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English Heritage Reviews of Environmental Archaeology: Southern Region Insects

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Summary

The evidence given by the analysis of insect remains, from sites of Late Glacial to post-medieval date, is reviewed for the English Heritage Region of Southern England including London. An introduction is given to insect taxonomy, the preservation of insect remains in archaeological deposits and the methodology of insect analysis. Insect results are reviewed by theme within a chronological framework of eight major periods. The major developments shown by the insect fauna of the region are outlined and directions suggested for research.

Keywords

Environmental Archaeology
Insects
Coleoptera
Review
England

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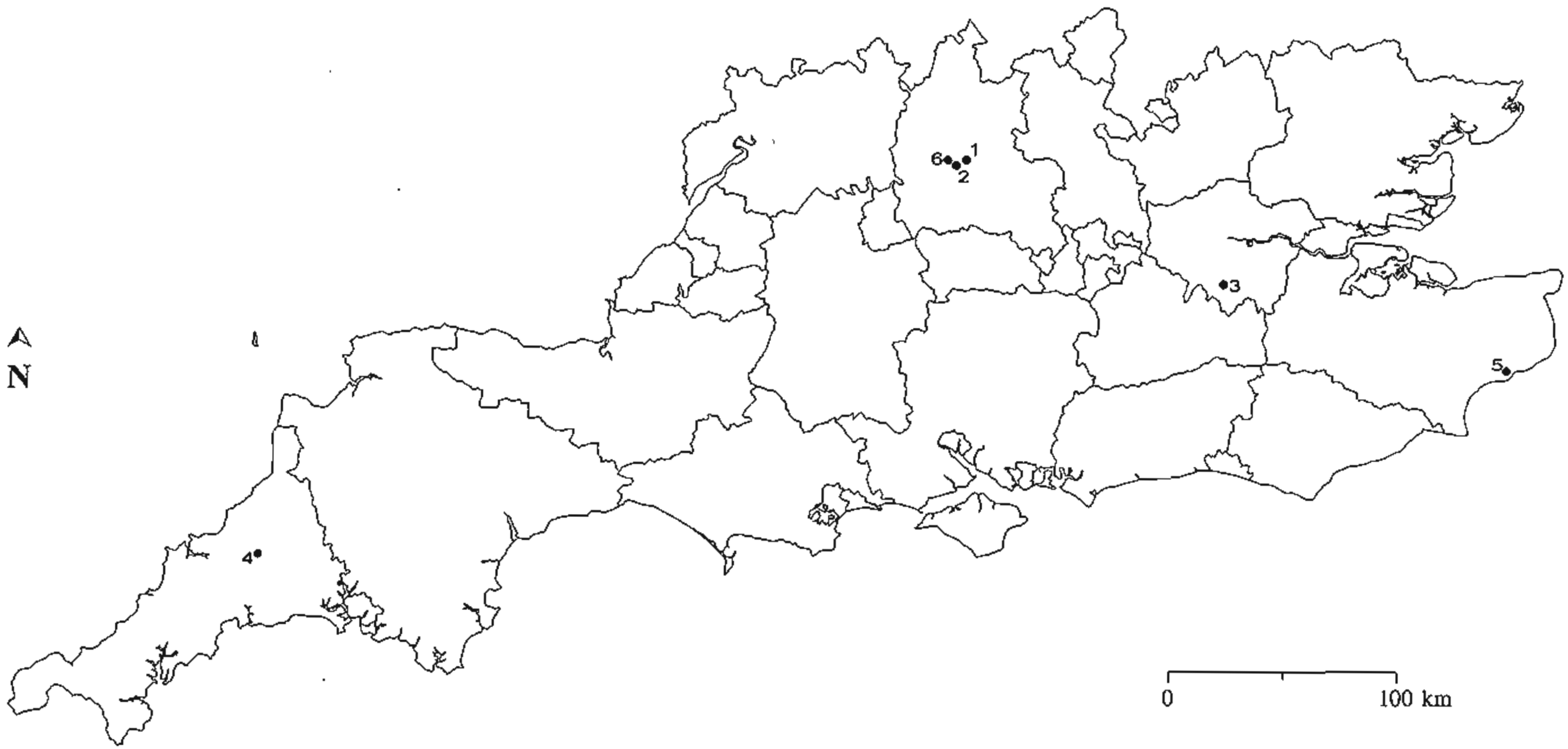

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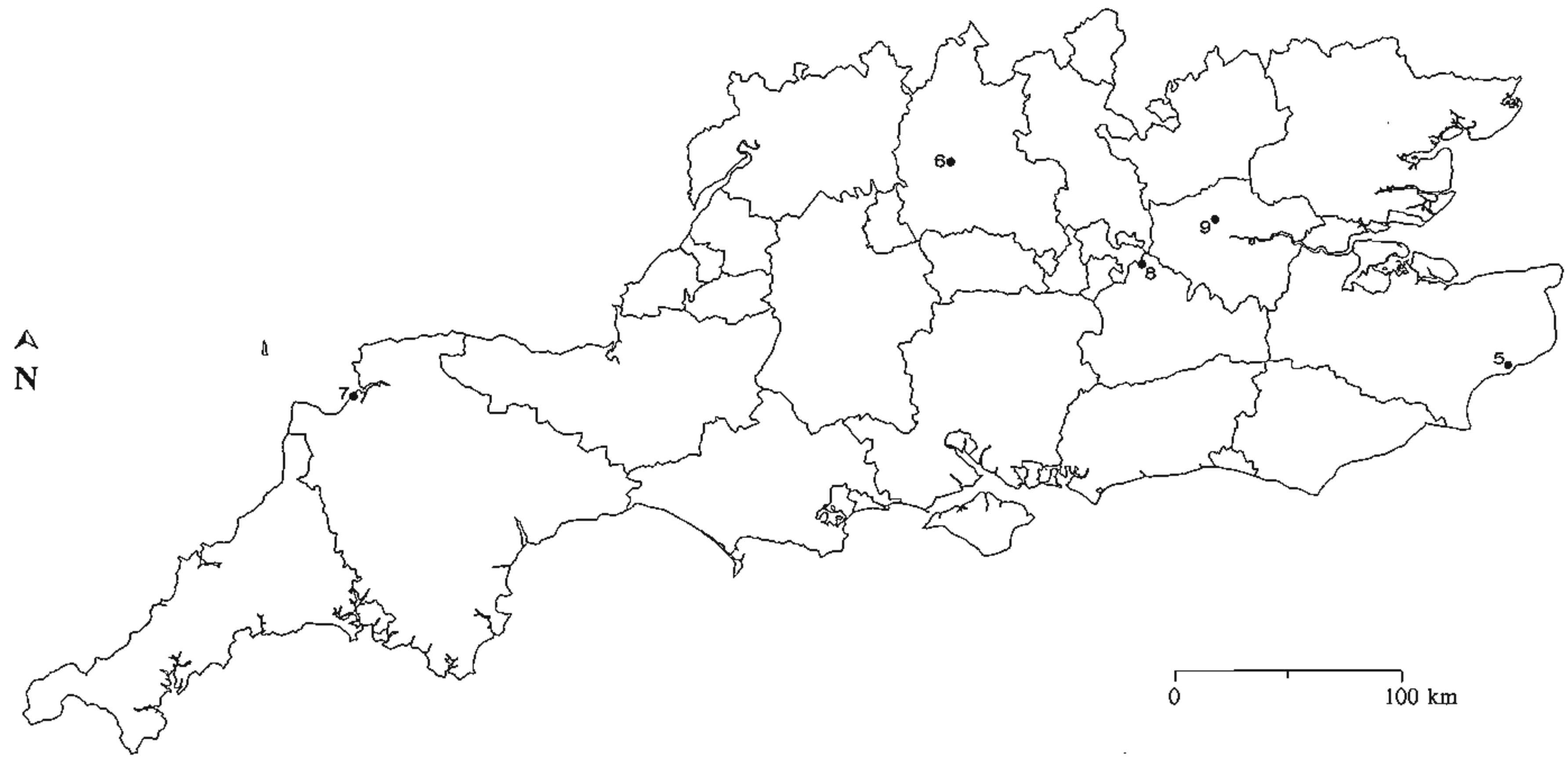

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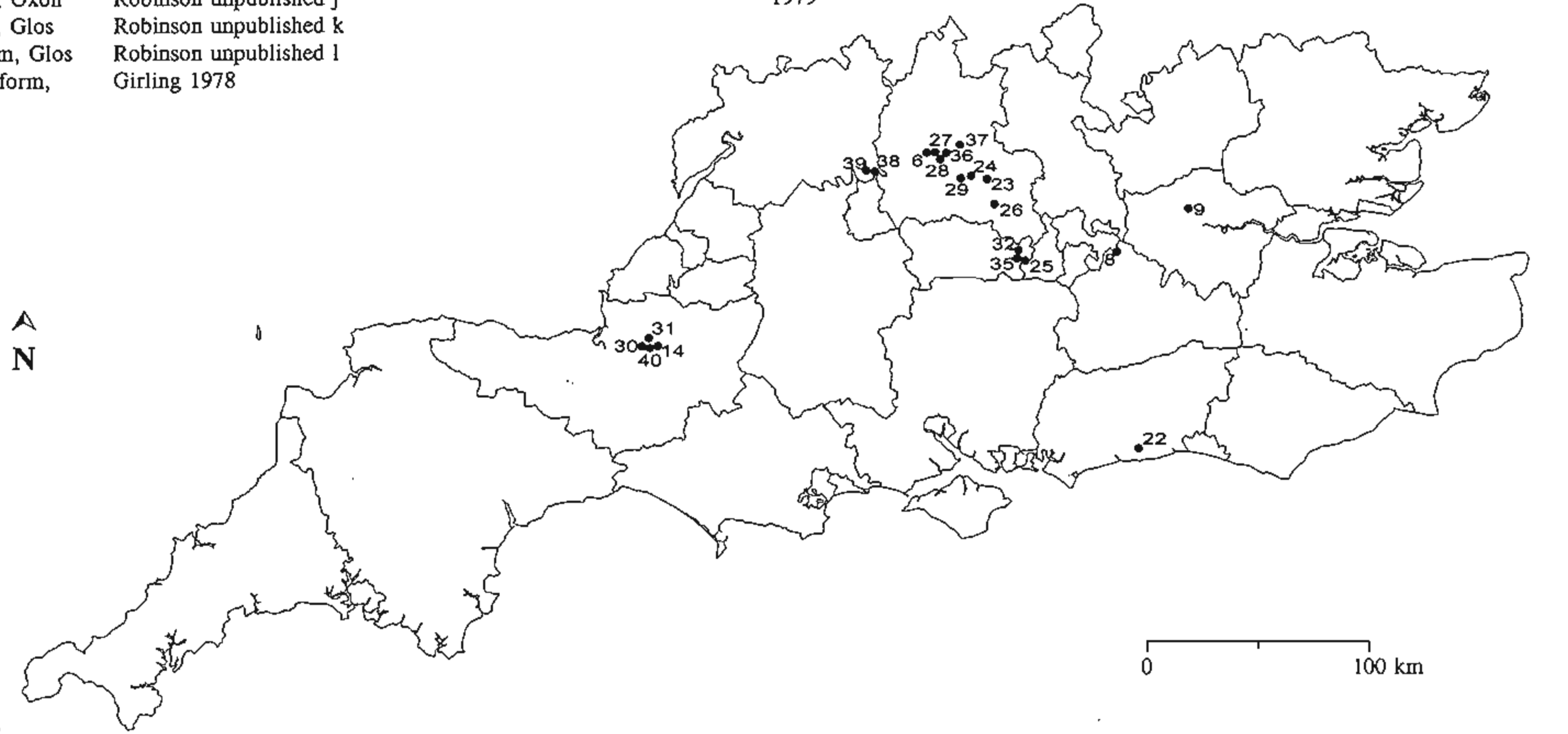

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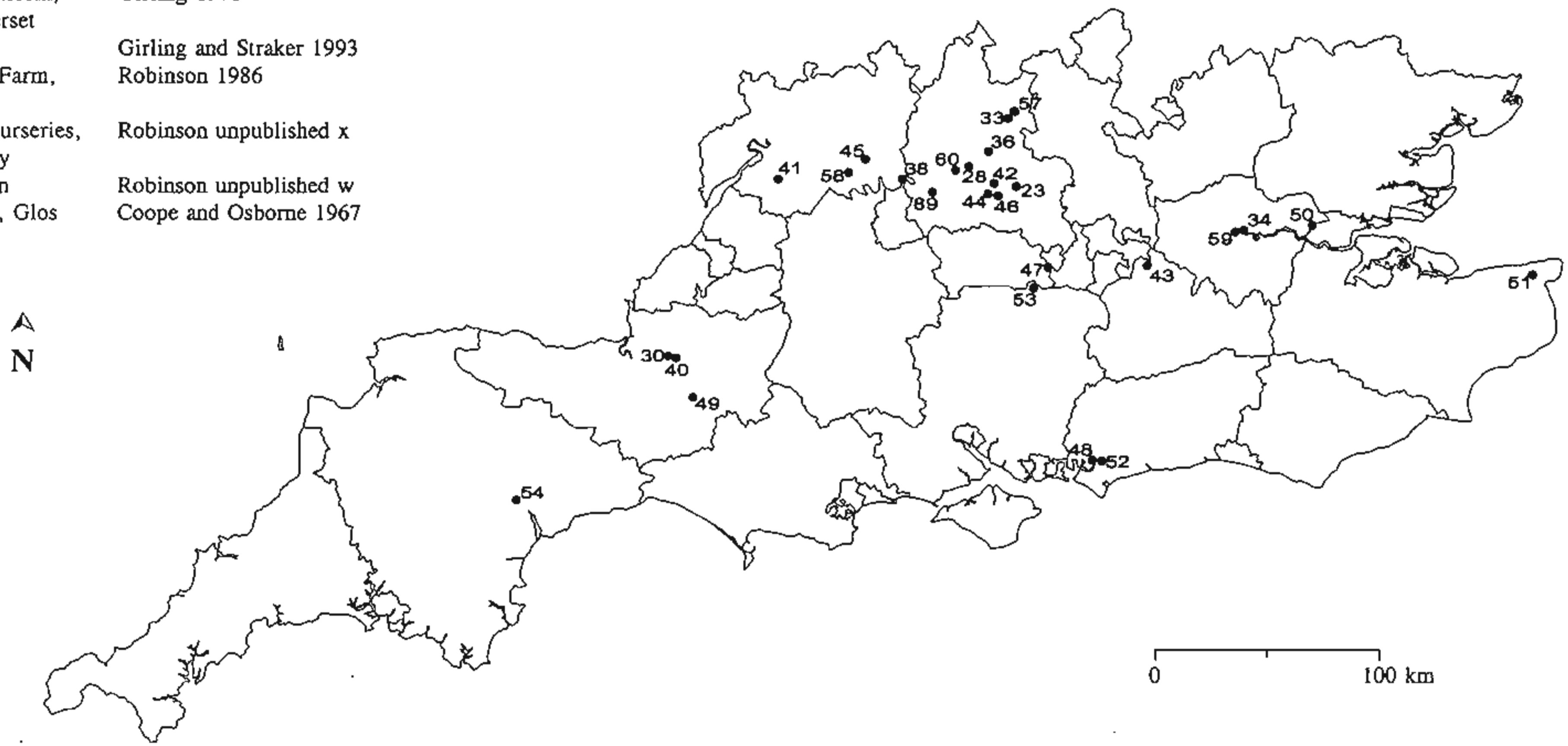

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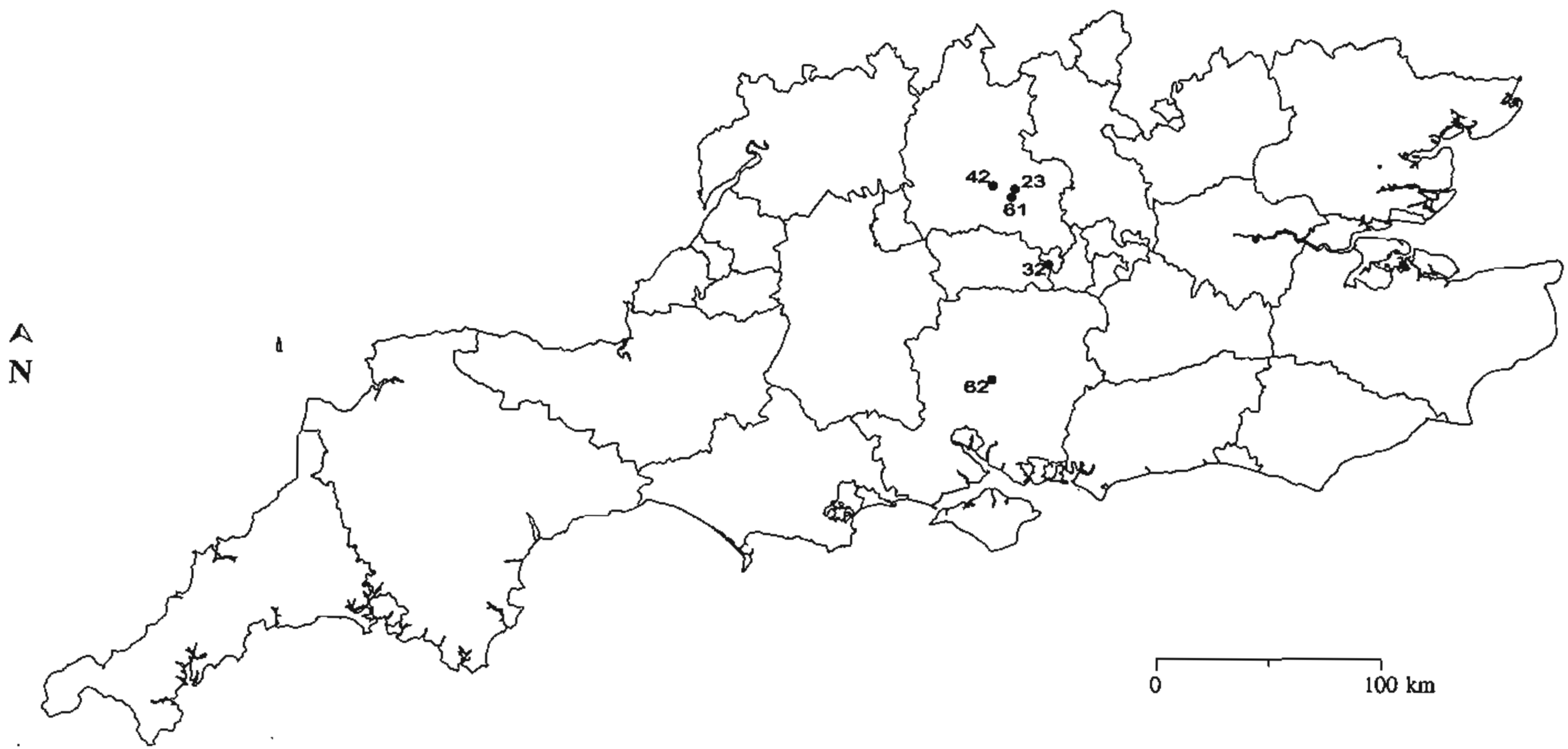

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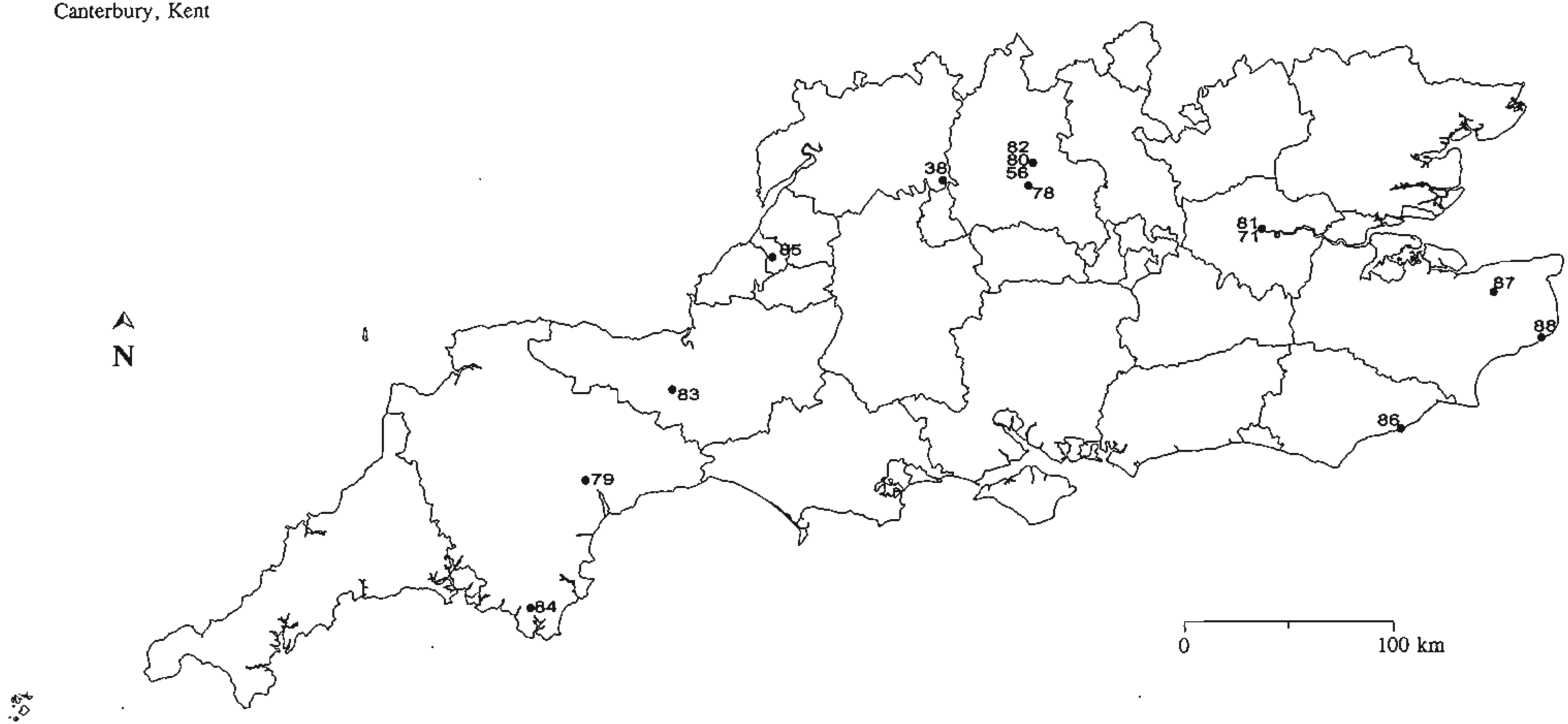

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ENGLISH HERITAGE REVIEWS OF ENVIRONMENTAL ARCHAEOLOGY: SOUTHERN REGION INSECTS

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 Southern Region of England (Fig. 1) and to place the results within a chronological framework. 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, the final cold episode of the Late Glacial) 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, looking at a single line of evidence, 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 Somerset Levels. Some parts of the region have had sufficient work done on them that it is possible to trace their environmental development from insect evidence, for example the Upper Thames Valley. There are other 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 Southern Region, they are widespread, especially in those areas with a high water table.

Archaeoentomology in the Southern 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 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 undertook limited work on Holocene deposits and some useful pioneering work was undertaken on archaeological material from the region. Even so, it was not until after the growth of rescue archaeology in the 1970s that large-scale studies began bringing together the results from many sites. They were in response to the cutting of peat in the Somerset Levels and the extraction of gravel in the Upper Thames Valley. Both studies were supported by funding from English Heritage and its Department of the Environment predecessor. A third part of the region which was in receipt of substantial funds for rescue archaeology and certainly yielded many suitable deposits, the City of London, was sadly neglected, leaving York unchallenged as the city of urban palaeoentomology.

The creation of the Southern Region 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.

The Region

The Southern Region of England comprises, for the purposes of this review, the counties of Berkshire, Cornwall (including the Isles of Scilly), Devon, Dorset, East Sussex, Gloucestershire, Hampshire, Isle of Wight, Oxfordshire, Somerset, Surrey, West Sussex and Wiltshire, the former county of Avon (North Somerset) and Greater London. 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.i-ii) 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 particular problems. The middle Bronze Age assemblages from the Wilsford Shaft and Yarnton, whose radiocarbon dates span the division, have been placed in the earlier period because they are so unlike any assemblage from 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 moult 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 1991a).

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 1986) 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 Girling 1984b). Remains of *Pediculus humanus 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 remain but many fragments are readily identifiable. Useful supplementary palaeoecological information can be obtained from them (eg Robinson 1980a) and some are host-specific in their food plants. The bed bug (*Cimex lectularius*) has possibly been recorded from archaeological contexts (eg Girling 1984b). 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 freshwater 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 to 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 1991a) 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-bodied, laterally compressed, wingless, jumping insects which feed on the blood of birds and mammals. They tend to have preferred host species and are found in the same type of deposits as Phthiraptera (eg Girling 1984b).

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 exoskeletons 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 1984b).

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 Robinson 1991a) but the larvae themselves have more potential (Wilkinson 1987). The Trichoptera have some palaeoecological value because they can be fastidious in their water quality requirements.

Order Hymenoptera (Bees, 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 (Allen and Robinson 1993). 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 1986). 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 have yet to be found in the Southern Region.

Insect remains can also be preserved by mineralisation. Girling (1979a) 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 Southern Region. Examples have been found in cob walling (Robinson, unpublished z). They also occur 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. There is, however, one example of exceptionally well-preserved remains of the woodworm parasite *Theocolax formiciformis*, a minute wasp from woodworm tunnels, in a piece of charcoal (Robinson and Wilson 1987, 62).

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, sometime 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 of other species earlier in the Quaternary as they do today and specialist feeders are found associated with the same hosts. The water beetle *Helophorus lapponicus* was widely distributed across Western Europe in the Late Glacial but the climatic amelioration of the Holocene separated a population which retreated up the Pyrenees from a northern Scandinavian population. Despite a genetic isolation of 10,000 years, experiment has shown that the two populations can still successfully interbreed (Angus 1983). 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, the Mutual Climatic Range method (Atkinson *et al.* 1986; Atkinson *et al.* 1987). Principal component analysis shows over 96 per cent of the variance in thermal climate of the Palaeoarctic (Europe and Asia) is described by the warmth of the summer (TMAX) combined with the temperature range between the warmest and coldest months (TRANGE). They express the warmth of the climate and its degree of continentality. These parameters were plotted for species of Carabidae (ground beetles), water beetles and scarabaeoid dung beetles which occur as Pleistocene fossils, using data from meteorological stations throughout their modern geographic range. (Phytophagous beetles, whose distributions might reflect those of their host plants, were not used.) This gave a climatic range envelope for each species of TMAX against TRANGE. To estimate past climate by this method, the modern climatic range envelopes for all the relevant species in a Quaternary assemblage are compared and the area of greatest overlap is found. This gives a plot of TMAX against TRANGE most likely to correspond with the climatic conditions at the time the deposit was laid down. Unfortunately, this technique is not so 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", fitting together the ecological requirements of all the species identified 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 1985, 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 (1981a, 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 1983a). Further groups were also added. By the time this system was applied to the results from Runnymede (Robinson 1991a, 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 of a beetle diagram is given in Fig. 4.

The groups used follow Robinson (1981a, 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*, *Caccobius* 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 corral 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*, *Lyctus linearis* and *Xestobium rufovillosum* 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 1983a): 6a, species of weedy disturbed ground (*Agonum dorsale* and *Harpalus rufipes*); and 6b (Species Group 6 of Robinson 1981a, 279-82), 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 1981a, 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 1983a, 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 Southern 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. Where possible the development of coherent parts of the region are considered but 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: Devensian Zone III (Loch Lomond Stadial, c11,000-10,000 BP)

The seasonally very cold conditions followed by partial summer thaw during Late Devensian Zone III resulted in much accumulation of sediment conducive to the preservation of insect remains. Where rivers crossed regions of very soft bedrock, particularly clay, and there was a supply of hard rock on the interfluves, they created broad gravel floodplains across which many minor braided channels actively migrated. Lengths of channel would become cut off, fine organic sediments would accumulate and, since this was a period when much gravel terrace aggradation was occurring in river systems (eg Briggs *et al.* 1985, 65), the beds of the cut-off channels sometimes became sealed by further gravel deposition. Towards the end of the period, channels were sometimes abandoned that had been incised into the gravels.

Slope processes also resulted in the preservation of organic material beneath solifluction debris, where the underlying rock was impermeable. The region does not, however, have the lake beds, pingos etc which tend to characterise the Late Glacial of more northern parts of Britain.

Climate

Insect assemblages of this period comprise arctic faunas which today occur north of or above the tree line. They do not tend to contain so many of the species of Eastern Siberia and the mountains of central Asia which commonly occur in Mid-Devensian cold faunas although *Pterostichus magus* was recorded from Farmoor. Most of the species can now be found in Northern Scandinavia with some species restricted to the Arctic Circle and the tops of mountains further south. An assemblage was analysed from a palaeochannel cut into the Floodplain Gravel Terrace of the Upper Thames Valley at Farmoor, Oxon (Briggs *et al.* 1985, 54-64; Lambrick and Robinson 1979, 141-2). It gave a radiocarbon date of 10,600±250 BP (Birm-590). By far the most numerous beetle from it was *Helophorus glacialis*. This beetle no longer occurs in Britain but can be found in arctic Europe, the Alps and the Pyrenees, where it lives in pools of snow meltwater. Its presence implies patches of snow lasting, at least on shaded slopes, into the early summer. Another beetle of the same genus from the deposit was *H. obscurellus*, which occurs in arctic Russia as far east in Siberia as the Lena River and also on the Altai and Tien Shan Mountains, on the border between Kazakhstan and China. A total of 17 species indicative of cold conditions which no longer occur in Britain were identified from the site (Table 1) and others, for example *Notaris aethiops*, have a northerly distribution in Britain and are now absent from the region. Coope suggested that the average July temperature was close to 10° and that the average January temperature was no warmer than -10°C.

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

	Northmoor	Mingies Ditch	Farmoor	Wandle1	Wandle2	Hawks Tor	Folkestone
Radiocarbon date BP	11250±100	10860±130	10600±250		10130±120	between 9654±190 10884±210	before 9960±170
Data from:	1	2	1	3	3	4	5
Diacheila arctica Gyl.	+	-	-	-	-	-	-
Dyschirius septentrionum Munst.	-	-	+	-	-	-	-
Bembidion dauricum Mots.	-	-	+	-	-	-	+
B. difficile Mots.	-	-	-	-	-	-	+
B. crenulatum Sahl. or *fellmanni* Muh.	-	-	-	+	-	-	-
B. hyperboraeorum Munst.	-	-	+	-	-	-	-
B. transparens Gebl.	+	-	-	-	-	-	-
Pterostichus magus Muls.	-	-	+	-	-	-	-
Amara torida Ill.	+	-	-	-	-	-	-
Chlaenius costulatus Mots.	+	-	-	-	-	-	-
Oreodytes alpinus (Pk.)	-	-	+	-	-	-	-
Colymbetes dolabratus (Pk.)	-	-	+	-	-	-	-
Helophorus glacialis Villa	-	+	+	+	+	-	+
H. lapponicus Thom.	-	-	+	-	-	-	-
H. oblongus Le Conte	-	-	+	-	-	-	-
H. obscurellus Popp.	-	-	+	-	-	-	-
H. sibiricus Mots.	-	-	+	-	-	-	-
Pycnoglypta lurida Gyl.	+	-	-	-	-	-	-
Olophrum boreale Pk.	-	-	-	-	-	+	+
Arpedium quadrum Gr.	-	-	-	-	-	-	+
Acidota quadrata Zett.	+	-	+	+	+	+	-
Boreaphilus henningianus Sahlb.	+	-	+	+	+	+	-
Syncalypta cyclolepidia Munst.	-	-	+	-	+	-	-
Hypnoidus rivularis (Gyl.)	-	-	+	+	-	-	+
Hippodamia arctica Sch.	-	+	+	+	-	-	-
Anthicus ater Pz.	?	-	-	+	-	-	-
Chrysolina septentrionalis gp.	-	-	-	?	-	-	-
Chrysomela collaris L.	-	+	+	-	-	-	-
Phytodecta affinis Gyl or *linnaeanus* Schr.	-	-	-	+	-	-	-

1. Briggs *et al.* (1985), 2. Allen and Robinson (1993), 3. Peake and Osborne (1971),
4. Coope (1977), 5. Coope (1980)

Somewhat similar cold-indicative insect assemblages have been identified from other palaeochannels in the floodplain gravels of the Thames drainage system:

Northmoor, Oxon	11,250±100 BP (Birm-105)	Briggs *et al.* 1985, 54-64
Mingies Ditch, Oxon	10,860±130 BP (Har-8356)	Allen and Robinson 1993, 84-5
River Wandle, Greater London	10,130±120 BP (Birm-101)	Peake and Osborne 1971

The most numerous beetle from Northmoor, which was also present at Farmoor, Mingies Ditch and the River Wandle, was *Arpedium brachypterum*. It is a northerly staphylinid which occurs in organic debris. Another beetle of similar habitats present at five of the sites (Table 1) was *Boreaphilus henningianus*. Apart from a relict population in Germany, it occurs in Europe north of 60°, extending eastwards into Siberia. Snow meltwater at most of these sites was suggested by *Helophorus glacialis* and the carabid beetle *Patrobus septentrionis*, from the Wandle, is able to hunt over snow for frozen insects.

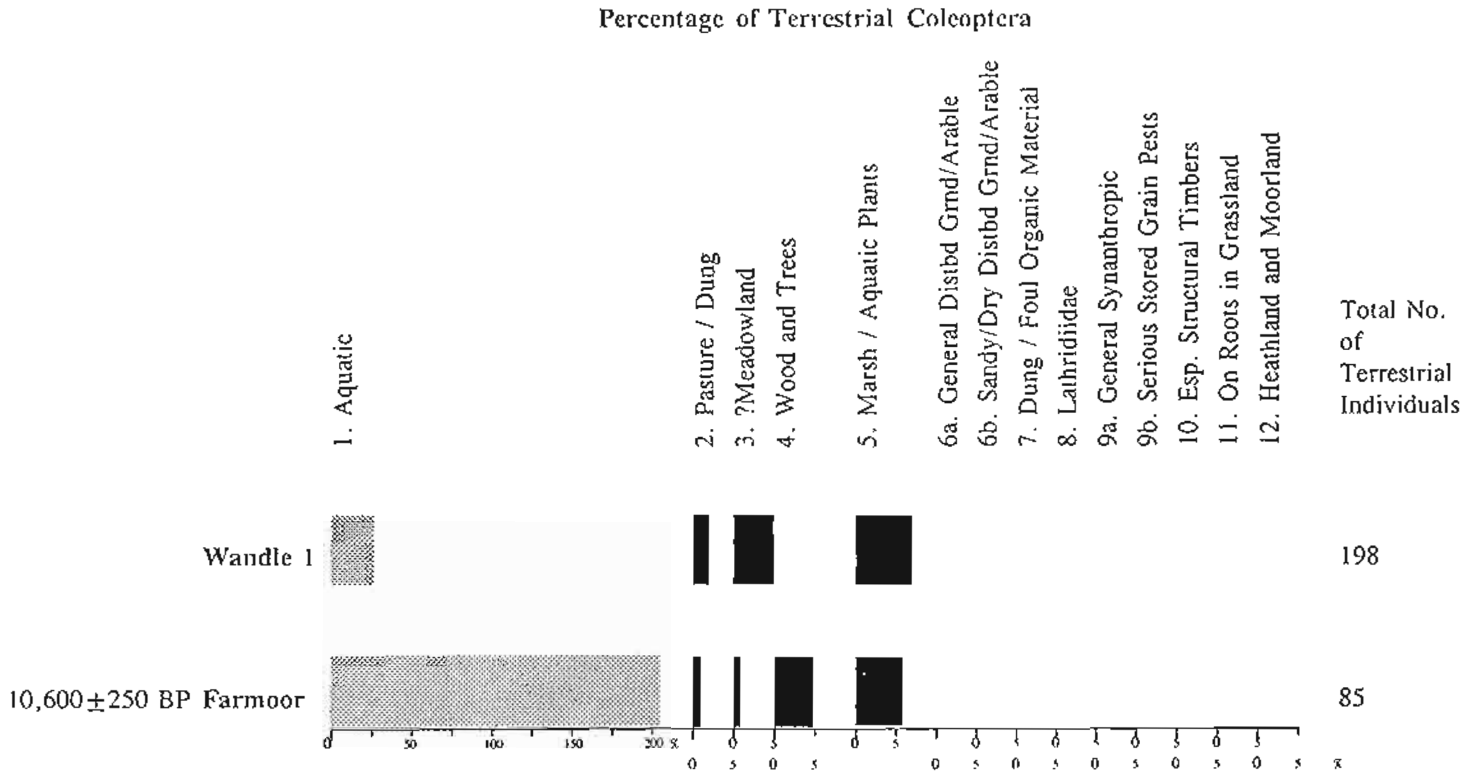
Similar insect faunas occurred off the river gravels. Small assemblages of insects dominated by arctic / alpine Coleoptera, some of which are now extinct in Britain (Table 1), were recovered from an organic deposit dated to before 9960±170 BP (Q-1508) over Gault Clay at the mouth of a coomb near Folkestone, Kent (Coope 1980) and from the base of blanket peat, stratified between deposits dated to 10,884±210 BP (Q-1016) below and 9654±190 BP (Q-1017) above, exposed in a China Clay pit at Hawks Tor, on Bodmin Moor (Coope 1977, 330). The staphylinid *Olophrum boreale*, which has an arctic distribution was present at both sites.

Site Conditions and Vegetation

The Coleoptera from the cut-off channels in the river gravels such as *Notaris aethiops* suggested that waterside vegetation such as aquatic grasses and sedges grew around the pools of stagnant water where the organic sediments were accumulating. Marshy ground at the channel edge provided a habitat for several species of *Bembidion* and *Dyschirius septentrionum*. Various Staphylinidae probably occurred in strand lines of decaying plant debris. However, beyond the pool margins, much of the newly deposited floodplain gravel probably presented a bare, harsh, environment with a few low-growing weeds or moss on which the weevil *Otiorhynchus nodosus* fed. The older areas of gravel could have supported grassy vegetation and *Salix repens* (creeping willow) or one of the woolly species of willow such as *S. lapponum* or *S. lanata* probably grew in slacks between gravel ridges. These species of willow are the food plants of the leaf beetle *Chrysomela collaris*, which was identified at both Mingies Ditch and Farmoor. The occurrence of arctic shrubs was also suggested by the ladybird *Hippodamia arctica* at Mingies Ditch, Farmoor and the Wandle. It feeds on aphids on *Salix* spp. (willows), *Betula nana* (dwarf birch), *Empetrum nigrum* (cranberry) and *Arctostaphylos alpinus* (alpine bearberry). There were possible records from the Wandle of two beetles which feed on *Salix herbacea* (dwarf willow), a very low-growing, creeping arctic / alpine plant: *Phytodecta affinis* and *Rhynchaenus flagellum*.

Botanical analyses at Farmoor and Mingies Ditch confirmed the evidence of the Coleoptera for tundra-like conditions. Along with seeds of aquatic and marsh species such as *Menyanthes trifoliata* (bogbean) and *Carex* spp. (sedges), both deposits contained many seeds of *Betula nana* (dwarf birch), a low-growing arctic shrub. Twigs of *Salix* cf. *repens* (creeping willow) reinforced the evidence of *Chrysomela collaris* at Mingies Ditch while calyces of *Armeria maritima* from Farmoor showed that there were also areas of sparse xerophytic vegetation.

The species groups used to interpret the Coleoptera results were not designed to cope with Late Glacial faunas, so many of the categories in Fig. 2 for Farmoor and the Wandle Site 1 are blank. However, it still serves to illustrate the rather barren nature of the landscape apart from the aquatic and waterside habitats. The wood and tree-feeding Coleoptera of Species Group are those which feed on *Salix repens*, so they only imply low scrub. Although *Salix herbacea* is technically a shrub, species which feed on it have not been placed in Species Group 4, so this category was not represented at the Wandle Site 1. The percentages for Species Group 2, scarabaeoid dung beetles were low, which is typical for the Late Devensian, whereas some Mid Devensian cold faunas have higher percentages of dung beetles, implying a significant presence of large herbivores.



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 Farmoor Glacial and Wandle Glacial**

Later 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 and many of the river systems of the Southern Region, for example the Upper Thames, showed little lateral channel migration. Reduced peak discharge in rivers tended to favour silting and organic sediments accumulated in channels, which have proved a major source of insect remains. Organic deposits also formed at sites where water seepage occurred, especially in partly blocked, deep-sided valleys, sometimes in conjunction with tufa formation. In the western part of the region where rainfall levels are high, blanket peat formation was initiated on some base-depleted substrates, particularly in upland areas. The rise in sea level consequent upon melting ice favoured the formation of coastal and estuarine peats. Most are now submerged or in inter-tidal localities but in some estuaries, for example the Thames, mineral sedimentation was sufficient that they can be found inland at depth.

Climate

Around 10,000 BP a major change occurred to the British insect fauna consequent upon rapid climatic amelioration (Osborne 1976). Indeed the initial evidence for a very rapid rise in temperature, from the arctic conditions of 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 Coleoptera. This challenged the then accepted view of a gradual climatic amelioration, which was based on the evidence of tree pollen. It was initially seen as controversial but is now supported by other lines of evidence, both biological and physical. The reason the insects were able to respond so rapidly to climatic warming, in comparison with the trees, is that many insects have good long-range dispersive powers, a short generation time and can colonise simple habitats.

While the Wandle Late Devensian site was the only one in the Southern Region used by Osborne in the initial survey, subsequent work in the region supports his findings. The arctic fauna at Folkestone was replaced by an apparently temperate fauna, with all the species still extant in Britain, by about 9960±170 BP (Q-1508) (Coope 1980). Arctic species were absent from a palaeochannel on the Upper Thames floodplain at Mingies Ditch (TS2) dated to 9380±100 BP (HAR-8366), Flandrian Early Zone I (Allen and Robinson 1993). However, it did contain one northern species, the carabid beetle *Patrobus assimilis*, which now only occurs as far south as Cannock Chase, Staffs.

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

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. Osborne (1965) was the first to draw attention to the development of the Flandrian woodland insect fauna, although the sites used were in the Midland Region.

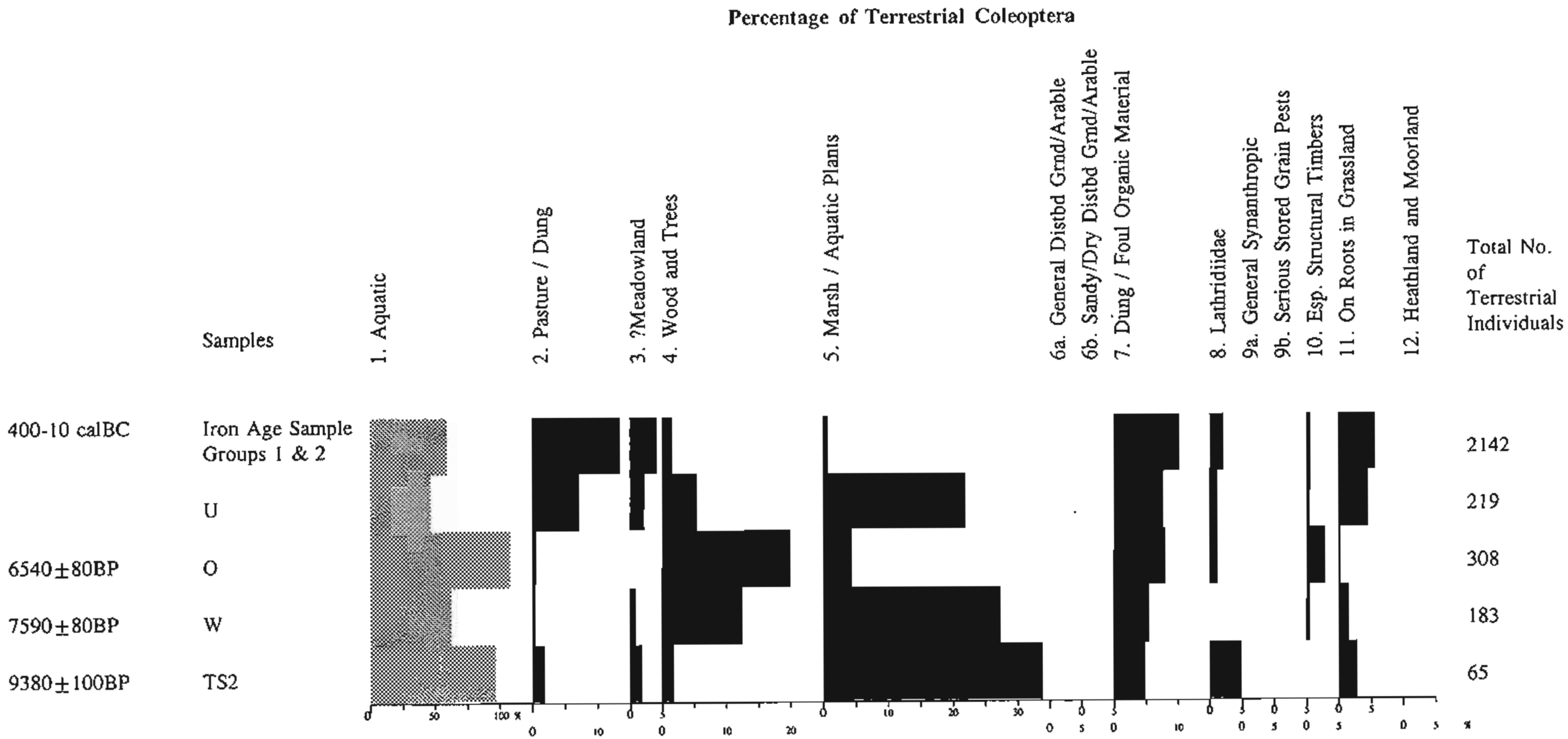
While several sites of Flandrian Zone II have now been investigated in the Southern Region, only the sequence at Mingies Ditch also spans Flandrian Zone I. The Coleoptera from Mingies Ditch Sample TS2 (see above) showed woodland development on the site was by no means complete (Fig. 3) (Allen and Robinson 1993). There was only a single tree-dependent beetle amongst the insects, the weevil *Cossonus linearis*. It lives in the rotten wood of old willows and poplars and is now very rare in Britain. The botanical evidence suggested very open woodland of *Populus* cf. *tremula* (aspen), *Salix* sp. (willow) and *Betula pendula* or *pubescens* (birch). The Coleoptera included a significant grassland element with the chafer *Serica brunnea* and the elaterid *Agrypnus murinus* of Species Group 11 being present. Given the rather open conditions, it is possible that the radiocarbon date of 9380±100 BP, which was obtained from a block of organic sediments, was 500 years too young.

The next sample in the sequence at Mingies Ditch (W) was from the channel of the River Windrush and was dated to 7590±80 BP (HAR-8354), Flandrian Late Zone I. It showed further woodland development, with wood and tree-dependent Coleoptera (Species Group 4) rising to 13% of the terrestrial Coleoptera. The more host-specific of the tree-feeding species included:

Rhynchaenus quercus	on *Quercus* spp. (oak)
Deporaus betulae	on *Betula* spp. (birch)
Phyllodecta vulgatissima	on *Populus* and *Salix* spp. (poplar and willow)

This accorded well with the botanical evidence for the woodland. Other insects of a balanced woodland fauna were present, for example the beetle *Melasis buprestoides*, which lives in rotten hardwood and the ant *Dolichoderus quadripunctatus*, which nests in hollow branches and under bark. Although this sample did not yield a full old woodland fauna, this is so far the only British record of *D. quadripunctatus*, which still occurs in woodland in Belgium.

The vegetational succession continued at Mingies Ditch and a channel sample (O) dated to 6540±80 BP (HAR-8355), Flandrian Zone II, gave botanical evidence for dense alder woodland. The insects presented a similar picture, with over 20% of the terrestrial Coleoptera being the wood and tree-dependent individuals of Species Group 4. They certainly confirmed the importance of alder woodland with the occurrence of *Agelastica alni* and *Rhynchaenus testaceus*, which feed on the leaves of *Alnus glutinosa* and *Dryocoetinus alni*, which tunnels under bark, mostly of alder. Alder is very productive of pollen and seeds, so tends to be over-represented amongst plant remains, but does not support large numbers of Coleoptera. The Coleoptera at Mingies Ditch provided a means of "seeing beyond" the alder woodland of the floodplain through to the First Gravel Terrace and there was a significant presence of Coleoptera dependent on other trees and shrubs:



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. 3: **Species Groups of Coleoptera from Mingies Ditch**

Rhynchaenus quercus	on *Quercus* spp. (oak)
Curculio nucum	on *Corylus avellana* (hazel)
Hylesinus crenatus	esp. on *Fraxinus excelsior* (ash)
Ernoporus caucasicus	on *Tilia cordata* (small-leaved lime)
Ochina ptinoides	on *Hedera helix* (ivy)

Oak and lime woodland probably grew on the higher ground.

There was a very rich woodland fauna of Coleoptera, with species from the full range of habitats that occur in wet woodland. Many are associated with dead wood, for example, *Gastrallus immarginatus* in dead wood of old deciduous trees, *Platystomos albinus* in decaying trees and *Eledona agricola* in bracket fungi on trees. All three species are characteristic of old woodland and are now rare in Britain, indeed *G. immarginatus* is now only known in Britain from Windsor Great Park. Another species, *E. caucasicus*, is a bark beetle that is now restricted to a few old parkland and woodland lime trees in the Midlands. *A. alni* is a leaf-feeder rather than a beetle of dead or moribund wood but it seems to have required extensive tracts of alder woodland to maintain a viable population in Britain. It is now possibly extinct, although there are earlier 20th century records of its capture.

Very similar results to those from Mingies Ditch Sample O were obtained from a palaeochannel of the Thames at Runnymede, Berks, dated to 6,500-5,950 calBC (Robinson, unpublished a; Robinson 2000). Dense alder woodland again fringed the river and gave a value of 20% for the wood and tree-dependent Coleoptera of Species Group 4 (Fig. 4, Column 40). The woodland fauna again included *Agelastica alni* and there was another beetle which is now unique in Britain to Windsor Forest, the wood-boring weevil *Dryophthorus corticalis* (Table 2).

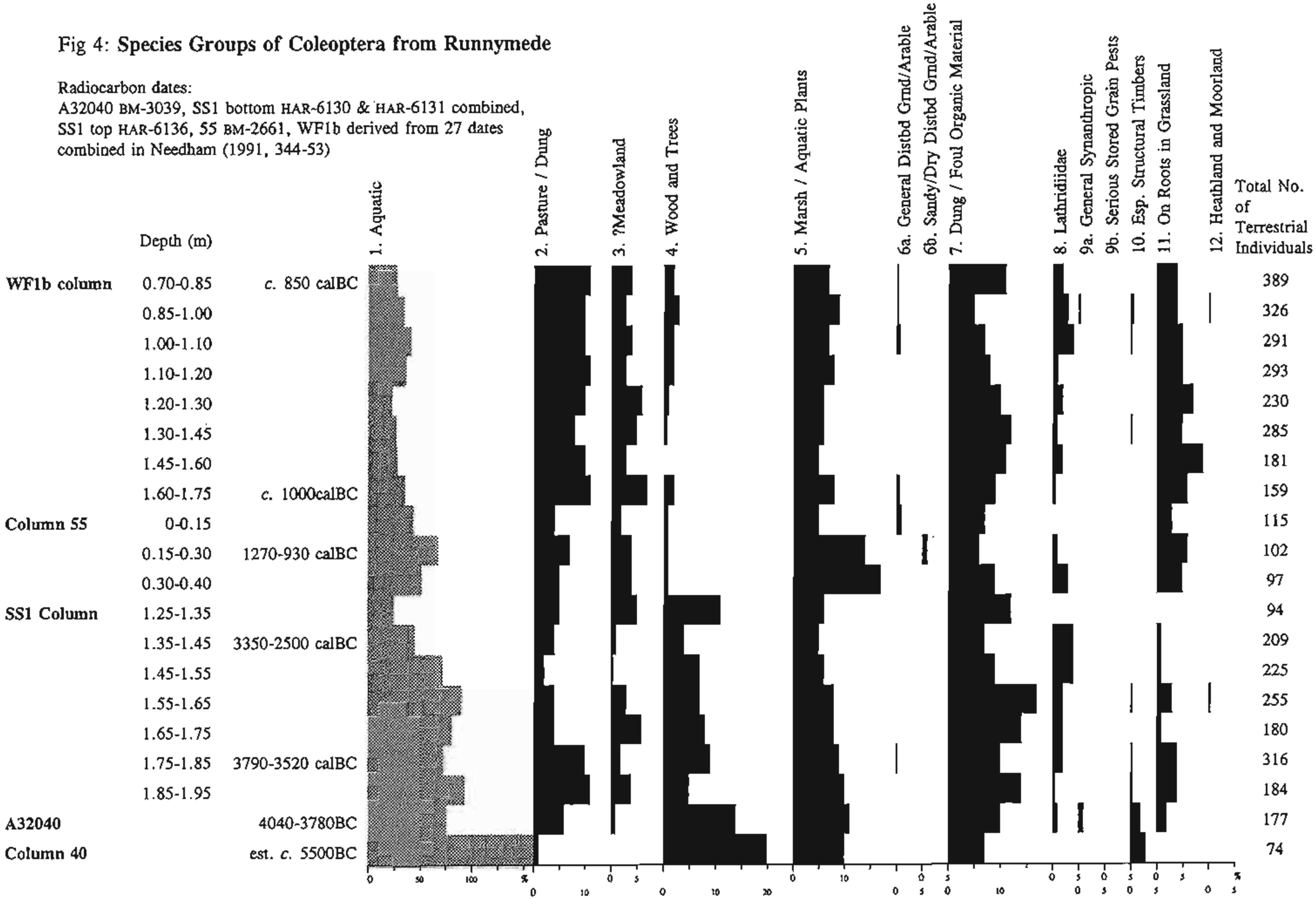
Good coleopteran evidence of the lime woodland which predominated in the better-drained soils over much of the region during the Atlantic (Flandrian Zone II) (Greig 1982a) came from a small spring-fed bog at West Heath, Hampstead Heath, London (Girling 1989b). The bog was surrounded by the dry, acidic soils of the Bagshot Sands, which were probably the source of the majority of the terrestrial insects. Pollen analysis suggested that the lower part of the sequence (WHS 1) pre-dated the Elm Decline and belonged to Flandrian Zone II. The fauna of WHS 1 was dominated by Coleoptera of closed woodland, a value of over 38% being obtained for Species Group 4 (Fig. 5) The most numerous of the more host-specific of these beetles was the small bark beetle *Ernoporus caucasicus*, which feeds on *Tilia cordata* (small-leaved lime). Other host-specific tree and shrub-feeding Coleoptera included:

Rhynchaenus quercus	on *Quercus* spp. (oak)
Curculio nucum	on *Corylus avellana* (hazel)
Scolytus scolytus	mostly on *Ulmus* spp. (elm)
Kissophagus hederae	on *Hedera helix* (ivy)

This would suggest that the site was surrounded by mixed lime woodland.The Coleoptera from WHS 1 included the strong element of ancient woodland species dependent on dead and decaying wood. In addition to the two "Windsor Forest rarities" also recorded from Mingies Ditch and Runnymede, there were two species now extinct in Britain, *Pycnomerus terebrans* and *Isorhipis melasoides*. Both these beetles now have disjunct distribution in Central Europe and are now regarded as relict species of old woodland.

Fig 4: **Species Groups of Coleoptera from Runnymede**

Radiocarbon dates:
A32040 BM-3039, SS1 bottom HAR-6130 & HAR-6131 combined,
SS1 top HAR-6136, 55 BM-2661, WF1b derived from 27 dates
combined in Needham (1991, 344-53)

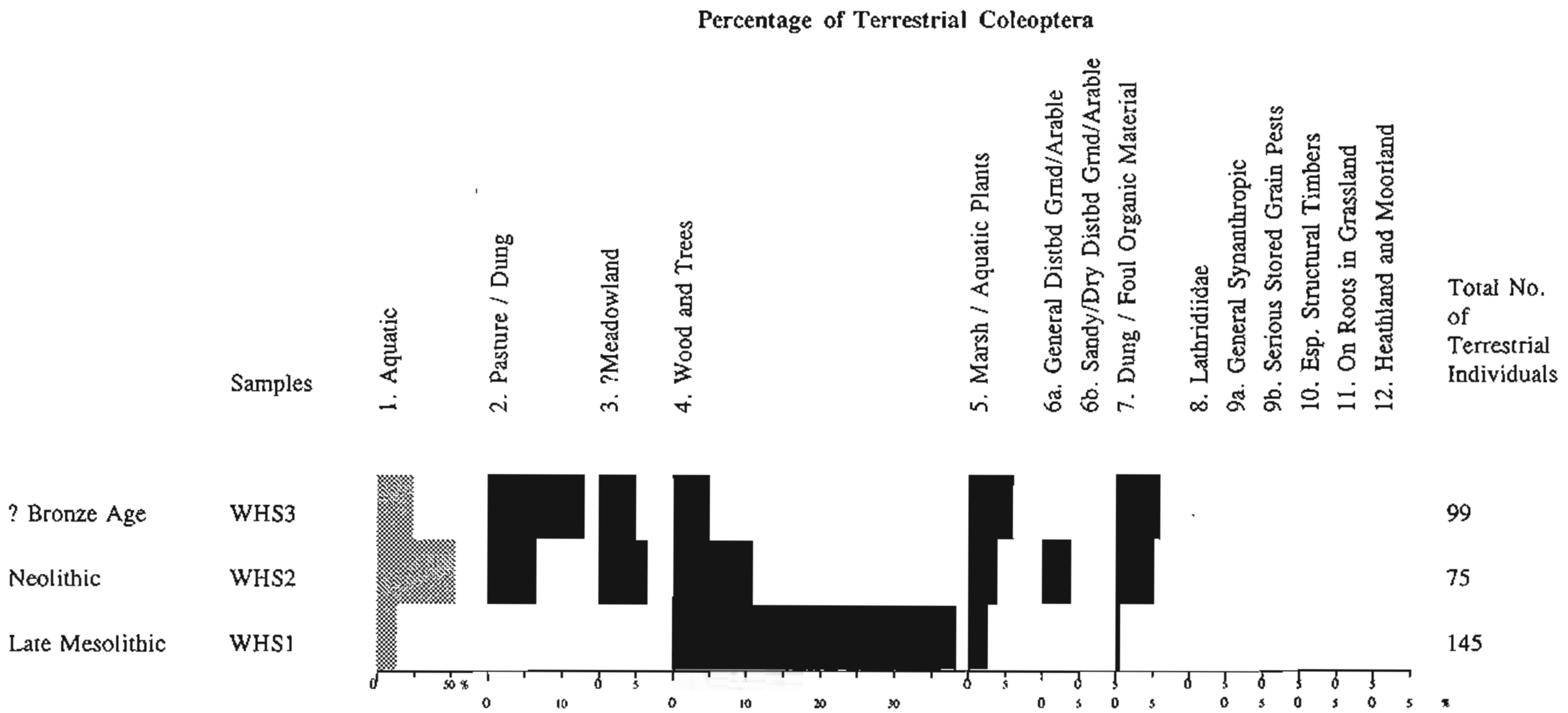


Species groups expressed as a percentage of the total terrestrial Coleoptera (ie aquatics excluded). Not all the terrestrial Coleoptera have been classified into groups.

Table 2: "Old Woodland" Insects from the Southern Region

Period	Earlier Mesolithic		Later Mesolithic			Neolithic							Late Bronze Age	
	Mingies Ditch TS2	Mingies Ditch W	Mingies Ditch O	Runnymede Column 40	Hampstead Heath	Runnymede A32040	Runnymede SS1 Column	Fishbourne	Sweet Track	Abbot's Way	Baker Platform	Stileway	Runnymede WF1b Column	Patching Junction
Data from	1	1	1	2	3	2	2	4	5	6	7	8	2	9
COLEOPTERA														
**Rhysodes sulcatus* F.	-	-	-	-	-	-	-	-	-	-	+	-	-	-
**Batrisus formicarius* Aubé	-	-	-	-	-	-	-	-	-	-	-	+	-	-
Ampedus nigerrimus (Lac.)	-	-	-	-	-	-	-	-	-	-	-	-	+	-
**Isorhipis melasoides* (Lap.)	-	-	-	-	+	-	-	-	-	-	+	-	-	-
**Dromaeolus barnabita* (Villa)	-	-	-	-	-	-	+	-	-	-	-	-	-	-
Platycis sp. (not *minutus*)	-	-	+	-	-	-	-	-	-	-	-	-	-	-
Gastrallus immarginatus (Müll.)	-	-	+	-	+	-	+	+	+	-	-	+	-	+
**Pelta grossum* (L.)	-	-	-	-	-	-	+	-	-	-	-	-	-	-
Uleiota planata (L.)	-	-	-	-	-	-	-	-	+	-	-	-	-	-
**Prostomis mandibularis* (F.)	-	-	-	-	-	-	-	-	+	-	-	-	-	-
Colydium elongatum (F.)	-	-	-	-	-	-	+	-	-	-	-	-	-	-
**Pycnomerus terebrans* Ol.	-	-	-	-	+	-	-	-	-	-	-	+	-	-
Teredus cylindricus (L.)	-	-	-	-	-	-	+	-	-	-	-	-	-	-
**Bothrideres contractus* F.	-	-	-	-	-	-	-	-	-	-	-	+	-	-
Prionychus melanarius (Gem.)	-	-	-	-	-	-	+	-	+	-	-	-	-	-
**Strangalia attenuata* (L.)	-	-	-	-	-	-	-	-	+	-	-	-	-	-
**Agelastica alni* (L.)	-	-	+	+	-	+	+	-	-	-	+	-	-	-
Cossonus linearis (F.)	+	-	-	-	-	-	-	-	-	-	-	-	-	-
**Eremotes punctulatus* Boh.	-	-	-	-	-	-	-	-	-	-	-	+	-	-
Dryophthorus corticalis (Pk.)	-	-	-	+	+	-	-	-	+	-	-	-	-	-
*Cossoninae indet.	-	-	-	+	-	-	-	-	-	-	-	-	-	-
Ernoporus caucasicus Lind.	-	-	+	-	+	-	+	-	+	+	-	-	-	-
HYMENOPTERA														
**Dolichoderus quadripunctatus* (L.)	-	+	-	-	-	-	-	-	-	-	-	-	-	-

* Now extinct in Britain 1. Allen and Robinson (1993), 2. Robinson (1991a); Robinson (2000), 3. Girling (1989b) 4. Robinson (unpublished d) 5. Girling (1979c); Girling (1984a),
6. Girling (1976) 7. Girling (1980), 8. Girling (1985), 9. Robinson (unpublished g).



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 West Heath Spa, Hampstead Heath**

The high percentage of wood and tree-dependent Coleoptera along with the occurrence of what are now regarded as old woodland species is typical of Flandrian Zone II insect assemblages. This was a reflection of the largely undisturbed woodland which extended over most of the British Isles during this period (Girling 1982c). The occurrence of a continuous habitat, over-mature trees and much deadwood enabled species to thrive which as a result of clearance and the management of what woodland remained, have now become extremely rare or extinct in Britain. Those species from Southern Region sites of Mesolithic date are listed in Table 2.

***Scolytus scolytus* and the Elm Decline**

The Elm Decline is probably the most studied, best dated and least understood event of the Flandrian. It is manifest as a decline in elm pollen values by about 50%, which occurred at around 5200 BP (4000 BC). The Elm Decline was broadly synchronous over much of north-west Europe. Given the date of the phenomenon, it might seem a topic more appropriate to the next section. However the evidence related below belongs firmly in Flandrian Zone II.

The discovery of two individuals of *Scolytus scolytus* (elm bark beetle) in the Hampstead Heath sequence attracted considerable interest because it is the main vector of the fungus *Ophiostoma ulmi*, the cause of Dutch elm disease (Girling 1988; Girling and Greig 1985; Moore 1984). The catastrophic decline in the elm population of Southern England during the early 1970s due to Dutch elm disease had raised the possibility that it or a similar disease had caused the Elm Decline. Those papers were misunderstood and a popular belief grew up that the Elm Decline was caused by *O. ulmi* spread by *S. scolytus* which was introduced to Britain by the first Neolithic settlers. The assumption that *S. scolytus* always carries the fungus with it is perhaps the result of confusion with ambrosia beetles (both are members of the family Scolytidae).

There has also been a determined effort with the Hampstead Heath results not to let evidence stand in the way of a good hypothesis. In both the text and tables of the full report of the excavation, the specimens of *S. scolytus* were described as coming from about 0.20m below the horizon in which the Elm Decline could be discerned in the pollen record (Girling 1989b, 77, 88). In Girling (1988, 34) and Girling and Greig (1985, 349) they were noted as being from about 0.15m below the Elm Decline whereas in Mannion (1993) they were found just 0.10m below the Elm Decline. Peglar and Birks (1993) stated the beetles to have been from immediately pre-Elm Decline deposits.

With the slow (or discontinuous) rate of sediment accumulation at the Hampstead Heath site, 0.20m below the level of the Elm Decline (with three insect samples in between), the date of the beetles can be placed chronologically well before the Elm Decline. Given the present pan-European distribution of both *S. scolytus* and elms, the occurrence of the beetle at Hampstead Heath should not be seen as exceptional. *S. scolytus* was also recorded from the Late Mesolithic sediments of Column 40 at Runnymede. However, an increase in the numbers of moribund elms would be expected to result in a rise in the numbers of *S. scolytus* whether or not their morbidity was due to Dutch elm disease. A peak in numbers of *S. scolytus* and indeed other beetles of dying elms at the Elm Decline is definitely something to look out for and, if found, would certainly give useful information on the phenomenon.

Open Habitats and Human Activity

The occurrence of beetles of grassland in the early Post-Glacial at Mingies Ditch, before complete tree cover had become established, has already been mentioned. Most Flandrian Zone II insect assemblages give little indication of open habitats. Scarabaeoid dung beetles of Species Group 2, such as *Aphodius rufipes*, only comprised around 1% of the terrestrial Coleoptera from Mingies Ditch Sample O and Runnymede Column 40 and were absent from Hampstead Heath WS 1 (Figs. 3-4). A presence of wild woodland herbivores, such as deer, would have been expected on these sites but at a very much lower level than that of domestic animals after clearance. Some members of the genus *Apion* (Species Group 2) can feed on woodland herbs while values for Species Group 11 are generally low.

Insects were analysed from a Late Mesolithic midden now in the inter-tidal zone at Westward Ho!, Devon (Girling and Robinson 1987; Wilkinson 1987). The insects were from the midden itself, which gave radiocarbon dates of 6100±200 BP (HAR-5632) and 6320±90 BP (HAR-5645), and the overlying fen peat. The peat was dated to 5740±100 BP (HAR-5641) immediately above the midden and 5200±120 BP (HAR-5640) at the top. The majority of the insects from both the midden and the peat were characteristic of freshwater fen woodland. There were, however, three beetles characteristic of dry open sandy ground near the coast: *Harpalus sabulicola*, *Phylan gibbus* and *Opatrum sabulosum*. A chrysomelid beetle from the site, *Chrysolina banksi* has a somewhat coastal distribution, feeding mostly on *Ballota nigra* (black horehound) and *Teucrium scorodonia* (wood sage). This group of beetles probably represented an insect community of exposed sand dunes along the coastline in front of the fen woodland, rather than the fauna of a cleared area. Beetles of decaying plant material were abundant throughout the sequence. They were predominantly species which would favour the type of debris which would be accumulating on the floor of fen woodland, such as *Oxytelus fulvipes* and *Corylophus cassidoides*. Some can live in decaying organic materials as occur around settlements but none is so restricted. Indeed, despite some of the sample being from a Mesolithic midden, beetles undoubtedly indicative of human habitation were absent.

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. To avoid repetition, the rich, clean-water, aquatic and marginal insect fauna of the River Thames and its tributaries will be described in the next section (p.59). The Westward Ho! inter-tidal site, however, provided a good example of freshwater fen woodland that has developed in slacks behind coastal dunes (Girling and Robinson 1987). Such woodland was probably extensive around the coast at this date but has now disappeared. It is also the only site in the region on which detailed studies of Trichoptera (caddis flies) was undertaken (Wilkinson 1987). The Trichoptera larvae suggested sediment and peat accumulating in small pools with dead leaves in the bottom under woodland conditions. One of the Trichoptera, *Glyphotaelius pellucidus*, is intolerant of brackish conditions, showing that the slack was well-protected from the sea. The upper samples from the peat contained *Crunoecia irrorata*, a species of very small woodland streams, although its presence need imply no more than wet flushes on the peat surface dribbling freshwater. The beetle fauna of both the midden and the peat was also characteristic of freshwater fen woodland. Species such as *Hydroporus rufifrons*, *Agabus affinis* and *A. melanarius* inhabit peaty pools while other beetles such as *Anacaena globulus* are amphibious, occurring under wet leaf litter as well as in water. The Carabidae (ground beetles) were mostly hygrophilous species from the genera *Bembidion* and *Agonum*, with habitats such as amongst fallen leaves in marshy forests. Species of decaying fen vegetation have already been mentioned. A full fauna of tree-dependent Coleoptera was present, ranging from leaf-feeders through to beetles which feed on wood in all stages of decay. Species such as *Ramphus pulicarius* suggested that *Salix* spp. (willows) grew in the swampy carr with pools of water on the surface, while *Curculio nucum* and *Rhynchaenus quercus* respectively suggested *Corylus avellana* (hazel) and *Quercus* sp. (oak) on areas of dry fen.

Discussion

The Mesolithic was characterised by the very rapid displacement of arctic faunas by temperate insects at the start of Flandrian Zone I, followed by the more gradual diversification of woodland faunas as woodland succession took place throughout Flandrian Zone I. Even before Flandrian Zone II, the quantity of over-mature trees and dead wood gave a fauna that nowadays is only to be found in the great woodlands of Central Europe. Many of these species are now rare in Britain, some are extinct. In some cases it is the association with very old trees which is more important than the woodland habitat, so the insects can now only be found in the elderly pollards of early medieval parks, for example, Windsor Forest. Detailed climatic studies other than at the start of Flandrian Zone I are difficult because habitat destruction, rather than climatic change, was responsible for the restriction of these "old woodland" species to a modern geographic range which experiences a more continental climate than present-day Britain. No evidence has yet been found of any human influence on the insect population of the region during the Mesolithic.

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). 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 Neolithic occurred earlier and the date of 4300 BC has been taken for the start of the period. Even though the organised agricultural landscape of Wessex had its origins prior to 1500 BC, this date towards the end of the middle Bronze Age 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 (although the deposition of tufa itself in calcareous valley fens ceased). Middle Bronze Age organic deposits of this sort containing well-preserved insect remains have proved rather elusive but they do occur. A marine regression in the estuary of the River Brue in Somerset resulted in the formation of a major area of fenland where peat accumulation kept pace with any subsequent rises in sea level. Human activity also resulted in the preservation of insect remains in the bottoms of ponds, water holes and wells, although such features are not common during this period.

The Neolithic to middle Bronze Age is the period when humans first 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. It is also the first period when sufficient variation can be discerned between insect assemblages from different parts of the region for it to be worth considering some sites by divisions of the region rather than as a simple chronological sequence for each theme.

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

Two sites in the region from which insects have been analysed possibly had deposition of organic sediments across the period boundary at c. 4300 BC, between the Mesolithic and Neolithic. This was best shown at Westward Ho!, Devon (Girling and Robinson 1987) where the bottom of a peat sequence was dated to 5740±100 BP, 4900-4350 calBC (HAR-5641) and the top of the sequence was dated to 5200±120 BP, 4350-3700 calBC (HAR-5640). Pollen from the top 0.05m of the peat showed the Elm Decline and some evidence for a slight opening of the tree canopy (Scaife 1987, 225). There was a slight increase in beetles which tend to be indicative of grassland, including *Agrypnus murinus* and *Athous* sp., in the uppermost sample from the peat. Scarabaeoid dung beetles were also present. It is possible that slight clearance and grazing were occurring but there does not seem to have been large-scale human activity occurring alongside the Elm Decline.

In contrast, the Elm Decline at Hampstead Heath was co-incident with a substantial rise in herb pollen, including Gramineae (grasses) (Greig 1989, 93-4). Unfortunately, it was not possible to obtain radiocarbon dates on the sequence and the apparent Elm Decline could also have been the result of a hiatus in sedimentation. The relatively high levels of *Tilia* sp. (lime) pollen just after the Elm Decline would, however, suggest a Neolithic or early Bronze Age date for the sediment. The insects from the sediments (WHS 2) showed that substantial changes had occurred on the site (Girling 1989b). Wood and tree-dependent Coleoptera (Fig. 5, Species Group 4) had fallen to less than a third of their previous level. Scarabaeoid dung beetles from the genus *Aphodius*, which was entirely absent from the Mesolithic deposits, comprised almost 7% of the terrestrial Coleoptera and weevils from the genera *Apion* and *Sitona* which feed on grassland Leguminosae (vetches and clovers) rose to a similar percentage. One species, *Aphodius scrota*, is now very rare or extinct in Britain. Clearance had apparently occurred to provide pasture for domestic animals, which were perhaps brought to drink at the spring. The presence of the carabid beetle *Agonum dorsale* would suggest that there were also sparsely vegetated areas of weedy ground. Trees, were, however, by no means absent and, on the insect evidence, cover could have been as high as 50%. The lime-feeding *Ernoporus caucasicus* and the rare species of rotten wood were absent. However, the oak leaf weevil *Rhynchaenus quercus* had been joined by *Hylesinus crenatus*, a bark beetle which mostly occurs on *Fraxinus excelsior* (ash). These partly-wooded conditions probably persisted throughout the Neolithic and Bronze Age.

Although the insect sequence from palaeochannels of the River Thames at Runnymede did not include a single series of samples scanning the Elm Decline, Column 40 (see above) was from the late Mesolithic (Flandrian Zone II) and Sample A32040 gave a radiocarbon date of 5130±50 BP, 4040-3780 calBC (BM 2657), which would place it as almost contemporaneous with this event (Robinson, unpublished a; Robinson 2000). The insect remains from this sample showed that the site remained densely wooded, about 14% of the terrestrial Coleoptera belonging to Species Group 4: wood and trees (Fig. 4). Several examples of *Agelastica alni* suggested that alder woodland remained along the river bank. *Rhynchaenus quercus* (oak leaf weevil) and *Leperisinus varius*, a bark beetle mostly of ash, were probably derived from mixed deciduous woodland on drier ground. The Coleoptera included elements from a wide range of woodland habitats, for example *Colenis immunda*, which occurs amongst mouldy leaf litter, *Silpha atrata*, a predator under bark or in rotten wood, and the leaf and bark beetles already mentioned, as well as the beetles which feed on wood in various stages of decay. As might be expected, the latter group included an "old woodland" element, with *Rhyncolus truncorum* and an unidentified species of Cossoninae.

The Coleoptera also gave a little evidence for grassland, or at least grassy glades in the woodland. Elateridae with larvae which feed on roots in grassland, including *Agrypnus murinus*, (Species Group 11). However, very few of the other phytophagous beetles could be tied down as feeding on light-demanding terrestrial herbs. In contrast, the mid to late Neolithic sequence from the site (Column SS1, below) contained many insects which feed on grassland herbs even though much tree cover remained. Most interestingly, the proportion of scarabaeoid dung beetles of Species Group 2 was as high as from the mid to late Neolithic sediments, at 6% of the terrestrial Coleoptera. *Aphodius* cf. *sphacelatus* was the most numerous of these beetles but there were also other species of *Aphodius*, *Onthophagus* spp. and *Geotrupes* sp. There was clearly a concentration of large herbivorous mammals in the area, above the usual level for wild species. It is possible that this represents some of the earliest Neolithic activity so far detected in the region, with animals being herded in woodland where the canopy was largely intact. The two most likely domestic animals to have been grazed under woodland conditions are cattle and pig.

Woodland Survival and Clearance

In some parts of the region, for example the Thames Valley, the insect evidence showed woodland retaining much of the character of Mesolithic woodland survived throughout the Neolithic. In other parts of the region, for example on the Chalk of Wessex, there were areas which had almost entirely lost their woodland insect faunas. Almost all the early and middle Bronze Age insect assemblages so far investigated are, however, from largely open landscapes.

The Thames Valley Sequence

A long waterlogged sequence was analysed for insects from a palaeochannel at Runnymede (Fig. 4, Column SS1) which began in the middle Neolithic at c 3500 BC and spanned the late Neolithic to 2000 BC (Robinson 1991a). There appeared to be no major change in the insect fauna over this period other than a decline in grassland species. Over 7% of the terrestrial Coleoptera were the wood and tree-dependent species of Species Group 4. In addition there were many insects of other woodland communities, for example Carabidae (ground beetles) of the woodland floor and phytophagous species which feed on woodland herbs. The results are regarded as reflecting between one third and two thirds woodland cover in the catchment.

The relative abundance of the host-specific tree and shrub-feeding beetles, compared with the results from the late Bronze Age channel sequence Column WF1b, is shown in Fig. 6. It is clear that most of the Neolithic tree and shrub cover was from potential woodland trees rather than thorn or willow scrub. The relative abundance of the different groups of beetles in Fig. 6 is not in direct proportion to the degree of representation of each tree species. Oak, for example, supports a diverse and abundant beetle fauna, whereas there are few beetles exclusive to hazel. When due allowance is made for differential representation of the various trees, these results can be interpreted as showing alder woodland (indicated by *Agelastica alni*) growing on the lower parts of the floodplain and mixed oak woodland growing on the higher part of the floodplain and the gravel terraces. In addition to oak, indicated by several species of *Rhynchaenus*, other members of the mixed woodland included ash, small-leaved lime, hazel and probably elm (indicated by *Leperisinus varius*, *Ernoporus caucasicus*, *Curculio nucum* and *Acrantus vittatus* respectively). A strong old-woodland element was still present in the fauna, the species which are now very rare or extinct in Britain being listed in Table 2.

Insect remains from a palaeochannel dated to 4010±90 BP, 2900-2300 calBC (HAR) at Buscot Lock, much farther up the Thames on the Oxon / Glos border, suggested an even more thoroughly wooded landscape than Runnymede in the late Neolithic (Robinson 1981b, 113-27; Robinson and Wilson 1987, 31-2). Wood and tree-dependent Coleoptera (Species Group 4) comprised 17% of the terrestrial Coleoptera. Although none of these species is a great rarity or extinct in Britain, the fauna was still characteristic of ancient woodland.

A small assemblage of insect remains was recovered from a minor palaeochannel of the River Windrush which ran along the junction between the floodplain and the Second Gravel Terrace of the Upper Thames at Gravelly Guy, Oxon. (Robinson, unpublished e). It was dated to 3740±50 BP, 2340-2020 calBC, which would place it as broadly contemporary with the top

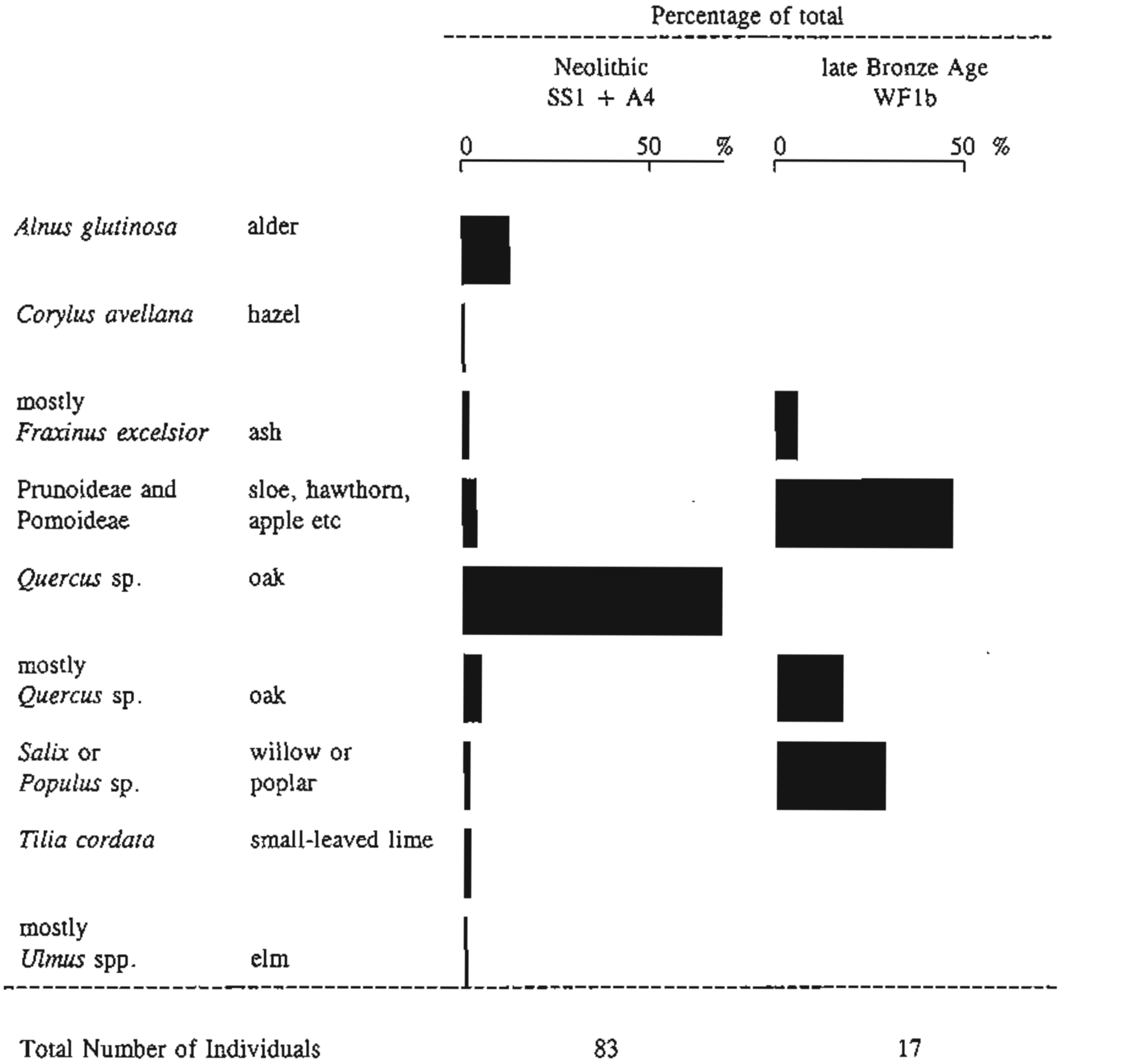


Fig. 6: **Host plants of the more host-specific tree and shrub-feeding Coleoptera from Runnymede**

of Column SS1 from Runnymede. It presented a picture of conditions more open than at Runnymede. Wood and tree-dependent Coleoptera (Species Group 4) comprised 5% of the terrestrial Coleoptera and a strong open-country faunal element was present. Even so, the woodland species do seem to have comprised a woodland, rather than a scrub or hedgerow fauna, unlike the Coleoptera from an early Bronze Age pond at Staines Road Farm, Shepperton, Surrey, on the gravels of the River Ash, a tributary of the Middle Thames (Robinson, unpublished b). The Coleoptera, which were from sediments dated to 3630±90 BP, 2300-1750 calBC, were mostly from open-country habitats. However, an element of scrub was suggested by several examples of *Acalles turbatus*, a wood-boring weevil which is now most usually found in dead hawthorn branches in old hedges. The botanical results very much confirmed the entomological evidence for the occurrence of thorn scrub on the site.

An open-country insect fauna was recorded from a pair of middle Bronze Age ceremonial ditches on the floodplain of the Upper Thames at Yarnton, Oxon, from which wood and tree-feeding Coleoptera were absent (Robinson, unpublished c). Seven radiocarbon dates were obtained for the ditches, which ranged from 3175±65 BP, 1620-1310 calBC (OxA-6347) to 3005±60 BP, 1420-1060 calBC (OxA-6348). Nearby at Yarnton, on a higher area of the floodplain, woodland tree-feeding Coleoptera were absent from a middle Bronze Age well which gave radiocarbon dates of 3255±70 BP (OxA-6548) and 3115±70 BP (OxA-6549), combined date 1610-1390 calBC.

While the results from the Thames Valley tend to present a picture of progressive clearance, the process would not have been quite so uniform. Some areas were probably permanently cleared at quite an early date whereas in other parts of the Thames Valley, especially along the tributaries, woodland which supported old-woodland species probably survived into the late Bronze Age.

The Wessex Chalk

Although conditions on the Chalk downs of Wiltshire are not generally conducive to the survival of insect remains, they were preserved at two exceptional sites, Silbury Hill and the Wilsford Shaft. At Silbury, a huge mound was constructed on low-lying ground close to the ceremonial complex at Avebury. The turf core and chalk rubble body of the mound were sufficient to enable the old ground surface beneath to remain permanently moist and to prevent the diffusion of air to it. Conditions of preservation were similar to those in ordinary waterlogged deposits. The mound was shown to be late Neolithic in date, a radiocarbon date of 4095±95 BP, 2910-2460 calBC (I-4136) being obtained for the buried ground surface. Preliminary investigations were made of insects by MCD Speight when the mound was tunnelled 30 years ago but the material has now been fully analysed (Robinson 1997). The insect assemblages from both the turf stack and the old ground surface comprised faunas of open grassland. There was only a single beetle which was dependent on trees or shrubs.

The Wilsford Shaft was a middle Bronze Age well on the Chalk of Normanton Down, about 1.5km from Stonehenge. Wood from buckets and bone from the bottom of the shaft gave radiocarbon dates of 3160±60 BP (OxA-1216), 3150±60 BP (OxA-1217) and 3200±80 BP (OxA-1229), combined date 1520-1390 calBC. The shaft had acted as a pitfall trap and a large number of insect fragments were recovered from the bottom (Osborne 1969; Osborne 1989). Only 0.04% of them belonged to the wood, tree and shrub-dependent category

(Species Group 4) (Fig. 7). Even these were species which live in dead wood, for example *Strangalia melanura*, and it was suggested that they could have been carried to the site in wood.

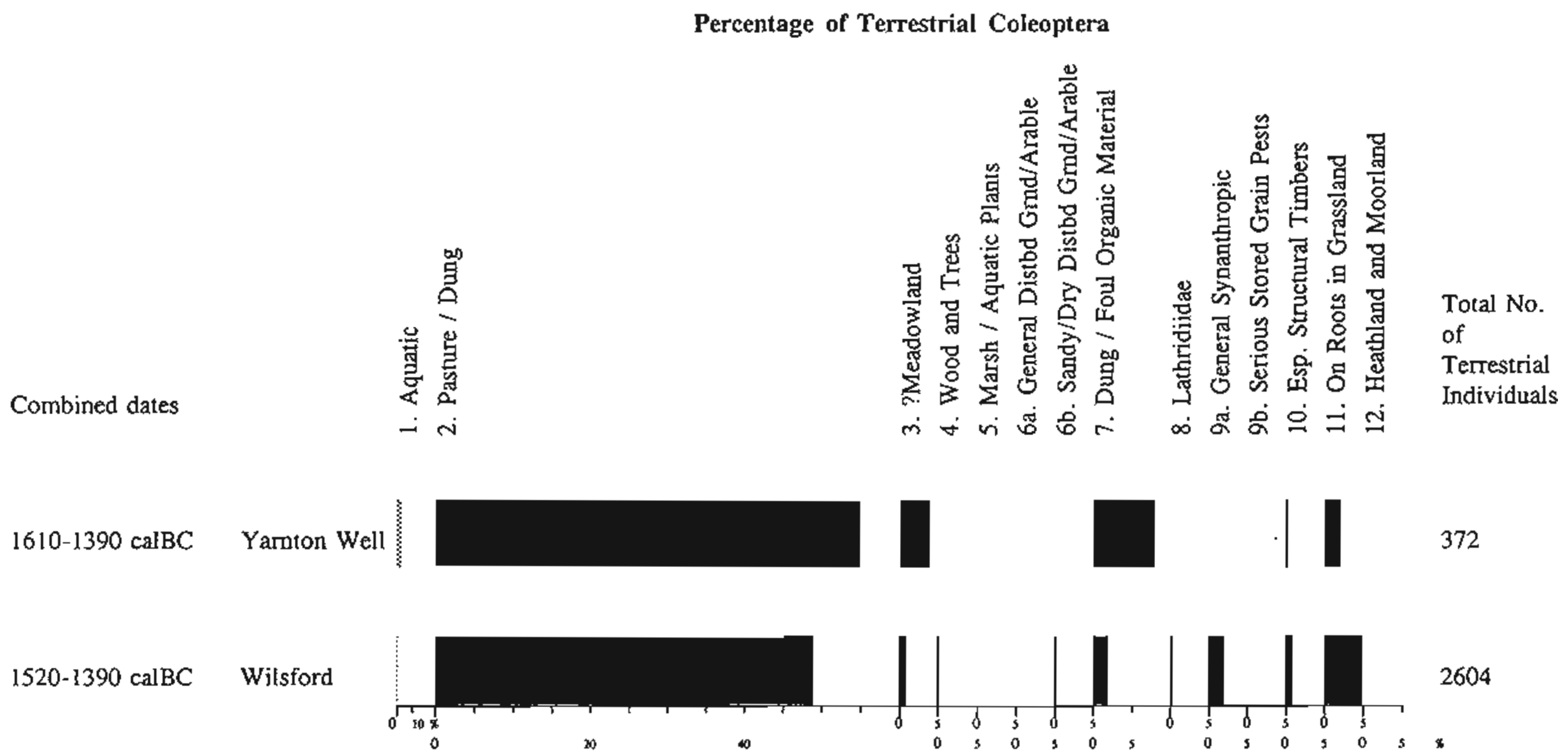
As was argued for the Thames Valley, there were presumably areas on the Chalk of Wessex, especially where poor soils had developed on drift covering the Chalk, which retained woodland of old-woodland character throughout the period. However, the impression of early and extensive clearance on the Chalk is probably correct.

Woodland Colonisation and Marine Regression

Although the period was one of rising sea level around the coast of the region, the rate of rise was by no means constant at any given locality and there were episodes when regression occurred. Sometimes freshwater fen succession occurred following a regression and woodland colonised the fen. Two such sites have been investigated in the region, Fishbourne on the Isle of Wight and the Somerset Levels, Somerset. At Fishbourne, insects were analysed from Neolithic peat that has been exposed in the intertidal zone (Robinson, unpublished d). The peat which had developed over reedswamp sediment following a fall in relative sea level, supported dry fen woodland. A full "old woodland" insect fauna had colonised, including *Gastrallus immarginatus*, one of the "Windsor Forest rarities". A cluster of Coleoptera sclerites was found in the peat which comprised fragments of large woodland Carabidae (ground beetles) including three species of *Carabus* and *Abax parallelepipedus*. It probably represented a pellet or dropping of a predator which had hunted over the woodland floor.

Woodland colonisation also occurred on the fen peats of the Somerset Levels, a major wetland bounded by the Mendips to the north and the Polden Hills to the south, from 4000 BC to 3200 BC in different parts of the Levels. The succession from marine inlet to *Phragmites* swamp which then gave rise to the fen, is considered in more detail in the section on woodlands. The only woodland insects from this lower part of the sequence were occasional individuals from the surrounding hillsides, for example, the lime-feeding scolytid beetle *Ernoporus caucasicus* from the base of the *Phragmites* peat at the Abbot's Way (Girling 1976). (This is in contrast to the pollen which, because it is derived from a larger catchment than insects, provides a good picture of the woodland on the dry ground from before the Elm Decline).

The earliest of the wooden trackways discovered on the Somerset Levels was the Sweet Track, on which dates of 5218±75 BP (Q-963), 5159±70 BP (Q-966), 5150±65 BP (Q-162) and 4887±90 BP (Q-991), combined date 4040-3790 calBC, were obtained. Insects were analysed from peat associated with the southern end of the track, about 20m north of the higher ground of the sand island (burtle) at Site SWD (Girling 1979c) and towards the northern end of the track about 500m south of Westbury Island at Site SWTG (Girling 1984a). Wood and tree-associated Coleoptera were present in the assemblages from both sites and such large samples were examined from SWTG that a wide range of woodland Coleoptera was identified, even though these species were not major components of the assemblages. Conditions in the swampy fen crossed by the track were argued by Girling to have been too wet for the woodland indicated by the Coleoptera and it was suggested that they had been brought to the site amongst timber that was trimmed on site for trackway construction. However, the insects were from the full range of woodland habitats. They included *Calosoma inquisitor*, an arboreal predator of caterpillars, *Curculio glandium*, a



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 Wilsford Shaft and Yarnton Well**

weevil which bores into acorns and the oak-leaf weevil *Rhynchaenus quercus*. Some were found below the trackway levels. There were many beetles which live in rotten wood, not all of which would have plausibly occurred in the trackway timbers. It seems more likely the woodland was extending onto the peat from the higher ground at either end of the trackway. The trees indicated by the more host-specific Coleoptera included oak, elm, ash, lime and a member of the Rosaceae. The fauna of rotting wood included several examples of *Lucanus cervus* (stag beetle) while extinct old-woodland species (Table 2) included *Prostomis mandibularis*, a predator on the larvae of wood-boring insects which is now very rare in Continental Europe. Two "Windsor Forest rarities" *Gastrallus immarginatus* and *Dryophthorus corticalis* were also present. The impression given is of colonisation by the full mixed deciduous woodland fauna very similar to that of Flandrian Zone II.

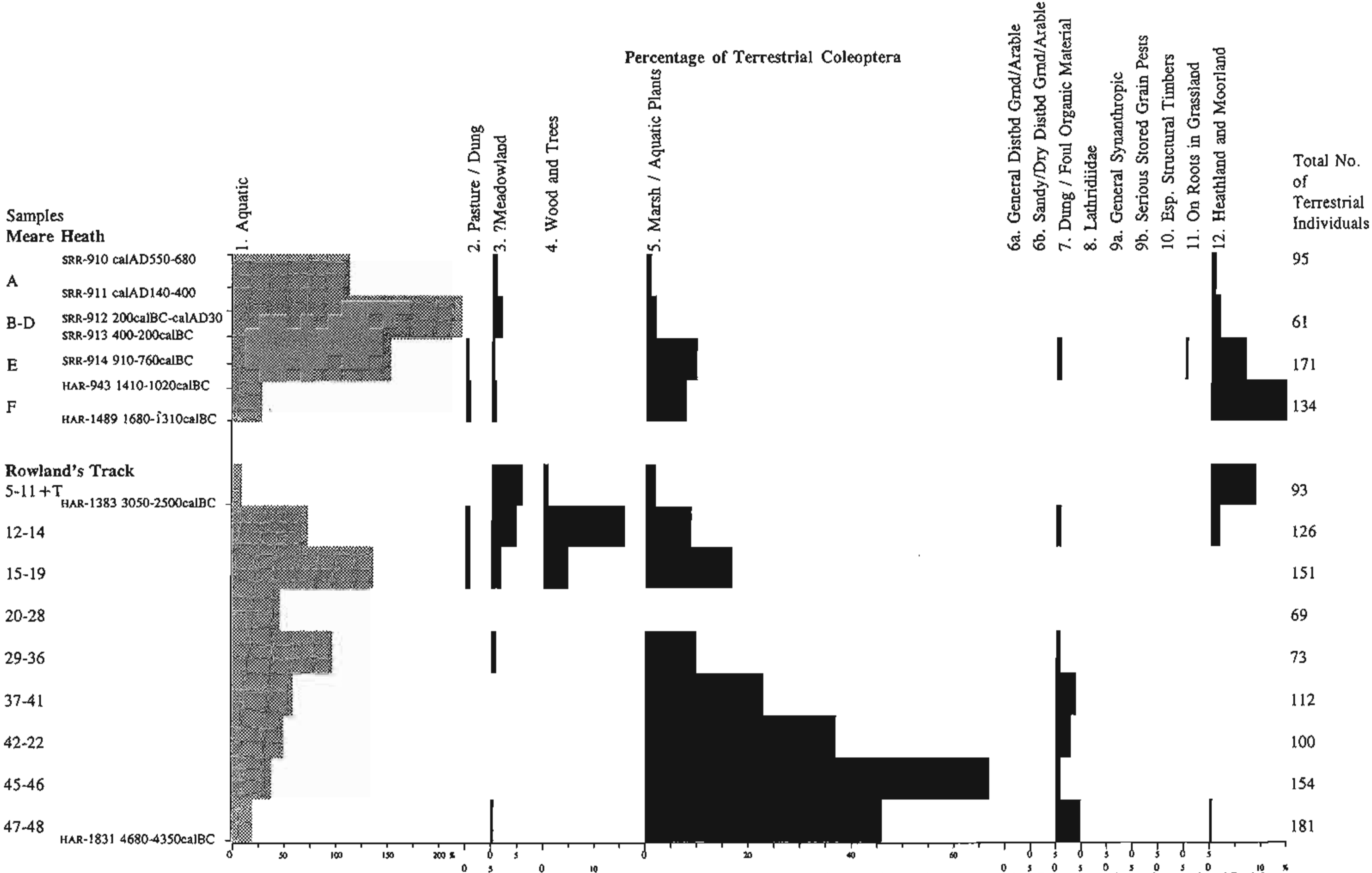
A complex of laid timbers and brushwood of Neolithic date, known as the Baker Platform, was found at the edge of Westbury Island (Girling 1980) Five dates on timbers from the platform ranged from 4950±80 BP, 3970-3530 calBC (HAR-2845) to 4450±100 BP, 3500-2900 calBC (HAR-2846). The peat at depth beneath the platform, which on pollen evidence extended up to the Elm Decline, contained few woodland insects. The fen peat from 0.4m below the platform to just above it had a much higher proportion of woodland Coleoptera. They included again a high proportion of species of dead wood, including now extinct old-woodland beetles (Table 2). Of particular interest were the only records for the region of *Rhysodes sulcatus* and *Isorhipis melasoides*. *R. sulcatus* still occurs in northern Italy and eastern Europe but has become extinct in Southern Sweden and Germany since the 19th century. *I. melasoides* is still of wider occurrence in decaying wood in continental Europe. Some of the more host-specific of the tree-feeding weevils such as *Rhynchaenus quercus* were probably from trees extending onto the peat from Westbury Island but the occurrence of *Agelastica alni* (alder leaf beetle) might have been the result of more general carr woodland developing on the fen peat. Girling suggested that the high proportion of dead-wood species reflected trees killed during clearance but this was complicated by wood being brought to the site for platform surfaces. One section of a worked piece of alder yielded several examples of *Dryocoetinus alni* and a heavily infested piece of rotten wood produced over 20 examples of *Xyleborus dispar*. It is difficult to estimate the scale of interference with the woodland but there was a slight presence of open-country species.

A sequence of woody peat at Stileway, which was dated to 4470±70 BP, 3360-2920 calBC (HAR-1465) from the bottom and could be related to Bronze Age structures dated to 3050±70 BP, 1510-1090 calBC (HAR 1221), contained a mature forest insect fauna throughout (Girling 1985). It was thought that the fauna partly reflected conditions on Meare Island. Relatively dry woodland conditions were suggested by *Acrantus vittatus*, which is usually found under the bark of elm, and two species of bark beetle which occur on ash, *Hylesinus crenatus* and *H. oleiperda*. Extinct old woodland beetles (Table 2) included the weevil *Eremotes punctulatus*, which now occurs in rotten wood in Eastern Germany, the Czech Republic, Poland and further eastwards. There was very little evidence for human disturbance of the woodland and the only scarabaeoid dung beetle was *Aphodius zenkeri*, which does not occur in open habitats.

The sites considered so far have shown evidence of woodland extending onto the peats of the Levels from higher ground. By about 3200 BC there was extensive fen woodland over most of the Somerset Levels. For example, at Rowland's Track sedge fen had given way to woodland at around 3500 BC, if not earlier, (Fig. 8, 15-19) (Girling 1977b). The most numerous of the more host-specific of the tree-feeding beetles was the leaf weevil *Rhynchaenus testaceus*, which feeds on alder but *Ramphus pulicarius* suggested willow and the bark beetle *Scolytus ratzeburgi* is dependent on birch. *S. ratzeburgi* is now extinct in England but still occurs in Scotland. The occurrence of *Rhynchaenus quercus* suggested conditions were sufficiently dry for some oak to become established.

The later Neolithic part of the Abbot's Way insect sequence (Girling 1976) showed much less evidence of woodland colonisation, probably because conditions were wetter. Woodland was lost from the Rowland's Track area, not through clearance but as a result of increasing acidification as the accumulation of peat took the surface level above the influence of groundwater. The wooded fen carr had largely been succeeded by raised bog by 4210±90 BP, 3050-2500 calBC (HAR-1383), the date of the trackway. This transition occurred throughout much of the Somerset Levels, although not where the woodland was adjacent to higher ground, for example at Stileway.

The results from Fishbourne, Isle of Wight and the Somerset Levels have shown, albeit on very different scales, that colonisation by woodland which supported a full "old woodland" fauna was able to occur following succession on areas exposed by marine regression. This was in spite of at least limited Neolithic activity at these sites. At Fishbourne, where peat development on the woodland floor could not keep pace with rising sea level, the woodland gave way to saltmarsh. In contrast, on the Somerset Levels, where peat growth exceeded the rise in sea level, the woodland was engulfed by raised bog. Although human activity in the area, such as the removal of timber for trackways and platforms, would have had some influence on the insect fauna, the main determinants in the insect succession were factors beyond human control.



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 Somerset Levels**

The Development of the Open Landscape
Even though much of the region remained substantially wooded throughout the Neolithic, most of the insect assemblages showed at least some evidence for openings in the tree canopy which could be related to human activity. On some sites there had been sufficient clearance for the development of a full grassland fauna. By the Bronze Age, open country species were usually the major component of the terrestrial fauna. Wetland sites that were open, for example parts of the Somerset Levels, are considered elsewhere.

The Thames Valley Sequence
Although there was no certain evidence for clearings from the earliest Neolithic deposit at Runnymede (Fig. 4, Sample A32040, Robinson 2000), there was a significant proportion of grassland Coleoptera from Column SS1 especially from towards the bottom, which just post-dated Neolithic settlement activity on the site and started around 3500 calBC (Robinson 1991a). Some of the more host-specific phytophagous Coleoptera included *Ceuthorhynchidius troglodytes* which feeds on *Plantago lanceolata* (ribwort plantain), *Hydrothassa glabra* on *Ranunculus* spp. (buttercups) and *Hypera punctata* on *Trifolium* spp. (clovers). Chafers and elaterids such as *Phyllopertha horticola* and *Agrypnus murinus* which feed on the roots of grassland herbs (Species Group 11) comprised 4% of the terrestrial Coleoptera at the bottom of the column but were absent from the top (Fig. 4). Scarabaeoid dung beetles of Species Group 2, particularly *Aphodius granarius* and *A.* cf *sphacelatus*, comprised almost 6% of the terrestrial Coleoptera, suggesting that the areas of grassland were being used as pasture for domestic animals. Most of these beetles are still common in dung around Windsor but one, *Onthophagus taurus*, is now extinct in Britain and another, *Copris lunaris*, is very rare.

There was a group amongst the open-country species of beetles which tend to be associated with sun-warmed habitat on sandy and sometimes chalky soils with only patchy vegetation. Some now tend to have a coastal distribution. They included *Rhinocyllus conicus*, which is now only known from a few localities on the south coast and *Caenopsis waltoni*, which is monophagous on *Plantago coronopus* (stags-horn plantain), a plant that although mostly coastal, does also occur inland on bare, sandy and gravelly soil. It is possible that these beetles were favoured by tree clearance on the gravel terraces and the tertiary sands beyond exposing the subsoil to erosion.

The results from Runnymede possibly showed a clearing related to the settlements gradually becoming overgrown. This was set against a background of a mosaic of woodland and clearings.

There were few phytophagous species of grassland plants from the late Neolithic site at Buscot Lock (p.47) (Robinson 1981b, 113-27). Dung beetles from the genera *Geotrupes*, *Aphodius* and *Onthophagus* (Species Group 2) made up 2.5% of the total terrestrial Coleoptera. While this is a very much lower proportion than from most open-country sites, it is higher than might be expected from completely undisturbed woodland. It is probable that some grazing / browsing from domestic animals was occurring even though any clearances were slight.

A picture of much more open conditions was presented by the insect evidence for the end of the Neolithic at Gravelly Guy (p.47) (Robinson, unpublished e). Scarabaeidae and Elateridae with larvae that feed on the roots of grassland herbs (Species Group 11), in this case mostly the chafer *Phyllopertha horticola*, were at the very high level of 15% of the terrestrial Coleoptera. Given the situation of the deposit between the Second Gravel Terrace and floodplain, it is possible that the Second Gravel Terrace, where there is much archaeological evidence in the form of pits and monuments for Neolithic and Bronze Age activity, was completely open.

Open conditions prevailed in the landscape around the early Bronze Age pond at Staines Road Farm, Shepperton (p.49), the beetles including *Agrypnus murinus* and the very large weevil *Liparus coronatus*, which feed on Umbelliferae (Robinson, unpublished b). A significant presence of scarabaeoid dung beetles suggested the pond was being used to water domestic animals.

Grassland also predominated around the pair of middle Bronze Age ceremonial ditches on the Thames floodplain at Yarnton (p.49) (Robinson, unpublished c). *Phyllopertha horticola* was identified from all the samples. The site was very low-lying, so Carabidae appropriate to damp grassland, such as *Bembidion guttula* and *Calathus fuscipes*, were also present. Scarabaeoid dung beetles (Species Group 2) comprised around 7% of the terrestrial Coleoptera, suggesting some grazing by domestic stock, despite the ceremonial nature of the site.

The nearby middle Bronze Age well on the higher area of floodplain at Yarnton contained a very different open-country insect fauna from the ceremonial ditches. About 55% of the terrestrial Coleoptera were the scarabaeoid dung beetles of Species Group 2 (Fig. 7), implying a very high concentration of domestic animals in the vicinity of the well. Whereas members of the genus *Aphodius* are usually the most abundant beetles in this species group, here they were outnumbered by species of *Onthophagus*. Two of these species, *O. nutans* and *O. taurus,* are now extinct in Britain, although there are 19th century records of both species (Allen 1965; Allen 1967). Another, *O. fracticornis*, is only known with certainty from two captures in the early years of the 20th century, (Hyman 1992, 393; Robinson, unpublished f). A fourth scarabaeid from the well, *Copris lunaris*, has only been captured sporadically in Britain (Allen 1956). The high concentration of Scarabaeoidea from the well in comparison with the nearby ceremonial ditches, with which it was almost contemporaneous, was probably because the well was used to water stock. The reason for the unusual composition of the scarabaeoid fauna from the well is unclear. All the species from the ditches are still common in Britain and individuals of *Aphodius* outnumbered *Onthophagus*. The wider implications of the Scarabaeoidea from the Yarnton well are considered below (p.67).

The remaining insects from the Yarnton well included beetles which feed on a range of foul organic material as well as dung (Species Group 7), particularly *Megasternum obscurum* and *Anotylus sculpturatus* gp., but the droppings of domestic animals would provide a satisfactory explanation of their occurrence. There was also a terrestrial fauna appropriate to grassland, with *Pterostichus cupreus* in all the samples. The phytophagous species were mostly weevils which feed on *Trifolium* spp. (clover), such as *Sitona hispidulus* and *Tychius* sp.

The Chalk of Wessex

Rich fully-developed insect faunas of chalk grassland were found in deposits of late Neolithic date at Silbury Hill and middle Bronze Age date from the Wilsford Shaft. At Silbury Hill (p.49), the two most abundant species from Species Group 11 (beetles with larvae feeding on the roots of grassland plants) were *Phyllopertha horticola* and *Agrypnus murinus* (Robinson 1997). They occur in the turf of well drained, permanent grassland. This group comprised 7% of the terrestrial Coleoptera. The phytophagous species included *Hydrothassa* sp. which feeds on *Ranunculus* spp. (buttercups), *Phyllobius* cf. *viridiaeris* which feeds on Compositae eg *Leontodon* spp. (hawkbits) and *Hieracium* spp. (hawkweeds), *Sitona lepidus* which feeds on *Trifolium pratense* (red clover) and *Lotus corniculatus* (bird's foot trefoil) and *Mecinus pyraster* which feeds on *Plantago media* (hoary plantain) and *P. lanceolata* (ribwort plantain). All these herbs occur in chalk pasture but can also occur in grassland on circumneutral soil. There was only a single individual of a beetle which is restricted to calcicolous plants, *Mantura matthewsi*, which feeds on *Helianthemum* spp. (rock roses).

The scarabaeoid dung beetles of Species Group 2 comprised 14% of the Coleoptera, which would be typical for pastureland away from watering places or areas where stock was concentrated. They were dominated by species of *Aphodius*, particularly *A.* cf. *sphacelatus*, with lesser numbers of *Geotrupes* and *Onthophagus* spp. Most of them still occur in the region but there were two examples of *O. fracticornis* (Table 3). Almost all the remaining Coleoptera went towards making up a balanced fauna of well drained, lightly grazed grassland on calcareous or circumneutral soil. The most numerous predatory ground beetles, *Calathus fuscipes* and *C. melanocephalus,* would be expected in such habitats unless very closely grazed. Two species of ground beetle, *Pterostichus niger* and *Abax parallelepipedus*, are now more usually associated with woodland habitats than grassland in Southern England. Their occurrence was probably a reflection of taller grass or tussocks.

The ants from Silbury Hill were the one aspect of the original palaeoenvironmental work to catch the public imagination. Fragments of ants characteristic of grassland were said to have been found at a winged stage which showed that the turf had been cut and placed in the mound in late July or August (Dimbleby 1977, 32; Malone 1990, 23). Remains of the ant *Myrmica rubra* were abundant in one of the samples. While the majority were workers, there were heads of two females and one male. No wings were present. While the winged males develop in the nests in July and mating flights occur in early August, the occurrence of one male (females without wings are present throughout the year) was insufficient to provide an indication of the season during which the mound was constructed. *M. rubra* nests in loamy pastures, under stones and in decaying tree stumps.

The middle Bronze Age insect assemblage from the Wilsford Shaft (p.49) (Osborne 1969; 1989) showed many similarities with the fauna of the same date from the well at Yarnton. It was another open-country assemblage dominated by scarabaeoid dung beetles of Species Group 2, which comprised about 50% of the fauna (Fig. 7). Members of the genus *Onthophagus* were again very abundant. Not only was *Onthophagus fracticornis* present, it was one of the most numerous beetles from the site, with 277 individuals being identified. Two scarabaeoid dung beetles which are now extinct in Britain, *Onthophagus nutans* and *Aphodius quadriguttatus*, were identified, the former also being present at Yarnton (Table 3). The scarabaeoid dung beetles suggested that there was much dung in the vicinity of the shaft, probably because it was used to water stock, most likely to have been cattle, in an otherwise dry landscape. The climatic inferences that can be drawn from these beetles are discussed below.

Table 3: **Rare and Extinct Scarabaeidae from the Southern Region**

Period	Neolithic			Early and Middle Bronze Age			Late Bronze Age					Late Bronze Age or Iron Age	Iron Age		
	Runnymede	Silbury Hill	Hampstead Heath	Staines Road Farm	Wilsford Shaft	Yarnton	Mount Farm	Runnymede Bronze Age	Radley	Reading Business Park	Wallingford	Blackditch	Mingies Ditch	Watkin's Farm	Abingdon Vineyard
Data from	1	2	3	4	5	6	7	1	8	9	10	11	12	13	14
**Aphodius quadriguttatus* (Hbst.)	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-
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. Robinson (1991a), 2. Robinson (1997), 3. Girling (1989b), 4. Robinson (unpublished b), 5. Osborne (1989), 6. Robinson (unpublished c), 7. Robinson (unpublished h), 8. (Robinson (1995a), 9. Robinson (1992a), 10. Robinson (unpublished i), 11. Robinson (unpublished e) 12. Allen and Robinson (1993), 13. Robinson (1990), 14. Robinson (unpublished m).

In addition to the scarabaeoid dung beetles the Wilsford fauna included many other grassland beetles. Most of these were also common at Silbury Hill including the carabids (ground beetles) *Calathus fuscipes* and *C. melanocephalus*. *Phyllopertha horticola* and *Agrypnus murinus* were the most abundant members of Species Group 11 (beetles with larvae feeding on the roots of grassland plants). The Chrysomelidae (leaf beetles) and Curculionidae (weevils) were mostly characteristic of rather herb-rich, dry chalk pasture. The three most common of these species were *Crepidodera ferruginea*, *Hypera punctata* and *Mecinus pyraster*. *C. ferruginea* feeds on grasses (not nettles and thistles as noted by Osborne (1969, 562; 1989, 97), see Koch (1992, 119)). *H. punctata* is dependent on *Trifolium* spp. (clover) and *Medicago* spp. (medicks) while *M. pyraster* feeds on *Plantago lanceolata* (ribwort plantain). A calcicolous element was provided by *Mantura matthewsi*, which feeds on *Helianthemum* spp. (rock roses), but there was also a single individual of *Lochmaea suturalis*, which is restricted to *Calluna vulgaris* (heather). This latter beetle had probably been derived from an area of chalk heath where drift deposits over the bedrock were sufficiently deep to allow a superficial layer of acidic soil to develop.

Unlike at Silbury Hill, the Coleoptera also suggested the proximity of weedy disturbed ground. There were many individuals of the weevil *Stenocarus umbrinus*, which feeds on *Papaver* spp. (poppies) and some of the other phytophagous beetles were more likely to have been feeding on annual weeds than grassland herbs. It has been argued that the shaft was at the junction between pasture and arable.

Marsh, Fen and Aquatic Habitats

Insects of aquatic and marginal habitats were, by virtue of the nature of the deposits, abundant in almost all the insect assemblages from the Neolithic to the middle Bronze Age. Only the old ground surface at Silbury Hill and the two Bronze Age wells at Wilsford and Yarnton did not have autochthonous aquatic faunas.

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, the occurrence of the small weevil *Tanysphyrus lemnae* from the early Bronze Age pond at Staines Road Farm, Shepperton (p.49) (Robinson, unpublished b) would suggest that the surface of the water was carpeted with *Lemna* sp. (duckweed). There have, however, been major changes to the insect faunas of the rivers in the region for which the Neolithic sequence Column SS1 from Runnymede (p.47) (Robinson 1991a) serves as a good example. There had also been major developments in some of the large wetlands of the region during the period although the Somerset Levels are the only wetland where the insects have been studied.

The River Thames

As might be expected, a high proportion of the insects from Runnymede Column SS1 were aquatic and many more of them feed on aquatic or marginal plants (Robinson 1991a). The most abundant of these phytophagous beetles was *Donacia impressa*, which feeds on *Schoenoplectus lacustris* (bulrush), followed by *D. clavipes*, which feeds on *Phragmites australis* (common reed). This would suggest tall emergent reedswamp vegetation lining the banks of the river. A floating-leaved element to the aquatic flora was suggested by *Donacia crassipes*, which feeds on *Nymphaea alba* and *Nuphar lutea* (white and yellow water lily).

Most of the Trichoptera (caddis) larval remains were not identified but cases of the caddis *Ithytrichia* sp., which requires running water, were present in most of the samples. The most abundant aquatic beetles belonged to the family Elmidae. They occur in clean flowing water (and large lakes), clinging to stones and aquatic plants. Some of these species are so fastidious in their requirements for clean, well oxygenated water that in most of the major English lowland river systems, if they occur at all, they are now restricted to weir outflows and the fast-flowing tributary streams. One of the elmids from Runnymede, *Stenelmis canaliculata*, was only added to the British list about 30 years ago when it was discovered living in Lake Windermere (it is a distinctive, medium-sized beetle). Another, *Macronychus quadrituberculatus*, now only occurs in the upper reaches of the Trent basin. Its larvae feed on decaying submerged wood in flowing water and so would very much be favoured by a wooded river bank. Other water beetles from Runnymede which apparently no longer occur in the Thames included *Helophorus arvernicus* and *Helichus substriatus*. Similar assemblages of water beetles were found in all the sequences from Runnymede (Table 4) including the Mesolithic phase. Such a fauna probably occurred throughout much of the length of the Thames while it remained in its unpolluted and unmanaged state.

The Somerset Levels
By 4300 BC the sea had begun to retreat from an inlet, on the SE side of the Bristol Channel, which was to become the Brue Valley bounded to the north by the hills of Wedmore and the Mendips and to the south by the Polden Hills. There began a succession from estuarine clays to *Phragmites* swamp which then gave way to sedge peat fen. The fen became colonised by woodland, but as peat growth raised the surface level above the influence of the calcareous waters of the River Brue, so acidification occurred. Nutrient levels fell and the trees were killed by the spread of raised bog. Beginning around 1000 BC, the raised bog experienced episodes of freshwater flooding, which served to re-calcify it, enabling sedge to re-establish itself.

Detailed palaeoecological work has been undertaken on the peats of the Somerset Levels (Coles 1988). This was mostly associated with prehistoric timber trackways and platforms. Although a monolith through the peat within which the timbers were stratified was generally analysed for insects, there was rarely any dating evidence available apart from radiocarbon dates on the structures themselves. A very useful correlation diagram, which shows the approximate timespan of each insect monolith and pin-points radiocarbon-dated structures, was prepared by Coles (1988, 9). The only monolith to span almost the complete sequence of peat was from the Abbot's Way (Girling 1976). Unfortunately the insect assemblages were small, not all the insects were attributed to individual samples and the fen-woodland was not well-developed. However, two monoliths, one from Rowland's Track (Girling 1977b), the other from Meare Heath (Girling 1982a), between them spanned the full sequence and were quite well-dated, including a radiocarbon date from the peat / clay interface at the bottom of the Rowland's Track monolith. The top of the Rowland's Track monolith ends in the raised bog stage, which is where the Meare Heath monolith begins. These two sequences have been used to construct a coleopteran diagram, which provides a framework around which all the sites can be discussed (Fig. 8).

Obligate halophytic (salt-loving) species were absent but *Bembidion fumigatum*, which occurs on reed refuse specially in brackish swamps, was well-represented at the bottom of the Rowland's Track monolith, which was dated to 5650±70 BP, 4680-4350 calBC (HAR-1831),

Table 4: **Records of Coleoptera of Very Clean Flowing Water in the Thames**

Period	Mesolithic	Neolithic			Late Bronze Age			Roman	Early Saxon	Late Saxon	
	Runnymede Column 40	Runnymede A32040	Runnymede SS1 Column	Buscot Lock	Runnymede Column 55	Runnymede WF1b	Wallingford	Mingies Ditch	Anslow's Cottages XB625	Anslow's Cottages AA1073	St Aldate's Oxford
Data from	1	1	2	3	1	2	4	5	6	6	7
Helophorus arvernicus Muls.	-	+	+	+	-	+	-	-	-	-	-
Macronychus quadrituberculatus Müll.	+	+	+	+	+	+	+	-	+	+	-
Stenelmis canaliculata (Gyll.)	+	+	+	+	+	+	+	+	-	-	+
other Elmidae	+	+	+	+	+	+	+	+	+	+	+

1. Robinson (unpublished a); Robinson (2000), 2. Robinson (1991a), 3. Robinson (1981b), 4. Robinson (unpublished i), 5. Allen and Robinson (1993), 6. Robinson (1992c), 7. Robinson (unpublished t).

as well as being present at the peat / clay interface at the Abbot's Way. The very high percentage of phytophagous species of marsh and aquatic plants (Species Group 5) from the lower samples from Rowland's Track (42-48 in Fig. 8) was due to numerous individuals of *Plateumaris braccata* and, to a lesser extent, *Donacia clavipes*, both of which are monophagous on *Phragmites australis* (common reed). The occurrence of *Donacia impressa* and *Prasocuris phellandrii* suggested respectively *Schoenoplectus lacustris* (bulrush) and an aquatic umbellifer, probably *Oenanthe aquatica* gp. (water dropwort), to have been minor members of the reedswamp community. These are all potentially deep-water plants and areas of open water were suggested by *Tanysphyrus lemnae*, which feeds on the minute floating plant *Lemna* sp. (duckweed). Some of those Coleoptera from the lower samples of Rowland's Track which are not aquatic climb from reed stem to reed stem, for example the unusual carabid beetle *Odacantha melanura*. Others, for example *Corylophus cassidoides*, live in accumulation of decaying reed debris, showing that organic material was beginning to collect above the water level. Such material was probably the habitat of the members of Species Group 7, species of dung / foul organic material, and also the staphylinid beetle *Micropeplus caelatus*, which is now extinct on the British mainland (Table 5). Somewhat similar assemblages were found from the other two sites on which the reedswamp stage of the succession was represented, the Sweet Track (Girling 1979c) and the Abbot's Way. They included *M. caelatus* at the Sweet Track. There were two species of reedswamp habitats which are now extinct throughout the British Isles, *Anthicus gracilis* on both sites and *Oodes gracilis* at the Abbot's Way (although it was present higher up the sequence at the Sweet Track).

The decline in the Coleoptera from the Rowland's Track monolith that feed on marsh or aquatic plants from 41% to 20% (Fig. 8) was a reflection of reedswamp vegetation giving way to sedge fen. Initially, the presence of small peaty pools favoured the small water beetles *Hydroporus scalesianus*, which is now very rare (Table 6), and *Hydraena palustris*. The occurrence of the flowing water elmid beetles *Esolus parallelepipedus*, *Oulimnius troglodytes* and *Riolus cupreus* alongside the Sweet Track (Girling 1979c; 1984a) suggested episodes of freshwater flooding when the track, which dated to around 4000 BC (p.51) was in use. Records of *Corylophus cassidoides* and *Anthicus gracilis* at Rowland's Track showed the continuing availability of some reed refuse, while a thickly vegetated organic substrate next to eutrophic water was implied by three species of carabid beetle at the Sweet Track which are now extinct in Britain: *Chlaenius sulcicollis*, *C. tristis* and *Oodes gracilis*.

As nutrient levels declined up the profile at Rowland's Track, however, the insect fauna became more impoverished, with only the Scirtidae managing to hold up their numbers. They have aquatic larvae, some species of which occur in sedge or *Sphagnum* peat pools, while the rest can be found on vegetation near water. At about this stage there was an inwash of clay onto the peat at the Baker Platform, site perhaps as a result of clearance on nearby higher ground (Girling 1980). This enabled *Sphaerius acaroides*, a minute beetle of muddy seepages that is now very rare, to flourish.

Species Group 5, beetles which feed on marsh and aquatic vegetation, re-appear above Sample 18 at Rowland's Track (Fig. 8). This was due to conditions becoming sufficiently acidic for the establishment of *Eriophorum angustifolium* (cotton grass), the host plant of *Plateumaris discolor* and marked the beginning of raised bog development. Initially, trees were able to colonise and the peat became substantially wooded (p.52) The surface conditions

Table 5: **Rare and Extinct Fenland / Wetland Coleoptera from the Southern Region**

Period	Mesolithic	Neolithic				Late Bronze Age	Iron Age	
	Mingies Ditch W	Sweet Track	Abbot's Way	Rowland's Track	Buscot Lock	Meare Heath	Meare Heath	Meare Lake
Data from	1	2	3	4	5	6	6	7
Trechus rivularis (Gyll.)	+	-	-	-	-	-	-	-
Pterostichus aterrimus (Hbst.)	-	+	-	-	-	+	+	-
**Chlaenius sulcicollis* (Pk.)	-	+	-	-	-	+	-	-
**C. tristis* (Schal.)	-	+	-	-	+	-	-	-
**Oodes gracilis* Villa	-	+	+	-	-	-	-	-
Micropeplus caelatus Er.	+	+	-	+	-	-	-	-
Lathrobium rufipenne Gyll.	+	+	-	-	-	-	-	-
**Anthicus gracilis* Pz.	-	+	+	+	-	-	-	+

* now extinct in Britain

1. Allen and Robinson (1993), 2. Girling (1979c); Girling (1984a), 3. Girling (1976),
4. Girling (1977b), 5. Robinson (1981b), 6. Girling (1982a), 7. Girling (1979b).

Table 6: **Other Rare and Extinct Water Beetles from the Southern Region**

Period	Neolithic	Neolithic to Late Bronze Age	Neolithic			Late Bronze Age				Roman	
	Sweet Track	Other Somerset Levels	Buscot Lock	Runnymede A3204	Runnymede 55 Column 5	Runnymede Column 55	Runnymede WF1b	Radley	Anslow's Cottages Bronze Age	Alchester	Copthall Avenue
Data from	1	2	3	4	5	4	5	6	7	8	9
* *Bidessus* cf. *grossepunctatus* Vorb.	+	-	-	-	-	-	-	-	-	-	-
Hydroporus scalesianus Step.	+	+	-	-	-	-	-	-	-	-	-
Hydrophilus piceus (L.)	+	+	-	+	-	-	+	-	-	+	+
Hydrochara caraboides (L.)	-	-	-	-	-	-	+	+	-	-	-
Helichus substriatus (Müll.)	-	-	+	+	+	+	+	-	+	-	-

* now extinct in Britain 1. Girling (1984a); Girling (1984c), 2. Girling (1984c), 3. Robinson (1981b), 4. Robinson (unpublished a); Robinson (2000), 5. Robinson (1991a), 6. Robinson (1995a), 7. Robinson (1992c), 8. Robinson (1975), 9. Allison and Kenward (1987).

of the peat became a little drier, perhaps allowing some meadowland herbs to colonise (Species Group 3) and limited grazing of domestic animals (Species Group 2). However, as raised bog development progressed and the peat became more acidic, so tree growth was suppressed. The wood and tree-dependent Coleoptera of Species Group 4 had almost disappeared by the top of the Rowland's Track monolith.

Its place was taken by a full raised bog insect fauna. *Lochmaea suturalis* and *Micrelus ericae*, beetles which feed on *Calluna vulgaris* and *Erica* spp. (ling and heather) and comprise Species Group 12, heathland and moorland, comprised 9% of the Coleoptera from the top of the Rowland's Track monolith. They were joined by other typical raised bog species such as the ground beetles *Agonum ericeti* and *Bradycellus ruficollis*. The trackway itself, which was dated to 4210±90 BP, 3050-2500 calBC (HAR-1383), was set amidst the raised bog. A similar fauna was present in the raised bog stage of the Abbot's Way sequence, but conditions were probably wetter at the Abbot's Way because there was a higher proportion of aquatic beetles. The water beetle fauna was dominated by species of stagnant, acid peaty pools such as *Ilybius guttiger* and *Hydroporus melanarius*.

Peat accumulation on the Somerset Levels slowed during the raised bog stage, which lasted over 1000 years. Essentially the same fauna was found associated with the Meare Heath trackway, which was dated to 3060±80 BP, 1520-1090 calBC (HAR-1494) from the outer rings of a trackway timber and 2980±70 BP, 1410-1020 calBC (HAR-943) from laid brushwood. Later developments on the Somerset Levels, including the effect of flooding episodes on the insect fauna, will be considered in the next section.

While the basic sequence for the Somerset Levels has been described above, this does not fully bring out the interesting water beetle faunas that were found on some of the sites. These are considered in more detail elsewhere (Girling 1984c) and are set against the modern water beetle fauna of the Somerset Levels (Foster 1984). They include (Table 6) possible records of *Bidessus grossepunctatus*, a species no longer found in Britain, from the Sweet Track and sporadic records of *Hydrophilus piceus* (great silver diving beetle), a rare beetle that is now confined to areas of extensive wetland. It does still occur in the Somerset Levels.

Human Habitation and Structures

Although insect assemblages of the Neolithic to middle Bronze Age from the region provide much evidence of human activity, they show very little evidence of human settlement or structures. The insects of foul organic material can be explained by the occurrence of natural accumulations of organic debris. Some of the cut timbers of the Baker Platform in the Somerset Levels had become infested with the scolytid beetle *Xyleborus dispar* (see above) (Girling 1980) but the same beetle would have been infesting dead trees in the Neolithic woodland. Most of the Neolithic records of *Anobium punctatum* (woodworm beetle) were probably of beetles which had emerged from naturally occurring dry dead wood. However, a synanthropic fauna was identified from the Wilsford Shaft (p.49) (Osborne 1969; 1989). *Anobium punctatum* (Fig. 7, Species Group 10, especially structural timbers) comprised around 1.5% of the terrestrial Coleoptera. While this percentage might not seem particularly high, it represented 39 individuals and there were only four other wood or tree-dependent (Species Group 4) from the deposit. It seems likely that there was some sort of wooden structure near the mouth of the shaft.

The synanthropic beetles of Species Group 9a made up 2% of the terrestrial Coleoptera, which is a high value for this group even from a late prehistoric context. They comprised 42 individuals of *Ptinus fur* and 3 individuals of *Stegobium paniceum*. *P. fur* feeds on a wide range of rather dry, starchy or protein-rich material. It is most usually found inside buildings, feeding in food waste in neglected corners of kitchens, amongst old hay or straw in barns and in stables. Although it often occurs in very old grain residues, it is not primarily a pest of stored grain. In addition to the indoor habitats, it can also occur outside, for example feeding on debris in birds' nests. *S. paniceum* has the reputation of being an omnivorous pest of stored products, especially of a farinaceous nature. It is only a minor grain pest but it also attacks biscuits, spices, some animal products and dried medicinal herbs. While almost all the British records of this species are from inside buildings, there is slight evidence that it can live independently of human influence (Robinson 1991a, 324). It is perhaps significant that it is the only grain beetle so far to have been recorded from prehistoric contexts in Britain (Table 8). The occurrence of *P. fur* in such high numbers and of *S. paniceum* suggests that there was a building which contained at least some cereal debris in the vicinity of the Wilsford Shaft.

The Wilsford Shaft also contained several examples of *Dermestes laniarius*, a "bacon beetle" which has otherwise not been recorded from Britain. Members of this genus feed on old and often rather dry carrion including sinews on bone and animal hides. Osborne (1989) speculated that the beetle had perhaps been accidentally imported on skins but had failed to establish itself in Britain.

Climate

It becomes particularly difficult to draw climatic inferences from changes in the insect fauna at a time when human activities were also causing changes in the insect fauna. The technique of mutual climatic range which has been so successful at showing Late Devensian climatic changes (Atkinson *et al.* 1986) would suffer some drawbacks if used to compare the Neolithic climate of Southern England with that of the present. 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 warmer than in Britain. This problem was recognised by Osborne (1982a).

Some of the early attempts to trace climate change using the insect sequence from a single site were not entirely satisfactory. For example Girling (1977b) noted the occurrence of the thermophilous beetle *Oodes gracilis*, which no longer occurs in Britain, in the early Neolithic peat at the bottom of the Rowland's Track monolith and the presence of *Scolytus ratzeburgi*, which is now restricted in Britain to Scotland, further up the monolith in peat of late Neolithic date. She postulated a climatic oscillation from a climate warmer than at present to one cooler than at present. However, the disappearance of *O. gracilis* from the site can also be attributed to the loss of its eutrophic fen and reedswamp habitat while it was not until the late Neolithic that there was extensive birch woodland with moribund trees, the food of *S. ratzeburgi*.

As more evidence emerged from the Somerset Levels, Girling (1984a) argued that the beetle fauna showed a Neolithic climate with distinctly warmer summers combined with more pronounced continentality. Four species from the Neolithic deposits which are now extinct in Britain, *Chlaenius sulcicollis*, *Oodes gracilis*, *Airaphilus elongatus* and *Anthicus gracilis* all have northern limits in Europe which lie well within the 16°C mean July isotherm which Girling regarded as showing "considerably higher summer temperatures". On the basis of the distribution of the two most thermophilous of the species, *C. sulcicollis* and *O. gracilis* she suggested that the Neolithic mean July temperature was about 2°C higher than at present but that the mean January temperature was depressed by a corresponding amount (Girling 1984a). The discovery of *C. sulcicollis* in a late Bronze Age deposit on the Somerset Levels at Meare Heath led to the suggestion that the warmer but more continental regime continued throughout the Bronze Age (Girling 1982a). However, the Somerset Levels also lie well within the 16°C mean July isotherm, so habitat change could still be an explanation for the loss of these species.

The occurrence of species that now have a markedly southern distribution in the Neolithic insect assemblages from Runnymede and Silbury, for example the large weevil *Liparus coronatus*, suggests that mean summer temperatures were unlikely to have been any lower than at present (Robinson 1991a; 1997). The occurrence on these sites of two species of scarabaeid dung beetles from the genus *Onthophagus*, one of which (*O. taurus*) is extinct in Britain and the other of which (*O. fracticornis*) is of uncertain status (Table 3) might suggest warmer conditions than at present. Their current ranges in Europe are almost entirely 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 and *O. taurus* does still occur in the Channel Islands, which have milder winters and cooler summers than central and SE England (Robinson, unpublished f). It is possible that the ploughing of pastureland on better-drained more fertile soil, where their juveniles would have been overwintering in tunnels, was responsible for their disappearance rather than climatic change.

One of the beetles from Neolithic Runnymede, *Chrysolina banksi* now has an Atlantic distribution in NW Europe. It does not occur in Germany but has been recorded from the coastal counties of the southern half of England. Its presence at Runnymede might be argued as suggesting winter temperatures no colder than at present.

The balance of insect evidence for the Neolithic climate of the region is that mean summer temperature was unlikely to have been any lower than at present. The occurrence of certain fen Carabidae and dung-feeding Scarabaeidae would not be inconsistent with summer temperatures 2-3°C higher than at present, although it is possible to advance other explanations than climatic deterioration for their loss from the British fauna.

If it were not for the results from the Wilsford Shaft (Osborne 1969; 1989) and Yarnton (Robinson, unpublished c), the same considerations could also be applied to the early and middle Bronze Age. Not only did these sites have four species of scarabaeid dung beetles between them which are now extinct (*Aphodius quadriguttatus*, *Onthophagus nutans* and *O. taurus*) or of uncertain status in Britain (*O. fracticornis*) (Table 3), they stood out from all other archaeological insect assemblages so far analysed from Britain because there was a much higher ratio of individuals of the genus *Onthophagus* to individuals of the genus *Aphodius*. At the Wilsford Shaft, *Onthophagus* spp. comprised 49% of the total of 867 individuals of *Onthophagus* plus *Aphodius* and at Yarnton *Onthophagus* spp. comprised 73% of a total of 197. The corresponding percentages from Neolithic Runnymede and Silbury were respectively 17% and 11%.

Scarabaeinae (*Onthophagus* and related genera) are the main dung beetles of the Mediterranean basin, being replaced by Aphodiinae (*Aphodius* and related genera) further north (Jessop 1986). Osborne (1989) pointed out that the ratio of *Onthophagus* to *Aphodius* from the Wilsford Shaft would now be more appropriate to mid-France. In the absence of any obvious ecological reasons as to the abundance of *Onthophagus* spp. at Wilsford and Yarnton, it is tentatively suggested that it could have been due to a brief warm episode, of perhaps only a few decades, at the end of the middle Bronze Age, with summer temperatures in southern England as warm as those in mid-France at present. Populations of these beetles would be expected to respond very rapidly to any climatic change. The radiocarbon dates from the Wilsford Shaft and the Yarnton Well overlap:

Wilsford Shaft	Yarnton Well
3200±80 BP (OxA-1229)	3255±70 BP (OxA-6548)
3160±60 BP (OxA-1216)	3115±70 BP (OxA-6549)
3150±60 BP (OxA-1217)	combined date 1610-1390 calBC
combined date 1520-1390 calBC	

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. Much of the Neolithic landscape was probably a mosaic of relatively small clearances, abandoned clearings in various stages of scrub to woodland succession and relatively undisturbed, perhaps even primary, woodland. 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. However, even old-established woodland was not the same as in the previous period because a rise in the abundance of scarabaeoid dung beetles suggested widespread browsing by domestic animals under woodland conditions.

Insects of open habitats appear to have been efficient colonists once clearances were made. In some parts of the region, for example parts of the Wessex Chalk, the landscape was very open indeed and supported a fully developed open-country fauna. The occurrence of numerous scarabaeoid dung beetles emphasises the importance of the cleared areas but the reasons for differences between these faunas and modern pastureland faunas remains unclear. Synanthropic beetles, albeit species with natural habitats away from human influence, put in their first significant appearance towards the end of this period, occurring under circumstances where it was likely that they had been living in structural timbers and inside buildings.

The period was one during which the aquatic and wetland habitats of the region were still in an unmanaged state. The fauna of the Thames, for example, included some species that now tend only to be found in the unmanaged rivers of the highland zone. Fenland faunas were richer than at present. The Somerset Levels showed the coleopteran succession of the full lowland hydrosere on a very large scale which culminated in raised bog.

There was some evidence from the occurrence of Coleoptera which are now extinct in Britain for slightly warmer climatic conditions than at present, possibly with a brief very warm episode towards the end of the middle Bronze Age. However, it is difficult to determine whether the loss from Britain of some thermophilous fenland beetles and a scarabaeid dung beetle fauna that now might seem more appropriate to France was the result of climatic deterioration or subsequent human activity.

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

The late Bronze Age to Iron Age was the period when the character of the landscape over much of the region was changed by organisation towards more intensive agricultural systems. One aspect of this seems to have been considerably more hole-digging below the water table than in the previous period. Although wells are not common, deep ditches, water holes and ponds containing organic sediments provide major sources of insect remains for the period. Natural deposits, however, such as palaeochannel sediments and fen peats remain important sources of evidence.

It is likely that there were major difference shown by the insect faunas of different parts of the region. Unfortunately, with the exception of the Somerset Levels, work on sites of this period has almost entirely been concentrated in the Thames Valley. The basic sequence, therefore, is largely based around the Thames Valley.

The Remaining Woodland, Scrub and Hedges

The modern occurrence of an "old woodland" insect fauna in the New Forest and Windsor Forest shows that there must have been survival of woodland with over-mature trees or much dead wood. However, there is little evidence of this in the archaeological record. Woodland persisted at Stileway at the eastern end of Meare Island in the Somerset Levels into the late Bronze Age (Girling 1985). Unfortunately, the insects from the top of the sequence were not examined separately. Some woodland also survived at Hampstead Heath, with tree and wood-dependant species (Species Group 4) comprising 5% of the terrestrial Coleoptera in Zone WH53, which perhaps belonged to the first millennium BC (Fig. 5) (Girling 1989b). The occurrence of *Sinodendron cylindricum* (lesser stag beetle) suggests that large dead timbers were present. It is likely that clearance was never very thorough because of the poor quality of the soil. A mixed picture was presented by insects from a late Bronze Age pond associated with burnt mounds at Patching Junction, West Sussex (Robinson, unpublished g). On the one hand the old woodland beetle *Gastrallus immarginatus* was present but on the other hand the majority of Coleoptera were grassland species such as *Serica brunnea*, *Phyllopertha horticola* and *Athous hirtus*.

The insect sequence from the Runnymede palaeochannels (p.47) resumed at the beginning of the Bronze Age with Column 55 (Robinson, unpublished a; Robinson 2000) and continued with the WF1b column until about 850 calBC (Robinson 1991a). The upper part of the WF1b column was associated with timber waterfront structures. At some stage between the end of the Neolithic (the top of the SS1 Column) and the late Bronze Age, substantial clearance had occurred. Wood and tree-dependent beetles comprised under 2% of the terrestrial Coleoptera from the late Bronze Age sediments. Not only was the number of the beetles greatly reduced, they mostly comprised species which do not feed on the major trees of primary woodland. About half were species which feed on rosaceous trees and shrubs, such as hawthorn and sloe, including the weevil *Magdalis hispidus* and the bark beetle *Scolytus rugulosus*. Perhaps there were areas of thorn scrub on the grassland around the site but they could also have been growing in hedgerows. Beetles that feed on willows and poplars, including *Chalcoides* sp. and *Ramphus pulicarius* comprised around a quarter of the more host-specific wood and tree-feeding species. It is possible that once the alders, which cast dense shade, had largely been removed from the floodplain, the more light-demanding willows grew up along the water courses. Oak woodlands, or at least old oak trees, were not entirely absent from the catchment. There was an example of *Ampedus nigerrimus*, a beetle which has been captured from the rotting wood of old, damaged oaks in Windsor Great Park, the only locality in Britain where it is now known to occur. Another "old woodland" beetle, *Pediacus dermestoides,* was also present. The woodland from which these beetles were derived could have been that part of the primary woodland cover which survived the onslaught of agricultural clearance, ultimately to become the parkland of Windsor Forest.

A somewhat similar sequence of Coleoptera was identified from late Bronze Age palaeochannel sediments upstream on the Thames at Wallingford, Oxon (Robinson, unpublished i). It was likewise associated with waterfront structures but the sequence was probably slightly younger in date, extending to the end of the late Bronze Age. Wood and tree-dependent beetles comprised 2% of the terrestrial Coleoptera, which would suggest the landscape of the catchment was largely open, although there would have been some scrub, hedges or limited areas of woodland. In this aspect, the insect results were also very similar to those from the late Bronze Age phase at Runnymede. They included species both of scrub and trees, for example *Anthonomus* cf. *pedicularius*, which feeds on *Crataegus* sp. (hawthorn) leaves and *Leperisinus varius*, a bark beetle which occurs mostly on *Fraxinus excelsior* (ash).

Rather more woodland appears to have survived on the banks of the River Kennet at Anslow's Cottages, Burghfield, but the insect assemblages from the palaeochannel deposits were small (Robinson 1992c). Insects from a slightly later late Bronze Age ditch on the site suggested that the woodland was subsequently removed because the wood and tree-dependent beetles of Species Group 4 were absent. This group of beetles was also absent from a nearby late Bronze Age settlement on the First Terrace of the Kennet at Knight's Farm (Bradley *et al.* 1980). However, they comprised 3.5% of the terrestrial Coleoptera from a pond and a waterlogged pit at another late Bronze Age settlement on the First Terrace at Reading Business Park, Burghfield (Robinson 1992a). This is a rather higher value than might be expected from an almost fully cleared landscape in which trees and shrubs were restricted to hedgerows, being twice the percentage that was recorded for Runnymede or Wallingford. The majority of the beetles which are associated with particular woody species either feed on rosaceous trees and shrubs (hawthorn, sloe etc), for example *Scolytus rugulosus*, or on *Salix* and *Populus* spp. (willows and poplars) rather than trees of established woodland. Willows probably grew along some of the water courses and there were perhaps areas of thorn scrub on pasture.

Late Bronze Age settlements on the gravels of the Upper Thames Valley have given rather similar results to those in the Kennet Valley. Two Bronze Age sites were excavated on the First Terrace at Goose Acre Farm, Radley. The earliest was dated to 3250±60 BP, 1680-1420 calBC (GU-3379) and the later one to 2720±70 BP, 1040-790 calBC (GU-3378) although the archaeologist regarded both of them as belonging to the late Bronze Age on the basis of the pottery recovered from them. The insect assemblages from them were, however, consistent with there being a significant difference in date between the deposits (Robinson 1995a). 3% of the terrestrial Coleoptera from the earlier water hole fell into the wood and tree-dependent category. Oak leaf-feeding weevils from the genus *Rhynchaenus* and an ash bark beetle *Leperisinus varius* perhaps reflected a slight background presence of woodland.

This group had declined to 1% in the later water hole and woodland species were absent. Wood and tree-dependent Coleoptera comprised 2% of the terrestrial Coleoptera from a late Bronze Age pond at Mount Farm, Dorchester, on the Third Gravel Terrace of the Upper Thames (Fig. 9, Robinson, unpublished h). Radiocarbon dates of 3000±80 BP and 2850±70 BP, combined date 1310-980 calBC, were obtained on wood from the pond. These beetles were mostly species of scrub, for example, the weevil *Acalles turbatus*.

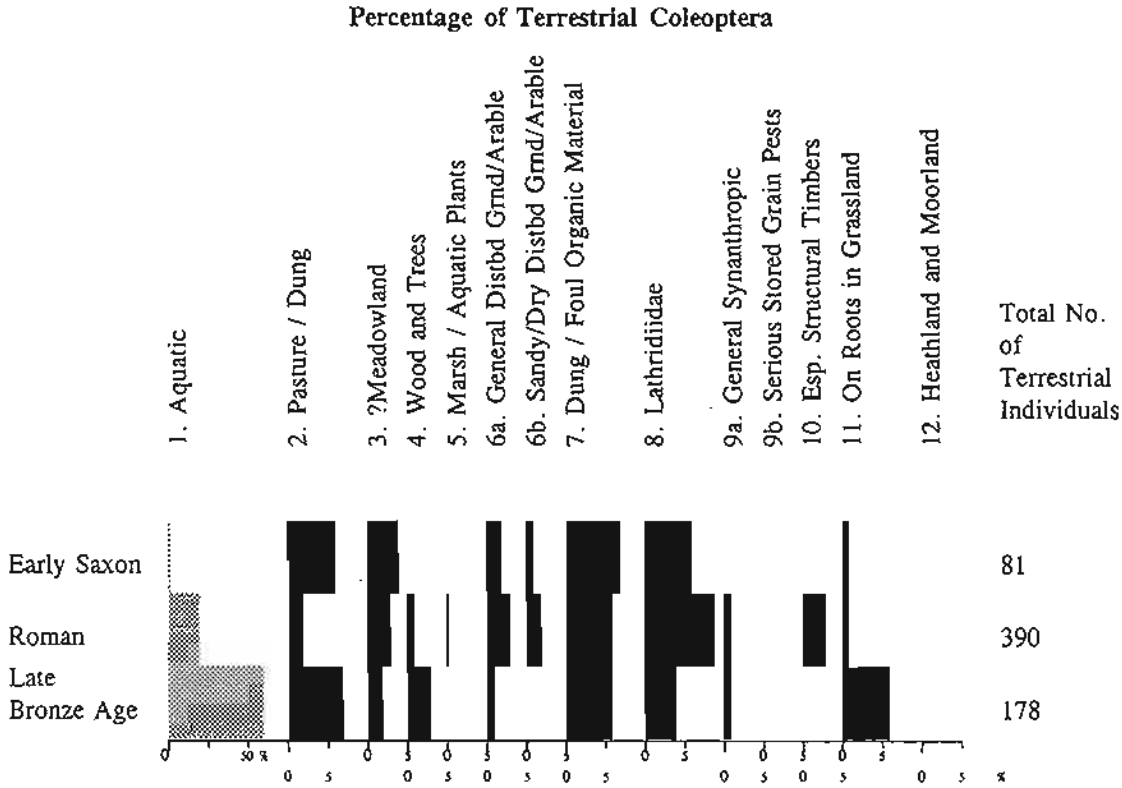
The picture presented by the insects from late Bronze Age settlements in both the Middle and the Upper Thames Valley is one of landscapes that were largely open but with some scrub. On the most open sites, the scrub could just have been in the form of hedgerows and willows along water courses but on others there was probably some scrub on areas of rough pasture and perhaps a background presence of a little woodland.

The insect faunas from Iron Age sites in the Upper Thames Valley fall into two categories. There are those of middle Iron Age date from enclosed settlements which show similarity with those from late Bronze Age settlements in having around 2% of their terrestrial Coleoptera from the wood and tree-dependent group of Species Group 4. The assemblages from middle and late Iron Age settlements which are unenclosed, in contrast have few if any beetles from Species Group 4.

The middle Iron Age settlement of Mingies Ditch, on the floodplain of the River Windrush, falls into the former category. Large insect assemblages were recovered from its enclosure ditches, which were dated to 2170±90 BP (HAR 4485) and 2150±80 BP (HAR-5942), combined date 390-70 calBC (Allen and Robinson 1993). Species Group 4 comprised 1.8% of the terrestrial Coleoptera (Fig. 3). It was very much a hedge or scrub fauna, with *Acalles turbatus*, which feeds on small dead branches, *Scolytus mali* which attacks *Prunus* spp. (sloe etc), *Crataegus* spp. (hawthorn) and *Malus* spp. (apple) and *Ramphus pulicarius*, which feeds on *Salix* spp. (willows) and *Populus* spp. (poplars). In addition to the members of Species Group 4, there were many examples of *Batophila rubi* and *Anthonomus rubi*, which mostly feed on *Rubus* spp. (brambles). *A. turbatus*, *R. pulicarius* and *A. rubi* were all identified from Watkin's Farm Northmoor, on the First Terrace of the Thames (Robinson 1990), another enclosed Iron Age settlement. Species Group 4 comprised 1.6% of the terrestrial Coleoptera.

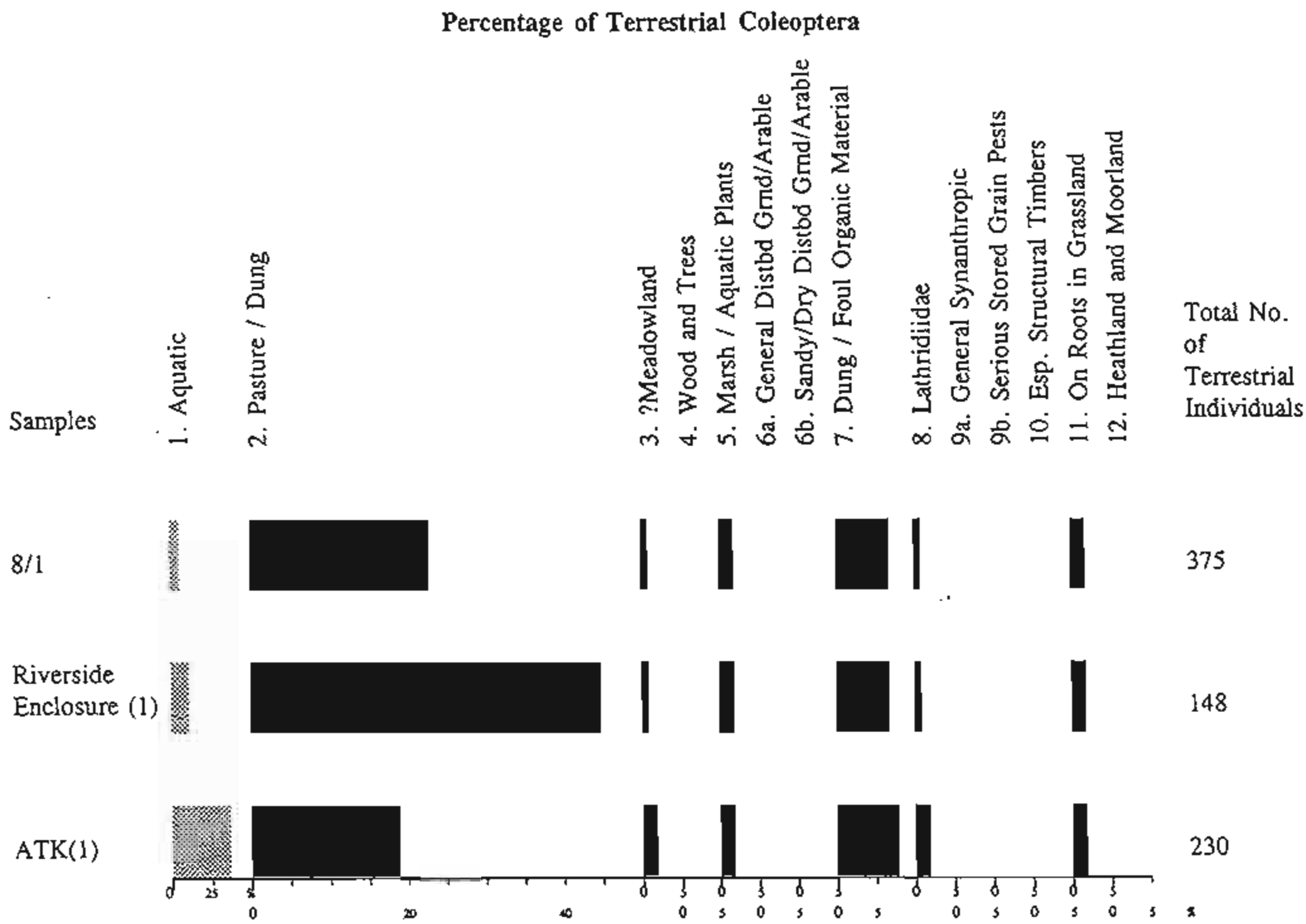
In contrast, Species Group 4 was virtually absent from the large insect assemblages identified from two middle Iron Age settlements on the Thames floodplain at Port Meadow (Fig. 10) (Robinson, unpublished j) and Farmoor (Lambrick and Robinson 1979, 91-97; Robinson 1981a, 280-1). This group was absent from two late Iron Age settlements on low-lying areas of the First Gravel Terrace of the Thames near Lechlade, Glos. at Claydon Pike (Fig. 11) (Robinson, unpublished k) and Thornhill Farm (Robinson, unpublished l). Similar results were obtained from major late Iron Age defensive ditches at the Vineyard, Abingdon (Robinson, unpublished m).

These results can be interpreted as showing that the enclosed settlements were surrounded by hedges which supported a scrub insect fauna. It is also possible that there was also some scrub in the surrounding landscape, that was perhaps only in the process of being brought into more intensive management. In contrast, the results from the unenclosed settlement seem to suggest them to have been set in landscapes virtually devoid of trees and shrubs. However,



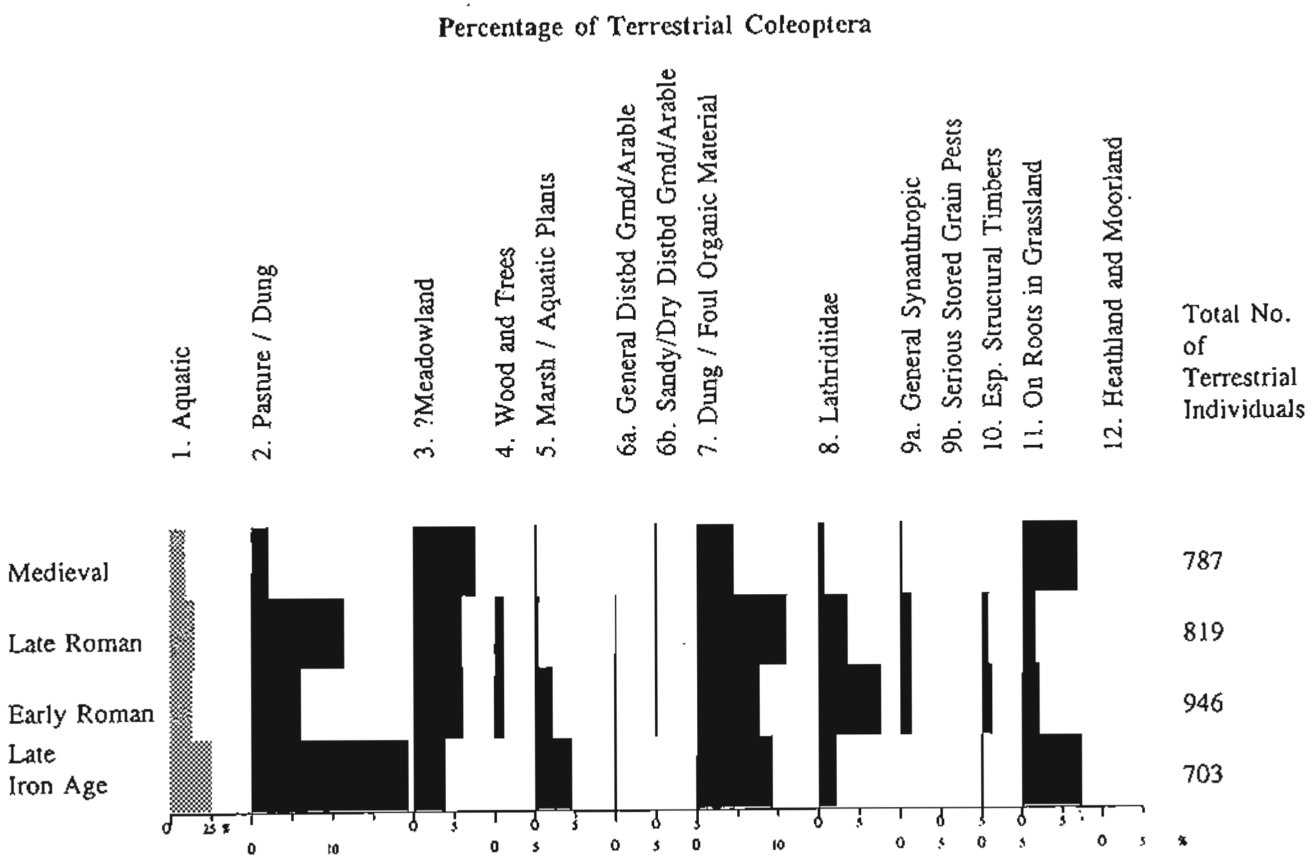
Species groups expressed as a percentage of the total terrestrial Coleoptera (ie aquatics excluded). Not all the terrestrial Coleoptera have been classified into groups.

Fig. 9: **Species Groups of Coleoptera from Mount Farm**



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 Port Meadow**



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 Claydon Pike**

it is possible that such open conditions were a reflection of the use of the floodplain and low-lying areas of First Gravel Terrace as open pasture (see below) and there would be more evidence of trees and shrubs from other parts of the Upper Thames Valley.

Grassland, Pasture and the Open Landscape

The insects from Column 55 and the WF1b column at Runnymede suggested that the late Bronze Age landscape of the site was mostly grazed grassland (Fig. 4) (Robinson 1991a; Robinson 2000). The scarabaeid chafers and elaterid click beetles which have larvae that feed on roots in grassland (Species Group 11) made up 5.3% of the terrestrial Coleoptera. *Phyllopertha horticola* was the most numerous chafer and *Agrypnus murinus* the most numerous of the elaterids. Just as in the Neolithic, the fauna appears to have been one of well-drained permanent pasture, although much greater expanses existed by the late Bronze Age. The clover and vetch-feeding weevils of the genera *Apion* and *Sitona* (Species Group 3) comprised 4% of the terrestrial Coleoptera, which is insufficient to indicate true meadowland (grassland mown for hay). The phytophagous Coleoptera showed the grassland to have been very herb-rich, with the same species noted as for the Neolithic SS1 Column (p.55). The scarabaeoid dung beetles of Species Group 2 comprised around 5% of the terrestrial Coleoptera from Column 55, which rose to 10% of the terrestrial Coleoptera of the WF1b column. *Aphodius granarius* and *A. sphacelatus* were the most numerous species but they had been joined by *Aphodius contaminatus*. *A. contaminatus* can be common in late Bronze Age and more recent assemblages but does not yet seem to have been recorded from the Neolithic. *Onthophagus taurus* was absent but another extinct dung beetle, *Aphodius varians*, was present. In addition to the Scarabaeoidea, there was a balanced fauna of the Hydrophilidae and Staphylinidae that occur in dung, confirming the interpretation that domestic animals were grazed in the vicinity of the site.

It is difficult to distinguish an arable component in insect assemblages. Although some of the ground beetles from the WF1b column, such as *Agonum dorsale*, occur in disturbed or bare ground and some of the phytophagous species can attack arable weeds, such as *Phyllotreta vittula* on Cruciferae, none is restricted to arable habitats. However a bird pellet from the river channel sediments presented a different picture. Just over half the beetles from it either fell into Species Group 6a (General Disturbed Ground / Arable) or Species Group 6b (Sandy / Dry Disturbed Ground / Arable). Most abundant was *Harpalus rufipes*, a beetle that appears to be well-adapted to arable conditions, feeding on annual weed seeds and aphids. *Amara apricaria*, which normally occurs in weedy open dry places, where it feeds on fallen seeds, was also well represented. The bird which cast the pellet was probably a member of the Corvidae (crow family) which had been feeding on arable land before it flew to the site. Corvids do not fly long with a full crop, so the area of arable was probably not far beyond the catchment of the beetles in the WF1b column.

Similar grassland beetle faunas to that from Runnymede were identified from the other late Bronze Age sites in the Middle and Upper Thames Valley: Wallingford, Anslow's Cottages, Knight's Farm, Reading Business Park, Eight Acre Field and Mount Farm. The scarabaeid chafers and elaterid click beetles which have larvae that feed on the roots of grassland plants (Species Group 11) ranged from 5 to 9% of the terrestrial Coleoptera and the clover and vetch-feeding weevils of the genera *Apion* and *Sitona* (Species Group 3), ranged from 2 to 6% of the terrestrial Coleoptera. In addition to the clovers or vetches indicated by Species Group 3, a strong presence of *Plantago lanceolata* (ribwort plantain) was suggested by

Ceuthorhynchidius troglodytes, *Gymnetron labile* and *G. pascuorum*. Another species from most of these sites, *Mecinus pyraster*, feeds on *P. media* (hoary plantain) as well as *P. lanceolata*. Grassland conditions were also reflected by the Homoptera (bugs), with the occurrence of members of the genus *Aphrodes* , especially *A. bicinctus*. This genus favours grass that is not very closely grazed. However, grazing was occurring and the scarabaeoid dung beetles of Species Group 2 comprised from 7 to 10% of the terrestrial Coleoptera. Species of *Aphodius* predominated, especially *A. sphacelatus*. Most of the Scarabaeoidea were species which are still common in the region but there were examples of the following species which are extinct or very rare in Britain: *Aphodius varians*, *Copris lunaris* and *Onthophagus taurus* (Table 3). As was noted for the previous phase, the occurrence of all these species in Britain during the 19th century, when climatic conditions were slightly cooler than at present, suggests that factors other than climatic deterioration, most probably ploughing of grassland, were responsible for their decline. Unlike Runnymede, however, these sites did not give good entomological evidence for the occurrence of arable even though the botanical results from some of the sites suggested involvement in mixed agriculture.

The results from the enclosed middle Iron Age settlements in the Upper Thames Valley, Mingies Ditch and Watkin's Farm, gave a rather similar picture to that from the late Bronze Age sites. The percentages for Species Groups 11 and 3 were within the ranges for the earlier sites. The plantain-feeding weevils *Gymnetron labile* and *Mecinus pyraster* were present, as were the grass-feeding bugs of the genus *Aphrodes*. Values for scarabaeoid dung beetles (Species Group 2), however, were higher, being 13.5% of the terrestrial Coleoptera from Mingies Ditch (Fig. 3) and 14.3% from Watkin's Farm. These higher percentages were probably because both enclosures had areas for stock as well as for domestic activity. There were two species of scarabaeoid dung beetle now extinct in Britain: *Aphodius varians* and *Onthophagus nutans* (Table 3). *Copris lunaris* and *O. nutans* were present at Blackditch, another site on the Upper Thames gravels, which was possibly of the same date. There was again no reliable evidence from insects for arable on these sites.

Although the landscape around the unenclosed middle and late Iron Age settlements in the Upper Thames Valley was also grassland, grazing pressure seems to have been much heavier. The percentages for the beetles with larvae that feed on roots in grassland (Species Group 11) from Port Meadow (Fig. 10), Farmoor, Claydon Pike (Fig. 11) and Thornhill Farm, were lower, ranging from 2.0 to 7.5% of the terrestrial Coleoptera. The values for the clover and vetch-feeding weevils of Species Group 3 had fallen to between 1.1 and 4.0% of the terrestrial Coleoptera. The percentage of scarabaeoid dung beetles of Species Group 2 had risen substantially to between 19.5 and 27.9% of the terrestrial Coleoptera. With more intensive grazing and therefore short-turfed grass, conditions would have been less favourable for the members of Species Groups 3 and 11. Numbers of other phytophagous insects of grassland plants, for example the plantain-feeding weevils, were also reduced. All the scarabaeoid dung beetles were species which still occur in the region. These sites were, however, all specialised settlements concerned with the grazing of domestic animals on the floodplain and would not be typical of the mixed agricultural settlements on the higher gravel terraces of the Thames, let alone other parts of the region.

The results from the late Iron Age defensive ditches at Abingdon for grassland insects were perhaps more similar to those from the Iron Age enclosed settlements. Species Group 11 (larvae on roots in grassland) was at 6.6% of the terrestrial Coleoptera, Species Group 3 (weevils favoured by meadowland) at 4.2% and Species Group 2 (scarabaeoid dung beetles of pasture) at 7.1%. The scarabaeoid dung beetles included three species which are now extinct or are of uncertain status in Britain: *Caccobius schreberi*, *Onthophagus fracticornis* and *O. nutans* (Table 3). There was no evidence for arable conditions.

Marsh, Fen and Aquatic Habitats

The late Bronze Age insect assemblages from the River Thames at Runnymede and Wallingford showed that the river retained the full fauna of clean, well-oxygenated water that was noted for the Neolithic (p.59) including the elmid beetles which no longer occur in 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* group) and *Ochthebius minimus*.

Carabidae and Staphylinidae of wet habitats are present in the late Bronze Age deposits from the Thames at Runnymede and Wallingford. They would have been living on the well vegetated river banks whereas the floodplain seems to have been relatively dry. One unusual bankside beetle from Wallingford was *Drypta dentata*, which is now restricted to a few localities on the south coast where there is freshwater seepage from the base of cliffs. The middle and late Iron Age sites in the Upper Thames Valley, however, were exploiting floodplain pasture at a time when conditions were becoming wetter on the floodplain, with widespread seasonal flooding (Robinson 1992b). This was reflected in the insect fauna with the occurrence of wet ground Carabidae, such as *Agonum marginatum*, *A. viduum* and *Chlaenius vestitus*. The heavy trampling of the wet pasture had, from the botanical evidence, resulted in the creation of areas of dung-enriched mud (Lambrick and Robinson 1988) which was perhaps the reason for high numbers of *Carpelimus bilineatus* in some of the samples.

The Somerset Levels

Raised bog conditions over much of the Somerset Levels lasted into the late Bronze Age and the bottom of the Meare Heath monolith, including the Meare Heath Trackway, belonged to this period (Fig. 8) (Girling 1982a). A similar raised bog insect fauna to that which was associated with the Meare Heath Trackway was found above and below the brushwood complex of the Tinney's Ground Trackway (Girling 1982b). A series of eight radiocarbon dates on the trackway ranged from 3040±70 BP, 1450-1060 calBC (HAR-681) to 2920±60 BP, 1320-930 calBC (Har-2429). In addition to a raised-bog beetle fauna which included the heather-feeders *Lochmaea suturalis* and *Micrelus ericae*, the cotton-grass-feeding *Plateumaris discolor*, the ground beetles *Agonum ericeti* and *Bradycellus ruficollis* and the water beetle of acid peaty pools *Hydroporus melanarius*, there was also a significant presence of scarabaeoid dung beetles. They comprised *Geotrupes* sp., *Colobopterus fossor*, three species of *Aphodius* and *Onthophagus ovatus*. They were most abundant at the trackway level itself and possibly reflected domestic animals being driven along it.

Starting at around 2624±45 BP, 910-760 calBC (SRR-914) and continuing until around 2252±45 BP, 400-200 calBC (SRR-913), the raised bog at Meare Heath experienced flooding with calcareous water from the River Brue (Girling 1982a). This resulted in a very substantial rise in the percentage of water beetles (Fig. 8 Sample E). While *Hydroporus melanarius* disappeared, its place was taken by beetles requiring calcareous water:

Noterus clavicornis	*Hydrovatus clypealis*
Laccophilus variegatus	*Hygrotus inaequalis*
Porhydrus lineatus	*Copelatus haemorrhoidalis*

The occurrence of the flowing water elmid *Riolus cupreus* confirmed that there had been an input of water from the river. Some of the other raised-bog species were lost including *Plateumaris discolor*, *Lochmaea suturalis*, *Bradycellus ruficollis* and *Agonum ericeti*. Their place was taken by fenland species including *Pterostichus aterrimus* and *Chlaenius sulcicollis*, which is now extinct in Britain but was recorded from Neolithic peats in the Somerset Levels. The raised-bog beetles did not entirely disappear and the occurrence of the heather-feeding weevil *Micrelus ericae* resulted in the persistence of Species Group 12 (heathland and moorland) albeit at a reduced level.

The end of this flooding episode was also represented at the bottom of the sequence from Difford's Brushwood Platform (Girling 1978). Further up the sequence, the number of aquatic beetles declined but the appearance of species such as *Bradycellus ruficollis* and *Hydroporus melanarius* suggested a return to raised-bog conditions. On the basis of the insect evidence, raised bog persisted into the Roman period. There was botanical evidence that there was also a return to raised-bog conditions at Meare Heath which was followed by a second flooding episode starting around 2062±45 BP, 200calBC - calAD30 (SRR-912). However, the insect fauna of Samples B to D was sparse and developments were unclear.

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 on river banks and at the edge of scrub, which were indeed probably their habitats when they were recorded from earlier periods. However, the context of some of these insects sometimes suggests that they were growing in ruderal habitats. For example, the following three species of beetle and one species of heteropteran bug were identified from organic sediments associated with the late Bronze Age settlement on an island in the River Thames at Wallingford, whereas they were absent from the general channel sediments (Robinson, unpublished i). Their host plants are also listed:

Pria dulcamara	on *Solanum dulcamara* (woody nightshade)
Apion aeneum	on Malvaceae (mallows)
Cidnorhinus quadrimaculatus	on *Urtica dioica* (stinging nettle)
Heterogaster urticae	on *Urtica dioica* (stinging nettle)

The larger scale of settlement activity during this period also means that there is more evidence of refuse, structures and habitation.

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. However, waterlogged late Bronze Age midden material was found on the edge of the palaeochannels alongside the settlements at Runnymede and Wallingford. The Runnymede midden samples contained many beetles and fly puparia which had lived in the midden before the material had become incorporated into the channel sediments (Robinson 1991a). There was a significant decomposer community of beetles. Species Group 7, which comprises certain Hydrophilidae and Staphylinidae of foul organic material, made up 17% of the Coleoptera from the midden. The most abundant beetles of decaying organic material were:

Cercyon analis	*Leptacinus pusillus*
Oxytelus sculptus	*Gyrohypnus fracticornis*

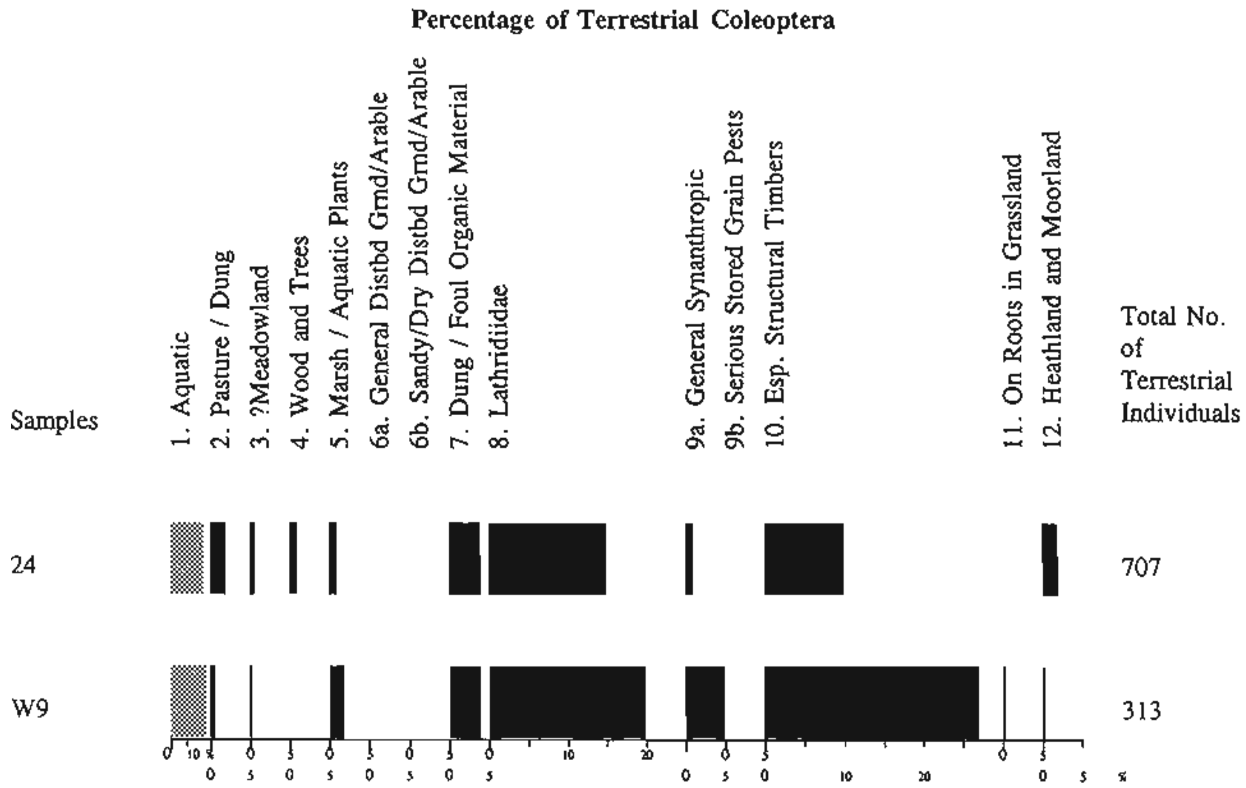
There were many fly puparia in the midden, *Musca* cf. *domestica* (house fly) being the most abundant, followed by *Stomoxys calcitrans* (stable fly). The beetle community was one associated with foul rotting matter including dung. *M. domestica* feeds in a wide range of decaying plant and animal remains while *S. calcitrans* usually lays eggs on old straw which has been enriched with urine or faeces. The presence of a few puparia of *Scathophaga stercorarium* (yellow dung fly), whose larvae live in fresh dung, confirmed the dung component while frond fragments of bracken and capsules of flax showed that imported plant material had also been incorporated. However, the midden included neither the synanthropic species nor numerous examples of *Anobium punctatum* which would be expected if the midden contained material from inside a building.

Refuse which had been dumped into the palaeochannel at Wallingford from the late Bronze Age settlement (Robinson, unpublished i) also gave values for Species Group 7 above 15%. There were high numbers of another beetle *Oxytelus sculptus*, which tends to be favoured by manure heaps and puparia of *Musca domestica* were present. Beetles from the family Lathridiidae such as *Lathridius minutus* gp. (Species Group 8) which feed on woody plant material were better represented than in other samples from the site but, as for Runnymede, the insects did not suggest any of the refuse had its origin inside a building. An indication that some of this refuse had been dumped on the river bank and had begun to develop its own insect fauna as it became submerged was given by numerous examples of *Carpelimus bilineatus*, which occurs in very wet decaying organic material, especially on bankside mud.

Timber Structures

Despite the occurrence of substantial late Bronze Age timber waterfront structures at both Runnymede and Wallingford, there were very few woodworm beetles (Species Group 10) from either site. In addition to *Anobium punctatum*, Runnymede did, however, provide an early record for *Lyctus linearis*, another member of Species Group 10. Species Group 10 was also virtually absent from the five other late Bronze Age settlements in the Middle and Upper Thames Valley which were investigated for insects (p.71), with only a couple of examples of *A. punctatum* from Reading Business Park (Robinson 1992a). *A. punctatum* was recorded from five of the six middle and late Iron Age settlement sites in the Upper Thames Valley described above (p.72) but was absent from Port Meadow. Although it was probably occurring in structural timbers the values for Species Group 10 on all the sites were below 1.0% except for Thornhill Farm, where is comprised 3% of the terrestrial Coleoptera.

A very different result was given by Meare West Iron Age Lake Village in the Somerset Levels (Girling 1979b). Radiocarbon dates of 2200±70 BP (HAR-2654) and 2130±90 BP (HAR-2668), combined date 380-100 calBC, were obtained on wood from the site. *Anobium punctatum* was the most numerous beetle in Sample W9, comprising 27% of the terrestrial Coleoptera (Fig. 12). This sample had been taken from below a timber in the centre of the settlement. However, Sample 24, which was from the edge of the settlement, had a value of



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 Meare Village**

10% for Species Group 10. The reasons for the high levels of *A. punctatum* were probably twofold. Firstly, the village had many closely-spaced housed. Secondly, the ground surface was peat and insect remains were preserved close to their places of emergence from wood rather than only those insects which by chance reached a waterhole or waterlogged ditch being preserved.

Habitation

The only synanthropic beetle of Species Group 9 from the Bronze Age deposits at Runnymede was a single specimen of *Stegobium paniceum* (Fig. 4), a minor grain pest that also attacks many other stored products (p.66). Numbers of Lathridiidae were not particularly high. The synanthropic beetles were entirely absent from the late Bronze Age site at Wallingford. It is possible that the insects from both Runnymede and Wallingford included so few synanthropic species because the settlement buildings were on the far ends of the islands from the sampling localities.

The only member of Species Group 9 to be recorded from any of the other late Bronze Age and Iron Age sites in the Middle and Upper Thames Valley was *Ptinus fur*, represented by single individuals from Reading Business Park, Mount Farm and Watkin's Farm and a couple of specimens from Mingies Ditch. The percentages for Lathridiidae (Species Group 8) were not unusually high from these sites.

Meare West Iron Age lake Village again presented a contrast. Species Group 9, in the form of *Ptinus fur*, comprised 5% of the terrestrial Coleoptera from Sample W9 (Fig. 12). There can be little doubt that *P. fur* was living inside buildings on the site, feeding on debris from food preparation, cereal waste etc. The Lathridiidae (Species Group 8) comprised 20% of the terrestrial Coleoptera from this sample and 15% from Sample 24. *Lathridius minutus* or *pseudominutus* was the most numerous. These beetles are favoured by human habitation, feeding on moulds in thatch, on old hay etc. The results serve to stress the intensity of human occupation at Meare in comparison with the other settlement sites which were investigated from this period.

Activities and Storage Pests

Much of the evidence that has already been presented was concerned with the effect of human activity on the insect fauna of the region but a couple of aspects of interest remain. Remains of single workers of *Apis mellifera* (honey bee) were identified from the late Bronze Age sediments of Column 55 at Runnymede (Robinson, unpublished a; Robinson 2000) and in a middle Iron Age sump at Mingies Ditch (Robinson 1984a, 119; Allen and Robinson 1993). Although Limbrey (1982, 285) believes the honey bee to be native to Britain, the discovery at Runnymede is so far the earliest record from Britain. At the very least it shows that the various resources from honey bees, honey, beeswax and propolis (a resinous adhesive) were available for exploitation and the possibility of apiculture in this period is raised.

There were no records of serious pests of stored grain from this period and indeed on present evidence it seems that such species were not introduced to the British Isles until the Roman period. However, charred *Vicia faba* (field / Celtic beans) showing insect tunnels were found at Meare East Iron Age Village (Caseldine 1987). Several contained charred insect fragments, one of which could be confirmed as the leg of *Bruchus rufimanus* (bean beetle).

Although *B. rufimanus* adults will emerge from dried beans in storage, it is not strictly a stored products pest because infestation can only occur by oviposition on bean flowers. Unlike some other bruchids, it will not breed on bean seeds. *B. rufimanus* does not attack any native species of Leguminosae and must have been introduced in imported beans.

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 3000 and 2700 BP, with perhaps a slight, though only temporary, amelioration around 2350 BP. The carabid beetle *Chlaenius sulcicollis*, which is now extinct in Britain and whose occurrence in the Somerset Levels during the Neolithic was regarded by Girling (1984a) as suggesting a climate with mean July temperature 2°C higher than at present, was identified from Meare Heath Insect Sample Group E (Girling 1982a). Sample Group E spanned the date range 2624±45 BP, 910-760 calBC (SRR-914) to 2252±45 BP, 400-200 calBC (SRR-913) (the first flooding episode of the raised bog) and therefore belonged firmly in the period following the climatic deterioration. The most plausible explanation is that the occurrence of *C. sulcicollis* does not imply summer temperatures warmer than at present and that its extinction was due to habitat loss. Another beetle from the Somerset Levels regarded by Girling (1984a) as suggesting warmer conditions during the Neolithic, *Anthicus gracilis*, was identified from an Iron Age deposit at Meare West Iron Age Lake Village (Girling 1979b).

The persistence of low numbers of scarabaeoid dung beetles that are now very rare or extinct in Britain throughout the late Bronze Age and into the Iron Age (Table 3) has already been attributed to a qualitative difference in grassland rather than climatic change (p.77). The waterlogged deposits of the WF1b column at Runnymede spanned the period of the presumed climatic deterioration in the late Bronze Age but there were no changes in the insect fauna which could be related to climatic change (Robinson 1991a,).

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. The only sites where there was a major woodland element to the fauna were in marginal localities: the Somerset Levels and Hampstead Heath. Agricultural intensification seems to have continued throughout the period and there is some indication in the Thames Valley of a progression from a landscape with some scrub to one which was very open indeed.

The insects give the impression that the open landscape was predominantly grassland being grazed by domestic animals. This, however, was in part due to the increasing complexity of agricultural systems in the Iron Age, such that not all settlements undertook mixed farming. The evidence from the Upper Thames Valley was derived from low-lying sites that were specialised pastoral settlements exploiting floodland grazing. If deposits containing insects been found in this part of the region on the Iron Age settlements in the dry higher gravel terraces, presumably a different picture would have been obtained.

Various categories of synanthropic insects were favoured by the structural timbers, accumulations of organic material and indoor habitats. The species that had adopted synanthropy appear all to have been native members of the British fauna. *Anobium punctatum* (woodworm beetle), which was adapted to developing in dry dead timber on trees, found an ideal habitat in structural timbers. *Ptinus fur* (spider beetle) found food waste inside buildings as attractive as debris left by birds in their nests. The only insects identified so far from this period suspected of being exotic imports are *Apis mellifera* (honey bee) (Table 7), perhaps introduced for apiculture, and *Bruchus rufimanus* (bean beetle), which presumably arrived in infested beans. The relative abundance of synanthropic insects between settlements in part serves as a reminder that the density of archaeological features on the ground is not necessarily an indication of the intensity of settlement. Some of the settlements with low vales for synanthropic species need only have had one house occupied at a time. In contrast, the large compact settlement of Meare West Iron Age Lake Village gave high values for these species.

Whereas the hydrological changes occurring in wetland habitats which reflected their insect populations were, in earlier periods, due to natural agencies, for example sea level changes, human activity had a significant effect during this period. The flooding episode of the raised bog on the Somerset Levels and the increasing wetness of the floodplain in the Upper Thames Valley were possibly related to clearance in the catchments (Robinson 1992b).

The insect evidence for climate during this period was by no means clear. Taken in isolation, it would either suggest conditions similar to or slightly warmer than the present. There was no evidence of climatic deterioration in the early first millennium bc.

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

Period	Late Bronze Age	Iron Age	Roman					Late Saxon	Late Medieval	
	Runnymede Column 55	Mingies Ditch	Claydon Pike	Hunts Hill Farm	Bowling Green Farm	Old Shifford	Thorpe Lea Nurseries	Winchester	Oxford Blackfriars	Claydon Pike
Data from	1	2	3	4	5	6	7	8	9	3
Apis mellifera L.	+	+	+	+	+	+	+	+	+	+

1. Robinson (unpublished a); Robinson (2000), 2. Allen and Robinson (1993), 3. Robinson (unpublished k), 4. Robinson (unpublished n), 5. Robinson (unpublished v), 6. Robinson (1995b), 7. Robinson (unpublished x), 8. Carrott *et al*. (1996), 9. Robinson (1985).

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 organisation and intensification, continued into the Roman period. Towns 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. The use of cesspits resulted in a new source of evidence in the form of calcium phosphate-replaced insect remains, although this was limited to a few unidentified Diptera (fly) puparia from Uley, Glos (Girling and Straker 1993). The coverage of the region is not as uneven as for the previous period, although opportunities were lost with urban sites in London and Gloucester. Over half the large insect assemblages were from the Upper Thames Valley.

Woodland, Scrub and Hedges

The only evidence of true woodland from insects of this period was from moss which had been brought to the site of the Barton Court Roman Villa, on the Second Gravel Terrace of the Upper Thames near Abingdon, Oxon and used to pack between the stones lining a late 3rd century well (Robinson 1986). The moss contained oak leaf and bud galls which had been induced by parasitic wasps of the family Cynipinae (Robinson 1980b). They included the oyster leaf gall of the unisexual generation of *Andricus ostreus*, the April bud gall of the bisexual generation of *A. ostreus* and the smooth spangle leaf gall of the unisexual generation of *Neuroterus albipes*. The moss had probably been collected in oak woodland and indeed the mosses themselves were species of deep shaded woodland (Dickson 1986). Other insects had probably been brought to settlements in wood from woodland. For example a couple of individuals of the cerambycid beetle *Phymatodes testaceus*, which tunnels into recently dead hardwood, especially oak, with the bark on, were identified from the fill of a 4th century well at the Barton Court Villa (Robinson 1986). This beetle usually occurs on woodland trees.

Otherwise, the insect results only suggest a limited presence of trees and shrubs in open agricultural landscapes. There is some evidence from Coleoptera that increased use was made of hedges on some settlements in the Upper Thames Valley in comparison with the Iron Age. At Farmoor, the proportion of wood and tree-dependent Coleoptera (Species Group 4) from a 2nd to 4th century Roman settlement at the edge of the floodplain on the First Gravel Terrace had risen to 1.4% of the terrestrial Coleoptera from 0.1% in the Iron Age (Lambrick and Robinson 1979; Robinson 1981a). They included both hedgerow / scrub species such as *Scolytus rugulosus* which attacks the bark of moribund rosaceous trees and shrubs and *Acalles turbatus*, which bores into dead twigs. There were also two bark beetles which feed on *Fraxinus excelsior* (ash): *Hylesinus oleiperda* and *Leperisinus fraxini*. Species Group 4, which were entirely absent during the late Iron Age (Fig. 11), had risen to 1.2% of the terrestrial Coleoptera at both the early Roman and the late Roman settlements on low gravel islands on the floodplain at Claydon Pike, Glos (Robinson, unpublished k). In addition to most of the species noted for Farmoor, there was the weevil *Magdalis ruficornis* which feeds on numerous trees and shrubs, *Leperisinus varius* which feeds on ash and *Chalcoides* sp. which feeds on *Salix* and *Populus* spp. (willow and poplar).

It is suggested that the enclosure ditches on these sites were lined with thorn hedges of hawthorn and sloe, host plants of the beetles which are dependent on rosaceous trees and shrubs. In addition, it is possible that standard trees, particularly ash, were grown in the hedges for timber. Similar results were obtained from a Roman settlement on the First Gravel Terrace of the Thames at Appleford, Oxon, where Species Group 4 comprised 1.2% and included beetles which feed on rosaceous trees and shrubs, ash and willow or poplar (Robinson 1980a).

Not all sites on the Upper Thames gravels fall into this pattern. At the Barton Court Roman Villa (see above), Species Group 4 only comprised 0.2% of the terrestrial Coleoptera (Fig. 13). On the First Gravel Terrace at Watkin's Farm, Northmoor, Species Group 4 comprised 1.2% of the terrestrial Coleoptera from the Roman settlement (Robinson 1990). Most of the host-specific members of this group, however, were species which feed on willow or poplar. They included *Phyllodecta vulgatissima*, which only feeds on a restricted range of willow plants including *Salix viminalis* (osier). The macroscopic plant remains from the site included both bud scales of poplar and leaves of osier or an osier hybrid. The low-lying water-filled ditches on the site were interpreted as having had osiers planted along their banks. A high value of 4.4% for Species Group 4 from a Roman settlement on the Third Terrace at Mount Farm, near Dorchester (Fig. 9) could mostly be attributed to the willow and poplar-feeding beetle *Chalcoides* sp. (Robinson, unpublished h). Willow trees probably grew around a pond on the site from which some of the samples had been obtained.

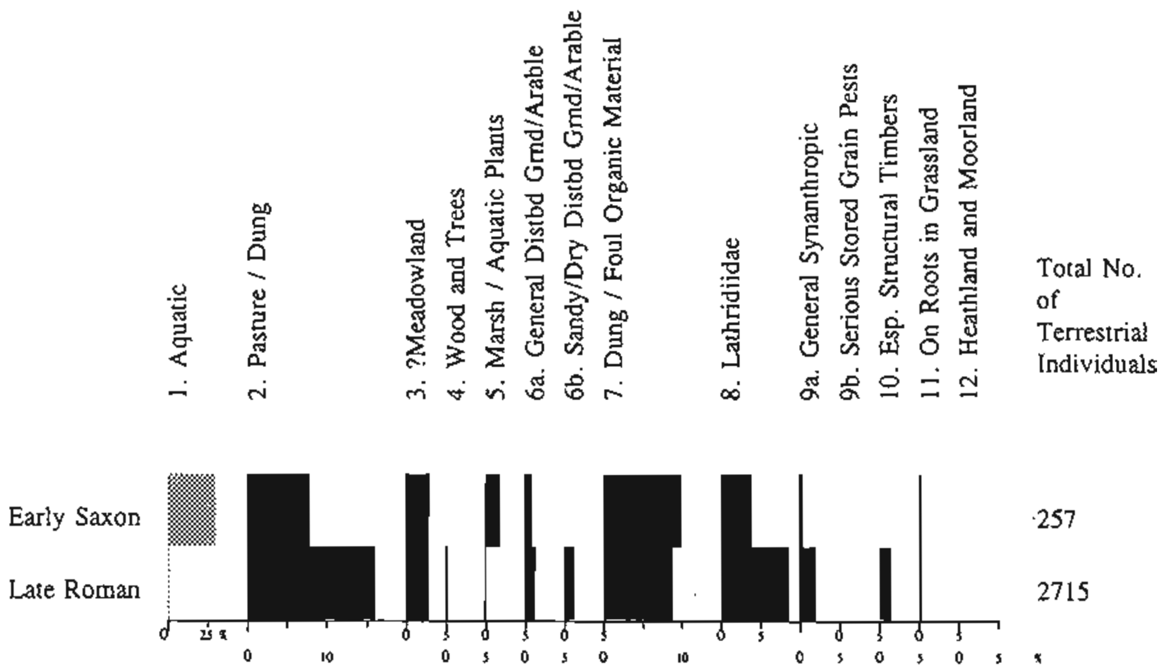
There is little evidence available from outside the Upper Thames Valley. On the gravels of the Middle Thames at Thorpe Lea Nurseries, Surrey, species Group 4 comprised 1.2% of the terrestrial Coleoptera and species associated with rosaceous trees and shrubs were present in a Roman water hole (Robinson, unpublished x). However, this group was absent from a Roman well at the Barnsley Park Villa, Glos (Coope and Osborne 1967).

Pasture, Haymeadow and Arable

The Upper Thames Valley

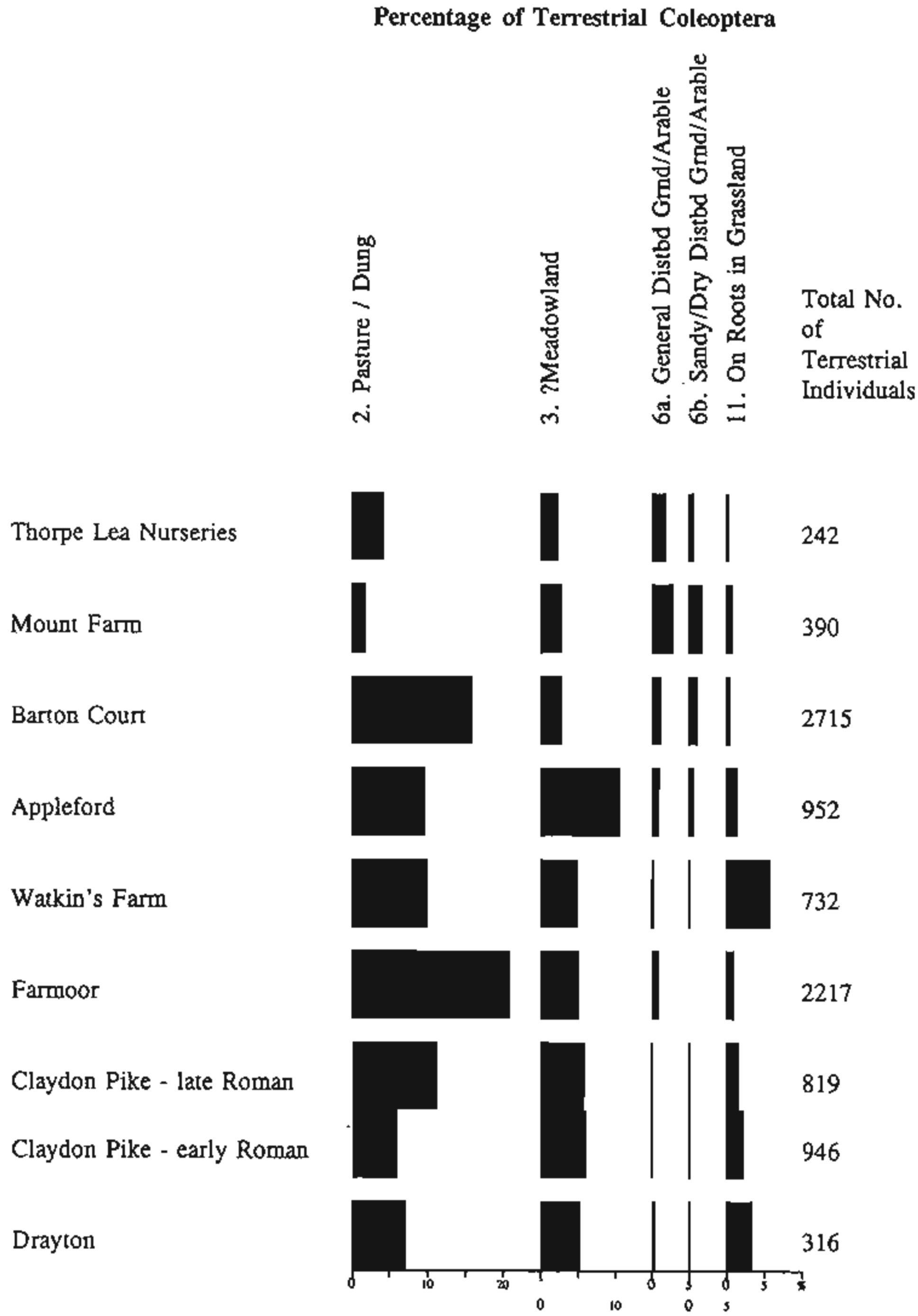
The majority of the terrestrial insects from Roman rural sites in the region were species of open country habitats. By comparing the relative percentages between sites of five of the species groups of Coleoptera, it proved possible to show the importance of pastureland and gain some information about meadowland and arable (Robinson 1983a). The groups used were 2. Pasture / Dung, 3. ? Meadowland, 6a. General Disturbed Ground / Arable, 6b. Sandy / Dry Disturbed Ground / Arable and 11. On Roots in Grassland. The results for these groups from all the Roman sites mentioned above plus Drayton, on the edge of the Upper Thames floodplain near Abingdon, have been displayed in Fig. 14, with the exception of Barnsley Park, for which the numbers of individuals were not available. Claydon Pike has been divided into an early Roman phase, which lasted from the late 1st to the early 3rd century and a later Roman phase, which dated from the late 3rd to the late 4th century. The early Roman phase of the site was a state-controlled agricultural settlement whereas the late Roman phase was a small villa. Thorpe Lea Nurseries, Mount Farm and Barton Court were all dry, well drained sites on higher gravel terraces, the other sites were lower-lying, being situated on the First Terrace or floodplain edge.

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. 13: **Species Groups of Coleoptera from Barton Court**



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: **Roman Thames Valley Grassland and Arable Coleoptera**

The three driest sites all had the highest values for the Carabidae of Species Group 6 which favour arable habitats: *Agonum dorsale*, *Harpalus rufipes* and various species of *Amara*, especially *A. apricaria* and *A. bifrons*. These beetles are not exclusive to arable and also occur on weedy open ground. However, there was botanical evidence for the involvement of these sites in cereal cultivation and the soils of these sites were well-suited to arable agriculture. Interestingly, there were several examples of the beetle *Zabrus tenebrioides*, which is now very rare in Britain. In Continental Europe it is a pest of cereals, the larvae devouring the young shoots and the adults climbing the plants to feed on the grains. In Britain, however, it is perhaps better known from areas of tall grass. All these sites also had beetles which feed on weeds, for example *Phyllotreta atra*, *P. nigripes* and *Ceutorhynchus erysimi* on Cruciferae (wild mustard, shepherd's purse etc) and *Chaetocnema concinna* on Polygonaceae especially *Polygonum aviculare* agg. (knotgrass). The lowest values for Species Group 11, chafers and elaterids with larvae that feed on the roots of grassland herbs and Species Group 3, weevils from the genera *Apion* and *Sitona* that are favoured by meadowland conditions, were obtained from these three sites. At both Thorpe Lea Nurseries and Mount Farm, the percentages of the scarabaeoid dung beetles of Species Group 2, which suggest the pasturing of domestic animals, was very low. However, at the Barton Roman Villa, Species Group 2 comprised over 16% of the terrestrial Coleoptera, suggesting that, in addition to arable farming, there was also a concentration of domestic animals on the site. The most numerous species were *Aphodius contaminatus* and *A. granarius*, but another 16 species of *Geotrupes*, *Colobopterus*, *Aphodius* and *Onthophagus* were present.

Four other sites had quite high values for Species Group 2, ranging from around 10% at Appleford and Watkin's Farm up to 21% at Farmoor, suggesting pasture to have been important at these sites. *A. contaminatus* and *A. granarius* tended to be the most numerous members of the group, sometimes in company with *A. sphacelatus*. With the exception of Appleford, these sites were adjacent to the Thames floodplain which, by the Roman period, was experiencing seasonal inundation and, from other sources of evidence, appears to have been grassland (Robinson 1992b). Not all these sites had a strong presence of Species Group 11, chafers and elaterids with larvae that feed on the roots of grassland plants. The lowest value was from Farmoor, at little over 1% of the terrestrial Coleoptera. However, the other phytophagous grassland insects were quite well represented, for example the homopteran bug *Aphrodes bicinctus*, flea beetles of the genus *Longitarsus* and the plantain-feeding weevil *Mecinus pyraster*. There were also grassland carabid beetles, for example *Calathus fuscipes*. It is possible that winter waterlogging of the floodplain soil resulted in the low values for Species Group 11. Values for Species Group 3, the weevils of the genera *Apion* and *Sitona* which feed on clovers and vetches, were relatively high, ranging from 5.1% at Watkin's Farm to 10.8% at Appleford. Although some of the samples from Watkin's Farm gave high values for Species Group 3, there was insufficient supporting evidence for the presence of hay meadows and the results were attributed to the occurrence of areas of neglected ungrazed grass (Robinson 1990, 70). Appleford gave the highest value for Species Group 3 from any of the Thames Valley Roman sites. It was thought possible that there were hay meadows in the vicinity of the site but again there was no supporting botanical evidence (Robinson 1983a, 37). At Farmoor, however, there was supporting botanical evidence that some of the grassland there was cut for hay. It is now realised that Sample 1060/2 from an early Roman well (Lambrick and Robinson 1979) included a hay meadow assemblage. It contained seeds of *Rhinanthus* sp. (yellow rattle), *Leucanthemum vulgare* (ox-eye daisy) and *Centaurea* cf. *nigra* (knapweed). Species Group 3 comprised over 14% of the large assemblage of terrestrial Coleoptera from the well. The results from the late Roman phase at Claydon Pike were somewhat ambiguous. The value of Species Group 3, at 6% of the terrestrial Coleoptera, was not so high as to confirm the presence of hay meadow but traces of *Rhinanthus* sp. and *Centaurea nigra* type. pollen were identified (J Turner, pers comm). The percentages for Species Group 6a plus Species Group 6b ranged from 0.2% at the late Roman phase of Claydon Pike to 1.9% at Appleford. While they could have been living on disturbed ground around the settlements, there was evidence from several of the settlements for horticulture and it is possible there was some arable agriculture on the gravel terrace.

The remaining two sites, the early Roman phase of Claydon Pike and Drayton (Robinson, unpublished, w and k) had relatively low values for Species Group 2 and intermediate values for Species Group 3. The botanical evidence from Drayton suggested the vegetation of the site to have been a type of flood-pasture which included some tall-growing species (Lambrick and Robinson 1988, 69-71), that would shelter the host-plants of Species Group 3. At Claydon Pike, there was botanical evidence that hay meadow grew on the floodplain and cut hay was brought into the settlement during the early Roman phase (Robinson, unpublished k; Turner, unpublished). A hay meadow flora was identified from a ditch of the same phase outside the settlement. The seeds from the ditch included:

Ranunculus cf. *acris*	(meadow buttercup)	*Leucanthemum vulgare*	(ox-eye daisy)
Rhinanthus sp.	(yellow rattle)	*Centaurea* cf. *nigra*	(knapweed)

The pollen included *Rhinanthus* sp. and there was a much higher percentage of *Plantago lanceolata* (ribwort plantain). The clover and vetch-feeding weevils of Species Group 3 comprised 13% of the terrestrial Coleoptera. Other phytophagous beetles from the sample included *Hydrothassa marginella*, which feeds on *Ranunculus* spp. (buttercups) and *Mecinus pyraster*, which feeds on *Plantago lanceolata* (ribwort plantain) and *P. media* (hoary plantain). The scarabaeoid dung beetles of Species Group 2 were entirely absent from this sample. The entomological results from the early Roman phase at Claydon Pike suggested that there were some domestic animals in the settlement but that a large area around it was grassland managed as hay meadow. One interpretation placed on the site was that it was a *prata* which supplied the civilian administration in Cirencester with fodder (D. Miles, pers comm).

Small samples were examined for insects from a low-lying site on the floodplain gravels of the Kennet at Pingewood, Berks (Girling 1983-5). They also fitted into the general pattern, with dung beetles suggesting that enclosures on the site were used for domestic animals.

The results from the additional Roman sites on the Thames Valley gravels successfully extended the study of Robinson (1983a). They confirmed that the best-drained settlements tended to concentrate on arable whereas the lower-lying sites, especially those adjacent to the floodplain tended to concentrate on grassland. They also proved successful in showing whether the grassland was exploited for grazing or cut for hay. The scarabaeoid dung beetles recorded in earlier periods (Table 3) which are now very rare or extinct in Britain were not found.

Other Parts of the Region

There is less evidence from the remainder of the region. The occurrence of scarabaeoid dung beetles and beetles such as *Agrypnus murinus* in the well of the Roman villa at Barnsley

Park, Glos was noted as suggesting pastureland (Coope and Osborne 1967). A small insect assemblage from a Romano-British village at Catsgore included some species which implied grazing occurred near the site (Girling 1984d). A Roman well on gravels at Hunt's Hill Farm, Upminster, NE London contained relatively high concentrations of scarabaeoid dung beetles from the genera *Geotrupes* and *Aphodius* suggesting domestic animals were tended in the vicinity of the well (Robinson, unpublished n). However, the scale of work was insufficient to establish the importance of arable. An early to mid Roman well on the Chalk of the Isle of Thanet, Kent near Monkton yielded waterlogged sediments at a depth of 38m from which insect remains were recovered (Robinson, unpublished o). The Coleoptera included various Carabidae such as *Pterostichus melanarius* and *Agonum dorsale* which readily occur on weedy disturbed ground or arable. There was also a strong faunal element of grassland. *Agriotes* sp. and scarabaeoid dung beetles were particularly well represented. One species of *Aphodius*, *A. sus*, is now very rare in England and there have been very few recent records although it was captured in Kent in the 19th century. *Brachinus crepitans* (bombardier beetle), another species which is no longer common, was present. This curious beetle, which defends itself by emitting an explosive discharge of corrosive steam, tends to occur in warm, dry, short turf. It was also present on some other Thames Valley sites, for example Appleford, Oxon (Robinson 1980a).

Marsh, Fen and Aquatic Habitats

Only very limited evidence was available for the riverine insect fauna of the region during this period. An example of the beetle *Stenelmis canaliculata* from a Roman stream deposit at Mingies Ditch, Oxon (Allen and Robinson 1993) showed that this most fastidious beetle of clean, flowing water survived in the Thames drainage basin beyond the late Bronze Age.

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.78) continued to be abundant in such archaeological features during the Roman period. However, some of the deeper Roman wells gave clean water supplies and the few individuals of *Helophorus* cf. *brevipalpis* from them probably represented beetles which accidentally flew into the wells rather than populations which lived in them.

The floodplain of the upper Thames basin continued to receive seasonal inundations throughout the Roman period. Just as in the Iron Age, this was reflected in the insect fauna of the lower-lying sites, for example the occurrence of the carabid beetle *Blethisa multipunctata* at Farmoor (Lambrick and Robinson 1979, 91) and beetles which feed on marsh or fen plants at Claydon Pike, for example *Plateumaris sericea*, which feeds on *Carex* spp. (sedges), and *Aphthona nonstriata*, which feeds on *Iris pseudacorus* (yellow flag) (Robinson, unpublished k).

The Somerset Levels

Only limited insect evidence was available for Roman developments on the Somerset Levels. The top of the Meare Heath sequence, which was bracketed by the radiocarbon dates 1746±45 BP, 140-400 calAD (SRR-911) and 1414±45 BP, 550-680 calAD (SRR-910) (Fig. 8) contained beetles suggestive of fenland conditions, for example the water beetle *Noterus clavicornis* in company with the carabid *Dromius longiceps* (Girling 1982a). Radiocarbon dates of 1730±70 BP (HAR-1854) and 1710±80 BP (HAR-1842), combined date calAD 140-430, were obtained from Difford's Brushwood Platform. The level of the platform corresponded with a second episode of flooding of the raised bog with calcareous water (Girling 1978). This was marked by a disappearance of water beetles associated with acid conditions, for example *Hydroporus melanarius*, although the heather-feeding weevil *Micrelus ericae* persisted. The flooding resulted in a great increase in the number of water beetles. Species indicative of calcareous water included:

Noterus clavicornis	*Porhydrus lineatus*
Hydrovatus clypealis	*Copelatus haemorrhoidalis*

The occurrence of the weevil *Tanysphyrus lemnae* suggested duckweed-covered, still water as flood levels began to fall.

There were, of course, other parts of the region which retained extensive wetlands in the Roman period. The discovery of an adult and larvae of *Hydrophilus piceus* (great silver diving beetle) in the late Roman town ditch of Alchester was probably related to the proximity of Otmoor (Robinson 1975).

Urban and Rural Living Conditions and Settlement Activities

There have been few insect assemblages examined from Roman towns or fortresses in the region and most of them were from perimeter ditches. In contrast, many samples have been analysed from rural settlements.

Towns and Military Sites

A substantial assemblage of insects was analysed from a Roman well at Chichester, West Sussex, which was just outside the walls of the Roman town (Girling 1989a). It remains the most useful urban insect fauna of Roman date studied so far from the region although unfortunately part of the species list including most of the Staphylinidae was omitted from the published report. Insects have also been identified from various waterlogged deposits at Copthall Avenue, in the Roman city of London (Allison and Kenward 1987; Allison and Kenward in de Moulins 1990).

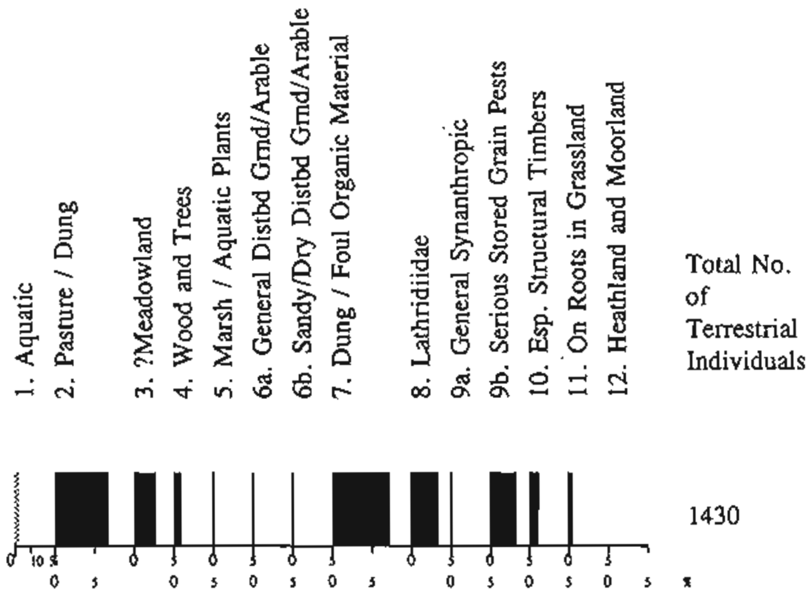
There seems to have been much weedy waste ground in the vicinity of the Chichester well. Carabidae which commonly occur in this habitat which were well represented included *Bembidion properans*, *Pterostichus melanarius* and *Amara aenea*. Phytophagous beetles of this habitat included:

Phyllotreta nigripes	on Cruciferae (wild mustard etc)
Apion aeneum	on Malvaceae (mallows)
Rhinoncus pericarpius	on *Rumex* spp. (docks)

Similar weedy waste ground was suggested by Coleoptera from Roman wells at Silchester, Hants (Amsden and Boon 1975). There was a range of carabid beetles including *Pterostichus melanarius* and *Amara* spp. The phytophagous species included *Apion aeneum* and *Rhinoncus* sp. This work, however, was based on specimens originally extracted by A H Lyell during the excavations of 1901 to 1909 and identified at the time by C O Waterhouse. The analyses were not quantitative and the species lists have obvious gaps in them. However, the work was better than anything done in the region for the next 50 years.

Scarabaeoid dung beetles of Species Group 2 comprised almost 7% of the terrestrial Coleoptera from the Chichester well (Fig. 15). While not a high value in comparison with

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. 15: **Species Groups of Coleoptera from Chichester Well**

the results from many rural settlements, it does imply the presence of some domestic animals. It is relevant to establish whether they were grazing on pasture outside the walls of the Roman 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 therefore thought that these dung beetles had their origins within the town. A small enclosure, with a donkey or a couple of pigs in it, close to the well would probably have been sufficient to give this result provided there were discrete droppings which were left on the ground. The records of *Aphodius* spp. from Silchester might suggest some domestic animals were also kept within this town. (The suggestion by Girling that *Aphodius* spp. fly by night and would have been attracted to light within the town is not applicable. Most species of *Aphodius* fly by day and only *A. rufipes*, which was very much in the minority at Chichester, has the reputation of flying towards light).

Given the likely presence of domestic animals on the Chichester site, the numbers of *Cercyon* spp., *Megasternum obscurum* and *Anotylus* spp. of foul organic material, which comprise Species Group 7, were not unusually high from the Chichester well. However, another species, *Platystethus degener*, comprised over 9% of the terrestrial Coleoptera and suggested much nutrient-rich wet mud on the site. Foul organic material at Copthall Avenue was suggested by *Cercyon* spp., *M. obscurum* and *Oxytelus sculptus*.

The percentage of beetles of Species Group 10 which favour structural timbers was, at 1.3% of the terrestrial Coleoptera from the Chichester well, rather low for a town, but sufficient to suggest the proximity of timber buildings. Of particular interest was the occurrence of *Lyctus brunneus*, a powder-post beetle of uncertain status in the British fauna, in addition to the more usual *Anobium punctatum* (woodworm beetle). *A. punctatum* was also present at Silchester and abundant at Copthall Avenue, London.

General synanthropic beetles (Species Group 9a) only comprised 0.3% of the terrestrial Coleoptera for Chichester. This was no higher than might be found on a sparsely settled late prehistoric site. However, in addition to *Ptinus fur*, *Tipnus unicolor* was also present. 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 than *P. fur* and is characteristic of Roman and more recent settlements. The Lathridiidae of Species Group 8 made up 3.6% of the terrestrial Coleoptera from Chichester. They were likely to have been living in old straw, thatch etc on the site. *Aglenus brunneus*, a synanthropic beetle of old granary residues and buried organic material, for example in floor layers, was identified from both Chichester and Copthall Avenue, although not in the huge numbers that it has been recorded from some medieval towns outside the region.

The serious stored grain pests of Species Group 9b made up 3.4% of the terrestrial Coleoptera. Four species were present:

Cryptolestes ferrugineus	*Tribolium castaneum*
Oryzaephilus surinamensis	*Sitophilus granarius*

All but *T. castaneum* were also present at Copthall Avenue along with *Tribolium* sp., *Palorus ratzeburgi* and some minor grain pests (Table 8).

Table 8: **Stored Grain Pests from the Southern Region**

Period	Middle Bronze Age	Late Bronze Age	Roman									Late Saxon	Medieval	Late Medieval
	Wilsford Shaft	Runnymede WF1b	Exeter Fortress	London	Farmoor	Barton Court Villa	Barnsley Park Villa	Fishbourne	Catsgore	Chichester	Copthall Avenue London	Brooks Winchester	Brooks Winchester	Blackfriars Oxford
Data from	1	2	3	3	4	5	6	7	8	9	10	11	11	12
Stegobium paniceum (L.)	+	+	-	-	+	+	-	-	-	-	+	-	-	-
Cryptolestes ferrugineus (Step.)	-	-	-	-	-	-	-	+	-	+	+	-	+	-
Oryzaephilus surinamensis (L.)	-	-	-	-	-	-	+	-	+	+	+	+	+	+
Tribolium castaneum (Hbst.)	-	-	-	-	-	-	-	-	-	+	-	-	-	-
Tribolium sp.	-	-	-	-	-	-	-	-	-	-	+	-	-	-
Palorus ratzeburgi (Wiss.)	-	-	-	-	-	-	-	-	-	-	+	-	-	-
Tenebrio molitor L.	-	-	-	-	+	-	-	-	-	-	-	-	-	-
T. obscurus F.	-	-	-	-	-	-	-	-	-	-	+	+	+	-
Sitophilus granarius (L.)	-	-	+	+	-	-	-	-	+	+	+	+	+	+

1. Osborne (1989), 2. Robinson (1991a), 3. Straker *et al.* (1984), 4. Lambrick and Robinson (1979) 5. Robinson (1986), 6. Coope and Osborne (1967), 7. Osborne (1971), 8. Girling (1984d), 9. Girling (1989a), 10. Allison and Kenward (1987); Allison and Kenward in de Moulins (1990), 11. Carrott *et al.* (1986), 12. Robinson (1985)

The range of species suggests that grain pests were established rather than of chance occurrence. *S. granarius* is the only one of them which can readily attack intact 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 is released by the metabolism of the beetles to enable the spoilage of further grain and for the infestation to become self-sustaining. All these serious pest species were probably Roman introductions. *S. granarius* was recorded from late 1st century AD sediments in the bottom of the ditch of the legionary fortress at Exeter (Straker *et al.* 1984) and *C. ferrugineus* was identified from late 1st century AD sediments in a Roman harbour close to Chichester at Fishbourne (Osborne 1971). 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 keeps the grain dormant, 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, for example in a late 1st century granary in York (Kenward and Williams 1979). *S. granarius* has also been recorded from Roman London from a mid 1st century AD context (P. Boyd quoted in Straker *et al.* 1984). Although grain beetles were not found at Silchester, most of them are small and could easily have been overlooked given the early and pioneering nature of the work.

There was, however, one very interesting possible record of a synanthropic beetle from Silchester, the tenebrionid *Blaps lethifera*. 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. *Blaps* sp. was present at Copthall Avenue.

The majority of the insects from the late 1st century AD sediments in the ditch of the legionary fortress at Exeter (Straker *et al.* 1984) and the late 1st to 4th century ditch fills from the boundary of the Roman town of Alchester, Oxon (Robinson 1975) were mostly species which lived in the ditches or were from the surrounding countryside. However, Species Group 10, woodworm beetles, comprised 5% of the terrestrial Coleoptera from the Exeter legionary fortress. They included *Lyctus linearis* as well as *Anobium punctatum*. Synanthropic beetles were absent from the Alchester ditches other than an example of *Stegobium paniceum*, a minor grain pest which belongs to Species Group 9b. *A punctatum* and *Ptinus fur* were recorded from a late 1st century pit or ditch on a roadside settlement outside Alchester (Giorgi and Robinson 1984). Scarabaeoid dung beetles were amongst the few beetles from a Roman ground surface just outside the fort at Cirencester (Osborne 1982b).

Rural Settlements

Weedy waste ground seems to have been a usual feature of rural settlements. The fauna of this habitat from the late Roman villa at Claydon Pike provides a typical example (Robinson, unpublished k). 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):

Apion malvae	*A. aeneum*
A. rufirostre	*A. radiolus*

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 *Pterostichus melanarius* and *Harpalus* S. *Harpalus* sp.

Large accumulations of organic refuse do not seem to have been major features of the Roman settlements investigated. Such material was certainly present. One of the highest values for Species Group 7, certain Hydrophilidae and Oxytelinae of dung and other foul organic material, was from Farmoor, Oxon, where they comprised over 15% of the terrestrial Coleoptera (Lambrick and Robinson 1979; Robinson 1981a). However, this was also the site with the highest concentration of the scarabaeoid dung beetles of Species Group 2 and these beetles, such as *Megasternum obscurum* and *Anotylus sculpturatus* gp., readily occur in animal droppings on pasture. Other beetles which occur in a wide range of foul organic material included the staphylinids *Philonthus* spp. and the fierce, maggot-feeding *Ontholestes tessellatus*. One of the wells at Farmoor contained numerous examples of *Platystethus cornutus* gp. as did a well at the Barton Court Roman Villa (Robinson 1986) which would imply nutrient-rich mud, which perhaps resulted from the splashing of water onto animal droppings near the tops of the shafts. However, none of these sites had the very high levels of Coleoptera or Diptera puparia that occur in foul manure heaps.

The beetles of Species Group 10, which infest structural timbers, were present on almost all the Roman settlements investigated, generally at higher levels than in the Iron Age. With the exception of the Roman settlements at Watkin's Farm, where they only comprised around 0.5% of the terrestrial Coleoptera, values for Species Group 10 ranged from 1.3% at Appleford to 8.7% at Thorpe lea Nurseries on the seven Upper and Middle Thames Valley settlements described above (p.86-91, Figs. 9, 11, 13). The beetles were almost entirely *Anobium punctatum* (woodworm beetle) although a few examples of *Lyctus linearis* (powder post beetle) were also present on a couple of the sites. Species Group 10 was absent from Drayton, another Upper Thames Valley site, which was distant from any settlement.

The synanthropic beetles of Species Group 9a occur in various indoor habitats on all seven of the Upper and Middle Thames Valley settlements (p.86, Figs. 9, 11, 13), ranging from 0.4% of the terrestrial Coleoptera at Watkin's Farm to 4.1% at Thorpe Lea Nurseries. *Ptinus fur*, although generally the most abundant, had been joined by several other species. For example, the members of this group from Roman Farmoor were:

Stegobium paniceum	*Mycetophagus quadriguttatus*
Tipnus unicolor	*Typhaea stercorea*
Ptinus fur	*Tenebrio molitor*

The Barton Court Roman Villa added *Mycetaea hirta* to the list. The habitats of *S. paniceum*, *T. unicolor* and *P. fur* have already been given (p.66, 95). *M. quadriguttatus* occurs in fungi on trees and in mouldy hay and straw refuse. *T. stercorea* feeds on fungi on old hay and straw. *T. molitor* feeds on debris in birds' nests and is also a minor pest of stored farinaceous material. *M. hirta* is a fungal feeder on old straw, hay and wood which most usually occurs indoors. 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 habitats.

Members of the Lathridiidae (Species Group 8) especially *Lathridius minutus* gp., ranged from 3.8% of the terrestrial Coleoptera at Watkin's Farm to 9.6% of the terrestrial Coleoptera at Farmoor on the seven Thames Valley settlement sites considered above (p.86 - 91). 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.

The results from the Thames Valley settlements for Species Groups 8-10 suggested an intensity of occupation greater than that 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. Possibly some domestic animals were being overwintered under cover. Rural settlements in other parts of the region, where assemblages were unfortunately not quantified or were small, presented a similar picture. *Anobium punctatum* and *Ptinus fur* were present at Catsgore, Somerset (Girling 1984d) and Monkton, Kent (Robinson, unpublished o) as well as at Old Shifford, Oxon (Robinson 1995b) another Thames Valley site, while at the Barnsley Park Roman Villa *A. punctatum* occurred in company with *Tipnus unicolor*.

Although many of the Roman settlements in the Thames Valley were at least partly involved in cereal cultivation and large-scale crop processing occurred on some of the sites, serious pests of stored grain were absent. The only grain beetles identified from these sites were *Stegobium paniceum* and *Tenebrio molitor* (Table 8), native members of the British insect fauna, which, although they can be found in old grain residues and *S. paniceum* can certainly be a voracious pest of some dried commodities in the kitchen, do not contribute to large-scale infestations in granaries. As the results from the town, military and harbour sites discussed above (p.93-7) show, some of the exotic major grain pests of Species Group 9b had been introduced to the region early in the Roman period and they were established in the only town for which detailed palaeoentomological studies have been published. These beetles ought to have experienced no difficulty in reaching the Thames Valley as a result of trade. Their absence, therefore, implies that conditions on these rural settlements were in some way not conducive to grain beetles, so infestations were of comparatively rare occurrence. Unlike the Iron Age, grain was not stored in pits, so there is not an obvious explanation. It is probable that surplus grain from the settlement sites 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. Perhaps the dehusked grain was only stored in large quantities in the towns and military establishments.

Serous grain pests were, however, present on two rural settlements in the region (Table 8), the Barnsley Park Roman Villa, Glos (Coope and Osborne 1967) and the Romano-British village at Catsgore, Somerset (Girling 1984d). *Oryzaephilus surinamensis* was recorded from both sites, with the addition of *Sitophilus granarius* at Catsgore. It is possible that there was more long term grain storage on these sites than the Thames Valley settlements because they were larger. The Barnsley Park Villa was certainly a larger establishment than either of the two villas from which insects were investigated on the Thames gravels, Barton Court and the late phase at Claydon Pike. The Catsgore village was also larger than the Thames Valley settlements.

Workers of *Apis mellifera* (honey bee) were recorded from five Roman sites in the region (Table 7). At both Bowling Green Farm, Faringdon, Oxon and the late Roman phase of Claydon Pike, Glos, the remains of several individuals were discovered in a single context, suggesting the proximity of colonies (Robinson, unpublished k, v). Given the knowledge of apiculture in the Roman world (Robinson 1984a), it seems likely that bee-keeping was being practised.

A curious find was made from the late Roman villa at Claydon Pike of six elmid beetles of the species *Elmis aenea*, *Esolus parallelepipedus* and *Limnius volckmari* from a rectangular tank which had been cut below the water table (Robinson, unpublished k). They are species which require clean, well-oxygenated, moving water and would not have been able to live in the tank. It is possible that the tank was used for the temporary storage of fish which had been caught in the nearby river. One of the items preserved by waterlogging in the tank was a wickerwork fish trap or keep basket. Elmids would certainly crawl onto such an item if it had been placed in a river and thus have a ready means of transport to the site.

Single finds were made from each of the Roman settlements at Appleford (Robinson 1980a) and the early phase of Claydon Pike (Robinson, unpublished k) of puparia of *Melophagus ovinus* (sheep ked). It is a highly specialised wingless fly which is an ectoparasite of sheep and does not readily leave its host. The female produces fully grown larvae which attach themselves to the wool of their host and immediately pupate. This fly could have been introduced to Britain at any date from the Neolithic onwards. Its presence at Appleford and Claydon Pike shows that some activity concerning sheep or wool was occurring in the settlements.

Introduced Insects

The serious grain pests of Species Group 9b that were recorded from the region, *Cryptolestes ferrugineus*, *Oryzaephilus surinamensis*, *Tribolium castaneum* and *Sitophilus granarius* (Table 8) are all likely to have been Roman introductions to Britain, mostly probably from the Mediterranean region (p.97) Another indoor species, *Blaps* sp., could have been a Roman introduction although the species identification of *lethifera* is tentative (p.97). *Melophagus ovinus* (sheep ked) was also a Roman or earlier introduction (above). Coope and Osborne (1967) noted that their record of *Pterostichus madidus* from the late Roman well at Barnsley Park was the first from all the many Pleistocene and few Holocene insect assemblages that they had analysed from Britain. It was also present in a late 4th century well at Claydon Pike (Robinson, unpublished k). *P. madidus* is a carabid beetle that is now very common in arable fields, grassland and gardens. Either *P. madidus* was a Roman introduction that was only becoming established towards the end of the Roman period 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. The claim that *Stomis pumicatus* is an introduced species (Girling 1984d) seems unlikely. Although it is quite often found in gardens, it is not restricted to them and, unlike *P. madidus*, is known from pre-Roman contexts (Allen and Robinson 1993).

Climate
There was no entomological evidence from the region to suggest that climatic conditions in the region were any different during the Roman period from those at present. Some insects which now have their northern limit in Britain south of a line between the Bristol Channel and the Wash were identified from Roman sites in Oxfordshire, for example the heteropteran bug *Syromastus rhombeus* (Robinson 1980a) and the nettle-feeding weevil *Apion urticarium* (Lambrick and Robinson 1979, 107) which would suggest summer temperatures no cooler than at present. However the argument by Girling (1989a) that the occurrence of *Aglenus brunneus* at Chichester implied warmer conditions cannot be sustained. *A. brunneus*, although now rare and cryptic, has been recorded from the region in such habitats as haystack bottoms in recent times.

Discussion
The insect assemblages from the Roman countryside reflected an organised agricultural landscape in which settlements tended to specialise in those agricultural activities to which local conditions were best suited. As in the previous period, much of the evidence comes from the Thames Valley, but the insect evidence was more comprehensive suggesting much arable on the better drained higher gravel terraces and a concentration on grassland in the valley bottom. Managed woodland was present although probably remote from settlements. Much use seems to have been made of thorn hedges on settlements and the Coleoptera from several sites raised the possibility that larger trees were grown in some hedges.

In addition to providing pasture for domestic animals, some of the grassland on the floodplain and parts of the First Terrace of the Upper Thames Valley was managed for hay. The entomological evidence was supported by evidence from macroscopic plant remains for hay meadows. The need for hay had developed with the rise of towns, the demands of the army and perhaps more domestic animals being overwintered within settlements rather than on pasture.

The overwintering of domestic animals in settlements was perhaps one of the reasons why the synanthropic Coleoptera appear to show an increase in the intensity of occupation. *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.

The main centres for the storage of agricultural products seem to have been the larger rural settlements and towns. An unfortunate combination of increased trade with the Continent and the abandonment of pit storage for grain resulted in the introduction of serious grain pests and provided suitable conditions for them to flourish. It is possible that grain beetles were a considerable nuisance in stores of fully cleaned (de-husked) grain in towns.

Evidence from towns was regrettably limited. However, the results from Copthall Avenue, London and Chichester, suggested that with the foundation of the first towns in the region during the Roman period, so the same specialised urban synanthropic fauna of indoor species known from towns such as York (Kenward 1982) became established. Insect ectoparasites of humans doubtless await discovery in London and elsewhere. On the limited evidence available, Roman towns seem to have been cleaner than early medieval towns.

The Dark Ages and Early to Middle Saxon Period (Flandrian Late Zone III, AD410 - AD850)

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. However, the Saxons did dig shallow wells on their settlements and organic sediments continued to accumulate in palaeochannels. Unfortunately, this evidence is confined to the Upper and Middle Thames Valley. Somewhat unexpectedly, cesspits of this date containing mineralised remains were found on a site in Hampshire.

Landscape Conditions

Insect remains were recovered from an early Saxon well which was cut into a Roman ditch on the site of the Barton Court Roman Villa, Oxon (Fig. 13) (Robinson 1986). The site was on the Second Gravel Terrace of the Upper Thames. A sample was obtained from an early Saxon well at Mount Farm, Berinsfield, Oxon (Fig. 9) on the Third Terrace of the Upper Thames (Robinson, unpublished h). A well, dated to the 5th-6th century AD on pottery, was discovered about 500m to the west of the Roman town of Dorchester, Oxon at Bishop's Court, on the First Terrace of the Thames (Robinson 1981a, 1981b). All three wells gave similar results. The wood and tree-dependent insects of Species Group 4 were absent, suggesting open conditions. Scarabaeoid dung beetles of Species Group 2 ranged from 6% of the terrestrial Coleoptera at Mount Farm to 10% at Bishop's Court. They comprised species of *Geotrupes*, *Colobopterus* and *Aphodius* which still occur in the region. Some grazing by domestic animal was clearly taking place in the vicinity of the settlement. There was no strong evidence for meadowland, the weevils of Species Group 3 comprising 3-4% of the terrestrial Coleoptera. Arable cultivation is plausible for all three sites, the Carabidae favoured by disturbed or cultivated ground reaching 2% of the terrestrial Coleoptera for Species Group 6a and 1% for Species Group 6b at Mount Farm (Fig. 9).

A small assemblage of insects from palaeochannel sediments at Anslow's Cottages, Berkshire included an alder leaf beetle, *Chrysomela aenea* and *Curculio* cf. *nucum*, which develops in hazel nuts (Robinson 1992c). There was only a slight presence of scarabaeoid dung beetles and no other indication of grassland. However, it is uncertain whether the banks of the channel of the Kennet had been clear of alder woodland during the Roman period. Species of elmid beetle, including *Macronychus quadrimaculatus*, which is now extinct in the region, showed that the water in the channel was very clean and well-oxygenated.

Settlement Conditions

There was some weedy waste ground on the Saxon settlements on the Upper Thames gravels. The nettle-feeding weevil *Apion urticarium* occurred on all three sites as did a mallow-feeding weevil of the same genus, *A. radiolus* at Mount Farm and *A. aeneum* at the other two.

Anobium punctatum (woodworm beetle) and the other members of Species Group 10 were absent although some hint of settlement was given by the occurrence of the synanthropic beetles *Ptinus fur* and *Typhaea stercorea*, both members of Species Group 9a at respectively

Barton Court and Bishop's Court. The percentage of Lathridiidae (Species Group 8) declined to the sort of values seen on Iron Age settlements in the Thames Valley. Some calcium phosphate-replaced puparia of Sphaeroceridae (which include sewage flies) and *Fannia* cf. *scalaris* (latrine fly) were found in cesspits of 6th-mid 9th century AD date on a settlement at Abbots Worthy, Hampshire (Robinson 1991b).

Discussion

Despite the collapse of Roman administration, abandonment of towns and probable decline in population level, the insects gave no evidence for the abandonment of land or woodland regeneration on the gravel terraces of the Upper Thames Valley. However, there was probably some decline in the intensity of agricultural activity as suggested by lower percentages of scarabaeoid dung beetles. The intensity of occupation of settlements as reflected by synanthropic beetles fell back to the low level of the pre-Roman period, which is largely in agreement with the structural archaeological evidence.

The Late Saxon and Medieval Period to the Black Death (Flandrian Late Zone III, AD850 - AD1350)

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. Just 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 probable that the rainfall is only sufficiently high for such preservation to occur in the far west of the region. Organic sediments continued to accumulate in river channels, aided by interference with the channels related to water mill construction. The use of cesspits again resulted in the preservation of insect remains by calcium phosphate replacement, but on a much larger scale than in the Roman period. The evidence for the medieval period is unfortunately largely restricted to towns. Even so, opportunities for investigation were missed in Bristol and London.

Aspects of the Rural Insect Fauna

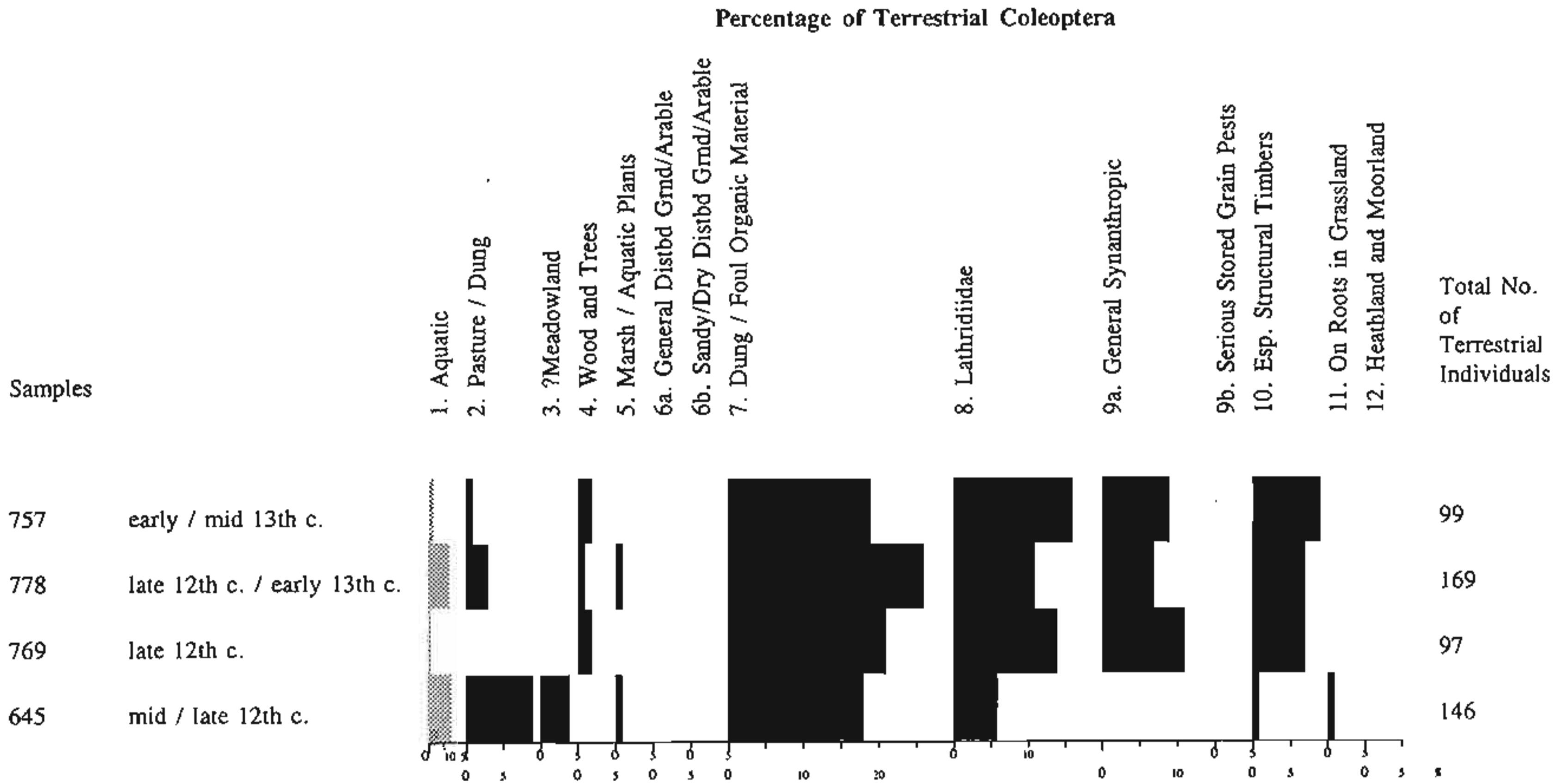
A final sample in the series from Anslow's Cottages, Berks from a palaeochannel of the River Kennet was dated to the late Saxon period (Robinson 1992c). It gave much the same evidence as the sample which belonged to the previous period (p.71). Trees remained present alongside the channel and there was only slight evidence of dung beetles. The flowing water fauna continued to include *Macronychus quadrituberculatus*.

Only limited waterlogged insect evidence was available from a moat around a medieval manor house at Chalgrove, Oxon but an example of *Xestobium rufovillosum* (death-watch beetle) was present (Robinson, unpublished p). It is most likely to have emerged from a hardwood structural timber on the site although the beetle has occasionally been recorded from old pollard willows near Oxford.

Calcium phosphate-replaced Diptera remains, primarily puparia of Sphaeroceridae (sewage flies) were recovered from the 13th century fill of a shaft at Middleton Stoney Castle, Oxon. (Robinson 1984b). Such remains accorded well with the evidence of mineralised fruit pips for the use of the shaft as a latrine.

The Rural-Urban Transition

Although the insect sequence from the Hamel, a suburb of Oxford, is by no means the earliest of insect samples from a town in the region, it does provide a particularly good example of the changes which occur to the insect fauna with urbanisation (Robinson 1980c). The samples were derived from Context 645 (a mid to late 12th century ditch), Context 769 (a late 12th century pit), Context 778 (a late 12th to early 13th century ditch) and Context 757 (an early to mid 13th century pit). They are show in Fig. 16 in stratigraphic order. The insects from Context 645 are typical of the fauna that might be expected from floodplain pasture with perhaps a limited rural settlement nearby. The scarabaeoid dung beetles of



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. 16: **Species Groups of Coleoptera from The Hamel**

Species Group 2, including *Aphodius* cf. *prodromus* and *A. rufipes,* comprised 9% of the terrestrial Coleoptera. Phytophagous grassland Coleoptera of Species Groups 3 and 11 were present, such as *Athous hirtus* and *Sitona* sp. There was a slight presence of *Anobium punctatum* (woodworm beetle, Species Group 10). The numbers of Lathridiidae (Species Group 8) at 6% of the terrestrial Coleoptera and beetles of general foul organic material (Species Group 7) at 18% of the terrestrial Coleoptera were rather on the high side for a site completely remote from human occupation. However, the synanthropic beetles of Species Groups 9a and 9b were absent.

The grassland-related beetles of Species Groups 2, 3 and 11 were absent from the next sample in the sequence, Context 769. *Anobium punctatum* had risen to 7% of the terrestrial Coleoptera. Species Group 4, beetles dependent on wood or trees, was also present, represented by the wood-boring beetle *Ptilinus pectinicornis*. Given the composition of the fauna, it is more likely that this beetle was infesting structural timbers along with *A. punctatum*, rather than being derived from dead wood in the countryside. The synanthropic beetles of Species Group 9a comprised 11% of the terrestrial Coleoptera, the following species being present: *Tipnus unicolor*, *Ptinus fur*, *Mycetaea hirta* and *Typhaea stercorea*. The first two species occur indoors, feeding on a wide range of rather dry, starchy or protein-rich material. They can be found in neglected corners in houses and amongst old straw in stables. The last two species are strongly synanthropic fungal feeders which often live in old damp hay and straw, although *M. hirta* sometimes feeds on fungi in decaying structural timbers. The Coleoptera thus furnished good evidence of the habitats provided by the first buildings as the suburbs of Oxford extended onto the site.

The insects from Context 769 gave further information about conditions and activities on the site. The members of the genera *Cercyon*, *Cryptopleurum* and *Anotylus* which occur in a wide range of foul organic material rose to 21% of the terrestrial Coleoptera implying accumulations of foul refuse on the site. Puparia of *Scopeuma stercorarium* (yellow dung fly) showed the presence of fresh dung. The sample also contained 23 puparia and 3 adults of *Melophagus ovinus* (sheep ked), a wingless fly which is an ectoparasite of sheep. Perhaps sheep were washed on the site prior to being sent to market, or maybe wool was being carded and washed.

The Coleoptera from the remaining two samples continued to show a strong presence of those species groups indicative of settlement and of decaying organic material. *A. punctatum* (woodworm beetle) had been joined by *Lyctus linearis* (powder post beetle) and there were further examples of *Ptilinus pectinicornis* likely to have been occurring in structural timbers. In addition to the Coleoptera of foul organic material (Species Group 7), there were also puparia of *Musca domestica* (house fly) and *Stomoxys calcitrans* (stable fly) suggesting dumps of old straw enriched with animal dung. The samples did not, however, contain an insect fauna suggestive of human sewage. Although the grain storage pests of Species Group 9b were absent, there were several examples of *Bruchus rufimanus* (bean beetle) which emerges from dried *Vicia faba* (field or broad bean) in storage but is unable to re-infest them.

Vegetation in Towns

Remains of phytophagous species occurred generally 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 these insects had been derived from the surrounding countryside. Insects of aquatic plants are considered below.

Aspects of the Aquatic and Waterside Environment in Towns

As the suburb of St Aldates developed to the south of Oxford alongside the route across the Thames, from about AD 850 onwards, so activity occurred alongside various of the river channels (Robinson 1984c; Robinson, unpublished t). The insects from the channels initially showed flowing water conditions, with for example larval cases of the caddis *Ithytrichia* sp. Even though activity on the banks resulted in organic material being deposited in the channels, the flow of clean water was sufficient to prevent an oxygen deficit. The lowest channel sediments at the Head of the River site contained some flax-retting debris, yet there was a clean-water elmid beetle fauna including *Stenelmis canaliculata*, a species so fastidious in its water requirements that it is now extinct in the region. There were also Coleoptera that feed on emergent vegetation, for example *Donacia clavipes* on *Phragmites australis* (common reed) and *Prasocuris phellandrii* on *Oenanthe aquatica* gp. (water dropwort) and other aquatic Umbelliferae. As dumping reduced the flow in the channels, so the flowing water insects were lost, the stagnant water caddis *Orthotrichia* sp. replacing *Ithytrichia* sp. Species which feed on reedswamp vegetation also declined.

General Organic Refuse

Insects which feed on various categories of decaying organic refuse were a usual component of the late Saxon to middle medieval urban insect fauna. In many cases the refuse can be attributed to a particular source, examples of which are given below. Sometimes it is less easy to categorise. Organic material was investigated from a pit dated to 1000±80 BP, 880-1220 calAD (HAR-570) in the Saxon town of Hamwic at Southampton (Buckland *et al.* 1976). Although much was written about the insect assemblage, little more can be said about it other than that it was characteristic of decaying organic material. The most numerous species were *Xantholinus linearis* and *X. longiventris* which would suggest that conditions were not too foul. A small assemblage of insects was identified from a pit dated to 840±90 BP, 1010-1290 calAD, at Taunton Priory Barn (Greig and Osborne 1984). Rotting vegetation was suggested by the most numerous beetle, the staphylinid *Micropeplus fulvus*. A sample from a nearby ditch contained staphylinids of foul organic material including *Anotylus nitidulus*. A rather un-diagnostic range of Coleoptera of decaying organic material was recovered from sediments which accumulated in the palaeochannels of the Thames to the south of Oxford at St Aldates (above). Some of the beetles, for example *Megasternum obscurum*, would just as readily have lived in flood debris deposited alongside the channels.

Stable Manure

Some more recognisable organic refuse was investigated for insect remains from a palaeochannel of the River Kennet at the Oracle, Reading (Robinson, unpublished q). It comprised a substantial dump of laminated plant material including cereal straw, pea, bean and vetch pods and bracken. It was of 14th-15th century date. Some of the samples contained large numbers of puparia of *Musca domestica* (house fly). *Stomoxys calcitrans* (stable fly) was also present. Given the full range of remains present, the main component of the deposit was probably stable waste. It would accord 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 insect 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.

A review was undertaken of the Diptera puparia from twelve waterlogged cesspits on seven sites in London which ranged in date from Saxon to 18th century (Belshaw 1988). They included a 12th century deposit at Moorgate. Insect remains from the pits included puparia of *Fannia scalaris* (latrine fly), *Themira putris* and various species of Sphaeroceridae (sewage flies). However, the most commonly encountered and common species was the sphaerocerid *Thoracochaeta zosterae* (seaweed fly). It is a small fly which can now be found breeding in wet decaying seaweed on the strand line around the coast of Britain and rarely occurs inland.

Very high concentrations of *T. zosterae* puparia were recovered from two 13th-14th century waterlogged cesspits at 113-119 High Street, Oxford (Robinson, unpublished r). Puparia of *Fannia* sp. and *Leptocera* sp. s.l. (sphaerocerid sewage flies) were present, but they comprised less than 0.5% of each assemblage. The nitrogen isotope ratio of some of the puparia was investigated, which established that the flies had derived their nitrogen from a terrestrial food chain rather than from feeding on material of marine origin (S. Webb, pers comm). 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 were also found in high concentrations in a medieval well at Cross Street, Reading which had subsequently been re-used as a latrine (Robinson, unpublished s). They had originally been misidentified as puparia of *Teichomyza fusca*, an ephydrid fly whose larvae also occur in sewage. Confusion had arisen because the reference puparia of *Teichomyza fusca* in the Natural History Museum, London were mislabelled puparia of *T. zosterae*. It is possible that other archaeological records of *Teichomyza fusca*, eg Greig (1982b), were in fact *T. zosterae*.

Not all cesspit assemblages are dominated by *T. zosterae*. *Leptocera* sp. s.l. (sewage fly) puparia predominated in an early 13th century cesspit at 89 St Aldates, Oxford and *T. zosterae* comprised less than 10% of the assemblage. *Fannia* cf. *scalaris* (latrine fly) was also present. (Robinson, unpublished t).

Relatively few Diptera puparia were recovered from a waterlogged 13th century garderobe at Upper Bugle Street, Southampton although some puparia of "*Teichomyza fusca*" were noted (Kenward and Girling 1986; Kenward and Allison 1987). The garderobe did, however, contain many examples of the beetle *Hister merdarius* and larvae of Histeridae. *H. merdarius* feeds on the larvae of other insects, especially Diptera in foul organic material. The beetles were presumably feeding on the larvae of sewage flies.

Another aspect of the cesspit fauna was illustrated by the insect remains from a series of waterlogged cesspits which ranged from late 10th-11th century to 14th-15th century in date at the Brooks, Winchester (Carrott *et al.* 1996). The most numerous remains from them were

Diptera puparia, *T. zosterae* tending to be outnumbered by many species of Limosinae (*Leptocera* sp. s.l.). However, the deposits also contained many Coleoptera, mostly indoor synanthropic species. The most abundant of these was the fungal feeder *Mycetaea hirta*. While it is a common beetle on urban sites, the concentrations were unusually high, in some instance comprising over 40% of assemblages of several hundred individuals. It is possible that the beetle had been feeding on fungal mycelia growing on the sides of the pits above the level of their contents. The pits also contained some beetles of subterranean habits including *Quedius mesomelinus* and *Coprophilus striatulus* which either lived in the dark, dank conditions on the sides of the pit or entered the contexts post-depositionally. The only Saxon pit, which was late 10th-11th century in date, contained what Hall and Kenward regarded as a faunal element characteristic of a primitive cesspit, with species of beetles such as *Philonthus* cf. *politus*, *Anotylus rugosus* and *Cercyon analis* that usually occur in outdoor habitats, living in the contents of the pit above the level of liquid.

Mineral-replaced insect remains are less easily identified than those preserved by waterlogging. However a late Saxon cesspit at Hinxey Hall, Oxford contained numerous calcium phosphate-mineralised puparia of Sphaeroceridae and a few puparia of *Fannia* sp. (Robinson 1983b). There was also a beetle from the sub-family Histerinae, many of which are predators on the larvae of Diptera. A few mineralised puparia of *Thoracochaeta zosterae* and *Leptocera* sp. s.l. were identified from a latrine in the Bishop's Palace, Witney, Oxon. (Robinson, unpublished u).

Mineralised Diptera puparia were recovered by non-standard techniques from cesspits on a series of sites in Southampton (Kenward and Girling 1986). They were mostly of Saxon date and from the Saxon town of Hamwic. Several thousand Diptera puparia were present in a sample from a medieval cesspit at Southampton "Site SOU124", the majority of which could have been *T. zosterae* (Kenward and Allison 1987).

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. There have been occasional finds of parasites and predators of these beetles. Some charred hazel wattles from a fence dated to 980±70 BP, 890-1220 calAD at All Saints, Oxford had woodworm tunnels which contained *Theocolax formiciformis* (Robinson and Wilson 1987, 62). It is a minute hymenopteran parasite of *A. punctatum*. The late 10th-11th century Saxon pit at the Brooks, Winchester contained the beetle *Teretrius fabricii*, a predator of *Lyctus* species (Carrott *et al.* 1996). Now a considerable rarity, it has mostly been recorded from oak palings.

The likely occurrence of *Ptilinus pectinicornis* in structural timbers at the Hamel, Oxford has already been mentioned (p.106). It was probably occurring in rather damp hardwood timbers. There were several records of *Xestobium rufovillosum* (death watch beetle) from the late 13th-14th century and the 14th-15th century cesspits at the Brooks, Winchester (Carrott *et al.* 1996). *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 beetle. Infestations progress slowly but over a period of several hundred years can be devastating to a major building. At the other end of the scale, an example of the small cerambycid beetle *Gracilia minuta*, which has a reputation for attacking old basketwork, was identified from an 11th-12th century pit at the Priory Barn, Taunton (Greig and Osborne 1984).

General Indoor Synanthropic Insects

The habitats of three of the most important members of the general indoor beetle fauna, *Tipnus unicolor*, *Ptinus fur* and *Mycetaea hirta* have already been noted (p.106). *P. fur* seems to have been almost as ubiquitous as *A. punctatum*. *T. unicolor* is regarded by Carrott *et al.* (1996) as more typical of the late medieval and post-medieval indoor fauna than the fauna of late Saxon and earlier medieval buildings. The earliest post-Roman record of *T. unicolor* from the region was from the 11th-12th century pit at the Priory Barn, Taunton (Greig and Osborne 1984) and it was recovered in quite high numbers from the late 13th-14th and 14th-15th century cesspits at the Brooks, Winchester.

The majority of late Saxon and medieval urban insect assemblages from the region were from deposits which accumulated either out of doors, for example the pits and ditches at the Hamel, Oxford (Robinson 1980c), or in cesspits. Although insects from inside buildings are present in the former, there are also many outdoor insects. The cesspit assemblages generally contained little else apart from fly puparia, for example Coleoptera comprised less than 0.1% of the insects recovered from the cesspits at 113-119 High Street, Oxford (Robinson, unpublished r).

However, the cesspits at the Brooks (Carrott *et al.*, 1996) did contain many indoor Coleoptera. It was suggested that the pits were inside buildings and the beetles were amongst floor sweepings thrown into them. In addition to the three species mentioned above, another member of the Species Group 9a synanthropics from the pits was *Tenebrio obscurus* (mealworm beetle). Interestingly the species of mealworm beetle recorded from Roman sites in the region (eg Farmoor, Lambrick and Robinson 1979) and the one now common in England, is *T. molitor*.

Some of the other beetles from these pits which commonly occur indoors but are not members of Species Group 9a were *Blaps* sp., an omnivorous tenebrionid which occurs in dark places, *Aglenus brunneus*, a colydiid of buried organic material (for example compressed plant debris on a floor), *Xylodromus concinnus*, a staphylinid of stable waste and old granary residues, and *Anthrenus* sp., an anthrenid which feeds on keratin, including wool, and dried protein, including dead insects. The Lathridiidae (Species Group 8), particularly *Lathridius minutus* gp., which would occur indoors on material such as damp thatch as well as in material such as old hay, were quite well represented. Another group, the Cryptophagidae, some of whose members occur in similar habitats to the Lathridiidae, for example *Cryptophagus* sp., were also present. The Brooks cesspits thus provided particularly good examples of the urban medieval indoor insect fauna of the region.

Stored Products Pests

The only serious grain pests of Species Group 9b recorded from the region for this period were from the late 10th-11th century, late 13th-14th and 14th-15th century cesspits at the Brooks, Winchester (Carrott *et al.* 1996). They were not abundant. The species present (Table 8), *Oryzaephilus surinamensis* and *Sitophilus granarius* from the Saxon pit being joined by *Cryptolestes ferrugineus* in the medieval pits, are all small beetles which could have been contaminants of food that was consumed then voided into the pits.

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, however, emerge from the dried beans in store, as for example, was probably the case at the Hamel, Oxford (Robinson 1980c) and the Trill Mill Stream, Oxford (Robinson, unpublished t). Sometimes, however, beans were consumed which contained dormant adults, which probably accounted for the occurrence of *B. rufimanus* in cesspits at the Brooks, Winchester, (Carrott *et al.* 1996) and 89 St Aldates, Oxford (Robinson, unpublished t). A late 11th century dump of charred pea and bean threshing debris against a Norman bridge causeway at 33 St Aldates, Oxford contained a couple of seeds of *Vicia faba* (field bean) showing the characteristic tunnels of *B. rufimanus* (Robinson 1984c).

Parasites

Several species of blood-sucking insects which are parasitic on humans and/or their domestic animals were identified. *Stomoxys calcitrans* (stable fly) occurred at the Hamel, Oxford (Robinson 1980c) and the Oracle, Reading (Robinson, unpublished q). It lives in old straw enriched with animal dung and tends to occur around stables and byres. The fly is a nuisance both to humans and their stock. The discovery of *Melophagus ovinus* (sheep ked), a wingless fly which is parasitic on sheep, at the Hamel, Oxford has already been considered (p.106). Single puparia of *M. ovinus* were found in late Saxon sediments at the Trill Mill Stream, Oxford (Robinson, unpublished t) and a 14th-15th century context at the Oracle, Reading, (Robinson, unpublished q), showing sheep-related activity occurring in towns. *Pulex irritans* (human flea) was identified from a late 10th-11th century cesspit at the Brooks, Winchester, while both *P. irritans* and *Ctenocephalides canis* (dog flea) were found in late 13th-14th century cesspits on the site (Carrott *et al.* 1996). It was noted that this suggested dogs were allowed indoors.

Other Entomological Aspects

The only record of *Apis mellifera* (honey bee) from the region for this period was from a late 10th-11th century cesspit at the Brooks, Winchester (Carrott *et al.* 1996). It was speculated that they could have originated from honeycomb or poorly-filtered honey which had been eaten.

Fly puparia were found with a skeleton in a 12th century coffin at St Budoc's Church, Oxford (Varley 1976). Two species could be identified: *Muscina stabulans*, which is well known from corpses and probably *Hydrotaea dentipes*, which is often associated with carrion. *M. stabulans* is part of the first wave of colonisation of buried corpses.

Discussion

Very little general landscape information was available from insects for the late Saxon to middle medieval period. There was limited evidence for the survival of trees alongside the River Kennet and the town of Oxford was expanding onto open pastureland. There was no evidence for climatic conditions any different from those of the present. One interesting aspect, however, was the persistence in the Thames system of the clean-water elmid beetles which are now extinct in the region, at least into the beginning of the period. This means that

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

Period	Iron Age	Late Saxon		Medieval		
	Meare Lake Village	St Aldate's Oxford	Brookes Winchester	The Hamel Oxford	St Aldate's Oxford	Brooks Winchester
Data from	1	2	3	4	5	3
Bruchus rufimanus Boh.	+	+	-	+	+	-
B. cf. *rufimanus* Boh.	-	-	+	-	-	+

1. Girling (1979b), 2. Robinson (unpublished t), 3. Carrott *et al.* (1986), 4. Robinson (1980c),
5. Robinson (1984c); Robinson (unpublished t).

they were able to survive despite the heavy load of fine sediment carried by the water of the river during the Roman period.

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 biting 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 Britain 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. (Rather too many of the indoor beetles were familiar occupants of the kitchen of a damp basement flat in Oxford in the 1970s).

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 the region before the Roman period yet it was not recorded from Roman sites. 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 of 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 1994) and the more limited evidence from the Southern Region is in agreement. However, one aspect which was not covered and about which much of the evidence does come from the south 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 - AD2000)

The late medieval and post-medieval period was 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). The main archaeological source of evidence for this period was cesspits, both waterlogged and those in which calcium phosphate mineralisation had occurred. They mostly gave information on human living conditions. However, insects have also been recovered from sources as diverse as a well in a hay meadow and a shipwreck.

Hay Meadow in the Upper Thames Valley

A late medieval well was excavated on an island of gravel terrace surrounded by the floodplain of the River Colne at Claydon Pike, Glos on the site of the Roman villa (see above). A silver halfpenny of 1473-77 was found in the waterlogged deposits at the bottom. Both the entomological and botanical evidence suggested the well to have been set amidst hay meadow (Lambrick and Robinson 1988; Robinson, unpublished k). The wood and tree-feeding Coleoptera of Species Group 4 were absent (Fig. 11) suggesting very open conditions. The scarabaeoid dung beetles of Species Group 2 only comprised 2.3% of the terrestrial Coleoptera but chafers and elaterid beetles which feed on the roots of grassland plants (Species Group 11) comprised about 7% of the terrestrial Coleoptera. This suggests that domestic animals were not concentrated in the vicinity of the well and that there was extensive grassland which was no more than lightly grazed. This impression was confirmed by the clover- and vetch-feeding weevils of the genera *Apion* and *Sitona*, which tend to be at their most prolific in meadowland (Species Group 3), which had the rather high value of about 8% of the terrestrial Coleoptera.

Overall, the insect assemblage comprised a rich hay-meadow fauna. Some of the more numerous Carabidae (ground beetles) included *Calathus fuscipes*, *C. melanocephalus* and *Amara aulica*, all typical meadowland beetles. The most abundant carabid beetle, however, was *Pterostichus madidus*, showing that this species had become very well established in the region by the late medieval period. Although the chafer *Hoplia philanthus* was present. Species Group 11 was mostly represented by Elateridae, in particular: *Athous hirtus*, *Agriotes lineatus*, *A. obscurus* and *A. sputator*. There was also a wide range of species of *Sitona* which feed on clovers and vetches (Species Group 3) including *S. hispidulus*, *S. lepidus*, *S.* cf. *lineatus* and *S. sulcifrons*. *Plantago lanceolata* (ribwort plantain) was indicated by the weevil *Gymnetron pascuorum* while there were numerous flea beetles of the genus *Longitarsus* likely to have been feeding on grassland herbs. The other insects were also characteristic of meadowland. The grass-feeding bugs of the genus *Aphrodes*, especially *A. bicinctus*, were very well represented. Workers of *Lasius flavus* (yellow meadow ant), which builds mounds in grassland, were sufficiently numerous to suggest a nest nearby. Insects from the assemblage that are attracted to meadowland flowers included the beetle *Oedemera lurida* and *Apis mellifera* (honey bee).

The botanical remains suggested species-rich grassland that was shut up for hay in spring, cut after Midsummer Day and the aftermath grazed. Such grassland might even have been of Roman origin in a few areas but it was certainly widespread in the medieval period on the floodplain of the Thames Valley. A few areas still survive with their rich insect fauna (Robinson 1983a). There was a slight presence of synanthropic beetles in the form of *Typhaea stercorea* Possibly it lived in haystacks built on the island above the level of winter floods.

Aspects of Late Medieval Conditions in Oxford

Sediments of 15th century date were analysed from a drain that ran through the kitchens of the Blackfriars Priory at Oxford (Robinson 1985). It was flushed by water taken from a back stream of the Thames. The occurrence of larval cases of the caddis *Ithytrichia* sp. and the beetle *Oulimnius* sp. showed that the water remained clean and well oxygenated. The beetle evidence suggested trees grew alongside the open route of the culvert, with *Plagiodera versicolorea* which feeds on *Salix* (willow) or *Populus* sp. (poplar), *Rhynchaenus alni* which feeds on *Ulmus* spp. (elms) and *Leperisinus varius* which feeds on *Fraxinus excelsior* (ash). There was little sign of foul conditions. Both the botanical and the documentary evidence confirmed the wooded nature of part of the site.

Human Sewage

Cesspits were investigated from London (Belshaw 1988; Girling 1984b), Abingdon (Robinson 1979), Exeter (Bell 1984), Oxford (Brown and Robinson 1984, Robinson, unpublished y), Taunton (Skidmore 1988) and Winchester (Carrott *et al.* 1996). They ranged in date from late 15th century to 18th century. All contained waterlogged or calcium phosphate-replaced fly puparia. *Thoracochaeta zosterae* (sewage fly) tended to predominate, but smaller Sphaeroceridae and *Fannia* cf. *scalaris* (latrine fly) were also often present. *Teichomyza fusca* was identified from an early 18th century cesspit at Cutler's Garden, City of London (Girling 1984b) and from a 16th century cesspit at 5-8 Fore Street, Taunton (Skidmore 1988). In the absence of any identifications of *T. zosterae* from either of these sites and on account of the confusion that has existed between the puparia of *T. zosterae* and *T. fusca* (p.108), it seems possible that they were also *T. zosterae*. The discovery of many semi-waterlogged puparia of *T. zosterae* in a latrine in the Provost's Lodging at Oriel College, Oxford, suggested a squalid aspect to upper class living conditions in the late 17th century because the flies would have emerged into the house (Robinson 1982; Robinson, unpublished y).

Structural Timbers

Anobium punctatum (woodworm beetle) remained troublesome, as it has done to the present day. At the Oxford Blackfriars Priory in the 15th century, it had been joined by *Korynetes caeruleus*, a beetle which is a predator in the tunnels of wood-boring insects especially on the larvae of *A. punctatum* (Robinson 1985). *Xestobium rufovillosum* (death watch beetle) was also present.

General Indoor Synanthropic Insects

Tipnus unicolor, *Ptinus fur* and *Mycetaea hirta* maintained their presence in this period. All were found in the 15th century drain at the Oxford Blackfriars Priory (Robinson 1985) while the first two were identified from the late 17th century latrine of the Provost of Oriel College, Oxford (Robinson, unpublished y). An interesting range of indoor synanthropic beetles, serious grain pests and beetles which infest structural timbers was recovered from the cob walling of a late 16th-17th century farmhouse at Leigh Barton, Devon (Robinson 1998; Robinson, unpublished z). The remains had been preserved by desiccation. However, the dating of the remains was uncertain. Most of the samples contained the lathridiid beetle *Lithostygnus serripennis*, a very recent introduction from New Zealand, so it is thought likely that some, perhaps all, the beetles entered the cob after the construction of the walls. A similar problem occurs with the intrusion of more recent insects into old thatch, another source from which insect remains have been recovered in the region.

Foul organic liquid was present in a late 17th-18th century covered drain inside a building at Pooles Wharf, Bristol (Robinson, unpublished aa). It contained a very high concentration of pupae of *Psychoda* cf. *alternata* (moth fly). It is now sometimes known as the trickling filter fly because of its prevalence in sewage filter beds. It tends to occur in organic-rich liquid in the dark and is also know from habitats as diverse as sink U traps and washings from animal cages.

Both the Pooles Wharf drain and the Blackfriars Priory drain contained the beetle *Trox scaber*. It feeds on dried animal remains. While their occurrence can be related to such activities as the preparation of animal skins, it is just as likely that they were associated with dead birds in the roof spaces. *T. scaber* has a particular liking for pigeon colonies in buildings and owls' nests. In contrast, six individuals of *T. scaber* from an early 18th century pit at Cutler's Gardens in the City of London could plausibly be interpreted as attacking hides because numerous horn cores, which would be waste from skinning, were found on the site. (Girling 1984b).

Stored Products Pests

The serious grain pests *Sitophilus granarius* and *Oryzaephilus surinamensis* showed a continuing presence, with records from the Oxford Blackfriars (Robinson 1985). *S. granarius* was also identified from the late 17th-18th century building at Pooles Wharf, Bristol, but by this date inter-continental trade was making casual introductions of other species of *Sitophilus* to Britain (see below).

Parasites

A surprisingly wide range of insects that are parasitic on humans were found, preserved partly preserved by calcium phosphate replacement and partly by waterlogging, in an early 18th century cesspit at Cutler's Gardens in the City of London (Girling 1984b). They comprised:

Pediculus humanus ssp. *humanus* or *capitis*	body or head louse
Pthirus pubis	crab louse
Pulex irritans	human flea
Ctenocephalides felis ssp. *felis*	cat flea
Cimex columbarius or *lectularius*	pigeon or bed bug

The cat flea lives on cats and dogs but will readily bite humans. Pigeon and bed bugs are difficult to separate, but bed bugs were notorious in London at this date and seem highly plausible given the other contents of the pits. The insects 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. Human fleas live in dirty houses and bed bugs need cracks to hide in. All thrive when humans live in close proximity. The crab louse is spread by sexual contact.

Insects and Overseas Trade

Insect remains were studied from the wreck of the Dutch East Indiaman "Amsterdam" which ran aground off Hastings in 1749 (Hakbijl 1986; 1987). Two likely pests of the food supplies on the ship were discovered, *Bruchus rufimanus* (bean beetle) and *Sitophilus granarius* (grain weevil). They could easily have been loaded with stores in the Netherlands and flourished on the ship. Most interestingly, fragments of the beetle *Lytta vesicatoria* (Spanish fly) were found along with a fragment of *Cetonia* cf. *aurata* (rose chafer). Dried, ground *L. vesicatoria* is the active ingredient of the drug *Cantharidum*, a dangerous blistering agent (also used as an aphrodisiac). Both *L. vesicatoria* and *C. aurata* are bright metallic green in colour but *C. aurata* has no pharmacological effect, so it was probably an adulterant. The likely source of the drug would be Southern Europe. Another stored products pest, *Stegobium paniceum*, was as likely to have been feeding on the *Cantharidum* as on the cereal stores in the ship.

Insect remains were also found in tropical produce on the ship. The beetle *Sitophilus linearis* was found in large numbers in a jar of tamarind. Three beetles from the Americas, *Cathartus quadricollis*, *Acanthinus* sp. and *Cotolethmus* sp., were identified from a barrel of tobacco. The distribution of *Cotolethmus* sp. suggested that the tobacco was from the Caribbean or tropical America, sources of inferior leaf. Also present on the ship was the beetle *Dimoderus* sp., which attacks bamboos. Of uncertain origin was *Sitophilus oryzae*, (rice weevil), which has been spread widely by trade, and the ant *Camponotus* sp.

The weevil *Caulotrupodes aeneopiceus* was found in remains of a wooden chest in the 15th / 16th century fill of a cellar at Biggen Street, Dover (Robinson unpublished ee). This beetle, which is associated with rotten wood, particularly old casks in cellars, occurs in buildings in ports along the SE coast of England. It was possibly introduced from the Azores or Madeira.

Other Entomological Aspects

Apis mellifera (honey bee) was recorded from two sites, the late medieval meadowland at Claydon Pike, Glos (Robinson, unpublished k) and a late medieval deposit at the Blackfriars Priory, Oxford (Robinson 1985). An example of the weevil *Apion ulicis*, which develops in the pods of *Ulex* sp., at the Oxford Blackfriars had probably been imported to the site in gorse (macrofossils of which were also found), perhaps for fuel in bread ovens. Remains of *Rhizophagus parallelocollis* (graveyard beetle) were found in fragments of the chasuble of Abbot Dygon (Girling 1981). The Abbot, wearing his chasuble embroidered with couched brass thread, was buried at St Augustine's Abbey, Canterbury in 1510. His grave was excavated in 1901. Brass corrosion products had probably facilitated the preservation of the remains. *R. parallelocollis* is particularly characteristic of buried corpses, which it is adept at reaching about a year after burial.

Discussion

The insects provided useful insights into aspects of the late medieval and post-medieval environment and activities, despite coverage being by no means even. The discovery of a rich late medieval hay meadow fauna filled a gap in the evidence from the previous period, when floodmeadows were certainly of similar importance in the Upper Thames Valley. A more pleasant aspect of the late medieval urban environment was also seen. Although buildings of this date were still infested with woodworm and other synanthropic beetles and flies bred in their cesspits, late medieval towns were probably cleaner than early medieval or late Saxon towns. However, the range of human ectoparasites from an early 18th century cesspit in the City of London showed the entomological aspects of squalid living conditions that were well documented in the poorest parts of towns in the region until recent times. The results from the wreck of the "Amsterdam" illustrate well the exotic insects carried by ships as a result of overseas trade. Some of these would become casuals in ports and a few, if they were able to find suitable habitats, would become established in Britain. The native insect fauna is well adapted to the natural and semi-natural habitats of the British Isles, so it tends to be the very artificial habitats, for example warm indoor ones, in which these exotic insects can thrive and outcompete native species. *Caulotrupodes aeneopiceus* is an example of a beetle which does not seem to have managed to extend its range much beyond its ports of introduction. In contrast, the New Zealand weevil *Euophryum confine*, which has a somewhat similar habitat, has become well-established in damp buildings inland. *E. confine* is perhaps best known archaeologically from its ability to bore into polythene sample bags that have been stored in cellars.

Conclusions and Recommendations

Although the coverage of the Southern Region was by no means even, 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 Southern 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 1000 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 in the region.

4) Some of the wetlands of the region developed diverse fenland faunas which included beetles, particularly Carabidae, which are now extinct in Britain. Such a fauna was present on the Somerset Levels from the Neolithic at least until the start of the Iron Age. Although these species are thermophilous, they need not imply temperatures warmer than at present. Their extinction is more likely to have been due to wetland habitat change, for example acidification, or wetland drainage.

5) The present open-country fauna of the region began to rise to prominence with the first clearances of the Neolithic shortly after 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

5 (cont) 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.

6) 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 Britain, although some survived in Britain until recently, albeit as great rarities, for there are 19th century records of their capture. Throughout most of Flandrian Zone III (Neolithic to present day), scarabaeids from the genus *Aphodius* greatly outnumbered scarabaeids from the genus *Onthophagus*. However, in two very large middle Bronze Age assemblages of scarabaeid beetles dated to around 1450 BC, the extinct species were well represented and numbers of *Onthophagus* spp. equalled or exceeded *Aphodius*. Such a fauna would now be characteristic of latitudes further south than Britain and perhaps represented the response of the insect fauna of the region to a brief warm climatic episode.

7) 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), some Ptinidae which are scavengers or minor household pests and the fungal-feeder *Mycetaea hirta*, 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 1450 BC and large numbers were recorded from one Iron Age settlement but from the Roman period onwards they were ubiquitous.

8) With the great increase in trade with Southern Europe and the change to large-scale above-ground storage, ideal conditions were created for the establishment of exotic beetles that are serious pests of stored grain. They had reached the region by the end of the first century AD. 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).

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 late Bronze Age but it was 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

10 ctd) Diptera (flies) from the families Sphaeroceridae and Fanniidae, flourished in vast numbers. Roman cesspits have yet to be investigated from the region, the first record for such a fauna being early to middle 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 adapted to the habitat and was one of the most abundant flies breeding in sewage in cesspits, 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, and at least some were present in Britain during the Roman period, all the records from the region were from late Saxon to post-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.

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. There are many activities which result in these destructive processes, one of which can be archaeological excavation. Looking back to the era of archaeology when excavation directors could not be expected to be aware of preserved insect remains, the impression gained is as much one of remarkable survival as loss. Detailed analyses of insects were undertaken for Silbury Hill (Robinson 1997) and the Wilsford Shaft (Osborne 1969; Osborne 1989) albeit the final reports not appearing until decades after the completion of the excavations. The unique nature of these sites in terms of date and locality make the insect assemblages from them probably the most important from the region. Obviously much was lost with the great excavations at Silchester and on the Somerset lake villages but even these were not total disasters. Limited contemporaneous work was done at Silchester (Amsden and Boon 1975) and some waterlogged Roman wells still survive unexcavated. The destruction of the Somerset lake villages was not complete, enabling some modern work to be done on them (Girling 1979b). These sites, at least, can be balanced against those totally lost.

In 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 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 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. 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.

There was, however, sometimes a loss of information even when insects were analysed. Sample sizes have been inadequate and insects lost through the use of non-standard recovery techniques (Kenward and Girling 1986). These problems were most serious when general environmental sampling and processing had been undertaken without prior consultation with the specialist who was to analyse the insects. They seem particularly to have been a feature of late 1970s and early 1980s urban excavations. Information has also been lost through poor presentation of data. 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, for example the Oxford Archaeological Unit and Wessex Archaeology, 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. For example, evaluation trenching at Quay Street, Gloucester revealed waterlogged waterfront sediments of Roman date and also waterlogged medieval pits. The high potential of the site for insect studies was noted. Even so, no provision was made for the work as part of the full-scale excavation. English Heritage refused to fund the work because the discoveries were not unexpected, they were exactly what had been predicted from the evaluation. London, one of the places where developer-funded archaeology was pioneered long before the onset of PPG 16 has also neglected archaeoentomology (until comparatively recently), even though there have been many high-value developments where the developers have made substantial contributions to archaeology.

Insect remains are also lost through the insidious effects of drainage. This has been demonstrated by excavating further trenches in 1992 on the line of the Abbot's Way trackway in the peats of the Somerset Levels, close to the excavations of Coles and Orme in 1974 (Robinson, unpublished bb). It was known that there had been a general drying out and shrinkage of the peat in recent years. The insects from the earlier excavation (Girling 1976) were compared with those from eighteen years later. Biological reworking, which has introduced the remains of many modern insects, and decay in the peat above the trackway (now shrunk but the equivalent of at least the top 0.5m of the Girling column) had rendered the insect remains from it worthless for palaeoecological studies. Even the insect remains from the trackway and below it (the equivalent of perhaps another 0.5m to 1.0m of the Girling column) had experienced some degradation. However, not all the insect remains in the Somerset Levels are in such a bad state. A similar exercise on the Sweet Track compared the state of insect remains in 1995 with those from nearby excavations in 1977 (Girling 1979c) and 1981 (Girling 1984a). Although there had been episodes when the water table had fallen below the level of the trackway, there was no sign of contamination by recent insects and little evidence of recent deterioration of the ancient remains (Brunning *et al.* 2000; Robinson, unpublished cc). It is suggested that colonisation by decay organisms takes time and brief episodes of low water table (perhaps 3 months) probably result in little, if any, decay. However, once decay has been initiated, the early stages of the rate of decay will be exponential as the decay organisms reproduce and damage will soon (perhaps 3 years) become serious.

The relevance of this is that if insect remains are to survive in organic sediments, those sediments must be kept waterlogged. For example, a late Bronze Age settlement was discovered in fen peat at Shinewater Marsh, Eastbourne during the digging of a lake (Robinson, unpublished dd). The lake was re-sited to preserve the settlement remains. However, unless a high water table is maintained on the site, the insects remains within the sediments (along with all the plant remains) will be destroyed just as completely as if the lake had not been re-sited.

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 is now becoming evident at Yarnton, Oxon (Robinson, unpublished c), where preservation appears less good in the most recently excavated deposits.

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 early to middle Bronze Age

2) Roman urban, especially where the site potentially has a late Iron Age origin, for example Silchester

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 extreme south-west, where conditions are at their most Atlantic

7) The extreme south-east, where conditions are continental and the proximity of Europe possibly had a greater influence on the fauna after separation from the Continent

8) Some of the major towns of the region, including London, Gloucester and Bristol

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) Iron Age hillforts, *oppida* and coastal trading settlements in relation to aspects of the synanthropic fauna

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 Southern 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 fauna marking the start of the Holocene provided a particularly good illustration of the climate change that occurred then. 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 medieval town-dweller was 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. As the director of a commercial archaeology organization said, "I do not have much call for insect work. My clients only pay for the minimum work to meet the brief." Curators and excavators are urged to obtain archaeoentomological advice at an early stage when planning projects.

BIBLIOGRAPHY

Allen, A A, 1956 '*Copris lunaris* L. (Col. Scarabaeidae) in the Box Hill area of Surrey'. *Entomologist's Monthly Magazine*, **92**, 382

Allen, A A, 1965 'Is *Onthophagus nutans* F. (Col. Scarabaeidae) still taken in Britain?' *Entomologist's Monthly Magazine*, **101**, 30

Allen, A A, 1967 'A review of the status of certain Scarabaeoidea (Col.) in the British fauna; with the addition to our list of *Onthophagus similis* Scriba'. *Entomologist's Record and Journal of Variation*, **79**, 201-6, 220-4, 257-62, 284-90

Allen, T G and Robinson, M A, 1993 *The prehistoric landscape and Iron Age enclosed settlement at Mingies Ditch, Hardwick-with-Yelford, Oxon,* Oxford: University Committee for Archaeology

Allison, E P and Kenward, H K, 1987 *Insect remains from Copthall Avenue, London*. (Ancient Monuments Laboratory Report, 194/87). London: English Heritage

Amsden, A F, and Boon, G C 1975 'C O Waterhouse's list of insects from Silchester (With a note on early identifications of insects in archaeological contexts)'. *Journal of Archaeological Science*, **2**, 129-136

Angus, R B, 1983 'Evolutionary stability since the Pleistocene illustrated by reproductive compatibility between Swedish and Spanish *Helophorus lapponicus* Thompson (Coleoptera: Hydrophilidae)'. *Biological Journal of the Linnean Society of London* **19**, 17-25

Atkinson, T C, Briffa, K-R, Coope, G R, Joachim, J M and Perry, D W, 1986 'Climatic calibration of coleopteran data', *in* Berglund, B E (ed) *Handbook of Holocene Palaeoecology and Palaeohydrology*. Chichester: J Wiley and Son, 851-858

Atkinson, T C, Briffa, K R and Coope, G R, 1987 'Seasonal temperatures in Britain during the past 22,000 years, reconstructed using beetle remains'. *Nature* (London), **325**, 587-592

Bell, M, 1984 'Environmental archaeology in South West England', *in* Keeley, H C M (ed) *Environmental archaeology: a regional review* (Department of the Environment, Directorate of Ancient Monuments and Historic Buildings Occasional Paper 6). London:DoE, 43-133

Belshaw, R D, 1988 'A note on the recovery of *Thoracochaeta zosterae* (Haliday) (Diptera : Sphaericidae) from archaeological deposits'. *Circaea*, **6**, 39-43

Bradley, R, Lobb, S, Richards, J and Robinson, M, 1980 'Two late Bronze Age settlements on the Kennet Gravels: excavations at Aldermaston Wharf and Knight's Farm, Burghfield, Berkshire'. *Proceedings of the Prehistoric Society*, **46**, 217-95

Briggs, D J, Coope, G R and Gilbertson, D D, 1985 *The Chronology and Environmental Framework of Early Man in the Upper Thames Valley* (Brit Archaeol Rep 137), Oxford:BAR

Bronk Ramsey, C, 1995 'Radiocarbon calibration and analysis of stratigraphy. The OxCal Program'. *Radiocarbon*, **37**, 425-30.

Brown, A P and Robinson, M A, 1984 'A summary of plant and insect remains from the post-medieval pits at Church Street (Site A)', *in* Hassall, T G, Halpin, C E,and Mellor, M, 'Excavations in St. Ebbe's, Oxford, 1967-1976 : Part II : Post-Medieval Domestic Tenements and the Post-Dissolution Site of the Greyfriars'. *Oxoniensia*, **49**, 268 + Fiche VI, F3

Brunning, R, Hogan, D, Jones, J, Jones, M, Maltby, E, Robinson, M and Straker, V, 2000

'Saving the Sweet Track: the *in situ* preservation of a Neolithic wooden trackway, Somerset, UK'. *Conservation and Management of Archaeological Sites*, **4**, 3-20

Buckland, P C, 1978, 'Cereal production, storage and population : a caveat', *in* Limbrey, S and Evans, J G (eds) *The effect of Man on the Landscape : the Lowland Zone* (Counc Brit Archaeol Res Rep 21). London: Counc Brit Archaeol, 43-45

Buckland, P C and Coope, G R, 1991 *A bibliography and literature review of Quaternary entomology*, introduction, Sheffield: J R Collis, 1-24

Buckland, P C, Holdsworth, P and Monk, M, 1976 'The interpretation of a group of Saxon pits in Southampton'. *Journal of Archaeological Science* **3**, 61-69

Carrott, J, Hall, A, Issitt, M, Kenward, H and Large, F, 1996 *Medieval plant and invertebrate remains principally preserved by anoxic waterlogging at The Brooks, Winchester, Hampshire (site code: BRI and BRII): technical report*, (University of York Environmental Archaeology Unit Technical Report 96/20) York:EAU

Caseldine, A, 1987 'Charcoal patches from Meare Village East 1982, in J M Coles, Meare Village East. The excavations of A. Bulleid and H. St. George Gray 1932-1956'. *Somerset Levels Papers*, **13**, 223-226

Coles, B, 1988 Fossil insect assemblages from the Somerset Levels : the work of Maureen Girling, *in* Murphy, P and French, C (eds) *The Exploitation of Wetlands* (Brit Archaeol Rep 186). Oxford:BAR, 5-20

Coope, G R, 1970 'Interpretations of Quaternary insect fossils'. *Annual Review of Entomology* **15**, 97-120

Coope, G R, 1977 'Fossil coleopteran assemblages as sensitive indicators of climatic changes during the Devensian (last) cold stage'. *Philosophical Transactions of the Royal Society of London*, **B280**, 313-40

Coope, G R, 1980 'Appendix 1. Coleoptera from Late Glacial and Early Flandrian deposits at Folkestone'. *Philosophical Transactions of the Royal Society of London* **B291**, 38-39

Coope, G R and Joachim, M J, 1980 'Late glacial environmental changes interpreted from fossil Coleoptera from St Bees, Cumbria, NW England', *in* Lowe,J J, Gray, and Robinson, J E (eds) *Studies in the Lateglacial of North-West Europe*. Oxford: Pergamon, 55-68

Coope, G R and Osborne, P J, 1967 'Report on the Coleopterous Fauna of the Roman Well at Barnsley Park, Gloucestershire'. *Transactions of the Bristol and Gloucestershire Archaeological Society* **86**, 84-87

Dickson, J H, 1986 'Mosses from the Roman well 832, *in* Miles,D (ed) *Archaeology at Barton Court Farm, Abingdon, Oxon* (Counc Brit Archaeol Res Rep 50), London: Counc Brit Archaeol, microfiche chapter VIII

Dimbleby, G W, 1977 *Ecology and archaeology*,London: Arnold

Fell, V, 1996 'Washing away the evidence', *in* Roy, A and Smith, P, *Archaeological conservation and its consequences*.London: International Institute for Conservation of Historic and Artistic Works, 48-51

Foster, A, 1984 'Modern water beetles from the Somerset Levels and Moors' *Balfour-Browne Club Newsletter* **30**, 11-24

Giorgi, J and Robinson, M, 1984 'The Environment', *in* M Foreman, and Rahtz, S, 'Excavations at Faccenda Chicken Farm, near Alchester', 1983'. *Oxoniensia*, **49**, 38-45

Girling, M A, 1976 'Fossil Coleoptera from the Somerset Levels: the Abbot's Way'. *Somerset Levels Papers*, **2**, 28-33

Girling, M A, 1977a 'Bird pellets from a Somerset Levels Neolithic trackway'. *Naturalist* (Hull) **102**, 49-52

Girling, M A, 1977b 'Fossil insect assemblages from Rowland's Track'. *Somerset Levels Papers*, **3**, 51-60

Girling, M A, 1978 'Fossil insect assemblages from Difford's I site'. *Somerset Levels Papers*, **4**, 107-113

Girling, M A, 1979a 'Calcium Carbonate-replaced Arthropods from Archaeological deposits'. *Journal of Archaeological Science*, **6**, 309-320

Girling, M A, 1979b 'The fossil insect assemblages from the Meare Lake Village'. *Somerset Levels Papers* **5**, 25-32

Girling, M A, 1979c 'Fossil insects from the Sweet Track'. *Somerset Levels Papers*, **5**, 84-93

Girling, M A, 1980 'The fossil insect assemblage from the Baker Site'. *Somerset Levels Papers*, **6**, 36-42

Girling, M A, 1981 'Beetle Remains', *in* Thorn, J C, 'The Burial of John Dygon, Abbot of St. Augustine's' *in* Detsicas, A, (ed) *Collectanea Historica : Essays in memory of Stuart Rigold*. Maidstone: Kent Archaeological Society, 82-4

Girling, M A, 1982a 'The effect of the Meare Heath flooding episodes on the Coleopteran succession'. *Somerset Levels Papers*, **8**, 46-50

Girling, M A, 1982b 'Indications from Coleoptera of the local environment at Tinney's brushwood complex'. *Somerset Levels Papers*, **8**, 64-66

Girling, M A, 1982c 'Fossil insect faunas from forest sites', *in* Limbrey, S and Bell, M (eds), *Archaeological Aspects of Woodland Ecology* (Brit Archaeol Rep 146), Oxford:BAR, 129-46

Girling, M A, 1984a 'Investigations of a second insect assemblage from the Sweet Track, *Somerset Levels Papers*'. **10**, 79-91

Girling, M A, 1984b 'Eighteenth century records of human lice (Pthiraptera, Anoplura) and fleas (Siphonaptera, Pulicidae) in the City of London'. *Entomologist's monthly Magazine* **120**, 207-210

Girling, M A, 1984c 'Aquatic Coleoptera in the Fossil Insect assemblages from Archaeological Sites in the Somerset Levels'. *Balfour-Browne Club Newsletter* **30**, 1-11

Girling, M A, 1984d The Insect Fauna, in *Catsgore 1979. Further Excavation of the Romano-British Village* (ed P Ellis), 39-40

Girling, M A, 1983-85 'Insect remains', *in* Johnston, J, 'Excavations at Pingewood', *Berkshire Archaeological Journal* **72**, 49

Girling, M A, 1985 'An `Old-Forest' Beetle Fauna from a Neolithic and Bronze Age Peat Deposit at Stileway'. *Somerset Levels Papers*, **11**, 80-83

Girling, M A, 1988 'The bark beetle *Scolytus scolytus* (Fabricius) and the possible role of elm disease in the early Neolithic', *in* Jones, M (ed) *Archaeology and the Flora of the British Isles*, University Committee for Archaeology Monograph 14). Oxford: University Committee for Archaeology. 34-38

Girling, M A, 1989a 'The Insect Fauna of the Roman Well at the Cattlemarket', *in* Down, A, *Chichester Excavations*, **6**. Chichester: Philimore, 234-41

Girling, M A, 1989b 'Mesolithic and later landscapes interpreted from the insect assemblages of West Heath Spa Hampstead', *in* Collins, D and Lorimer, D, (eds) *Excavations at the Mesolithic Site on West Heath, Hampstead 1976-1981* (British Archaeological Reports **217**), Oxford: BAR, 72-89

Girling, M A and Greig, J R A, 1985 'A First Fossil Record for *Scolytus scolytus* (F.) (Elm Bark Beetle): its Occurrence in Elm Decline Deposits from London and the Implications for Neolithic Elm Disease'. *Journal of Archaeological Science* **12**, 347-52

Girling, M A and Robinson, M, 1987 'The Insect Fauna', *in* Balaam, N D, Bell, M G, David, A E U, Levitan, B B, McPhail, R I, Robinson, M and Scaife, R G, 'Prehistoric and Romano-British Sites at Westward Ho!, Devon. Archaeological and Palaeoenvironmental Surveys', 1983 and 1984', *in* Balaam, N D, Levitan, B, and Straker, V (eds) *Studies in palaeoeconomy and environment in South West England*, (Brit Archaeol Rep 181), Oxford: BAR, 239-46,

Girling, M A and Straker, V, 1993 'Plant macrofossils, arthropods and charcoal', *in* Woodward, A and Leach, P, *The Uley shrines, excavation of a ritual complex on West Hill, Uley, Gloucestershire: 1977-9* (English Heritage Archaeological Report, 17). London: English Heritage, 250-3

Green, F J, 1979 'Phosphate mineralisation of seeds from archaeological sites'. *Journal of Archaeological Science*, **6**, 279-84

Greig, J R A, 1982a 'Past and present lime woods of Europe', *in* Bell, M, and Limbrey, S(eds), *Archaeological aspects of woodland ecology* (Brit Archaeol Rep International Series, 146). Oxford: BAR, 23-55

Greig, J R A, 1982b 'Garderobes, sewers, cesspits and latrines'. *Current Archaeology*, **85**, 49-52

Greig, J R A, 1989 'From lime forest to heathland - five thousand years of change at West Heath Spa, Hampstead, as shown by the plant remains', *in* Collins, D, and Lorimer, D, (eds) *Excavations at the Mesolithic site on West Heath, Hampstead 1976-1981* (Brit Archaeol Rep 217). Oxford:BAR, 89-99

Greig, J R A and Osborne, P J, 1984 'Plant and insect remains from Taunton Priory' *in* Leach, P (ed) *The archaeology of Taunton, excavations and fieldwork to 1980* (Western Archaeological Trust Excavation Monograph, **8**), Gloucester: Allan Sutton, 160-7

Hakbijl, T, 1986 'Remains of Insects', *in 1985* Gawronski, J H G (ed) *Amsterdam Project. Annual Report of the VOC Ship "Amsterdam" Foundation*, Amsterdam: VOC Ship "Amsterdam" Foundation , 72-3

Hakbijl, T, 1987 'Insect remains: unadulterated Cantharidum and tobacco from the West Indies', *in* Gawronski, J H G (ed) *Amsterdam Project. Annual Report of the VOC Ship "Amsterdam" Foundation 1986*. Amsterdam: VOC Ship "Amsterdam" Foundation, 93-4

Hammond, P M, 1974 'Changes in the British Coleopterous Fauna' *in* Hawksworth, D L (ed) *The Changing Flora and Fauna of Britain* (Systematics Association Special Volume, 6), London:Academic Press, 323- 69

Hyman, P S, 1992 *A review of the scarce and threatened Coleoptera of Great Britain*, **1**, Peterborough: UK Joint Nature Conservation Committee

Jessop, L, 1986 *Dung beetles and chafers, Coleoptera: Scarabaeoidea* (Royal Entomological Society Handbook for the Identification of British Insects 5, pt 11). London:Royal Entomological Society

Kenward, H.K. 1974 'Methods for palaeo-entomology on site and in the laboratory'. *Science and Archaeology* **13**, 16-24.

Kenward, H K, 1975 'The Biological and Archaeological Implications of the Beetle *Aglenus brunneus* (Gyllenhall) in Ancient Faunas' *Journal of Archaeological Science* **2**, 63-9

Kenward, H K, 1978 *The Analysis of Archaeological Insect Assemblages: a New Approach*, (Archaeology of York, 19/1), London: Counc Brit Archaeol, for York Archaeological Trust
Kenward, H K, 1982 'Insect communities and death assemblages, past and present', *in* A R Hall, A R, and Kenward, H R (eds),*Environmental archaeology in the urban context* (Counc Brit Archaeol Res Rep 43). London: Counc Brit Archaeol, 71-8
Kenward, H K and Allison, E, 1987 *Waterlogged Insect Remains from Southampton* (Ancient Monuments Laboratory Report 124/87). London: English Heritage
Kenward, H K and Allison, E P, 1994 'Rural origins of the urban insect fauna' *in* Hall, A R, and Kenward, H R (eds) *Urban-rural connexions: perspectives from environmental archaeology* (Oxbow Monograph 47). Oxford: Oxbow 55-77
Kenward, H K and Girling, M, 1986 *Arthropod Remains from Archaeological Sites in Southampton* (Ancient Monuments Laboratory Report 46/86), London: English Heritage
Kenward, H and Hall, A, 1997 'Enhancing bioarchaeological interpretation using indicator groups: stable manure as a paradigm'. *Journal of Archaeological Science* **24**, 663-73
Kenward, H K, Hall, A R and Jones, A K G, 1980 'A tested set of techniques for the extraction of plant and animal macrofossils from waterlogged archaeological deposits'. *Science and Archaeology* **22**, 3-15
Kenward, H K and Williams, D, 1979 *Biological evidence from the Roman warehouses in Coney Street* (Archaeology of York 14/2), London: Counc British Archaeol
Kloet, G S and Hincks, W D, 1964 *A check list of British insects, 2nd edition (revised): small orders and Hemiptera* (Royal Entomological Society of London Handbook for the Identification of British Insects 11, pt 1). London: Royal Entomological Society
Kloet, G S and Hincks, W D, 1976 *A check list of British insects, 2nd edition (revised): Diptera and Siphonaptera* (Royal Entomological Society of London; Handbook for the Identification of British Insects 11, pt 5). London: Royal Entomological Society
Kloet, G S and Hincks, W D, 1977 *A check list of British insects, 2nd edition (revised): Coleoptera and Strepsiptera* (Royal Entomological Society of London; Handbook for the Identification of British Insects 11, pt 3). London: Royal Entomological Society
Kloet, G S and Hincks, W D, 1978 *A check list of British insects, 2nd edition (revised): Hymenoptera* (Royal Entomological Society of London; Handbook for the Identification of British Insects 11, pt 4). London: Royal Entomological Society
Koch, K, 1992 *Die Käfer Mitteleuropas Ökologie*, **3**, Krefiled: Goecke and Evers
Lamb, H H, 1981 'Climate from 1000 BC to 1000 AD' *in* Jones, M and G W Dimbleby, G W (eds) *The environment of man: the Iron Age to the Anglo-Saxon period* (British Archaeological Reports British Series 87), Oxford:BAR, 53-65
Lambrick, G H and Robinson, M A, 1979 *Iron Age and Roman riverside settlements at Farmoor, Oxfordshire* (Counc Brit Archaeol Res Rep 32). London: Counc Brit Archaeol
Lambrick, G H and Robinson, M A, 1988 'The development of floodplain grassland in the Upper Thames Valley', *in* Jones, M K (ed) *Archaeology and the flora of the British Isles*), 35-75
Limbrey, S J, 1982 'The honeybee and woodland resources', *in* Bell, M and Limbrey, S J (eds) *Archaeological Aspects of Woodland Ecology* (Brit Archaeol Rep S146), Oxford:BAR, 279-286
Lowe, J J and Walker, M J C, 1984 *Reconstructing Quaternary Environments*. New York: Longman

Lucht, W, 1987 *Die Käfer Mitteleuropas, Katalog*. Krefeld: Goecke and Evers

Malone, C, 1990 *Prehistoric monuments at Avebury*. London:English Heritage

Mannion, A M, 1993 *The mid-Holocene Elm Decline: a palaeoecological puzzle* (University of Reading Department of Geography Discussion Paper 14). Reading: Reading Univeristy

Moore, P D, 1984 'Hampstead Heath clue to historical decline of elms'. *Nature*, **312**, 103

de Moulins, D, 1990 'Environmental analysis', *in* Maloney, C, *The upper Walbrook valley in the Roman period* (Counc Brit Archaeol Res Rep 69) York: Counc Brit Archaeol, 85-115

Naurmann, I D, Carne, P B, Lawrence, J F, Nielsen, E S, Spradbery, J P, Taylor, R W, Whitten, M J and Littlejohn, M J (eds), 1991 *The insects of Australia*, **1** and **2**. 2nd edn Melbourne: (CSIRO Division of Entomology) University Press

Osborne, P J, 1965 'The effect of forest clearance on the distribution of the British Insect fauna', *Proceedings XII International Congress of Entomology 1964*. London: Royal Entomological Society, 456-7

Osborne, P J, 1969 'An insect fauna of Late Bronze Age date from Wilsford, Wiltshire'. *Journal of Animal Ecology* **38**, 555-66

Osborne, P J, 1971 'The Insect Fauna from the Roman Harbour', *in* Cunliffe, B W *Excavations at Fishbourne, 1961-1969* (Research Reports of the Society of Antiquaries of London, 27). Oxford: Society of Antiquaries, 393-96

Osborne, P J, 1976 'Evidence from the insects of climatic variations during the Flandrian period a preliminary note'. *World Archaeology* **8**, 150-58

Osborne, P J, 1982a 'Some British later prehistoric insect faunas and their climatic implications', *in* Harding, A (ed)). *Climatic Change in Later Prehistory* Edinburgh: Edinburgh University Press, 68-74

Osborne, P J, 1982b 'Report on the Insect Remains from Cirencester', *in* Wacher, J and McWhirr, A (eds) *Early Roman Occupation at Cirencester* (Cirencester Excavations 1), Cirencester: Cirencester Excavation Committee, 232

Osborne, P J, 1989 'Insects', *in* Ashbee, P, Bell, and Proudfoot, E, *Wilsford Shaft. Excavations 1960-62*. London: English Heritage, 96-9 + fiche C1-7

Peake, D S and Osborne, P J, 1971 'The Wandle Gravels in the vicinity of Croydon'. *Proceedings and Transactions of the Croydon Natural History and Scientific Society* **14**, 145-75

Pegler, S M and Birks, H J B, 1993 'The mid-Holocene *Ulmus* fall at Diss Mere, south-east England - disease and human impact?'. *Vegetation History and Archaeobotany* **2**, 61-8

Phipps, J, 1987 'The archaeological remains of flies'. *Circaea*, **5**, 65-6

Robinson, M A, 1975 'The environment of the Roman defences at Alchester and its implications'. *Oxoniensia* **40**, 161-70

Robinson, M A, 1979 'Calcified seeds and arthropods', *in* Parrington, M 'Excavations at Stert Street, Abingdon, Oxon' *Oxoniensia* **44**, 23-4

Robinson, M A, 1980a 'Roman waterlogged plant and invertebrate evidence', *in* Hinchliffe, J and Thomas, R, 'Archaeological Investigations at Appleford'. *Oxoniensia* **45**, 90-106

Robinson, M A, 1980b 'Archaeological Finds of Wasp Galls'. *Journal of Archaeological Science* **7**, 93-5

Robinson, M A, 1980c 'Waterlogged plant and invertebrate evidence', *in* Palmer, N 'A Beaker burial and medieval tenements in the Hamel, Oxford'. *Oxoniensia* **45**, 199-206 + fiche

Robinson, M A, 1981a 'The Iron Age to Early Saxon Environment of the Upper Thames Terraces', *in* Jones, M and Dimbleby, G (eds) *The Environment of Man: the Iron Age to the Anglo-Saxon period* (Brit Archaeol Rep 87). Oxford:BAR, 251-86

Robinson, M A, 1981b *Investigations of Palaeoenvironment in the Upper Thames Valley*, PhD thesis, Univ London

Robinson, M A, 1982 'Waterlogged plants from archaeological sites in the Oxford region 2'. *Council for British Archaeology Group 9 Newsletter* **12**, 178-81

Robinson, M A, 1983a 'Arable/Pastoral Ratios from Insects', *in* Jones, M (ed) *Integrating the Subsistence Economy* (Brit Archaeol Rep S181). Oxford: BAR, 19-55

Robinson, M A, 1983b 'Plant and Invertebrate Remains', *in* Halpin, C 'Late Saxon Evidence and Excavation of Hinxey Hall, Queen Street'. Oxford, *Oxoniensia* **48**, 69 + fiche

Robinson, M A, 1984a 'An apicultural postscript: the honey bee in the Iron Age', *in* Cunliffe, B W and Miles, D (eds) *Aspects of the Iron Age in Central Southern England* (Oxford University Committee for Archaeology Monograph 2). Oxford: Oxford University Committee for Archaeology,1-11

Robinson, M A, 1984b 'A sieved sample from the latrine shaft', in S P Q Rahtz, S P Q and T Rowley, T R *Middleton Stoney: Excavation and survey in a North Oxfordshire Parish*. Oxford: Oxford University Department for external studies, 151-2

Robinson, M, 1984c '33 St. Aldates: Agricultural Debris against the Norman Bridge', *in* Durham, B 'The Thames Crossing at Oxford: Archaeological Studies 1979-82'. *Oxoniensia* **49**, 78-9

Robinson, M, 1985 'Plant and invertebrate remains from the Priory drains', *in* Lambrick, G 'Further Excavations on the Second Site of the Dominican Priory'. Oxford, *Oxoniensia*, **50**, 196-201 + fiche E10-F1

Robinson, M, 1986 'Waterlogged plant and invertebrate evidence', *in* Mile, D (ed) *Archaeology at Barton Court Farm, Abingdon, Oxon* (Counc Brit Archaeol Res Rep 50). London: Counc Brit Archaeol, microfiche chapters VIII, IX and XI

Robinson, M A, 1990 'The waterlogged seeds, insects, molluscs and other biological evidence', *in* Allen, T G, *An Iron Age and Romano-British enclosed settlement at Watkins Farm Northmoor, Oxon*. 64-72 (Thames Valley Landscapes: the Windrush Valley vol 1). Oxford: Oxford Archaeological Unit, 98-117

Robinson, M A, 1991a 'The Neolithic and Late Bronze Age insect assemblages', *in* Needham, S *Excavation and salvage at Runnymede Bridge, 1978: the Late Bronze Age waterfront site*. London: British Museum, 277-326

Robinson, M A, 1991b 'Calcium phosphate-replaced arthropod remains from the Abbots Worthy settlement', *in* Fasham, P J and Whinney, R J B *Archaeology and the M3*, (Trust for Wessex Archaeology and Hampshire Field Club Monograph 7) Salisbury: Hampshire Field Club, 75

Robinson, M A, 1992a 'Insect remains from two late Bronze Age waterlogged features', *in* Moore, J and Jennings, D, *Reading Business Park: a Bronze Age landscape* (Oxford Archaeological Unit Thames Valley Landscapes: the Kennet Valley 1), Oxford: Oxford Archaeology, 112-16

Robinson, M A, 1992b 'Environment, archaeology and alluvium on the river gravels of the South Midlands', *in* Needham, S and M G Macklin, M G (eds) *Alluvial archaeology in Britain* (Oxbow Monograph 27). Oxford: Oxbow, 197-208

Robinson, M, 1992c 'Insects', *in* Butterworth, C A and Lobb, S J (eds), *Excavations on the*

Burghfield Area, Berkshire; developments in the Bronze Age and Saxon landscapes (Wessex Archaeological Report 1). Salisbury: Wessex Archaeology, 159

Robinson, M A, 1995a 'Plant and invertebrate remains', *in* Mudd, A 'The excavation of a late Bronze Age / early Iron Age site at Eight Acre Field, Radley'. *Oxoniensia* **60**. 41-50

Robinson, M A, 1995b 'Plant and invertebrate remains', in Hey, G 'Iron Age and Roman settlement at Old Shifford Farm, Standlake'. *Oxoniensia***60**, 158-67

Robinson, M A, 1997 'The insects from Silbury Hill', *in* Whittle, A *Sacred mound, holy rings, Silbury Hill and the West Kennet palisade enclosures: a late Neolithic complex in North Wiltshire* (Oxbow Monograph 74). Oxford: Oxbow, 36-47

Robinson, M A, 1998 'The insect remains', *in* Brown, S 'Recent building recording and excavation at Leigh Barton, Churstow, Devon'. *Devon Archaeological Society Proceedings* **56**, 87-9

Robinson, M A, 2000 'Middle Mesolithic to Late Bronze Age insect assemblages and an Early Neolithic assemblage of waterlogged macroscopic plant remains', *in* Needham, S *The passage of the Thames, Holocene environment and settlement at Runnymede*. London: British Museum, 146-67

Robinson, M A, (unpublished, a) *Middle Mesolithic to late Bronze Age insect assemblages from Runnymede Bridge, Berks*

Robinson, M A, (unpublished, b) *Macroscopic plant and invertebrate remains from an Early Bronze Age water hole and other features at Staines Road Farm, Shepperton, Surrey*

Robinson, M A, (unpublished, c) *The environmental evidence from Yarnton, Oxon*

Robinson, M A, (unpublished, d) *Waterlogged macroscopic plant remains and insects from intertidal sites at Wotton-Quarr, Isle of Wight*

Robinson, M A, (unpublished, e) *Invertebrate and macroscopic plant remains from Gravelly Guy and Blackditch, Oxon*

Robinson, M A, (unpublished, f) *Holocene archaeological evidence of extinct British Scarabaeoidea*

Robinson, M A, (unpublished, g) *Macroscopic plant and invertebrate remains from the late Bronze Age site at Patching Junction, West Sussex*

Robinson, M A, (unpublished, h) *Late Bronze Age to Saxon waterlogged plant and invertebrate remains from Mount Farm, Oxon*

Robinson, M A, (unpublished, i) *Macroscopic plant and invertebrate remains from the late Bronze Age waterfront site at Wallingford Bypass Bridge (Whitecross Farm, Cholsey), Oxon*

Robinson, M A, (unpublished, j) *Waterlogged plant and invertebrate remains from Iron Age enclosures on Port Meadow, Oxon*

Robinson, M A, (unpublished, k) *The invertebrate and waterlogged plant remains from Claydon Pike, Glos*

Robinson, M A, (unpublished, l) *Plant and invertebrate remains from the late Iron Age settlement at Thornhill Farm, Glos*

Robinson, M A, (unpublished, m) *Plant and insect remains from the Iron Age ditch at the Vineyard, Abingdon, Oxon*

Robinson, M A, (unpublished, n) *Assessment of waterlogged macroscopic plant and insect remains from Hunts Hills Farm, Upminster*

Robinson, M A, (unpublished, o) *Assessment of macroscopic plant and invertebrate remains from Monkton-Mount Pleasant, Kent*

Robinson, M A, (unpublished, p) *Environmental evidence from the Chalgrove moat system, Oxon*

Robinson, M A, (unpublished, q) *Evaluation of macroscopic plant and invertebrate remains from the Reading Oracle site in relation to their sedimentary stratigraphy*

Robinson, M A, (unpublished, r) *Macroscopic plant and invertebrate remains from 113-119 High Street, Oxford*

Robinson, M A, (unpublished, s) *Waterlogged insect and further plant remains from the medieval well at Cross Street, Reading*

Robinson, M A, (unpublished, t) *The environmental archaeology of the St. Aldgates area of Oxford in relation to the Thames crossing*

Robinson, M A, (unpublished, u) *Thirteenth century plant and invertebrate remains from the Bishop's Palace, Witney, Oxon*

Robinson, M A, (unpublished, v) *Macroscopic plant and invertebrate remains from a Roman well at Bowling Green Farm, Faringdon, Oxon*

Robinson, M A, (unpublished, w) *Palaeoenvironmental studies on the site of the Drayton Cursus, Oxon*

Robinson, M A, (unpublished, x) *Macroscopic plant and invertebrate remains from Thorpe Lea Nurseries, Surrey*

Robinson, M A, (unpublished, y) *The Provost of Oriel College's cesspit*

Robinson, M A, (unpublished, z) *Insect remains from the cob walling of a farmhouse at Leigh Barton, Devon*

Robinson, M A, (unpublished, aa) *Insect remains from a drain within a building at Pooles Wharf, Bristol*

Robinson, M A, (unpublished, bb) *The survival of Coleoptera associated with the Abbot's Way, Somerset*

Robinson, M A, (unpublished, cc) *The survival of Coleoptera associated with the Sweet Track, Somerset*

Robinson, M A, (unpublished, dd) *A preliminary account of the sedimentary stratigraphy and aspects of the environmental archaeology of the late Bronze Age site at Shinewater Marsh*

Robinson, M A, (unpublished, ee) *A note on insects from Biggen Street, Dover*

Robinson, M and Wilson, R, 1987 'A Survey of Environmental Archaeology in the South Midlands', *in* Keeley, H C M (ed) *Environmental Archaeology: a Regional Review* Vol 2 (Historic Buildings and Monuments Commission for England Occasional Paper, 1). London: HBMCE, 16-100

Scaife, R G, 1987 'Pollen analysis', *in* Balaam, N D, Bell, M G, David, A E U, Levitan, B, McPhail, R I, Robinson, M and Scaife, R G 'Prehistoric and Romano-British Sites at Westward Ho!, Devon. Archaeological and Palaeoenvironmental Surveys 1983 and 1984', *in* Balaam, N D, Levitan, B and Straker, V (eds) *Studies in palaeoeconomy and environment in South-West England* (British Archaeological Reports 181). Oxford:BAR, 223-32

Skidmore, P, 1988 'The fly puparia', *in* Burrow, I (ed) 'Excavations at 5-8 Fore Street, Taunton, 1979'. *Proceedings of the Somerset Archaeological and Natural History Society* 132, 146

Straker, V, Robinson, M and Robinson, E, 1984 'Biological Investigations of Waterlogged Deposits in the Roman Fortress Ditch at Exeter'. *Devon Archaeological Society*

Proceedings, 59-69

Turner, J, (unpublished) *Pollen results from Claydon Pike*

Varley, G C, 1976 'Insect remains', *in* Hassall, T G 'Excavations at Oxford Castle 1965-1973'. *Oxoniensia* **41**, 308

Walker, I R, 1987 'Chironomidae (Diptera) in palaeoecology'. *Quaternary Science Reviews* **6**, 29-40

Wilkinson, B J, 1987 'Caddis Fly (Trichoptera) Remains', *in* Balaam, N D, Bell, M G, David, A E U, Levitan, B B, McPhail, R I, Robinson, M and Scaife, R G, 'Prehistoric and Romano-British Sites at Westward Ho!, Devon. Archaeological and Palaeoenvironmental Surveys, 1983 and 1984', *in* Balaam, N D, Levitan, B, and Straker, V (eds) *Studies in palaeoeconomy and environment in South West England*, (Brit Archaeol Rep 181). Oxford: BAR, 247-8