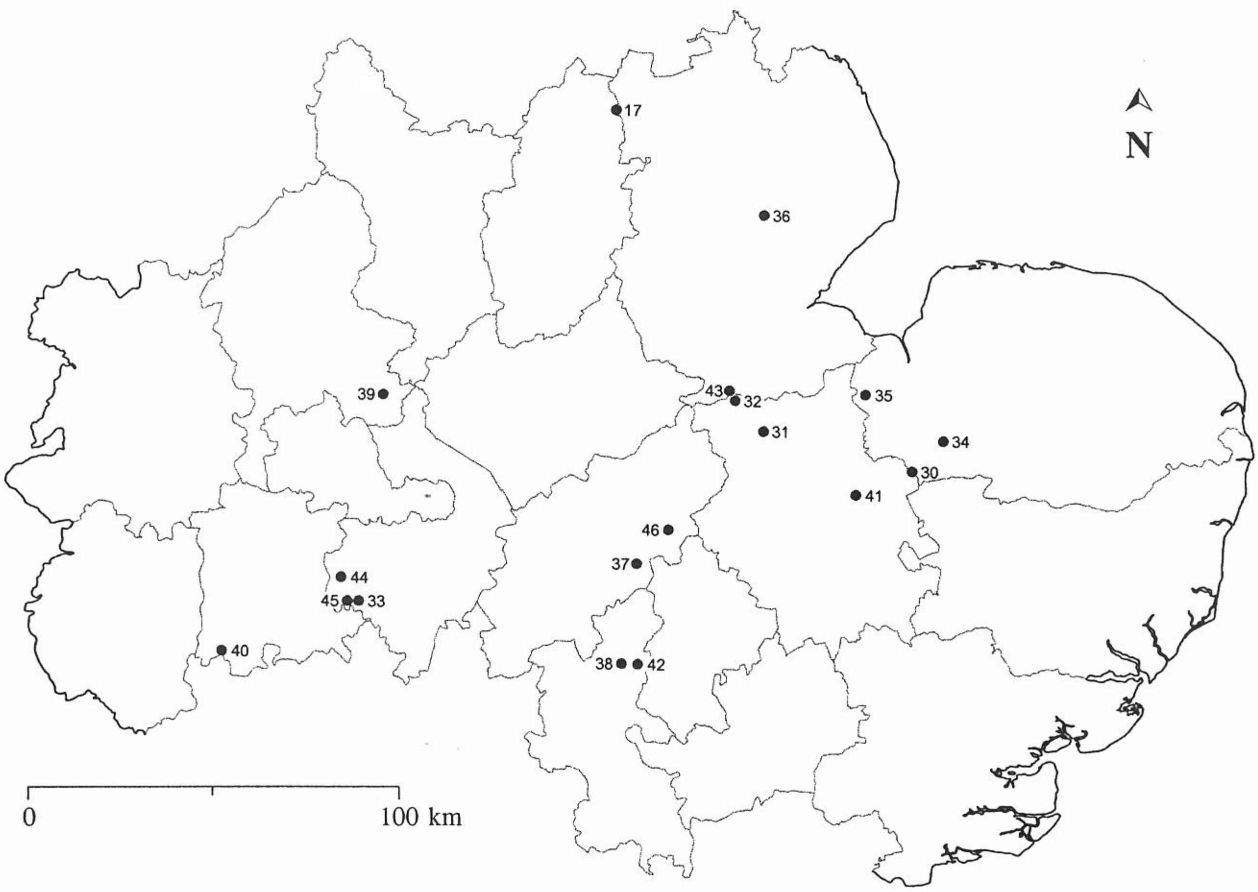

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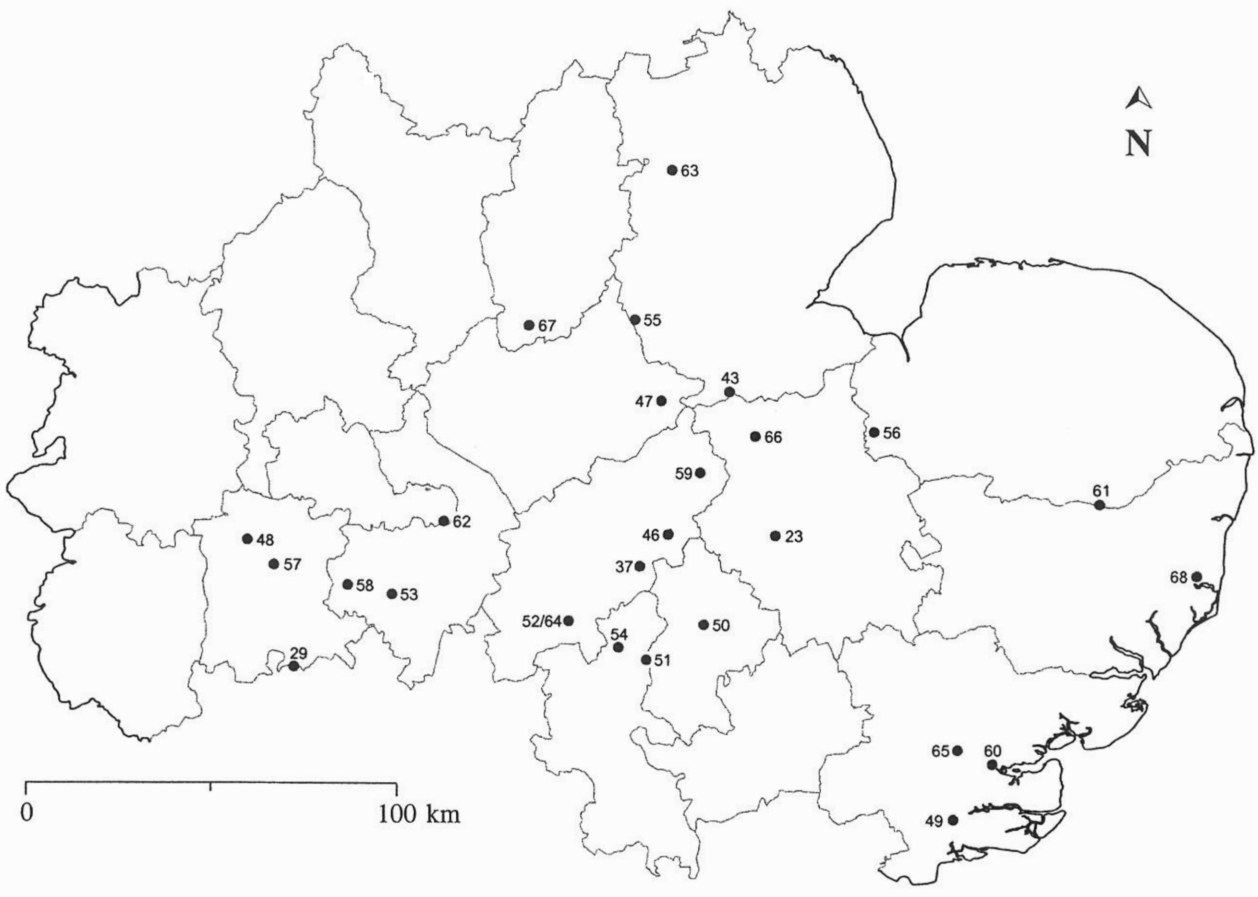

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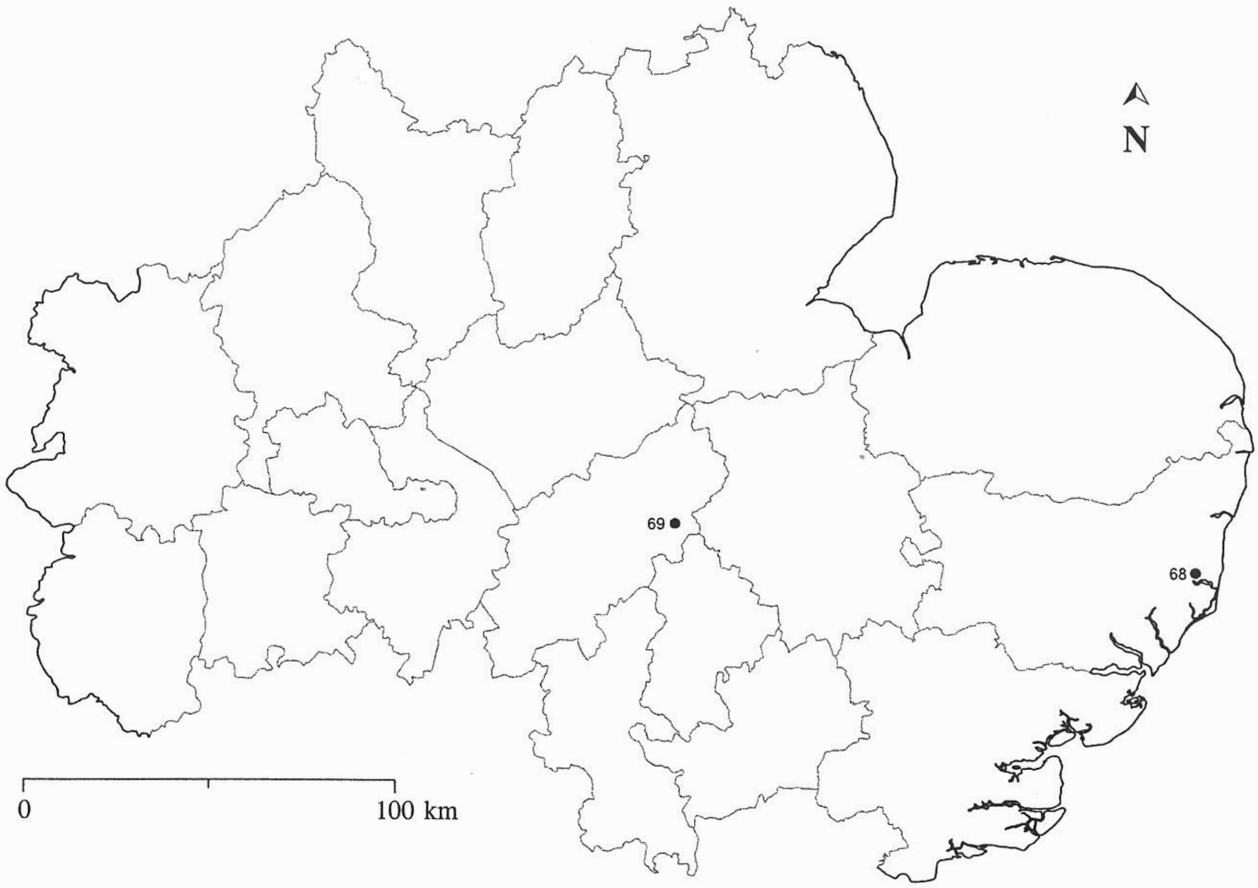

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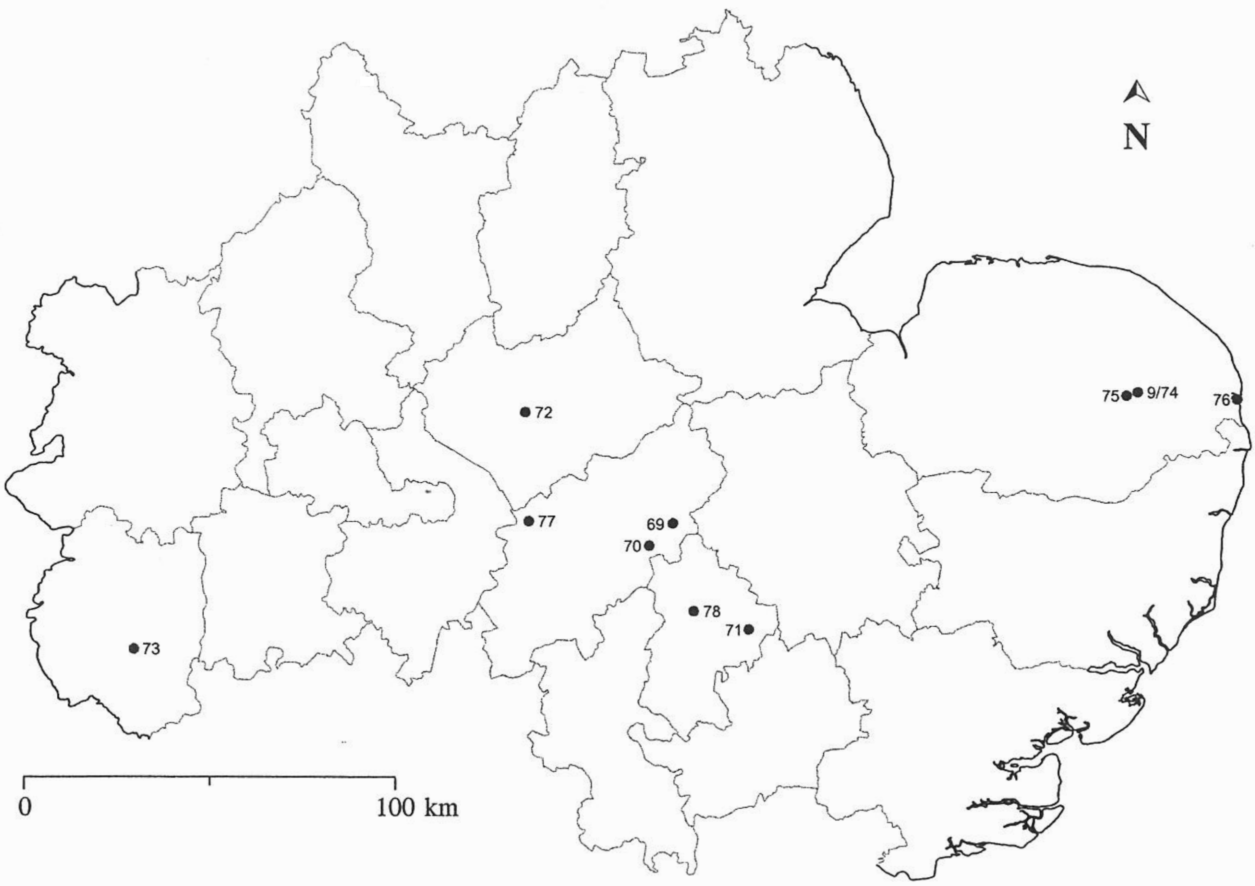

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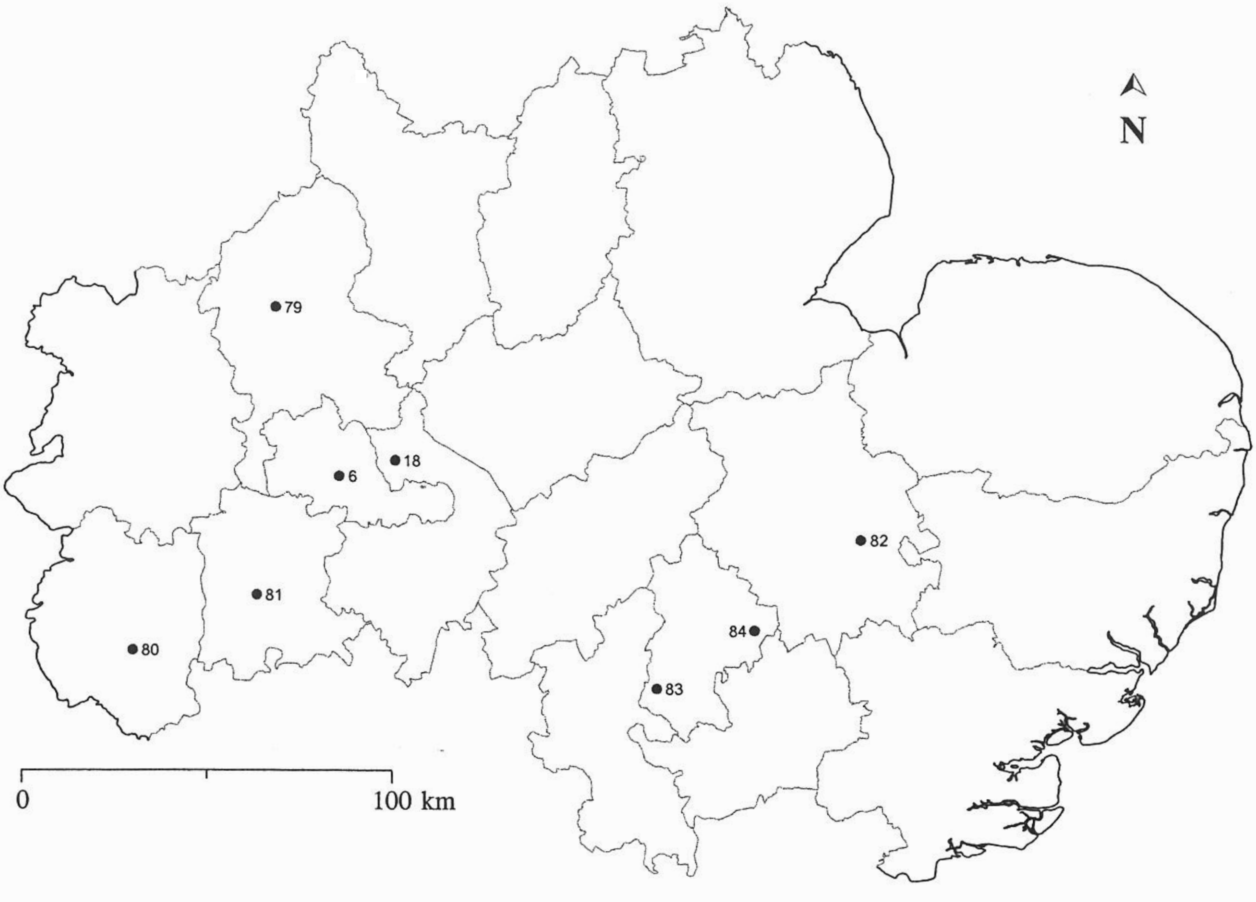

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ENGLISH HERITAGE REVIEWS OF ENVIRONMENTAL ARCHAEOLOGY: MIDLANDS REGION INSECTS

INTRODUCTION

The analysis of insects, especially Coleoptera (beetles), is now an important part of the palaeoenvironmental studies which occur on some archaeological excavations in England. The purpose of this review is to consider what has been achieved by archaeoentomological studies in the Midlands Region of England (Fig. 1) and to place the results within a chronological framework along the lines of a similar survey which has been prepared for the Southern Region (Robinson 2002). It is neither a gazetteer of all the work that has been done in the region, nor does it review the extensive literature of Pleistocene studies covered in Buckland and Coope (1991). Although humans were probably present in the British Isles contemporaneously with the accumulation of some of the Pleistocene insect assemblages, there is no evidence for the proximity of humans to those deposits, let alone any human influence on the insect faunas. An arbitrary starting point has been taken of Zone III of the Late Devensian (the Loch Lomond Stadial) so as to set the scene for the Flandrian (Holocene or Post-Glacial Period). Human modification of the environment has made this inter-glacial so different from those which preceded it that different considerations apply to the insect evidence.

The overriding chronological approach does have drawbacks. On some projects, palaeoentomology has been just one aspect of integrated palaeoenvironmental studies and the interpretation of the evidence needs to be de-constructed in order to extract that derived from insects. Some of the areas within the region would have been better discussed as separate entities because their characters are so different from the remainder of the region, for example the Fens. Coverage has been very uneven. There are some parts of the region where no sites at all have been investigated or only a single period is represented. However, by applying a standard method of analysis to the results from many of the sites, it has proved possible to present the data in a form which does provide a continuous theme.

The information which can be derived from assemblages of ancient insect remains covers diverse aspects of the past environment and human activities. Some of this reinforces the evidence of other biological groups. However, insects have proved to excel at providing details that would otherwise be lacking on, for example, the presence and use of grassland, the character of woodland and human living conditions.

Insect remains of archaeological interest are preserved in waterlogged organic sediments both of natural occurrence, for example palaeochannel silts and fen peats, and in archaeological features, for example in well bottoms or organic floor layers. They can also be preserved by mineralisation, especially in cesspits and, to a much lesser extent, are occasionally found charred or desiccated. While suitable deposits for archaeoentomology are not ubiquitous in the Midlands Region, they are widespread, especially in those areas with a high water table.

Archaeoentomology in the Midlands Region largely developed over the past 25 years. This was in part a factor of the expansion of environmental archaeology which occurred over this period but the subject also faced particular difficulties. Early excavators in the region certainly picked out brightly coloured insect fragments from organic sediments and passed them on to entomologists. However, fragments proved difficult to identify without extensive collections of reference specimens, there was no interpretive framework to take results further than species lists and only the larger species would have been noticed during excavation.

By the early 1960s, the work of GR Coope in the Department of Geology at the University of Birmingham on Pleistocene insect remains had shown the potential of the subject for palaeoenvironmental reconstruction by using large assemblages of remains recovered by sieving and identifying them accurately. His team also did limited work on Holocene deposits. One member of his team, PJ Osborne, undertook some useful pioneering work on archaeological material from the region. He was joined from the early 1980s onwards by archaeoentomologists funded by English Heritage to analyse material from rescue excavations. However, the large-scale studies that brought together the results from many sites that were occurring elsewhere did not take place throughout the region, although a special effort has been made in recent years to investigate Neolithic sites on the river gravels of the South Midlands. Particular attention was paid to insect remains from Neolithic and Bronze Age sites in Cambridgeshire and Northamptonshire.

The creation of the Midlands Regional Environmental Archaeology Team by the Ancient Monuments Laboratory of English Heritage has provided entomological coverage for all EH-funded excavations in the region, making use of the Hope Entomological Collections at the Oxford University Museum of Natural History. Coverage has been less even, however, for developer-funded excavations required under PPG 16, with the best response being from archaeological units which had already undertaken projects with EH-funded archaeoentomology. Recently, D. Smith, in the Department of Ancient History and Archaeology at Birmingham University, has been working on insects from sites in the Trent Valley.

The Region

The Midlands Region of England comprises, for the purposes of this review, the counties / former counties of Bedfordshire, Buckinghamshire, Cambridgeshire, Derbyshire, Essex, Herefordshire, Hertfordshire, Leicestershire, Lincolnshire (excluding Humberside), Norfolk, Nottinghamshire, Rutland, Shropshire, Staffordshire, Suffolk, Warwickshire, West Midlands and Worcestershire. Site location by period and boundaries are shown in Figs. 1a-h.

Dates

Dates for the Late Glacial and Mesolithic (up to 5500BP, 4300 BC) are given in radiocarbon years BP (before present). Radiocarbon dates are expressed in radiocarbon years BP to one standard deviation. Dates from the Neolithic to the present are expressed in calendar years BC / AD. Radiocarbon dates have been calibrated using OxCal Program v2.18 (Bronk Ramsey 1995) and are expressed as a date range in calendar years to two standard deviations as years cal BC / AD.

The Periods

The time under consideration has been divided into one Late Devensian and six Flandrian periods. These are listed in the Table of Contents (p.ii-iii) and in Figs. 1a-h. The boundaries between some of the periods are clear but the transition between "The Rise of Agriculture" and "The Development of the Open Landscape" at 1500BC presented problems. The middle Bronze Age assemblages from Godmanchester, whose radiocarbon date spans the division, have been placed in the earlier period, although the presence of spelt wheat in one of the deposits shows an affinity to the later period.

THE CLASS INSECTA AND ARCHAEOLOGY

The group of invertebrates commonly known as insects are now classified as comprising the Hexapoda, a super-class of the phylum Arthropoda (Naurmann *et al.* 1991). They are segmental organisms with, in the adult, a body divided into head, thorax and abdomen. The head carries a pair of antennae and compound eyes, the thorax is made up of three segments each with a pair of legs and the abdomen is up to eleven segments long. Many insects have two pairs of wings on the last two segments of the thorax. The exoskeleton of insects is made of a substance called chitin which is a fibrous amino-polysaccharide, somewhat similar to the cellulose of plants. It is a tough, flexible, lightweight, waterproof material. In the sclerites, the more rigid armoured plates of an insect's cuticle, the chitin of the upper layer of the cuticle (exocuticle) has been combined with cross-linked protein molecules of sclerotin. Above this is a thin layer of epicuticle which contains densely packed wax molecules.

British insects range in body size from about 0.2mm to 45mm for the bulkiest, or 75mm for the most elongate. They occur in a very wide range of terrestrial and freshwater aquatic habitats. Although there are no fully marine species, there are many from brackish and strand-line habitats. Insect species feed on a wide range of living, dead and decomposing biological material. Most plants are attacked by insects, while there are both carnivores and parasites which feed on other animals. There are more species of insect in Britain than all the other British members of the kingdoms Plantae and Animalia put together.

There are three classes to the Hexapoda: Diplura, Ellipura and Insecta. Only the Insecta have so far proved of archaeological relevance. The Insecta comprises two sub-classes, the more primitive wingless Archaeognatha and the more advanced Dicondylia in which members of the infraclass Pterygota are either winged or were derived from winged ancestors.

Nine orders of the Pterygota include members which are regularly found in archaeological deposits although there have been occasional finds from other orders.The orders Odonata, Dermaptera, Phthiraptera and Hemiptera are conveniently grouped in the non-taxonomic unit Exopterygota. They undergo incomplete metamorphosis. The nymph which hatches from the egg shows much resemblance to the adults except wings are absent. As the nymphs grow, they moult and wings being to develop. After each moult the insect emerges larger and the wings grow at a faster rate than the rest of the body until the final result when the imago, or fully winged adult, emerges.

The orders Coleoptera, Siphonaptera, Diptera, Trichoptera and Hymenoptera all belong to the taxonomic sub-division Endopterygota, whose members show complete metamorphosis. A larva very different in morphology from the adults hatches from the egg. The larva undergoes a series of moults as it grows. Once growth is complete it moults and becomes a pupa (or in the case of some Diptera, a puparium if the last larval skin is retained). The insect undergoes substantial internal re-organisation within the pupa before the winged adult emerges. The adult often has a different food source from the larva.

Order Odonata (Dragonflies)

The Odonata have aquatic predatory nymphs and adults which hunt their prey in the air. Remains of both nymphs and adults are sometimes found in aquatic deposits (eg Robinson 1991).

Order Dermaptera (Earwigs)

The Dermaptera are terrestrial insects which mostly feed on dead and decaying plant and animal material. Their remains, including their characteristic cerci (pincers) are quite often abundant in waterlogged deposits (eg Robinson, unpublished o) but their palaeoecological value is limited because there are so few British species and most finds are of *Forficula auricularia* (common European earwig).

Order Phthiraptera (Biting and Sucking Lice)

The Phthiraptera are wingless, obligate ectoparasites at all stages of their life. Most biting lice are associated with birds but the sucking lice (Suborder Anoplura) just feed on the blood of mammals, often being host-specific. Anoplura remains are sometimes found in waterlogged organic material where there has been close contact with humans or domestic animals (eg Carrott *et al.* 1995). Remains of *Pediculus capitis* (human head louse) have been found on waterlogged fine-toothed boxwood combs of Roman date (Fell 1996).

Order Hemiptera (True Bugs)

The Hemiptera have mouthparts adapted for piercing and sucking. The great majority of them feed on the sap of plants but a few suck blood. Most are terrestrial although there are some aquatic species. Hemipteran remains are never as abundant in waterlogged sediments as coleopteran remains but many fragments are readily identifiable. Useful supplementary palaeoecological information can be obtained from them (eg Robinson, unpublished o) and some are host-specific in their food plants. The bed bug (*Cimex lectularius*) has possibly been recorded from archaeological contexts (eg Osborne 1971). One curious aspect about the survival of hemipteran remains is that aphids are more readily preserved by waterlogging when they have been parasitised by Hymenoptera.

Order Coleoptera (Beetles)

Although Coleoptera outnumber in species every other order of animals in the world, the number of British species (3729 extant species on the last full British list, Kloet and Hincks 1977) is exceeded by the British numbers in two other orders, Diptera and Hymenoptera. With the exception of some lake deposits, however, Coleoptera are by far the most abundant closely identifiable insects from organic sediments, in part because the adults are so heavily sclerotised. Their fore-wings are in the form of rigid sheaths (elytra), the motive power for flight being provided by the hind wings. They occur in almost every conceivable terrestrial and aquatic habitat. There are also a few of brackish habitats. Many are free-ranging carnivores but dung, carrion, decaying vegetable material and dead wood all support large associations of decomposer Coleoptera. Several families of Coleoptera feed on plants, some species being host-specific. The aquatic Coleoptera range from species of stagnant water through those which are extremely fastidious in their requirement for clean, well-oxygenated flowing water. The very diverse assemblages of Coleoptera from some rural archaeological sites (eg Robinson 1996b) contrast strongly with the restricted range, mostly of synanthropic species including pests, which can be found in some urban deposits. Coleoptera have proved to be the order with the greatest palaeoecological value.

Order Siphonaptera (Fleas)

Siphonaptera are hard-bodies, laterally compressed, wingless, jumping insects which feed on the blood of bird and mammals. They tend to have preferred host species and are found in the same type of deposits as Phthiraptera (eg Carrott *et al.* 1995).

Order Diptera (Flies)
The Diptera are a large order of insects. Their distinguishing feature is the possession of only a single pair of wings, their hind wings being modified into balancing organs. The larvae of flies can be either terrestrial or aquatic, a high proportion feeding on decaying organic material although some are some parasitic. Adults have sucking mouthparts, the food of different species ranging from nectar, through liquid exuded by decaying organic material, to blood. Remains of larvae, puparia and adults are preserved in waterlogged organic sediments but they often present great problems of identification, the remains of adults tending to be fragmentary while the immature stages are often taxonomically undescribed. However, identifiable larval head capsules of Chironomidae (midges) can be very common in lake sediments (Walker 1987). This family is very sensitive to water quality and temperature. Puparia, especially of Muscidae and Sphaeroceridae have proved useful in characterising waterlogged deposits of organic refuse, including middens and cesspits (Phipps 1987; Belshaw 1988). Fly larvae and puparia are also susceptible to calcium phosphate mineralisation in cesspits (eg Robinson, unpublished bb).

Order Trichoptera (Caddis Flies)
The Trichoptera are moth-like insects with aquatic larvae. Many of the larvae make proteinaceous cases to which foreign material such as grains of sand or twig fragments are often attached. The larvae have diverse feeding habits but many feed on organic detritus. Both cases and larval sclerites survive in aquatic sediments. Some larval cases can be identified (eg Kelly and Osborne 1963-64) but the larvae themselves have more potential (Wilkinson 1987; Wilkinson in Osborne 1995). The Trichoptera have some palaeoecological value because they can be fastidious in their water quality requirements.

Order Hymenoptera (Bugs, Wasps and Ants)
The Hymenoptera are characterised by two pairs of wings which are linked in flight. The larvae of many feed on plants or are parasitic on other insects, many of the adults feed on nectar. The remains of the adults, especially the heads, which tend to be more heavily sclerotised than the remainder of the body, are commonly preserved in waterlogged organic sediments. They have, however, proved exceedingly difficult to identify. An exception to this is *Apis mellifera* (honey bee), where it was worth the effort to characterise their remains because it is a species of particular interest in its own right (eg Robinson 1994a). One of the social groups of Hymenoptera, the Formicidae (ants) is, however, sufficiently distinctive and small that the members can readily be identified (eg Robinson, unpublished o). Some Hymenoptera, including the Cynipidae (gall wasps) induce the formation of galls, clusters of enlarged or additional cells in plants, to provide food and protection for their larvae. These galls, which are morphologically distinct and host-specific are preserved in waterlogged sediments along with other plant remains (Robinson 1980b).

THE PRESERVATION OF INSECT REMAINS

Chitin and sclerotised chitin are quite resistant to decay although they are attacked by fungi. In an aerobic environment the skeletons of dead insects soon decay unless conditions are very dry or very cold. However, the permanent waterlogging of a fine sediment so greatly reduces the diffusion of oxygen through it that the limited decay of any organic material in it rapidly results in the deposit becoming anaerobic (or anoxic). These conditions are hostile to the organisms which decay chitin. Preservation is probably best in circumneutral to slightly acidic organic silts whereas in very acidic peat specimens are sometimes rendered flimsy and pale. Inevitably, the most heavily sclerotised remains are the best preserved. Under good conditions of preservation, fine detail survives, including surface microsculpturing, scales and setae (hairs).

Structural colours which result from thin films creating interference patterns with light, or surface irregularities scattering light, are usually retained. These are the metallic or iridescent colours shown particularly by Odonata and Coleoptera. Not all pigments survive so well, reds for example, tending to be fugitive but the blacks and browns due to heavy sclerotisation do not deteriorate. One curious effect of this is that because sclerotisation enhances preservation only the black spots survive from the elytra (wing cases) of Coccinellidae (ladybirds) when conditions for preservation are poor. Although freshly extracted, well-preserved beetle sclerites can appear almost identical to modern examples when wet, there has in fact been a loss of proteins from them and they will often shrivel or crack on drying.

As a general guide, if conditions are suitable for the preservation of macroscopic plant remains by waterlogging, insect remains will also survive. These conditions are likely to occur in natural situations such as lake beds, palaeochannel sediments and peat fens / bogs. They will also be present in archaeological features which extend below the water table such as pits, well bottoms and ditches. A rising water table can result in the preservation of insects in deposits which are not usually waterlogged, for example floor layers and true soils. In Northern and Western Britain there have been episodes in the lives of some towns, for example Dublin and York, where the rate of deposition of organic refuse has exceeded the rate of decay. The organic material has then held water in the manner of an ombrogenous peat bog. However, such a process is favoured by a cool wet climate and deposits of this sort are not fully developed in the region although conditions possibly approached this in Lincoln.

Insect remains can also be preserved by mineralisation. Girling (1979) reported the discovery of calcium carbonate-replaced arthropod remains from archaeological deposits. The finds were mostly of Isopoda (woodlice) and Diplopoda (millipedes) but there were a few records of insects including an internal cast of a Diptera puparium. A brief re-examination of this material showed the insect remains to have experienced calcium phosphate rather than calcium carbonate replacement (*cf.* Green 1979). Isopoda and Diplopoda contain calcium carbonate in their skeletons but these remains too seemed largely to have been preserved by calcium phosphate replacement. (The Diplopoda remains from Winklebury Camp, a site on the Chalk, were not examined and it is possible that these did indeed represent calcium carbonate survival). Subsequently, many finds have been made of calcium phosphate-replaced insects, usually from cesspits or sediments which contained material re-worked from cesspits. Calcium phosphate mineralisation appears to occur rapidly after insects have been incorporated into sediments with an organic liquid rich in phosphate ions, such as sewage, against a background of calcium carbonate, for example a limestone lining to a cesspit. Mineralisation most usually occurs by the infiltration of voids within specimens, producing an internal cast, rather than the replacement of hard parts. This can create considerable problems for identification. True calcium carbonate-replaced insect remains have occasionally been noticed in tufa deposits, for example cases of Trichoptera.

Metal corrosion products sometimes result in the preservation of insect remains. In the case of iron it is predominantly by replacement or the formation of an external cast, whereas with bronze it seems largely to be by its biocidal action. Both types of preservation are perhaps most frequently encountered on grave goods accompanying inhumations, where the remains preserved are usually Diptera puparia. However, such remains are rarely preserved well enough for close identification and often go unreported.

Insect remains are only very rarely preserved by desiccation, in the Midlands Region. Examples have been found in ancient thatch although their date is difficult to establish.

Insects can be preserved by charring but finds of identifiable material in the region are very few.

SAMPLING, EXTRACTION AND IDENTIFICATION OF INSECT REMAINS

The sampling and extraction of insect remains from waterlogged sediments has been covered in detail elsewhere (Kenward 1974; Kenward *et al.* 1980; Buckland and Coope 1991, 2-5). For most insects groups, including Coleoptera, sequential samples divided at 50mm to 200mm intervals and of 1kg to 10kg weight are taken from freshly exposed sections. The sampling interval is in part related to the rate of sedimentation but the difficulty of establishing contemporaneity over the large surface area necessary for samples of this size and problems with mixing during sedimentation mean that sample intervals closer than 50mm are rarely practicable. Spot samples are taken from deposits of interest and floor layers sampled from a grid. (Chironomidae larvae are analysed from much smaller samples which can be taken by coring (eg Walker 1987) but little work has yet been done in Britain of archaeological relevance.)

Samples are disaggregated in water, possibly using a wash-over technique to separate the organic from the mineral fraction, (which is discarded), drained on a 0.2 or 0.3mm sieve, mixed with paraffin in a bowl and water added. The insect remains are poured off onto the sieve, washed with hot water and detergent, sorted in water under a binocular microscope and stored in 70% ethanol to await identification. (Some workers glue specimens onto card and dry them, but this can damage the specimens.) Identifications are made by direct comparison of the sclerites with reference specimens. This is mostly done using a binocular microscope at magnifications of up to x100. The results are tabulated to give for each sample the minimum number of individuals of each taxon represented by the sclerites identified from it. The taxonomic nomenclature used in this survey, below the level of order, follows Kloet and Hincks (1964; 1976; 1977; 1978) for species extant in Britain and Lucht (1987) for Coleoptera now extinct in Britain. Some workers, however, use Lucht (1987) for all Coleoptera.

INTERPRETATION

The techniques used for the interpretation of waterlogged assemblages of insect remains are very much dependent on the aims of the research. It is convenient to divide studies into three categories: Pleistocene, rural archaeological and urban. In general, Pleistocene studies are concerned with major aspects of the environment, especially climate. The biogeographic implications of species now extinct in Britain but occurring elsewhere in the Northern Hemisphere can be substantial. The term 'rural archaeological' has been used to cover remains from natural Holocene (Post-Glacial) deposits and also man-made deposits where many of the insects were derived from the surrounding landscape or at least outdoor habitats. The main aims are likely to be determining the landscape setting of the site and the site environment, with particular emphasis being placed on evidence for human activities or settlement. Any climatic signal beyond conditions being broadly similar to those of the present is often obscured by the effects of human activity, although early Holocene assemblages are a notable exception. The occurrence of species now extinct or very rare in Britain tends to be related to habitat loss caused by human activity. The term 'urban' has been used for sites on which many of the insect assemblages are dominated by indoor species or are members of decomposer communities of organic refuse. Insects from the wider landscape tend to be no more than a background presence. While not all insect assemblages from towns are of this character and 'urban' faunas can be found on some rural sites, it is a useful division. The aims of the research tend to be concerned with determining what particular deposits represent, what activities were occurring on the site and the living conditions of the occupants. Species introduced to Britain as a result of trade and only able to survive in Britain in the highly artificial conditions created by humans are sometimes present.

In all three categories, consideration needs to be given to the taphonomy (in the widest sense) of the insect assemblages, that is where the individual insects came from, how they entered the deposit and what factors of preservation operated. Death assemblages usually include members of several different life communities, some individuals of which only rarely, if ever, live together. With Pleistocene assemblages the considerations have generally been simple although establishing that sampling units do not cross boundaries that would give spurious intermediate faunas is important.

With rural archaeological material there is the additional possibility of human as well as natural agencies transporting insects to the deposit. It is usually relatively easy to divide the assemblages into the aquatic species, most of which probably lived in the water above the deposit, and the terrestrial species, which will provide the information on the surrounding landscape and site environment. However, it is rather harder to separate assemblages from peatland landscapes into the autochthonous species (those derived from the immediate environs) and the allochthonous species (those from elsewhere, ie the surrounding landscape). It can also be very difficult dividing urban assemblages into their autochthonous and allochthonous components although this can be very important for the purposes of interpretation.

Whereas with rural archaeological assemblages the allochthonous insects tend to be of greater interest, the autochthonous component is often of more interest in the urban assemblages. For example, the insects which lived in a building in a town will tend to be of more archaeological significance than the "background fauna" of insects which flew in from beyond the town. Sometimes the autochthonous insects from such a structure will be truly autochthonous, perhaps being preserved in an organic floor layer, sometimes they are not truly autochthonous but are derived, perhaps being dumped in a pit along with refuse from the floor, but this part of the assemblage is still distinct from the background fauna. If the autochthonous component is absent, perhaps because an urban site was very clean and only the background fauna is present, this could result in an incorrect interpretation unless its long-distance origin can be identified (Kenward 1978).

One way of tackling the problem of the origin of the insects in an urban assemblage has been to calculate an index of its species diversity, that is its species richness (Kenward 1978). The index chosen by Kenward is Fisher's alpha, which enables direct comparisons to be made between assemblages of different sizes. If an assemblage is dominated by the background fauna, there will be insects from many different habitats with each species only represented by a few individuals, giving a high index of diversity. If an assemblage is dominated by autochthonous insects from a single habitat there will tend to rather fewer species each represented by rather more individuals, giving a lower index of diversity. There are very few insects able to live in some man-made habitats, for example clean, relatively dry stored grain, but those species which are adapted to them can flourish in vast numbers, giving a very low index of diversity.

Some archaeological features such as pits and wells can act as pitfall traps giving very high concentrations of insect remains (eg Osborne 1969). However, this does tend to result in a bias towards larger Coleoptera which crawl readily. Care must also be taken to recognise other taphonomic factors which can concentrate insect remains, for example the droppings of animals or the pellets cast by birds (Girling 1977a).

Palaeoecological interpretation of any fossil group is made easier if the ancient species are the same as the extant species, that is they are morphologically and physiologically identical. This does, indeed, appear to be true for Coleoptera, and probably also for other orders of insects well back into the Pleistocene (Buckland and Coope 1991, 7-11). Species kept the same company earlier in the Quaternary as they do today and specialist feeders are found associated with the same hosts. Even races of Coleoptera and their ecological requirements seem to have remained stable. For example, samples of the small water beetle *Helophorus glacialis* from a Mid-Devensian cold assemblage from Warwickshire showed the fine morphological characteristics of the Siberian race whereas the beetles from temperate assemblages belong to the European race (Coope 1970, 103-4). This is not to say that all ancient habitats and the species associations that go with them have modern analogues. In the case of the beetle *Aglenus brunneus*, more has probably been learnt about its entomology from the archaeological contexts in which it has been found than was learnt about past conditions from modern records of the beetle (Kenward 1975).

The interpretation of Pleistocene insect assemblages for general environmental reconstruction has tended to be based on a mosaic approach of fitting together the ecological requirements of all the species present. Initially, climate was included in this approach by finding the modern geographic area where the maximum number of the species now occur and assuming the climatic regime to be similar. Subsequently, a more advanced technique was developed by Coope and his collaborators which involves establishing the climatic parameters within the modern area of distribution of each species. (Atkinson *et al.* 1986; Atkinson *et al.* 1987). The plots for all the species are compared and the climatic limits of the area of maximum overlap are assumed to be those which prevailed when the deposit was laid down. Unfortunately, this technique is not applicable to Holocene assemblages once human activity has had an effect on the insect fauna. Clearance has resulted in the extinction in Britain of various 'old woodland' species now only found further south or east in Europe.

The interpretation of rural archaeological assemblages was also initially done on a mosaic approach and this is still often used. It has come under criticism (Kenward 1978) although this has been rejected by other researchers (Buckland and Coope 1991, 11). One implicit aspect of the criticism does, however, retain its validity: a simple mosaic approach does not always use the evidence to its full potential. The mosaic approach also makes it difficult for the non-specialist to see how the interpretation was reached.

One of the problems with coleopteran results from rural archaeological deposits is the very high species diversity, so that even if large assemblages are identified in terms of minimum number of individuals, most species are only represented by a few individuals. It is not possible to present readily intelligible results in the manner of a pollen diagram although this has been attempted for a late Glacial site (Coope and Joachim 1980). Various attempts have been made at the statistical manipulation of the data. Girling (1980, 37) used a crude system of grouping Coleoptera from a Somerset Levels site, according to the main habitat requirements of certain families, into four categories but it had the disadvantage that not all the members of the family were associated with that habitat. She also used a points system to score the host requirements of Coleoptera from a second site on the Somerset Levels in order to gain an impression of forest composition (Girling 1985a, 82).

The approach adopted by Kenward (1978) for the interpretation of urban insect assemblages makes further use of the population structure. The percentage of outdoor individuals and species is calculated for each sample. The most abundant species are listed as a percentage of the total individuals in the sample. An attempt is made to identify insect species associations in the assemblages and to relate them to communities from which habitat information can be derived (Kenward 1982).

A series of habitat-related species groups were devised by Robinson (1981, 279-82) to assist with the interpretation of Coleoptera results. Some species of Coleoptera are eurytopic, that is they occur in many different habitats, so not all the beetles could be classified into groups. Modern studies of the Coleoptera of various habitats were undertaken by pitfall trapping, a system of sampling that shows some similarity with the incorporation of allochthonous insects into archaeological deposits, to establish the interpretative validity of some of the species groups (Robinson 1983). Further groups were also added. By the time this system was applied to the results from Runnymede (Robinson 1991, 278-81) there was a large enough corpus of results available for comparative purposes to gain some idea of the importance of the habitat of a particular grouping from its percentage value.

What is basically the same system as was used for Runnymede and other sites analysed by Robinson since 1983 is used for this survey. The composition of the species groups has largely been retained for purposes of comparability with earlier published work although some further categories have been added. The results are expressed as a percentage of the minimum number of individuals of terrestrial Coleoptera in each assemblage, excluding the aquatic species. This is because the assemblages accumulated under water and it enables some of the differences due to the environment of the deposit itself to be removed. (Pollen analysts often express their results as a percentage of the dry-land pollen sum for similar reasons). Only around 40% of the terrestrial Coleoptera from a site will fall into a species group so the sum does not add up to 100%. An example can be seen in Fig. 7.

The groups used follow Robinson (1981, 279-82) unless stated:

1. Aquatic
These beetles are all species which can spend much of their adult life under water although many readily leave water for dispersal flights and some can also be found amongst wet leaf litter eg. *Anacaena globulus*. A few Chrysomelidae and Curculionidae which feed on aquatic plants give classification problems, *Macroplea appendiculata*, *Eubrychius velutus* and *Litodactylus leucogaster* being included in the aquatic group.

2. Pasture / dung
The scarabaeoid dung beetles of the genera *Geotrupes*, *Colobopterus*, *Aphodius*, *Copris* and *Onthophagus* mostly occur in the dung of large herbivores in the field rather than in manure heaps and therefore provide a good indication for the proximity of grazed pasture. *Aphodius niger*, *A. plagiatus*, *A. villosus* and *Oxyomus sylvestris* have been excluded because they rarely occur in animal droppings on pasture. A value of below 1% for this group can be expected for closed woodland without domestic animals, rising to about 10% in a largely pastoral landscape away from concentrations of domestic animals which occur around settlements. The proportion of these beetles can reach 20 to 25% or more in samples from the ditches of Iron Age enclosures used to coral stock, but can be as low as 6% from a settlement primarily engaged in arable agriculture.

3. ?Meadowland
Members of the genera *Apion* and *Sitona* which mostly feed on vetches, clovers and other grassland trefoils, are favoured by haymeadow conditions because they need their host plants to reach maturity rather than being constantly eaten back to ground level. Some members of the genus *Apion* feed on other plants, for example mallows and nettles, but many of these can be identified from fragments and so excluded from the total. While this group is particularly favoured by haymeadow conditions, reaching values of 8 to 12%, it can also reach quite high values where there is ungrazed wayside vegetation. Grassland which is not so heavily grazed as to prevent the flowering of *Lotus* sp. (bird's foot trefoil) and *Trifolium* sp. (clover) gives values of 2.5% to 5% from archaeological assemblages but their level falls to 1% for overgrazed pasture. Some species of *Sitona* also attack peas and broad / field beans so caution must be applied to their interpretation.

4. Wood and trees
This group comprises Coleoptera which feed on wood in various stages of decay, leaves, fruits, bark and live wood of trees and shrubs, plus fungal feeders and predators which are strictly associated with wood, such as *Cis* sp. and *Pediacus* sp. General woodland beetles, such as *Calosoma inquisitor*, a predatory arboreal carabid, have been excluded. *Anobium punctatum* and *Lyctus linearis* have also been excluded because they have been placed in a separate category. The members of this group come from many families. The proportion of this species group can be a high as 20% where closed old woodland overhung the deposit and even higher if some of the trees were moribund. However, many of the tree-dependent beetles do not have very good dispersive powers, so this aspect of the landscape can be under-represented if the woodland was some distance from the deposit. For example, values as low as 10% have been recorded from somewhat open woodland of early Flandrian date separated

from the deposit by an extensive reedswamp. Values just over 7% from a Neolithic site were interpreted as reflecting between one third and two thirds tree cover. The percentage for a hedged, but otherwise open, landscape tends to be around 0.5% to 1.5% but values as low as 0.1% have been recorded from Iron Age sites on the treeless landscape of areas of the Upper Thames floodplain. It must be remembered that some of the wood-dependent beetles can be introduced in imported timber, particularly firewood.

5. Marsh / aquatic plants

The many species of Chrysomelidae and Curculionidae which feed exclusively on marsh and aquatic plants make up this group. Their value can be as high as 50% from fen deposits to 0.5% to 1.5% from a floodplain landscape which was wet but where marsh and aquatic plants did not fringe the deposit.

6. Disturbed ground / arable

This group was extended to give two categories (Robinson 1983): 6a (Species Group 6 of Robinson 1981, 279-82), species of weedy disturbed ground (*Agonum dorsale* and *Harpalus rufipes*); and 6b, species of *Amara* of bare ground and arable on sandy soils (*A. apricaria*, *bifrons*, *similata* and *tibialis*). Neither group is particularly abundant even when their favoured habitat seems to have been well represented, 1.5% being a high value for 6a and 3.0% being a high value for 6b. Unfortunately it is not possible to use coleopteran evidence to differentiate arable from other types of bare or disturbed ground and the members of this group do not have such good dispersive powers as the members of the grassland groups (Species Groups 2, 3 and 11). Coleoptera are not as reliable for detecting arable as for detecting grassland.

7. Dung / foul organic material

Certain members of the Hydrophilidae and Staphylinidae which live in various types of foul organic material including dung, manure heaps, compost and other categories of decaying vegetation: *Cercyon* spp., *Megasternum obscurum*, *Cryptopleurum* spp., *Anotylus rugosus*, *A. sculpturatus* and *Platystethus arenarius*, make up this group. Many rural archaeological assemblages show values between 7.5% and 15%, seemingly independently of the percentage of scarabaeoid dung beetles or the intensity of human habitation at the sites. Naturally occurring accumulations of decaying plant debris along the edges of some deposits in ditches, palaeochannels and ponds seem to be significant contributors of members of this group. On some urban sites with large accumulations of decaying refuse, however, percentages rise considerable higher than 15%.

8. Lathridiidae

Most of the members of this family of Coleoptera feed on surface mould on decaying plant material. They tend not to live in such foul, wet conditions as Species Group 7 and can be found in such habitats as grass tussocks. Values up to 2.5% are quite usual for assemblages from prehistoric occupation sites and semi-natural deposits, but Roman and more recent settlements often produce values in excess of 8%, where the abundance of this family seems to be related to concentrations of old thatch, vegetation used as bedding for animals, the storage of hay etc.

9. Synanthropic

The original group which comprised various members of the Anobiidae, Ptinidae, Cucujidae, Silvanidae, Endomychidae, Mycetophagidae, Tenebrionidae and Curculionidae which usually live in buildings or are associated with human habitation (Robinson 1981, 265, 268) has been divided into two. Species Group 9a comprises the species which are no more than minor granary pests including *Stegobium paniceum*, *Ptinus fur*, *Mycetaea hirta*, *Typhaea stercorea* and *Tenebrio molitor*. They do, however, occur in granary refuse and are often associated with hay waste or decaying parts of timber buildings. In Britain they also have habitats away from human habitation such as birds' nests, but are very rare unless in their synanthropic habitats. The percentage for this group ranges from 0 to 0.2% for most prehistoric and semi-natural deposits but values of 2 to 5% are commonly found on Roman rural occupation sites and urban sites often give higher values. The members of Species Group 9b are species of Cucujidae, Silvanidae, Tenebrionidae and Curculionidae, in particular *Cryptolestes ferrugineus*, *Oryzaephilus surinamensis*, *Tribolium* spp., *Palorus* spp. and *Sitophilus granarius* which can be very serious pests of stored grain and only occur in Britain under artificial conditions. *C. ferrugineus* and *O. surinamensis* have been captured out of doors, for example under the bark of trees, but it is uncertain whether they represent self-sustaining populations or individuals which have spread from grain infestations. Most of them were probably introduced to Britain by the Romans. They are rarely found on rural sites other than military or manorial sites (although they presumably occur in mills) but in towns, especially Roman towns, the presence of infested grain in refuse can give values of 15% or more. The wood-boring synanthropic species, which have been placed in Species Group 10, and *Aglenus brunneus*, a synanthropic beetle whose habitat range does not entirely overlap with the others of Species Group 9a, have been excluded.

10. Especially structural timbers

Three native members of the British wood and tree-dependent fauna, *Xestobium rufovillosum* (death watch beetle), *Anobium punctatum* (woodworm beetle) and *Lyctus linearis* (powder post beetle) have been placed in this group. A fourth species, *Lyctus brunneus,* which is not necessarily native has also been included. They live in dry dead wood, which is not particularly common under natural conditions but the beetles, especially *A. punctatum*, whose numbers usually greatly exceed the other species, can proliferate in structural timbers. Natural woodland assemblages normally have values below 1% although this percentage can rise to 3%. Values from prehistoric occupation sites are usually below 1% unless the deposit itself contained woodworm-infested timber. The higher levels of these beetles, at 1.5 to 2.5% on Roman sites, probably reflects a greater density of buildings and on urban sites *A. punctatum* is usually even more abundant.

11. On roots in grassland

This group which was added later (Robinson 1983, 34-5) comprises various Scarabaeidae and Elateridae with larvae which live on the roots of herbs in permanent grassland including *Serica brunnea*, *Hoplia philanthus*, *Phyllopertha horticola*, *Agrypnus murinus*, *Athous* spp. and *Agriotes* spp. The adults of two other genera of Scarabaeidae with larvae that feed on roots in grassland, *Amphimallon* and *Melolontha*, congregate in woodland, so they have been excluded. Under conditions of closed woodland their value is below 0.5% but it rises in open woodland. An open landscape of permanent grassland can give a value up to about 7% when the grassland is well-drained, but this falls to about 1% in ill-drained grassland. The abundance of these beetles would also be cut drastically by episodes of cultivation.

12. Heathland and moorland

This newly-created group comprises the chrysomelid beetle *Lochmaea suturalis*, which feeds on *Calluna vulgaris* (ling) and the curculionid *Micrelus ericae*, which feeds on *C. vulgaris* and *Erica* spp. (heather). These beetles are only present in acid landscapes but values can be up to 15%.

It would be possible to define species groups to cover other aspects of the environment, for example there is a distinct group of Coleoptera which occur in carrion and there are many species of beetle which just feed on *Urtica dioica* (stinging nettle). However, if too many minor categories are created, it will defeat the purpose of being a simple system applicable to most insect assemblages which clearly displays environmental trends.

Once an interpretive framework has been established using the percentage abundance of the various species groups, the mosaic approach can be used to fill in the details, For example, the percentage of Species Group 4 might be used to give an indication of the degree of tree cover while the host plant requirements of the phytophagous species would be used to establish the tree species. However, a check must be kept that the insect communities postulated are balanced and plausible.

There are relatively few urban insect assemblages which have been analysed from the Midlands Region and it was decided to present the data from them using the same species groups as for the rural sites. Although no problems were experienced with these sites, some modifications would be required to cope with the decomposer-dominated assemblages typical of medieval York and some other towns. A separate category would probably have to be created for *Aglenus brunneus*. *Oxytelus sculptus* perhaps needs to be placed in Species Group 7, while the status of *Xylodromus concinnus* and some species of *Anthicus* needs consideration.

As a final point about interpretation, it is worth repeating the statement of Buckland and Coope (1991, 11): "Despite the refinements that numerical approaches to the data may offer, there remains no substitute for a sound ecological knowledge of the animals concerned."

Survey of the Evidence

The review places the data within a chronological framework. Although it is mostly not possible to trace developments within individual geographically distinct parts of the region, it is still possible to relate many of the results to the wider aspects of landscape change within the region as a whole.

Late Glacial Background: Late Devensian Zone III (Loch Lomond Stadial, c. 11,000-10,000 BP)

Almost all the region was within the limit of maximum glacial advance, during the Anglian, and was just beyond the southern limit of the Late Devensian ice sheet. This resulted in an extensive cover of drift in the region. The seasonally very cold conditions followed by partial summer thaw during Late Devensian Zone III generated further sediment and gave river flow patterns conducive to the re-working of these sediments. Where rivers crossed regions of soft bedrock or drift, they created broad gravel floodplains across which many minor braided channels actively migrated. Lengths of channel would become cut off and fine sediments, in which insects are preserved, accumulated in them. The beds of these minor channels were often sealed by further gravel aggradation.

Other periglacial processes have resulted in the preservation of organic material containing insect remains in the region including sand blow, solifluction, the formation of ice features such as pingos and kettle holes, and the obstruction of drainage systems creating lakes.

Climate

Insect assemblages of this period indicate conditions with average summer temperatures around 10°C and average winter temperatures no warmer than -15°C (Atkinson *et al.* 1987). They comprise arctic faunas which today occur north of, or above, the tree line. Most of the species now occur in Northern Scandinavia and Arctic European Russia, some species being restricted to the Arctic Circle and perhaps a few mountain tops further south. A particularly rich sequence was investigated from organic muds (2.05 - 2.30 m depth) in a kettle hole at Rodbaston Hall, Staffs (Ashworth 1973). They accumulated between 10,670±130 BP (Y 464) and 10,300±170 BP (Birm-92) placing them firmly in the Late Devensian. There was a very high representation of the northern element of the fauna, with 30% of the individuals being from species which now commonly occur in boreal or montane regions although some are occasionally found in more southerly latitudes and lowland districts. The more numerous of these species included the beetles *Arpedium brachypterum* and *Boreaphilus henningianus*. Seventeen of the species of Coleoptera are now extinct in Britain (Table 1), ten, for example the water beetles *Colymbetes dolabratus*, *Helophorus fennicus* and *H. obscurellus* being restricted to north of the Arctic Circle except where they occur on mountain tops. A comparison was made with the present day coleopteran fauna of Scandinavia and a close similarity was found with the range of species which now occurs in the Torneträsk region of Arctic Sweden. The mean July temperatures in Torneträsk range from 10° to 13° and the mean January temperatures range between -12° to -13°. However, two of the species from Rodbaston Hall now extinct in Britain, *Chlaenius costulatus* and *Airaphilus elongatus*, have a more southerly modern distribution. While their continental distribution, *C. costulatus* for

Table 1: **Extinct Coleoptera from Late Devensian III sites in the Midlands Region**

	Rodbaston	West Bromwich E	West Bromwich F	Sproughton	Wilden	Church Stretton $RS_2$30-16 $CS_2$1	Birmingham Moat	West Cotton
Radiocarbon date BP	between 10,300±170 10,670±130	10,025±100	9970±100	below 9880±120	9830±350 9860±240 9930±220	11,048±376		
Data from:	1	2	2	3	4	5	6	7
Carabus convexus L.	+	-	-	-	-	-	-	-
Diacheila arctica Gyl.	+	-	+	-	-	-	-	-
Dyschirius septentrionum Munst.	-	-	-	-	+	-	-	-
Bembidion dauricum Mots.	-	-	-	-	-	+	-	-
Agonum consimile Gyl.	+	-	-	-	-	-	-	-
Amara torida Ill.	+	-	-	-	-	-	-	-
Chlaenius costulatus Mots.	+	-	-	-	-	-	-	-
Ilybius angustior Gyl.	+	-	-	-	-	-	-	-
Colymbetes dolabratus (Pk.)	+	-	-	-	-	-	-	-
C. striatus L.	+	-	-	-	-	-	-	-
Helophorus fennicus Pk.	+	-	-	-	-	-	+	-
H. glacialis Villa	-	-	-	+	+	+	-	+
H. obscurellus Popp.	+	-	-	-	-	-	-	-
H. sibiricus Mots.	-	+	-	-	-	-	+	-
Pycnoglypta lurida Gyl.	-	-	-	-	-	-	+	-
Olophrum boreale Pk.	+	+	-	+	+	-	+	-
Acidota quadrata Zett.	+	+	-	-	+	-	+	-
Boreaphilus henningianus Sahlb.	+	+	-	-	+	+	+	-
Simplocaria metallica Sturm.	+	-	-	-	-	-	-	-
Hypnoidus rivularis (Gyl.)	-	-	-	-	-	+	-	-
Airaphilus elongatus Gyl.	+	-	-	-	-	-	-	-
Hippodamia arctica Sch.	-	-	-	+	-	-	-	-
Anthicus ater Pz.	-	-	-	-	+	-	-	-
Adoxus obscurus L.	+	-	-	-	-	-	+	-
Chrysomela collaris L.	+	-	-	-	-	-	-	-
Rhynchaenus flagellum Er.	-	-	-	-	-	-	+	-

1. Ashworth (1973), 2. Osborne (1980a), 3. Rose *et al.* (1980),
4. Shotton and Coope (1983), 5. Osborne (1972), 6. Osborne (1978-79),
7. Robinson (1992a).

example now being found no further west than Szcezcin, in Poland, indicates they can tolerate extremely cold conditions, their presence serves as a reminder that Late Devensian Zone II climate in the English Midlands was not simply the modern conditions of Arctic Sweden moved further south.

Somewhat similar cold-indicative insect assemblages including arctic species now extinct in Britain (Table 1) have been discovered throughout the region:

West Bromwich, Staffs	10,025±100 BP (IGS-C14/79: St.3686) 9970±100 BP (IGS-C14/12: St.3060)	Osborne 1980a
Sproughton, Suffolk	below 9880±120 BP (HAR-259)	Rose *et al.* 1980
Wilden, Worcs	9830±350 BP (Birm-1019) 9860±240 BP (Birm-907) 9930±220 BP (Birm-905)	Shotton and Coope 1983
Church Stretton, Salop	11,048±376 BP (Birm-9)	Osborne 1972
Birmingham, Warks		Osborne 1978-79
West Cotton, Northants		Robinson 1992a

Such faunas were also widespread in Southern England at this time (Osborne 1976; Robinson 2002) while an arctic fauna dated to 10,550±250 BP (Birm-707) was recorded just to the north of the region at Messingham, Humberside (Buckland 1982).

Site Conditions and Vegetation

The insect faunas were all characteristic of harsh, unstable and sparsely vegetated as well as cold environments. *Helophorus glacialis*, a small water beetle of snow meltwater pools, was identified from four of the sites (Table 1). The occurrence of the elmid beetles *Elmis aenea* and *Normandia nitens* in cold Late Devensian deposits in a pingo at Boxmoor, Herts (Robinson, unpublished dd) suggested episodes of general surface flow, perhaps of meltwater, which linked it to the local stream system. The deposits in which the insect remains accumulated had marginal reedswamps of Cyperaceae (sedges, bulrush etc) as shown by numerous examples of *Plateumaris sericea* at Rodbaston Hall and *Limnobaris pilistriata* at both Rodbaston Hall and West Bromwich. Decaying plant debris along the margin of the water tended to support staphylinid beetles, such as *Arpedium brachypterum*, which is now a northern species. Another northern species from some of the sites, *Otiorhynchus nodosus*, is characteristic of sparse low-growing weeds and moss. Various of the beetles from the sites are associated with low-growing arctic shrubs, for example the ladybird *Hippodamia arctica* from Sproughton while *Chrysomela collaris* from Rodbaston Hall on *Salix repens* (creeping willow) and the *Salix lanata* group (woolly willows). Scarabaeoid dung beetles which feed on the droppings of larger herbivores were rare on most of the sites. Larger numbers were present at Rodbaston Hall, but even there, they only comprised 1.4% of the total terrestrial Coleoptera.

Late Hunter-gatherers: Final Upper Palaeolithic and Mesolithic (Flandrian Zones I and II, 10,000-5500 BP, 4300 BC)

The conditions in the first half of the Flandrian were very much more stable than in the Late Devensian. River flow became confined to larger, incised channels. Some of the river systems of the Midlands Region with lowland catchments, for example the Nene, showed little channel migration. Reduced peak discharge in rivers tended to favour silting and abandonment of multiple channels. Organic sediments which accumulated in channels have proved a major source of insect remains. Some rivers with upland catchments, however, for example the Trent, had incised channels which actively migrated across their gravel floodplains, so that fine sediment of Flandrian date containing insect remains can sometimes be found within floodplain gravel terraces. Organic deposits continued to form in ice features such as kettle holes, which often show a transition from more mineral-rich sediments to peat at the beginning of the Flandrian. Peat also formed at sites where water seepage occurred or drainage was impeded. Lake sediments which have yielded pollen are known from East Anglia, for example Old Buckenham Mere, but their potential for the preservation of insect remains is uncertain. The rise in sea level consequent upon melting ice favoured the formation of coastal peats. These are now submerged or in inter-tidal localities. The largest of the areas of submerged peat is the Dogger Bank, which has been included in the Midlands Region because most finds of Dogger Bank "moorlog" (rafts of peat) have either been washed up on the coast of the region or have been caught in the nets of fishing vessels operating out of the region's ports.

Climate

Around 10,000 BP a major change occurred to the British insect fauna consequent upon a rapid climatic amelioration (Osborne 1976). Indeed the initial evidence for a very rapid rise in temperature, from the arctic conditions of Late Devensian Zone III to mean summer temperatures similar to those of the present day at the start of Flandrian Zone I over a period perhaps less than 50 years (less than the error on a radiocarbon date), came from a sequence of deposits at West Bromwich, Staffs (Osborne 1980a).

The sequence from the kettle hôle at Rodbaston Hall, Staff, continued into the Flandrian (Ashworth 1973). Northern species of insect declined above the level of the organic mud dated to 10,300±170 BP (Birm 92) and species which require arctic conditions were entirely absent from the very top of the organic mud. Mineral sedimentation gave way to peat formation and all Coleoptera from the peat, with the exception of *Airaphilus elongatus*, occur in Britain. *A. elongatus* occurs in southern and central Europe and some of the other beetles, for example the Carabidae *Bembidion fumigatum*, *B. octomaculatum* and *Acupalpus elegans* are confined to southern and eastern England. This might imply conditions that were at least as warm, if not warmer, than those in the Midlands today. Pollen analysis of the sequence showed the transition from Godwin Pollen Zones III to IV (Late Devensian III to Flandrian early I) to occur towards the bottom of the peat. However, the Coleoptera had indicated climatic amelioration lower down the profile within the organic mud. It was argued that when climatic conditions became favourable, certain insects were capable of responding by immigration more rapidly than were the plants.

Unfortunately, the Devensian-Flandrian transition at Rodbaston Hall was not closely dated. A series of radiocarbon-dated samples spanning this time from a peat bed resting on sands and gravels at West Bromwich, Staffs was, however, analysed for Coleoptera (Osborne 1980a). Although the assemblages were not as large as from Rodbaston Hall, they clearly showed the faunal change that occurred. Sample E, which was dated to 10,025±100 BP (IGS-C14/79: St.3686), had the full arctic fauna characteristic of Late Devensian Zone III. Species which no longer occur in Britain included *Helophorus sibiricus* and *Boreaphilus henningianus* (Table 1) while the species which still occur in Britain, for example *Arpedium brachypterum*, are confined to the north, predominantly on high ground. Next in the sequence was Sample F, which was dated to 9970±100 BP (IGS-C14/12: St.3060). Apart from a single exotic arctic species, *Diacheila arctica*, there was nothing left of the cold-indicative fauna of the previous sample, all the other species still occurring in Britain. All the species in this sample do now live in Scandinavia, some having a distinctly southerly distribution. The assemblages from Samples G and H were very small but the only non-British species was the ladybird *Coccinula quatuordecimpustulata*, which is of widespread distribution in temperate Europe. Radiocarbon dates of 9640±100 BP (IGS-C14/80: St.3698), 9305±110 BP (IGS-C14/81: St.3697) and 9450±100 BP (IGS-C14/82: St.3693) were obtained on the next part of the sequence, Samples IJK and L. Although the assemblages were small, they included a thermophilous woodland element with tree-dependent species such as *Cerylon histeroides*. The only species which are now restricted to a northern distribution in Britain, *Melolontha hippocastani* and *Scolytus ratzeburgi*, occurred much further south in the mid-Flandrian, *S. ratzeburgi*, for example, formerly occurring in the Somerset Levels (Girling 1977b). The top of the sequence, samples M and N, was dated to 9080±455 BP (IGS-C14/83: St.3688). The fauna was suggestive of temperatures similar to those of the West Midlands at present, some species, for example *Plateumaris braccata* not occurring in the northern half of Britain.

A couple of other small coleopteran assemblages from the region have been dated to the start of Flandrian Zone I. The Northern British species *Arpedium brachypterum* and *Notaris aethiops* were identified from a peat level at Leicester dated to 9920±100 BP (HAR-4260) but exotic arctic species were absent (Shackley and Hunt 1984-5). In contrast, no cold element was present in a reedswamp deposit of the River Wensum at Fishergate, Norwich which was dated to 9410±110 BP (HAR-7062) (Kenward and Allison 1994a).

The only two samples with faunas that were apparently climatically intermediate, West Bromwich Sample F and the Leicester deposit, gave radiocarbon dates which were very similar: 9970±100 BP and 9920±100 BP. Osborne (1980a) was of the opinion that the solitary arctic individual in West Bromwich Sample F was from the very bottom of the sample and that the climatic transition was very abrupt. It is also possible that the Leicester deposit contained a full arctic fauna but the exotic species had not been recognised. Even if both assemblages did represent true intermediate faunas, the insect evidence still suggested a climatic warming very much more rapid than that suggested by the evidence of tree pollen, The insect evidence for a rapid rise in temperature around 10,000BP is now supported by other lines of evidence, both biological and physical. The reason that insects were able to respond promptly to climatic warming, in comparison with the trees, is that many insects can colonize simple habitats and have good long-range dispersive powers and a short gestation time.

None of the more recent insect assemblages from Flandrian Zones I and II give convincing evidence that the climate was any different from that of the present day. Some contain species which are now very rare or extinct in Britain but in all cases explanations for their decline can be found in the human activity of Flandrian Zone III (the Neolithic onwards). This is not to say that there were not minor climatic fluctuations following the rapid amelioration at the start of Flandrian Zone I and the results do not conflict with the concept of a "Mid Flandrian Climatic Optimum".

Woodland Development and Succession

Attention was first drawn to the development of the Flandrian woodland fauna of the Midlands Region by Osborne (1965). Insects dependent on arctic shrubs were already present in the region at the end of the Devensian. The woodland succession of the Flandrian was reflected not just in the arrival of host-specific tree-feeding insects as their host trees colonised but in the occurrence of specialised insects of over-mature trees and esoteric dead-wood habitats as woodland matured. Many of the latter have poor dispersive powers and were dependent on almost continuous tree cover from Continental Europe to England prior to the severance of land connections around 8500 BP. Indeed there is a record of one of these species from the North Sea banks (see below).

The harsh conditions of the new sediments upon which soils began to develop at the start of the Flandrian was shown by the beetle fauna from West Bromwich Sample F, which was dated to 9970±100 BP (Osborne 1980a). It included the halophytic carabid beetle *Bembidion aeneum*, which is now found on the sea shore and the banks of estuaries. Its occurrence inland was probably a reflection of the unleached state of the soil. Tree and shrub-dependent Coleoptera were absent from Sample F at West Bromwich, making their first appearance in Sample I, which pre-dated 9640±100 BP. In Samples I to L 8% of the terrestrial Coleoptera were wood and tree-dependent individuals of Species Group 4 (Fig. 2). They included *Scolytus ratzeburgi*, a bark beetle which is exclusively found on *Betula* spp. (birch). Species Group 4 rose to 9% of the terrestrial Coleoptera from Samples M and N, which were dated to 9080±455 BP. The scolytid *Hylastes brunneus* suggested that *Pinus sylvestris* (Scots pine) was becoming established while beetles such as *Melasis buprestoides* showed that the habitat of rotten hardwood was becoming available. Tree cover at West Bromwich was, however, by no means complete, weevils from the genus *Apion* suggesting the presence of light-demanding herbaceous vegetation.

A rich Flandrian early Zone I woodland insect fauna was discovered from an organic, probably backswamp, deposit over the gravels of the River Tame at Lea Marston, Warwickshire (Osborne 1974). It gave the following radiocarbon dates:

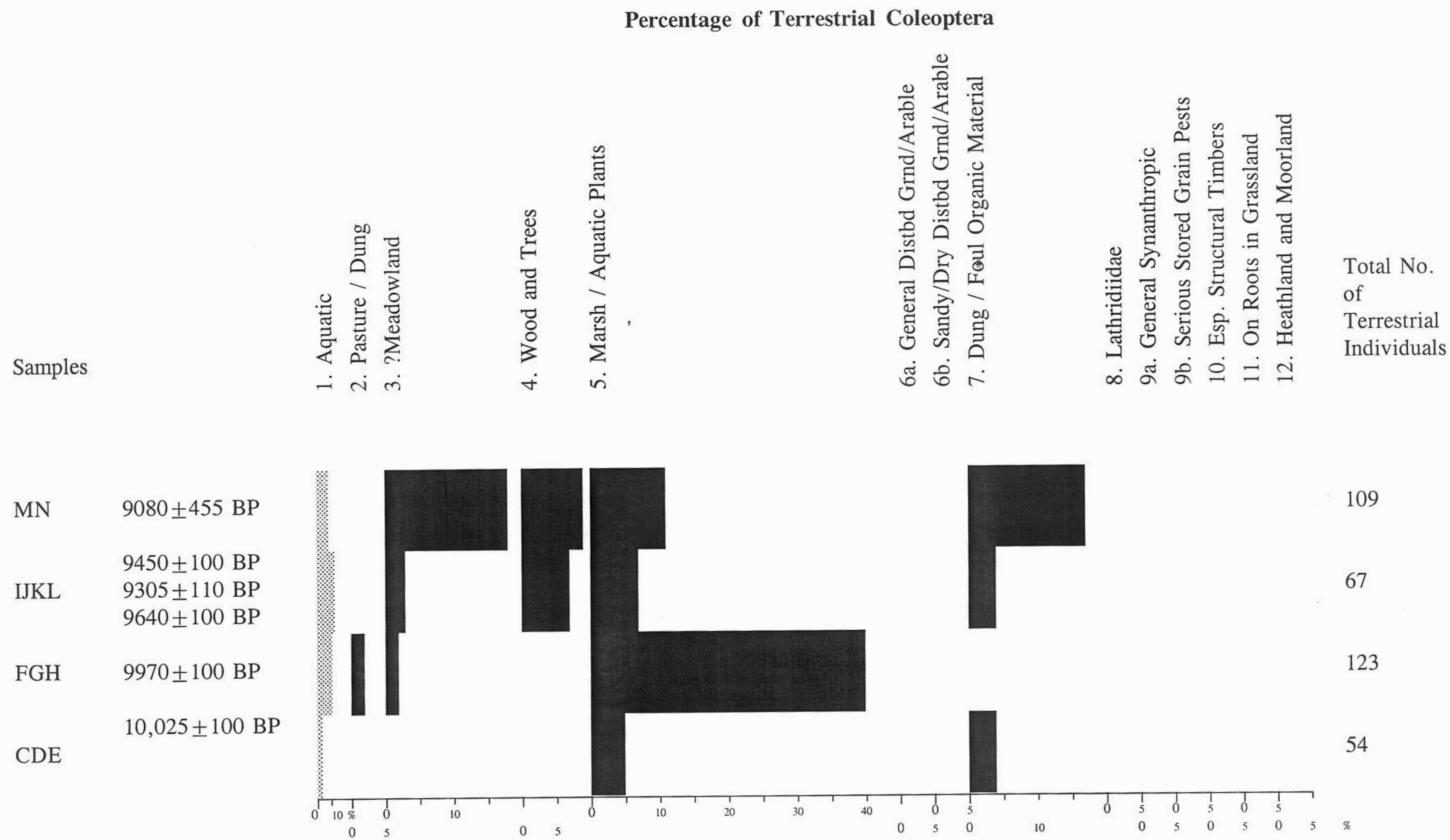
9550±200 BP (Birm-312)	9450±90 BP (Birm-329)
9510±235 BP (Birm-215)	9420±200 BP (Birm-311)
9470±200 BP (Birm-310)	

The more host-specific of the tree and shrub-feeding species included:

Phyllodecta vulgatissima	on	*Salix*
Chalcoides sp.	on	*Populus* and *Salix* spp. (poplar and willow)
Rhynchaenus rusci	on	*Betula* sp. (birch)
Scolytus rugulosus	on	Rosaceae (hawthorn, sloe, rowan etc)

By far the most numerous of these was *P. vulgatissima*.

The insect evidence for woodland composition was very much supported by the pollen results, with pollen of *Salix* predominating followed by pollen of *Betula* sp. Pollen of *Corylus avellana*



Species groups expressed as a percentage of the total terrestrial Coleoptera (ie aquatics excluded). Not all the terrestrial Coleoptera have been classified into groups.

Fig. 2: **Species Groups of Coleoptera from West Bromwich**

(hazel), *Quercus* sp. (oak) and more thermophilous trees was absent. This evidence included the predatory arboreal beetles *Calosoma inquisitor* and *Dendroxena quadrimaculata*, which feed on lepidopterous caterpillars. There was also a rich fauna of decaying wood including such conspicuous beetles as *Sinodendron cylindricum* and *Gnorimus nobilis*. Some have never been found living in Warwickshire, for example *Dorcatoma dresdensis*, while *Hylis cariniceps* is only known in Britain from the New Forest area and seems associated with ancient trees (Table 2). The weevils included *Cossonus linearis*, which lives in the rotten wood of old willows and poplars and is now very rare in Britain.

Although the deposit at Lea Marston dated from only 500 years after the end of the Late Devensian Zone III cold period, the non-host specific part of the woodland fauna showed greater similarity to the present day fauna of the New Forest rather than the modern fauna of boreal willow/birch woodland. The Scandinavian ranges of all 120 of the beetle species was compared with the vegetation zones of that region and over 90% are found today in the *Fagus* (beech) zone, in the extreme south. Fewer than 50% occur in the area of willow, birch and conifers to the north of the *Quercus* zone. These results show the rapidity with which woodland insects were able to respond to the climatic amelioration, limited only by the availability of suitable host trees.

Tree cover at Lea Marston was, however, by no means complete. The Coleoptera included a significant grassland element with the chafer *Serica brunnea* and the elaterid *Agrypnus murinus* present. The occurrence of the weevil *Micrelus ericae*, which feeds on *Calluna vulgaris* and *Erica* spp. (heathers) suggested some heathland vegetation, while a meadow-like element was suggested by *Cyphocleonus trisulcatus*, a weevil now extinct in Britain that feeds on *Leucanthemum vulgare* (ox-eye daisy) and *Apion craccae*, a weevil that feeds on vetches such as *Vicia cracca*. Vegetation cover appears to have been incomplete, with *Opatrum sabulosum* favouring sandy and gravelly exposures. There was no evidence that the open areas resulted from grazing pressure, remains of scarabaeoid dung beetles which feed on the droppings of larger herbivores being sparse. It is thought more likely that the bare terrace gravels of the River Tame presented a rather hostile environment at the beginning of the Flandrian upon which vegetation only slowly became established. Even after 500 years, succession to woodland was not complete. It is possible that the dynamic nature of the floodplain resulted in surface instability to the gravel.

Trees also became established on what is now the bed of the North Sea, before its submergence. Pollen analysis of peats from the Dogger, Leman and Owen Banks have shown they formed in Flandrian early Zone I and a radiocarbon date of 8415±170 BP has been obtained on a sample (Godwin 1975, 24). An example of the beetle *Rhysodes sulcatus* was discovered in "moorlog", a lump of this peat, which had been washed up on the coast at Caister-by-Yarmouth (Blair 1935). *R. sulcatus* is an old woodland species which is associated with rotten trees. It still occurs in northern Italy and eastern Europe but has become extinct in Southern Sweden and Germany since the 19th century.

Insects have been investigated from four other Flandrian Zone I sites in the region. Flandrian early Zone I sediments in the palaeochannel of a stream at Stebbingford, Essex contained remains of the leaf beetles *Phytodecta pallida* and *P. viminalis* which showed the presence of *Salix* sp. (willows) (Robinson 1996a) . In contrast, tree and wood-dependant insects were absent from deposits at Alcester, Warwickshire, on the floodplain of the River Alne, which gave

Table 2: "**Old Woodland" Coleoptera from the Midlands Region**

Period:	Early Mesolithic				Late Mesolithic				Neolithic										Early Bronze Age		Late Bronze Age	
	West Bromwich	Lea Marston	Bole Ings	North Sea Peat	Alcester	Bournville	Bole Ings	Misterton Carr	Shustoke A	Bole Ings	Worldsend	Redlands Farm	West Cotton	Godmanchester Cursus	Godmanchester Pits	Etton Causewayed Camp	Etton Woodgate	Isleham	Bole Ings	Ramsey Heights	Feltwell Anchor	Flag Fen
Data from:	1	2	18	3	4	5	18	6	7	18	8	9	10	11	11	12	13	14	18	15	16	17
* *Rhysodes sulcatus* F.	-	-	-	+	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-
* *Valgus hemipterus* (L.)	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-
* *Porthmidius austriacus* (Schr.)	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-
Dromaeolus barnabita (Villa)	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hylis cariniceps (Reit.)	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gastrallus immarginatus (Müll.)	-	-	-	-	-	-	-	-	-	-	-	-	+	-	+	-	-	-	-	-	-	-
Colydium elongatum (F.)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	+	-	-	-	-	-
Teredus cylindricus (L.)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-
* *Cerambyx cerdo* L.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	+	-	-
* *Agelastica alni* (L.)	-	-	-	-	-	-	-	-	-	-	-	-	+	-	+	+	+	-	-	-	+	+
* *Rhynchites auratus* (L.) or *bacchus* (L.)	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cossonus linearis (F.)	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
* *Eremotes elongatus* (Gyl.)	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-
* *E. strangulatus* Perris	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-
Dryophthorus corticalis (Pk.)	-	-	-	-	-	-	-	-	+	-	+	-	-	-	-	-	-	-	-	-	+	-
* Cossoninae indet.	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ernoporus caucasicus Lind.	-	-	-	-	+	+	+	+	+	-	-	-	-	+	+	-	-	-	+	-	-	-

* Now extinct in Britain

1. Osborne (1980a), 2. Osborne (1974), 3. Blair (1935), 4. Osborne (1965), 5. Greig (1982), 6. Greig (1982); Girling (1982), 7. Kelly and Osborne (1963-64), 8. Osborne (1972), 9. Robinson (unpublished a), 10. Robinson (unpublished b), 11. Robinson (unpublished c), 12. Robinson (1998), 13. Robinson (unpublished d), 14. Duffey (1968); Buckland and Kenward (1973), 15. Harding and Plant (1978), 16. Robinson (unpublished e), 17. Robinson (1992b); Robinson (unpublished f), 18. Brayshay and Dinnin (1999).

There is also a Roman record of *E. caucasicus* from the Empingham Villa (Buckland 1986).

radiocarbon dates of 8480±140 BP (Birm-709), 7450±500 BP (Birm-694) and 7440±200 BP (Birm-680) (Shotton *et al.* 1977). However, the assemblages largely comprised marsh and aquatic species. Insects were investigated from three sites in the Church Stretton Valley, Shropshire, below The Long Mynd (Osborne 1972). The bottom of one of the organic sequences, at Little Stretton, was dated to 8101±138 BP (Birm-8). The series of samples from Sample 1 to Sample 7 probably spanned the second half of Flandrian Zone I. The wood and tree-dependent Coleoptera of Species Group 4 comprised about 17% of the terrestrial Coleoptera from these samples (Fig. 3). The first insect evidence for the occurrence of *Quercus* sp. was provided by *Rhynchaenus quercus* (oak leaf weevil). A second thermophilous tree suggested by the insects was *Fraxinus excelsior* (ash), the usual host of *Leperisinus varius* (ash bark beetle). However, another bark beetle, *Hylastes ater* showed some *Pinus sylvestris* (Scots pine) remained. The presence of dead wood was shown by beetles such as *Grynobius planus* and *Alosterna tabacicolor* but there was not a distinctive old woodland element to the fauna. Tree cover of the terrestrial landscape was likely to have been complete.

A long sequence of organic sediments, beginning at 8240±60 BP (Beta-75273), was investigated from the floodplain of the River Trent at Bole Ings, Notts (Brayshay and Dinnin 1999) . The insects suggested that the developing woodland of Flandrian Zone I contained three main canopy-forming elements. Beetles associated with conifers, such as the pine-shoot feeding weevil *Hylobius abietis*, were perhaps from *Pinus sylvestris* (Scots pine) growing on gravel ridges on the floodplain, while beetles associated with deciduous trees, such as the acorn-feeding weevil *Curculio villosus*, were from woodland elsewhere on the floodplain. Poplar and willow-leaf feeding beetles, such as *Chalcoides fulvicornis* and *Phyllodecta vulgatissima*, suggested open pioneer woodland, along the wetland margins to the river. There was a record of the weevil *Rhynchites auratus* or *bacchus* which is associated with the fruit of rosaceous shrubs, both species now being extinct in Britain. The saproxylic (dead wood) insect community was initially restricted, but beetles such as *Melasis buprestoides* and *Tomoxia biguttata* suggested very rotten wood associated with fungi.

Before 6290±70 BP (Beta-75272), the dead-wood community at Bole Ings had become more diverse and included *Dromaeolus barnabita*, which is now extinct in Britain. By Flandrian Zone II, changes had occurred to the floodplain woodland. The occurrence of *Chrysomela aenea* after 6290 BP probably reflected the displacement of *Salix* sp. (willow) by *Alnus glutinosa* (alder) on the wettest parts of the floodplain. The addition of *Tilia cordata* (small-leaved lime) to the mixed deciduous woodland of the remainder of the floodplain was suggested by the small scolytid *Ernoporus caucasicus*. *Hylesinus oleiperda*, a bark beetle of *Fraxinus excelsior* (ash), was also recorded.

The next five samples in the series from Little Stretton (Samples 8 to 12) spanned Flandrian Zone II. Although wood and tree-dependent beetles of Species Group 4 fell to 8% of the terrestrial Coleoptera, this was probably a reflection of an increase in wetland habitats rather than an opening of the tree canopy. There was a continued presence of oak as suggested by the weevil *Rhynchaenus quercus*.

Little other evidence is available for Flandrian Zone II woodland in the region. A deposit near Little Stretton at Church Stretton, Site RS_2 (Osborne 1972) contained small assemblages of this date, with for example, the dead-wood feeding beetle *Grynobius planus*. There are several other records of *Ernoporus caucasicus* but the published dates and localities for them are not entirely

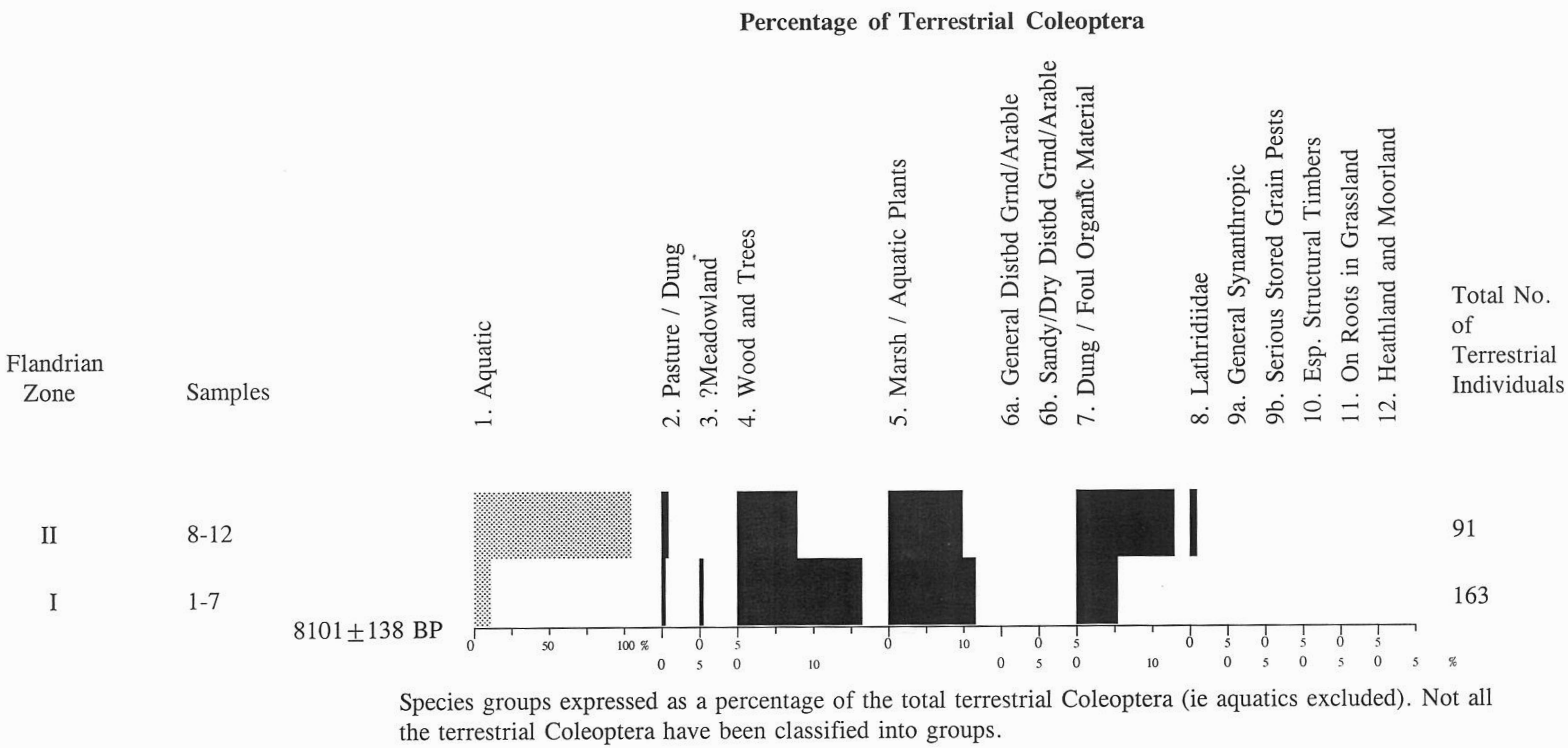


Fig. 3: **Species Groups of Coleoptera from Little Stretton**

satisfactory (Alcester, Warks, "before the Neolithic forest clearance" Osborne 1965; Bournville, Warks Greig 1982; Misterton Carr, Notts, "Pollen Zone VIIa" Greig 1982 but Girling 1982 gives Misterton Carr as Bronze Age). The significance of this beetle is that it is dependant on *Tilia cordata* (small-leaved lime), the predominant tree of much of the woodland which covered the region during Flandrian Zone II (Pollen Zone VIIa or Atlantic (Greig 1982)). *E. caucasicus* is now restricted to a few old parkland and woodland trees in the Midlands.

Open Habitats and Human Activity

The occurrence of beetles of open habitats at West Bromwich and Lea Marston during Flandrian early Zone I has already been mentioned. The early Post-Glacial open area which dated from before complete tree cover had become established, were, with their immature soils, probably more similar to recently abandoned mineral workings than prehistoric agricultural clearances. These somewhat different conditions were perhaps the reason for the occurrence at Lea Marston of three species of beetle which are now extinct in Britain: the ladybird *Coccinula quatuordecimpustulata*, the lathridiid *Leucohimatium* sp. and the weevil *Cyphocleonus trisulcatus* (Table 3). It is, however, also possible that they were unable to survive the woodland conditions of the mid Flandrian and have been unable to recolonise.

Grassland persisted on parts of the Trent floodplain at Bole Ings throughout the second half of Flandrian Zone I and, at a reduced level, in Flandrian Zone II (Brayshay and Dinnin 1999). The weevils *Ceuthorhynchidius troglodytes* and *Gymnetron pascuorum*, which are both restricted to feeding on *Plantago lanceolata* (ribwort plantain), as well as the chafer beetles *Serica brunnea* and *Phyllopertha horticola* were present in the deposits between 8240±60 BP (Beta-75273) and 6290±70 BP (Beta-75272). It is likely that the migration of channels of the Trent created open areas on the floodplain.

There was no evidence from insect assemblages for human activity during either Flandrian Zone I or Zone II. Scarabaeoid dung beetles of Species Group 2 tended to comprise no more than 1% of the terrestrial Coleoptera which is what would be expected if only wild herbivores were present.

Marsh, Fen and Aquatic Habitats

Insects of aquatic and waterside habitats were, as might have been anticipated, major components of all the Flandrian Zone I and Zone II insect assemblages. These species, for example, were the most important elements in the coleopteran fauna from Alcester (Shotton *et al.* 1977). They involved carabidae of the water's edge, such as *Elaphrus cupreus* and weevils of marsh or swamp vegetation, such as *Limnobaris pilistriata*, which feeds on Cyperaceae (sedges and bulrushes) as well as water beetles, for example *Hydraena riparia*. All the species named were also found at Lea Marston (Osborne 1974). The occurrence of *Donacia impressa* suggested that the palaeochannel of the Tame at Lea Marston was formerly lined with reedswamp of *Schoenoplectus lacustris* (bulrush) while *Tanysphyrus lemnae*, which feeds on *Lemna* sp. (duckweed), suggested that there were times when the flow of water in the channel was sufficiently slow for this minute floating-leaved plant to carpet the surface. However, there was also a strong presence of elmid beetles, which require clean, well oxygenated moving water. They included species which are so fastidious in their requirements that if they occur at all in major rivers in the region, they are restricted to weir outflows and the fast-flowing headwaters or tributary streams. One of the elmids from Lea Marston, *Stenelmis canaliculata*, was only added to the British list about 30 years ago when it was discovered living in Lake

Table 3: **Miscellaneous Extinct and Extremely Rare Coleoptera from the Midlands Region**

Period:	Early Mesolithic			Late Mesolithic	Neolithic		Middle Saxon
	West Bromwich	Lea Marston	Alcester	Church Stretton RS_2	Godmanchester Cursus	Godmanchester Pits	West Cotton
Data from:	1	2	3	4	5	5	6
* *Coccinula quatuordecimpustulata* (L.)	+	+	-	-	-	-	-
* *Leucohimatium* sp.	-	+	-	-	-	-	-
Otiorhynchus ligustici (L.)	-	-	-	+	+	+	+
* *Cathormiocerus validiscapus* Roug.	-	-	+	-	-	-	-
* *Cyphocleonus trisulcatus* (Hbst.)	-	+	-	-	-	-	-

* Now extinct in Britain

1. Osborne (1980a), 2. Osborne (1974), 3. Shotton *et al.* (1977), 4. Osborne (1972), 5. Robinson (unpublished c), 6. Robinson (unpublished x).

Windermere (it is a distinctive, medium-sized beetle). It has subsequently been found in the upper reaches of the Severn drainage system (Table 4). Another, *Macronychus quadrituberculatus*, now only occurs in the upper reaches of the Trent basin. Its larvae feed on decaying submerged wood in flowing water, so it would be very much favoured by a wooded river bank. Both *S. canaliculata* and *M. quadrituberculatus* were also identified from deposits on the Trent floodplain at Bole Ings (Brayshay and Dinnin 1999).

Extensive freshwater fen prevailed in parts of what are now the North Sea in Flandrian early Zone I. Four species of donaciine chrysomelid beetle and at least four other species of fenland beetle were identified from blocks of "moorlog" dredged from the Dogger Bank (Whitehead and Goodchild 1909-11; Whitehead 1918-21). They included *Donacia clavipes*, which feeds on *Phragmites australis* (common reed) and *Plateumaris affinis*, which feeds on *Carex* spp. (sedges) and *Iris pseudacorus* (yellow flag). There were also Carabidae of peaty substrates including *Chlaenius tristis*, which until recently was thought extinct in Britain.

Discussion

The Mesolithic was characterised by the very rapid displacement of arctic faunas by temperate insects at the start of Flandrian Zone I. Only 500 years after the onset of climatic warming, a thermophilous woodland fauna was present in the region which might now seem appropriate to the New Forest and included some species which are typical of old woodland with much dead wood. As woodland succession took place, so new host-specific tree-feeding Coleoptera arrived in the region. No large Flandrian Zone II assemblage has yet been investigated, so the full range of the woodland fauna remains to be established. However, there are already records both of species which are very rare in Britain and species which are now extinct. The rising sea level of the Post-Glacial caused the drowning of extensive fenland in the North Sea off what is now the east coast of the region. The fauna of this area is also likely to have included insects which are now extinct in Britain. No insect evidence has yet been found for climatic change other than at the very start of the period or of human activity in the region during the Mesolithic.

Table 4: **Rare and Extinct Wetland and Aquatic Species from the Midlands Region**

Period:	Early Mesolithic						Late Mesolithic		Neolithic			Early/Middle Bronze Age		Late Bronze Age		Roman		Medieval
	Fishergate Norwich	Dogger Bank	Lea Marston	West Bromwich	Rodbaston	Bole Ings	Bole Ings	Little Stretton	Shustoke A	Worlds end	West Cotton	Holme Fen	Aston Mill	Flag Fen	Pilgrim Lock	Stour port	Droit wich	Austin Friars Leicester
Data from:	1	2	3	4	5	16	16	6	7	6	8	9	10	11	12	13	14	15
Trechus rivularis (Gyll.)	+	-	+	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-
Pterostichus aterrimus (Hbst.)	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-
Chlaenius tristis (Schal.)	-	+	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-
Hydroporus scalesianus Step.	-	-	-	-	-	-	-	+	-	+	-	+	-	-	-	-	-	-
Agabus wasastjernae Sahl.	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-
* *Gyrinus colymbus* Er.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+
Helophorus arvensis Muls.	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-
Hydrophilus piceus (L.)	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-
Hydrochara caraboides (L.)	-	-	-	-	-	-	+	-	-	-	-	-	+	-	-	-	-	-
Micropeplus caelatus (Er.)	-	-	+	-	-	-	-	-	-	-	+	-	-	+	-	-	-	-
Helichus substriatus (Müll.)	-	-	-	-	-	-	-	-	+	-	+	-	-	-	-	+	-	-
Macronychus quadrituberculatus Müll.	-	-	+	-	-	+	+	-	-	-	+	-	-	-	+	+	-	-
Stenelmis canaliculata (Gyll.	-	-	+	-	-	+	+	-	-	-	+	-	-	-	+	-	-	-
* *Airaphilus elongatus* Er.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	-

* Now extinct in Britain

1. Kenward and Allison (1994a), 2. Whitehead and Goodchild (1909-11), 3. Osborne (1974), 4. Osborne (1980a), 5. Ashworth (1973), 6. Osborne (1972), 7. Kelly and Osborne (1963-64), 8. Robinson (unpublished a), 9. Robinson (unpublished g), 10. Whitehead (1989), 11. Robinson (unpublished f), 12. Osborne (1988), 13. Osborne (1995), 14. Osborne (1973), 15. Girling (1981) 16. Brayshay and Dinnin (1999).

The Rise of Agriculture: Neolithic to Middle Bronze Age (Flandrian Early Zone III, c. 4300-1500 BC)

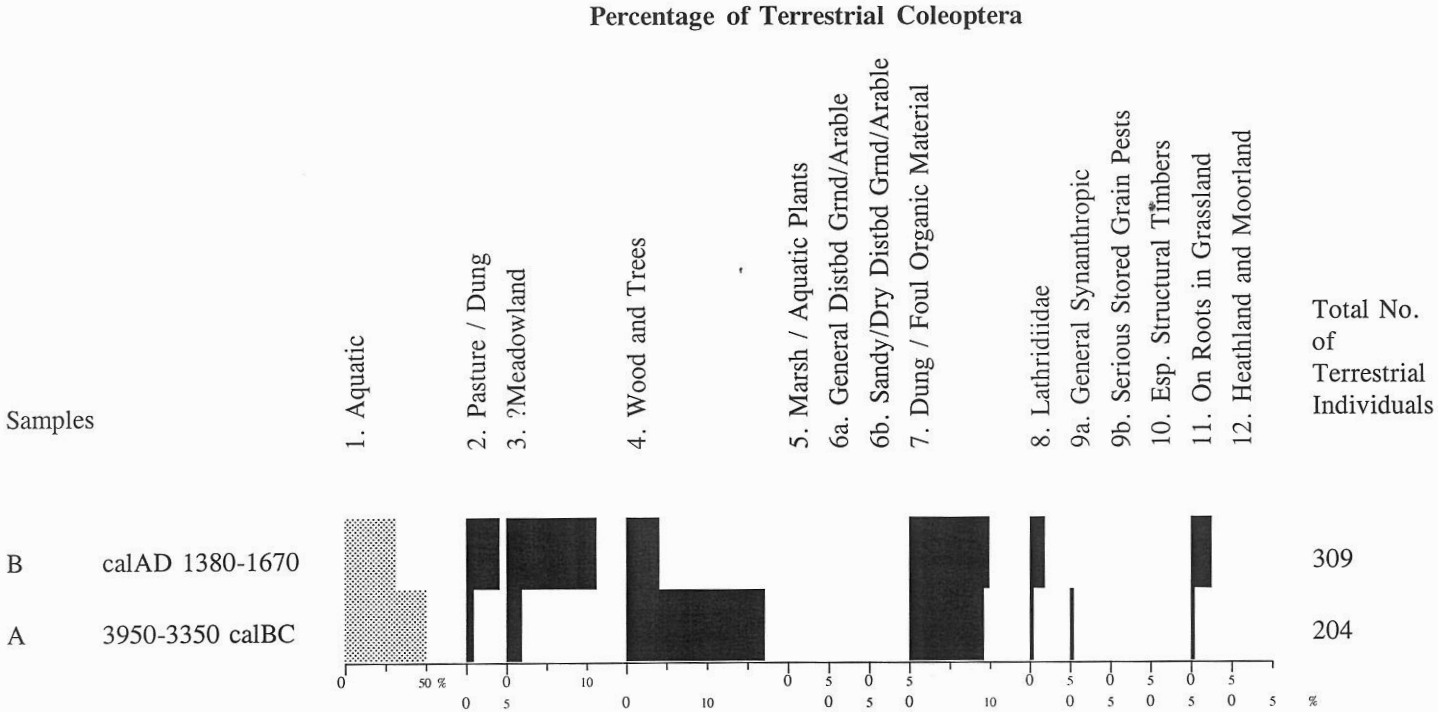
The event which defines the boundary between Flandrian Zones II and III is the Elm Decline, which is shown in pollen diagrams at around 4000 BC (see above). It is manifest as a decline in elm pollen values by about 50%. After the Elm Decline, some pollen diagrams show evidence of an opening of the tree canopy and a few have evidence suggestive of Neolithic agricultural activity. Thereafter, clearances are likely to occur. However, it is believed that the transition from the Mesolithic to the Neolithic occurred earlier and the date of 4300 BC has been taken for the start of the period. A date of 1500 BC has been taken for the onset of agricultural intensification which defines the following period.

The natural situations where insect remains tend to be preserved continued to accumulate organic sediments throughout the Neolithic and earlier Bronze Age other than that sedimentation tended to be complete in smaller glacial features such as kettle holes. Earlier Bronze Age palaeochannel sediments containing well-preserved insect remains have proved much more elusive than Neolithic sediments of this sort but they have been found. Although rising sea level resulted in the loss of the wetlands of the Dogger Bank in the previous period, it also served to impede drainage in East Anglia, resulting in the formation of the Fenlands. Other than during episodes of marine transgression, peat formation occurred throughout this period although the insects from natural deposits in the Fens have been little studied. Human activity also resulted in the preservation of insect remains in the bottoms of ditches and water holes, although such features have not commonly been recorded in the region.

The Neolithic to middle Bronze Age was a period when humans had a major impact on the insect fauna of the region, particularly with clearance and the introduction of domestic animals. This makes the interpretation of climatic evidence from insects even more difficult than it was during the previous period. Climate will therefore be considered after the details of human influence on the insect fauna have been presented. While there was certainly regional variation between insect assemblages, this was mostly due to clearance activity occurring earlier in some parts of the region than others, so the simple thematic structure will be retained for this chapter.

The Mesolithic / Neolithic (Flandrian Zone II / Zone III) Transition

Three sites in the region from which insects have been analysed had organic sedimentation occurring at around the period boundary of c. 4300 BC although none gave a good transitional sequence. By far the largest sequence was from Shustoke A, Warks from organic sediments of the River Bourne (Kelly and Osborne 1963-64). A radiocarbon date of 4830±100 BP, 3950-3350 calBC (NPL-39) was obtained on the sediments, while pollen analysis showed that the upper part of the 0.66m sequence spanned the Elm Decline. Unfortunately, the concentration of insect remains was insufficient for sequential analysis so the insects were studied as a single assemblage (Fig. 4). They very much comprised a woodland fauna, wood and tree-dependent Coleoptera of Species Group 4 comprising 17% of the terrestrial Coleoptera. The most numerous of these was the now very rare scolytid



Species groups expressed as a percentage of the total terrestrial Coleoptera (ie aquatics excluded). Not all the terrestrial Coleoptera have been classified into groups.

Fig. 4: **Species Groups of Coleoptera from Shustoke A + B**

beetle *Ernoporus caucasicus*, which feeds on *Tilia cordata* (small-leaved lime). Other host-specific Coleoptera included:

Chrysomela aenea	on	*Alnus glutinosa*	(alder)
Rhynchaenus salicis	on	*Salix* spp.	(willows)
Hylesinus crenatus	mostly on	*Fraxinus excelsior*	(ash)
Leperisinus varius	mostly on	*Fraxinus excelsior*	(ash)

These results suggested alder and willow growing on the floodplain alongside the river and lime woodland with a little ash growing on the higher ground. Pollen analysis confirmed this picture, adding *Quercus* sp. (oak) and *Ulmus* sp. (elm) to the trees of higher ground. The Coleoptera included many species from woodland habitats which together comprised a balanced woodland fauna. There was the ground beetle *Pterostichus oblongopunctatus*, which hunts amongst leaf litter, *Colenis immunda*, a fungal feeder which occurs in mouldy leaf litter and the weevil *Barynotus moerens*, which feeds on woodland herbs, especially *Mercurialis perennis* (dog's mercury). There were beetles which feed on wood in various stages of decay with a significant " old woodland" element. They included *Rhysodes sulcatus*, a beetle now extinct in Britain which occurs in decaying tree trunks and *Dryophthorus corticalis*, which lives in rotten wood often in association with the ant *Lasius brunneus*. *D. corticalis* is now only known in Britain from Windsor Great Park. *E. caucasicus* is a beetle of over-mature lime trees, particularly parkland pollards.

Although the pollen evidence showed the Shustoke A deposit spanned the Elm Decline, the insects gave no indication of any opening of the tree canopy. Scarabaeoid dung beetles of the genera *Geotrupes* and *Aphodius* only comprised 1% of the terrestrial Coleoptera. Bones of *Cervus elaphus* (red deer) and *Bos primigenius* (aurochs) confirmed the occurrence of large wild woodland herbivores on which these beetles were very likely to have been dependent. It is possible that a very few of the phytophagous Coleoptera, for example an individual of *Phyllopertha horticola*, were from grassy glades within the woodland but there was no evidence to relate them to human activity.

Two of the sites in the Church Stretton Valley, Shropshire, had organic sequences which spanned the Elm Decline, but the post-Elm Decline assemblages from them were small and not closely dated (Osborne 1972). At Little Stretton, there were a couple of scarabaeoid dung beetles from the top of the sequence but the results were not very informative. At Church Stretton RS_2, there was a continued presence of woodland species, for example *Anoplus roboris* which feeds on *Alnus glutinosa* (alder), *Tomicus minor* which is associated with Scots pine and *Pediacus dermestoides* which occurs under loose bark. However, there was a stronger presence of scarabaeoid dung beetles, particularly from the genus *Aphodius* but including both *Onthophagus fracticornis* and *O. similis*. These beetles were sufficiently abundant to suggest domestic animals in the vicinity while the occurrence of weevils from the genera *Apion* and *Sitona*, which feed on vetches and clovers, along with the leaf beetle *Hydrothassa marginella*, which feeds on *Ranunculus* spp. (buttercups), suggested some clearance had occurred. *O. fracticornis* is one of several species of scarabaeid dung beetles which occurred in the region during the Neolithic and Bronze Age but are now either very rare or extinct in Britain (Table 5). It is only known with certainty from two captures in the early years of the 20th century (Hyman 1992, 393; Robinson, unpublished h). While the changes at Church Stretton were very much what might have been expected with small-scale clearance at around the date of the Elm Decline, it is possible that this activity did not occur until much later, perhaps in the late Neolithic or earlier Bronze Age.

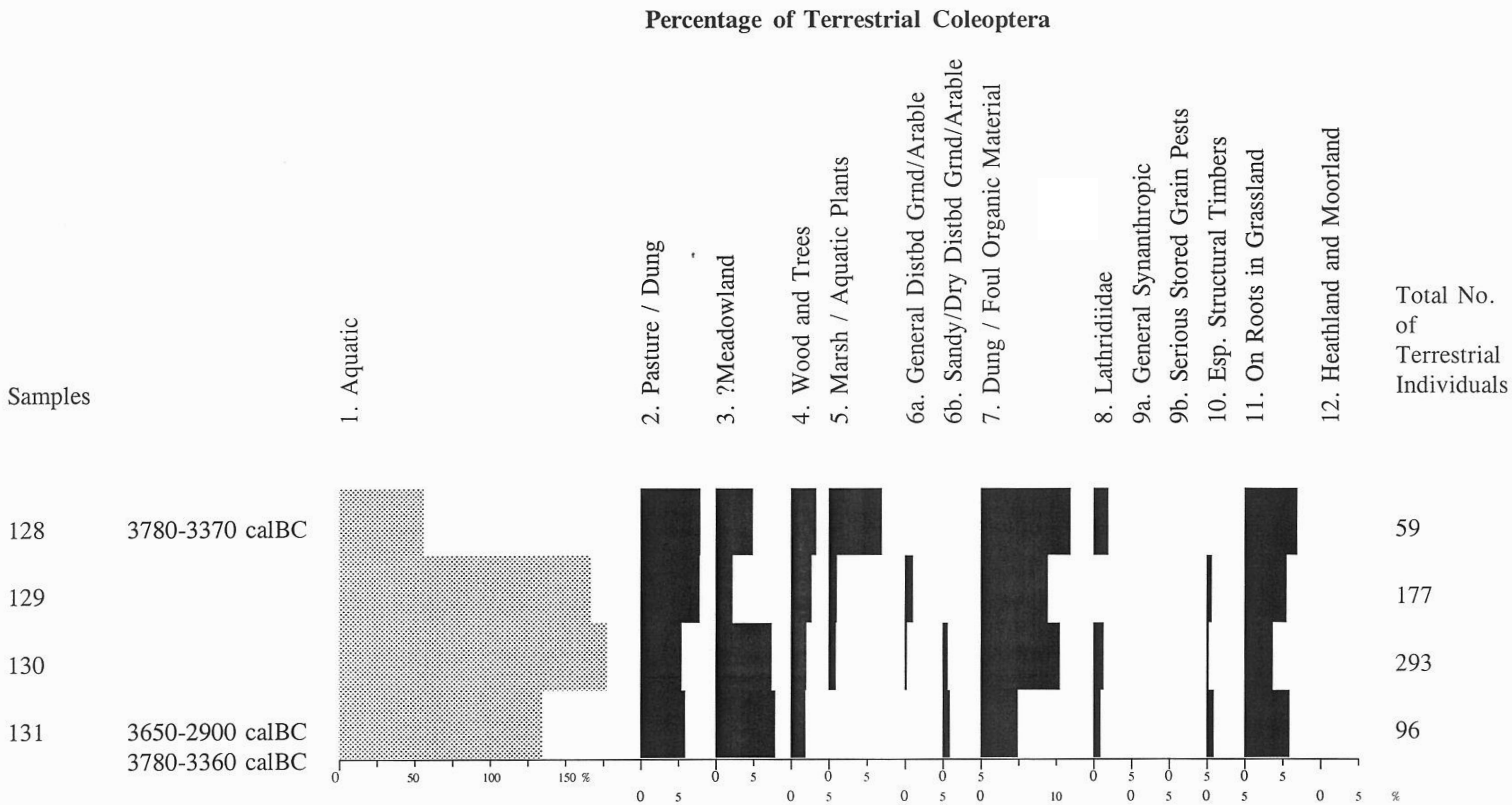
Woodland Survival, Clearance and Regeneration

In some parts of the region, for example the Church Stretton Valley, the insect evidence showed woodland retaining much of the character of Mesolithic woodland survived throughout the Neolithic and probably well into the Bronze Age. In other parts of the region, for example on the gravels of the River Nene, there were quite large clearances but until the Bronze Age there always seems to have been a background presence of woodland and in some instances regeneration occurred.

A third site in the Church Stretton Valley, at Worldsend, yielded a coleopteran fauna of undisturbed woodland dating to Flandrian Zone III (Osborne 1972). It was remarkable for the range of exotic, old woodland beetles that were present in a relatively small assemblage (Table 2). They included *Dryophthorus corticalis* and three species which are now extinct in Britain: *Porthmidius austriacus*, *Eremotes elongatus* and *E. strangulatus*. The last two species are dependent on pine or other conifers. Other pine-feeding beetles included *Tomicus minor* and *Pityogenes bidentatus*, suggesting that *Pinus sylvestris* (Scot's pine) survived on the slopes of the Long Mynd. There was also evidence for deciduous woodland with, for example, the weevil *Rhynchaenus quercus*, which feeds on the leaves of *Quercus* sp. (oak) and beetles which attack rotten hardwood, including *Melasis buprestoides*. There was no indication of any human disturbance to the woodland.

There was insect evidence for woodland at Bole Ings, on the Trent floodplain, until 2690±100 BP, 1200-500 calBC (Beta-75270) (Brayshay and Dinnin 1999). There was little evidence for human interference with the tree cover prior to 3570±70 BP, 2140-1740 calBC (Beta-75271) and the lime-dependent scolytid *Ernoporus caucasicus* was present. However, after this date there was more evidence for open areas and *E. caucasicus* was absent.

All the other Neolithic insect assemblages were from archaeological contexts, so gave evidence of human activities. Three groups of sites on river gravels in the East Midlands gave sequences which continued from the Neolithic into the Bronze Age: the Raunds area on the gravels of the River Nene, Northants, Godmanchester on the gravels of the Great Ouse, Cambs. and the Etton area on the gravels of the River Welland, Cambs. At Redlands Farm (South Stanwick), near Raunds, waterlogged organic sediments were discovered in the base of the ditches of a long barrow (Robinson, unpublished a). Radiocarbon dates of 4810±80 BP, 3780-3370 calBC (OxA 3001), 4790±90 BP, 3780-3360 calBC (OxA 3003) and 4560±140 BP, 3650-2900 calBC (OxA 3002) were obtained on the sediments in the southern ditch of the barrow. The insect sequence from this ditch (Fig. 5) showed that substantial clearance had occurred before the construction of the barrow. Wood and tree-dependent Coleoptera of Species Group 4 comprised 2.4% of the terrestrial Coleoptera. This perhaps reflected rather less than a quarter tree cover in the catchment although certainly more than just the presence of hedges. There was some evidence to suggest clearance could have been a recent event when the barrow was constructed. The wood and tree-dependent Coleoptera only included three species of rotten wood. Two of them, *Valgus hemipterus*, which is now extinct in Britain, and *Dorcus parallelipipedus*, are large, strong-flying Scarabaeoidea that are particularly associated with large rotten hardwood stumps. It is possible that these beetles were living in stumps left to decay after clearance.



Species groups expressed as a percentage of the total terrestrial Coleoptera (ie aquatics excluded). Not all the terrestrial Coleoptera have been classified into groups.

Fig. 5: **Species Groups of Coleoptera from Redlands Farm early Neolithic Long Barrow Ditch**

The long barrow at Redlands Farm formed the end of an alignment of monuments which ran for 2 km along the Nene Valley. At the other end of the alignment, at West Cotton, was a platform of cut alder branches. Insect remains were recovered from sediments associated with the platform and just predating it (Robinson, unpublished b). Radiocarbon dates of 4062±54 BP, 2870-2490 calBC (UB-3321) and 3990±54 BP, 2700-2300 calBC (UB-3319) were obtained on the platform while a date of 4268±32 BP, 2930-2770 calBC (UB-3419) was obtained on the earlier sediments. In contrast to Redlands Farm, over 7% of the terrestrial Coleoptera from the palaeochannel were the wood and tree-dependent members of Species Group 4. Many more of the insects were from woodland communities. These results would suggest that a substantial part of the catchment, perhaps between one third and a half, was wooded. The more host-specific amongst these beetles were dependent on the following trees:

Agelastica alni	on	*Alnus glutinosa* (alder) - leaves
Curculio cf. *nucum*	on	*Corylus avellana* (hazel) - nuts
C. pyrrhoceras	on	*Quercus* spp. (oak) - leaf galls
Rhynchaenus quercus	on	*Quercus* spp. (oak) - leaves
R. salicis	on	*Salix* spp. (willows) - leaves
Scolytus scolytus	mostly on	*Ulmus* spp. (elm) - under bark of dead branches
Kissophagus hederae	on	*Hedera helix* (ivy) - under bark of dead stems

Although fruits of *Tilia* sp. (lime) were present, the small, lime-feeding scolytid *Ernoporus caucasicus* was not found. There were also beetles that occur in different categories of dead and decaying wood, ranging from hard and dry through to soft and very rotten. They included *Melanotus erythropus*, *Gastrallus immarginatus* and *Thymalus limbatus*. The relative abundance of the various host-specific individuals and the occurrence of the Coleoptera of dead and decaying wood implied that much of the tree cover was from established alder and oak woodland rather than thorn or willow scrub. The remainder of the woodland fauna included *Calosoma inquisitor* and *Dendroxena quadrimaculata*, which hunt caterpillars in the tree canopy and *Apteropeda orbiculata*, which mostly feeds on *Ajuga reptans* (bugle) on the woodland floor. As is typical for Neolithic woodland insect assemblages, the West Cotton samples included Coleoptera which are now very rare or extinct in Britain. *G. immarginatus* is now restricted to Windsor Great Park and *A. alni* is apparently extinct. However, the site did not produce the great range of "old woodland" species associated with decaying wood that have been identified from some sites.

Although the Redlands Farm sequence was older than the assemblages at West Cotton, the main reason for the difference in representation of woodland insects between the two sites was probably due to catchment size rather than chronology. The catchment for the long barrow ditches would have been small and centred on the ditches. The catchment of the palaeochannel, however, would have been very much larger because it would have been a strip along either side of the river, of similar width to the diameter of the catchment of the barrow ditches but extending a considerable distance upstream. Thus the results from the Redlands Farm long barrow showed the local environment to have been relatively open whereas the more regional picture from West Cotton showed that the background landscape retained much woodland.

After a hiatus in deposition in the West Cotton palaeochannel, further sedimentation occurred in the Bronze Age. The wood and tree-dependent Coleoptera of Species Group 4 were entirely absent from a sample dated by OSL to 1890-1470 BC. The only insect suggestive of woody vegetation was a single example of the bug *Pentatoma rufipes*, which commonly occurs in woods and orchards. Clearance seems to have been very thorough since the Neolithic.

Insect remains were investigated from a middle Neolithic cursus ditch, some late Neolithic water holes and some middle Bronze Age water holes on the first gravel terrace of the Great Ouse at Godmanchester, Cambs (Robinson, unpublished c). Around 3.7% of the terrestrial Coleoptera from the cursus ditch, which dated to around 3200 calBC were wood and tree-dependent members of Species Group 4 (Fig. 6). A few other insects were species restricted to woodland habitats, for example the caterpillar-feeding beetle *Calosoma inquisitor*, but there were few species that are associated with rotten wood. The rather limited evidence of the more host-specific phytophagous Coleoptera were from oak-lime woodland, with the weevil *Curculio* cf. *venosus* feeding on acorns and the bark beetle *Ernoporus caucasicus* being dependent on lime. Given that a full woodland fauna was not present, it can be speculated that the woodland was some distance from the cursus.

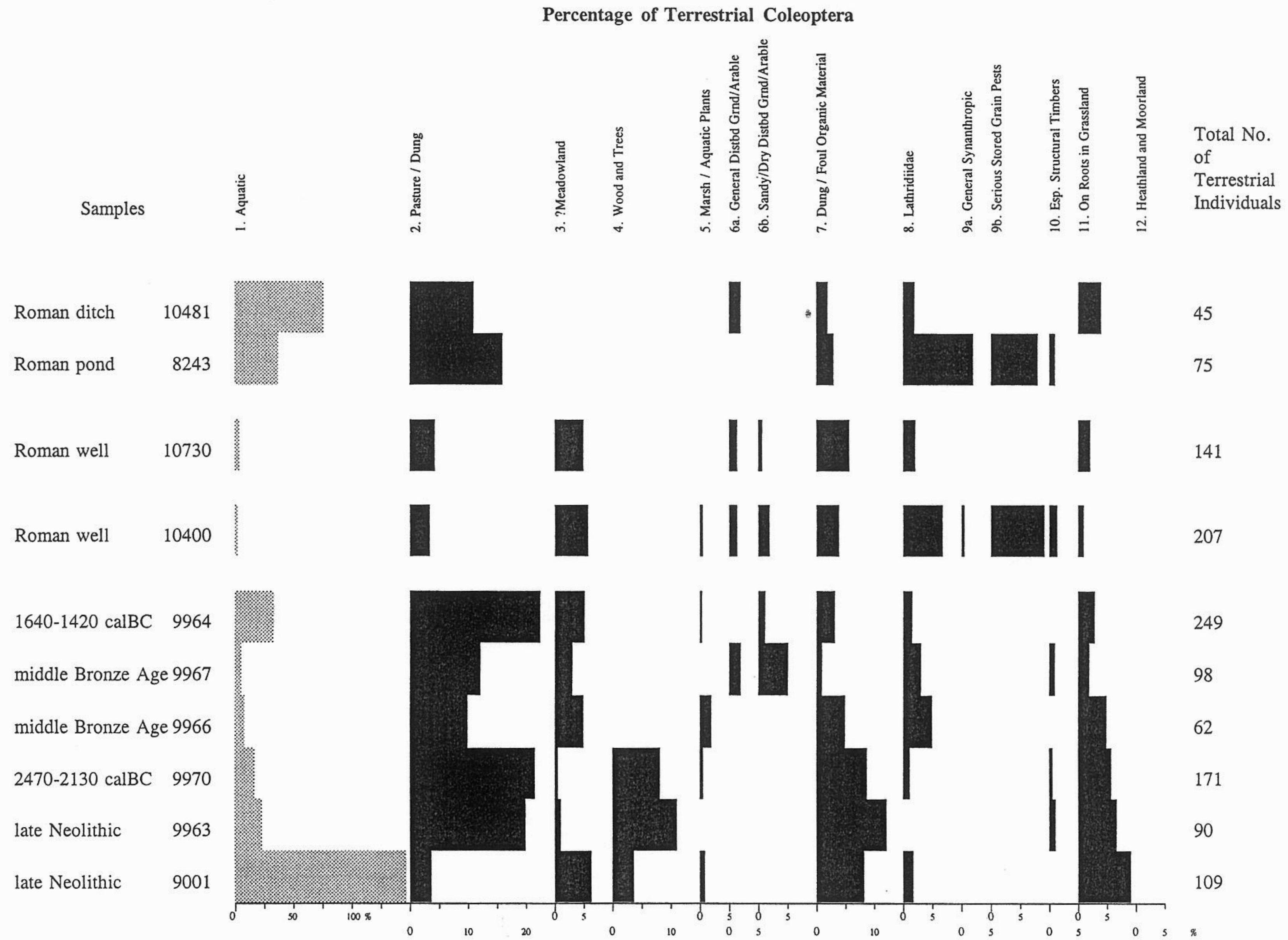
The proportion of wood and tree-dependent Coleoptera of Species Group 4 from the late Neolithic pits, one of which gave a radiocarbon date of 3830±60 BP, 2470-2130 calBC (GU5267) had doubled to over 9% of the terrestrial Coleoptera compared with the proportion from the cursus ditch (Fig. 6). There was a full woodland beetle fauna, *C. inquisitor* being joined by, for example, *Melasis buprestoides*, which feeds on rotten wood. *Anthobium atrocephalum*, which lives in leaf litter and *Silpha atrata*, which hunts snails beneath loose bark. The following compositions of the woodland is suggested by the more host-specific tree and shrub-feeding Coleoptera:

Agelastica alni	on	*Alnus glutinosa* (alder)
Chalcoides sp.	on	*Salix* or *Populus* spp. (willow or poplar)
Curculio cf. *nucum*	on	*Corylus avellana* (hazel)
Rhynchaenus quercus	on	*Quercus* spp. (oak)
Scolytus scolytus	mostly on	*Ulmus* spp. (elm)
Ernoporus caucasicus	on	*Tilia cordata* (small-leaved lime)

The woodland was perhaps little different in composition from the middle Neolithic woodland but the regeneration of this woodland over the cursus has given a more detailed picture. There was probably of the order of 50% tree cover in the vicinity of the pits. Although the late Neolithic woodland was secondary woodland, the pits contained three other "old woodland species", in addition to *E. caucasicus*, which are now very rare in Britain (Table 2):

Gastrallus immarginatus *Teredus cylindricus*
Colydium elongatum

All are associated with dead wood and are largely restricted in Britain to Windsor Great Park, the New Forest and Sherwood Forest. The reason that "old woodland" beetles were present in the secondary woodland is that they would have been able to colonise from adjacent tracts of old woodland once the trees in the regenerated area had reached an appropriate age, provided there had been sufficient neglect to allow dead wood to accumulate.



Species groups expressed as a percentage of the total terrestrial Coleoptera (ie aquatics excluded). Not all the terrestrial Coleoptera have been classified into groups.

Fig. 6: **Species Groups of Coleoptera from Godmanchester**

In complete contrast to the late Neolithic water holes at Godmanchester, the wood and tree-dependant Coleoptera of Species Group 4 were entirely absent from three very similar middle Bronze Age water holes adjacent to them, one of which gave a radiocarbon date of 3240±50 BP, 1640-1420 calBC (GU-5213). Neither were there any other insects suggestive of woodland scrub or even hedgerows from the pits. Clearance must have been very thorough since the Neolithic.

The final group of Neolithic to Bronze Age sites was on the first gravel terrace of the Welland in the Etton area. Just under 5% of the terrestrial Coleoptera from the Neolithic contexts associated with Etton Causewayed Camp fell into Species Group 4, wood and tree-dependent species, suggesting a background presence of woodland (Robinson 1998) The more host-specific of the tree and shrub-feeding Coleoptera included:

Agelastica alni	on	*Alnus glutinosa*
Chalcoides sp.	on	*Salix* and *Populus* spp. (willow and poplar)
Rhynchaenus quercus	on	*Quercus* sp. (oak)
Scolytus rugulosus	on	Rosaceous trees and shrubs (eg Hawthorn, sloe)
Lymantor coryli	mostly on	*Corylus avellana* (hazel)

Wood and tree-dependent Coleoptera comprised around 8% of the terrestrial Coleoptera from a Beaker pit at the nearby site of Etton Woodgate (Robinson unpublished d). They suggested woodland of similar composition to that at Etton Causewayed Camp and the species included *Agelastica alni* (alder leaf beetle) again, which is now probably extinct in Britain. An "old woodland" element to the fauna was represented by *Colydium elongatum* and unlike the causewayed camp, there was a woodland ground fauna of species such as *Colenis immunda* which occurs in leaf litter.

In comparison with the earlier sites, Species Group 4 comprised a very much reduced percentage from a middle Bronze Age well in the Etton area (Etton Landscape), at 2% of the terrestrial Coleoptera (Robinson unpublished d). The well gave a radiocarbon date of 3470±70 BP, 1980-1620 calBC.

Little work has been done on insect remains from deposits in the Fenland of East Anglia from this period. However, there are two interesting records of the very large Cerambycid beetle *Cerambyx cerdo*, which is now extinct in Britain, from the galleries they had made in bog oaks. Some examples were found at Isleham, Ely, Cambs, from a tree which gave a radiocarbon date of 4000±66 BP, 2900-2300 calBC (Birm-1) (Duffey 1968). Although Duffey believed that the beetle had attacked the tree trunk after it had been dug from the peat, it was subsequently confirmed that the beetle remains were contemporaneous with the wood (Buckland and Kenward 1973). A second discovery of *C. cerdo* was made from a bog oak at Ramsey Heights, Cambs, a radiocarbon date of 3690±100 BP, 2500-1750 calBC (Birm-853) being obtained on the wood (Harding and Plant 1978). This beetle develops in the wood of large dead hardwood trees, especially *Quercus* spp. (oak) and its occurrence was a reflection of the extensive woodland which formerly grew in the Fenland.

The evidence from Neolithic to middle Bronze Age sites in the region gives the impression that there was extensive clearance activity during the Neolithic but there always remained a strong background presence of an "old woodland" insect fauna. During the Bronze Age, clearance appears to have been very extensive, with little woodland surviving. These impressions, however, are biased because almost all the results were from sites that were being investigated for cultural remains. The full woodland insect fauna as was found at Worldsend was probably more typical for much of the region throughout the Neolithic. While there was more extensive clearance during the earlier Bronze Age, the picture from the river gravels was probably far from typical for the region as a whole.

The Development of the Open Landscape and Woodland Grazing

With the bias towards archaeological sites, many of the Neolithic assemblages showed the occurrence of a full grassland fauna and by the Bronze Age, open country species were usually the major component of the terrestrial fauna. Curiously, however, there was one site where scarabaeoid dung beetles, which are usually members of pastureland communities, occurred with a woodland fauna.

An open country fauna was entirely absent from the insect sequence from Worldsend, in the Church Stretton Valley (p.47) (Osborne 1972) and it was not until after 3570± BP, 2140-1740 calBC (Beta-75271) in the Bronze Age that the occurrence of grassland beetles, such as *Agrypnus murinus* and *Gymnetron pascuorum* at Bole Ings, Notts, suggested limited clearance (Brayshay and Dinnin 1999). However, the majority of the beetles from the Redlands Farm (South Stanwick) early Neolithic Long Barrow in the Nene Valley were open country species (p.47) (Robinson, unpublished a). Some of the more host-specific phytophagous Coleoptera included:

Gastrophysa viridula	on	*Rumex* spp. (docks)
Sitona hispidulus	on	*Trifolium* spp. esp. *T. pratense* (red clover)
Ceuthorhynchidius troglodytes	on	*Plantago lanceolata* (ribwort plantain)

These are all common grassland herbs. There were also insects which feed on the leaves of grasses themselves, including the homopteran bug *Aphrodes bicinctus* and the chrysomelid beetle *Crepidodera ferruginea*. Chafers and elaterids such as *Phyllopertha horticola* and *Agrypnus murinus* which feed on the roots of grassland herbs (Species Group 11) comprised around 5% of the terrestrial Coleoptera (Fig. 5). Scarabaeoid dung beetles of Species Group 2, particularly *Onthophagus ovatus* and species of *Aphodius* comprised 6.6% of the terrestrial Coleoptera, giving sufficient evidence for the droppings of the larger herbivorous mammals to imply that the grassland was being grazed by domestic animals (Fig. 5). They included three species which are either extinct or very rare in Britain (Table 5): *Copris lunaris*, *Caccobius schreberi* and *Onthophagus taurus*. Weevils of the genera *Apion* and *Sitona*, which comprise Species Group 3, made up 5.9% of the terrestrial Coleoptera. This group mostly feeds on grassland trefoils and vetches. They are favoured by hay meadow conditions. While their relative abundance was not high enough to confirm the presence of managed hay meadow and there was no botanical evidence for hay meadow, neither does the grassland appear to have been so heavily grazed as to prevent the flowering of clovers etc.

The carabid and staphylinid beetles included many species that commonly occur in grassland although they are not restricted to it, for example:

Calathus fuscipes	*X. longiventris*
C. melanocephalus	*Staphylinus aeneocephalus* or *fortunatarum*
Xantholinus linearis	*S. olens*

Two of the Carabidae, *Pterostichus niger* and *Abax parallelepipedus*, would usually be regarded as woodland beetles in Northamptonshire although they do occasionally venture into arable fields. In Northern England, however, they frequently occur in grassland provided conditions are humid. Their numbers from Redlands Farm were far greater than would have been expected given the proportion of woodland insects. They have been recorded from Neolithic and Bronze Age sites in southern England where they were apparently living under non-woodland conditions (Robinson 1997, 43). Their occurrence is thought likely to be due to light grazing, although it could have been a reflection of recent clearance.

Table 5: **Rare and Extinct Dung-Feeding Scarabaeidae from the Midlands Region**

Period	Neolithic				Middle Bronze Age	Late Bronze Age			Iron Age	Roman	Medieval
	Church Stretton RS_2	Redlands Farm	Godmanchester Pits	Etton Camp	Godmanchester Pits	Etton / Welland	Pilgrim Lock	Flag Fen	North Furzton	Aston Mill	Coslany Street Norwich
Data from	1	2	3	4	3	5	6	7	8	9	10
Aphodius lividus (Ol.)	-	-	-	-	-	-	-	-	-	-	+
A. scrofa (F.)	-	-	-	-	+	-	-	-	-	-	-
**A. varians* Duft.	-	-	+	-	+	-	-	-	+	-	-
Copris lunaris (L.)	-	+	-	-	+	-	-	-	-	-	-
**Caccobius schreberi* (L.)	-	+	-	-	-	-	-	-	-	-	-
Onthophagus fracticornis (Preys.)	+	-	-	-	+	+	-	-	-	+	-
**O. nutans* (F.)	-	-	-	-	-	+	+	-	-	+	-
**O. taurus* (Schr.)	-	+	-	+	-	-	+	+	-	-	-

* now extinct in Britain

1. Osborne (1972), 2. Robinson (unpublished a), 3. Robinson (unpublished c), 4. Robinson (1998), 5. Robinson (unpublished d), 6. Osborne (1988), 7. Robinson (1992b); Robinson (unpublished f), 8. Robinson (unpublished j), 9. Whitehead (1992), 10. Robinson (unpublished z).

There was a group amongst the open-country species of insect from the bottom two samples from the barrow ditch which tend to be associated with sun-warmed habitats on sandy and sometimes chalky soils with only patchy vegetation. Some now tend to have a coastal distribution and no longer occur in the Nene Valley. They included the beetles *Amara consularis*, *Opatrum sabulosum* and *Meloe violaceus* and the ant *Tetramorium caespitum*. They would probably have found suitable conditions on the newly constructed barrow but would also have been favoured by the disturbance caused by tree clearance.

Although a major part of the catchment for the insects from the Neolithic deposits in the palaeochannel at West Cotton was wooded, tree cover was by no means complete (p.47) (Robinson, unpublished b). The Scarabaeoidea and Elateridae with larvae that feed on the roots of grassland plants (Species Group 11) comprised 4% of the terrestrial Coleoptera. They included *Agrypnus murinus*, which is characteristic of well aerated soils. This would be consistent with other evidence (Robinson 1992a) that much of the Nene floodplain formerly had well-drained soils and did not experience flooding during the prehistoric period. Other phytophagous Coleoptera of grassland included *Mecinus pyraster*, which feeds on *Plantago lanceolata* (ribwort plantain). The occurrence of scarabaeoid dung beetles of Species Group 2, such as *Geotrupes* sp. and *Aphodius* spp. at 3% of the terrestrial Coleoptera suggested the presence of some grazing animals over and above that of any wild, medium to large-sized herbivores that might have lived in the region. However, this was still a relatively low value for Species Group 2 and does not imply that domestic animals were concentrated at West Cotton itself.

The insects from the Redlands Farm Long Barrow gave some indication of weedy disturbed or almost bare ground. The carabid beetles *Harpalus rufipes* and *Amara tibialis* favour such conditions, respectively being members of Species Groups 6a and 6b, and were present in low numbers. It is possible that there were arable plots in the vicinity but they could also have been living on disturbed areas related to the construction or use of the barrow. Phytophagous insects of waste ground vegetation, for example *Brachypterus urticae*, which feeds on *Urtica dioica* (stinging nettle), were identified from both Redlands Farm and the Neolithic deposits at West Cotton. However, such vegetation would also have been growing at the edge of woodland or along the river banks.

A comparison of the results from the Redlands Farm Long Barrow and the Neolithic deposits at West Cotton raises the possibility that the series of ceremonial sites aligned on the long barrow were set in a cleared corridor which ran along the valley bottom in an otherwise largely wooded landscape. Grazing by domestic animals was occurring, but does not seem to have been particularly intensive.

With woodland clearance at West Cotton, there was a corresponding rise in grassland insect (p.49) (Robinson, unpublished b). The Scarabaeidae and Elateridae with larvae that feed on the roots of grassland herbs (Species Group 11) comprised 6% of the terrestrial Coleoptera from the middle Bronze Age deposit. The clover and vetch-feeding weevils of the genera *Apion* and *Sitona* (Species Group 3) were also well-represented at 7% of the terrestrial Coleoptera. The assemblage was not sufficiently large to contain a wide range of host-specific grassland Coleoptera, but *Crepidodera ferruginea*, which feeds on grasses, and *Mecinus pyraster*, which feeds on *Plantago lanceolata* (ribwort plantain), were again present. There were also grass-feeding bugs from the genus *Aphrodes*. Scarabaeoid dung beetles of

Species Group 2, including *Aphodius rufipes* and *Onthophagus ovatus*, comprised 7% of the terrestrial Coleoptera. Such a value for these beetles would be appropriate to a largely pastoral landscape away from any concentrations of domestic animals such as those that occur around settlements.

As at the Redlands Farm Long Barrow, the majority of the insects from the Godmanchester Cursus ditch were mostly open country species (p.50) (Robinson, unpublished c). The proportion of Scarabaeidae and Elateridae with larvae that feed on the roots of grassland plants was high, at over 9% of the terrestrial Coleoptera (Fig. 6, Species Group 11). The most abundant of these was *Agrypnus murinus* which is characteristic of well-drained soils. One of the most abundant weevils from the Sample was the plantain-feeding *Mecinus pyraster*. Two other weevils which feed on *Plantago lanceolata* (ribwort plantain), *Gymnetron labile* and *G. pascuorum* were also represented by several individuals. Weevils of the genus *Apion*, which feed on grassland trefoils (*Trifolium* spp. etc) and tend to be favoured by conditions where grazing is not heavy, (Species Group 3), comprised 6.4% of the terrestrial Coleoptera. This is not as high as might be anticipated for grassland managed as hay meadow. The scarabaeoid dung beetles of Species Group 4, which mostly occur in the droppings of the larger herbivorous mammals in the field rather than in manure heaps etc, comprised less than 4% of the terrestrial Coleoptera. Under conditions of permanent pasture, the dung beetles of Species Group 2 usually outnumber the phytophagous weevils of Species Group 3 and form perhaps 10% or more of the terrestrial Coleoptera. Two species of weevil which feed on members of the Malvaceae, especially *Malva sylvestris* (common mallow), *Apion aeneum* and *A. radiolus*, were each represented by several individuals. While the native members of this family are not usually regarded as grassland plants, some readily grow in ungrazed grassland. The evidence of both phytophagous beetles and dung beetles suggested that herb-rich grassland which was not closely grazed was a major aspect of the Neolithic ceremonial site. The insects did not give any indication of arable land and few of the phytophagous species occur on weeds of disturbed ground. Just as at Redlands Farm, beetles which tend to be associated with sun-warmed coastal sites with sandy or chalky soils were present, *Aphodius villosus* and *Otiorhynchus ligustici* being well represented. *A. villosus* is one of the few members of the genus Aphodius which do not live in animal droppings, the larvae feeding on organic material in soil. *O. ligustici* is now very rare in Britain although a colony has long been known at Ventnor on the Isle of Wight (Morris 1965).

The proportion of phytophagous Coleoptera at Godmanchester which feed on grassland herbs had declined by the late Neolithic in comparison with the previous period as a result of woodland recolonisation on the site (p.50). Weevils of the genus *Apion* which feed on grassland trefoils were almost absent. However, the occurrence of scarabaeid and chafer beetles of Species Group 11 (Fig. 6) showed that there was still a significant presence of grassland in the vicinity of the late Neolithic pits. Surprisingly, the scarabaeoid dung beetles of Species Group 2 comprised over 20% of the terrestrial Coleoptera. Even in a fully open pastoral landscape, this group would only be expected to be around 10% of the terrestrial Coleoptera unless there were special reasons for domestic animals to be concentrated in the vicinity of the deposit (Robinson 1991, 278-80). The values from the late Neolithic pits are similar to those which have been recorded from the ditches of Iron Age enclosures used to control stock. The results strongly suggested that the pits were being used to water domestic animals that were being grazed, or allowed to browse, under partly wooded conditions. By far the most numerous of the scarabaeoid dung beetles was *Aphodius* cf. *sphacelatus*, which is still very common in England, but another species, *A. varians*, has not been recorded from Britain this century (Table 5).

The middle Bronze Age landscape at Godmanchester was mostly grassland. If perhaps not as herb-rich or tall as the earlier Neolithic grassland of the cursus, it was by no means a barren or overgrazed sward. The favoured foods of some of the more host-specific phytophagous Coleoptera from the Bronze Age pits included:

Olibrus sp.	on	various Compositae esp. *Achillea millefolium* (yarrow) and *Leontodon* spp. (hawkbit)
Hypera punctata	on	*Trifolium* spp. (clovers)
Ceuthorhynchidius troglodytes	on	*Plantago lanceolata* (ribwort plantain)

Whereas the proportion of weevils from the genera *Apion* and *Sitona* that feed on grassland trefoils and comprise Species Group 3, rose to 4.6% of the terrestrial Coleoptera (Fig. 6) from the middle Bronze Age pits, the percentage of chafers and elaterid beetles with larvae that feed on the roots of grassland plants (Species Group 11) fell to around 3% of the terrestrial Coleoptera. While 3% is still within the range of values for Species Group 11 which have been recorded elsewhere from sites which appear largely to have been surrounded by grassland (Robinson 1983, 37-9; Robinson 1991, 281), an explanation is needed for the decline. Some of these beetles are susceptible to severe soil waterlogging but the insect evidence suggested that the soil of the site was well-drained at this period. They are also particularly vulnerable to cultivation because they have a long larval stage to their life cycle, often several years. It is possible that episodes of cultivation had reduced the population levels of the grassland chafers and elaterids.

The percentage of scarabaeoid dung beetles from the middle Bronze Age pits remained about as high as from the late Neolithic pits, averaging over 18% of the terrestrial Coleoptera. This suggests that there continued to be a concentration of domestic animals leaving dung in this part of the site. The pits were very probably being used to water stock. The most abundant of the dung beetles was again *Aphodius* cf. *sphacelatus* and there was a further example of *A. varians*. There were three other Scarabaeid beetles which are now very rare or extinct in Britain (Table 5): *Aphodius scrofa*, *Onthophagus fracticornis* and *Copris lunaris*.

There was rather more evidence from the phytophagous Coleoptera from this phase for plants which could have grown as arable weeds, although they do also grow in other disturbed ground habitats:

Stenocarus umbrinus	on	*Papaver* spp. (poppies)
Ceutorhynchus erysimi	on	Cruciferae esp. *Capsella bursa-pastoris* (shepherd's purse)
Chaetocnema concinna	on	Polygonaceae esp. *Polygonum aviculare* agg. (knotgrass)

Carabid beetles of Species Groups 6a and 6b, which tend to favour ground with a relatively sparse cover of weeds, occurred in some of the Bronze Age pits whereas they were entirely absent from the Neolithic samples (Fig. 6). The average value of 2% of the terrestrial Coleoptera from the Bronze Age pits shown by *Amara apricaria*, *A. bifrons* and *A. tibialis* (Species Group 6b), species which favour sandy disturbed or bare ground, is sufficient to confirm that such a habitat existed in the vicinity of the pits. It would also be an appropriate value if cultivated areas were present.

The open-country insects from the Neolithic deposits at the Etton Causewayed Camp included many from grassland habitats (p.52) (Robinson 1998). A similar range of species was present as was identified from the Redlands Farm Long Barrow and the Godmanchester Cursus. Scarabaeoid dung beetles of Species Group 2 comprised around 12% of the terrestrial Coleoptera from the deposits with the exception of Phase 2B, which was represented by a pit in the interior. This certainly showed the grazing of domestic animals in the vicinity. The relative abundance of these beetles from the Phase 2B pit, however, was very much higher, at 34% of the terrestrial Coleoptera. This suggests that the enclosure of the causewayed camp was being used to corral stock during this period. The dung beetles from the pit included *Onthophagus taurus*, which is now extinct in Britain.

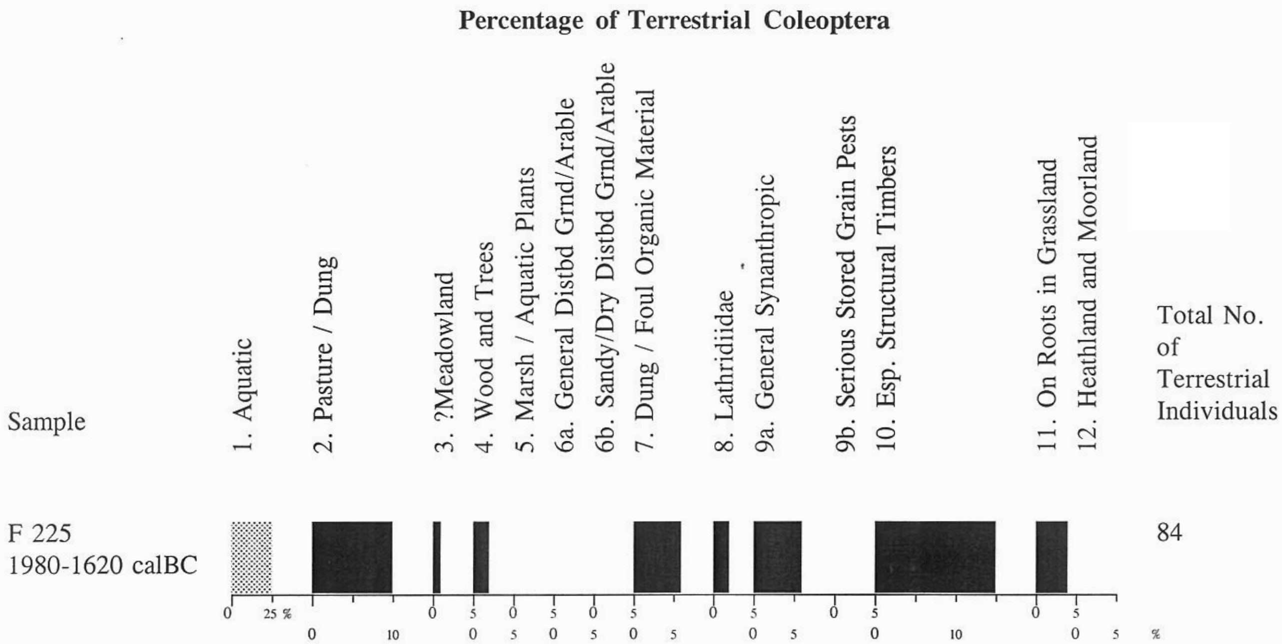
A grassland element was present in the Beaker pit at Etton Woodgate and also in the middle Bronze Age well in the Etton area (p.52) (Robinson, unpublished d). Scarabaeoid dung beetles suggested that there was some presence of domestic animals (Fig. 7).

The Neolithic thus saw the rapid establishment of open-country insect faunas as suitable habitats were presented by clearance. However, scarabaeoid dung beetles, which tend to be thought of as open-country species, were able to flourish under woodland conditions when there was woodland grazing. Conversely, the occurrence in open country faunas of carabid beetles which now usually occur in woodland in the region might suggest that the open-country fauna was not fully mature. By the Bronze Age, there were parts of the region where clearance had been so thorough that the entire terrestrial component of some insect assemblages was of open-country species.

Marsh, Peat and Aquatic Habitats

Insects of aquatic and marginal habitats were, by virtue of the nature of the deposits, abundant in all the insect assemblages from the Neolithic to the middle Bronze Age. Some of the information which can be derived from this element of the fauna is useful for the interpretation of site conditions but does not necessarily have a wider significance. For example, numerous examples of the water beetle *Hydrobius fuscipes* from the ditch of the Redlands Farm Neolithic Long Barrow show it held stagnant water and had a bed of organic detritus (p.52) (Robinson, unpublished a). Of perhaps more interest, the occurrence of small water beetles, such as *Helophorus* cf. *brevipalpis* and *Ochthebius minimus* in the late Neolithic and middle Bronze Age water holes at Godmanchester (p.50) (Robinson, unpublished c) and the middle Bronze Age well near Etton (Etton Landscape, p.52) (Robinson, unpublished d) showed that the water from them was by no means pure. However, the absence of many beetles which feed on aquatic and marginal vegetation showed that neither had they taken on the character of small ponds.

Water in streams and rivers remained clean and well-oxygenated, with most assemblages from these sorts of contexts containing beetles from the family Elmidae. The elmids *Macronychus quadrituberculatus* and *Stenelmis canaliculata* were found in Neolithic sediments of the River Nene at West Cotton, Northants (p.47) (Robinson, unpublished b). They no longer occur in the Nene drainage system (Table 4). Little work has been done on Trichoptera (caddis) larval remains, but cases of *Ithytrichia* sp., which requires running water, were identified from the West Cotton channel and the sediments of the River Bourne at Shustoke, Warks (Kelly and Osborne 1963-64). The phytophagous Coleoptera from the West Cotton palaeochannel included a range of species which feed on aquatic and marginal



Species groups expressed as a percentage of the total terrestrial Coleoptera (ie aquatics excluded). Not all the terrestrial Coleoptera have been classified into groups.

Fig. 7: **Species Groups of Coleoptera from Etton Landscape**

plants, for example *Donacia crassipes* on the water lilies *Nymphaea alba* and *Nuphar lutea*, *D. impressa* on *Schoenoplectus lacustris* (bulrush) and the now very rare *Macroplea appendiculata* on *Myriophyllum* (water-milfoil) and *Potamogeton* (pondweed) species. Insects of bankside habitats included the carabid beetle *Elaphrus cupreus* and the staphylinid *Micropeplus caelatus* which is now restricted in the British Isles to SW Ireland. Such faunas were probably typical of the larger rivers of the region during the Neolithic and Bronze Age.

Only limited work has been done on the peatlands of the region. Samples of peat from immediately above and below a band of clay deposited by a marine transgression during the middle Bronze Age at Holme Fen, Cambs (Robinson, unpublished g) were characterised by the small water beetle *Hydroporus scalesianus*. It lives in shallow, clear water pools choked with moss between the tussocks of a *Sphagnum* bog. It is now very rare in Britain and only known from a few localities. A sequence from the Church Stretton Valley, Shropshire at Worldsend showed the replacement of a fauna of shallow stagnant water by a fauna of acid water peat pools (Osborne 1972). One of the water beetles from the upper part of the sequence was *Agabus wasastjernae*. It was, until recently, thought to be extinct in Britain (Table 4) and tends to have a northerly distribution in Europe. It is often associated with areas surrounded by conifer woodland and indeed there was insect evidence of pine trees growing in the catchment (p.47). The recent British discovery was in pine woodland at Speyside, Scotland (Owen *et al.* 1992). A peaty pool at Aston Mill, Worcs which was associated with Carrant Brook contained the hydrophilid beetle *Hydrochara caraboides*, which is now only known in Britain from the Somerset Levels (Whitehead 1989). It was dated to 3390 BP (no error quoted), about 1700 calBC (Birm-667).

Human Habitation and Structures

Although the insect assemblages of the Neolithic to middle Bronze Age provided much evidence of human activity, they showed very little evidence of human settlement or structures with the exception of the assemblage from the middle Bronze Age well near Etton (Etton Landscape, p.52) (Robinson, unpublished d). Most of the Neolithic records of *Anobium punctatum* (woodworm beetle) were probably of beetles which had emerged from naturally occurring dry, dead wood. However, the assemblage from the middle Bronze Age well near Etton contained a significant synanthropic element (Fig. 7). *A. punctatum* (Species Group 10) made up over 15% of the terrestrial Coleoptera from the well, while the synanthropic beetles (Species Group 9a) comprised 6% of the total. Slightly damp, seasoned timber in buildings provides an ideal habitat in which *A. punctatum* can flourish. The value from the well was so high as to suggest that either the well was adjacent to a building, perhaps even within an open-sided structure, or refuse from a building had been deposited into it. Two members of the synanthropic group, *Ptinus fur* and *Stegobium paniceum*, were identified from the well. The former is an omnivore on rather dry decaying animal and vegetable material including straw, granary debris and hay waste. It can be found in birds' nests but mainly occurs in buildings. *S. paniceum* is a serious stored-products pest. It infests a great variety of plant and animal products, including farinaceous material, although it is only a minor pest of stored grain. While almost all the British records of *S. paniceum* are from inside buildings, it can possibly live in natural outdoor habitats in Britain (Robinson 1991, 324). This is possibly the reason that it is the only grain beetle so far to have been recorded from prehistoric contexts in Britain (Table 6). The percentage of Lathridiidae (Species Group 8), which feed on moulds on dead plant material ranging from old thatch and damp hay through to leaf litter was not unusually high. However, there were several

Table 6: **Stored Grain Pests from the Midlands Region**

Period	Middle Bronze Age	Iron Age		Roman											Late Saxon		Medieval			
	Etton Land-scape	Tatters-hall Thorpe	Market Deeping	Alcester	Water-side Lincoln	Alchester Road Towcester	Ashton	Elms Farm Heybridge	Wickford	Godman-chester	Tiddington	Bancroft Villa	Lynch Farm	Droit-wich Villa	Water-side Lincoln	Fisher-gate Norwich	Castle Norwich	Austin Friar's Leicester	Sidbury Worcester	Stone
Data from	1	2	3	4	5	6	7	8	9	10	11	12	13	14	5	15	16	17	18	19
Stegobium paniceum (L.)	+	+	+	+	+	-	-	+	+	-	-	+	-	-	-	-	-	-	-	-
Tenebroides mauritanicus (L.)	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cryptolestes ferrugineus (Step.)	-	-	-	-	+	+	-	+	+	+	-	+	-	+	-	-	-	-	-	-
C. turcicus (Grouv.)	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Oryzaephilus surinamensis (L.)	-	-	-	+	+	-	+	+	+	+	-	+	-	+	-	-	-	+	+	-
Tribolium castaneum (Hbst.)	-	-	-	-	+	+	-	-	-	-	-	-	-	+	-	-	-	-	-	-
T. confusum J. du Val	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Palorus ratzeburgi (Wiss.)	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P. subdepressus (Woll.)	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tenebrio molitor L.	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-
T. obscurus F.	-	-	-	+	+	-	-	+	-	-	-	-	-	-	+	+	-	-	-	-
Sitophilus granarius (L.)	-	-	-	+	+	+	-	-	-	-	-	-	+	+	-	-	+	+	-	+

1. Robinson (unpublished d), 2. Chowne *et al.* (1986), 3. Robinson (unpublished i), 4. Osborne (1971); Osborne (1994), 5. Carrott *et al.* (1995), 6. Girling (1983), 7. Robinson (unpublished t), 8. Robinson (unpublished u), 9. Robinson (unpublished o), 10. Robinson (unpublished c), 11. Robinson (unpublished s), 12. Pearson and Robinson (1994), 13. Buckland (1981), 14. Osborne (1973); Osborne (1977), 15. Kenward and Allison (1994a), 16. Robinson (unpublished aa), 17. Girling (1981), 18. Greig (1981), 19. Moffett and Smith (1995).

examples of *Xylodromus concinnus*, a beetle which has mostly been recorded from indoor assemblages with these beetles. The results from the well strongly suggested the proximity of a building and showed that a synanthropic fauna had developed in the region by the middle Bronze Age.

Climate

It becomes more difficult to draw climatic inferences from the changes in the insect fauna at a time when human activities were also causing changes in the insect fauna. The "old woodland" species of Table 2 which are now extinct in Britain have been lost as a result of clearance and woodland management. However, they all still occur in areas of central or eastern Europe where the climate is more continental and the summers are warmer than in Britain.

Osborne (1982) argued from results from two sites in the region from this period for episodes of climatic deterioration, with mean temperatures lower than at present. The first of these sites was Shustoke A, Warks, which was radiocarbon-dated to 4830±100 BP, 3950-3350 calBC (p.44) (Kelly and Osborne 1963-64). The majority of insects recorded from the site are still to be found in the Midlands. Some old woodland species were present whose distributions are now more southerly, indeed one, *Rhysodes sulcatus*, is now extinct in Britain. However, the contraction of the ranges of these species was attributed to habitat destruction. There were also four species whose range in Britain was stated to be well north of Warwickshire: *Bembidion stomoides*, *Sphaerites glabratus*, *Tropiphorus obtusus* and *Barynotus squamosus*. Their occurrence was said to be most readily explained in terms of a deterioration of the thermal environment. The second of these sites was Worldsend, in the Church Stretton Valley, Salop, where the top part of an organic sequence was attributed to the later part of Pollen Zone VIIb (the middle Bronze Age) (p.47) (Osborne 1972). As at Shustoke A, these deposits contained old woodland species which are now extinct in Britain but still occur further south in Continental Europe (Table 2). However, there were also three species of wood-boring weevil which were stated to have distributions which tend towards the boreo-montane. *Hylastes brunneus* is exclusively northern in Britain, whilst *Eremotes ater* and *E. elongatus* (which is now extinct in Britain), though not restricted to the north, are predominantly high ground species further south on the continent. It was suggested that these deposits formed during a period of lowered temperatures.

While the insect assemblages from Shustoke A and the upper part of the Worldsend sequence would not be inconsistent with climatic conditions slightly cooler than at present, the evidence that this was so is by no means convincing. Two of the species noted by Osborne still have distributions in England that extend further south than the two sites, *Bembidion stomoides* (Lindroth 1974, 60) and *Eremotes ater* (Fowler 1891, 394). Four of the others are strongly associated with coniferous woodland. *H. brunneus* and *E. elongatus* bore into the wood of pine and other conifers. *S. glabratus* is associated with fungi generally in coniferous woodland. *A. wasastjernae* favours acid water pools overhung by conifers. The occurrence of these beetles is more likely to have been due to the persistence of stands of *Pinus sylvestris* (Scot's pine) on areas of very poor acid soil rather than climatic deterioration. Other insect evidence for pine at Worldsend has already been mentioned (p.47) and there was a strong presence of pine pollen from the bottom of the Shustoke A sequence (Kelly and Osborne 1963-64). The remaining two beetles, *T. obtusus* and *B. squamosus*, feed on herbs on the woodland floor. There is certainly no reason why all beetles whose range has been contracted as a result of the loss of their woodland habitats in Britain should be restricted to the southern half of their former range.

There is also possible evidence from Coleoptera for warmer summer temperatures during the Neolithic and middle Bronze Age than at present. Several species of scarabaeoid dung beetles which are now extinct in Britain were discovered on Neolithic and Bronze Age sites in the region (Table 5): *Aphodius scrofa*, *A. varians*, *Caccobius schreberi*, *Onthophagus nutans* and *O. taurus*. Another species of *Onthophagus*, *O. fracticornis* is of uncertain status. Their current ranges in Europe are almost certainly in regions with warmer summer temperatures and a more continental climate than Britain. However, there are reliable old records of the capture of these species from Britain, apart from *C. schreberi* (Robinson, unpublished h). *O. taurus* does still occur in the Channel Islands, which have milder winters and cooler summers than the eastern part of the region, from which the Neolithic and middle Bronze Age records of this beetle originate. It is possible that the ploughing of pastureland on better-drained, more fertile soil, where their juveniles would be overwintering in tunnels, was responsible for their disappearance rather than climatic change.

There is no need, on current evidence, to invoke a climatic change for the loss of insect species from the region since the middle Bronze Age. The occurrence of certain dung-feeding Scarabaeidae would not be inconsistent with summer temperatures 2-3°C higher than at present but other explanations are possible. While the possibility of episodes of slight climatic deterioration at the start of the Neolithic and in the middle Bronze Age cannot be excluded, the evidence remains dubious.

Discussion

The Neolithic to the end of the middle Bronze Age was a period of change when the "old woodland" fauna from Flandrian Zone II existed alongside the fauna of the man-made open landscape. Indeed, because relatively little work has been done on woodland sites of Flandrian Zone II in the region, more evidence has been obtained of old woodland insect faunas from sites of Neolithic date. Much of the Neolithic landscape was probably a mosaic of relatively small clearances, abandoned clearings in various stages of scrub to woodland succession and older woodland. Large areas of woodland probably occurred in a relatively undisturbed state well into the Bronze Age. There is evidence that so long as areas of woodland with an "old woodland" fauna were adjacent to areas where woodland colonisation was occurring, the old woodland species were able to spread into the new area once it had reached the appropriate stage of succession.

Insects of open habitats appear to have been efficient colonists once clearances were made. There were, however, differences between Neolithic and modern faunas. What are now coastal species and certain woodland Carabidae were sometimes present. It is possible that they were ready colonists, but as open country faunas matured, so they were displaced by competition from species which arrived later. Some quite extensive clearances were made in the region during the Neolithic but there always seems to have been a background presence of woodland. Some clearances were certainly used for the grazing of domestic animals and supported high populations of scarabaeoid dung beetles. However, open areas related to ceremonial monuments were not always heavily grazed. Some ceremonial monuments seem to have been set in cleared corridors that were only lightly grazed in otherwise wooded landscapes. Conversely, there was evidence from scarabaeoid dung beetles for domestic beetles being herded under partly wooded conditions during the Neolithic.

More extensive and probably more permanent clearances occurred during the Bronze Age. Woodland or even scrub-related Coleoptera were absent from some middle Bronze Age sites. While insects from these sites primarily gave evidence for pasture, there was a significant presence of Coleoptera which tend to be favoured by arable conditions on one site, Godmanchester. Synanthropic beetle faunas, albeit composed of species with natural habitats away from human influence, put in their first appearance in the middle Bronze Age, occurring under circumstances where it was likely that they had been living in structural timbers and inside a building.

The period was one during which the aquatic and wetland habitats of the region were still in an unmanaged state. The rivers of the region had faunas which included species now only to be found in a few rivers of the Highland Zone. Peatland insects have so far been little studied but some evidence was obtained of a raised bog fauna of the Fens.

Evidence from insects for climatic change during this period has proved ambiguous. The reasons for differences between scarabaeoid dung beetle faunas of this period and faunas of modern pastureland remain unclear.

Diversification and Intensification: Late Bronze Age to Iron Age (Flandrian Mid Zone III, c 1500BC - AD43)

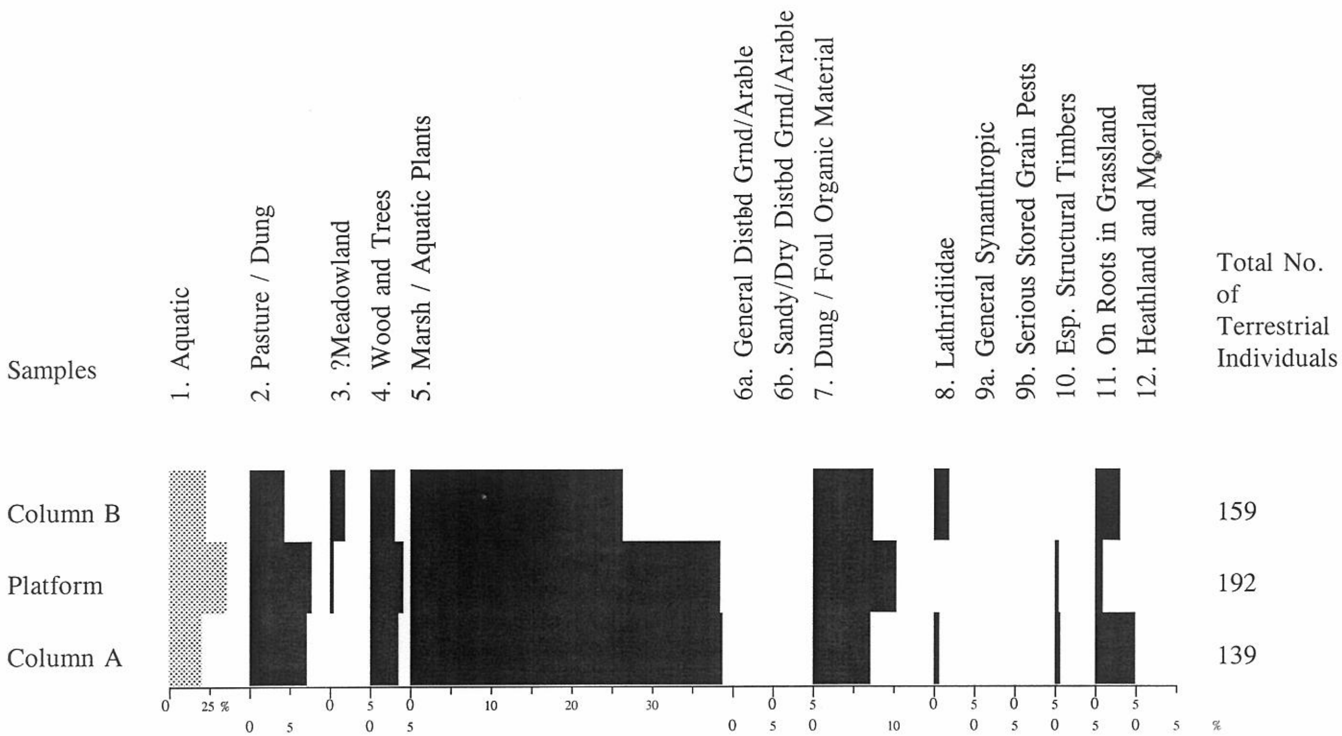
The late Bronze Age to Iron Age was the period when the character of the landscape over much of the region was altered by a move towards more intensive agricultural systems. One aspect of this seems to have involved more hole-digging below the water table than in the previous period. Deep ditches, water holes and ponds containing organic sediments provide the major sources of insect remains for the period. Only limited investigations have been made of palaeochannel sediments and fen peats, while coastal peats are an untapped resource. This means that the results are very much biased towards settlement (and burnt mound) sites.

The Remaining Woodland, Scrub and Hedges

The modern occurrence of an "old woodland" insect fauna in, for example, Sherwood Forest showed that there must have been survival of woodland with over-mature trees or much dead wood in the region. However, there is little evidence of this in the archaeological record. The weevil *Dryophthorus corticalis*, which occurs in rotten wood and is now only known in Britain from old oak trees in Windsor Great Park, was identified from a late Bronze Age pit associated with a burnt mound at Feltwell Anchor, Norfolk (Robinson, unpublished e). While the site was probably set against a background of old woodland, pastureland species were also present. Several examples of *Agelastica alni* (alder leaf beetle), which is probably extinct in Britain, were found from the late Bronze Age platform at Flag Fen and the fen peats associated with it (Robinson 1992b; Robinson, unpublished f). This beetle seems to require large tracts of alder woodland to maintain a viable population. Several examples of *Phyllodecta vulgatissima*, which feeds on the leaves of *Salix* S. *Caprisalix* sp. (sallows and osiers) were also present. Tree and shrub-dependent Coleoptera (Fig. 8, Species Group 4) comprised 3.7% of the terrestrial Coleoptera, suggesting that there was an extensive background presence of carr woodland on the fen peat. There was, however, little evidence for woodland on drier ground. Clearance was extensive at Bole Ings, Notts after 2690±100 BP, 1200-500 calBC, although the occurrence of the weevil *Curculio villosus* suggested at least some oak trees remained (Brayshay and Dinnin 1999).

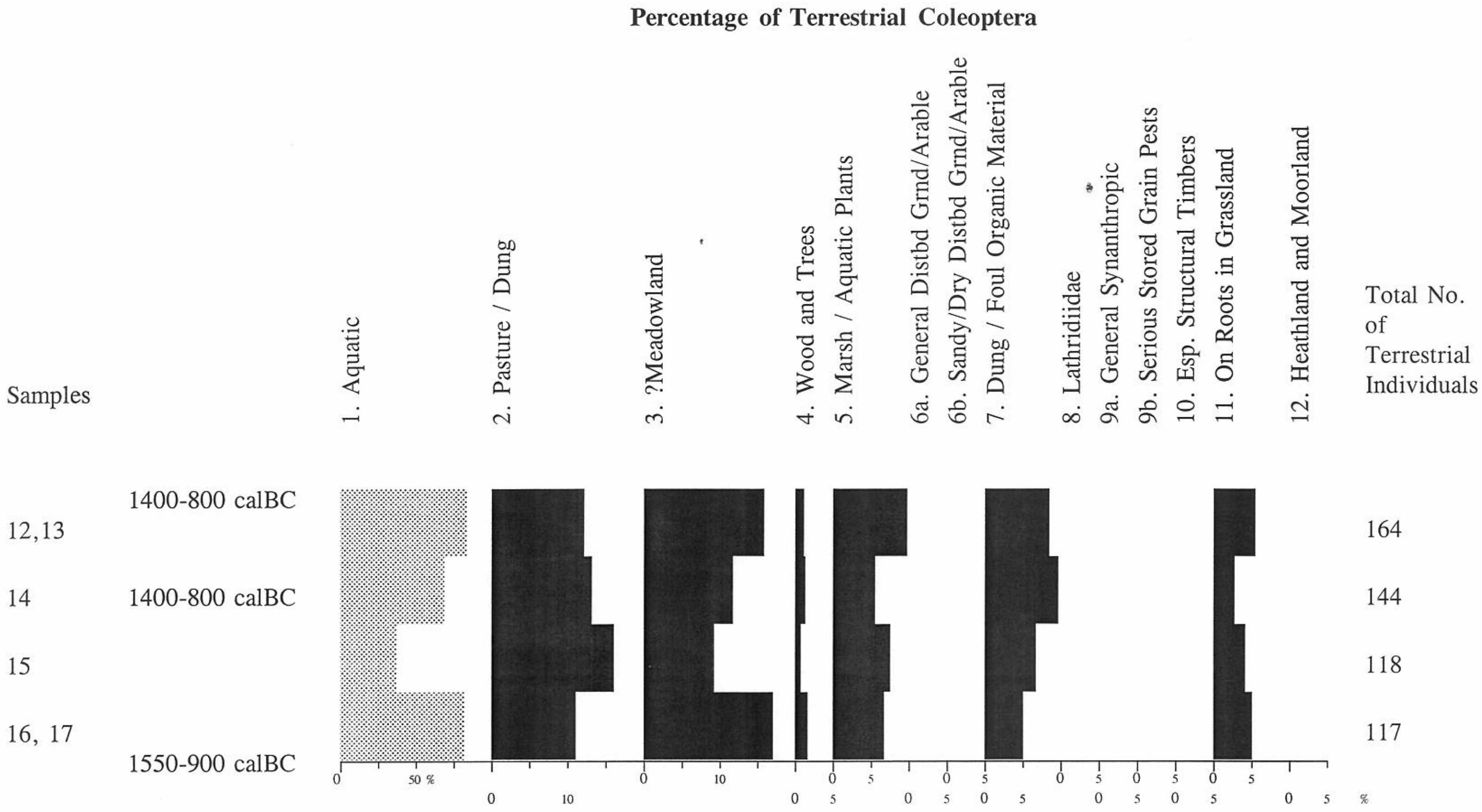
Other late Bronze Age sites in the region gave less evidence of woodland and some Iron Age sites were very open indeed. The proportion of wood and tree-dependent Coleoptera from a late Bronze Age ditch on the gravels of the River Welland near Etton (Etton/Welland) was below 2% of the terrestrial Coleoptera (Robinson, unpublished d). A radiocarbon date of 3040±45 BP, 1430-1160 calBC was obtained on organic material from the bottom of the ditch. The more host-specific of these beetles were species which feed on *Salix* and *Populus* spp. (willows and poplar) for example *Chalcoides* sp., or just *Salix* spp., for example the now rare *Acalyptus carpini*. It is possible that the immediate landscape was entirely open apart from willows / sallows lining the ditch. Values around 1.5% were obtained for wood and tree-dependent Coleoptera from a sequence of sediments in a palaeochannel of the River Avon at Pilgrim Lock, Warks (Fig. 9, Species Group 4) (Osborne 1988). The sequence ranged in date from 3006±117 BP, 1550-900 calBC (Birm-247) towards the bottom to 2890±100 BP, 1400-800 calBC (Birm-632) at the top. They included *Ochina ptinoides*, which feeds on dead wood of *Hedera helix* (ivy), *Scolytus rugulosus*, which is a bark beetle of rosaceous trees and shrubs (hawthorn, sloe etc), and species which feed more generally on dead wood. *Anthonomus rubi* was indicative of the presence of *Rubus* spp.

Percentage of Terrestrial Coleoptera



Species groups expressed as a percentage of the total terrestrial Coleoptera (ie aquatics excluded). Not all the terrestrial Coleoptera have been classified into groups.

Fig. 8: **Species Groups of Coleoptera from late Bronze Age Flag Fen**



Species groups expressed as a percentage of the total terrestrial Coleoptera (ie aquatics excluded). Not all the terrestrial Coleoptera have been classified into groups.

Fig. 9: **Species Groups of Coleoptera from Pilgrim Lock**

(brambles).They need have reflected no more than clumps of tees and old bushes on the river bank. However, trees or hedges were probably more widely scattered in the landscape.

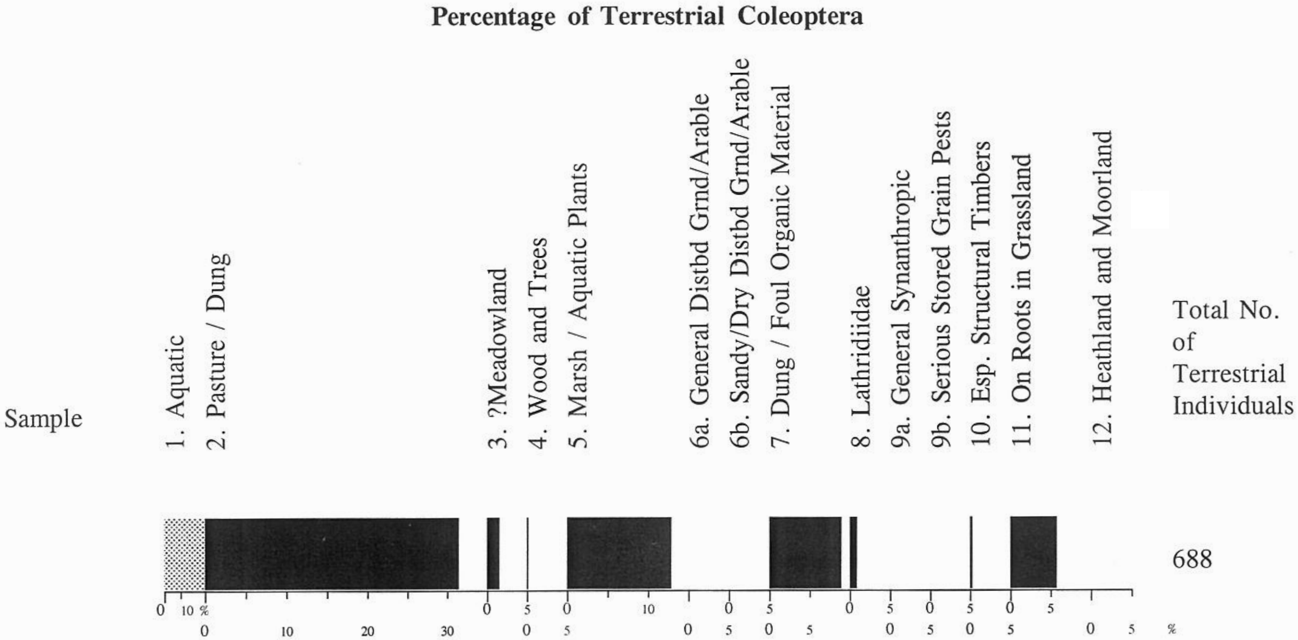
A very large assemblage of insects was recovered from the outer ditch of a late Iron Age defended enclosure on the gravels of the River Witham at Tattershall Thorpe, Lincs (Chowne *et al.* 1986). A radiocarbon date of 2350±90 BP, 800-200 calBC (HAR-4315) was obtained on wood from the ditch. Wood and tree-dependent Coleoptera (Species Group 4) comprised 2.0% of the terrestrial Coleoptera from the samples. Some of these insects were possibly from thorn hedges related to the enclosure including *Scolytus mali* and *Acalles turbatus* (mis-identified as *A. ptinoides*). Others, however including *Rhynchaenus quercus* (oak leaf weevil) and the arboreal caterpillar-feeding carabid beetle *Calosoma inquisitor*, suggested that a little woodland or at least some clumps of trees remained in the vicinity of the site. The occurrence of *Ochina ptinoides* suggested that ivy grew up the trees.

All the other Iron Age sites which have been investigated from the region, most of which also lay on river gravels, gave values of 1% or less for Species Group 4. Wood and tree-dependent Coleoptera only comprised 0.2% of the terrestrial Coleoptera from an Iron Age enclosure ditch on the gravels of the River Tame at Fisherwick, Staffs (Fig. 10) (Osborne 1979). However some examples of *Ptinomorphus imperialis* were discovered in tunnels which had been bored into a piece of *Prunus spinosa* (sloe) wood. Very low values of Species Group 4 were obtained from a late Iron Age enclosure ditch radiocarbon dated to 1940±100 BP, 2000 calBC - calAD 350 (HAR-5614) at Caldecotte, Milton Keynes, Bucks (Robinson 1994a), a palaeochannel containing occupation debris next to an Iron Age settlement at Market Deeping, Lincs (Robinson, unpublished i) and swamp sediments radiocarbon dated to 2410±110 BP, 850-200 calBC (HAR-4905) at Coulters Garage, Alcester (Girling 1985-86). Wood and tree-dependent Coleoptera were entirely absent from the ditch of an Iron Age enclosure at North Furzton, Milton Keynes, Bucks (Robinson, unpublished j) and from amongst a large assemblage of insects from an Iron Age enclosure ditch on the gravels of the River Nene at Wollaston, Northants (Robinson, unpublished k).

There results can be interpreted as showing that there had been extensive clearance in the region on at least the river gravels by the late Bronze Age. There was limited woodland and scrub on some of these sites but this habitat had largely disappeared from certain Iron Age sites. Even on those sites with wood and tree-dependent Coleoptera, scrub could largely have been in the form of hedgerows along boundaries and bushes at the margins of water courses. However, the results from Flag Fen serve as a reminder that parts of the landscape had retained much tree cover. Little is known of the extent of woodland away from the river gravels during the Iron Age.

Grassland, Pasture and the Open Landscape

Insects of open habitats, particularly grassland, were identified from all the late Bronze Age and Iron Age sites which have been investigated in the region. Small assemblages of insects were investigated from late Bronze Age water holes or pits at Feltwell Anchor, Norfolk, High Fen Drove, Northwold, Norfolk and Deeping St. James, Lincs (Robinson, unpublished e, l, m). All contained examples of the beetle *Phyllopertha horticola*, whose larvae feed on the roots of grassland herbs, and scarabaeoid dung beetles. This suggested that there was grazed grassland in the vicinity of these deposits. Chafers, such as *P. horticola* and elaterid beetles with similar life cycles, such as *Agrypnus murinus*, were also present in the sequences



Species groups expressed as a percentage of the total terrestrial Coleoptera (ie aquatics excluded). Not all the terrestrial Coleoptera have been classified into groups.

Fig. 10: **Species Groups of Coleoptera from Iron Age Fisherwick**

associated with the late Bronze Age platform at Flag Fen, Cambs (Fig. 8, Species Group 11) (p.66) (Robinson 1992b; Robinson, unpublished f). They would have been unable to develop in wet peat, suggesting that there was grassland on the drier ground with a mineral soil surrounding the fen. Scarabaeoid dung beetles (Species Group 2) comprised around 6.5% of the terrestrial Coleoptera, suggesting this grassland was being grazed by domestic animals. Most numerous was *Aphodius* cf. *sphacelatus*, but there was also a single example of *Onthophagus taurus*, which is now extinct in Britain (Table 5).

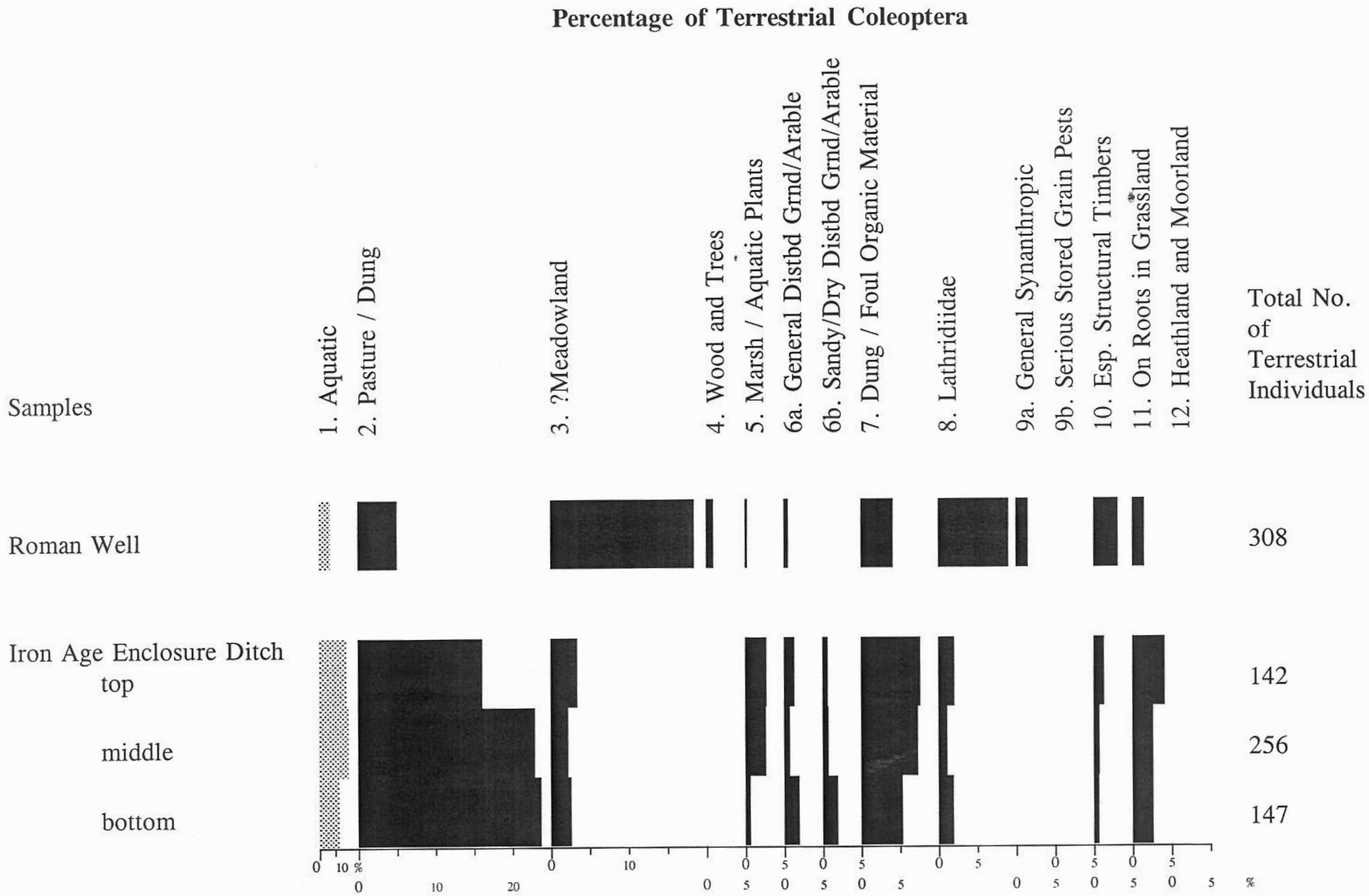
Late Bronze Age pastoral landscapes were evident on the gravels of the River Welland near Etton (Etton/Welland p.66) (Robinson, unpublished d) and alongside the River Avon at Pilgrim Lock (p.66) (Osborne 1988). The chafers and elaterids of Species Group 11 with larvae that feed on the roots of grassland herbs comprised over 12% of the terrestrial Coleoptera from the former site and around 5% of the terrestrial Coleoptera from the latter site (Fig. 9). The faunas of both sites appear to have been ones of well-drained, floristically rich, permanent grassland. Clover and vetch-feeding weevils of the genera *Apion* and *Sitona* (Species Group 3) such as *A. craccae* and *S. hispidulus*, which are favoured by hay meadow conditions, were particularly abundant from Pilgrim Lock, where they comprised over 15% of the terrestrial Coleoptera in some of the samples. This value is sufficiently high that some of the grassland could have been in the form of true meadowland, that is grassland mown for hay. Species Group 3 was also well-represented at Etton/Welland, where they made up of 10% of the terrestrial Coleoptera. Other phytophagous Coleoptera that feed on grassland herbs were abundant at Etton/Welland, for example *Gymnetron pascuorum*, whose sole host plant is *Plantago lanceolata* (ribwort plantain). Scarabaeoid dung beetles of Species Group 2 comprised around 13% of the terrestrial Coleoptera from Pilgrim Lock and 9% of the terrestrial Coleoptera from Etton/Welland. Most numerous of these beetles from both sites were species of *Aphodius*. At Pilgrim Lock, they included *Aphodius contaminatus*, which can be common in late Bronze Age and more recent assemblages but does not yet seem to have been recorded from sites earlier in the Bronze Age or sites of Neolithic date. Other members of Species Group 2 from the two sites were species of *Onthophagus*, including species which are now extinct or of uncertain status in Britain (Table 5). *O. nutans* and *O. taurus* were present at Pilgrim Lock while *O. fracticornis* and *O. nutans* were found at Etton/Welland. There must at least have been episodes when there was a strong presence of domestic animals grazing the grassland although at other times grazing was sufficiently light to allow the rich grassland flora to flower. It is possible that the grassland was managed so that some areas were grazed and others cut for hay.

It is more difficult to distinguish an arable component in insect assemblages than a grassland component. Many of the insects from Pilgrim Lock and Etton/Welland can occur in arable as well as grassland habitats, but the carabid beetles of Species Group 6, which show a certain association with arable, were absent. Some of the phytophagous species from both sites can attack arable weeds, such as *Stenocarus umbrinus* from Pilgrim Lock on *Papaver rhoeas* (field poppy) and *Ceutorhynchus erysimi* from Etton/Welland on Cruciferae but such weeds are not restricted to arable habitats. It is, however, entirely plausible that there was arable activity around these sites.

The Iron Age sites on river gravels also had major grassland components to their insect assemblages. Grazing pressure seems to have been very heavy at Wollaston (p.69) (Robinson, unpublished k), North Furzton (p.69) and Fisherwick (p.69) (Osborne 1979). The percentage of scarabaeoid dung beetles of Species Group 2 had risen in comparison with the late Bronze Age sites to between 21% of the terrestrial Coleoptera at Wollaston (Fig. 11) to 31% of the terrestrial Coleoptera at Fisherwick. Species of *Aphodius*, particularly *A. contaminatus*, predominated and there were no records of species of *Onthophagus* now extinct in Britain. However, a species of *Aphodius* which is now extinct in Britain, *A. varians*, was identified from North Furzton and was possibly present at Wollaston. Ten of the examples of *A. varians* from North Furzton were found in an agglomeration of beetle sclerites amongst the skeleton of a medium sized toad (*Bufo* sp.). A minimum of 66 individual beetles were represented by the sclerites associated with the toad bones, mostly species of *Aphodius*, particularly *A. granarius*, but including *Hister bissexstriatus*, another beetle which readily occurs in dung. It is likely that the toad had been feeding on Coleoptera emerging from the droppings of domestic animals in the vicinity of the enclosure ditch in which it was found. With more intensive grazing and therefore short-turfed grass, conditions would have been less favourable for the phytophagous beetles of Species Groups 3 and 11. The values for the clover and vetch-feeding weevils of Species Group 3 had fallen to between 2.8% of the terrestrial Coleoptera at Wollaston and 1.6% of the terrestrial Coleoptera at Fisherwick. Numbers of other phytophagous insects of grassland plants were also reduced. The raising of domestic animals was clearly a major function of the settlements at Fisherwick, North Furzton and Wollaston. It is very likely that the enclosure ditches from which the samples were obtained were concerned with the management of stock. An Iron Age ringwork in the Fens at Coveney, near Ely, Cambs, also seems to have had a major involvement in stock rearing, with numerous scarabaeoid dung beetles being recovered from its ditch (Robinson, unpublished n). Although only a small sample was investigated from the waterlogged basal fill of the ditch to the Iron Age hillfort at Midsummer Hill, Herefordshire, the numerous examples of *Aphodius* spp., particularly *A. contaminatus*, suggested a concentration of domestic animals in or around the hillfort (Osborne 1981).

Rather lower values for scarabaeoid dung beetles were recorded for the other Iron Age sites in the region. Even so, all three sites had significant faunas of grassland insects and the grazing of domestic animals was still a feature of the landscapes around them. For example, at the defended Iron Age enclosure at Tattershall Thorpe (p.69) (Chowne *et al.* 1986), the chafer *Phyllopertha horticola* was unusually abundant and members of Species Group 11 comprised 17.6% of the terrestrial Coleoptera. They were so numerous that their larvae were probably having an adverse effect on the growth of the grass. The clover and vetch-feeding weevils of Species Group 3 were quite well represented at 6.4% of the terrestrial Coleoptera. Given the numerous seeds of *Leontodon* sp. (hawkbit) found from the ditch, it is thought possible that the beetles attributed to *Polydrusus* spp. could have been *Phyllobius viridiaeris*, which feeds on Compositae, especially *Leontodon* spp. They made up over 3% of the terrestrial Coleoptera. This, along with records of other phytophagous grassland Coleoptera, for example *Gymnetron labile*, which feeds on *Plantago lanceolata* (ribwort plantain), provided strong evidence for herb-rich grassland. Scarabaeoid dung beetles, of which *Aphodius prodromus* was the most abundant, comprised 11.8% of the terrestrial Coleoptera.

Although it is very likely that many of the Iron Age sites that were investigated for insects were involved in arable agriculture, insect evidence of this came from one site alone. Only at Wollaston (p.69) (Robinson, unpublished k), where the gravel terraces of the River Nene would have been very suitable for cultivation, was there a significant presence of the two groups of ground beetles that are favoured by arable habitats. Species Group 6a, which was



Species groups expressed as a percentage of the total terrestrial Coleoptera (ie aquatics excluded).
Not all the terrestrial Coleoptera have been classified into groups.

Fig. 11: **Species Groups of Coleoptera from Wollaston**

represented by *Agonum dorsale* and *Harpalus rufipes*, comprised around 1.5% of the terrestrial Coleoptera, while Species Group 6b, which was represented by *Amara apricaria* and *A. bifrons*, comprised a similar proportion of the Coleoptera (Fig. 11). The former group can be found in a wide range of weedy disturbed ground and arable habitats, the latter group tends to occur on dry and sandy ground. Members of Species Group 6 were absent for the other large assemblages of Iron Age insects from the region, for example Fisherwick and Tattershall Thorpe.

Fen, Marsh and Aquatic Habitats

No late Bronze Age or Iron Age riverine assemblages have been investigated from the region. Many of the insect samples of this period were from ditches and water holes on settlement sites. These usually supported numerous small water beetles, particularly from the Hydrophilidae and Hydraenidae. The most numerous were *Helophorus* spp. (*brevipalpis* size) and *Ochthebius minimus*. In some instances the small weevil *Tanysphyrus lemnae* suggested that the surface of the stagnant water in the feature was carpeted by its host plant, *Lemna* sp. (duckweed). The occurrence of the staphylinid beetles *Lesteva longoelytrata* and *Platystethus cornutus* gp. in sone of these deposits was probably related to a splash zone of organic-rich mud around them from their use as water holes for both humans and domestic stock.

One fenland sequence was investigated in detail from the peats within which the late Bronze Age timber platform at Flag Fen was stratified (p.66) (Robinson 1992b; Robinson, unpublished f). The Coleoptera suggested that the peat formed under well-vegetated stagnant water. The most numerous beetle was the duckweed-feeding *Tanysphyrus lemnae*. The main emergent reedswamp monocots seem to have been *Phragmites australis* (common reed), the host plant of *Donacia clavipes* and *Plateumaris braccata*, and *Sparganium erectum* (bur-reed), the host of *Donacia marginata*. Minor components of the aquatic vegetation included *Nymphaea* or *Nuphar* sp. (water-lily), the food plants of *Donacia* cf. *crassipes*. In addition to the permanent or almost permanent shallow water where the bur-reed and water-lilies would have grown, there was evidence from numerous Carabidae, such as *Blethisa multipunctata*, that the reedswamp zone merged with an extensive area of exposed peat supporting sedges. One of these beetles, *Pterostichus aterrimus*, is now very rare, being restricted in Britain to a few localities in Hampshire, Cambridgeshire and Norfolk with peaty soil. It was identified from both the platform and the fen peat. There were also beetles which occur in decaying organic debris in reedswamp, for example *Corylophus cassidoides*. A small assemblage of insects from an Iron Age swamp deposit at Coulters Garage, Alcester (p.69) (Girling 1985-6) included the minute, very rare, or at least very obscure, beetle of wet mud, *Sphaerius acaroides* (Table 4) as well as species of reedswamp vegetation, for example *Prasocuris phellandrii*, which feeds on aquatic Umbelliferae (water dropwort etc).

Human Habitation, Refuse and Structures

One aspect of insect assemblages from settlement sites of this period is the occurrence of phytophagous insects which feed on ruderal plants. Most of these plants would also have been able to grow in other habitats, for example river banks and at the edge of scrub. Indeed these probably were the habitats of such beetles when they were recorded from earlier periods. In particular, insects which feeds on Malvaceae (mallows) and *Urtica dioica* (stinging nettle) tended to be associated with settlements. For example, the following five species of beetles (all weevils) and one species of bug were identified from the Iron Age enclosure at Wollaston (p.69) (Robinson, unpublished k):

Apion malvae	on	Malvaceae
A. rufirostre	on	Malvaceae
A. aeneum	on	Malvaceae
A. urticarium	on	*U. dioica*
Cidnorhinus quadrimaculatus	on	*U. dioica*
Heterogaster urticae	on	*U. dioica*

The larger scale of settlement activity during this period means that more sites have evidence of refuse, structures and habitation. However, it was the absence of these insects from the late Bronze Age timber platform at Flag Fen which was important in showing that the site was not a settlement and that the timbers had rapidly become waterlogged once they were placed in the peat (Robinson 1992b).

Refuse

On most of the settlement sites it has proved difficult to differentiate insects of naturally occurring accumulations of foul organic debris and dung from those of man-made dumps of refuse. For example, the numerous examples of *Megasternum obscurum* from the Iron Age defended enclosure at Tattershall Thorpe (p.69) (Chowne *et al.* 1986) could have come from any of these habitats. A sample of a midden-type deposit at Market Deeping (p.69) (Robinson, unpublished i) contained various beetles of foul organic material belonging to Species Group 7 such as *Cercyon analis*, *Megasternum obscurum* and *Anotylus rugosus*, but they were not unusually abundant for a rural site. However, the occurrence of *Oxytelus sculptus* is very much characteristic of refuse. Most of these beetles had probably been dumped in the palaeochannel with the refuse.

Timber Structures

Although *Anobium punctatum* (woodworm beetle) was identified on the majority of late Bronze Age and Iron Age sites, it was the only member of Species Group 10, beetles which favour structural timbers, from this period and it rarely exceeded 1% of the terrestrial Coleoptera. Even so, *A. punctatum* was probably occurring in structural timbers on these sites.

Habitation

The synanthropic beetles of Species Group 9 were absent from the late Bronze Age sites that have been investigated in the region. There was, however, a slight presence of *Ptinus fur* at Tattershall Thorpe (p.69) (Chowne *et al.* 1986), Market Deeping (p.69) (Robinson, unpublished i) and Caldecotte (p.69) (Robinson 1994a). There can be little doubt that *P. fur* was living inside buildings on these sites, feeding on debris from food preparation, cereal waste including damp straw etc. *Typhaea stercorea*, which tends to be associated with mouldy hay and straw, was represented by a single individual at Caldecotte. *Stegobium paniceum*, a minor grain pest that also attacks many other stored products (p.61), was identified from Tattershall Thorpe and Market Deeping, where it was as likely to have been feeding on cereal processing waste in the corners of buildings as infesting stored commodities. All these beetles belong to Species Group 9a, general synanthropic species. Although they flourish in indoor habitats, they all probably have natural habitats in Britain away from human influence, for example birds' nests. There were no records of the serious pests of stored grain which belong to Species Group 9b from this period, indeed it seems possible on present evidence that such species were not introduced to the British Isles until the Roman period. The values for Species Group 9a on the three Iron Age sites were all below 1%, which probably implies less "intensive" occupation on settlements than was seen in later periods. The Lathridiidae (Species Group 8), beetles which are favoured by human habitation because they fed on moulds in thatch, on old hay etc, were not particularly abundant. However, two examples of the beetle *Aglenus brunneus*, which formerly flourished in profusion in composted organic debris on floors of buildings, were found at Market Deeping. *Xylodromus concinnus*, which has often been found in company with *A. brunneus*, was also recorded.

Honey Bees
Remains of worker *Apis mellifera* (honey bee) were found from the Iron Age enclosure ditches at Coveney (p.72) (Robinson, unpublished n), Caldecotte (p.69) (Robinson 1994a) and Wollaston (p.69) (Robinson, unpublished k) (Table 7). The occurrences at Coveney and Wollaston are of interest because the discovery of several examples suggested that they were not simply stray finds. Honey bees from a colony tend to choose a particular place to drink even when there are other water sources nearby. Inevitably some fall in and drown. It is probable that the terminals of the ditches were being used as such drinking places. The apparently very open landscape round Wollaston would not have been a very suitable locality for a wild colony of honey bees to nest because they tend to prefer old hollow trees. While it is possible that they were nesting in an abandoned building, at least at Wollaston, the most likely explanation for the bees is that there was a hive nearby.

Climate
The late Bronze Age has traditionally been regarded as a period of climatic deterioration, ie the climate becoming colder and wetter. Lamb (1981, 54-5) estimated that there was a fall of nearly 2°C in overall mean temperature in England between about 1250 and 850 BC. Taken in isolation, the insect evidence might be taken to support such a hypothesis. The insect assemblages from Pilgrim Lock (p.66) (Osborne 1988) spanned the date range 3006±117 BP, 1550-900 calBC to 2890±100 BP, 1400-800 calBC. The fauna included two species of *Onthophagus* dung beetles which are now extinct in Britain, *O, nutans* and *O. taurus*. Osborne (1982; 1988) argued that the occurrence of these two species, which are still to be found further south in Europe, was suggestive of summer temperatures warmer than at present (Pilgrim Lock is called Bidford-on-Avon in Osborne 1982. Bidford-on-Avon in Osborne 1988 is a separate site of Iron Age date about 1km distant). The absence of exotic species of *Onthophagus* and the paucity of those members of the genus *Onthophagus* which are still extant in Britain amongst dung faunas from the Iron Age palaeochannel deposit at Bidford-on-Avon, which was dated to 2270±90 BP, 800-50 calBC (HAR-3069), and from the Iron Age settlements at Fisherwick (p.69) was used as evidence for a decline in summer temperatures to today's levels in the Iron Age.

The results of subsequent work in the region tend to confirm the trend for *Onthophagus* species. Exotic species of *Onthophagus* were identified from Flag Fen (p.71) and the Etton Landscape site (p.71), both of which were late Bronze Age in date whereas they were absent from more recent sites. However, another species of dung beetle, *Aphodius varians*, which is also now extinct in Britain but occurs further south in Europe was identified from North Furzton, a site of Iron Age date. In addition, some of the species of *Onthophagus* which are now extinct in Britain have been recorded from Iron Age sites in Oxfordshire (eg Robinson 1990). Their persistence in the British fauna into the 19th century has already been

Table 7: **Records of Honey Bee from the Midlands Region**

Period	Iron Age				Roman		Middle Saxon	Late Saxon
	Coveney	Wollaston	Caldecotte	Stanwick	Scole	Godmanchester	West Cotton	Waterside Lincoln
Data from:	1	2	3	4	5	6	7	8
Apis mellifera L.	+	+	+	+	+	+	+	+

1. Robinson (unpublished n), 2. Robinson (unpublished k), 3. Robinson (1994a), 4. Robinson (unpublished p), 5. Robinson (unpublished v), 6. Robinson (unpublished c), 7. Robinson (unpublished x), 8. Carrott *et al.* (1995).

mentioned. Changes in grassland quality have also been advanced as the cause of their decline (p.64). Therefore, the insect evidence from the region for warmer conditions during the late Bronze Age and a climatic deterioration by the Iron Age is by no means unequivocal.

Discussion

The late Bronze Age and Iron Age insect assemblages from the region did indeed reflect the intensification and diversification of agricultural activity. Almost all the deposits of this date gave evidence for open agricultural landscapes. However, the concentration on the investigation of sites on the river gravels of the region for this period would have emphasised this trend. The results from Flag Fen showed that there were still extensive wetlands and also areas of woodland with insect faunas that have been little studied. The insects gave the impression that the open landscape was predominantly grassland being relatively lightly grazed in the late Bronze Age and more heavily grazed in the Iron Age. However, a bias towards grassland is inherent in insect evidence and arable agriculture was possibly an important activity on some of those sites where there was only a small element of species of weedy disturbed ground in the fauna.

Various categories of synanthropic insects were favoured by the structural timbers, accumulations of organic material and indoor habitats, although in no case did they become particularly abundant. The species that had adopted synanthropy appear all to have been native members of the British fauna. *Anobium punctatum* (woodworm beetle), for example, was adapted to developing in dry dead timber on trees but found an ideal habitat in structural timbers. The only insect identified so far from this period suspected of being an exotic import is *Apis mellifera* (honey bee) (Table 7), perhaps introduced for apiculture.

The insect evidence for climate during this period was by no means clear. Taken in isolation, it would suggest summer temperatures slightly warmer than at present in the late Bronze Age, with a climatic deterioration occurring by the Iron Age.

The Roman Period (Flandrian Late Zone III, AD43 - AD410)

Many of the developments which began in the late Bronze Age or Iron Age, related to agricultural intensification and organisation, continued into the Roman period. Towns and forts provided a new category of settlement-derived evidence. The Romans dug many pits and ditches below the water table on lower-lying settlements, which provide good sources of waterlogged organic sediments. Wells are usually present on settlements, even when the water table is deep, enabling evidence also to be obtained from dry landscapes. Organic sediments continued to accumulate in palaeochannels, fens etc but have been little studied for insects.

Woodland, Scrub and Hedges

There were few sites with insect evidence of true woodland from the Roman period. An example of *Lucanus cervus* (stag beetle) was identified from a Roman well at the Empingham Villa, Rutland (Buckland 1986). This beetle develops in partly buried rotten wood, particularly oak stumps. There are no recent records of this conspicuous beetle from the East Midlands although it formerly occurred in Sherwood Forest and it is possible that a relict population still survives there. A significant presence of woodland and scrub insects was recorded from palaeochannel sediment of the River Severn at Stourport, Worcestershire which was radiocarbon dated to 1770±60 BP, calAD 110-400 (Birm-1167) (Osborne 1995). Wood and tree-feeding beetles of Species Group 4 comprised 15% of the terrestrial Coleoptera. Some open scrub on acid soil was indicated by the scolytid beetle *Phloeophthorus rhododactylus*, which bores under the bark of *Ulex* spp. (gorse) and *Cytisus scoparius* (broom). However, there were also elements of a woodland ground beetle fauna (with for example *Patrobus atrorufus* and *Pterostichus oblongopunctatus)*, species which develop in rotten wood (for example *Denticollis linearis*) and tree leaf feeders (for example *Rhynchaenus quercus*). There was probably over 50% tree cover in the catchment although some grassland was certainly present (p.83). The following more host-specific of the beetles are dependent upon the following trees:

Phyllobius calcaratus	on	*Alnus glutinosa* (alder)
Curculio villosus	on	*Quercus* spp. (oak)
Scolytus scolytus	on	*Ulmus* spp. (elm)
Hylesinus crenatus	on	*Fraxinus excelsior* (ash)
Ernoporus caucasicus	on	*Tilia cordata* (small-leaved lime)

The range of tree species very much suggested established mixed deciduous woodland. The occurrence of *E. caucasicus* at least hints at continuity from mid Flandrian lime woodland.

Values for Species Group 4 were below 1% on almost all the other Roman sites that have been investigated and wood and tree-feeding beetles were entirely absent from some sites. This, in part, is probably because they were mostly settlement sites. In some instances beetles of this group may have been amongst wood imported for fuel, for example the cerambycid *Phymatodes alni*, which was found in a late 4th century AD well at a large Roman settlement on boulder clay at Wickford, Essex (Robinson, unpublished o). Other species, however, were probably living in thorn hedges on these sites, for example the bark beetle *Scolytus rugulosus*, which is associated with rosaceous trees and shrubs, also from Wickford. The occurrence of beetles which feed on *Salix* or *Populus* spp. (willow or poplar) on some of the lower-lying sites, for example *Chalcoides* sp. at the Stanwick Roman Villa complex in the

Nene Valley, Northants (Robinson, unpublished p), Wollaston, Northants, also in the Nene Valley (Robinson, unpublished k), Eastcotts in the Ouse Valley, Bedfordshire (Robinson, unpublished q) and Market Deeping, Cambridgeshire (Robinson, unpublished i) was possibly a reflection of these trees growing on the banks of water courses. The occurrence of buds of *Salix* sp. and sometimes *Populus* sp. in these deposits tends to support this interpretation. Another tree which the insect evidence suggested was of widespread occurrence on Roman settlements was *Fraxinus excelsior* (ash). The beetle *Leperisinus varius* (ash bark beetle) was identified from Wollaston, Eastcotts, the ditch of the Roman town at Towcester, Northants (Robinson 1992c) and the small Roman town on the gravels of the River Avon at Tiddington, Warwickshire (Robinson, unpublished s). It was very well represented from a large mid to late 3rd century AD pit at Wavendon Gate, Bucks (Robinson 1996b). There was strong evidence from both the macroscopic plant remains and the pollen that an ash tree grew adjacent to the pit. Of particular interest was the occurrence of the beetle *Lytta vesicatoria* in this deposit. It is mainly a Mediterranean insect but is sporadically found in Southern England. The adults chew on the leaves of various members of the Oleaceae, particularly ash. The dried elytra of this beetle are extremely poisonous but were well known in the classical world for their medicinal properties. *L. vesicatoria* is the notorious Spanish fly of medieval and post-medieval aphrodisiac potions but it does not seem to have been used by the Romans for this purpose. The occurrence of the beetle at Wavendon Gate does not, of course, demonstrate that it was being used for medicinal purposes there, but it is very likely that it was occurring in association with ash trees on the site.

Pasture, Haymeadow, Arable and Heathland

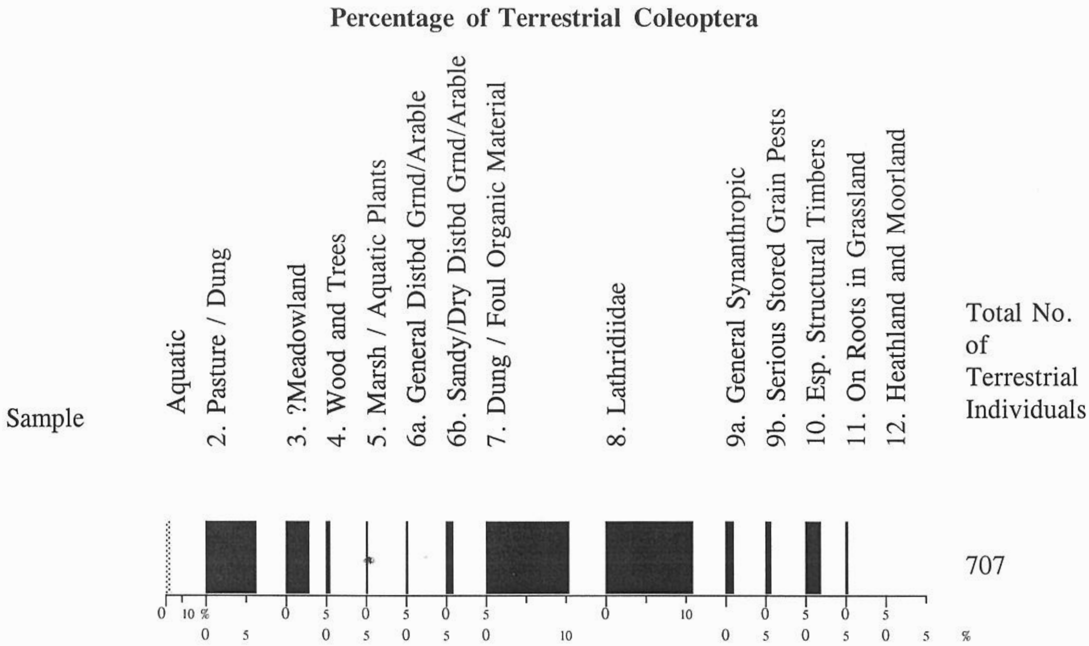
With the exception of those from Stourport (p.79), the majority of the terrestrial insects from Roman rural sites in the region were species of open country habitats. All the sites investigated gave at least some evidence from scarabaeoid dung beetles but some sites also had evidence for lightly grazed or ungrazed grassland that was possibly being cut for hay. Some sites also had insect faunas that would have been appropriate to arable conditions. Phytophagous species of grassland habitats such as *Agrypnus murinus*, *Athous* spp., *Agriotes* spp. and *Gymnetron* sp. were present although not particularly abundant in Roman wells at the Stanwick Roman Villa complex (p.79) (Robinson, unpublished p) and Empingham Villa (p.79) (Buckland 1986). Scarabaeoid dung beetles, particularly species of *Aphodius*, however, were very numerous, suggesting a high concentration of domestic animals adjacent to them. Similar conditions probably existed at the Denton Villa, Lincolnshire, where hand-picked insects from a Roman well included *Geotrupes spiniger*, *G. stercorarius* and *G. vernalis* (Britton 1971). Scarabaeoid dung beetles were numerous from a late 2nd century AD "dung pit" (probably a water hole in which organic refuse had accumulated) at Aston Mill, Worcestershire (Whitehead 1989; 1992). They included one species of *Onthophagus* now extinct in Britain, *O. nutans* and another, *O. fracticornis*, which is of uncertain status. A very rare histerid beetle which occurs in animal droppings, *Hister quadrimaculatus*, was also present. Species Group 2 comprised 10% of the terrestrial Coleoptera from a waterlogged pit and ditch associated with a possible kitchen garden enclosure at the Bancroft Villa, Milton Keynes, Buckinghamshire, suggesting that domestic animals were kept nearby (Pearson and Robinson 1994).

Much lower percentages of scarabaeoid dung beetles were recorded from the Roman well at Wickford (p.79) (Robinson, unpublished o), where they comprised 6.4% of the terrestrial Coleo2ptera and they only reached half this value from the Roman pit at Wavendon Gate (p.80) (Robinson 1996b). It is unlikely that there were concentrations of domestic animals in the vicinity of these deposits. Species Group 2 comprised around 4% of the terrestrial Coleoptera from two wells at a high status site on the gravels of the River Ouse near Godmanchester whereas they comprised around 15% of the terrestrial Coleoptera from a pond at the same site (Fig. 6) (Robinson, unpublished c). This suggests that the presence of domestic animals on the site was very localised.

Rather higher proportions of phytophagous Coleoptera which feed on grassland plants were found from the pit at Wavendon Gate, ditches at the Stanwick Villa complex, the Roman well at Wollaston, Northants (p.80) (Robinson, unpublished k) and the Roman pit at Eastcotts, Beds (p.80) (Robinson, unpublished q). The chafers and elaterid beetles with larvae which feed on the roots of grassland plants (Species Group 11) were not particularly abundant, ranging from 1.6% of terrestrial Coleoptera from Wollaston to 2.7% at Wavendon Gate. However, the proportion of clover and vetch-feeding weevils of Species Group 3 exceeded the scarabaeoid dung beetles of Species Group 2 from all these contexts. In addition to the members of Species Group 3, for example *Apion pomonae* which feeds on *Vicia* and *Lathyrus* spp. (vetches and tares) and *Sitona lepidus*, which mostly feeds on *Trifolium pratense* (red clover), other phytophagous Coleoptera which are favoured by hay meadow conditions were numerous. These included *Mecinus pyraster*, *Gymnetron labile* and *G. pascuorum*, which all feed on *Plantago lanceolata* (ribwort plantain) and in some instances also *P. media* (hairy plantain). Species Group 3 comprised 6.2% of the terrestrial Coleoptera from Wavendon Gate which need imply no more than the occurrence of lightly grazed, herb-rich and perhaps rather flowery grassland within the settlement. However, much higher percentages were given by the other sites, reaching 18.5% at Wollaston. It is thought very likely that there was grassland cut for hay on them. The evidence from the other insects would also support this interpretation, for example there were many examples of ants from the *Lasius flavus* group at Wollaston while grass-feeding bugs from the genus *Aphrodes* were numerous at Eastcotts. The scarabaeoid dung beetles showed the occurrence of some domestic animals on these sites as would have been expected. Indeed it is likely that the management of hay meadows would have included allowing stock to graze any regrowth (aftermath) once the grass had been cut.

At least a few of the Carabidae placed in Species Group 6 were present on most of the rural settlements. While they thrive under arable conditions, they also flourish on ground with bare patches and a sparse growth of weeds as occur in settlements. On some of the larger settlements where this group was present, including Wickford, (p.79) (Robinson, unpublished o), the Bancroft Villa (p.80) (Pearson and Robinson 1994), Godmanchester (Robinson, unpublished f) and Wavendon Gate (p.80), it is unlikely that they were from the landscape beyond the edge of the settlement. Whether they were from small cultivated plots within the settlements or from other open spaces remains uncertain. At Wickford, for example, Species Group 6a, which is favoured by general disturbed ground / arable, was represented by *Harpalus rufipes* and comprised 0.3% of the terrestrial Coleoptera (Fig. 12). Species Group 6b, which is favoured by sandy / dry disturbed ground / arable, was represented by *Amara apricaria*, *A. bifrons* and *A.* cf. *similata* and comprised 1.0% of the terrestrial Coleoptera.

Species Group 6a formed 2.0% and Species Group 6b 1.5% of the terrestrial Coleoptera from the pit in the possible kitchen garden enclosure at the Bancroft Villa (p.80) (Pearson and Robinson 1994) although these results alone cannot confirm the use of the enclosure for horticulture.



Species groups expressed as a percentage of the total terrestrial Coleoptera (ie aquatics excluded). Not all the terrestrial Coleoptera have been classified into groups.

Fig. 12: **Species Groups of Coleoptera from late 4th century Roman Well at Wickford**

It has already been noted that there was insect evidence for some open habitat with *Ulex* sp. (gorse) and *Cytisus scoparius* (broom) from a palaeochannel of the River Severn at Stourport (p.79) (Osborne 1995). While beetles such as *Agrypnus murinus* and *Apion* spp. suggested the occurrence of grassland, the presence of the weevil *Micrelus ericae*, which feeds on *Calluna vulgaris* and *Erica* spp. (heather) showed there was a heathland element to the flora.

Marsh, Fen and Aquatic Habitats

The only riverine insect assemblage of Roman date investigated from the region was from a palaeochannel of the River Severn at Stourport (p.79) (Osborne 1995). It had a rich and diverse fauna of elmid beetles, with seven species present including *Macronychus quadrituberculatus*, which is now of very restricted distribution. These beetles have extremely fastidious requirements for clean, well-oxygenated water. The larvae of *M. quadrituberculatus* feed on submerged wood which would accord with the evidence for partly wooded conditions at the site. This was the only site in the region from which the larvae of Trichoptera were investigated in detail. They suggested similar conditions to the elmid beetles, almost all now only being found in fast-flowing streams with clean, sandy or gravelly bottoms.

The same small water beetles from the Hydrophilidae and Hydraenidae that flourished in stagnant water in ditches and water holes in the region during the previous period (p.74) continued to be abundant in such archaeological features during the Roman period. The occurrence of *Tanysphyrus lemnae* in the pit at Wavendon Gate suggested that its host plant *Lemna* sp. (duckweed) congested the surface of the water (p.80) (Robinson 1996b). However, some of the deeper Roman wells gave clean water supplies and relatively few water beetles lived in them.

Insects were investigated from fen peat on two sites of Roman date. At Nordelph, Norfolk, peat was investigated from beneath a Roman road and the roadside ditch (Robinson, unpublished r). *Plateumaris braccata*, which feeds on *Phragmites australis* (common reed), was numerous in the peat beneath the road while *Plateumaris* cf. *affinis*, which feeds on *Carex* spp. (sedges) was found in the ditch. These results show that the road had been laid out across a reed fen. Peat formed in a small valley next to the Bancroft Villa, Milton Keynes, during the late Roman period, engulfing some of the outlying Roman structures (p.80) (Pearson and Robinson 1994). It contained numerous beetles of stagnant water from the genus *Helophorus* and a few beetles which feed on emergent aquatic vegetation, for example *Prasocuris phellandrii*, which feeds on aquatic Umbelliferae.

Some of the settlements investigated were close to low-lying ground which supported wet grassland or marsh vegetation and this was reflected in the insect assemblages. One noteworthy insect from such habitats was the cucujid beetle *Airaphilus elongatus*, which is now extinct in Britain but was recorded from two sites of Roman date (Table 4), a 4th century well at the Droitwich Villa, Worcestershire (Osborne 1973) and riverine sediments at Stourport (p.79) (Osborne 1995).

Urban and Rural Living Conditions and Settlement Activities

Insects have been investigated from a wide range of settlement types including major walled towns, smaller unwalled towns, forts and rural settlements. However, most work has been concentrated on rural sites.

Towns and Military Sites

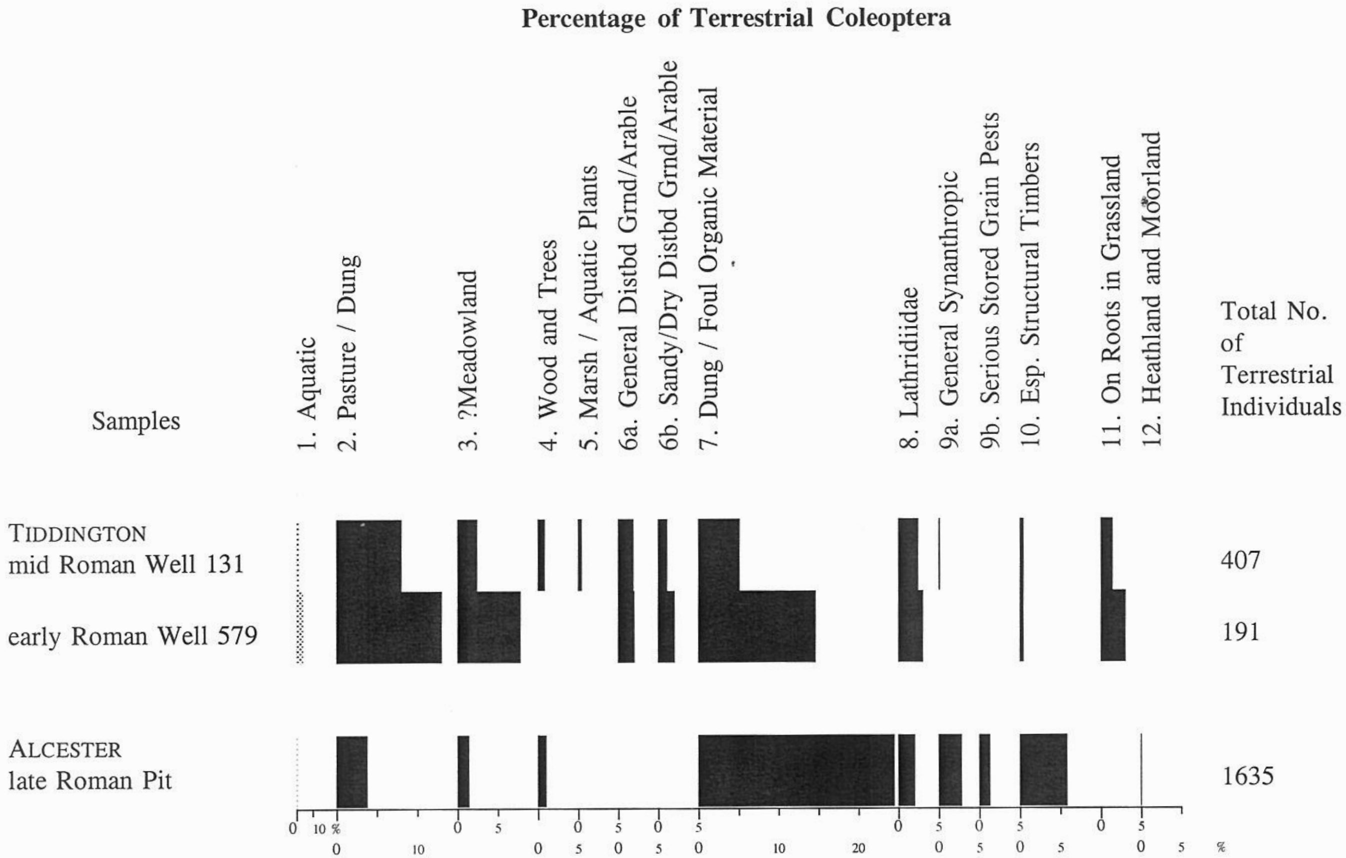
A substantial assemblage of insects was analysed from a 3rd century pit in the major walled town of Alcester, Warwickshire (Osborne 1971; Osborne 1994). The insects from it were almost all species associated with decaying organic refuse or indoor habitats and gave little indication of open habitats. Similar results were obtained from waterfront sites in Lincoln (Carrott *et al.* 1995). All the other urban insect assemblages gave evidence of weedy waste ground in the vicinity of the deposits. However, they were all from small, unwalled towns, suburban sites or in one case a town ditch rather than inside the walled area. For example, *Agonum dorsale* and *Harpalus rufipes*, carabid beetles which tend to be common on somewhat sparsely vegetated weedy disturbed ground including arable fields were, for archaeological deposits, particularly common from several wells at the small town of Tiddington, on the gravels of the River Avon, Warwickshire (Robinson, unpublished s). They ranged in date from early to late Roman. These beetles (Fig. 13, Species Group 6a) comprised around 2.5% of the terrestrial Coleoptera. Various species of *Amara* which favour bare sandy ground and arable (Species Group 6b) were also relatively abundant. The food plants of the more host-specific phytophagous Coleoptera and Hemiptera were mostly members of larger-leaved ruderal communities rather than arable weeds. Insects which feed on *Urtica dioica* (stinging nettle) were especially well represented, including:

Heterogaster urticae	*Apion urticarium*
Brachypterus urticae	*Ceutorhynchus pollinarius*

Others feed on Malvaceae especially *Malva sylvestris* (common mallow), including *Apion aeneum* and *Podagrica fuscicornis*. There was also a strong element which feed on Cruciferae (wild mustard), including various species of *Phyllotreta*, particularly *P. nigripes*. Rather similar pictures were given of much open space with waste ground vegetation inside the unwalled towns of Ashton, Northants, (Robinson, unpublished t), Elms Farm, Heybridge, Essex (Robinson, unpublished u) and Scole, Norfolk (Robinson, unpublished v).

Some of these towns gave evidence for the proximity of domestic animals. Scarabaeoid dung beetles of Species Group 2 comprised around 11% of the terrestrial Coleoptera from the Tiddington wells (Fig. 13). While the weevils of Species Group 3 which are favoured by hay meadow conditions were abundant from one of the wells at Tiddington, it is likely that they were feeding on Leguminosae growing amongst coarse herbage on the site. However, the chafer and elaterid beetles of Species Group 11, such as *Agrypnus murinus*, which feed on the roots of grassland herbs, comprised around 2% of the terrestrial Coleoptera. This suggested that there was grassland upon which the domestic animals could have grazed. It is relevant to establish whether they were grazing on pasture beyond the edge of the town or whether there were paddocks for livestock within the town. The other Coleoptera from the well suggested that there was a range of rich habitats for beetles close to the well. Thus insects of local origin would have been likely to predominate in the well over ones from distant sources. It is thought that these grassland and dung beetles had their origins within the town. The results from Ashton, Elms Farm and Scole also suggested that there were paddocks within those towns where domestic animals were kept.

The only military site to be investigated in the region was the fortress at the Lunt, Warwickshire, where a very small assemblage of insects was analysed from a 1st century AD well on the *intervallum* road (Osborne 1975). The Coleoptera from it included a few scarabaeoid dung beetles and the chafer *Phyllopertha horticola*.



Species groups expressed as a percentage of the total terrestrial Coleoptera (ie aquatics excluded). Not all the terrestrial Coleoptera have been classified into groups.

Fig. 13: **Species Groups of Coleoptera from Alcester Pit and Tiddington Wells**

The insect assemblage from the pit at Alcester contained a very high proportion of Coleoptera that are associated with decaying organic material. A quarter of the terrestrial Coleoptera belonged to Species Group 7, beetles which occur in a wide range of foul organic material (Fig. 13). Particularly numerous were species of *Cercyon* and *Platystethus arenarius*. While these species also occur in the droppings of domestic animals on pasture, the ratio between *Oxytelus sculptus* (not a member of Species Group 7), represented by 51 individuals, to *Anotylus sculpturatus*, represented by one individual, is highly characteristic of a dung-heap or other type of midden fauna. The abundance of *Leptacinus sulcifrons*, *Monotoma picipes* and *Anthicus floralis* is also suggestive of foul compost. In contrast, members of the Lathridiidae, which feed on moulds on such material as old hay and damp thatch, were not particularly abundant. The insects were probably living on the organic refuse when it was dumped in the pit and continued to thrive until it compacted down to the level of the water table. Whether the refuse was stable manure or waste from an industrial process remains uncertain.

Three sites close to the waterfront at Lincoln gave much evidence of late Roman dumps, of various kinds of decomposing organic matter including dung, onto waterside mud (Carrott *et al.* 1995). The sites were at Waterside North West, Waterside Foreshore and Woolworth's Basement. The organic refuse component of the insect assemblages was dominated by beetles which are associated with organic material on wet mud. These included many examples of *Carpelimus bilineatus*, *C. rivularis*, *Platystethus cornutus* and *P. degener* likely to have been breeding in the refuse as it became waterlogged. Other beetles, for example a range of *Cercyon* species, especially *Cercyon haemorrhoidalis*, *Anthicus* spp., *Platystethus arenarius* and *Oxytelus sculptus* were possibly well-established in the refuse before it was dumped. Some of the deposit, for example one of the dumps at Waterside North West, contained significant numbers of puparia of *Musca domestica* (house fly) and *Stomoxys calcitrans* (stable fly). *M. domestica* occurs in a wide range of sorts of decaying organic material, *S. calcitrans* has more restricted requirements but flourishes in old straw enriched with animal urine and dung. Stable manure may well have been the main component of this deposit but possible examples of puparia of the fly *Piophila casei* suggest that carrion was also present. Fly puparia, possibly of *Philygria* sp., suggested there were algae-rich puddles on the surface of this refuse dump.

Species of foul organic material occurred on the other urban sites in the region but they were not so abundant. They are noted as an element amongst the insects from the Alchester Road suburb of Towcester, Northamptonshire (Girling 1983) but unfortunately the tables of results were partly lost during the publication process. One of the pits at Scole gave a value of over 16% for Species Group 7, with *Cercyon sternalis* being especially numerous. Members of the Lathridiidae (Species Group 8), such as *Lathridius minutus* gp. were quite abundant at over 7% of the terrestrial Coleoptera. There was probably much rotting plant debris in the vicinity of this pit, if not amongst the backfill. Otherwise, however, insects of decaying organic material were not particularly abundant from the site.

Species Group 7 also comprised 15% of the terrestrial Coleoptera from one of the wells at Tiddington, mainly being represented by *Megasternum obscurum*, but they were not so abundant from the other contexts. Another of the Tiddington wells, however, contained three species of large carrion beetle: *Nicrophorus humator*, *Aclypea opaca* and *Silpha laevigata*. There was also a number of smaller beetles which are sometimes associated with carrion.

Although they only made a small proportion of Coleoptera from the well, these beetles were absent from the other wells. It is possible that they were either present on some dog carcasses which had been thrown into the well or had been attracted by the smell of floating carcasses. Coleoptera of foul organic material were no more numerous from Ashton and Scole than from many rural sites. There have so far been no discoveries of midden deposits with numerous puparia of *Musca domestica* (house fly) in the small towns.

The percentage of beetles of Species Group 10 which favour structural timbers was, at about 6% of the terrestrial Coleoptera from the Alcester pit, typical for a town with timber buildings in close proximity. *Anobium punctatum* (woodworm beetle), which was represented by over 80 individuals, had been joined by the rather rarer *Lyctus linearis* (powder post beetle). In addition to the native woodworm beetles, there were also 13 individuals of the cerambycid *Hesperophanes fasciculatus*. The larvae of this beetle, which is a Mediterranean species now most abundant in the Aegean, live in the wood of many different species of tree. The larvae of the beetle are sometimes transported in cut timber, to metamorphose and emerge after a protracted period. It is possible that the beetle had been imported to the site in packaging or furniture.

Both *A. punctatum* and *L. linearis* were identified from the Lincoln Waterside sites. They did not make up a high percentage of the total Coleoptera from these deposits but this was probably more due to the very high concentrations of beetles of decaying organic refuse and grain beetles in these deposits, rather than that these pests occurred less commonly at Lincoln than Alcester. Interestingly, however, there was a possible record of the woodworm predator *Korynetes caeruleus* from one of the Lincoln sites.

A. punctatum was identified from all the other urban sites that were investigated but was only abundant, at about 7% of the terrestrial Coleoptera, in the pit that contained the rich refuse fauna at Scole. *Lyctus linearis* was recorded from Elms Farm and the Roman fortress at the Lunt. These results do, however, show the use of structural timbers on these sites.

General synanthropic beetles (Species Group 9a) comprised 2.9% of the terrestrial Coleoptera from the pit at Alcester and were also well-represented in the Lincoln Waterside deposits. The most numerous of those from Alcester was *Typhaea stercorea*, which tends to be associated with old stable refuse and haystack bottoms, but *Ptinus* sp. was also present. In addition to *Ptinus fur*, *Tipnus unicolor* and possibly other species of *Ptinus* were present at the Lincoln Waterside sites. While *T. unicolor* also occurs in natural habitats such as birds' nests in Britain, in general terms it seems to be associated with more intensive human occupation that *P. fur* and is characteristic of Roman and more recent settlements. *Aglenus brunneus*, a synanthropic beetle of old granary residues and buried organic material, for example in floor layers, was present at Lincoln Waterside, although not in the huge numbers in which it has been recorded from some medieval towns outside the region. Other synanthropic beetles from Lincoln Waterfront included the staphylinids *Xylodromus concinnus* and *Crataraea suturalis*, both of which probably had their origin as nest insects but are now more usually found in such habitats as old granary waste, stables and cellars. Another species of stables and cellars which was present, *Blaps* sp., is of uncertain origin and not known from sites of pre-Roman date in Britain. The synanthropic beetles from the Alchester Road suburb of Towcester included another species of *Ptinus*, *P. subpilosus*, *Aglenus brunneus* and the carabid *Laemostenus terricola*. *L. terricola* tends to occur in and around houses, in cellars and in stables.

The most remarkable record from the Lincoln Waterside sites was a forewing of *Blatta orientalis* (oriental cockroach) from a late 4th century deposit at Waterfront North. It is the only archaeological find of a cockroach from Britain apart from a post-medieval example from York. *B. orientalis* is a notorious pest which in Britain is almost entirely confined to heated buildings although exceptionally it may survive on rubbish tips, probably as a result of heat generated by decay. It is believed that it originated in North Africa or Southern Central Asia and that the current population in Britain was introduced during the 16th century.

The species range and abundance of general synanthropic beetles was poorer from the unwalled towns than from the major towns. *Ptinus fur* was the only species commonly present, although it did comprise over 3% of the terrestrial Coleoptera from one of the pits at Scole.

The serious introduced stored-grain pests of Species Group 9b made up 1.4% of the terrestrial Coleoptera from the Alcester pit. Three species were present (Table 6):

Oryzaephilus surinamensis   *Sitophilus granarius*
Palorus subdepressus

The minor grain pests *Stegobium paniceum* and *Tenebrio obscurus*, which were perhaps originally native nest species, were also present. Serious grain pests, especially *Oryzaephilus surinamensis*, were much more abundant from the Lincoln Waterfront sites, being the most numerous species in some of the samples. Six species were present:

Tenebroides mauritanicus   *Tribolium castaneum*
Cryptolestes ferrugineus   *Palorus ratzeburgi*
Oryzaephilus surinamensis   *Sitophilus granarius*

Six species were identified from the Alchester Road suburb of Towcester (Table 6), adding *Cryptolestes turcicus* and *Tribolium confusum* to the list for the region. Grain beetles were absent from the samples investigated from the small towns of Scole and Tiddington. However, *O. surinamensis* was present at Ashton and has recently been noted, along with *Cryptolestes ferrugineus*, from an additional sample being processed from Elms Farm (Robinson, unpublished u).

The range of species and their abundance shows that serious grain pests were well established in the major towns rather than being of chance occurrence. *S. granarius* is the only one of them which can readily attack grain in good condition but once the surface has been nibbled, it is then rendered liable to infestation by the other species. Damp conditions which cause fungal growth can render grain liable to attack by *O. surinamensis* and once infestation has begun, sufficient warmth and moisture are released by the metabolism of the beetles to enable the spoilage of further grain and for infestation to become self-sustaining. All these serious pest species were probably Roman introductions. One species, *Cryptolestes turcicus*, so far only recorded from Towcester, is not now regarded as an established member of the British fauna because it only occurs under artificial conditions (Kloet and Hincks 1977). While the pit storage of grain which was practised in the Iron Age would not be conducive to these pests because of the build up of carbon dioxide which occurs in well-sealed storage pits (Reynolds 1979, 73-6), the above ground storage of grain in granaries as practised by the

Romans would have provided ideal conditions in which the beetles could flourish. Buckland (1978) estimated that 10% of Roman grain production in Britain was lost due to insect spoilage while in store. There is certainly evidence of very severe infestations elsewhere in Britain quite early in the Roman period, for example in a late 1st century granary in York (Kenward and Williams 1979).

Several species of blood-sucking insects were identified from the Lincoln Waterside sites. The occurrence of *Stomoxys calcitrans* (stable fly), whose larvae live in old straw enriched with animal dung and tends to occur around stables and byres has already been mentioned (p.86). It is a nuisance, biting both humans and their stock. Small numbers were found of puparia of *Melophagus ovinus* (sheep ked), a wingless fly which is an ectoparasite of sheep. It is unable to survive long away from its host, so the presence of *M. ovinus* suggested some sort of sheep-related activity occurring on the sites. Possibly sheep were being kept there temporarily, prior to being marketed, or wool was being cleaned. There was also a range of lice, bugs and fleas that live in close association with humans (Table 8):

Pediculus humanus ssp. *humanus* or *capitis*	body or head louse
Cimex columbarius or *lectularius*	pigeon or bed bug
Pulex irritans - larvae and adults	human flea

Pigeon and bed bugs are difficult to separate, but given the other insects from the deposits, it seems highly likely that the record was indeed of bed bug. An example of *C. columbarius* or *lectularius* was also found from the Alcester pit.

These insect parasites imply a low level of hygiene and cleanliness of the occupants of the site. Lice live in close contact with humans: body lice are favoured by the lack of frequent changes of clean clothes while head lice thrive in hair that is not combed with a fine-toothed comb. Both adults and larvae of human flea were found. They live in dirty houses, only the adults visiting their host to take blood, the larvae feeding on the droppings of the adults where the adults take refuge during the day. Bed bugs need cracks to hide in. All thrive where humans live in close proximity.

The full range of insects from the Lincoln Waterfront sites showed that some of the organic refuse had its origin in animal byres or stables. Refuse was also present from buildings where grain was stored, probably on a large scale. Finally, the deposits contained refuse from inside buildings, possibly heated, which had been used for human habitation.

Rural Settlements

Weedy waste ground seems to have been a usual feature of rural settlements. The fauna of this habitat from the 4th century well at the large Roman settlement at Wickford, Essex provides a typical example (p.79) (Robinson, unpublished o). Insects which feed on *Urtica dioica* (stinging nettle) were particularly prominent including the bug *Heterogaster urticae* and the following beetles:

Brachypterus urticae	*Cidnorhinus quadrimaculatus*
Apion urticarium	*Ceutorhynchus pollinarius*

There was also a range of beetles which feed on Malvaceae, most probably *Malva sylvestris* (common mallow):

Podagrica fuscipes	*A. aeneum*
Apion malvae	*A. radiolus*

Table 8: **Insect Ectoparasites of Humans and Domestic Animals from the Midlands Region**

Period		Roman		Middle Saxon	Late Saxon			Early Medieval
		Waterside, Lincoln	Alcester, Warwickshire	West Cotton, Northamptonshire	Waterside, Lincoln	Fishergate, Norwich	Biggleswade, Bedfordshire	Waterside, Lincoln
Data from		1	2	3	1	4	5	1
Damalinia cf. *ovis* (Schr.)	sheep louse	-	-	-	+	-	-	-
Pediculus humanus L.	body or head louse	+	-	-	+	-	-	+
Cimex columbarius Jen. or *lectularius* L.	pigeon or bed bug	+	+	-	+	+	-	-
Stomoxys calcitrans (L.)	stable fly	+	-	-	-	-	-	-
Melophagus ovinus (L.)	sheep ked	+	-	+	+	+	+	-
Pulex irritans L.	human flea	+	-	-	+	-	-	+
Siphonaptera indet.	flea	-	-	-	-	+	-	-

1. Carrott *et al.* (1995), 2. Osborne (1971); Osborne (1994), 3. Robinson (unpublished x), 4. Kenward and Allison (1994a), 5. Robinson (1994b).

Other plants of waste ground suggested by the insects included *Rumex* spp. (docks), the host of *Gastrophysa viridula*. The Carabidae (ground beetles) which are favoured by weedy waste ground with bare patches included *Bembidion obtusum* and *Harpalus* S. *Ophonus* sp. as well as the members of Species Group 6 discussed above (p.81).

Large accumulations of foul organic refuse do not seem to have been a major feature of the Roman settlements investigated. Such material was certainly present, for example Species Group 7, certain Hydrophilidae and Oxytelinae of dung and other foul organic material, comprised 10.5% of the terrestrial Coleoptera from Wickford (Fig. 12). The value for scarabaeoid dung beetles of Species Group 2 was low for this site, suggesting that some of the beetles were indeed from other sorts of decaying organic material. The most numerous species were *Megasternum obscurum* and *Anotylus sculpturatus* gp. However, none of the sites had the very high levels of those Coleoptera or Diptera puparia that occur in stable manure.

The beetles of Species Group 10, which infest structural timbers, were present on most of the settlement sites, generally at higher levels than in the Iron Age. They tended to comprise around 2% of the terrestrial Coleoptera. Apart from an example of *Lyctus linearis* from a Roman well on a high status site at Great Holts Farm, Boreham, Essex (Robinson, unpublished w), *Anobium punctatum* was the only member of Species Group 10 to be found.

The synanthropic beetles of Species Group 9a which occur in various indoor habitats occurred on most of the settlements investigated. They tended to comprise around 1% of the terrestrial Coleoptera, as for example at Wickford (Fig. 12). *Ptinus fur*, although generally the most abundant, had been joined by several other species, particularly *Typhaea stercorea*, but also including *Stegobium paniceum* and *Tipnus unicolor*. The habitats of all but *T. stercorea* have already been given. *T. stercorea* feeds on fungi on old hay and straw. At two of the sites where it was identified, Wollaston (p.80) (Robinson, unpublished k) and Eastcotts (p.80) (Robinson, unpublished q), there was possible evidence of grassland cut for hay, and its occurrence could have been related to haystacks. These are all native species with somewhat obscure habitats that have been able to flourish in much greater numbers when presented with their man-made counterparts.

Members of the Lathridiidae (Species Group 8) especially *Lathridius minutus* gp., ranged up to around 11% of the terrestrial Coleoptera, as at Wickford. Their abundance on most of these sites was sufficient to suggest that they were occurring in material such as haystack bottoms, old hay and straw, thatch etc on the settlements rather than just being derived from grass tussocks. At Wollaston, where it was speculated that haystacks might have been present, Species Group 8 comprised 9.1% of the terrestrial Coleoptera.

A rather unusual assemblages of insects was investigated from a Roman well at Great Holts Farm (p.91) (Robinson, unpublished w). The majority of them appeared to have been incorporated amongst organic refuse from inside a building which had been dumped in the well. The most numerous species was the beetle *Aglenus brunneus*, which is now very rare but was formerly characteristic of somewhat composted organic debris on floors, also occurring in stable and mill refuse (Kenward 1975). The general synanthropic beetles of Species Group 9a, represented by *Tipnus unicolor*, *Ptinus fur* and *Typhaea stercorea*, comprised 10% of the terrestrial Coleoptera while the Lathridiidae (Species Group 8) were at a similar level of abundance. Other beetles from the well which are characteristic of old damp hay or straw included the staphylinids *Phyllodrepa floralis* and *Xylodromus concinnus*. A couple of normal-sized adults of *Gymnetron pascuorum*, a grassland weevil that develops in the fruits of *Plantago lanceolata* (ribwort plantain), were present. There were also the elytra of two very dwarf Tychiinae which were probably *G. pascuorum*. It is possible that they had been derived from larvae in plantain heads cut with hay and had pupated early when the hay was dried. The debris which had been dumped in the well probably included old hay which had been trampled into the floor of the building.

The results from the region for Species Groups 8, 9a and 10 suggested an intensity of occupation of rural settlements greater than during the preceding period. There seems to have been a greater concentration of timber buildings and generally more material such as hay waste and old straw.

Although most of the Roman rural settlements were at least partly involved in cereal cultivation and large-scale crop processing occurred on some of the sites, the occurrence of serious pests of stored grain (Species Group 9b) was uneven. They were absent from, for example, the Stanwick Villa complex (p.79) (Robinson, unpublished p), Empingham Villa (p.79) (Buckland 1986) and Great Holts Farm (Robinson, unpublished w). However, *Cryptolestes ferrugineus* and *Oryzaephilus surinamensis* were identified from Godmanchester (p.81) (Robinson, unpublished c), Wickford (p.79) (Robinson, unpublished o) and the Bancroft Villa (p.80) (Pearson and Robinson 1994) (Table 6). *Sitophilus granarius* was recorded from a 4th century context at Lynch Farm, Peterborough, Cambs (Buckland 1981) while *S. granarius*, *O. surinamensis* and *Tribolium castaneum* were found in a 4th century well at the Droitwich Villa, Worcs (Osborne 1973). A late 4th century deposit of charred wheat grain containing numerous charred grain beetles was also found at the Droitwich Villa (Osborne 1977). Three species were present, *C. ferrugineus*, *O. surinamensis* and *Tribolium castaneum*. Unfortunately, the cereal remains were not identified in detail. The degree of infestation was heavy and it is possible that the grain had deliberately been burnt to destroy it.

The rather uneven occurrence of grain beetles on the rural settlements was possibly related to whether there was large-scale grain storage on them and the state in which the grain was stored. It is likely that surplus grain from many settlements was sent to the towns not long after harvest. If the grain that was needed on the rural settlements was stored in the spikelet form and only dehusked immediately prior to grinding, it would certainly be less vulnerable to attack. It is possible that infestations of serious grain pests were largely restricted to those settlements where there was large-scale storage of fully threshed grain.

Remains of workers of *Apis mellifera* (honey bee) were identified from two Roman wells at Godmanchester (p.81) (Robinson, unpublished c). A minimum number of 14 individuals were represented by the fragments recovered from one of the wells. Such a concentration of bees suggests bee-keeping on the site. It is possible that the bees in the well had been asphyxiated as part of the process of extracting honey from a skep and then discarded into the well. However, it is more likely that bees from a nearby colony were visiting the well to obtain water to dilute their honey. While this does not prove bees were being kept, a wild colony of bees in a settlement would have been a considerable nuisance. The Romans were familiar with relatively advanced apiculture and it is very likely that bee-keeping was practised in the region.

Introduced Insects

The serious grain pests of Species Group 9b are all likely to have been Roman introductions to Britain, mostly probably from the Mediterranean region (p.27, 88):

Tenebroides mauritanicus	*T. confusum*
Cryptolestes ferrugineus	*Palorus subdepressus*
C. turcicus	*P. ratzeburgi*
Oryzaephilus surinamensis	*Sitophilus granarius*
Tribolium castaneum	

Another indoor species, *Blaps* sp., could have been a Roman introduction.The human ectoparasites *Pediculus* ssp. *hammonis* or *capitis* (body or head louse), *Cimex columbarius* or *lectularius* (pigeon or bed bug) and *Pulex irritans* (human flea) are first recorded in Britain from Roman settlements but it is likely that some, if not all, of them have been in the British Isles for much longer. Perhaps some of them arrived with the first human colonists at the end of the Devensian. *Melophagus ovinus* (sheep ked) was also a Roman or earlier introduction (p.89). Two remarkable introductions recorded from the region were *Blatta orientalis* (oriental cockroach), possibly from North Africa (p.88) and *Hesperophanes fasciculatus*, a Mediterranean wood-boring beetle possibly from the Aegean (p.87). The occurrence of these insects emphasises the contrast between the region and the heart of the Roman Empire. There was a single record of *Pterostichus madidus* from a well at Tiddington (p.80) (Robinson, unpublished s) and another was found in a 4th century well at Bunny, Nottinghamshire (Alvey 1967). It is a carabid beetle that is now very common in arable fields, grassland and gardens but was only of sporadic occurrence in the Roman period and it has not been recorded from deposits of earlier date. Either *P. madidus* was a Roman introduction that was only just becoming established or some change occurred in the genotype of what had been a very rare native beetle, making it better adapted to the open landscape that humans had created.

Climate

There was no entomological evidence from the region to suggest that climatic conditions in the region were much different in the Roman period from those at present. Two carabid beetles identified from the Empingham Villa, Rutland (p.79) (Buckland 1986), *Brachinus crepitans* (bombardier beetle) and *Zabrus tenebroides* were on the northern limit of their range. *B. crepitans* favours warm grassy habitats, *Z. tenebroides* is associated with cereal crops in Continental Europe, where it is much more common. The heteropteran bug *Holcostethus vernalis*, for which there are only a few records from Southern England, was recorded from Wickford, Essex (p.79) (Robinson, unpublished o). The occurrence of another heteropteran bug *Heterogaster urticae* at Lincoln outside its present range, although it does occur further north elsewhere in England, possibly hints at slightly warmer conditions (Kenward 1995).

Discussion

The insect assemblages from the Roman countryside mostly reflected an organised agricultural landscape. Only one site, Stourport, Worcs., gave evidence of old woodland. Managed woodland was present although probably remote from settlements. Thorn hedges possibly ran along some boundaries while willows may have lined some low-lying drainage ditches. The Coleoptera from several sites raised the possibility that ash trees grew in some of the settlements or in hedges.

There was much evidence from scarabaeoid dung beetles for the grazing of domestic animals on pasture. However, not all sites had high concentrations of dung beetles, some gave evidence of grassland managed for hay. The need for hay had developed with the rise of towns, the demands of the army and possibly because more domestic animals were being overwintered within settlements rather than on pasture. Although it is difficult to confirm the occurrence of arable land from insect evidence, some sites had faunal elements appropriate to arable cultivation and other lines of evidence suggested their involvement in agriculture.

The storage of fodder, crops and perhaps the overwintering of domestic animals in settlements were some of the reasons why the synanthropic Coleoptera appear to show an increase in the intensity of occupation of settlements. *Anobium punctatum* (woodworm beetle) continued to proliferate but was joined by a much greater range of synanthropic beetles which are associated with old hay, mouldy straw etc. Large-scale, above-ground storage of grain, possibly in a fully cleaned state, enabled exotic grain beetles introduced by the Romans to flourish. They were established in some of the towns and the more important rural settlements. Some of these exotic species, for example *Tribolium castaneum*, which was identified from both rural and urban settlements, can only maintain themselves through the winter in heated buildings. The cosmopolitan nature of the Romans also resulted in the introduction of the oriental cockroach and an exotic wood-boring beetle. Along with these pests, ectoparasitic insects of humans (bugs, lice and fleas) were established in some of the towns.

The changes in the insect fauna in the region during the Roman period can all be attributed to aspects of Romanisation. Any changes due to natural factors were either slight or obscured by human activity.

The Dark Ages and Early to Middle Saxon Period (Flandrian Late Zone III, AD410 - 850)

The Dark Ages and early Saxon Period saw very much reduced activity in comparison with the previous period and recovery still had not reached Roman levels in the middle Saxon Period. The period is also the shortest of those into which the Holocene has been divided for this review. This combination has resulted in only limited palaeoentomological evidence being available. Evidence from settlements is lacking and while sediments continued to accumulate in palaeochannels, only one has so far been investigated. Insect remains have, however, been found preserved by toxic corrosion products of copper alloy items in Saxon inhumations in East Anglia.

Woodland and Scrub

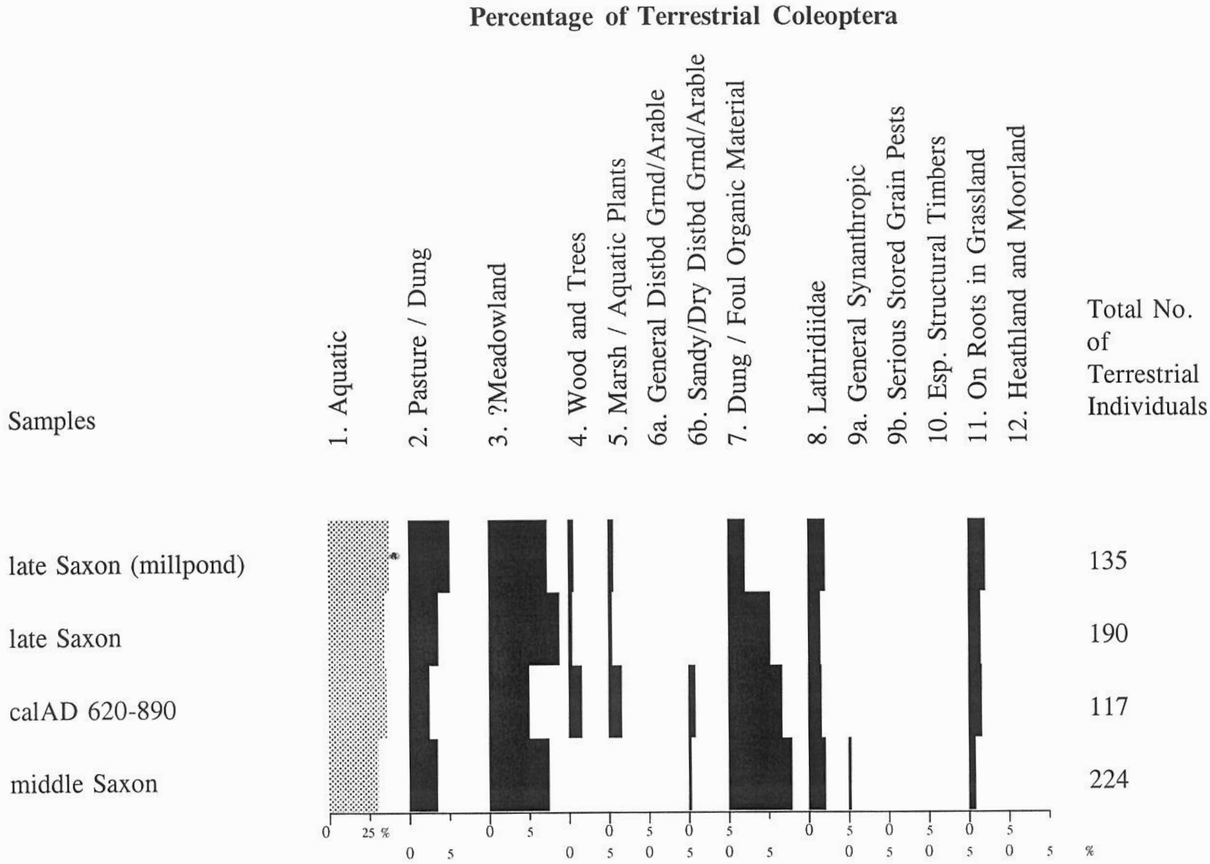
Although only a single site has been investigated which gave general landscape information, it did serve to show an open landscape apparently surviving from the Roman period. Sedimentation resumed in the palaeochannel of the River Nene at West Cotton from which Neolithic and Bronze Age insect remains were investigated (p.49) at the start of the middle Saxon period (Robinson, unpublished x). A radiocarbon date of 1295±70 BP, calAD 620-890 (OxA-4709) was obtained on flax capsules from retting debris at the bottom of the sequence. The wood and tree-feeding Coleoptera of Species Group 4 only comprised 0.5% of the total terrestrial Coleoptera from the palaeochannel (Fig. 14). This suggested that there had been little, if any, woodland regeneration in the catchment. Neither do the banks of the channel seem to have been tree-lined nor was it possible to detect any hedgerow element.

Grassland

While the insects suggested the landscape at West Cotton was very open, Scarabaeidae and Geotrupidae that feed on the droppings of domestic animals in grassland (Species Group 2) were, at 6.3% of the terrestrial Coleoptera, rather poorly represented. However, weevils of the genera *Apion* and *Sitona* such as *Sitona* cf. *lineatus*, which feed on grassland trefoils and vetches (Species Group 3), were much better represented, comprising 7.5% of the terrestrial Coleoptera. Under conditions of permanent pasture, the scarabaeoid dung beetles usually outnumber these weevils by a factor of two. Such results suggest that the grassland alongside the palaeochannel was managed as hay meadow and indeed the macroscopic plant remains from the deposits supported such an interpretation. Some of the more host-specific of the phytophagous grassland Coleoptera included *Sitona cambricus*, which feeds on *Lotus* spp. (bird's foot trefoil) and species of *Gymnetron* which feed on *Plantago lanceolata* (ribwort plantain). Amongst the other insect orders from the site, grass-feeding members of the genus *Aphrodes* were the most abundant Homoptera.

Disturbed Ground and Arable

There were many Carabidae and Staphylinidae from the West Cotton palaeochannel that occur in both grassland and arable. However, there was only a slight presence of the Carabidae which comprise Species Groups 6a and 6b, beetles which are favoured by arable and disturbed ground conditions. It is possible that there were cultivated areas on higher ground near the channel but the insect evidence is unable to confirm this. One species, *Aphthona* cf. *atrovirens*, represented by two individuals, was of particular interest. It can



Species groups expressed as a percentage of the total terrestrial Coleoptera (ie aquatics excluded). Not all the terrestrial Coleoptera have been classified into groups.

Fig. 14: **Species Groups of Coleoptera from West Cotton Saxon Palaeochannel and Millpond**

feed on *Linum usitatissimum* (flax) as well as *Helianthemum* spp. (rockrose). It is possible that it had been introduced to the deposit amongst flax being retted in the channel.

Settlement and Activities

The insect remains from the palaeochannel at West Cotton did not provide any firm evidence for the proximity of human habitation. The various beetles of foul organic material (Species Group 7) were quite abundant from the bottom of the sequence, but they were likely to have been living in plant debris alongside the channel.

Flax was being retted in the channel, which is generally regarded as a noxious and polluting process. However, the flow of clean, well oxygenated water over the flax was sufficient that larvae of the flowing water caddis *Ithytrichia* sp. could survive along with the extremely fastidious beetles from the family Elmidae. These included *Stenelmis canaliculata*, which is of extremely limited distribution in Britain.

The occurrence of 13 puparia of *Melophagus ovinus* (sheep ked) in the samples from the West Cotton palaeochannel is more than would have been expected if sheep had simply been grazing alongside the channel. This wingless ectoparasite of sheep spends its entire life cycle on its host. Perhaps sheep were washed in the channel or wool was being carded and washed using water from the channel.

A couple of examples of *Apis mellifera* workers (honey bee) were identified from the West Cotton channel. The riverside hay meadow would have provided a good supply of nectar in the early summer. It is likely that hive bees greatly outnumbered bees from any feral colonies in the region by the Saxon period.

Insect Remains from Cemeteries

A bird flea *Ceratophyllus gallinae* was recovered from the bronze hasp of a leather case in a burial from an unspecified site in Cambridgeshire or Suffolk (Lethbridge 1931, 39). Its occurrence could not be explained but feathers, probably from a pillow, were identified from a grave at Snape. Numerous puparia of the fly *Ophyra capensis* or *leucostoma* had been preserved in association with a copper alloy buckle in a pagan Saxon grave at Snape, Suffolk (Robinson, unpublished y). *O. leucostoma* and *O. capensis* are strongly attracted to corpses once they have reached a stage of ammoniacal fermentation (Smith 1973). Their larvae comprise the second stage of faunal succession on buried human corpses, probably appearing several months after burial. They are especially prevalent on corpses which have not been exposed to the air for long before burial, which would result in colonisation by other species of Muscidae and Calliphoridae (blow-flies). The beetle *Trox scaber*, amongst whose foods are dry carcasses and carrion in very advanced stages of decay, was also present. A puparium of *Fannia* sp. and the beetle *Grammostethus marginatus* were found in a second grave. The larvae of *Fannia* sp. have been recorded from corpses and while *G. marginatus* is usually found in moles' nests, it feeds on Diptera larvae underground, so would probably have found a suitable habitat around a buried corpse.

Discussion

Although the landscape evidence for this period was extremely limited, the sequence from West Cotton suggested a continuation of open conditions in the Nene Valley rather than scrub regeneration. The insect remains preserved in metal corrosion products have given a curious insight into early Saxon burial conditions.

The Late Saxon and Medieval Period to the Black Death (Flandrian Late Zone III, AD850 - 1350)

The late Saxon period and medieval period to the Black Death is also a short unit of time, but one with very much more human activity which resulted in the preservation of insect remains than in the previous period. As population levels recovered, there was renewed agricultural intensification and towns arose again. As in the Roman period, there was much pit and ditch-digging which, on low-lying settlements extended below the water table. Deep wells were also constructed. There was also a tendency in those towns adjacent to rivers for land to be claimed by dumping refuse in the channels and on the floodplain. This sometimes resulted in habitation occurring in very wet places, although the preservation of timber buildings and floor layers as occurs in York, has yet to be discovered. It is possible that the rainfall in the region is not sufficiently high for such preservation to occur. Organic sediments continued to accumulate in river channels, aided by interference with the channels related to water mill construction. The use of cesspits resulted in limited preservation of insect remains by calcium phosphate replacement. Unfortunately, most of the evidence for the period is largely from towns and studies have tended to be small-scale.

The Rural Landscape

It is quite likely that the organic sedimentary sequence in the West Cotton palaeochannel (p.95) (Robinson, unpublished w) extended into the late Saxon period. There was no evidence for changing landscape conditions, with continuing presence of the weevils of Species Group 3 which are favoured by hay meadow conditions. Samples were also investigated from a millpond adjacent to the late Saxon settlement at West Cotton which fed a mill on which radiocarbon dates of 1014±51 BP, calAD 890-1160 (UB-3327) and 941±53 BP, calAD 1000-1220 (UB-3325) were obtained. The results from the millpond mostly gave an impression similar to those from the palaeochannel for the surrounding landscape. Conditions were very open, with only a single wood or tree-feeding beetle of Species Group 4, *Chalcoides* sp., which feeds on the leaves of *Salix* sp. (willow) and *Populus* sp. (poplar). The proportions of scarabaeoid dung beetles of Species Group 2 had risen to 6% of the terrestrial Coleoptera while the proportion of clover and vetch-feeding weevils of Species Group 3 had fallen to 4%. However, this was probably more a reflection of the proximity of the millpond to the settlement because the floodplain meadowland was documented during the medieval period. There was also a slight presence of carabid beetles which are favoured by sparsely vegetated, weedy ground and arable conditions (Species Groups 9a and 9b) but it is as likely that they were derived from the settlement as from arable fields.

Insects were analysed from alluvial sediments above a causeway on the floodplain of the River Nene at Ditchford, Northamptonshire (Robinson 1996c). A wood fragment from a repair to a causeway gave a radiocarbon date of 640±50 BP, calAD 1270-1400 (GU-5440). The terrestrial Coleoptera mostly comprised a grassland fauna, with elaterid beetles such as *Athous* sp. and *Agriotes obscurus* that feed on the roots of grassland plants. They suggested that the grassland was being managed for hay, the species of *Apion* and *Sitona* of Species Group 3 comprising 9% of the terrestrial Coleoptera and being three times more abundant than the scarabaeoid dung beetles of Species Group 2. Species of *Longitarsus*, leaf beetles, which are favoured by hay meadow conditions, were the most numerous insects from the site.

Aspects of Rural Settlement Conditions and Activities

The insects from the late Saxon millpond at West Cotton (p.99) (Robinson, unpublished x) contrasted with those from the middle Saxon palaeochannel sediments in giving a slight hint of the occurrence of a settlement. The Lathridiidae (Species Group 8), at 3% of the terrestrial Coleoptera, were slightly better represented than from the palaeochannel sediments, but this value is still very low for an occupation site. The proportion of woodworm beetles (*Anobium punctatum*, Species Group 10) also at 3% of the terrestrial Coleoptera, suggested the occurrence of timber buildings. The Hydrophilidae and oxytelinae Staphylinidae of foul organic refuse (Species Group 7) had risen to 11% of the terrestrial Coleoptera, possibly reflecting settlement activities, although some of them would have been derived from plant debris alongside the millpond. Synanthropic beetles (Species Groups 9a and 9b), including grain beetles, were entirely absent despite the proximity of a mill. If any granaries associated with the mill had been experiencing severe infestations of grain beetles, some evidence would have been expected from the millpond.

Organic refuse from the late Saxon village or small medieval town of Biggleswade was entering the River Ivel, which runs alongside the settlement (Robinson 1994b). The remains included a puparium of *Melophagus ovinus*.

Vegetation in Towns

Remains of phytophagous species occurred in rather low concentrations in the urban insect assemblages that were investigated from the region. They tended to be weed-feeding species, such as *Phyllotreta atra*, which feeds on Cruciferae (wild mustard, shepherd's purse etc) and *Chaetocnema concinna*, which feeds on Polygonaceae (knotgrass, dock etc). Such weeds would be entirely plausible in the towns but it is possible that some of the insects had been derived from the surrounding countryside.

The Austin Friary at Leicester had a rural setting. Insects were analysed from two waterlogged ditches at the site (Girling 1981). The occurrence of the beetles *Phyllodecta vulgatissima* and *Leperisinus varius* suggested respectively a slight presence of trees of *Salix* sp. (willow) and *Fraxinus excelsior* (ash). The majority of the insects, however, suggested open conditions with both pastureland and meadowland. The scarabaeoid dung beetles of Species Group 2, mostly species of *Aphodius*, comprised 7.0% of the terrestrial Coleoptera. The clover and vetch-feeding weevils of Species Group 3 which are favoured by meadowland, were even more abundant, comprising 7.7% of the terrestrial Coleoptera. Weevils from the genus *Ceutorhynchus* sp. were perhaps feeding on weeds on the site.

General Organic Refuse

Insects which feed on various categories of decaying organic refuse were a usual component of the late Saxon to middle medieval insect fauna. Two of the sites in the waterfront area of the City of Lincoln from which Roman insect remains were investigated (p.86), Waterside North West and Woolworth's Basement, also had waterlogged deposits of late Saxon and early medieval date from which insect remains were recovered (Carrott *et al.* 1995). The deposits contained much organic refuse from a wide range of sources. They comprised both general dumps and pit fills. Some of the samples were from organic refuse which had been dumped on waterside mud, which had resulted in assemblages dominated by species of *Carpelimus*. Other assemblages characteristic of foul organic material included numerous examples of members of Species Group 7, including *Platystethus arenarius*, *Cercyon* *haemorrhoidalis* and *C. terminatus*. One pit contained numerous examples of *Lathridius minutus* gp. suggesting organic material that was neither so wet nor so foul. The best examples of general organic refuse faunas were from these Lincoln sites but elements of them have also been identified from other sites in the region. For example, mixed flood refuse to organic waterside dumps of late 10th to early 11th century date at Fishergate, Norwich contained numerous examples of *Carpelimus fuliginosus* while other species present included *Oxytelus sculptus* (Kenward and Allison 1994a). Numerous staphylinid beetles of decaying organic material were found in the late 12th to 13th century fill of a defensive ditch at the City Arms, Hereford (Girling 1985b). Beetles of foul organic material, for example *Anotylus rugosus*, were amongst the varied fauna identified from the medieval ditches at the Austin Friary, Leicester (p.100) (Girling 1981).

Stable Manure

Stable manure was probably amongst the mixed organic refuse from the Lincoln sites (above). However, a purer deposit of this material was investigated from a waterfront site at Coslany Street, Norwich (Robinson, unpublished z). The most numerous remains were puparia of *Musca domestica* (house fly). Relatively few other insect remains were present, although they included *Aphodius lividus*. This species of *Aphodius* is unusual in that it occurs in manure heaps as well as in the droppings of larger herbivores. It is now possibly extinct in Britain (Table 5) although it was known from several localities in Eastern England earlier this century. The reason why the samples contained relatively few insects other than fly puparia was perhaps because the material was dumped below the surface of the water in the river before a full insect fauna could become established. The plant and insect remains from the deposit accorded well with stable manure as characterised by Kenward and Hall (1997).

Human Sewage

Cesspits are particularly common features of urban medieval sites. Their semi-liquid, highly organic fill was an environment to which only a few species of insects were adapted but the larvae of some Diptera were able to flourish in vast numbers under these conditions. If the cesspit remained waterlogged, the insect remains were preserved by the anaerobic conditions, if the liquid contents drained away, preservation by calcium phosphate mineralisation sometimes occurred.

The most numerous insect remains from some latrine pits at Norwich Castle were puparia of *Thoracochaeta zosterae* (Robinson, unpublished aa). Some had survived in an undecayed state even though the deposits were not waterlogged, possibly because the range of decomposer organisms in the castle was restricted. Others had been preserved by calcium phosphate mineralisation. *T. zosterae* is a small fly belonging to the Sphaeroceridae which can now be found breeding in wet decaying seaweed on the strand line around the coast of Britain, rarely occurring inland. However, its puparia commonly occur in medieval and post-medieval cesspits (Belshaw 1988). Nitrogen isotope studies of *T. zosterae* puparia from a medieval cesspit in Oxford established that the flies had obtained their nitrogen from a terrestrial food chain rather than from feeding on material of marine origin (Webb *et al.* 1998). It is possible that the *T. zosterae* larvae were particularly well adapted to conditions in cesspits because the high concentration of salts in the urine gave an osmotic pressure similar to that from the seawater and the decaying faeces had similar characteristics to decaying seaweed. *T. zosterae* puparia also occurred in late Saxon pits on the two Lincoln Waterside sites (p.100) (Carrott *et al.* 1995) along with other species of Sphaeroceridae likely to feed on sewage. There were several sites where *Bruchus rufimanus* (bean beetle), which had probably been consumed as a food contaminant and then voided, was identified from cesspits (below). Some cesspits also contain Coleoptera that commonly occur indoors, for example *Atomaria nigripennis* and *Anobium punctatum* in one of the late Saxon pits at Lincoln Woolworth's Basement (p.100) (Carrott *et al.* 1995) which either fell in or were introduced as floor sweepings. One of the pits at Norwich Castle contained some beetles of subterranean habits, including *Coprophilus striatulus* which either lived in the dark, dank conditions on the sides of the pit or entered the context post-depositionally.

Structural Timbers

Anobium punctatum (woodworm beetle), which is the main member of Species Group 10, beetles which primarily infest structural timber, was recorded from almost all the late Saxon and medieval urban sites in the region where insects were analysed, sometimes in great profusion. Another member of this group, *Lyctus linearis* (powder post beetle) is often present although in very much lower numbers. *Xestobium rufovillosum* (death watch beetle) was identified from one of the latrine pits at Norwich Castle (p.101) (Robinson, unpublished aa) and from the Leicester Austin Friars (Girling 1981). *X. rufovillosum* feeds on dead hardwood which has been subject to fungal damage and it is thought that most indoor infestations begin as a result of using substantial oak timbers from trees with dead wood that had already been attacked by the beetles. Infestations progress slowly but over a period of several hundred years can be devastating to a major building.

General Indoor Synanthropic Insects

The habitats of two of the most important members of the general indoor beetle fauna, *Tipnus unicolor* and *Ptinus fur* have already been noted (p.87). *P. fur* seems to have been almost as ubiquitous in towns as *A. punctatum*. Whereas *Ptinus fur* is present throughout the period, for example being identified from late 10th to early 11th century deposits at Fishergate, Norwich (p.101) (Kenward and Allison 1994a) and a Saxo-Norman deposit at Duck Mill Lane, Bedford (Robinson 1986), *T. unicolor* was first recorded from a late 12th to early 13th century ditch deposit at the City Arms, Hereford (p.101) (Girling 1985b). *T. unicolor* appears to flourish under somewhat cleaner conditions than *P. fur* and is more closely tied to fully indoor habitats (when occurring as a synanthrope).

Many indoor insects, which had probably arrived in floor sweepings, were present in 10th century dumps on the two Lincoln Waterside sites (p.100) (Carrott *et al.* 1995). In addition to *P. fur*, other members of Species Group 9a (general synanthropic beetles) included *Tenebrio obscurus* (dark mealworm beetle), which is often associated with waste farinaceous material and *Typhaea stercorea*, a fungal feeder that occurs amongst old hay and straw. Other beetles which commonly occur indoors, but are not members of Species Group 9a, were *Aglenus brunneus* (a colydiid of buried organic material - for example compressed plant debris on a floor- and old granary residues) and another staphylinid, *Crataraea suturalis*, of somewhat similar habitats. The Lathridiidae (Species Group 8) such as *Lathridius minutus* gp., which would occur indoors on material such as damp thatch as well as in old hay, were present although not particularly abundant in the majority of the samples. Another group, the Cryptophagidae, some of whose members occur in similar habitats to the Lathridiidae, for example *Cryptophagus* sp., were also present. A rather similar faunal element including *Tenebrio obscurus* was present in late 10th to early 11th century riverside dumps at Fishergate, Norwich (p.101) (Kenward and Allison 1994a).

These two sites provided good examples of early / low-status urban medieval insect faunas of the region. A more restricted fauna lived in later/ higher-status buildings which were probably cleaner. For example, a much more restricted indoor fauna was identified from the Barbican Well of Norwich Castle, with *Mycetaea hirta*, a fungal feeder that commonly occurs inside buildings, sometimes being associated with fungi in structural timbers, joining *Tipnus unicolor* and *Ptinus fur* (Robinson, unpublished aa).

Several examples of the beetle *Trox scaber*, which feeds on dry animal carcasses, were identified from both the Lincoln Waterside sites and from the Norwich Castle Barbican Well and latrine pits. These beetles often occur in owls' nests which contain old bones and pigeons' nests with dead birds. It is possible that these beetles were from birds' nests in the roof spaces of the buildings.

One other synanthropic beetle of interest is the tenebrionid beetle *Blaps lethifera*, which was identified from a medieval context at Fullers Hill, Great Yarmouth (Jones 1976). It is an omnivorous beetle which occurs indoors in dark places such as cellars, outbuildings and granaries. *B. lethifera* is probably an introduced member of the British fauna and there have been few, if any, records over the last 50 years.

Stored Products Pests

The serious grain pests of Species Group 9b were not recorded from the region until well into the medieval period. *Sitophilus granarius* was the most numerous beetle from the Norwich Castle Barbican Well (above) (Robinson, unpublished aa). Possibly grain was stored nearby and they had crawled in. Grain beetles of Species Group 9b, in the form of *Oryzaephilus surinamensis* and *Sitophilus granarius*, comprised 8.9% of the terrestrial Coleoptera from the Leicester Austin Friars (p.100) (Girling 1981). It is again likely that grain was being stored nearby. Evidently the storage of grain was such in the late Saxon period that infestations of grain beetles were not ubiquitous, even in towns.

Of consistently more widespread occurrence was *Bruchus rufimanus* (bean beetle) (Table 9). Unlike the grain pests, infestation cannot spread amongst the stored crop because the adults only oviposit on bean flowers, the larva subsequently entering the developing bean. The adults will emerge from the dried beans in store. However, the context of the majority of the remains, which were from latrines, suggested that beans containing dormant adults had been consumed and the beetles then voided. The contexts from which *B. rufimanus* was recovered included a late 10th century cesspit at Lincoln Waterside North West (p.100) (Carrott *et al.* 1995), a late Saxon pit at St Peter's Square, Northampton (Keepax *et al.* 1979) and a latrine at Norwich Castle (p.101) (Robinson, unpublished aa).

Parasites

Several species of blood-sucking insects which are parasitic on either or both of humans or their domestic animals were identified from 10th to early 11th century riverside dumps of organic refuse which included both animal litter and sweepings from houses (Table 8). *Melophagus ovinus* (sheep ked) was identified from the Lincoln Waterside sites (p.100) (Carrott *et al.* 1995) and Fishergate, Norwich (p.101) (Kenward and Allison 1994a). *Damalinia* cf. *ovis* (sheep louse) was also present at Lincoln. It was argued that these remains had been derived from wool processing rather than that sheep were kept on the sites. The following insect parasites of humans were identified from both late Saxon and early

Table 9: **Records of Bean Beetle from the Midlands Region**

Period	Late Saxon			Medieval	Late Medieval	
Data from	Waterside North West, Lincoln 1	St Peter's Square Northampton 2	Duck Mill Lane, Bedford 3	Norwich Castle 4	Stratton Beds 5	Sidbury Worcester 6
Bruchus rufimanus Boh.	+	+	+	+	+	+

1. Carrott *et al.* (1995), 2. Keepax *et al.* (1979), 3. Robinson(1986), 4. Robinson (unpublished aa), 5. Robinson (unpublished cc), 6. Greig (1981).

medieval sites in Lincoln: *Pedicularis humanus* (body or head louse), *Cimex columbarius* or *lectularius* (pigeon or bed bug) and *Pulex irritans* (human flea). *C. columbarius* or *lectularius* and a possible example of *P. irritans* were found at Fishergate, Norwich.

Other Entomological Aspects

The only record of *Apis mellifera* (honey bee) from the region for this period was from a late 10th century dump at Lincoln Waterside (p.100) (Carrott *et al.* 1995). Bee-keeping is very likely by this date. The same deposit also contained specimens of heathland or moorland insects, the bug *Ulopa reticulata* and perhaps the beetle *Micrelus ericae*. They had possibly been imported some considerable distance with turf or peat.

Climate

Almost all the insects recorded from the region during this period still occur in this part of Britain. The discovery of the water beetle *Gyrinus colymbus*, which no longer occurs in Britain, at the Leicester Austin Friars (p.100) raised the possibility that the disappearance of this beetle was due to the "Little Ice Age", the period of climatic deterioration between 1550 and 1850 (Girling 1984). (Some confusion exists over the nomenclature of *G. colymbus* Er. and the name had erroneously been applied in the British list of Kloet and Hincks (1977) to its close relative, *G. distinctus* Aubé).

Discussion

Very little general landscape information was available from insects for the late Saxon to middle medieval period apart from the surrounds of the Austin Friary on the banks of the River Soar just outside Leicester. There was no evidence for climatic conditions any different from those of the present.

Although there was little insect evidence for the general landscape, there was considerable evidence for urban conditions. The overall impression is of decaying organic material: foul stable cleanings from which emerged flies, cesspits seething with maggots, timber buildings infested with woodworm and death watch beetles, assorted synanthropic beetles feeding on organic material about the house and beetles in dried foods. Certainly the medieval town did result in the bringing together of large quantities of organic material of various categories and there was an insect fauna already established in the country able to take advantage of it. Late Saxon and early medieval towns seem to have been dirtier places than Roman towns, perhaps because the Romans had efficient refuse disposal services. There was at least a hint that there was less vegetated open space in the medieval towns. However, the foul conditions of late Saxon and medieval towns should not be over-stressed. There certainly would have been disgusting stable yards but clean open areas would have contributed little to the insect record. Cesspits would indeed have been teeming with small flies but the woodworm and synanthropic beetles need imply no more than damp timber buildings that were not kept scrupulously clean. Some can still be found in houses that their occupants would regard as clean.

The insects did not provide evidence of trade beyond the import of material that could have come from the immediate hinterland of the towns. However, they possibly gave some significant dietary information. *Bruchus rufimanus* (bean beetle) was already present in Britain before the Roman period yet it was not recorded from Roman sites in the region. There were, however, many medieval examples of the beetle. It is possible that *Vicia faba* (broad, field or horse bean), played a much more important part in the diet either of humans or horses than it did earlier.

The origins of the urban insect fauna have already been considered in detail, largely using evidence derived from the north of England (Kenward and Allison 1994b) and the more limited evidence from the Midlands Region is in agreement. However, one aspect, about which much of the evidence does come from the Midlands, is the origin of the fauna of cesspits. The status of *Thoracochaeta zosterae* is of particular interest. It illustrates two aspects of the urban insect fauna. Firstly, when a species is able to exploit a man-made habitat and that habitat is abundant, it will do so in vast numbers if there are few other species able to form a community with it. Secondly, a species which has evolved to live in a completely different habitat may be successful in the artificial habitat, in this case a fly of rotting seaweed on the strand line has been able to flourish in the semi-liquid contents of cesspits.

The Late Medieval and Post-Medieval Periods to the Present (Flandrian Zone III, AD1350 - 2000)

The late medieval and post-medieval periods were a time of much change in the British insect fauna, the greatest changes occurring over the past 150 years. However, this section is strictly limited to evidence derived from archaeological investigations. It covers neither the profuse evidence to be derived from the records made by entomologists nor the contents of old insect collections. Some useful details of recent changes in the British beetle fauna are given in Hammond (1974).

Evidence was mostly available from palaeochannel deposits, dumps of urban organic refuse and cesspits, both waterlogged and those in which calcium phosphate mineralisation had occurred. However, there is also a curious report on insects from a late medieval lead coffin.

Woodland and Scrub

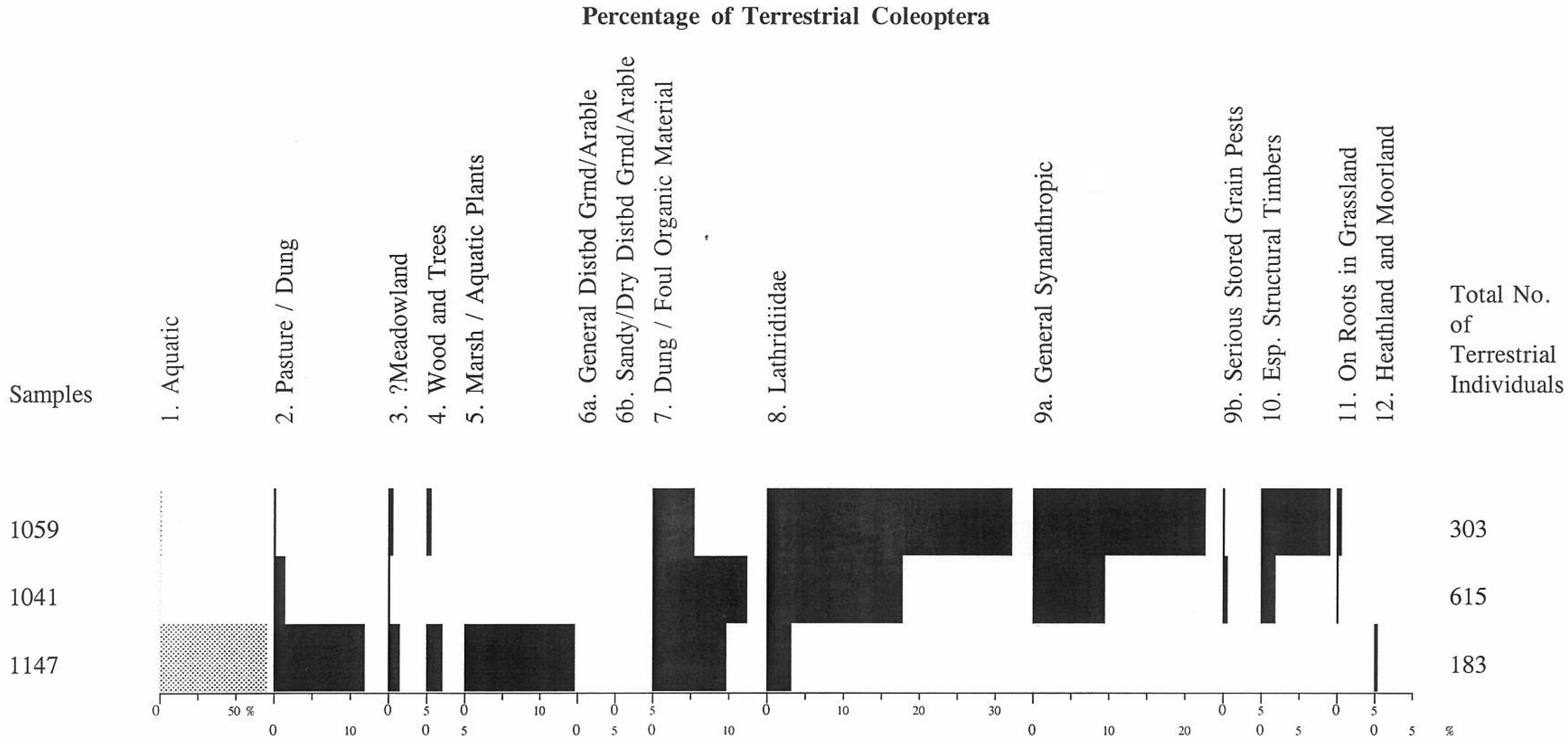
Insects were analysed from a second palaeochannel deposit at Shustoke, Warwickshire (p.44) which proved to date to 410±90 BP, calAD 1380-1670 (NPL-62) (Kelly and Osborne 1963-64). Not surprisingly, conditions on the site were very different from the conditions there in the early Neolithic. However, the landscape was by no means completely open. Wood and tree-dependent Coleoptera comprised 4.2% of the total terrestrial Coleoptera (Fig. 4, Species Group 4). Most numerous was *Leperisinus varius*, a bark beetle which feeds on *Fraxinus excelsior* (ash). There was also an example of the leaf beetle *Chalcoides fulvicornis*, which feeds on *Salix* sp.. (willow) and *Populus* spp. (poplar). It is likely that there were clumps of trees along or near the bank of the River Bourne. Unlike the Neolithic deposit at Shustoke, old woodland insects were entirely absent.

The occurrence of several examples of the beetle *Dorytomus* sp. from a swamp deposit of probable late medieval date beneath urban deposits at Stone, Staffordshire suggested some willow or poplar growing around it (Moffett and Smith 1995). Otherwise conditions seem to have been open.

Grassland

The majority of the terrestrial Coleoptera from Shustoke B (above) can occur in grassland habitats. The weevils of Species Group 3 which feed on grassland trefoils and vetches were, at 11.3% of the terrestrial Coleoptera, about three times as abundant as the scarabaeoid dung beetles of Species Group 2 (Fig. 15). They included, for example, *Apion craccae*, which feeds on *Vicia* spp. (vetches) and *A. virens*, which feeds on *Trifolium* spp. (clover). This result suggested floodplain hay meadow, with only a relatively slight presence of domestic animals.

In contrast, the scarabaeoid dung beetles of Species Group 2 comprised 12% of the terrestrial Coleoptera from the swamp deposit at Stone (above) (Fig. 15). *Aphodius prodromus* and *A. sphacelatus* were the most numerous species. The meadowland beetles of Species Group 3 only comprised 1.6% of the terrestrial Coleoptera. The floodplain of the Scotch Brook was very probably grazed pasture.



Species groups expressed as a percentage of the total terrestrial Coleoptera (ie aquatics excluded). Not all the terrestrial Coleoptera have been classified into groups.

Fig. 15: **Species Groups of Coleoptera from late medieval to early post-medieval Stone**

Arable and Disturbed Ground

Both Shustoke B and the swamp at Stone (above) were low-lying sites which gave no indication of arable or disturbed ground conditions from their insect faunas. Members of Species Group 6 were absent.

General Organic Refuse

Insect faunas associated with organic refuse were investigated from several settlement sites. At Stone, organic material was dumped over the swamp deposit in the 15th century (p.107) (Moffett and Smith 1995). It supported a thriving decomposer fauna of Coleoptera including Ptiliidae, *Carpelimus* spp. and *Oxytelus sculptus*. Species Group 7, beetles of dung and foul organic material comprised 12.5% of the terrestrial Coleoptera from this deposit (Context 1041), *Cercyon analis* and *Anotylus rugosus* being the most numerous. These beetles were probably living in the refuse as it decayed down to the level of the water table. However, there were at least as many beetles from the deposit likely to have been derived from indoor habitats (below). It is possible that stable manure was a major part of the refuse, the indoor component of the fauna being temporally earlier than the foul organic material component. Small assemblages of insects of decaying organic refuse have also been investigated from an early 18th century cesspit at Berrington Street, Hereford (Kenward 1985) and the post-medieval fill of Birmingham Moat, Birmingham (Osborne 1978-79).

Human Sewage

A sewage-related insect fauna was investigated from a waterlogged barrel-latrine radiocarbon-dated to 510±70 BP, calAD 1280-1510 (HAR-3100) at Sidbury, Worcester (Osborne in Greig 1981, 268-71). (It is possible that this was the same context as a 16th century pit containing fruit pips on the same site, from which Osborne (1980b) reported on a small indoor insect assemblage, most of the species also being identified from the Worcester Barrel). Puparia of Sphaeroceridae (sewage flies) were present but only the Coleoptera were analysed in full. The most numerous beetles were *Mycetaea hirta* and *Tipnus unicolor*, neither of which are normally members of dung or foul organic material. Osborne (1983) investigated the insects from a modern cesspit and found both these species. He argued that they were feeding on human sewage. Both *M. hirta* and *T. unicolor* are synanthropic beetles which most commonly occur indoors. *M. hirta* is a fungal-feeder and it is possible that it was feeding on moulds on the side of the barrel above the level of the liquid contents. Osborne regarded *T. unicolor* as feeding on the sewage. A more conventional interpretation would be that the beetles were living inside the building which housed the latrine and fell in. However, it must be admitted that remains of *T. unicolor* are frequently encountered in late medieval and post-medieval cesspits . For example, it was also the most numerous beetle from a garderobe which post-dated 1350 at Denny Abbey, Cambridgeshire (Robinson 1980a). Some of the other beetles from the Worcester Barrel included the maggot-feeding *Hister* sp. and *Creophilus maxillosus*, which were likely to have been feeding on the Diptera larvae in the sewage. There were also general synanthropic beetles and stored products pests likely to have fallen in (see below).

Mineralised insect remains from this period were restricted to calcium phosphate-replaced puparia of *Fannia* cf. *scalaris* (latrine fly) and Sphaeroceridae indet. (sewage fly) from a 15th to 16th century cesspit at Grove Priory, Bedfordshire (Robinson, unpublished bb).

Structural Timbers

Anobium punctatum (woodworm beetle) remained troublesome, as it has done to the present day. Of particular interest was the occurrence of *Lyctus brunneus* (a powder post beetle), a member of Species Group 10 (beetles which infest structural timbers) which is of uncertain status in the British fauna, along with the more usual *A. punctatum* in a 15th century deposit (Context 1041) at Stone (p.107) (Moffett and Smith 1995). *A. punctatum* comprised 9.2% of the terrestrial Coleoptera from late 15th to early 16th century organic refuse at the top of the sequence at Stone, confirming the indoor origin of this material (p.109). *A. punctatum* was also numerous in the Worcester Barrel (p.109) (Greig 1981), probably derived from a wooden malthouse sheltering it. *Lyctus linearis*, the more commonly occurring powder post beetle, was also present. *Xestobium rufovillosum* (death watch beetle) was identified from two high status sites, Denny Abbey (p.109) (Robinson 1980a) and a 14th to 15th century moat at Stratton, Beds (Robinson, unpublished cc). The buildings on both sites would have had substantial timbers used in their construction. This beetle is much less often found in lower status medieval / early post-medieval buildings and is unable to attack the softwood timbers of later post-medieval structures.

Thatch

Thatch was probably a component of many of the urban deposits of organic material that have been investigated for insects in the region from the Roman period onwards. However, plant remains from a late 15th to early 16th century dump of organic refuse at Stone (p.107) were highly suggestive that it was mostly thatch (Moffett and Smith 1995). The insect evidence tended to confirm this interpretation. Almost all the insects from the deposit can occur in indoor habitats. The abundance of woodworm beetles has already been mentioned. Over 32% of the terrestrial Coleoptera were members of the Lathridiidae (Fig. 15, Species Group 8, Context 1059), particularly *Corticaria* or *Corticarina* spp. They feed on surface moulds on material such as old straw and hay. They would certainly flourish on damp thatch. General synanthropic beetles (Species Group 9a) were also abundant, comprising about 24% of the terrestrial Coleoptera. The most numerous of these was *Ptinus fur*, which is well known from old damp straw.

General Indoor Synanthropic Insects

Tipnus unicolor, *Ptinus fur* and *Mycetaea hirta* maintained their presence in this period, being joined by *Mycetaea hirta* (see p.109 for discussion). All were present in the 15th to 16th century refuse deposits at Stone (p.107) (Moffett and Smith 1995). Several synanthropic species which were recorded from the Worcester Barrel (p.109) (Greig 1981), including *Laemostenus terricola*, *Aglenus brunneus* and *Blaps lethifera*, have all become much rarer in recent years as a result of increasing urban cleanliness. They were certainly better known to 19th century entomologists from such habitats as old cellars.

Stored Products Pests

The serious grain pests *Sitophilus granarius* and *Oryzaephilus surinamensis* showed a continuing presence (Table 6). Their occurrence in the Worcester Barrel latrine was probably the result of the consumption of contaminated food (p.109) (Greig 1981). The presence of *Bruchus rufimanus* (Table 9) was likewise probably due to the consumption of infested food.

Burials

Rhizophagus parallelocollis (graveyard beetle) was reported as being found in a late 15th century burial in a lead coffin (Stafford 1971). While such results are entirely plausible because *R. parallelocollis* is particularly characteristic of buried corpses, which it is adept at reaching about a year after burial, the report arouses suspicions about its authenticity. The author of the report, F. Stafford, seems unknown in entomology or archaeology and no source is given for the coffin. The report was published in a small journal *Science and Archaeology*, which was edited by F. Celoria, the place of publication, Stafford, appearing prominently on the cover.

Discussion

Insects provided useful insights into aspects of the late medieval and post-medieval environment and activities, despite coverage being by no means even. The contrasting grassland faunas were very much what would have been expected for the period. While late medieval towns were possibly cleaner than their late Saxon or early medieval predecessors, the entomological evidence has tended to be biased towards their more squalid aspects. The dumps of organic refuse and the flies in the cesspits were certainly familiar from earlier periods. It is only chance that human ectoparasites were not also found. Also awaiting discovery in the region are exotic insects introduced by inter-continental trade, such as those that thrive in the artificial habitats of modern towns.

Conclusions and Recommendations

Coverage of the Midlands Region was by no means even. The paucity of sites meant that, unlike the Southern Region (Robinson 2002), not much comparison could be made between different parts of the region. However, it has proved possible to trace the development of the insect fauna through the Holocene. This in turn has given much useful information, some of it unavailable from other sources, on the general environment, human living conditions and human activities. The work that has been done is sufficient to provide a basis for future research priorities and recommendations for the preservation of deposits *in situ*.

Major Developments Shown by the Insect Fauna of the Region

Twelve major developments characterise the changes shown by the insect fauna of the Midlands Region since the end of the Devensian.

1) There was a very rapid transition from the arctic insect fauna of the Late Devensian to the temperate fauna of the Flandrian Zone I at around 10,000 BP with little evidence for intermediate conditions.

2) During Flandrian Zone I a rich 'old woodland' insect fauna began to develop which reached its peak in Flandrian Zone II to Flandrian Early Zone III (Neolithic) but after 750 BC, with the increasing fragmentation of mature woodland as a result of clearance, it experienced a severe decline and is now restricted to a very few favoured localities. The 'old woodland' fauna was characterised by species associated with over-mature trees and dead wood, many of which were dependent on continuous tree cover for their dispersal. At its height it included species now extinct in Britain but which still occur in a few of the great woods of Central Europe.

3) As the water of the rivers of the region became warmer at the start of Flandrian Zone I, a diverse beetle fauna of Elmidae became established in them. These beetles are extremely fastidious in their requirements of clean, moving, well-oxygenated water with a solid substrate for them to cling to. However, they were able to flourish in rivers such as the Thames in their unpolluted and unmanaged state, at least until the late Saxon period. The smaller species are now restricted to the headwaters of the faster moving tributary streams, the larger species, which probably require larger bodies of water, are now extinct over much of the region.

4) The present open-country fauna of the region began to rise to prominence with the first clearances of the Neolithic around 4300 BC (marking the start of Flandrian Zone III). The majority of its members were probably native species from river banks, exposed coastal habitats or occurred in woodland in low numbers. They rapidly colonized the newly created habitat and appeared to comprise a balanced fauna. Only a few species subsequently retreated back to the coasts or woodland. While some members of the present open-country insect fauna are post-Neolithic additions to the British fauna, there were few species in the archaeological assemblages which gave grounds for suspecting they had arrived in the country after the Neolithic.

5) The Neolithic to Iron Age insect assemblages from the region included a slight presence of dung beetles from the family Scarabaeidae that are now extinct in

5 ctd) Britain, although some survived in Britain until recently, albeit as great rarities,for there are 19th century records of their capture. The decline of these beetles was as likely to have been due to the changing character of pastureland as climatic deterioration.

6) The construction of buildings incorporating wood for the housing of humans, their produce and domestic animals enabled certain rather rare native beetles of dry dead timber and obscure habitats such as old birds' nests to flourish as synanthropic species. Some of these species, particularly *Anobium punctatum* (woodworm beetle) and some Ptinidae which are scavengers or minor household pests, were able to occur at high levels inside buildings. The earliest evidence for them occurring under circumstances likely to be synanthropic was at the end of the middle Bronze Age around 1500 BC. Large numbers were recorded from one Iron Age settlement but from the Roman period onwards they were ubiquitous.

7) With the great increase in trade with Southern Europe and the change to large-scale above-ground storage, ideal conditions were created in the Roman period for the establishment of exotic beetles that are serious pests of stored grain. Two species in particular, *Oryzaephilus surinamensis* (saw-toothed grain beetle) and *Sitophilus granarius* (grain weevil) have remained significant pests, especially in towns, thereafter (although it is possible that they died out in the early Saxon period and were then re-introduced).

8) Long distance Roman trade also introduced casuals, for example the Mediterranean wood-boring beetle *Hesperophanes fasciculatus* and *Blatta orientalis* (oriental cockroach) which either failed to become established or remained extremely localised.

9) With the increasing intensity of human occupation in the region and the keeping of domestic animals in settlements, large quantities of foul organic refuse were generated comprising dung mixed with straw, bracken etc. This tended to be dumped in middens which provided ideal habitats for the development of the flies *Musca domestica* (house fly) and to a lesser extent *Stomoxys calcitrans* (stable fly), as well as various species of beetle. The earliest example of this type of assemblage from the region was Roman, but such deposits were probably widespread in early medieval towns. (Although there were a few records of the beetle *Aglenus brunneus* from the region, it was not found occurring in vast numbers in organic material in floors as has been the case for some northern and western towns such as Viking York (Kenward 1975)).

10) The use of cesspits created a habitat that was on the one hand very nutrient-rich but on the other hand had contents of semi-liquid sewage which was hostile to most insect life. Those species that were able to exploit this habitat, particularly Diptera (flies) from the family Sphaeroceridae, flourished in vast numbers. Roman cesspits have yet to be investigated from the region, the first record for such a fauna being late Saxon. Cesspit assemblages of Diptera puparia are common in towns from the late Saxon period until well into the post-medieval period and also occur on some rural sites. One particularly interesting aspect of this fauna is that the sphaerocerid *Thoracochaeta zosterae* (seaweed fly) proved to be particularly well adapted to this environment and was one of the most abundant flies breeding in sewage in cesspits,

10 ctd) but with the disappearance of the earth closet, this fly is now restricted to the sea shore again.

11) The high concentrations of humans living in close proximity in towns, often under squalid conditions, enabled insect ectoparasites of humans from the orders Phthiraptera (lice), Hemiptera (bugs) and Siphonaptera (fleas) to flourish. Although there is no reason why they should not also occur on rural sites, all the records from the region were from Roman to medieval towns.

12) The intercontinental trade of the post-medieval period introduced insects from all over the world to Britain. The native insect fauna of Britain is 'competitively advanced' and has been relatively resilient against exotics becoming established away from settlements. Exotic species able to colonise various artificial indoor habitats have fared better, but even so, most casuals have failed to become established, or remain extremely localised, perhaps just occurring in warehouses at the port of entry. As yet there is very little archaeological evidence from the region for these introductions.

The Balance Between Loss and Survival of the Evidence

Mechanical disruption of sediments will cause the loss of any palaeoenvironmental potential of insect remains within them and waterlogged insect remains will decay if the sediments containing them cease to be waterlogged. The era of archaeology when excavation directors could not be expected to be aware of preserved insect remains does not seem to have resulted in any great loss on sites threatened only by archaeology. There was, of course, large scale destruction in the 1960s and 1970s with the re-development of medieval town centres and gravel extraction. Even so, the activities of GR Coope, his research students and PJ Osborne achieved much, particularly on organic sediments of Late Devensian and Early Flandrian date in gravel exposures.

From the later 1970s into the early 1990s, the Department of the Environment / English Heritage was the main source of funding for rescue archaeology. The Ancient Monuments Laboratory of EH (now part of the Centre for Archaeology) concentrated the palaeoentomological research it funded on three very different environments: the peats of the Somerset Levels, the gravel terraces of the Thames and South Midlands, and the town of York. The work was related to large-scale rescue excavation projects. Although many sites elsewhere, particularly in the Midlands, were neglected, this policy did result in major advances for the subject. It proved possible to develop research themes bringing together the results from many sites within each area. Improvements were also made to techniques, making site sampling and the interpretation of data more effective. Nationally, the policy was certainly more successful than would have been spreading the available resources more thinly, so as to cover all EH-funded excavation where suitable deposits existed. Larger-scale work in the region, however, was largely restricted to the gravels of Cambridgeshire and Northamptonshire.

There was sometimes a loss of information even when insects were analysed. A failure to take adequate-sized samples has persisted to the present day even on sites where the excavator is in receipt of advice from an environmental archaeologist. Curiously, there has also been some resistance to archaeoentomology. For example, a suggestion that insects could be investigated from organic sediments related to post-Neolithic woodland regeneration on a Neolithic site being excavated with EH funds was rejected by the excavation director. Fortunately, the standard of identification work in the region has generally been high. Archaeoentomolgy is too difficult a topic to be undertaken by the badly paid, semi-skilled workers without reference material who are found in some other branches of bio-archaeology.

With the adoption of PPG 16, there has been a gradual shift from EH-funding to the developer-funding of rescue archaeology. It has become possible for EH-funded archaeoentomologists to provide complete coverage on the remaining EH-funded excavations where the work can be justified on academic grounds. PPG 16, however, has not resulted in a satisfactory coverage on developer-funded excavations. The majority of curators in the region, with only a few exceptions, seem to regard it as either an expensive luxury or an esoteric line of research that is only applicable to a few special sites. The initiative for archaeoentomology is as much taken by the more enlightened archaeological contractors as it is by curators. Archaeoentomology is indeed an expensive line of research, although it does provide important evidence unavailable from other sources. It is perhaps understandable that curators want to keep costs down on low-value developments and those developments where there is local political pressure for them to take place. However, archaeoentomology is also neglected on high-value commercial developments.

Insect remains are also lost through the insidious effects of drainage. The drainage of the fens of East Anglia has caused a general drying out, with much shrinkage and decay of peat in recent years. If organic sediments become aerobic, biological reworking first introduces modern insects and then insect remains are lost by decay. The excavations of the Fenland Archaeological Trust and the Fenland Management Project included palaeoentomological studies, but they were on archaeological sites. An investigation of the full Fenland peat sequence is urgently needed.

Drainage can cause problems even where it is intended to excavate a site. For example, when a new gravel quarry is opened, the water table is lowered over a large area. Unless archaeological excavation occurs promptly, and it could be many years before the whole area is quarried, there will be deterioration of the insect remains. This process became evident at Wollaston, Northamptonshire (Robinson, unpublished k) where organic remains in which insects were preserved were largely restricted to contexts close to a stream which ran across the area drained for the quarry.

Research Priorities for the Region

The research priorities which have emerged from the review can be divided into four: periods which have been neglected, parts of the region which have been neglected, individual research themes and advances in research techniques.

Periods which have been neglected

1) The later Mesolithic

2) The early to middle Bronze Age

3) The Dark Ages and early to middle Saxon period

4) Late Saxon and medieval rural

Parts of the region which have been neglected but are of special interest

5) Areas with little waterlogged evidence, for example the Chalk and the limestone areas

6) The peat fens of East Anglia

7) The upland parts of the region, for example the Peak District

8) Some of the major towns of the region

Individual research themes

9) Evidence for browsing under woodland conditions at the end of the Mesolithic / start of the Neolithic

10) Insect assemblages that can be related closely to the Elm Decline

11) Pre-Roman synanthropic faunas

12) Changes in the medieval and recent fauna of the major rivers

14) The origin of *Thoracochaeta zosterae* in cesspit faunas

Advances in research techniques

15) Carbon and oxygen isotope measurements on insects from sequences which suggest climatic change so that direct measurements can be obtained for dating and temperature

16) Comparative studies of modern death assemblages which can be related to the surrounding habitats from which they were derived

17) The successful use of other taxonomic groups that are not closely identified at present

18) The creation and possible stocking with live insects of some habitats which are suspected from ancient insect assemblages but for which no modern examples exist for comparative purposes

19) The development of improved techniques of data analysis, for example extending the species groups used in this review to cover more aspects of the urban fauna

These research themes are by no means exhaustive. Insect studies will be important on large scale investigations of major archaeological sites when all aspects of their archaeology are being examined, for example extensive "landscape" studies. There may well be projects on which particular questions are best answered by carefully directed insect studies. Insects will also continue to be a useful source of site environmental information on all excavations where suitable deposits for them to be preserved are discovered.

Conclusions

The palaeoentomological investigations in the Midlands Region of England covered by this review have shown the technique to be as powerful a tool of palaeoenvironmental reconstruction in the Holocene as had already been established for the Pleistocene. While in biogeographic terms the species changes of the Holocene were not on the same scale as those of the Pleistocene, they were not without significance.

The rapid transition from an arctic to temperate insect fauna marking the start of the Holocene provided the clearest illustration of the climate change that occurred. Pollen analysis had already shown the development of almost continuous tree cover over the region in the early Holocene and the woodland succession that followed, but it was the insect evidence that brought out the character of this woodland, including very old moribund trees and wood in various stages of decay. Insects also cast their own particular light on early agriculture, scarabaeoid dung beetles highlighting the grazing of domestic animals. At a later period they brought out the contrasts between pastureland and hay meadow.

In addition to climate and landscape evidence, insects gave a new insight on human living conditions, albeit emphasising some of the unpleasant aspects. The cosmopolitan Romans brought their grain pests, the Roman and medieval town-dwellers were bothered by flies, fleas and lice.

Careful palaeoentomological research has shown that it is possible to go beyond the parameters usually regarded as limiting palaeoecological reconstruction and listed by Lowe and Walker (1984, 155-6). The distributions of the plants and animals of the very early Holocene were not in equilibrium with their environmental controls. However, by looking at several lines of biological evidence it has proved possible both to reconstruct the vegetation and the climate. While the ecological affinity of *Thoracochaeta zosterae* (seaweed fly) may not have changed, the ability of this fly to exploit the contents of cesspits was completely unexpected. After the initial mistake of assuming that a pit in which it had been found was full of seaweed, the contextual and botanical information enabled the true contents of the pit to be established. Under the appropriate (ie non-maritime) circumstances, remains of this fly have subsequently proved particularly useful in showing the former presence of sewage.

Palaeoentomology ought to be seen as a usual part of integrated palaeoenvironmental studies on all archaeological excavations that occur in the region which encounter suitable deposits. Whether insects are analysed and the degree of detail in which they are studied should be determined by their archaeological potential rather than whether the excavator is aware of the subject. Curators working within PPG 16 should also take into account palaeoentomological considerations of sites. If not specified in briefs, they will be ignored by contractors in most cases. Curators and excavators are urged to obtain archaeoentomological advice at an early stage when planning projects.

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