Discerning beetles, an entomo-archaeological study of coleopteran faunas in relation to place and time

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ABSTRACT

This work initially examines the origins and methods of entomo-archaeological studies and reviews the current state of this discipline.

Original work is presented on coleopteran faunas, mainly from medieval pits, recovered and analysed from sites in Winchester, Southampton and Chichester. The faunas resemble those recovered from deposits of similar provenance from other sites. They also contain the earliest records of some species in Britain and the earliest medieval occurrences of others which, were common in Roman Britain, but missing from the Saxon urban record.

A modern analogue of a medieval cesspit was set up in order to investigate the coleopteran faunas, which develop in that environment. Further experimental work was carried out using a choice chamber, to determine the preferred pabulum of certain species of *Aphodius* dung beetles.

The findings are placed in a wider context as a representative sample of all work, carried out on Roman and post-Roman coleopteran thanatocoenoses, were included in the following investigations. Methods of standardising data from different sources are discussed.

The distribution of synanthropic species through time was studied, with special emphasis on *Tipnus unicolor* and *Cryptolestes ferrugineus*. Investigations into the characteristics of pit faunas and into the relationship between the assemblage and the physical properties of the feature, in which it formed, were undertaken. Correspondence analysis, from the CANOCO computer program, was used as an aid to interpretation, in both exercises. Definite faunal types were discovered in pit assemblages, which could be related to the known archaeological details and certain properties of the feature were shown to influence the development of the fauna. These exercises proved that comparing work by different authors can be productive and that CANOCO is a powerful tool in analysis.

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CHAPTER 1: Introduction, Aims and Objectives

1.1 INTRODUCTION

This thesis is a study in entomo-archaeology. Insect remains recovered from archaeological deposits have been used increasingly over the last thirty years as a source of information for archaeological interpretations. This sub-discipline arose out of the study of Quaternary entomology. Serious investigations in this area began about forty years ago, pioneered, in this country, by Russell Coope. He encountered fossil beetles in the sediments surrounding Pleistocene bones, and identified many of them by comparison with modern specimens (Coope *et al.* 1961). Coope (1965) admitted that he was "blissfully unaware" that the received wisdom was that all insect species of that era were now extinct. This discovery reawakened interest.

The early work had been laborious because it was necessary to examine the whole sample microscopically and extract insect fragments individually from the carefully teased out substrate (e.g. Coope 1959). A major advance took place when Coope and Osborne (1968) published a method of isolating and concentrating the insect remains by means of paraffin flotation. This technique has become standard practice and has enabled the study to burgeon and diversify into archaeological deposits.

The reasons why the Coleoptera are important in Quaternary studies and the way in which beetle assemblages form and are recorded are described in Chapter 2. Methods used in the interpretation of the assemblages are reviewed in Chapter 3 and studies which have increased understanding of the significance of what has been found, by reference to beetle ecology, are described in Chapter 4. The information gained from this study about the ancient environment has been summarised in Chapter 5.

1.2 TYPES OF EVIDENCE OBTAINED

Initially it was thought that fossil beetles had evolved rapidly and could be used to zone the Pleistocene, but it became clear that no discernible evolution had occurred during that period. Elias (1994, Table 1.1) lists some of the new species names given by the original researchers together with their true names identified later by reference to extant species. However, it was recognised that the changing distribution of species could provide even more information, as the ecological requirements of these extant beetles were known (Coope 1977).

1.2.1 CHANGES IN CLIMATE

Insects are temperature-dependant, as they are reliant on a particular range for breeding and dispersal. Their response to temperature changes is to migrate, making them good indicators of climate. The speed of climatic change had not been appreciated by previous workers in pollen analysis (Coope 1987), as vascular plants respond much more slowly to temperature variation. The conditions at a particular sampling point can be determined from a fossil beetle assemblage, by superimposing the known climatic ranges of each of the collected species. The most significant indicators have been found to be the maximum summer temperature and the temperature range between the coldest and warmest months. Using these parameters, the area of range overlap between species, the Mutual Climatic Range (MCR) is obtained. This method was developed by two palaeo-climatologists in collaboration with Coope and his research students (Atkinson *et al.* 1986; 1987) and has been widely applied, e.g. (Coope 1987; 1995; Walker *et al.* 1994).

By far the most important recent factor, affecting beetle distribution, has been the impact of *Homo sapiens* on the environment. The activities of this species in cutting down forests, draining land, and thus creating "culture steppe" conditions (c.f. Hammond 1974) have destroyed old natural habitats so that even when they remain they may be too small and isolated to support diverse communities of insects. Dinnin (1997) found that the effect of humans on the environment was already reflected in the beetle faunas by the early to mid-Holocene (c. 8300-2700 BP). Buckland (1976b) stated that the known fluctuations in climate over the last 3000 years could not be backed up by corresponding changes in the beetle faunas. The picture is further complicated because human habitations have created warm microclimates (see Section 5.2.2) and colonising species have been inadvertently transported about by human activity.

1.2.2 INSTRUMENTS FOR ARCHAEOLOGICAL INTERPRETATION

Beetles provide information about the physical environment, which can complement and extend other environmental studies. For example, the widespread presence in early Holocene deposits of the lime of the bark beetle (*Ernoporus caucasicus*) showed that *Tilia* (lime) was commoner in the forests than had been previously appreciated from palynological studies (Dinnin and Sadler 1999). This was because *Tilia* is poorly represented in the pollen record, as, unlike most trees, it is insect pollinated, and thus produces less pollen.

While the assemblages of beetles found in natural environments are normally good indicators of the surrounding environment, this is not the case when human activity becomes an important factor in its formation. A significant difference between natural and artificial environments is scale (see Chapter 3). Kenward (1978a, 1) asserts that "a much finer resolution" is required in the interpretation of archaeological as opposed to palaeo-entomological studies. This is because much more detailed interpretation is required of the data, which are used as tools to decipher the activities of our ancestors.

> "Along with other types of biological proxy data (e.g. plant macrofossils, vertebrate remains, pollen), fossil insects are now making an important contribution to the reconstruction of both the natural and the anthropogenic environments associated with archaeological sites, supplying evidence about human life-styles and living conditions." (Elias 1994, 107).

More information can be gleaned if the evidence from all sources is considered together, unfortunately this does not always happen (see Section 4.3).

Much of the work on archaeological insect assemblages has been carried out in the north of England and on early medieval urban faunas. In particular, York has been extensively studied. One of the aims of this study was to redress this balance, by investigating material from sites in the south of England. Winchester, flourishing contemporaneously with York, provided some Roman and medieval samples for examination, and other material, of medieval date, was available from Southampton, Chichester and a rural site at Fishbourne near Chichester. This work is described in Chapters 6-10.

1.2.3 UNDERSTANDING THE DEVELOPMENT OF THE BRITISH FAUNA

Studies of ancient beetles help in the understanding of the modern fauna. Changes in the British coleopteran population can be traced, as beetles are identified from dateable deposits. Many species, thought to have been new arrivals, have been proved not to be (e.g. *Aglenus brunneus* (see Section 12.3.1.2). The dynamics of insect communities can also be investigated. For example, it has been found from the archaeological record, that some species common in a particular community at one time are absent at others (see Chapter 12).

The earliest recorded findings of species, collected from the work of various authors, have been collated by Buckland in the database BUGS, devised by Philip Buckland and Yuan Zhuo Don (Buckland *et al.* 1997). The dates of introduction are being set back earlier and earlier as data accrue. The dates of extinctions are more difficult to document as they rely on negative evidence, but even today, species are being discovered that were considered to be extinct. The large and distinctive woodland beetle, *Lacon quercus,* for which no British records existed for the last hundred years, was found living in Windsor Forest, a relic of ancient woodland (Allen 1936), although it has not been seen since 1987 (Jones 1993).

1.3 AIMS AND OBJECTIVES OF THIS STUDY

The body of work amassed by entomo-archaeologists might yield more information if it is treated as a whole and not just used to interpret individual features or sites. This process is called meta-analysis and enables multiple studies by different researchers to be collated "to generate higher order conclusions about general trends and patterns" (Arnquist and Wooster 1995, 236). This approach was used in the furtherance of the main aims of this thesis. These were: -

1. To seek explanations for the hiatus in the records of some synanthropic beetles through time.
2. To investigate the nature of pit faunas
3. To determine the role of the feature type in the formation of the assemblage

Two beetles, in particular, are inexplicably absent from the archaeological records of certain periods. These are *Tipnus unicolor* from the urban early medieval period and *Cryptolestes ferrugineus* from the later. It was hoped that the patterns of distribution obtained from a database, listing the occurrences of these beetles, together with a study of archaeological, historical and ecological information might provide results (see Chapter 12).

The varied faunas associated with the more constant habitat provided by a cesspit is another enigma. In pursuance of this aim an experimental cesspit was set up in order to discover the types of beetles attracted to the pit (Chapter 11). Choice chamber experiments were also carried out to determine the microhabitat preferences of the

Aphodius dung beetle (see Chapter 11). Initially, the database, designed by the author and used above, was employed to investigate the distribution of decomposer species, common in pits, but it provided little information (see Chapter 12).

The possible effect of the feature, in which the assemblage collected, has been largely ignored to date, yet many samples have been taken from pits or wells, both of which have been recognised to have some influence on the resultant assemblages. The precise affects have not been studied.

A new and powerful technique of multivariate analysis, using correspondence analysis from the computer program CANOCO (Ter Braak 1988), was used in the furtherance of the above aims. Using a combined species list from the faunal lists produced by different workers, the relationships between the assemblages could be demonstrated. This method also identified the significant species causing the clustering of the samples. To create that list, from such a disparate selection of data, required the adoption of special procedures. More strategies had to be devised to reduce its size, so that the disparity between number of samples and number of taxa was lessened. The groupings determined by this technique were checked against other types of data. The investigations into faunas from pits and different feature types are reported in Chapters 13 and 14.

CHAPTER 2: The significance of fossil beetles and the process of recovery

2.1 INTRODUCTION

This chapter explains why Coleoptera are useful aids to interpretation, outlines the stages in the formation of the archaeological beetle assemblage and considers the collection and registration of data. The only published system for recording the degree of preservation of specimens is discussed.

2.2 THE USE OF BEETLES AS A RESEARCH TOOL

2.2.1 PRESERVATION OF REMAINS

The vast majority of insect remains preserved in sediments are coleopterous. This is for a number of reasons. Firstly, the body plan of the beetle, with its tough exoskeleton, wings, jointed limbs and a supply of air, ducted directly to all parts of the body, has made it one of the most successful animal groups on the earth. It incorporates one fifth of all known species (Tudge 2000) and has been able to colonise a wide variety of niches. The British Isles has nearly 4000 species.

Beetles have well developed sensory systems, especially olfactory, which together with good mobility, provided by the jointed limbs and wings, enable them to rapidly colonise newly available habitats. Thus, they are good environmental indicators. Secondly, preservation is due to the robustness of the beetle exoskeleton. This chitinous material is heavily sclerotised and survives well in anoxic or very dry situations. Most archaeological material has been preserved in the anaerobic conditions induced by waterlogging. More rarely preservation occurs by dehydration, in particular, in arid regions, the remains of stored product beetles may survive in tombs (Levinson and Levinson 1985; Panagiotakopulu 2000). For these reasons beetles are predominant in ancient deposits.

Moreover, remains may often be identified to species because of the distinctiveness of the sclerites, not only can shape and size be used but characteristics of the surface microsculpture are retained and are most useful diagnostically (Coope 1977).

Unfortunately, a bias exists in the records, because the main source of preserved material, in temperate regions, is in waterlogged deposits. Thus the best-documented natural habitats from the Quaternary are peat bogs, followed by lake, pond and coastal environments (Elias 1994, 18). When the study extended into archaeological deposits, there was a change in the type of feature examined from natural to artificial. Features cut below the water table, such as wells, drainage ditches and pits became the most promising sources of insect remains. The greater likelihood of preservation in low-lying areas remained, causing a potential bias in the results.

2.2.2 EVOLUTIONARY STABILITY OF COLEOPTERA

An important outcome of the early work was the realisation that beetles have not evolved significantly over the last two million years. Some species have remained stable for much longer; for example, the fossil beetle described by Wickham (1919 cited in Elias 1994) as *Donacia primaeva* is indistinguishable from the modern aquatic leaf eater *Plateumaris nitida* (Askevold 1990), although 30 million years separate the two. The evidence for beetles' evolutionary constancy is set out in Coope (1970) and Matthews (1976a; 1976b). This was an unexpected finding, as it had been assumed that the selection pressures imposed by the unstable climate during the Pleistocene, would have led to alterations in the gene pool (Coope 1978). These changes should have spread rapidly because of the high reproductive rate of insects and resulted in speciation. Instead, climate variations caused the insects to change their geographical range rather than adapt to the new conditions. This meant that migrating insects were constantly mixing the gene pool and conditions for the formation of new species, i.e. genetic isolation, did not occur. So that, for example, *Aphodius holdereri*, today restricted to the high Tibetan Plateau, was a common dung beetle in Britain during the Middle Devensian interstadial of the last glaciation (Coope 1973).

This has important implications for the study of palaeo- and archaeo-entomology because, as most of the recovered specimens are extant, it is possible for information to be gained about their ecological requirements. The usefulness of this knowledge depends on uniformitarian principles, that is an assumption that the forces, which acted in the past, are the same as those in operation now, and thus information about the past can be gleaned from comparison with the present. It also assumes that accurate identifications can be made from the remains and that detailed ecological information is available. There are problems in both these areas, which will be addressed later.

2.3 COLLECTION OF DATA

Although useful faunal lists can be obtained from archaeological material, information loss occurs at all stages from the formation of the death assemblage to its analysis. All the changes affecting the assemblage between the living community (biocoenosis) and the recovered death assemblage (thanatocoenosis) are termed taphonomic (from the Greek *Taphos* meaning a grave) (see Fig. 2.1). In this text, the word "assemblage" is used to mean death assemblage, and the term "fauna" has the same meaning.

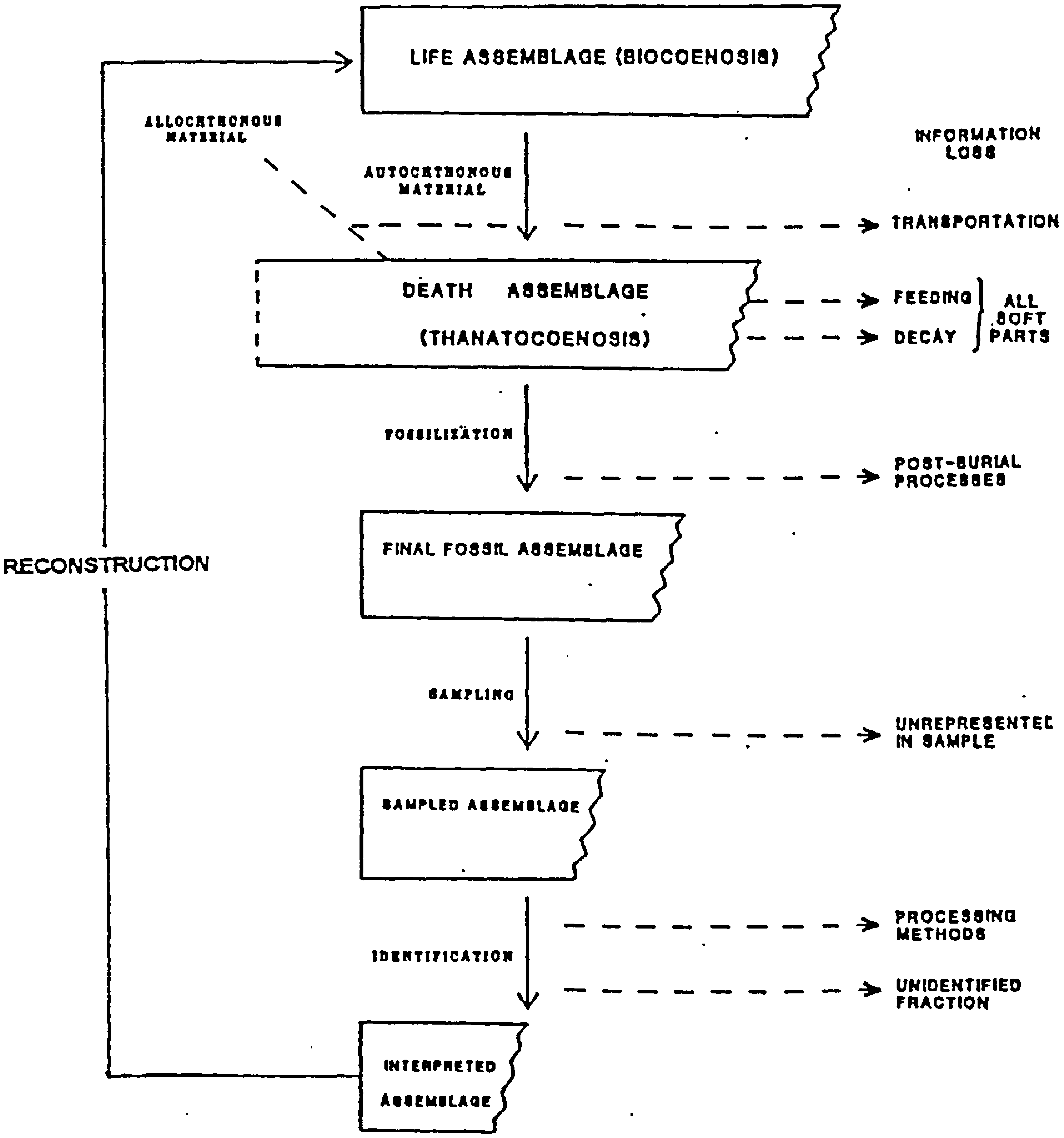
2.3.1 FORMATION OF THE THANATOCOENOSIS

The formation of a death assemblage is a chance process and only the remains of organisms, which remain in the preserving medium may survive. Beetles, which breed in the medium and then disperse from it, will be lost, although congenitally malformed or teneral examples may remain, providing proof of breeding. Teneral specimens are newly emerged imagoes. These are recognisable because the exoskeleton is soft and unpigmented and they indicate breeding because, in that state, the insect is unable to move. An event such as sudden flooding or burial may trap insects, which might otherwise have moved elsewhere. Some of the fauna will have been attracted to the medium; others will be chance arrivals, part of the background rain of insects.

Insects may enter the death assemblage by various routes, some of which are shown diagrammatically (Kenward 1985a, Fig. 1; Buckland *et al.* 1993, Fig. 33.6). If insect–bearing material, such as peat was present, specimens from a much earlier period may have been introduced e.g. (Buckland *et al.* 1993; Hall *et al.* 1980). A large proportion of the fauna may be stochastic, as beetles are mobile and may stray from their preferred habitat. Kenward (1978a) first stressed the importance of this random element. Further selection may occur on all those potential constituents. Some differences in the assemblages may be due to the characteristics of the particular feature type, e.g. wells act as pitfall traps and collect many more carabids than other features (see Chapter 14). Beetles may be "picked over" by birds or small mammals or conversely added to an assemblage in their faeces (Kenward 1978a). Another problem is that earlier deposits formed on the same site may become mixed with later.

The presence of species within an assemblage does not necessarily signify that the conditions within that medium were once suitable for it. They may have been attracted

Fig. 2.1: Information loss in the taphonomic process (after Sadler 1988)



to it by smell, like wasps to a jam jar trap. This particularly applies when the insects have been ejected from their normal habitat by, for example, the dismantling of a hay store (Smith 1991) or by heat rendering it temporarily uninhabitable. A Roman trap for grain weevils is described by Varro (cited in Beavis 1987), which consisted of placing the contaminated grain on the ground inside a ring of vessels filled with water. The beetles would crawl out from their disturbed habitat and be drowned.

Another reason why the thanatocoenosis does not reflect the living community is because certain species are more likely to be trapped in the type of deposits, from which the insect remains are recovered. This may explain why there are few dermestids (pests of dried organic matter) in ancient waterlogged samples and relatively few *Gracilia minuta*, which attacks wattle but likes dry twigs (Harde 1966; see Chapter 7). Naturally enough, the assemblages are dominated by species of decomposing material and damp, rather than dry ground, as these conditions favour preservation.

Insects from different habitats will accumulate within the layers transported by a number of different agencies; that is by mobility of the insects themselves or indirectly by humans, other animals, wind or water. This continues for an indefinite period of time, in the case of a well, for example, it may be a number of years, during which time further changes may occur to the thanatoceonosis.

2.3.2 CHANGES AFTER BURIAL

Beetles falling into water should sink to the bottom and be in an ideal position for preservation, although they may pass through an aquatic organism's gut before finally coming to rest. Beetles in rubbish-bearing features are often buried by the addition of more waste. However, the stratigraphic order implied by these methods may be lost.

Water is the most important agent in the taphonomic process as it is an effective medium of transport. For example flowing water can cause convergence of the remains in one spot; for example, this was suggested as a reason for a huge concentration of beetles, in a cesspit deposit in Norway (Kenward 1988). Assemblage mixing can also occur in standing water. It has been argued that a rubbish-filled Roman well at Skeldergate, York, had contaminated grain dumped in it and the dry grain pests within it floated, and eventually became incorporated in the upper layers (Hall *et al.* 1980). In pits, gases formed by the decomposition of organic material may result in much disturbance of the semi-liquid medium. This mixing may well explain the lack of variation in some pit samples.

Mixing may also occur by bioturbation, through the action of plant roots, earthworms and other organisms, which may include beetles, forming a post-depositional element of the assemblage (Kenward and Allison 1995). The area may by disturbed by further human activity. Deposits may be affected by physical processes, such as soil creep and cryoturbation. It is possible for the soil to be so thoroughly reworked that all evidence of structure is lost and only a dark earth remains (Macphail 1994).

The assemblage is also subjected to decay. Soft tissues and unthickened chitin may be broken down, thus coleopteran larval remains disappear except for their heads and caudal furcae, which may remain. The elytra of groups like the Cantharidae, which are poorly sclerotised, may also disappear (Buckland and Coope 1991). If water levels fluctuate, causing oxygen to enter the deposits, chemical breakdown will continue and the physical processes outlined above will cause further physical breakdown.

The decay of specimens not only makes identification more difficult but the preservation of remains may also be selective. However, at least for urban deposits, "It appears that either most insects are preserved or most have decayed completely," (Kenward and Large 1998, 52). Assemblages in which robust forms dominate, such as some rich in spider beetles, are thought to reflect the fauna at the time of deposition and not selective decay of species (Kenward and Large 1998). The very durable exoskeletons of some weevils and ground beetles are the last to decay and so assemblages, containing these taxa, may produce biased results, if the material is poorly preserved. (e.g. Wagner and Pelling 1995). According to Kenward and Large (1998), these groups are rarely significant in archaeological deposits, but, as they are found in samples from ditches and moats (e.g. Wagner and Pelling 1995) it seems sensible to consider the possibility of selective decay in interpretation.

2.3.2.1 Recording the state of preservation

The state of preservation of the insect remains should be recorded because it throws light on their taphonomic history. Kenward and Large (1998) proposed a system for doing this. This is an extension of a system already used by the EAU, although not normally published. Most authors, if they mention state of preservation at all, will simply give a subjective view of general condition if it is particularly good or bad. A five point scale is used by workers at ARCUS (University of Sheffield), but, while this has the merit of being simple to use, it does not distinguish between chemical breakdown (erosion) and physical (fragmentation); and it is, unfortunately, not published.

Kenward and Large argue that: -

> "The degree of decay, whether through chemical or mechanical damage, may give clues concerning, among other things, differential preservation, residuality, the separate origins of ecological components, time sequence in communities, unusual origins (e.g. milling, bird droppings), and episodes of dehydration or other transient assaults on deposits." (Kenward and Large 1998, 49).

The points at the end of their list are mainly useful in ascertaining whether buried material is still decaying. This information could be useful as a justification for further excavations. The scheme proposed allows for the recording of degree of erosion, degree of fragmentation, colour changes and other properties such as the occurrence of abrasion, soft/pale or associated sclerites. These measurements are designed to be as objective as possible, but they are very detailed and rely on comparative features, as for example in this statement from the scale of erosion: -

> "3.5 As 3, but thinning, colour change, and/or surface modification have progressed quite strongly" (Kenward and Large 1998, 53).

This means that much experience would be needed to obtain consistent results. In addition, calculations are required of the proportions of specimens affected, in order to determine separate depositional histories of sub-assemblages. Estimates of numbers at each level on the scales are required so that information about the pattern of distribution can be provided. For example, the presence of specimens at two levels of decay would indicate at least two origins of the insects. This is fairly straightforward but, in addition, information on the skewness of the distribution is required, although the possible significance of this is not remarked upon in their paper.

The aim of this system appears to be to measure everything, in case it may prove to be useful sometime in the future. For example, the only reason given for the recording of colour changes is that they appear to reflect important aspects of ground conditions. However the exact nature of these conditions still needs to be determined.

It has been argued that the detailed recording of the preservational state is a waste of time and resources (Kenward and Large 1998), although with practice, the authors claimed that it can be done in a matter of two to three minutes. Consistency of results is another important feature of any evaluation scheme and the authors concluded that: -

> "it is suspected that the only way to ensure absolute, as opposed to useful, comparability between records made by different workers would be a period of collaborative work, followed by a period of cross checking," (Kenward and Large 1998, 57).

It seems that this system is impractical and is unlikely to be adopted by workers outside the EAU.

2.3.3 SAMPLING PROCEDURE

Although ecological methods are often used in the analysis of archaeological assemblages, there are necessarily great differences between the two approaches, partly due to very different sampling procedures (see Kenward and Large 1998). Even the use of the word "sample" is different. The entomo-archaeologist uses it to mean the block of sediment from which the insects are extracted, not the insects recovered from it (Kenward 1978a). For ecological studies, all efforts are made to ensure random sampling of a population (see Magurran 1988), but even so it is difficult to eliminate all bias. Therefore great efforts are made, in modern ecological entomology, to ensure uniformity of the sampling points, not only standardising the collecting equipment but also the conditions at the site, such as height from ground and time and length of the period of capture. In contrast, the conditions under which the insects in archaeological features accumulated are unknown. They are not even representative of a once living community, as their origins are many and various. It is not always possible even to know for certain whether or not species had lived within the deposit. Borrowing terms from palaeontology (Brouwer 1967), those beetles, which had lived within the sampled material, became known as the autochthonous component and those from outside, the allochthonous component (Kenward 1978a). Detailed ecological knowledge about habitat requirements of individual species, which could help to elucidate this problem, is also often lacking (see Chapter 4).

A further loss of information occurs when collecting material, because it is not possible to be sure that the sample is fully representative of that context. This raises questions about sample size and number.

2.3.3.1 Sample size

Kenward (1978a) advocated taking a large enough sample so that an assemblage of at least one hundred individuals could be extracted. He claimed that this would be necessary to ensure that an unbiased faunal list was obtained. In order to do this, about 1-3kg of the sediment would normally need to be examined. Pressure of work at the EAU has led to the abandonment of this objective and normally only 1kg is studied from each context (Kenward *et al.* 1986), which often results in much smaller assemblages. This is due to the policy of the EAU (where Kenward's guidelines are practised) to investigate almost every excavated layer for insect remains and of necessity their emphasis has shifted from quality to quantity (e.g. Hall and Kenward 1990; Kenward and Hall 1995).

> "Its not a case of a magic cut off .. stats for 500 insects are better than those for 200, which are better than for 100, which are better than for 30, but they can all tell us something" Kenward (pers. comm. 1999).

However as Kenward himself points out, by implication, the smaller the assemblage the less representative it will be and therefore the greater will be the information loss.

Other workers, who have looked at smaller numbers of samples, have taken, on average, between 1-5kg of material to study. Sometimes due to small contexts or low concentrations of insects assemblage numbers are unavoidably small. Occasionally very large amounts of material are sampled. About 70kg was analysed from the Roman pit in Alcester and a minimum number of 1548 beetles were recorded. Although examining such large quantities of material may not be necessary in order to obtain a representative selection of the beetles present, the larger the assemblage the greater the chances of picking up previously unrecorded beetles for that period and so increasing biogeographical knowledge. The single specimen of the grain pest, *Palorus subdepressus*, the only Roman example of that species so far discovered, would probably have been missed in a smaller sample, as might the thirteen specimens of the exotic wood pest, *Hesperophanes fasciculatus*. This species was probably imported with timber from the Mediterranean (Osborne 1971b).

2.3.3.2 Measurement of sample size

Sample size is not always given by workers but, if it is, most have sampled by weight. Kenward (1992) takes General Biological Analysis samples of 5-10 kg from which to sub-sample for all small biological remains. The insect sub-sample is normally 1kg.

English Heritage guidelines recommend sampling by volume and consider a 10l sample a suitable quantity for insect extraction (de Rouffinac, English Heritage Environmental Officer, pers. comm.). The advantage of this method is that material can be placed on site into standard sized watertight containers without the need for weighing.

It can be seen that there is not a standard method and that there are pros and cons to each. In theory, collection by volume should give a more accurate measure of the density of the insect component. However, it may be difficult to sample accurately because the sampling process will disturb the compaction of the layer. If measurement is by weight, unmeasured factors such as wetness of sample and the presence of intrusions such as stones will affect the result. The amount of inorganic material, in samples collected by volume, will also affect the concentration of insects. For these reasons and also as a matter of necessity, when different or no units of measurements of sample sizes are given, the only way to compare disparate faunal lists is to look at overall assemblage composition.

2.3.3.3 Comparison of assemblages by percentage composition

If the numbers of each taxon are recorded as a percentage of the total number of individuals recovered (MNI), then comparisons can be made between assemblages of different sizes. This method has its drawbacks, if, for example, large numbers of autochthones are present, the figures will be distorted and the percentages of all the other species will be depressed. In a living community this type of calculation would be more meaningful as the organisms may interact with each other and so high numbers of one species may affect the levels of others in the same niche. On the other hand a death assemblage contains sub-faunas from different and unrelated habitats, so a large increase in the numbers of a species from one habitat would not have affected the numbers from other sources. This is why the numbers of the abundant species (superabundants) may be adjusted to be around 10% of the total assemblage size (see Kenward 1978a but see Section 3.3.4.2 and Chapter 13). This method is not perfect but it appears to be the most practicable.

2.3.3.4 Standardisation of sample collection

Standardising the size of samples collected, even from the same site, is not always possible or desirable. Different strategies may be needed for different feature types, because of the differing rates of formation and thickness of the layers, and there are difficulties in comparing very different types of substrate (see Chapter 11). On many sites selection is self-limiting because only the deepest features are waterlogged and context size may also be a limiting factor.

Due to the method of counting species numbers by the minimum possible number of individuals (MNI), doubling of sample size usually leads only to a small increase in assemblage size (Kenward *et al.* 1986). Thus it would be more profitable to take several samples from different parts of the context and deal with them separately than to sub-sample from one large block. Even so, it would not be possible to know, for certain, whether beetles were being counted twice because their parts had dispersed so widely.

2.3.3.5 Sampling frequency

Having considered size, the next problem is determining the number of samples to take from a context. This depends on the amount of spatial variation within the layer. Although intra-contextual variation is acknowledged as an important factor (Kenward *et al.* 1986), little work had been done on it. Strudwick (1979 cited in Hall *et al.* 1983b) studied this and other unpublished work has been undertaken at various sites in York. The results lead Kenward *et al.* (1986, 171) to the conclusion that "while there may be considerable variations in the identifiable biological remains, their general implications are usually much the same." The raw data of a study by Topsey of a pit is recorded in (Hall *et al.* 1993a, 12) and they demonstrated a good constancy of species. Further work on inter-contextual differences within pits was one of the stated aims of the excavation at Coppergate, York (Kenward and Hall 1995, 455). The only example in the text was of an atypical pit examined by McConaghey, "it seems most likely that the pit contained open water and that it stood unused for a considerable length of time" (Kenward and Hall 1995, 567). No results are given. Another study has been carried out by the present author (see Section 8.4.2.1).

Pit faunas, which form the bulk of the studies described above, are predictably uniform due to mixing of the contents (see Section 2.3.2). In deposits formed under large bodies of water, such as moats, samples are often taken from different depths because the stratification represents a time sequence (e.g. Girling and Robinson 1989). Taphonomic processes may cause some homogenisation in wet deposits and the material most likely to show lateral variation would be that which is spread out horizontally, but not formed under water, such as floor and midden deposits. Work by Smith (1991; 1998) seemed to confirm that there could be marked variation in midden deposits, although he describes differences between surface and internal samples, and not horizontal differences.

Kenward *et al.* (1986) suggested homogenising large samples before sub-sampling, if a method could be found that was not too destructive of the enclosed remains. The largely untested assumption made here is that spatial relationships are less important than the collection of a subset of species present.

2.3.4 EXTRACTION METHODS

The extraction process is the next point where information loss may take place. When specimens were picked out directly from sediment, it was occasionally possible to recover the whole exoskeleton with diagnostic parts like legs and antennae still in position (e.g. Coope 1959). In addition, more information about taphonomic processes was available from the condition and position of specimens. However the method is both too time consuming and inaccurate in other ways to be practical for archaeological material. However, it was used by Koch (1971). Recognition of remains is selective, dependant to some extent on visibility, thus favouring the extraction of large and brightly coloured specimens (Buckland and Coope 1991). These problems are overcome by the adoption of paraffin flotation methods, which involves mixing the deposit with water then adding a thin layer of paraffin. The insects separate from the sediment and float up to the paraffin/water interface, where they can be poured off and concentrated over a fine sieve (Coope and Osborne 1968). xxThis method has the great advantage of speed but there are certain associated disadvantages. Less taphonomic information can be extracted because the remains are disaggregated. Sieving loses small elements and individual sclerites are rendered unattributable to any particular specimen, so that counting has to be by the minimum possible number of individuals (MNI). Koch (1971) was able to achieve a better level of identification, by extracting specimens directly from the sediment, because he collected a greater number and variety of body parts from each specimen, than is possible with the paraffin flotation method, but the labour involved is much greater.

2.3.4.1 Efficacy of method

Studies on the efficacy of the paraffin flotation method introduced by Coope and Osborne (1968) have shown it to be very efficient at recovering coleopterous remains but not ideal for fly puparia or calcified material (Phipps 1986). This method was explained in detail by Kenward (Kenward *et al.* 1980), who also advocated boiling samples containing much plant material with caustic chemicals to disaggregate it, and prevent too much appearing in the flot. Although Kenward (1992) estimated that this method is 95% successful, he considered that a better recovery rate resulting from improvements in the efficacy of the paraffin would be a high priority (Kenward *et al.* 1986). As the initial examination of samples, at the EAU now involves normally involves only a single paraffining (Kenward *et al.* 1986) and because of the volume of material dealt with by this group, any advance that would speed up the process would be welcomed. There has also been some concern over the efficacy of the extraction procedure, possibly due to the type of paraffin used, concerning work from Carlisle (Kenward *et al.* 1992b, 4).

The first paraffin flotation normally removes most insects from the sample and should be representative of it. Usually, in the present author's own experience, second and subsequent flots increases the amount of plant and other non identifiable remains so much as to make them counter-productive. Kenward *et al.* (1986) reported that for inexplicable reasons, occasionally little is extracted until the second flot, especially in highly organic contexts. Silt-filled heads may sink and fail to be collected (Coope 1979) but generally sclerites will be missed randomly and so unless detailed information about concentration of remains is required, these losses will not be important.

2.3.4.2 The process of sorting

The process of extraction separates the chitinous element from most of the other materials. It is then necessary to sort through this insect-rich extract under a low power binocular microscope collecting certain elements for diagnosis. Heads, thoraces and elytra are the main elements required but the aedeagus and limbs parts may be of value as well. The possibility for loss of useful material due to human error is great. Strategies need to be developed by the sorter in order to reduce this risk, for example, it is more productive to concentrate on a limited number of diagnostic parts at one time (Kenward 1992). Insect parts are more likely to be overlooked if much plant material is present.

Nevertheless, sclerites will tend to be missed during the sorting procedure and as this is often random, it is not necessarily serious. One exception to this is the fragmented remains of large specimens, which have been unnoticed due to the lack of a recognisable shape, e.g. Sudell (1990, 269).

2.3.5 THE IDENTIFICATION PROCESS

The process of identification leads to a selective loss of information, but it is surprising how often identifications, right down to species level, can be made. This is partly due to the amount of detail that may be preserved. Structural colours, hairs, scales and surface patterns only visible under high magnifications are often still present on the exoskeleton (Buckland and Coope 1991). The aedeagus may enable identifications to species to be made in cases where other external differences are not apparent. The aedeagus is part of the male genitalia. Identification keys are useful aids but often require features such as antennae and legs, which are not recoverable whole, and so direct comparison with modern specimens is also necessary.

Full identification may not be possible if only fragments or a limited number of types of sclerites are recovered or the differences between species may not be distinguishable from the elements used for diagnosis. Even so, workers at the EAU not only record the numbers of species involved but also the numbers of individuals within the group, using labels, a, b, c etc. This level of identification can only be achieved by a mixture of experience and guesswork (Kenward pers. comm.). Information is lost not only because not all of the remains can be identified to species, but also because most authors do not record material at all, if, for example, it was only identifiable to family. This is unfortunate as even very general identifications can be useful. For example, recording the numbers of carabids (ground beetles) and curculionids (weevils) in faunas may be still be helpful in interpretation (see Chapters 13; 14).

If identification is only to genus or higher levels, the ecological data are much less specific, which causes problems when assigning habitat details (see Section 4.5). Most workers, if identifying to levels higher than species, do not indicate how many species may be present in that taxon. This distorts rank order lists and diversity indices.

A short cut used by workers at the EAU, in order to make the best use of limited time, is to not fully identify everything, *unless it is archaeologically important.* "This is not as illogical a statement as might first appear," (Kenward 1992, 86) as specimens are closely enough identified for their significance to be known. This approach is considered to be most suitable for use in urban settings where the total number of species is less than in rural sites (Kenward 1992). It sounds a dangerous precedent, as it relies on preconceptions, but it is unavoidable since, with limited resources, the emphasis on extensive sampling, must result in lower quality. One example of where this may have happened is at Coppergate, York, where it seemed likely that *Diphasium complanatum*, the club moss used in dyeing, had a Scandinavian origin, but no associated insect fauna had been identified with it.

> "with the exception of samples for which identification was carried out at the 'detailed level' the policy adopted for the examination of insect assemblages meant that rare taxa which were not immediately identifiable as unfamiliar aliens may have been overlooked" (Kenward and Hall, 1995, 772).

It has since been suggested (Buckland 1997) that the small rove beetle *Eucnecosum brachypterum* (Grav.) which was present, may have been introduced with the moss, as it normally inhabits mountainous regions (Harde 1984). This explanation has already been given for a similar occurrence of this beetle in York (Buckland *et al.* 1974).

2.3.6 THE RECORDING PROCESS

Another place where information loss occurs is in the recording of numbers. Since it is not possible to know the individual origin of the sclerites, unless still articulated, only a minimum number of individuals (MNI) can be estimated. Thus, although in theory, it would be possible for the head, thorax and left and right wing cases of a particular type of beetle to have come from four different individuals, they will be recorded as one. This is why additional samples only marginally increase the total number of specimens (Kenward *et al.* 1986).

The semi-quantitative recording methods of the EAU are also a source of information loss. Estimated numbers are deployed for the more frequent taxa with 6 being used for amounts between 4 and 9 and 15 for larger quantities. These figures are used because they have been shown to be the average and are used on assemblages regardless of size. If the state of preservation is poor, the relative quantities of the different species may only be scan recorded (e.g. Kenward 1985b), in these cases only a 3 or 4 point scale of abundance is used. These semi-quantitative lists have been found suitable for some comparative purposes (see Chapters 13 and 14). Problems do arise, however, if these lists are used for the creation of rank order curves (see Section 13.6.1.3.1).

2.4 CONCLUSION

A vast amount of information is lost between the laying down of the assemblage and its retrieval. Many of these losses are random, and so do not bias the composition of the resulting fauna. Those modifications that are selective often help to distinguish the particular characteristics of faunas from different features.

CHAPTER 3: The interpretation of the death assemblage

This chapter examines the interpretative methods used in archaeo-entomology.

3.1 EARLY WORK

Lyell (1911) produced the earliest faunal list of insects in archaeological contexts in this country comprising beetles found during the excavation of the Roman town at Caerwent. The list contained 51 taxa but interpretation on the implications for palaeo-economy and biogeography was lacking. In fact, it "had so little to strike the imagination" and no evidence of "pest species or the like" (Amsden and Boon 1975) that it did not immediately inspire others. Nothing more substantial was recorded until the 1950s when Kimmins (1954) and Bradley (1958) published their results. This early work was mainly in the form of lists of species, little interpretation was offered, which is unsurprising in view of the small size of the assemblages and the lack of comparative material.

The study did not became established until the catalyst provided by Coope and Osborne in 1968, with their development of the paraffin flotation method, which simplified the recovery of insect remains. A number of papers, citing the uses of insects to archaeology, were published in the early 1970s (e.g. Osborne 1973; Kenward 1974; Buckland 1974), as by then work had been undertaken on a variety of sites. So it was somewhat surprising that a review of the archaeological literature published in 1975 stated that: -

> "The endless repetition, however, of common ground beetles and the like in the published lists can but signal the severely restricted utility of the work from an archaeological standpoint." (Amsden and Boon 1975, 134)

Much of the work to date had been on Roman well faunas, which do contain high numbers of carabids. It is ironic that Ervynck *et al.* (1994), working in Belgium, have advocated using only the carabid beetles from well faunas as ecological indicators. They argued that they provided all the information that was required. In one case, they were able to show that Roman farming practices had exhausted the soil and led to abandonment of the surrounding fields and in another that the well had never been situated in a building. If other beetles had been considered, they might have been able to provide more wide-ranging information than just land usage.

Interpretative methods, established in the field of palaeo-entomology, continue to be used for archaeo-entomological studies.

3.2 MOSAIC METHOD OF INTERPRETATION.

The procedure, used by workers in palaeo-entomology, was outlined by Shotton (1959) with an ecological interpretation of a hypothetical pool. Two groups of beetles were recognised; the aquatics or aquatic marginals providing clues about the pond itself and the transported species giving information about the surrounding area. The ecology of the beetles provides the clues to the nature of the habitats.

This "mosaic" approach (Kenward 1978a) was carried forward into the interpretation of archaeological features. However, it was recognised that the situation was complicated by the fact that several habitats might be present. Thus Girling (1978, 86) states that:-

> "A particular feature of insect investigations from the Somerset Levels is the very close correspondence of habitat requirements of the successive faunas and it is not unusual for beetles tied to interdependent habitats to account for 100% of the stenotopes (habitat specific) in any sample. It is respect the faunas contrast strongly with those from urban situations where the artificial surroundings can result in apparently anomalous groups whose interpretation can be problematical."

Problems arose when attempts were made to work out the relative importance of the habitats indicated. Although Girling (1978) wrote that it was necessary to look at the whole assemblage and not at individual beetles as markers of a particular environment, Kenward stated that: -

> "Early interpretation relied (implicitly) on the assumption that there was a one to one specimen: habitat relationship, in combination with a measure of informed intuition." Kenward (1997, 136).

Some species will be naturally commoner than others; for example, small species with their smaller biomass tend to be more abundant than large. Some habitats support a wider variety of species than others. Some beetles may have been transported a long way from their point of origin in the gut of birds or mammals or by wind. The latter is referred to as "the background fauna" (Kenward 1975a) and is a component of most insect remains from archaeological sites (Kenward 1978a). Coupled with these problems is a lack of knowledge about the exact environmental requirements of many of the species.

Despite these caveats most workers still continue with the same approach, although improving their interpretations in the light of later knowledge. So Kenward (1997, 146) claimed that: -

> "The palaeoentomology of occupation sites has until now been largely a descriptive and deductive process. This is not a matter for shame, since every biological discipline must pass through the stage of "natural history"- observation and data collection - before synthesis and theorising of any value."

3.3 THE WHOLE ASSEMBLAGE APPROACH

Kenward (1978a) felt that the "mosaic" method, inherited from palaeo-entomologists, was suitable for the broader based climate and ecological studies of that discipline, but not precise enough for archaeological studies, where a much wider range of habitats and micro-habitats need to be investigated. In particular, methods were needed to distinguish that element of the fauna, which had been transported a long distance.

> "There is an overriding need to find ways of separating this background element from the autochthonous component of a death assemblage before making deductions about ecological conditions at the site of deposition" (Kenward 1978a, 7).

He felt that a new approach was required involving the whole assemblage, so he introduced quantitative methods, new species groupings and techniques previously used by ecologists. These methods facilitated comparisons as: -

> "The insect assemblage from any sample can only be fully understood against the background of many species lists from a wide range of sites and circumstances," Kenward (1978a, 26).

The Whole Assemblage Method, devised by Kenward (1978a) is still used by the Environmental Archaeology Unit (EAU) based at York, although it has evolved over time.

3.3.1 PRESENTATION OF DATA

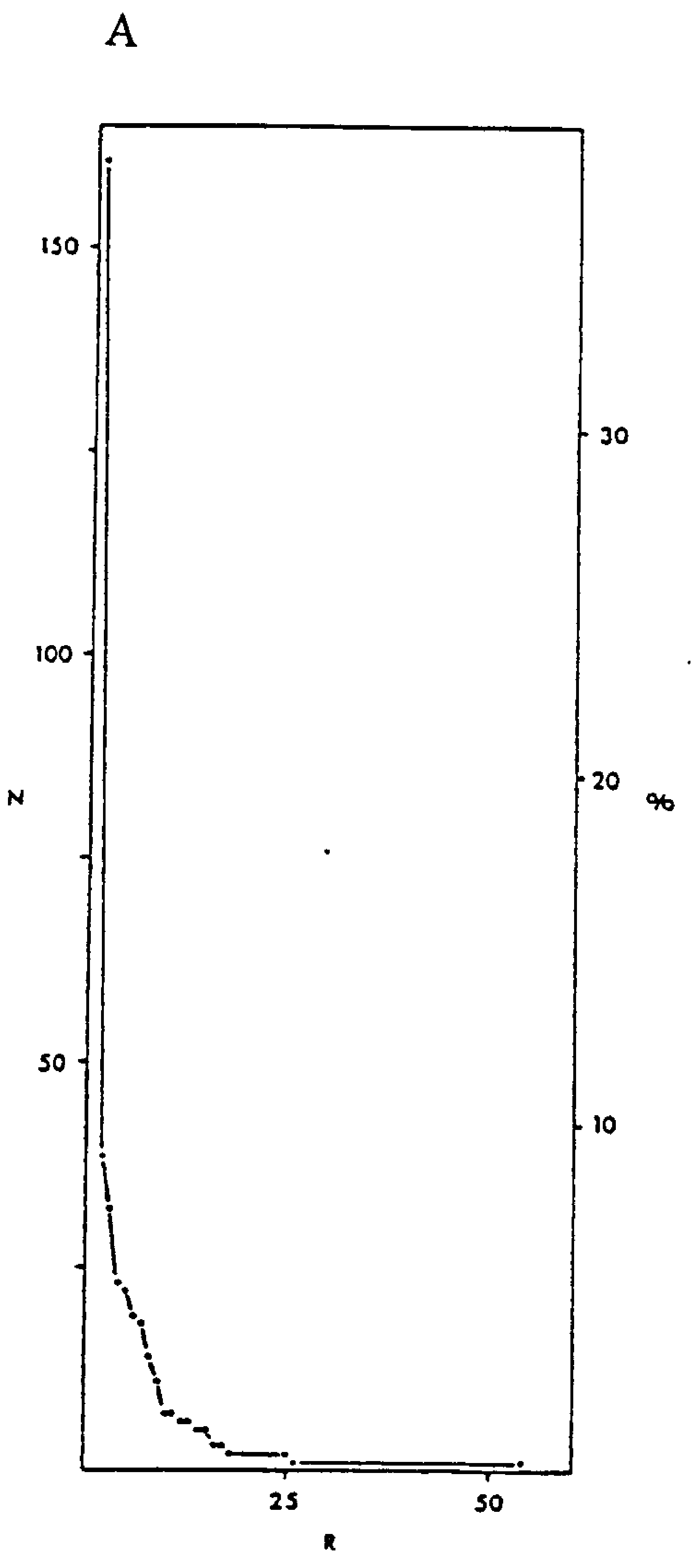
New ways of recording data were introduced. At first, the data for each taxon were registered in four ways; by the minimum number of individuals (MNI) present, as a concentration (numbers/kg), as a percentage figure (numbers/total number of individuals) and its position in rank order of abundance in that list. In later work the

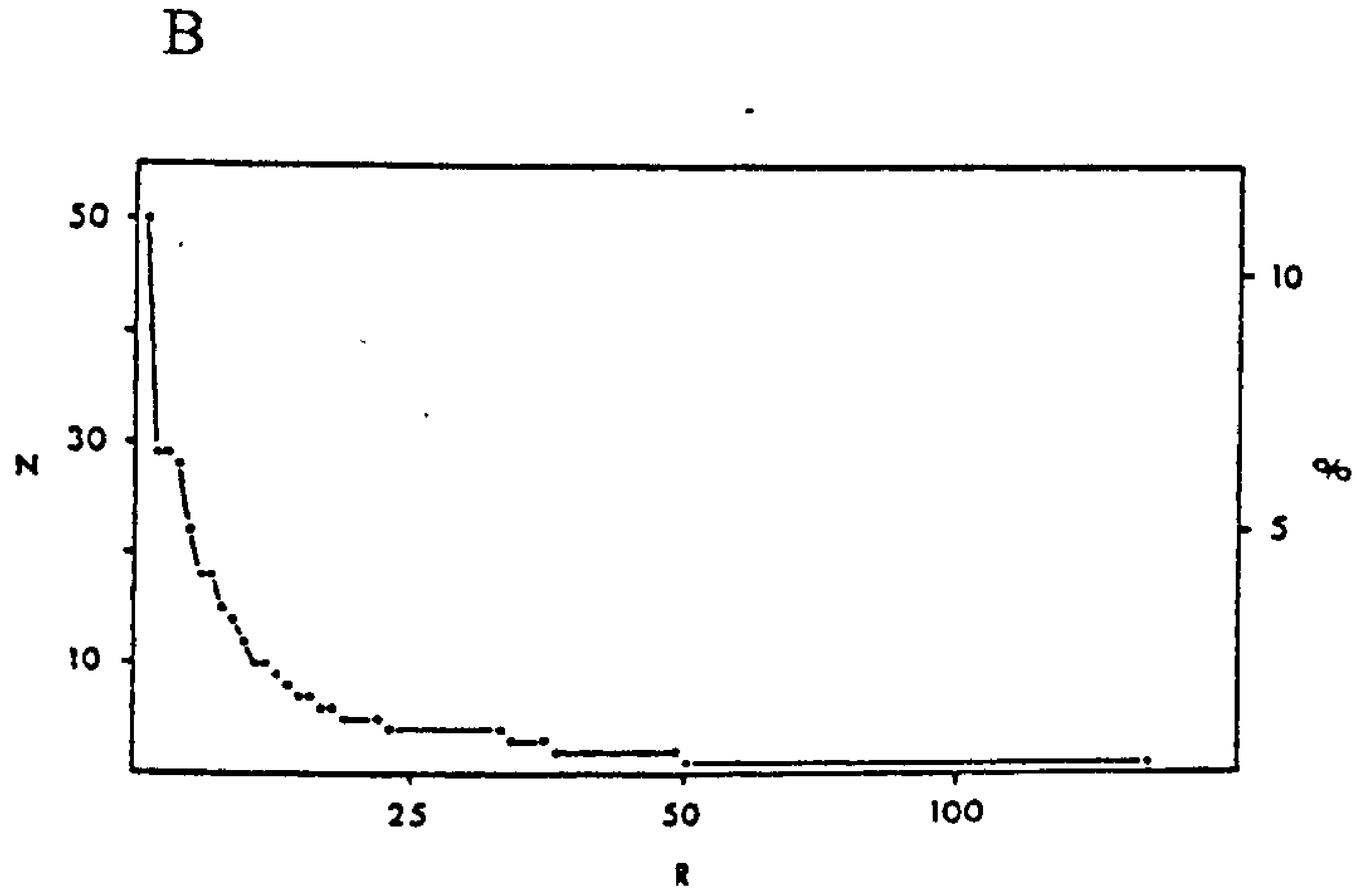
Fig. 3.1 Examples of rank order curves, showing features useful in diagnosis (after Kenward 1978b)

A: Rank order curve for an assemblage dominated by autochthonous "compost" insects from a floor layer

B: Rank order curve for an assemblage from a midden layer dominated by an autochthonous fauna of decaying matter, but with a strong admixture of insects from other habitats.

C: Rank order curve for a modern assemblage from a roof gutter, representing "background fauna".





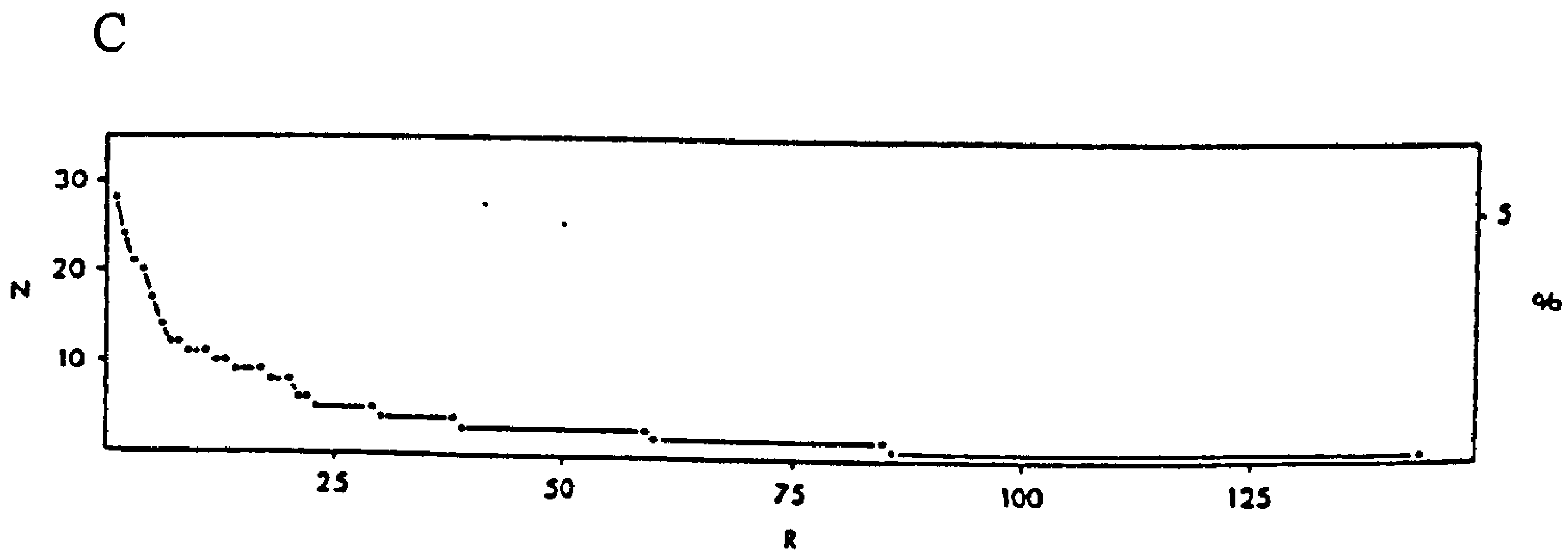
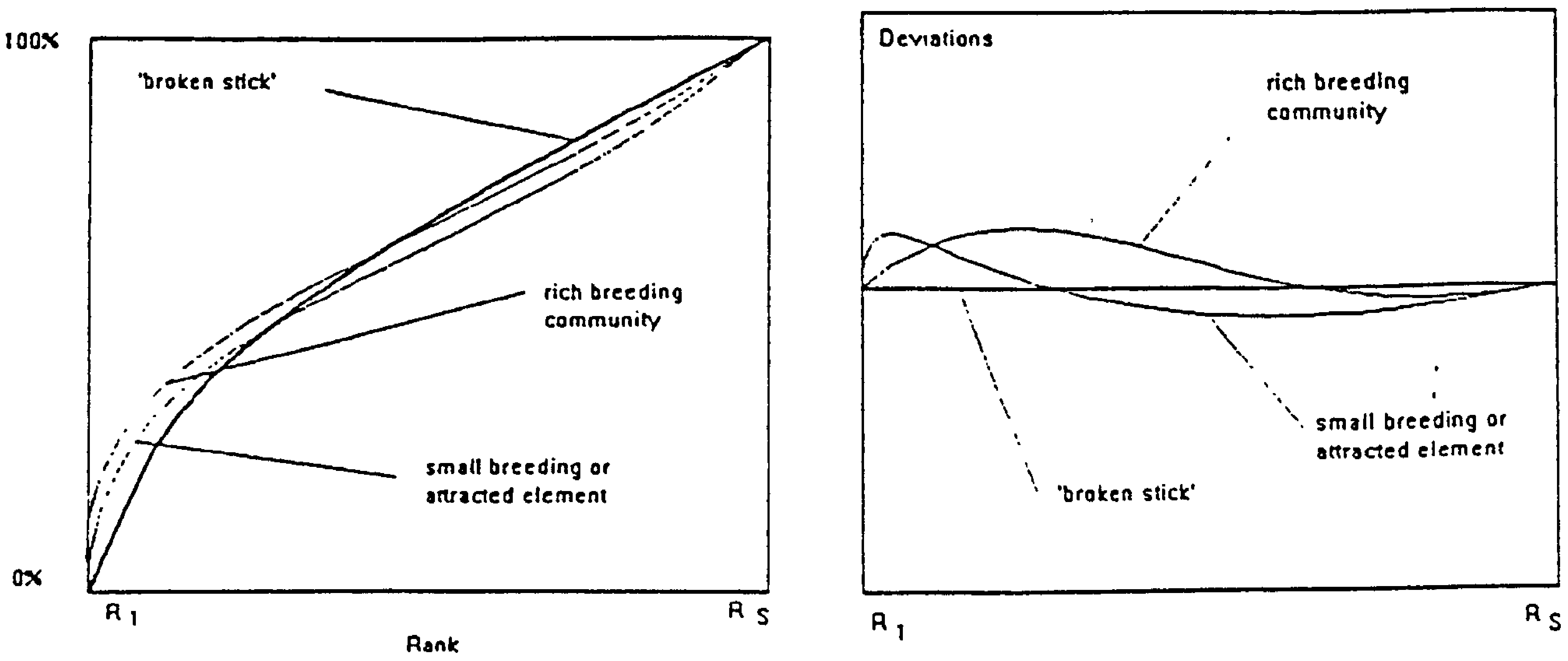


Fig. 3.2 Cumulative frequency graphs as a means of illustrating "community" structure in insect death assemblages. The bold line represents the "standard" derived from the model of MacArthur (1957) and the fine lines represent the observed curves. (After Kenward and Large 1998).



A: Cumulative frequency plots

B: Deviations from the model

sample size is standardised to 1kg so that concentration figures are no longer necessary works (e.g. Kenward *et al.* 1986). These data may be used in various ways.

3.3.1.1. Rank order curves

Rank order graphs may be drawn from the above information and the shape of the curve provides details about the nature of the assemblage. A steep beginning to the curve, caused by the abundance of some species, suggests the presence of autochthones. While a long tail, caused by many species at very low levels, suggests many allochthones; see Fig. 3.1). Although the expected profiles of assemblages formed under different conditions may not be known, these curves may be compared with others both ancient and modern. For example, this method was used in the interpretation of a layer of buried soil at Skeldergate, York (Kenward 1978a, 36) by making comparisons with modern curves produced from similar material. The first use of this technique had been on an assemblage from a Roman pit at Alcester (Osborne 1971b), as the realisation that decomposer species occupied the higher rankings enabled the deduction to be made that the pit was full of refuse.

3.3.1.2 MacArthur's broken stick method

Models of species abundance give a measure of the distribution of species abundances in an assemblage (species equitability) and this can be shown by a cumulative frequency curve. The shape of the curve has been found to fit certain mathematical formulae. The curve for The Broken Stick Model of Abundance Distribution is normally thought to represent well-established communities, which exploit the available living space randomly, as though it is divided between them like a "broken stick" (MacArthur 1957). This pattern of distribution was also found to fit archaeological assemblages, which were assumed to have a purely background origin (Kenward 1978a). This model, dismissed in Kenward (1978a) as being tedious to calculate and not very useful, became feasible with computerisation. Using the following formula the expected numbers of species at each level of abundance may be calculated.

$$S(n) = [S(S - 1)/N]\,(1 - n/N)^{s-2}$$

(derived from MacArthur 1957 cited in Magurran 1988, 30)

Where: -

S = Number of species

S(n) = Number of species in the abundance class with "n" individuals

N = Total number of individuals

The difference, between a theoretical result based on this model and the actual result, should indicate whether material was present which actively attracted beetles. This is illustrated by means of "community structure graphs" in which the theoretical Broken Stick component is reduced to a straight line and the actual results are shown as a deviation from it (see Fig. 3.2). The shape of the derived curve is significant. This method has limited application but it was used to show that beetles in the Bedern well, at York, were derived from two sources, the sump and the well infill (Kenward *et al.* 1986). It was also used by Kenward and Large (1995) to determine the degree of maturity of pit faunas (see Section 13.6.1.3.3).

Nowhere is the evidence presented justifying the use of this algorithm, it is simply used because "it works" and the degree to which it conforms to the model is not given. It is strongly affected by sample size (Poole 1974), which may cause difficulties in interpretation if widely differing assemblage sizes are involved. It was designed for living communities and represents the most equitable state of affairs with no competition for niche space (Magurran 1988, 29), as indeed may be true of a death assemblage.

3.3.2 HABITAT GROUPS

Like other workers, Kenward (1978a) attempted to separate species into habitat groups. Uniquely, the faunal lists, from the EAU, contain both Coleoptera and Hemiptera recorded together, although the numbers of Hemiptera are rarely large. A new artificial grouping was devised dependant on the ability to breed indoors. All species capable of living in "accumulations of organic matter" were omitted from this list, as their habitat may have been situated within a building. As this is not a well-defined difference, it was divided into two sub-groups; firstly, definite outdoor species and secondly, a larger group which included probable outdoor species (Kenward 1978a). Both figures are usually calculated. Some species remain problematical, especially those associated with decomposer habitats, such as may be found by rivers or in pastures, and the classification largely relies on the judgement of the researcher. The whole faunal list is divided up on the basis of this factor, which can provide information about the provenance of deposits and the influence of the background fauna. This grouping was probably of particular importance to Kenward because of his early work on identifying Anglo-Scandinavian floor deposits (Hall *et al.* 1983b). It has been used ever since by EAU workers but, rarely by others: Robinson (1981c); Smith (1996); Moffet and Smith (1997) are the only other published examples.

The assemblages are also divided into habitat groupings but, initially, only one of these was identified. This was the aquatic group (Kenward 1978a), and it was divided into water dwellers and waterside or damp ground species. These have the advantage of being reasonably clear-cut groups, although there are problems with some species, now restricted to waterside situations, which were once common in towns (see Section 4.2.1). These aquatic species may indicate background rain influence or imported waterside vegetation used for floor coverings, for example.

In urban archaeo-entomology the "decomposer" species are extremely important but they span a wide range of habitats, from mouldy litter under grass at one end to wet smelly dung at the other. The sub-division of this group, based on the wetness of the substrate, was undertaken by Kenward (1982) and is described in Section 4.2.1 below. From 1982 onward, the decomposer groups have been included in the sub-division of the assemblage (e.g. Hall *et al.* 1983b; Kenward *et al.* 1986). The state of the decaying material, signified by particular members of this group, has important consequences for health and hygiene. Those at the drier end of the scale include beetles living within the fabric of buildings, the "house fauna". However, this important element is not specified as such, although much work has been done in this area (see Chapter 4). Other categories have been added later. These are the phytophages (species feeding on plants), moorland, timber and grain species. The problems involved in the classification process are discussed in detail in Chapter 4.

3.3.3 ASSEMBLAGE STATISTICS

This new "Whole Assemblage" method differs from the "Mosaic Method" of analysis in that, after classifying species into these groups, various statistics are calculated. This is done so that the influence of the background fauna and the local habitats may be assessed more objectively.

The sizes of the various groups are calculated in two ways: by the numbers of taxa present and by the percentage of total numbers. The latter figure expresses the size of each of the sub-assemblages represented in relation to the whole assemblage. This gives useful data for comparisons and information is gained about the relative importance of the habitats. There are dangers in using percentage figures, which are discussed in Section 3.3.4.2. In addition, adjustments must be made during interpretation as, for example, the decomposer habitat is likely to be over-represented and the woodland under-represented, due to the different mobility of the insects in these groups (Kenward 1978a, 10). The size of the outdoor component gives an indication of the amount of background influence. Further information may be obtained from a measurement of diversity.

3.3.3.1 Measurement of diversity

Kenward places great importance on the measurement of diversity stating that it: -

> "will probably prove to be one of the most useful statistics of ancient insect assemblages, especially when it is combined with other properties." (Kenward 1978a, 23)

Diversity has been measured by means of Fisher's Alpha (Fisher *et al.* 1943), which is a gauge of species richness used in ecology. It compares the number of species present against the total numbers of individuals.

$$S = \alpha \log_e(1 + N/\alpha)$$

S = Number of species

N = Number of individuals

α = The index of diversity.

The index of diversity can be extrapolated from a graph (Fisher *et al.* 1943, 52) and the degree of error can be calculated at the same time. Fisher's Alpha is relatively independent of sample size, and for samples of a hundred individuals has a degree of accuracy of around 20% of the value of α. It is also suitable for use in situations where a number of random variables have acted on the material (May 1975), as is the case with thanatocoenoses. A figure for the whole assemblage is calculated and in later work (i.e from Hall *et al.* 1983b onwards), for the various habitat groupings, if they are large enough. A good correlation between the index of diversity and the amount of background influence has been found. For example, a high reading, together with a low concentration of individuals and the lack of a dominant habitat group, is characteristic of a fauna formed outside in yards and streets by random processes (e.g. Kenward 1979a, sample 1744). Fisher's Alpha can also be used in the calculation of the degree of maturity of certain types of deposit (see Section 13.6.1.3.3).

3.3.4 CRITICISM OF THE WHOLE ASSEMBLAGE METHOD

It has been stressed that great care is needed in interpretation, when using this method. Some pitfalls are discussed in Kenward 1978a, although some of the advice given has later been disregarded, see above. Even when first laid down, the methods outlined above were supplementary to existing procedures and were no substitute for experience (Kenward 1978a). This meant that the actual species present were considered as well as these reductive methods, which, being independent of species, lose much of the information. The algorithms are designed to show up diagnostic features and enable comparisons to be made with a variety of material, both ancient and modern.

Buckland (1979a) and Angus (1979) were both unimpressed by the statistical methods employed by Kenward (1978). Buckland thought that the loss of information caused by giving each species equal weighting was unjustified. They felt that the same results would have been reached by following traditional natural historical lines. Most workers in the field agreed with this and few adopted these methods. However, few other workers have dealt with such large numbers of samples.

Many of the criticisms that can be levelled against the method spring from this emphasis on non-selectivity in sample taking. In order to process them within budget, streamlining techniques had to be adopted (Kenward *et al.* 1986; Kenward 1992). In addition methodology has changed over the years and there is no published account of current practices (Kenward pers. comm. 1999).

3.3.4.1 Sample size

Due to the policy, adopted by the EAU of sampling as widely as possible, it became standard practice to analyse only 1kg of material from each context (Kenward *et al.* 1986). Frequently the resulting assemblage was smaller that the one hundred individuals initially considered necessary (Kenward 1978a). These small assemblages are treated to all the statistical tests used on larger assemblages (except for measurement of diversity if MNI is less than 20).

Yet no work has been published to show that small assemblages are typical of the whole context, if variation occurs, the smaller the sample the less representative it will be. Research has been carried out by the EAU on a pit fauna to examine intra-contextual variation (Topsey cited in Hall *et al.* 1993a). Samples from this type of feature have probably undergone post-depositional mixing and so are unlikely to exhibit much variation (see Chapter 3), which was indeed the case in this example. However, even though there was little variation, the concentration of specimens, in each 1kg sample, varied by a factor of two and a half (Hall *et al.* 1993c). This point was ignored by the authors, yet this measure is used to gauge the attractiveness of the substrate to insects.

3.3.4.2 The calculation of percentage figures

When the numbers of each taxa are calculated as a percentage of the total numbers of individuals, the value for each group is relative to the size of all the other groups. If the size of one group is swollen by high numbers of individual species (superabundants), the figures for the other taxa will be correspondingly depressed. Superabundants, defined as species forming 10% or more of the assemblage, probably represent beetles breeding in or circumadjacent to the deposit. In practice, less objective parameters are also used to identify reproduction, such as the appropriateness of the species in question and the presence of teneral or malformed specimens. Whether reproducing or not, it was acknowledged that figures, based on the percentage formed of the total number, will be seriously distorted if any species is present in large numbers (Kenward 1978a). Initially percentage figures were recalculated after their removal. Later no such action was taken, except with grain pests, (Kenward *et al.* 1992a; b; c). This was justified as follows: -

> "taking out superabundants is only really appropriate when they hide other information. Thus I look at stats with and without grain pests, since they often swamp everything but where they are part of a dominant community there is no problem, is there?" (Kenward pers. comm. 1999).

This research argues that there is.

The problem was sometimes solved in later work by the use of semi-quantified lists, whereby species numbers above 5 were estimated as 6 and 15. The latter figure usually denotes a superabundant species, but the method has been used arbitrarily. Sometimes actual and estimated figures for high rankings, have been used in the same work (e.g. Hall and Kenward 1990) and they were used regardless of total assemblage size and consequently the figure 15 does not always represent 10% or more of the total.

3.3.4.3 Use of the indoor/outdoor category

The division of whole assemblages into indoor or outdoor types has not been adopted by most other workers. It was designed to distinguish between deposits formed within buildings and those formed outside. In York, alternating high and low levels of species diversity of the "probable outdoor species" group were found in samples presumed to be from Anglo-Scandinavian floor deposits (Kenward 1978a). This was originally interpreted as layers of occupational build up, with low diversity due to enclosure within a building and therefore lack of access to "background rain" beetles, alternating with an influx of beetles in new flooring materials. By the time the site excavation was published, this neat interpretation had been discarded. After work on a modern barn, it had been discovered that many "outdoor" species can penetrate buildings and therefore the differences between deposits formed indoors with those formed outdoors are less clear cut (Hall *et al.* 1983b). However, more careful examination of the site data revealed that, true outdoor faunas were still recognisable, as they were much more diverse than any of the disputed assemblages. The assemblages with more diverse "probable outdoor species," originally interpreted as fresh floor coverings, also had a greater number of foul decomposer species, which suggested an alternative origin in squalid flooring materials (Hall *et al.* 1983b). It was, therefore, speculated that the differences may have been solely due to the position in the building, which could not be determined, and they are no longer considered to be very significant. This category has to be used with care in interpreting the location of assemblages.

A high value of species richness in the "outdoor" category is usually considered indicative of a high background fauna. This may be true in practice, although it is not directly measured. The main element of the background fauna is decomposer species (see Chapter 14), which are deliberately excluded from this category. In addition, aquatic species and phytophages, which are included in this group, may indicate the immediate surroundings. The main characteristic of the species in the background fauna is high mobility. This factor is discussed in Kenward (1978), but it is not used in classification.

However, the "outdoor" category is a useful indicator of the allochthonous component of an urban fauna, which is important in interpretation. The problem with other systems, which rely on classification by habitat to interpret the surroundings of an assemblage, is that few beetles provide incontrovertible evidence of a particular habitat. Thus it is a useful diagnostic tool, especially for urban archaeological studies (see Section 6.3.1 and Chapter 15).

3.3.4.4 The use of the index of diversity

Problems arise from using a procedure designed for ecological data on archaeo-entomological data and this applies to the use of diversity indices. The difficulty of identifying insect remains to species creates problems because each taxon is treated with equal weight. Identifications to genus or higher level conceal the number of individual species. Workers at the EAU from 1986 onwards have endeavoured to separate out the individual species even if they could not name them. This prevents distortion of the measurement of diversity. Direct comparisons of diversity with work by others, who have not done this, are not possible. Small assemblages may also produce unreliable results but they may be omitted if the degree of error is high (Kenward and Hall 1995, 465). The main difficulty is in the interpretation; Kenward (1997) admits that this is not always straightforward. For example, high diversity of the decomposer element could mean that a varied, well-established community was present or conversely it could indicate a random background fauna. So it is necessary to consider the ecological requirements of the constituent taxa. The greater diversity of large assemblages may simply indicate that they formed over a longer time span (Kenward 1978a). There are also differences between assemblages, which stem from their formation in different types of features (see Chapter 14). This point was illustrated in Kenward (1978, Fig. 8, 9) but not commented upon, and the importance of this aspect of assemblage formation was initially overlooked. Another difficulty with comparisons is that most other authors do not include Hemiptera within their lists.

3.3.4.5 Importance of feature type

In the early work, little consideration was given to the type of feature from which assemblages were collected. Thus, information about the habitat represented by the fauna was recorded regardless of the features from whence they came. The size of the habitat groupings were recorded, by period, in the form of bar charts (e.g. Hall and

Kenward 1990 fiche 11 figs 103-113). These charts are not referred to in the text, and they are not direct measures of temporal changes, as the type of feature in which the faunas developed had varied greatly over time. For example, all the features examined in Period 6 were cesspits, while earlier periods displayed more variety, with a number of samples from drainage ditches and floor deposits being examined. The information about feature type was present in the text but it was not easily accessible. Only in Hall and Kenward (1995) are the figures for habitat types per period broken down into feature types.

3.3.4.6 Difficulties in verifying interpretations

The difficulties of managing the large projects undertaken by the EAU (e.g. Hall *et al.* 1983b; Kenward and Hall 1990; Kenward and Hall 1995), inevitably gave rise to problems. Lost samples are mentioned and unease is expressed about the genuineness of really unexpected findings. For example, it was suspected that the Anglo-Scandinavian grain pests from Coppergate, York were cross-contaminants from Roman material (Kenward and Hall 1995, 761). 1600 samples were collected from that site and the amount of data generated by it has, so far, prevented its publication. Data are often published on fiches to save space, for example, the statistics for the environmental studies from the Colonia (Hall and Kenward 1990) occupy the equivalent of a book five times the size of the original monograph.

Although the reader is urged to study the raw data in order to fully understand the work (Hall and Kenward 1990), it is not displayed in a user-friendly fashion and the implications remain obscure unless a great deal more work is done. A large amount of statistical information is published but this depicts the raw data and is not always fully explained. For example, in Kenward *et al.* (1986, 255-257) figures 50, 51, 54 and 56 are not mentioned in the text, except as "certain data from insect analyses". Histograms of various parameters, such as those concerned with the composition of the decomposer fauna and the concentration of "outdoor species", are routinely expressed in several different ways. No explanation is given about how these various measurements affect the conclusions drawn. The written information is not backed up directly by charts or diagrams. Instead relevant information is scattered about and not cross-referenced. For example, in order to understand Kenward and Hall (1995, 644, Figure 178) it is necessary to look in six different places in the text. Even then, without the species lists for each sample, which still await publication in a "Technical Journal", the information cannot be verified.

3.3.4.7 Conclusions

Although there are problems with the individual components of the "Whole Assemblage Method", it has been used in combination with more traditional species-based methods and integrated with other environmental data, making it an effective tool in interpretation. The unique methods used lead to problems when comparisons are made with other work (see Chapter 13). However, because the bulk of the research on urban assemblages has been undertaken using the "Whole Assemblage Method", any synthesis of work in this field must incorporate it.

The deployment of these intensive methods was only possible because of the computerisation developed and used exclusively at York. This was innovative in the 1980s but now, when other computer techniques are available, the method seems unwieldy and outdated.

3.4 METHODS OF COMPARING FAUNAL DIVERSITY

3.4.1 JACCARD'S AND SORENSON'S MEASUREMENTS' OF DIVERSITY

Jaccard's method allows for the degree of diversity between faunas from different sites to be measured using the "coefficient of community". It can also be used to investigate species associations, as the frequency with which pairs of species occur together can be measured. It was used for this purpose, with some success, to sort out the habitat preferences of a number of beetles found in archaeological assemblages (Kenward 1982, see Section 4.2.1).

Jaccard's coefficient of community, $C_j = j/(a + b - j)$

j = Number of species common to both sites

a = Number of species at site A

b = Number of species at site B.

Like the similar Sorenson's index, which uses the same parameters, it only compares two variables at a time and only measures presence or absence of species. Many species are very common in archaeological deposits in low numbers as they form part of the "background rain". It would be more useful if species numbers were taken into account and this is provided by a modification of Sorenson's index: -

$$\text{Sorenson's quantitative index, } C_n = 2jN/(aN + bN)$$

aN = Total number of individuals at site A

bN = Total number of individuals at site B.

jN = sum of the lower of the two abundances recorded for species at both sites.

This can provide a better indication of species associations but even so the index is strongly influenced by species richness and sample size (Magurran 1988). More powerful methods using more variables became possible with advances in computerisation.

3.4.2 A STUDY BASED ON THE THEORY OF ISLAND BIOGEOGRAPHY

Islands in the Northern Hemisphere have impoverished faunas due to the last glaciation and difficulties of recolonisation caused by their physical isolation. Studies of the islands of the North Atlantic have shown a link between the spread of synanthropic species and distance from the country of human emigration. Synanthropic species are those which live in close association with humans. Thus the insect faunas of Greenland, Iceland, Faroe, Orkney and Shetland show many similarities to those of Britain and Scandinavia but there is a marked decrease in variety from east to west.

> "The only satisfactory view of these data is that the faunas were derived from the east and there is a progressive loss of species due to operation of a transatlantic sweepstake," (Sadler and Skidmore 1995, 211).

This has been demonstrated by archaeo-entomological studies, which showed that many of the synanthropic beetles, which form half of the total Coleoptera of the more westerly islands, first appear in the records at the same time as settlement by the Norse (Sadler and Skidmore 1995).

These studies also demonstrate a principle of island biogeography, which identifies a decrease in species diversity with increased distance from the point of colonisation (MacArthur and Wilson 1967). This tenet has been used in another context in an attempt to determine the longevity of settlements by an examination of the beetle colonisers

(Kenward 1997). Towns with their specialised synanthropic faunas are considered to be the equivalent of islands as they are surrounded by areas inhospitable to urban beetles. It is postulated that new settlements would soon acquire large numbers of quick-colonising eurytopic species, derived from the surrounding environment. Eurytopic species are those which inhabit a wide range of environments. The more specialised, less migratory species, many of which rely on humans for distribution, would follow later (Kenward 1997, 137). Kenward acknowledged many problems inherent in this approach. These range from insufficient understanding of the natural history of colonisation and of the amount of interaction between settlements to differences in the decomposer fauna due to cultural changes. It is assumed that there is a direct link between the dispersal of the more sedentary synanthropes and humans. However it had been discovered that in the Pleistocene, when human influence was minimal, the distribution of species was independent of their mobility (Elias 1992). It is probable that other dispersive factors, such as phoresy, were operating then and may be still. Phoresy is a device by which flightless beetles disperse by attaching themselves to larger more mobile organisms (Crowson 1981). Although, that entomologist did not consider the practice to be very widespread.

Another difficulty encountered was obtaining a sufficiently comprehensive selection of samples for comparisons to be made. Subjectively, Kenward believed some of the differences he has observed between sites may be due to the permanency of the settlement but so far this remains unproven. It may be possible in the light of further knowledge and with more sophisticated multivariate computer techniques to show these more objectively (Kenward 1997). One possible way of determining, whether a species has been introduced, may be to examine the genetic variation in the population.

> "Molecular genetic techniques hold great promise in studies of insect population, biology, ecology and biogeography" (Reiss *et al.* 1995).

Species with restricted gene pools would be strongly indicative of imported species.

> "The "founder effect" consequent upon the establishment of populations from a small number of individuals (resulting in genetic homogeneity) may be detectable through DNA uniformity in fossils." (Kenward 1997, 137).

3.4.3 MULTIVARIATE ANALYSIS

Multivariate analysis can be described as "the branch of mathematics that deals with the examination of numerous variables simultaneously" (Gauch 1984, 1). It is useful because the raw data are often too large and complex to be assimilated directly by the human mind. Multivariate analyses summarise the data, either by arranging like samples and species into clusters (Classification) or by representing samples and species relationships in a low dimensional space (Ordination, Gauch 1984). In contrast to classical statistics, multivariate analyses do not begin with any hypotheses, but instead is an exploratory technique, eliciting from the data some internal structure from which at a later stage, hypotheses may be generated (Gauch 1984).

One of the first attempts at more sophisticated computer analysis was undertaken on samples from two sites in York on Anglo-Scandinavian layers (Strudwick 1979, cited in Hall *et al.* 1983b, 173). Multivariate analysis of indicator species failed to differentiate between superficially similar assemblages, perhaps because complete faunal lists were not used in the analysis (Hall *et al.* 1983b).

3.4.3.1 Cluster analysis, a classification technique

CLUSTAN is a computer program which uses a type of cluster analysis, designed to measure the similarities between variables and express them in a dendrogram (Everitt 1980). This is arranged in a hierarchical agglomeration, with the degree of similarity shown by the level of the cross connections. This method was used to distinguish between faunas collected at different depths beneath a prehistoric raft (Perry 1981). The analysis was undertaken in two ways, using different parameters, and both gave similar results. The samples were arranged on the dendrograms according to depth and the greater diversity shown by samples from the higher levels equated with the evidence obtained from other sources (Perry 1981). Perry *et al.* (1985) used this method to differentiate between assemblages, which were formed indoors or outdoors in Iceland: -

> "Intuitive assessment of the data matrix to determine the problem of resemblance is extremely difficult; the actual faunal differences between the indoor and outdoor situations are quite subtle and hard to perceive by visual cross-comparison" (Perry *et al.* 1985, 340-341).

Several methods of analysis were used. Initially, species associations were identified using Jaccard's coefficient then cluster analysis was undertaken in two ways, one based on the numerical data and the other on the presence/absence data. The fact that these methods were successful in distinguishing different conditions is probably due to the harsher environment of Iceland, where fewer synanthropes have become established and the contrast between indoor and outdoor conditions must be greater. Nevertheless throughout the paper, it was stressed that mathematical methods must be used with great care and that they are no substitute for the more subjective, intuitive approach (Perry *et al.* 1985).

3.4.3.2 Ordination techniques

DECORANA is a computer package, which use a more rigorous ordination technique (Shennan 1997). It is described in Hill (1979). Ordination results in less loss of data because the differences between the variables are measured directly.

Smith (1991) used TWINSPAN (a cluster analysis package) and DECORANA (an ordination technique) to compare faunas from similar farm habitats but different countries, namely Greenland, Iceland, Scottish islands and England.

> "However the majority of the time both TWINSPAN and DECORANA continued to produce essentially spurious results, of little interpretative value. ....Moreover, the removal of the biogeographic species seems to have exacerbated the situation rather than improving it." (Smith 1991, 333).

Both programs selected species, which were too insignificant ecologically and numerically to be useful standards. This was even true after removal of "biogeographic" species, which are beetles, confined to certain regions by geographical considerations. Assemblages, from similar habitats but different regions, were not grouped together by the programming as hoped. Smith concluded that these methods work well when comparing samples along a connected ecological cline (e.g. Luff *et al.* 1989) but were not useful for the multitudinous and unknown variations in archaeological samples. It may have been unsuccessful because there was too much variation, due not only to geographical differences, but also to the different types of feature investigated at each site and possibly also because of the wide time scale involved (from early medieval to modern).

CANOCO (Ter Braak 1988) is a modification of DECORANA, which uses slightly different techniques of comparison and utilises the actual species numbers, expressed as a percentage of the total number of individuals in the assemblage. Thus more accurate comparisons can be made between assemblages of different sizes. It also allows environmental variables to be superimposed, making it useful for palaeo-climatic research. For example, Cong and Ashworth (1997) were able to relate the differences in assemblages from stratified samples, to temperature changes. However, this facility cannot normally be used with archaeological assemblages because the environmental factors are unknown.

Different methods of analysis are available using CANOCO and the most appropriate for archaeological assemblages is correspondence analysis. The advantage of this multivariate ordination technique is, that it is designed for use with community data, which involves large species sets with few but different species in each sample, producing many zeroes. Although in principle, with CANOCO, environmental variables may be added, this is usually not possible with archaeological data, as they are unknown. However the plotting of both the assemblage and the species data, using the same parameters, demonstrates the relationships between the two.

Whitehouse (1998) used Correspondence Analysis in the analysis of faunas from two peat bog sites. Although certain species associations were demonstrated, the ordination of the species did not show obvious patterns but the ordination of the samples from the different sites showed clear differences. Those from Hatfield Moor were closely associated, in keeping with them being from a stable natural area. Those from Thorne Moors were widely scattered demonstrated a more varied fauna due to human interference. The present author has used CANOCO to compare data collected by different workers from a variety of sites and periods and from selected feature types (see Chapters 13; 14).

Regardless of the method of data analysis, interpretation relies on ecological data about species and species associations, but there are many gaps in this knowledge, see the next chapter.

CHAPTER 4: Ecological studies for archaeological interpretations

One of the problems arising from the analysis of beetle assemblages is a lack of detailed ecological knowledge about species. This is particularly true of an archaeologically important group, the decomposers, which are small, non-spectacular and difficult to identify. The pest species have been better documented, because of their economic importance. The database BUGS has made access to available information much easier as it contains a compilation of ecological data from a variety of sources, including the ecological codings devised by Koch (1989; 1992). Another problem concerns species associations. These are difficult to resolve because insects occurring together in a death assemblage may never have been together in life and ancient conditions cannot be recreated. This chapter examines the various methods, which have been used to rectify the situation.

4.1 MODERN ANALOGUE STUDIES

4.1.1 CHARACTERISTICS OF THE DEATH ASSEMBLAGE

Kenward investigated modern thanatocoenoses to discover more about their nature. He examined assemblages derived from a suburban drain sump (Kenward 1975a), city roofs (Kenward 1976b), a rural well, a stream and flood deposits (Kenward 1978a). This work alerted him to the fact that the "background fauna" could be large enough to seriously bias the interpretation (Kenward 1978a). Previously, specimens unlikely to be naturally occurring at the site of deposition, were assumed to have been imported by humans. For example, *Helophorus*, a water beetle, was assumed to have been brought in with flooring material at an Anglo-Scandinavian site in York (Buckland *et al.* 1974, 26.) Kenward (1985a) also discovered that this outdoor element could penetrate into buildings. In conclusion of this later study he stated: -

> "These observations emphasise, .. the need for caution in the interpretation of insect assemblages from archaeological deposits. In particular, more modern and ancient comparative material must be examined." (Kenward 1985a, 103)

4.1.2 DETERMINATION OF SPECIES ASSOCIATIONS

One way of learning about insect associations is to use modern analogues. It is impossible to recreate ancient conditions, not only because of our ignorance of the details, but also because the beetle fauna has altered over time (see Chapter 5). This is caused by changes in climate, in changes in habitats due to human intervention and changes in the fauna itself, due to introductions from other countries (Kenward 1978a, 12). Nevertheless such studies can be useful.

4.1.2.1 Beetles in cess

Osborne (1983) identified two medieval deposits from Worcester as cess, by comparing their beetle faunas with those from a modern cesspit, compost and soil. The species from the various sources were tabulated and commented on. Despite features of the modern pit studied by Osborne (1983) not paralleled by the urban medieval examples, such as the rural location and the, not very effective, use of sterilising fluid, there were enough similarities in the assemblages for him to deduce that the medieval pits had also been filled with cess. An unexpectedly large component of cess assemblages was found to be "house beetles" (e.g. *Tipnus unicolor, Ptinus fur, Lathridius minutus*), which normally favour mouldy, damp conditions and timber pests, such as *Anobium punctatum*. It is only the latter xylophagous species, which could not possibly have bred in cess, which was assumed to have had an external origin. Although "its presence in cesspit material is an enigma" (Osborne 1983, 462), he concluded that the eleven specimens in his pit must have flown into the Elsan bucket while it was in the house. Osborne (1983) made a false assumption that the other house dwellers must have lived in the cess, along with species normally found in fouler conditions, as they occurred there in death. Kenward (1997) refuted this idea, which is discussed in Section 13.7.

Osborne (1983) concluded that the probable cess faunas have "restricted" numbers of species and some typical components were identified, but an overall picture of the expected coleopteran taxa was not given. The characteristics of faunas from waste pits are discussed in Chapter 13, and those from Worcester are shown to be typical of a certain type of cesspit fauna (Table 13.7). The characteristics of cess and Osborne's experiment are discussed further in the present author's own experiment (see Chapter 11).

4.1.2.2 Beetle associations of agricultural land

Robinson (1983a) investigated the differences in beetle faunas on land put to different agricultural uses. Beetles were collected from pitfall traps and in sweep nets, in two collections spread over two weeks. He was able to identify seven groups of beetles indicative of meadow, arable, disturbed ground or pasture. From these he selected beetles, which were also present in the archaeological deposits he had investigated, and, which were easy to identify from fragments. The material all came from prehistoric and Roman sites in the Thames Valley (Osborne 1979; Robinson 1979; 1981a; 1994; Robinson *et al.* 1984) and the data from one site, Mount Farm, have not yet been published. Indirect indicators had to be used for cereal crops due to a lack of coleopteran cereal pests, so they could only be investigated through the phytophages of their associated weed floras. Robinson (1983a) acknowledged that the selection of indicator species may need to be altered for use in different parts of the country.

Robinson (1983a) acknowledged that beetles found in death assemblages will differ from living communities, especially as the different dispersive powers of the different species, affects the likelihood of their being trapped in deposits, independent of their frequency. In addition, the ancient assemblages were formed over a much longer time-span, well faunas, in particular, may represent several years of fill, whereas the modern comparisons were collected over two weeks and may show seasonal differences. Some of the fauna might have been indicative of the feature in which the assemblage had collected, and not the surrounding agricultural environment. The archaeological features were wells and ditches and so species, which could have been associated with those habitats, were eliminated from consideration.

Notwithstanding these problems, the percentage of each of these indicator groups compared to total beetle numbers, were tabulated for both modern and ancient assemblages. He found that two of the groups (arable weeds and foul organic matter) were not useful as indicators, as the proportions of them bore no relationship to other inter-related groups. Smith (1991, 1998) also looked at modern farm sites and he reported that the same weeds grew in meadowland, arable fields and field edges, which might explain why the associated insect group was not useful as an indicator. The results from the five remaining categories tied in well with information from other sources, including pollen analysis and geographical considerations. However there were problems, as it is usually unknown how far beetles might disperse from their habitats. This applied especially to the highly mobile dung beetles associated with pastureland. Smith (1998) had observed that coprophagous species appear to be attracted to wet organic deposits, if they are dark and enclosed, regardless of their content. This group has other problems due to the mobility of the livestock, which may be grazed on meadowland and arable fields at certain times of the year and which may congregate in certain areas, causing unpredictable fluctuations in dung beetle numbers. This latter problem was also confirmed by Smith (1998), who found that the levels of coprophagous beetles collected from fields, varied according to the proximity of cowpats. Despite this, the conclusion was that the beetles are good indicators of pastureland and provide some indication of meadowland and disturbed or arable ground. It would have been most interesting if he had examined some death assemblages in the contemporary farmland sites, as these would have provided a better basis for comparison.

As part of his work on modern farm faunas, Smith (1991) produced a table showing the preferences of decomposer species for different amounts of wetness in the decaying matter. This is similar to that produced by Kenward (1982), but appears to be a more accurate representation (see Section 4.2.1). There are fewer difficulties in using rural faunas, than there are with their urban counterparts, because the management of farmland altered little over the centuries, that is until very recent times (Osborne 1978).

4.1.2.3 House faunas

Smith (1991; 1996) investigated the nature of the synanthropic component in deserted Hebridean blackhouses. He illustrated the faunas from roofs and floors, using the Whole Assemblage Method, and then compared them briefly with archaeological material from Anglo-Scandinavian York (Hall *et al.* 1983b; Hall and Kenward 1990) and Norse settlements in Iceland (Buckland *et al.* 1993).

Despite the fact that that these Hebridean "house" faunas had special features, caused by abandonment and the introduction of species in peat, they showed affinities with medieval examples. However this did not prove that deposits of the same origins were present, as they demonstrably were not, but that the fauna is characteristic of a microhabitat rather than a type of material. This will be discussed more fully below (see Section 4.2.2). However, Smith (1996) neglected to mention another difference, namely that *Ptinus fur*, which was common in antiquity, had been "replaced" by the recently introduced species, *P. tectus*. The two species differ in their tolerance to dry conditions (Solomon and Adamson 1955; Bentley *et al.* 1941) and even in his own work Smith (1991) demonstrated the differences between them.

4.2 EXAMINATION OF THE ARCHAEOLOGICAL RECORD

4.2.1 NICHES OCCUPIED BY URBAN DECOMPOSER SPECIES

> "Remarkably little is known about the typical habitat or range of the vast majority of the insects commonly encountered in urban situations, whether in ancient death assemblages or in modern communities." (Kenward 1982, 71).

The habitat of decomposer beetles, a type prevalent in ancient towns, can vary from the litter at the base of living grasses to a foul smelling cowpat. The most important variable is the amount of water present. Wetness of substrate equates with foulness because the greater the amount of water present, the less access there is for oxygen. Without that gas only incomplete breakdown of material occurs, which causes the formation of many strong smelling intermediate products. It would be particularly useful to know, more exactly, the preferences of individual beetle species, as they can be indicators of standards of hygiene. Another factor, which affects the decomposer community, is the nature of the substrate. If it is finely divided and contains mucus derivatives, as would be the case with faecal material, it will be "sticky". Only certain beetles are able to deal with this.

The classification of the decomposer species has been tackled by Kenward (1982), who attempted to categorise the large numbers of species associated with decomposing matter found in archaeological deposits, depending on the amount of water in the substrate. The "stickiness" of the substrate was not considered by Kenward (1982). Using a mixture of personal experience and written records, the niche requirements of some present-day decomposers were identified. Then, using Jaccard's "coefficient of community," which measures the number of times pairs of species occur together (see Section 3.4.1), the strength of the associations between species was calculated and related to the modern data. Direct comparisons with the urban environment could not be made because the differences between modern and medieval are so great.

Kenward had a large, if biased, database to work from, comprising 107 samples from six sites, and of periods ranging from Roman to late medieval. However, the geographical spread was limited, all sites being in northern England, with 94% of samples from York or nearby Beverley or Hull and the remaining ones from Durham. The age of the assemblages was also unevenly represented with 60% coming from Anglo-Scandinavian York. Kenward (1982) acknowledged the inherent dangers, which result from the mixed nature of the death assemblage, when using Jaccard's coefficient on archaeological material. To some extent, he countered this, by only including species forming 3% or more of the assemblage, thus eliminating many "background rain" beetles. He failed to consider another important aspect, namely the differences caused by the different feature types in which the beetles had collected. Those found in wells, for example, would not represent a living community but would be much more indicative of their powers of dispersal. Different communities of beetles might be expected in the foul matter of a pit, in middens and in soil although the same species might be present in all. Kenward (1982) acknowledged this point to some extent when he stated that eurytopic species caused problems. Jaccard's Coefficient is intended to be used in an ecological context, to compare communities of living organisms, which differ from each other by only a few known factors; for example, to compare the species associations in forestry sites managed in different ways (Magurran 1988). Interrelationships within archaeological materials may be too complex to interpret.

Despite all these drawbacks, Jaccard's coefficient showed the strongest links between a group representing drier "sweet compost" decomposers, which are common in buildings. These beetles namely; *Lathridius minutus*, *Cryptophagus* species, *Atomaria* species, *Aglenus brunneus*, and *Xylodromus concinnus* form part of the "house fauna". There was a major omission from this group, namely *Mycetaea hirta*, which was placed with *Platystethus cornutus*, a species thought to indicate clean mud (Kenward and Hall 1995). The other well established "house" beetles the Ptinids, *Tipnus unicolor* and *Ptinus fur*, had not been included in the calculations.

Kenward (1982) also proved from this analysis that two beetles, *Carpelimus bilineatus*, and *Cercyon analis* had been misplaced in previous work. *C. bilineatus*, nowadays commonest in waterside situations, was shown to have been previously common in decomposing material in towns. *C. analis* was found in slightly less foul conditions than others of its genus, and was more closely linked with the "house beetles". Further work has confirmed these placements; *C. bilineatus* has been frequently found in organic deposits from pits, floors, and middens and *C. analis* is especially common in material from early medieval floors (Kenward and Hall 1995). The latter beetle was found by Smith (1991) to be the only species of *Cercyon* present in exposed positions, which would be cooler and drier than normal. Although it has been postulated that early medieval floors provided central heating by the heat of fermentation (West Stow 1974, Coope 1981), this evidence suggests that, at least sometimes, they were cleaner and drier than that.

Those species representing fouler conditions show weaker, less easily explained connections from Jaccard's analysis that did not always marry up with the listed requirements of these beetles from modern observations. For example, *Oxytelus sculptus* and *Platystethus arenarius* are tightly associated according to the constellation diagram, derived from the Jaccard calculation (Kenward 1982, 77). Yet they have different affinities for very foul dungy matter, according to the habitat range diagram (Kenward 1982, 73). Interestingly, work by Smith (1991, 388), vindicated the conclusion from the Jaccard analysis, as his results showed a much better match between those two species. These two beetles were later found to indicate a certain type of deposit (see Chapter 13).

This method has proved to be useful, and may be more so if used on a less disparate group of samples. However as Jaccard's system only measures two variables at a time, multi-variate analysis, such as CANOCO would be more helpful.

4.2.2 DETERMINATION OF THE NATURE OF THE DEPOSIT

Finding ways of identifying the nature of the deposit is also a useful exercise, as this may be surprisingly difficult. For example, material designated "straw" in the field, may turn out to be dye plant remains (Kenward and Hall 1997), and even if it is straw it may have formed part of floor deposits, thatch, anal wipes or stable waste. The beetle faunas found with them may provide useful indicators. An indicator taxon is defined as: -

> "one which reliably carries the implication of the occurrence of some event, activity or ecological condition in the past" (Kenward and Hall 1997, 665).

Rarely does a situation arise like that at Coney Street, York, where the occurrence of huge numbers of grain pests, indicated the site of a Roman granary (Kenward and Williams 1979). Samples are seldom dominated by such stenotopic taxa i.e. taxa which are found in a very specialised habitat. Each type of deposit contains sub-assemblages from different sources; if these can be identified from all sorts of environmental and archaeological evidence, the identification of a deposit is much more secure. Therefore, an indicator package is considered to be a more reliable gauge. This is defined as: -

> "A collection of recordable data of any kind which, when occurring

> together, can be accepted as evidence of some past state or activity" (Kenward and Hall 1997, 665).

However, a note of caution regarding the coleopteran element, is provided by Smith (1991, 1998), who investigated the potential of modern farm faunas to interpret the nature of archaeological deposits. He identified a group, which live in stored hay, the "barn" beetles and found that this group dominated, whether the sampled material came from hay stores, cattle stalls or middens, despite the fact that the fodder had been fouled with urine and faeces en route. It seems that conditions in the deep litter beds at this farm were too foul for colonisation by many beetles, so beetles characteristic of that stage were obscured by those which had persisted in the hay from when it was in the haystore. Thus, foul conditions were not represented by those beetle faunas, which does not appear to be the case with those described from archaeological sites (Hall and Kenward 1990; Kenward and Hall 1995; 1997). Not only this, but there were two types of fauna represented within the midden. Only the cooler wetter outside layer supported the expected fauna of fouler decomposer species, while the warmer drier areas within were dominated by the same species that occurred in the hay stores. Therefore the exact nature of the material could not be determined from the associated beetle fauna. Similar conclusions were reached from the study of faunas in the Hebridean blackhouses described above, which is summarised as: -

> "the majority of the species present are indicative of a specific type of micro-habitat or biotype rather than the materials in which they occur," (Smith, 1996, 173).

Despite these findings, the following indicator packages have been identified.

4.2.2.1 Stable manure

A package of indicators for stable manure was identified in Kenward and Hall (1997). The insect component of this may include some grain pests from feed; hay meadow species introduced with fodder or bedding, some foul decomposers species living in soiled material and some "house" species from the building itself. Other environmental evidence might be present; like the seeds of meadowland plants, originating in the feed and stock parasites and Diptera (flies) associated with stock. Archaeological evidence might be, for example, indications of low-grade buildings and lack of domestic and industrial artefacts, or more direct clues may be present, such as at the Norman Castle at Hen Domen, where horseshoe nails were found (Greig *et al.* 1982).

4.2.2.2 Cess deposits

Similarly there are a number of ecological indicators for human cess. These include food remains such as the "medieval fruit salad" so labelled by (Robinson 1981c) This is a mixture of the seeds of edible plants, namely: strawberry, blackberry, *Prunus* species, fennel, apple, grape, fig and mulberry, which indicates that these fruits were part of the diet. Another indicator is the presence of large quantities of bran fragments (Hall *et al.* 1983a). Food pests, which may pass through the human gut and be eliminated in the faeces (Osborne 1983), may also be present.

The occurrence of large numbers of the eggs of human gut parasites is an identifier now used routinely on samples processed by the EAU at York (e.g. Hall and Kenward 1990; Kenward *et al.* 1992). This may be considered to be a direct indication, as infestation by gut parasites appears to have been universal in medieval times, but it is not always possible to be certain of the host if preservation is not good (Jones 1982). In addition these microscopic indicators are easily dispersed and are ubiquitous in early medieval sites, so that only high concentrations indicate cess (Hall and Kenward 1990).

The interpretation of decomposer beetles found in cess needs care. Although large numbers of "house" species may occur they are not thought to have bred there. A range of foul decomposer beetles have been found in cess but none have so far been found to signify that pabulum specifically as opposed to other noxious waste (but see Section 13.8).

The cesspit may have been a repository for all kinds of household and garden waste, according to Greig (1981), but some of these may not have been just thrown away. For example, scraps of woollen material, which are sometimes found, were most likely to have been secondarily used for feminine hygiene (Krzywinski 1983), rather than simply being offcuts from tailoring, as suggested by Greig (1981). Straw may have been from floors or gardens but, more probably, had been used as anal wipes (Wood 1965); moss was also used for this purpose (Hall *et al.* 1983b).

4.2.2.3 Long established buildings

It has been suggested that *Tipnus unicolor* is an indicator of long-lived buildings (Kenward and Allison 1995). This idea stems from the fact that this beetle is absent, or very rare, in early medieval times. The probability of this being due to the permanence of buildings is discussed in Chapter 12. *Aglenus brunneus* is also nominated as evidence of long term human occupation (Kenward and Allison 1995). These suppositions do not consider the human factor in introductions and also ignore phoresy, that is hitching a ride on other organisms (Woodroffe 1967), as a possible mechanism for dispersal.

4.2.3 DETERMINING THE SEASON OF DEPOSITION

Kenward and Large (1995) explored the possibility of determining the length of exposure of pit contents and the season of operation from the beetle faunas. This might explain differences in faunas and have implications for hygiene. The beetles are taken from the York site at the Coppergate described in Kenward and Hall (1995). As well as using the statistical methods described in Chapter 3, tables showing seasonal activity of certain insects were constructed, but neither method gave good results. They concluded that few seasonal decomposer beetles have been identified, so even their simpler method is unlikely to be workable. One species, which should have been ideal for the purpose, is *Anobium punctatum.* This timber pest is widespread in the archaeological record but the adult is only active in midsummer (Blake 1925, Horion 1966). So the ubiquity of this beetle in fills from urban deposits, remained a mystery. The reason for the failure of this method may be due to a misconception on the part of the researchers, who assumed that: -

> "most pit fills would have formed rapidly and have been covered rapidly too, for reasons of hygiene," (Kenward and Large 1995, 46).

On the contrary, the beetle evidence suggests that most deposits were left open for long periods.

4.3 INTEGRATION OF ALL TYPES OF DATA

As has been demonstrated in the previous section, much more information can be gleaned if the evidence from all sources is considered together, but unfortunately this rarely happens. Often the insect report is published as a separate item, sometimes relegated to fiche, and much of the archaeological information including even the date of the sample, may be elsewhere (e.g. Osborne 1971; 1981b; Girling 1979). Although feature type is usually recorded, any influence that this may have had on the assemblage is rarely considered; only in the latest York fascicule (Kenward and Hall 1995) is the occurrence of species in different habitat groups, linked to feature type.

> “It would be most desirable to co-ordinate closely work on bone and other biological remains; no one engaged in one of a series of parallel bioarchaeological investigations of a body of material should work in isolation” (Kenward and Hall 1995, 473).

Nevertheless, environmental archaeologists often work in isolation and their results are published separately and not cross-related (e.g. Girling 1979; Girling 1983). Other environmental studies may not even have been undertaken (Osborne 1971a; 1971b; Girling 1989). One worker who does integrate all environmental information is Robinson. He also economises on the collection of data by selecting the most appropriate evidence to answer specific questions. Thus, in Robinson (1981c), cesspits are identified by the presence of a "medieval fruit salad".

A particularly useful feature of Kenward's later work has been the lists of species, both plant and animal, connected with a particular ancient habitat. This was begun in Hall and Kenward's (1990) work on the Colonia in York and enlarged and expanded using the evidence from the Anglo-Scandinavian period from Coppergate, York. The most useful group identified, is the "house fauna". In Hall and Kenward (1990), the list is prefaced with the caveat; "a very arbitrary group based on archaeological associations". By 1995, Kenward was able to state that:-

> "This group of insect taxa, originally defined on the basis of archaeological assemblages, now appears considerably more secure on the basis of preliminary results of species association analysis for the Coppergate records and further investigations of the literature concerning their modern ecology." (Kenward and Hall 1995, 662)

This work continued with the indicators for stable manure described above (Section 4.2.2.1).

Although the plant, insect and endoparasite reports are considered together, even York can be criticised for not fully integrating data. This is partly due to different aspects of the excavation being published separately. For example, the evidence from the lice, for skin and fur processing, is discussed in Walton (1989) and the bone report in O’Connor (1989).

4.4 REASSESSMENTS DUE TO ECOLOGICAL STUDIES

The type of work outlined above, together with greater familiarity with ancient urban faunas, has caused some reappraisals of early work. See Buckland *et al.* (1974) and the reassessment by Hall *et al.* (1983b). The latter paper is a more detailed study of the same area.

> "The original account was optimistic in assuming that all insects occupied the same typical habitats in Anglo-Scandinavian York as in 20th century England." (Hall *et al.* 1983b, 221)

For example, the presence of *Aglenus brunneus*, now known to be very common in mouldering material of medieval date, was thought to demonstrate the presence of chickens, as their manure is one of the few remaining niches for them. Pieces of leather were present but the evidence for tanning, suggested by the beetles, was also later queried (Hall *et al.* 1983b). However, this has not quelled the misconceptions emanating from this paper. In Elias's (1994) summary of uses of fossil insects to archaeology, the site is described as a tannery in which chicken manure was probably used to tan hides.

Another good example, which has been reinterpreted several times, concerns the significance of grain pests. Osborne (1983) proved by experiment that they could signify the presence of human faecal material. This is a much more plausible explanation for the grain pests in the York Roman sewer (Buckland 1976a). Originally Buckland had postulated that they indicated grain storage. The lack of outdoor species in the drain in which they were found, suggested that it led from inside the building, which is not a typical arrangement. Therefore, some kind of general food store was proposed, but it is much more plausible that the drain led from latrines. Another example is that of Osborne (1994), who reviewed his own work on a Roman rubbish pit (Osborne 1971b). He then stated, that the presence of grain pests did not necessarily mean the discarding of spoilt grain by a Roman housewife, "the obvious answer in 1971", but may have meant the presence of human faecal material. However, Kenward reassessed this material again (Kenward and Hall 1997) and considered it more likely that the grain pests originated in a fill of stable waste. The same conclusion was reached by the present author (see Section 13.7.3). Unfortunately, as the plant evidence was not studied, the derivation of the contents of that pit will always remain uncertain.

4.5 CLASSIFICATION INTO HABITAT TYPES

In order to interpret their results, many authors devise classificatory systems based on ecological evidence. There is no standard system, a fact, which needs to be borne in mind, when comparisons are made between work by different authors. The system used by Kenward is exclusive to work by the EAU at York. Most authors use systems based on their own experience and provide no discussion of their merits or their derivation. An exception to this is Robinson (Pearson and Robinson 1995), who groups the Coleoptera from a Roman villa site and names his main sources of ecological information (Robinson 1981a, 1983a). His definitions differ from Kenward, so that, for example, his statement that no synanthropic taxa were present at Bronze Age, Runnymede (Robinson 1991) is disputed by that worker.

The sort of information that is useful to archaeologists, such as degree of synanthropy or foulness of substrate tolerated, is not recognised as so important by ecologists. Conversely, the archaeologist may wish to know, for example, whether a species is characteristic of woodland but not whether it feeds on leaves or fungi. This is why systems designed by ecologists tend not to be very useful. This was the case with the scheme devised by Koch (1989; 1992), which was appraised by Whitehouse (1998). The database BUGS includes a comprehensive list of ecological information which is helpful, although some is specific, some general and some may not be applicable, as it relates to other countries. The categories devised by Koch (1989; 1992) are in the process of being included in that resource as well. There is also the entomological work, described above, which has increased knowledge of insect behaviour in the ancient environment.

There are problems peculiar to archaeological ecological classificatory systems. One reason for this stems from the fact that it is impossible to name everything to species level. Much ecological information is lost because the higher taxa may contain species from a variety of habitats. In any case beetles are indicative of conditions, not particular habitats (Smith 1991), so that, for example, the synanthropic plaster beetle, *Lathridius minutus,* indicates dry mouldy material, which may occur in buildings but also in stored hay on a farm. This species is very mobile and its presence may only indicate a high "background rain" component (see Chapter 14).

Degree of mobility is a useful characteristic of species, not used in classification systems. This factor was mentioned in Kenward (1978a) and in Robinson (1983a). This would give a more accurate indication of background rain species and help generally in determining proximity of habitats. However it is not always possible to find the relevant information from the ecological literature. One of the reasons for this is the fact that mobility may vary within the range occupied by the beetle, as it is affected by temperature and beetles at the northern limit of their range may even be flightless (Crowson 1981).

No system of classification could be devised, that could be used without ambiguity on any archaeological deposit. The more universally applicable the system, the more information will be lost. Kenward's system is designed for use on any archaeological assemblage. Other workers have examined particular situations and made assumptions about beetles, identified to levels above species, to aid interpretation. Thus in urban situations, *Cryptophagus* and *Atomaria* species are considered as part of the "house fauna" and when examining pit faunas, the *Philonthus* species present are assumed to be those that live in foul conditions. There are obvious dangers in this approach, and circular arguments must be avoided, but due to the number of unknowns in archaeological interpretations, some assumptions are reasonable, especially if the results can be verified in other ways.

CHAPTER 5: Survey of work in the field

5.1 INTRODUCTION

This chapter surveys the work, which has been carried out in the British Isles, on insect assemblages, spanning the Roman to the late medieval period. Most of the published and some unpublished work has been reviewed, the list has been organised into a database, which is displayed in Table 5.1. The English sites, on that list, have been displayed on a map (Fig. 5.1). While the quantity of identified coleopteran remains, recovered from the sites, by period and geographical area is shown in Figs 5.2; 5.3; 5.4; 5.5. Fig. 5.6 shows the proportions of the different feature types, from which the assemblages were recovered, by period.

5.2 COMPILATION OF DATA

The position of sites, from which insect remains of Roman or medieval date have been investigated, has been recorded on a map of England. Sites, which are close together have been enclosed in dotted lines and the data from them, have been combined in the statistics, in order to reduce the total number of locations and simplify the charts. These amalgamated areas are designated HS (Humberside), SB (south Birmingham) and TV (Thames valley) on the map (Fig. 5.1).

The sizes of the recovered numbers of Coleoptera, which are displayed in Figs 5.2 -5, had been recorded on the database (Table 5.1) and the estimates were calculated from it: very small assemblages were ignored, the rest were assigned the following values: -

Small (S)) ≤ 50

Medium (M)) ≤ 100

Large (L) ≥ 500

The charts show other information about the distribution of the data. It has been displayed with the sites grouped into four areas according to latitude. Each site has also been designated "urban" or "rural", such a distinction can be somewhat arbitrary (*sensu* Kenward and Allison 1995), but large differences in assemblages can be attributed to this factor. Rural sites have been coloured green and urban ones red.

5.3 RESULTS OF THE SURVEY

It can be seen that the main bulk of the work has been done by Harry Kenward's team from the EAU at York. This group of workers has been able to study a comprehensive selection of material, while most of the other work consists of analysis of a limited number of samples from isolated features. Concentrations of sites occur around the main centres of study, namely York, Birmingham and Oxford. Only three sites from Scotland and two from Ireland are recorded in the database (Table 5.1) and these were omitted from these statistics. Data from the north of England is scarce, apart from a study of Roman Carlisle, and there is also little from the southern end of the country. especially for the Saxon period. The patchiness of the record is also evident from the charts, showing the quantity of material recovered (Figs 5.2-5). As well as the geographical bias, rural remains are concentrated in the Roman period and there is very little material from Saxon deposits. Further differences are shown up by the examination by period of feature types examined (see Fig. 5.6). This shows that the only working wells examined, came from the Roman period. That period had assemblages from the greatest variety of features. The Middle Ages is dominated by pit faunas and the few post medieval examples are open water or pit features.

There has been little work published on the characteristic faunas of the periods examined in this study. Much more work has been carried out on older, natural or semi-natural deposits (e.g. Coope 1995; Ashworth *et al.* 1997). Work by Dinnin and Sadler (1999) included both types of deposit and covered the periods under consideration in this chapter. The evidence produced here, has been mainly gleaned from the entomo-archaeological reports and may be backed up by other sources, including historical records and other environmental reports. The emphasis is on coleopteran evidence. A brief account of present day faunas has also been included.

5.3.1 ROMAN PERIOD

It can be seen by reference to Fig. 5.6 and Table 5.1 that most of the work on the Roman period has been carried out on water-bearing features, i.e. wells and drainage ditches. The nature of the death assemblages from these feature types will be discussed in a later chapter, but well faunas, are particularly biased (see Chapter 14). These differences must help to explain the greater diversity of Roman faunas compared to later ones.

Evidence from a variety of sources, reveals that there were slightly warmer conditions in this country in Roman times but how the affects of this on the coleopteran fauna are masked by the affects brought about by the Romans themselves. Hemipteran evidence is cited in Kenward *et al.* (1986) to indicate a higher July temperature in Roman York. However, Kenward in (Kenward and Hall 1997) later doubted a climatic interpretation. This is due to the realisation that these bugs may have been transported in hay, from more southerly locations. Only one of the species mentioned, namely *Heterogaster urticae,* a nettle-feeding bug, remains undisputed as climate influenced.

By the Roman period, agricultural practices had already given rise to changes in the native fauna due to the removal of the tree cover (Osborne 1978; Dinnin and Sadler 1999). These changes were accelerated by the more intensive farming methods of the Romans. Increased use of land for pasture favoured certain ground beetles adapted to dry conditions (e.g. *Agonum dorsale* and *Dromius linearis*) and certain seed feeders (e.g. *Amara* species and *Harpalus rufipes*). Another difference was the decline in certain members of the *Onthophagus* genus, a type of dung beetle, which had been as common as *Aphodius* in pre-Iron Age times (Osborne 1969). The beetles have similar requirements, although *Onthophagus* species are commoner, today, in the south. The reasons for the subsequent rarity of this genus are complex, both climate (Osborne 1997) and land management changes may be involved (Dinnin 1997). Root feeding beetles were common in grassland, although this had already been the case in the Iron Age, when populations of *Phyllopertha horticola* may have reached pest proportions in Lincolnshire pastures (Dinnin 1992).

There are increased numbers of phytophages of plants of disturbed ground in Roman assemblages compared to earlier. This does not of itself indicate crops, as these may have been feeding on weeds, but the botanical evidence provides support for arable farming. There is also evidence for this from the aquatic environment, as not only were terrestrial species affected by the disturbance of the ground cover. Runoff from the land led to a silting of the rivers and local extinctions of Elmid beetles, which favour a clean, stony bottom (Osborne 1997).

On rural sites, the assemblages show a degree of uniformity, with signs of a mixed farm economy ,

> "Outdoor sites have yielded assemblages typical of a mosaic landscape with

> a pasture, arable, hedgerow, and scattered trees, ...for the last 2000 years, the landscape of lowland Britain has remained more or less as we see it today, with agricultural land of all types expanding slowly at the expense of what remained of the forests." (Osborne 1978, 34).

Further work, using techniques like Robinson's (1983a) measurement of pastoral/arable ratios (see Section 4.1.2.2), may show that there were differences between the farms (Buckland 1986).

Although grain was stored in above ground granaries during the Roman period, and therefore the conditions were probably suitable for infestation by grain pests, none have been found so far on villa sites in the South Midlands area (Robinson and Wilson 1987). However, in his review on the dispersal of grain pests, Buckland (1981b) noted several instances of *Oryzaephilus surinamensis* and *Sitophilus granarius* from 4th century rural sites. He did not generalise about distribution as he felt that not enough material had been examined. The situation is very different in more densely populated areas: -

> "It seems likely that grain pests were a normal component of the "background fauna" of Roman towns in Britain" (Hall and Kenward 1990, 411).

Huge numbers of the grain beetles, *Oryzaephilus surinamensis, Cryptolestes ferringineus, Palorus ratzeburgi* and *Sitophilus granarius,* were found in a building interpreted as a Roman granary in York (Kenward and Williams 1979). Many Roman urban assemblages, from a range of features, are characterised by large numbers of grain pests, with the four beetles named above most commonly found (see Table 13.2). All the grain pests most common in the Roman period are thought to have been introduced at that time.

The presence of large numbers of these beetles in the Colonia at York was explained by the supposition that the area excavated was the site of the stables, and that grain was used as animal feed (Hall and Kenward 1990). Indeed stable waste appears to be the main type of organic waste tolerated by the Romans (Hall and Kenward 1990, 400-404) and thus was allowed to build up, which may explain why these beetles were so prevalent at that time. It is surprising that no grain pests were found at Silchester and Caerwent (Amsden and Boon 1975).

A characteristic "house fauna" had developed which was very similar to that found in late medieval times. A list of these synanthropic species is given in Hall and Kenward

(1990, 398) based on analysis from a number of sites reported in Kenward (1982). The authors believe that, in Roman times, this fauna may not have been associated with domestic buildings, but with outhouses such as stables. They also omit *Mycetaea hirta* from this grouping, although it was present, and is definitely a member of the medieval house fauna (Kenward and Allison 1995). The blind burrowing beetle *Aglenus brunneus*, was present, probably more associated with grain stores, and, therefore, not as widespread as it became in the medieval period when conditions became much more favourable to it (Kenward 1976a).

In towns, drainage ditches are frequently sampled for insects. The very presence of these in Roman towns shows that land drainage was extensively carried out, thus restricting the conditions in which organic material could survive. Nevertheless, the amount of bone remaining in surface deposits can be used as an indicator of organic matter and, by this criterion, most parts of Roman York were very clean (Hall and Kenward 1990, 389). According to Jurion (1890) there was a cult of cleanliness in the Roman Empire. Human waste was often removed by sewers and although little is known about rubbish collection, even in well-researched York, some kind of organisation must have been present (Addyman 1989). Domestic rubbish pits are not common but piles of refuse have been found in certain areas by the river (Addyman 1989). The only type of organic waste allowed to accumulate, appeared to have been horse manure.

Nevertheless, an array of decomposers is found associated with urban Roman assemblages (see Hall and Kenward 1990, 392-394). Most of these were probably native, moving from natural to artificial accumulations of organic matter (Kenward and Allison 1997), and of the three examples, which Hammond (1974) suggested were Roman imports, only one *Cilea (Leucoparyphus) silphoides* still stands. The others have since been found on prehistoric sites in this country (Girling 1984). From work on Roman faunas described in Chapters 13 and 14, it emerges that *Megasternum obscurum* was a very characteristic member of the decomposer fauna, both in rural and urban settings.

> "It appears that Roman "urban" settlement produced rather similar conditions wherever it occurred, in England at least" (Hall and Kenward 1990, 393).

So, there are characteristically Roman faunas of both town and country.

5.3.2 EARLY MEDIEVAL PERIOD

Most of the insect assemblages from the early medieval period (i.e. post Roman to the Norman Conquest) date from 9th to 11th centuries and have been from towns. Again, the most extensive studies have been in York (Hall *et al.* 1983b; Kenward and Hall 1995). The higher than present temperatures of the Roman period persisted into this era and in addition local climate in towns may have been raised by up to 5° C by the fermentation of organic material (Addyman *et al.* 1976). Nevertheless: -

> "The records give a strong impression that climate and geography had little influence on the distribution of urban insects in North Temperate Europe in the medieval period." Kenward (1988, 120).

Thus, although several instances of beetles north of present day limits are noted, (Hall *et al.* 1983b), they are not claimed as due to climate change.

Floor deposits and other surface layers have been extensively examined as well as pits, in which domestic rubbish and cess dominated the fills (see Fig. 5.6). There is a theory that the Roman cult of cleanliness was considered decadent after the fall of the empire (Jurion 1890). Kenward *et al.* (1978, 67) described Jorvik (Viking York) as:-

> "a town composed of rotting wooden buildings covered by decaying vegetation surrounded by streets and yards filled by pits and middens of even fouler organic waste."

The disposal of human excrement appears to have been a problem at that time in urban settlements, as excavations show that any empty hole in the ground became cess filled and, therefore, decomposer beetles abounded.

Not only is there much evidence of piles of decomposing rubbish but many Viking floors were more like compost heaps (Hall *et al.* 1983b, Kenward and Hall 1995; Coope 1981. It has even been suggested that fermentation was encouraged to provide a sort of "central heating" (West Stow Environmental Archaeological Group 1974). This group was working on an early Saxon site, and were speculating on the function of the under floor space in a "grubenhaus" but Coope (1981), independently, thought that this explanation might be applicable to Viking floors.

The most characteristic decomposer species were small staphylinids: *Carpelimus bilineatus, C. fuliginosus*; oxytelines, especially *Anotylus complanatus* and *O. sculptus, Platystethus arenarius* and *Neobisnius villosulus.* These may have the ability to withstand oxygen deficiency, toxic salts, and fouling by sticky material (Kenward and Allison 1994). They had been present in Roman towns but are not so prevalent in those assemblages (see Chapters 13; 14). Today, *Carpelimus* species and *Neobisnius villosulus* are only found in their original waterside habitat, as the highly organic conditions of the medieval town are rare in the contemporary urban setting. The commonest scarabaeids were *Aphodius granarius* and *A. prodromus*; both species, which can live in decaying vegetation as well as dung. Other decomposers such as *Trox scaber, Acritus nigricornis* and *Aglenus brunneus* were common. The latter is thought to have inhabited mouldy vegetation on floors or other accumulations of rubbish (Kenward and Hall 1995), it is rarely found today. The other house species were less frequent, with the apparent absence of one, namely, *Tipnus unicolor* (Kenward and Hall 1995, 662), which is discussed later (see Chapter 12).

The grain pests were also absent in the early medieval period. The few records of these "missing" species may be contaminants (Kenward and Hall 1995, 760). Field beans were now a part of the diet (Hall and Kenward 1990, 409) and *Bruchus rufimanus*, the bean weevil, is commonly found at this time, often turning up in cess deposits.

Most of the work of this period is from Coppergate in York, and this was an area where dyeing took place, a notoriously messy process (Biddle 1990). Nevertheless, studies from other areas colonised by Vikings including Norwich (Allison & Kenward 1994); Lincoln (Carrott *et al.* 1995c); Dublin (Coope 1981); Oslo (Kenward 1980); Germany (Koch 1971); the Northern Isles (Sadler 1991); Iceland (Buckland *et al.* 1992; Amorosi *et al.* 1994;) and Greenland (Buckland *et al.* 1983) all have very similar faunas. There is a paucity of Saxon data and, although, what there is fits into the same general picture, some differences, due to different cultural practices, may emerge with further study. A possible example of this is described in Chapter 13, regarding a type of pit fauna.

5.3.3 LATE MEDIEVAL PERIOD

A period called the "Little Ice Age" occurred from c. 1350 to 1850 (Grove 1988, Stuiver *et al.* 1995). The affect this had on beetle populations is not known. The sampling of anthropogenic features has been accompanied by a paucity of samples from contemporary natural deposits (Hammond 1974; Atkinson *et al.* 1987, Wagner 1997) and, without artefacts, it is more difficult to securely date them. So, not only is it difficult to attribute cause of extinction to climate change but, even for species unlikely to have been affected by humans, the lack of records may render the date of the disappearance uncertain. Osborne (1997) cites the disappearance of *Gyrinus colymbus*, as the only genuine casualty of that time. Girling (1981b; 1984a) recorded this whirligig beetle from 13th century Leicester and it has not been found since in this country. However there are very few records of any whirligig beetles in the archaeological record and even the modern continental records of this particular species are very scattered (Wagner 1997). In other words, there is insufficient evidence to pinpoint its demise to a particular time in history.

At first conditions in towns were similar to the previous period. Robinson and Wilson (1987, 63) described 12th to 13th century Oxford: -

> "The main impression given by the Coleoptera from the urban samples is of filth and decay. ....There was a great input of organic material to the towns: crops, timbers, straw, miscellaneous material such as bracken and gorse. The ultimate fate of much of this material was for it to decay or become ordure."

In Winchester all kinds of waste were dumped in the street, including the contents of privies (Keene 1981). This was despite the fact that many lined cesspits had been constructed which were emptied "with passable regularity" (Keene 1981). However, only the rich would have had their own sanitary arrangements, the poor were supposed to go to the public facilities. There were public latrines in Winchester, which consisted of planks with appropriate holes in placed over streams (Keene 1981). Similarly London had many public conveniences (Sabine 1934). However, cleanliness improved throughout the Middle Ages in the towns (Platt 1976). In York, for example, conditions returned similar to those, which had pertained in Roman times. No biological study has yet been published from that city, for this period, but the supporting evidence has been found (Addyman 1989). Streets were paved and cleaned by the authorities from 13th century. Cesspits were lined and their contents carried away at night and drainage was improved by the 14th century. The reduction in the labour force from the outbreaks of plague, which occurred quite frequently in the 14th century, meant that fewer cesspits were dug. In any case the odours from them were thought to be infectious and internal cesspits went out of fashion. Human excrement was removed nightly, hence the euphemism "night soil," (Platt 1976).

There is evidence from Winchester that floors were normally swept clean but layers of rubbish would build up in abandoned buildings (Keene 1981). Unfortunately, floor deposits from buildings of this period have rarely been sampled, but indoor fills, especially from internal cesspits, contain large numbers of "house fauna" beetles. These show a resurgence of *Tipnus unicolor* and *Mycetaea hirta*. The increase of the former beetle is thought by Kenward to indicate longer-lived buildings (Kenward and Allison 1995).

The commonest urban feature type sampled in this period is the cesspit (see Fig. 5.6), which is a good repository for grain pests. These reappeared, but only two species, namely *Oryzaephilus surinamensis* and *Sitophilus granarius*, are commonly found, although no authors so far, have remarked on this fact (see Chapter 12).

Cesspit faunas tend to be restricted and provide little information about outdoor habitats, while the other main feature, sampled for insects from medieval and post-medieval times, is the opposite. These are assemblages extracted from moats, which surrounded manor houses or monasteries and received some ejectamenta from the buildings as well as accumulating rural or even natural faunas. Although the assemblages are stratified, absolute dates are often difficult to ascribe. Several (e.g. Wagner and Pelling 1995, Hall *et al.* 1996) provide the main sources of comparison with prehistoric natural faunas and may give evidence of extinctions due to climate change e.g. *Gyrinus colymbus* (Girling 1981a).

5.3.4 COMPARISONS WITH MODERN FAUNAS

Due to large lacunae in the record, the dates of post-medieval changes to the fauna are largely unknown. The impact of humans on the environment has increased greatly in recent times, resulting in impoverishment of the insect fauna (see Dinnin and Sadler 1999, Table 8). Modern methods of agriculture, with the emphasis on high yields and low costs, favour large-scale enterprises, specialisation and mechanisation. This has led to the removal of hedges and "waste" land and the growing of monocultures, necessitating the widespread use of herbicides and insecticides (Hammond 1974). These developments have had "a more deleterious effect on the insects than all the events of the last ten thousand years" (Osborne 1997, 197). The accelerated rates of peat extraction and land drainage have caused many species inhabiting wetlands to become endangered in this country. The creation of seaside resorts and other coastal developments have adversely affected species of sandy soils, especially as many inland heath habitats have also been destroyed (Hammond 1974). The deterioration of climate in the "Little Ice Age" of the late and post medieval period may have accelerated the loss of species, already under pressure from agricultural and industrial processes (Dinnin and Sadler 1999).

Towns have become cleaner, although they may still suffer from high levels of air pollution. However, this has been found to have little affect on the beetle population (Davis 1982). Houses have become warmer and drier and the commonest house pests are dermestids, for example, *Anthrenus verbasci* and *Attagenus pellio.* These can digest the keratin in animal hair and hence eat woollen carpets. *A. pellio* has been recovered from early Holocene deposits (Dinnin 1997) but dermestids are rare in archaeological assemblages, which may reflect their preference for dry conditions more than their abundance.

When archaeological assemblages are compared to modern, it is often found that, while the genus has remained the same, the most commonly found species has altered. So that the spider beetle, *Ptinus tectus* is commonly found in buildings instead of *P. fur* (Hickin 1964). In this case, the replacing species is a recent introduction from Australia (Hammond 1974), first recorded in Europe in 1892 (Hickin 1964), its success is probably due to the warmer, drier habitat provided by modern housing.

The commonest oxytelines today are *Anotylus tetracarinatus* and *Oxytelus laqueatus* (Kenward 1988). The reasons for the differences from the members of that group common in medieval times, namely *A. complanatus* and *O. sculptus*, must be connected with changes in the disposal of human sewage. The reasons for other changes are not known. For example, the ground beetle *Pterostichus madidus* "the most familiar of back-garden beetles in Britain" (Hammond 1974, 332) has replaced *P. melanarius* (Kenward 1982) as the most frequently found congener. Similarly, the food pest *Tenebrio molitor* has replaced *T. obscurus* and the synanthropic darkling beetle, *Blaps mucronata* has replaced *B. lethifera* (Kenward 1988). The latter two species, were, probably, both introduced initially by the Romans. Some beetles have become common, including the eurytopic ground beetle *Abax parallelopipedus* (Kenward 1988) and *Barypeithes pellucidus,* which "has exhibited a dramatic expansion of range in the past fifty years" (Hammond 1974, 345). These recent changes are further discussed in Chapter 11.

5.4 DISCUSSION ON FAUNAL DIVERSITY

These studies show that many similarities between contemporaneous archaeological faunas occur. One of the reasons for this must be due to the nature of the culture steppe species involved. These: -

> "are typically eurytopic, predaceous or polyphagous species with high dispersal potential" (Dinnin and Sadler 1999, 556).

These characteristics can be traced back to their origins in ephemeral forest clearings, a habitat, which favoured opportunist species, adapted to seek out and rapidly colonise new ground. There will also be similarities between the sites in which entomological material is preserved. They will tend to be situated in low lying areas near rivers. However, the lack of data hampers the recognition of geographical variation. Possible examples are considered in Chapters 13, but it is often not possible to separate out those features, which may be characteristic of a particular site, from those due to period. This is due to insufficient entomological material for comparison.

Some differences in faunas over time can be ascribed to cultural changes and others may be due to the spread of newly introduced species. However, the reasons for many of the recorded changes in faunas are unknown and further work both ecological and archaeological is needed to elucidate these problems.

5.5 CONCLUSIONS

Urban faunas from the same period exhibit many similarities, regardless of geographical location. However, most of the archaeological studies to date are from the north of England and in particular from York. There are less data from the south and far north of Britain, making it difficult to assess changes, which may occur due to climate or cultural differences, especially in the early medieval period. The next part of this thesis attempts to redress the balance slightly, with environmental evidence from southern England.

CHAPTER 6: Introduction to entomo-archaeological studies and experimental work from southern England

6.1 INTRODUCTION

Chapters 7-11 describe archaeological and modern analogue investigations carried out by the present author. Most of the work on urban assemblages in this country, so far published, comes from the north of England (see Chapter 5). In addition, the majority of early medieval studies, so far, have been from areas of Viking settlement. In order to redress the balance, some work was undertaken on sites in two Saxon towns, Winchester and Southampton, in the south of the country. Further work was carried out on later deposits from these towns, including two from the time of the Norman Conquest. There has been little material studied of that date and as changes, wrought by the invaders, may have affected the indigenous Coleoptera, it is an important period to investigate. The late medieval investigations are of the entomological contents of garde-robe pits, a little recognised category of cesspit. One of these pits provides the data for an investigation of variation in the samples extracted from different levels.

Another study, of a pre-modern fauna from an extant medieval building from Chichester, is used to provide some direct evidence of the composition of "house" faunas, especially those found on floors. The dating of this material was not possible, but the characteristics of medieval and modern floor faunas were discussed.

Experimental work was undertaken on the characteristics of cesspit faunas by use of a modern analogue. Some choice chamber experiments were carried out using *Aphodius* dung beetles, to test their preferences for particular conditions. The aim was to investigate the taphonomic processes involved in the formation of an assemblage in a cesspit.

Changes, which have occurred in the native Coleopteran fauna, were also examined. A comparison was made between the beetles identified from a Saxo-Norman rural pit sample and a collection of present day beetles, from a similar area. The cesspit study also provided a source of data for this purpose. The beetles, which had collected in a control pit, not only allowed an evaluation of the differences in faunas due to pit contents, but could also be compared with other contemporary garden faunas.

6.2 METHOD OF EXTRACTION

The insect remains were extracted from the samples, using the paraffin flotation method pioneered by Coope and Osborne (1968) and described in more detail by Kenward *et al.* (1980). However the sieved material, after thorough washing in detergent was often stored in water before sorting and not alcohol. Sufficient material, i.e. between 2-5kg, was examined to give an assemblage size of between 100-300 individuals. Several flotations were carried out on each subsample, until chitinous material no longer appeared in the flot, but checks on the residue for remaining sclerites were not made. This was because any losses due to incomplete extraction would be random and so could be ignored. The sorting dish was divided into a grid system to aid more rigorous examination during the sorting process. Loss of sclerites will have occurred here also, but again these losses will have been random. Diagnostic insect parts were placed on moist filter paper and identified under a binocular microscope at magnifications from X20 to X60. It was found that the sclerites were less brittle and distorted if they were kept in water until after identification, then they were preserved in IMS (100% methlylated alcohol). This was only possible if specimens were kept for a short time, i.e. a few weeks, before identification, otherwise they deteriorated.

6.3 IDENTIFICATION AND RECORDING OF DATA

Identifications were checked by reference to modern specimens in the author's own collection and at the Booth Museum in Brighton, Sheffield University and Doncaster Museum. Nomenclature follows that of Lucht (1987) and abbreviations used follow Joy (1932). Identified species of Coleoptera have been listed in both taxonomic and rank order. In addition to counting the recovered sclerites by the minimum number of individuals represented (MNI), when identification was only achieved to higher taxonomic levels, the minimum number of species represented (MNS) was recorded. An ecologically based classificatory system was also used for each taxon so that the faunal assemblages could be separated into communities from different habitats. These groups are designated "eco codes" and the abbreviations used for the various categories are described in Fig. 6.1.

6.3.1 ECOLOGICAL CLASSIFICATION SYSTEM

The problems involved in devising a universal classificatory system, based on ecological evidence, have been discussed in Section 4.5. This present system is based on selected main habitat types, sub-divided where necessary. It is described in a flowchart (Fig. 6.1). The chosen categories are anthropologically based. Thus the artificial habitat "building" is used as is a "stored food" category. This system involves some loss of information, as, for simplicity of use, there are a limited number of habitats used and any taxa, which do not fit, are placed in an unclassifiable group. The work, done by the EAU in this area, has been invaluable in allocating categories, especially in cases where there are no modern analogues to ancient habitats. The Bugs database, which gives ecological information from a number of sources, was also very useful in assigning these eco-codes.

Although, it is possible to display the numbers in each of the sub-habitats, shown on the left hand side of the chart (Fig. 6.1), in fact, due to the small numbers involved, usually only the rotting matter category is subdivided, making thirteen groups in total. The division of the whole fauna into indoor and outdoor species is not made, as in the scheme from the EAU. Nevertheless, roughly the same result is achieved, as the categories representing the surrounding conditions; i.e. water (AA), ground conditions (GD, GX) and type of land use (GA, GP, TT) are nearly equivalent to Kenward's (1978) "outdoor" category. These are coloured on the charts in shades of blue and green to distinguish them from the other main group, the decomposers, coloured in browns.

Kenward (1982) sub-divided the decomposer category, into its two extremes of foul, wet and dry, and mouldy, leaving the remainder in a general decomposer category. Using the information in the Bugs database, a further category, for species inhabiting decomposing plant material or compost, which is between the wet and dry, was added by the present author (see Section 4.2.1). This would be a distinctly different habitat, the coarse plant fibres make the substrate less "sticky" and more porous, and so different beetles could colonise it. All four decomposer groups, the three specific and the general category are represented in shades of brown on the charts.

In the latest work from the EAU (Kenward and Hall 1995), higher taxa are not usually allocated a group, whereas in this system, they have been, where possible. The category, for species associated with buildings, is one not used, as such, by the EAU. It is difficult to use, because many of the species associated with buildings are mould feeders and are also able to live in haystacks or other outdoor habitats. Similarly, the timber pests found in houses can also be found on dead trees in the wild. However, this category is very useful in assessing the influence of buildings in interpretation. It could probably be enlarged to include more Corticariinae, for example. Due to the fact that this group merges with the dry decomposer group, many of whose members also frequent buildings, the two groups have been placed next to each other on the charts. Following the "house" group are the food pests, there is some ambiguity about one genus of these beetles in particular, namely *Bruchus* species which may have been caught in the wild and not in stored food.

Much useful information is lost by using this system, as beetles indicate conditions and not habitats. Therefore, in the interpretation of specific assemblages, it is usual to make assumptions about the probable habitats of certain taxa based on the characteristics of the whole assemblage and other known details. In this work some assumptions have been made in this respect regarding the author's own work, and these are noted in the text.

6.3.2.1 Further ecological classification

Habitat data have been shown to be of limited use but more information can be obtained from other aspects of beetle ecology. In particular, behavioural (burrowing in the ground or running on the surface) and food preferences (mould, carrion or plants). For example, this enables many phytophages, whose members are associated with a particular family of plants (e.g. *Phyllotreta* species feed on Cruciferous plants), rather than a wider habitat, to be included. Therefore, a second system was added, grouping beetles by habit. The codes for this second classification system occupy a second column enabling the data to be sorted both by habitat and habit. This system is displayed in Fig. 6.2.

It is not necessary to use all the components of it each time and other categories could be added. An obvious omission is a predator category, which has been omitted for lack of data. This group tends to be very mobile and forms a high proportion of the "background rain" species. A mobility component would also have been very useful in this respect but again there is insufficient evidence of dispersal characteristics in the literature. These factors are useful in determining the special characteristics of different feature types and the characteristics of "background rain" species.

6.4 METHODS USED TO COMPARE ASSEMBLAGES

Where assemblages of different sizes are compared, this is accomplished by using the numbers of individuals in the assemblage expressed as a percentage of the total minimum number of individuals. Numbers are adjusted so that no species has more than 10% of the original total number of individuals (see Section 2.3.3.3).

The proportions of the different habitat and habit groups represented by each assemblage are expressed as percentages of the total assemblage size. They are displayed as column charts, thus enabling assemblages of different sizes to be directly compared. The width of the columns is not significant since it relates only to the number of assemblages in the comparison.

These methods of presentation are applied throughout the text and further details of analytical methods are described in the relevant sections.

CHAPTER 7: Entomological evidence from Winchester

7.1 INTRODUCTION

This chapter examines the environmental evidence from an excavation carried out between 1987 and 1988 in the centre of Winchester (see Fig. 7.1). The 0.7 hectare site, which was between Upper and Middle Brook Street and St. George's Street, had recently been a car park and was awaiting development into a shopping complex to be known as "The Brooks" (Fig. 7.2). It was known that the site was located within the Roman town walls and, as well as Roman remains, there was evidence of Saxon occupation. From the 13th century the buildings were well documented (Keene 1985). The house of the wealthy wool merchant, John de Tytyng, and a tenement, occupied at one time by a fuller, both lay on this site. The area was low-lying and a tributary of the River Itchen originally flowed over the west side of the site; several attempts at drainage had been made at different times. Environmental remains such as plants and insects were often preserved, because of the waterlogged ground, and samples for analysis were taken during excavation.

7.2 THE SAMPLES

The present author had not been involved in the excavation. The 5kg samples had been stored in a double layer of polythene bags and kept in unheated wooden huts for two years before analysis. There was evidence of modern contamination in one of the samples analysed.

The EAU had carried out a preliminary investigation to assess the biological potential of this site. In some cases, they investigated samples from the same features as the present author. As well as insects, the EAU examined the material for plant remains and parasitic eggs (Carrott *et al.* 1996). Some of their results have been incorporated in this analysis. Features not studied by the EAU lack information about the plant content, except where identification is obvious to the non-specialist, and no further work was undertaken to look for gut parasites. This is a pity, especially as the first archaeological site, from which nematode parasites were isolated, was at Winchester (Pike and Biddle 1966). The archaeological details about the site are taken from Scobie *et al.* (1991).

The Roman samples represented a sequence of layers within early drainage ditches, on the eastern end of the site, where full excavation of these features was possible. The Late Saxon and early Norman samples were mainly from pits, with a high cess component, although other waste may also have been included and one sample from a floor was examined. The late medieval samples were also predominately cess, and were from an internal cesspit and a waste-filled ashlar-lined tank. All the medieval samples, which contained insect remains, came from the trench fronting Upper Brook Street on the western side of the site (Fig. 7.2).

Table 7.1 shows sample and context details and Table 7.2 gives a list of the Coleoptera from the site.

7.3. THE ROMAN PERIOD

The earliest features uncovered on this western part of the site were postholes and other features, all thought to be of Roman date. These were covered by a layer of Roman ploughsoil above which were traces of wooden buildings, which had often been obliterated by later development. This is the case in *Insula* XX111, the area to the north of the site. The term *Insula* refers to an area within the grid system of a Roman town, which is surrounded by roads (see Fig. 7.2). The first buildings, to leave substantial remains, were timber built and of beam in trench construction, in *Insula* VIII. They dated from late 1st century and fronted onto the street running north/south between *Insulae* VIII and IX. The street crossing it, running east/west between *Insulae* XXIII and VIII, was the one associated with the sampled drainage ditches (1706; 1697). The area investigated for insect remains was near the point where the two roads crossed, at the side of one of the houses, which was contemporary with the early ditch (1706) (see Fig. 7.3). From the pottery evidence, the recut (1697) was dug about fifty years later, and at this time the timber buildings were still in use. Both channels were lined with oak planks and, it can be deduced from the amount of rubbish they contained, that they were open features. The flow of water was to the east where it drained into another tributary of the River Itchen. The ditch cuts through a ridge of higher ground between the river and the marshy land to the west. As well as throwing household refuse in the ditches, more constructively, some of it was deposited down the slope at the back of the houses, helping to raise the level and make the area more habitable. The ditches probably went out of use in the middle of the second century.

7.3.1 SAMPLE DETAILS

The Roman samples represented a sequence of contexts from the drainage ditch, [1706], or its replacement [1697] (See Fig. 7.4).

The sample material consisted of water-worn deposits, granular chalk with dark, sticky silt; and contained few and poorly preserved insect remains. After processing these were very fragmentary. Sample 897 from the top of the first ditch was the best preserved.

7.3.2 THE FAUNA

Only the beetle remains were identified, although a few other insects, such as Hemiptera, were present. Many fragments could only be identified to genus and some were not identified at all. There was a bias towards more easily recognisable beetles and those with more durable sclerites. Not all samples were fully examined, because of the low numbers and poor preservation. No sample yielded an assemblage of a hundred beetles, the minimum size considered to be representative (Kenward 1977a), thus inter-context analysis was not possible, although by combining information from all contexts some useful comparisons could be made with other sites. A list of the recorded taxa is shown in rank order in Table 7.3. The habitats represented by the beetles were classified according to the system described in the previous chapter and are displayed in (Fig. 7.7).

The small mud–loving species, *Platystethus nitens*, dominated these assemblages. To some extend its prominence may be due to its small size and distinctive thorax, which was normally preserved intact and was thus easy to identify. However, other members of the genus, with similar habits, namely *P. degener/cornutus* and a rarer member *P. alutaceus*, were also present. The two closely related species *P. degener* and *P. cornutus*, are distinguishable by their elytra, and some examples of *P. degener* were definitely present and all may have been of this type. This species may be more typical of more organically enriched mud than *P. cornutus* (Hammond 1971). Even so, these congeners are indicative of muddy areas, which have not been fouled by cattle. This is reinforced by the presence of other beetles preferring damp situations, such as *Trechus micros* and a beetle from the genus, *Bledius*.

There were low numbers of aquatic and aquatic marginal species recovered from these samples, they formed only 3% of the total assemblage. This may have been partly due to the poor preservation, as aquatic species tend to have thinner cuticles then their terrestrial counterparts as they are not in danger of dehydration, and so they would decay more easily. *Helophorus* is the commonest water beetle identified from these ditches. Although some species are terrestrial these are easy to separate from the aquatic species by their ridged elytra. Aquatic species of *Helophorus* are well-known colonisers of temporary water bodies, as they are good fliers and are attracted to shiny surfaces. Another beetle, *Berosus affinus*, had been found both at the bottom of the original ditch and in its recut, signifying detritus-rich stagnant water (Koch 1989). The presence of *Limnebius truncatellus* in these ditches is interesting since, although the evidence is contradictory, the main view is that this species is stenotopic and is found in clean, running water, especially at springs (Friday 1988; Koch 1989).

Nearly 40% of species present were decomposers. Individuals of *Cercyon* species, *Sphaeridium* species and *Oxyomus sylvestris*, were recovered from most contexts and these inhabit wet foul decomposing matter. The high numbers of *O. sylvestris* retrieved must be partly due to the distinctiveness of its elytra. Various species of oxytelines, belonging to the following genera: *Anotylus*, *Oxytelus* and *Carpelimus* and other staphylinids, namely *Gyrohypnus fracticornis* and *Xantholinus longiventris* were also widespread in these ditches. These very mobile beetles actively seek out rotting matter. Several species of dung beetle were present, including various species of *Aphodius* and an individual belonging to the genus *Onthophagus*. Among the Aphodini, was *Heptaulacus testudinarius*, which is now rare (Shirt 1987).

Some plant feeding beetles were found although, due to the poor nature of preservation, many could not be identified to species. Although weevils tend to predominate in poorly preserved insect assemblages, because of their robust exoskeletons (Kenward and Large 1995), few occurred in these faunas and even fewer were identifiable. Most of the phytophages identified are associated with weeds or crops of cultivated land. The small weevil, *Ceutorhynchus erysimi*, feeds on Shepherds Purse, (*Capsella bursa-pastoris*), (Bullock 1993) which is a common weed of open ground. Many members of the genus *Apion* are associated with leguminous plants such as clover. Members of another phytophagous group, which were recovered, were flea beetles, of the genera *Phyllotreta* and *Longitarsus*. The former attack Brassiceae, some of which may be crops or weeds of disturbed ground. It is surprising that no phytophages specifically associated with marshland plants were identified given the low-lying marshy location.

The presence of *Brachypterus glaber* signifies nettles, a weed of organic rich waste ground but one which is not without its uses. Pliny writes: -

> "What can be more hateful than the nettle? Yet this plant ... simply abounds in remedies," (Pliny trans. W.H.S.Jones 1969, 315)

He goes on to give a long list of its properties, which include a cure for gout, baldness, prolapse of the womb and healing ulcers. As well as its diverse medical uses, it makes a "*not unpleasant food*" (Pliny trans. W.H.S.Jones 1969, 229). It is an indicator of phosphate-rich soils, which form after human settlement. Nettles were still growing in the water meadows around Winchester in medieval times and continue to this day (Green 1979).

A number of synanthropic beetles were found, especially in the upper two levels of these ditches. Some of these beetles will also be in the category marked "mouldy", at the dry end of the decomposer group. "House" species formed 10% of the total assemblage. One possible specimen of *Bruchus rufimanus* was also found, this feeds on field beans and is an active flier (Jones and Jones 1974).

7.3.3 COMPARISON WITH THE ARCHAEOLOGICAL RECORD

The paucity of aquatic species is not confined to these poorly preserved specimens, it is a not unusual feature of drainage ditch faunas generally (e.g. Girling 1983; Koch 1971; Hall *et al.* 1990; Kenward 1979a). Apart from *Helophorus* species, which are colonisers of temporary water bodies, no other species occurs frequently enough in ditches to be diagnostic of them, although various stagnant water species are found occasionally (see Chapter 14). The presence of *Limnebius truncatellus*, indicative of fast, clean flowing water, is unexpected. Nevertheless it occurred, in similar conditions of slow flowing or stagnant water, in a Roman drainage ditch at Towcester (Girling 1983) and a medieval moat at Cowick (Girling and Robinson 1989). Possibly the right conditions occurred upstream of the ditch in the River Itchen. *L. truncatellus* has also been previously recorded in a Saxon pit in Winchester, where it may have been thrown in with water (Osborne unpub.). It is now common in most clean flowing water in the south of England (Sadler pers. comm.).

Stagnant water is potentially a hostile environment for several reasons; firstly, it lacks oxygen, because it is used up in the process of decay, secondly, soluble matter, formed during decomposition, raises the osmotic pressure of the water and thirdly, the substances formed may themselves be toxic. Aquatic beetles are able to survive these conditions better than most organisms, because they do not rely on dissolved oxygen, instead they use air from the surface and their waxy waterproof exoskeleton, cuts down the transfer of water by osmosis. However, there must be a limit beyond which even beetles cannot survive. Alternatively or additionally the ditch may have frequently dried up and aquatic beetles may have migrated, but, even so, the bodies of dead beetles would be expected to remain.

The presence of dung taxa might suggest the proximity of pastureland. Robinson (1983a) has devised a test for grazed grassland using indicator species, i.e. dung beetles, from the genera *Geotrupes, Colobopterus, Aphodius* and *Onthophagus*. He specifically mentions *Heptaulacus* (*Aphodius*) *testudinarius* as not being a good indicator as it may be found on manured fields. From the above listed taxa, he calculated that the proportion of individuals, expressed as a percentage of the total terrestrial beetles, needs to be about 15-20% to be diagnostic (see Section 4.1.2.2). The figure for these ditch-fills is only 6%. All these species are highly mobile and so they may simply form part of the "background rain." Alternatively they may have been introduced in bird droppings, the fragmented nature of the insect remains makes this a possibility.

Sphaeridium is another coprophagous genus present in some numbers in the Winchester ditches, but one, which was not used by Robinson (1983a) as an indicator. However, one of the three species found in this country, *S. bipustulatum*, is less stenotopic and can be found in rotting vegetation (Koch 1989), so the presence of this genus, is also not necessarily indicative of pasture.

Decomposers of wet anaerobic materials, other than coprophages, were also widespread in these assemblages, including *Cercyon species, Megasternum obscurum* and *Anotylus sculpturatus*. These can provide supporting evidence for grazing land (Robinson 1983a) but their high numbers here are more likely to indicate ditches where wet rotting vegetation had collected, especially as *Platystethus arenarius* is missing. According to Hammond (1971), *P. arenarius* is closely associated with dung because it needs a substrate which is finely divided. It was a common member of the "background rain" and has been frequently found in drainage ditches and all types of archaeological features (see Chapter 14). Its absence here is surprising.

All the main species of "house" fauna beetles, found at the Colonia in York and described in (Hall & Kenward 1990, 398), occurred here. These were the mould-eating *Tipnus unicolor*, *Ptinus fur*, *Lathridius minutus*, and unidentified species of *Cryptophagus* and *Atomaria*, the predatory *Xylodromus concinnus* and the timber pests *Anobium punctatum* and *Lyctus linearis*. *Oryzaephilus surinamensis*, also found in the ditch, was one of the four main grain pests common in Roman towns (Hall and Kenward 1990, 398), as grain stores were infested with them. A flightless synanthropic beetle absent from these Roman layers was *Mycetaea hirta*. This species has been found associated with Roman buildings (see Chapter 12), but it was never common. Its absence has been noted, because in the Middle Ages, it was unusually abundant in the assemblages recovered from this town. *Bruchus* species feed on the seeds of leguminous plants and *B. rufimanus*, so common in later deposits, is a pest of peas and beans. They are strong fliers and this individual may be wholly adventitious in this assemblage.

7.3.4 IMPLICATIONS OF THE FAUNA

From the evidence of the pottery, it is known that these ditches were open for a long time, around twenty-five years, and many of the species must have collected in it randomly, forming the "background rain" of species (Kenward 1978a). This would explain the presence of dung beetles, as other evidence, especially from the *Platystethus* species, suggests muddy banks without grazing livestock. Decomposer beetles are abundant probably indicating rotting vegetation as well as being present in the background fauna.

The lack of aquatic beetles is inconclusive but, if it is not taphonomic, it indicates very choked rubbish filled ditches. This might also explain the lack of marshland phytophages from the drained area to the west, as the phytophagous fauna is more indicative of disturbed ground rather than wetland in the immediate vicinity. The archaeological evidence supports this interpretation as there was evidence of ploughing in the surrounding area prior to development. However the coleopteran evidence is weak, because most of the plant-feeding beetles that were identified are very mobile and could have travelled long distances.

The presence of rubbish in the ditches is further supported by the presence of synanthropic "house" species, including the less mobile species such as *Tipnus unicolor* and *Ptinus fur*. These may have been introduced with rejectamenta from the town houses on the south side of the ditch. The growth of the Roman town may be reflected in the higher numbers of synanthropic species recovered from the upper levels of the ditch.

7.4 SAXON AND NORMAN PERIODS

There is no trace of occupation between the Roman and the late Saxon on the western side of this site. It is likely that the drainage system broke down and the area was flooded. There is evidence of this from the partial washing away of the foundations of a Roman building, which once stood facing what later became known as Upper Brook Street. By the late 9th century the whole city was reorganised under King Alfred and water was channelled down each of the three Brook Streets making the area habitable again. There was evidence of buildings and pits of late Saxon and early Norman date, on the whole site but well preserved insect remains were only recovered from the west side (see Fig. 7.2). The poor preservation on the other side could be attributed to the higher ground surface.

7.4.1 SAMPLE DETAILS

The samples consisted of a number of cess-like pit fills and one sample from a floor layer. The specimens from the latter were scarce and fragmented so that it was difficult to identify them fully, but preservation in the pit samples was good. The other samples came from a disused well, a timber-lined pit and an unlined sub-rectangular pit (Fig. 7.5).

The pit contents looked like cess. The samples were dark brown and homogeneous and some of the material was bound up in yellowish amorphous concretions. These dissolved in dilute hydrochloric acid and could have been composed of calcium phosphate, which had been found in similar deposits by Hall *et al.* (1983b). These workers also concluded, that the slurry-like properties of the ground matter, a description also relevant to this material, were due to that fact that it mainly consisted of the indigestible remains of cereal bran, a large component of the contemporary diet. Another typical constituent of ancient cess is fruit stones, presumably ingested with the fruit, and these were present in all samples. Another diagnostic feature was the impressions of grasses on some of the concretions, also found in confirmed cess samples from 10th or 11th century York (Hall *et al.* 1983a) and interpreted as anal wipes. Plant analysis and parasitic worm egg counts, were not carried out on these samples but these investigations were carried out on a similar pit (Pit F1087), which confirmed that that pit had contained cess (Carrott *et al.* 1996).

7.4.2 THE FAUNAS

The four pit samples produced at least 640 individuals of 106 species from 4.25kg of material, while 2.25kg of a deposit from a floor yielded only 6 specimens from as many taxa (see Table 7.1). The faunal lists arranged in rank order from the pit samples are shown in Table 7.4 and histograms, demonstrating the distribution of habitats indicated by the taxa, may be seen in Fig. 7.7.

7.4.2.1 Assemblage from Pit 5799

This sample (275), from the late 9th century, was probably the earliest of the four. It came from a timber lined pit (F5799), within a gravelled enclosure, in which there was some evidence for glass working (see Fig 7.5). At a later date the drainage system appears to have broken down and flooding occurred leaving a 0.3m layer of silt over this area of the site. Following this a late Saxon burial took place over this deposit and the body slumped down into it.

This pit had supported a large breeding fly population, as their puparia were the commonest of the insect remains. It had also been colonised by an interesting group of staphylinids, and the fact that they had been breeding was indicated by the numbers of teneral specimens present. The most numerous of these was *Anotylus rugosus*, which may feed on dipteran larvae (Coacker and Williams 1963). The next two are the smaller species, *Carpelimus bilineatus* and *Neobisnius villosulus*.

The burial may have been the reason for the large numbers of *Rhizophagus parallelocollis*, as it breeds in corpses and also burrows (Peacock 1977). Coincidentally, this beetle and *Coprophilus striatulus*, also present in large numbers, are part of the group of post depositional invaders, identified by Kenward (Hall and Kenward 1990) which frequent pit faunas, even without a body being present (see Chapter 13).

Another interesting beetle in this assemblage was *Gracilia minuta*. This develops in the twigs of deciduous trees, especially osiers, and may emerge from wicker baskets or from wattle (Kauffman 1948).

7.4.2.2 Assemblage from Pit F5961

Sample 281 came from an 10th century unlined sub rectangular pit (F5961), which was not obviously associated with a building (see Fig. 7.5). The most numerous species found within it was *Anotylus complanatus* representing 15% of the fauna, but there was no evidence that it was breeding, neither was there evidence of breeding flies. All other species were in low numbers, the most notable of which, were several examples of *Bruchus rufimanus*, a pest that attacks beans. It can over-winter undetected under the testa of the bean and so it could be easily eaten. The exoskeleton is indigestible and so it would pass through the gut and out with the excrement (Osborne 1983). Indeed, a deformed elytron was found, proving that that beetle had never flown. This species frequently occurs in assemblages from medieval pit fills. One probable specimen had also been found in the Roman samples from this site (see Section 7.3.2).

7.4.2.3 Assemblage from a floor layer

A sample (358) was taken from the floor of a 10th-11th century building, which had had a frontage on Upper Brook Street (see Fig. 7.5. Shallow beam slots and flint packed sleeper walls were all that survived of its structure. The floor were described as consisting of laminated clays and charcoal. The fact that the floor sample contained such scant and fragmentary insect remains probably indicates that they were kept clean. The huge build up of rotting vegetation with their associated faunas seen on some sites in York (Hall *et al.* 1983b; Hall and Kenward. 1995) did not occur here. The specimens include house species, *Xylodromus concinnus*, and *Cryptophagus* species; decomposers *Anotylus nitidulus* and *Rhizophagus* species, some members of the latter genus may burrow into floors. These are all typical of urban faunas of the time but they are far too few of them for any further conclusions to be drawn.

7.4.2.4 Assemblages from the disused well (F5726)

The dates of these fills are not exactly known. This feature started life as a well at the end of the 10th century, based on the date of the timber lining. Sample 236 came from a context immediately above the basal fill, which contained pottery of 10th-11th century date. Sealing the upper context, the source of Sample 228, was pot dating to about hundred years later. It appears, therefore, that this well was abandoned rather quickly and it is possible that all these deposits formed after the Norman Conquest.

Both layers examined contained large numbers of puparia from breeding flies and staphylinids predatory on them. These were *Philonthus* and *Quedius* species especially *P. politus* and *P. cephalotes.*

The commonest beetle in the assemblage from Sample 236 was *Omalium allardi,* it forming 18% of the total number of individuals, but there was no evidence of breeding. This beetle is found in decomposing matter and it is now rare. The decomposer species, mainly oxytelines or *Carpelimus* species, which were common in the earlier pits, were only found in small numbers. This fill also had a diverse collection of carabids. This is interesting, as it is unusual for cesspits to contain ground beetles, although it is common for wells, which this feature once was. Wells can act as large pitfall traps (Osborne 1981b, Buckland 1986). They may have originally formed part of the well sump along with other specimens in this assemblage.

The other sample (228) was much more typical, with a number of individuals of *Oxytelus sculptus,* some *Anotylus rugosus,* as well as *Phyllodrepa floralis.* All these species have been found in rotting materials, including cess. Other decomposer species, less common in cess, were *Cercyon analis, Ptenidium* species, and *Aglenus brunneus.* These beetles, have been associated by Kenward, with a build up of vegetation on floors in Anglo-Scandinavian York (Hall *et al.* 1983b, 200) and they may have come from discarded floor coverings.

Both assemblages had higher numbers of synanthropes than the earlier samples (275; 281) they were more comparable with the late medieval assemblages (see Fig. 7.7). *Mycetaea hirta* was common in both layers and this has been particularly associated with floor deposits (Coope 1981).

Layer (228) contained two beetles not normally found in Saxon deposits, namely the spider beetle, *Tipnus unicolor* and the Saw-toothed Grain Beetle, *Oryzaephilus surinamensis.*

7.4.3 COMPARISON WITH THE ARCHAEOLOGICAL RECORD

Although all the pit assemblages formed in pits containing cess, the commonest species were very different. This fact has also been noted by the York workers who stated: -

> "It is interesting to note the great variation observed in the composition of pit fills confidently regarded as "cess". (Hall *et al.* 1983b, 91)

Especially variable were the numbers of certain small decomposer beetles, such as Oxytelines and *Carpelimus* species, termed "pit colonisers" by the present author. The presence of *O. allardi* is interesting as this beetle has so far only been found on three other sites (Southampton, Chapter 8; Worcester, Osborne 1981a; Hereford Kenward 1985b). The first two were late medieval and the other 18th century, so these Winchester records are the earliest in Britain.

There were also large differences in the numbers of synanthropic species, with later samples having more. This may reflect increasing levels due to urbanisation, more suitable buildings for colonisation or more enclosed latrine buildings. *Mycetaea hirta* was commoner here, both at the present and the Lower Brooks site (Osborne unpub.), than it was in contemporary samples from York. Another beetle particularly prevalent in Winchester, was the staphylinid, *Philonthus politus*, which feeds on fly larvae. It was found not only in these pits but also in the ones from nearby Lower Brook Street, sometimes appearing in such numbers that it may have been breeding (Osborne unpub.).

Gracilia minuta, a beetle, which may be found in wickerwork, has been described as: -

> "having enjoyed a population boom during the early centuries of this millennium, possibly on account of the widespread use of wattle and daub house construction, but has declined almost to rarity today." (Osborne 1984, 165).

Despite this statement, considering the great opportunity for the spread of this beetle, in those times, it has been recorded surprisingly infrequently and only one example occurred here in Sample 275. It has been found spasmodically in post-Roman deposits at The Lower Brooks site, Winchester (Osborne unpub.); Taunton (Osborne 1984); Dublin (Coope 1981); Oxford (Robinson 1981c) and at the Lloyd's Bank site in York (Hall *et al.* 1983b) but, in each case, only in one's or two's in each context. Only in one pit, at the extensively investigated Anglo/Scandinavian site at Coppergate in York (Kenward and Hall 1995) has it been found in any numbers. This beetle burrows into thin dry twigs (Harde 1966) and this may explain why it is rarely found in the wet waterlogged conditions in which beetles are preserved, so the size of the ancient population cannot be gauged.

7.4.4 DISCUSSION

7.4.4.1 The function of the pits

The pits discussed in this section all contained cess but were they originally designed for that purpose? Two types of early medieval pit have been recognised on this site,

> "sub-circular unlined pits of varying depth, which contained material of a domestic nature and a second type timber-lined which appeared to have an industrial function." (Scobie *et al.* 1991, 38)

The latter were square or rectangular, had an internal step and, if large, showed evidence of partitioning and there was also some evidence that there had been planking across the top. Biddle (1975, 316-7) had interpreted two similar pits at the Lower Brook Street site as having had an industrial purpose, and because they were situated in Tanner Street, he thought they had probably been used for tanning. The only evidence cited was the distribution of pollen, which was more frequent and more diverse in species at the base of the pit than in the "peaty" layers of the final fill. This was taken to indicate that the pits had originally been filled with liquid. The entomological evidence indicated "accumulations of decaying organic debris", which could have come from a stable and may have been a mixture of fodder, litter and dung. The presence of a few beetles connected with tree bark in some of the pits gave a "slight suggestion of an association with tanning but this is very tenuous" (Osborne unpub.).

On the contrary, there is good evidence to suppose that the lined examples were latrine pits and their contents original. The position of these structures, throughout the Brooks area, makes this a likely explanation of their purpose, as "whatever function they served occurred on most tenements at this date." (Scobie *et al.* 1991). The timber lining would have prevented the sides collapsing and facilitate cleaning out and large pits may well have been partitioned and multi-seated. The accumulations of decaying organic debris noted by Osborne (unpub.) may have been cess and Biddle (1975) noted straw and tufts of animal hair in them, both materials sometimes used for anal wipes (Murphy 1989). The material in the samples from The Brooks was probably cess also (see above).

When the latrine pits were full, the contents may have been placed in the unlined pits described above. Biddle (1975) records two sets of lined "industrial" pits with associated bare-sided ones, although the evidence for the connection was not given. The two sequences were separated by time. Some evidence for a connection between the contents of each pit sequence comes from the faunas listed by Osborne (unpub.) from the pits described above Biddle (1975, 316-7). One of these lined pits has been used in the investigation into pit faunas (Chapter 13). It contained a type of fauna, which was mirrored in the two unlined pits associated with it. Whereas the fauna in the other lined pit, which was of a different type, resembled that in its associated pit. This suggests that the cess, instead of being dumped simultaneously into disused industrial features had collected in one and been moved into the other.

All the evidence points to the lined pits, investigated so far, as being built as latrine pits, and never having had an industrial function and for the unlined pits acting as depositories of the waste when they needed cleaning out.

7.4.4.2 The re emergence of certain beetles

Certain beetles are not typically found in Saxon deposits. These are *Tipnus unicolor* and the grain pests, *Oryzaephilus surinamensis*, *Cryptolestes ferrugineus*, *Palorus ratzburgi*, *Tribolium* species and *Sitophilus granarius*. All of these species are common in Roman deposits and *T. unicolor* and some of the grain pests reappear in the late medieval period.

The lack of grain pests in the earlier Saxon samples, described above, may indicate that these beetles were absent at that time, as the cesspit is one place where they would be expected to show up, incorporated in the faeces (Osborne 1983). They are found in this feature type in later deposits. "House" species, such as *T. unicolor* are also commonly found in cesspits. *O. surinamensis* and *S. granarius* were reported from a late 10th-early 11th century pit (F1087) on the same site in Winchester by Carrott *et al.* (1996). So the finding of *O. surinamensis* in the top layer (228) of the well, although it predates those from other sites, is probably not the earliest medieval recording, but the record of *T. unicolor* from the same layer is. These findings are discussed in more detail in Chapter 12.

7.5 LATE MEDIEVAL PERIOD

Two samples date from the late 14th century (see Table 7.1). One was from a stone lined garde-robe pit and the other was from a disused well, which had been converted from a circular tank. Other samples from these structures were examined by Jones *et al.* (1991) and Carrott *et al.* (1996). The cesspit was situated within the house of a wealthy merchant (365), originally owned by John de Tytyng and the tank was within the grounds of the Fuller's House (350), which lay behind it (see Fig. 7.6).

De Tytyng's property had been enlarged and extended in the 14th century, when the pit was constructed. It was situated at the back of a room, which had probably been used as a warehouse or shop and it is likely that it serviced a garde-robe opening from the rooms above, as there was no obvious means of access from the ground floor. The external walls of the building were of mortared flint and Chalk, but the upper storeys may have been of timber with wattle and daub infill. There is some surviving evidence of the roof structure, as slates and timbers fell into the top of the pit, when the building was demolished in the 15th century. Welsh slate was used as a building material on high status buildings in this area at that time (Platt 1976).

By end of the 14th century the tenement was owned by William de Langeport and it remained a large and important property. It is probable that the garde-robe was still in use and the final fill was deposited at that time.

The circular tank F5013 lay in a yard, where fulling of cloth took place, at the back of tenement 380. The Chalk blocks that formed the base had been broken through in order to convert the structure to a well and no clues remained of its original function.

Tenement 380 was smaller and less grand that the merchant's house already described. It was probably only one storey high and of flint and Chalk construction. The complete layout is not known, as much of the remains still lie under Middle Brook Street. It was demolished around the end of the 14th century and after that the area became a garden.

7.5.1 SAMPLE DETAILS

As no other environmental investigations had been undertaken on the samples examined for insect remains by the present author, information has been included from the work done by Jones *et al.* (1991) and Carrott *et al.* (1996). Small numbers of fly puparia occurred in each pit and Sample 60 had a breeding population of a nematoceran fly. This was probably post-excavational contamination (c.f. Kenward and Hall 1995), as the other sample (57) taken from this layer, several years earlier, for examination by the EAU, did not contain them.

7.5.1.1 Samples from Pit 5300

Sample 60 from the latrine pit (F5300) was much less obviously cess-like than those discussed above from an earlier period. It was not the foul slurry described by Hall *et al.* (1983b), as earth appeared to have been added to it. No records exist of this practice and it had not been mentioned in any previous research, including that by Carrott *et al.* (1996), who looked at these same deposits, but they did report a slightly sandy texture. It is possible that other rubbish, such as flooring material or kitchen waste was present (c.f. Greig 1982). However, in view of the position of the pit, which was not close to the kitchens, the latter seems unlikely. Food remains, presumably from the faecal content, were found. These included black mulberry (*Morus nigra*), cherry (*Prunus cerasus*), fig (*Ficus carica*) and grape (*Vitis vinifera*), as well as commoner local food plants, which had also been present in F5013 (Carrott *et al.* 1996). Eggs of human gut parasites (*Trichuris* sp.) were also present (Carrott *et al.* 1996). Mineralised plant remains were found in Samples 57 (Carrott *et al.* 1996) and 11399 (Jones *et al.* 1991), interpreted as short lengths of straw and rush (*Juncus*) stems, probably from floor coverings. Remains of another plant in that sample, obviously not food, were the leaves of the ornamental shrub, *Buxus sempervirens* (Jones *et al.* 1991). In Sample 45 there were some unexpected findings. These were large amounts of teasel heads (*Dipsacus sativus*), together with some seeds of the dye plant, weld (*Reseda luteola*), and very small (below 0.5mm) fragments of cloth (Carrott *et al.* 1996). As this is a high status dwelling this evidence of cloth working is surprising, but it is further evidence of the addition of floor sweepings. No remains of 'toilet paper equivalent' were noted.

7.5.1.2 Samples from Pit 5013

The samples from F5013 were less obviously organic and they contained a higher proportion of natural Chalk. They also contained fruit stones, which are typically found in medieval cess and occurred in all other cess samples from this site. The plant analysis by the EAU found remains of mainly indigenous edible species as well as abundant fig seeds (*Ficus carica*) and traces of grape (*Vitis vinifera*) (Carrott *et al.* 1996). Another cess indicator comes from the presence of moderate numbers of eggs of the endoparasite, *Trichuris* (Carrott *et al.* 1996).

7.5.2 THE FAUNAS

Faunal lists in rank order are shown in Table 7.5 and it can be seen that the commonest beetle in the cesspit assemblage (60) was the synanthrope *Mycetaea hirta.* In fact, when the beetles were classified according to the habitats they represented (Fig. 7.7), nearly all were found to be in the "house" or "dry decomposer" sections. Many of those in the latter category are also often found in buildings.

It contained very small numbers of those beetles, common in earlier cesspits, which have been termed pit colonisers, e.g oxytelines and *Carpelimus* species (see Chapter 13). The assemblages from samples (45, 57 and 11399), examined by Jones *et al.* (1991) and Carrott *et al.* (1996) from the same pit, were similar to those from Sample 60 with *Mycetaea hirta* the dominant beetle in each case. They all had quite high numbers of *Quedius mesomelinus*, a predatory beetle found in rotting vegetation and in cellars (Koch 1971) whereas Sample 60 had only contained evidence of a single individual. The other main anomaly between these assemblages was in the species of *Dienerella* present. This very small mould-eating "house beetle" was quite common, as three individuals of *D. ruficollis* were identified from Sample 60 but the six specimens recovered from Sample 45, from the same context, were *D. ?filum.*

The fauna from Sample 49, shared many of the same species with that from 60, but differed in the proportions. The numbers of synanthropes were lower, the numbers of decomposer beetles higher and there were more "outdoor" beetles (Fig. 7.7). In the fauna from the disused tank, the pit coloniser beetles (e.g. *Carpelimus bilineatus* and *Anotylus complanatus*) were more in evidence and *Tipnus unicolor* was the most frequently occurring synanthropic species. The assemblages from Samples 47 and 48 (Carrott *et al.* 1996) were broadly similar in composition.

A few beetles were present from non-decomposer habitats in both features, although more were present in the assemblages from the tank samples. Many of these beetles were of phytophages of cultivated plants or their weeds, such as are found in gardens. Thus the genera *Apion, Sitona* and *Phyllotreta* were present in all assemblages and these may feed on leguminous plants or *Brassicas* respectively. Also present, in Sample 60, was *Helophorus porculus,* the Turnip Mud Beetle, which is not aquatic, like most of the genus, but has been found feeding on turnips (Petherbridge 1928) and in rotting vegetables (Koch 1989). The Summer Chafer, *Amphimallon solstitialis,* was found in the disused tank. Its larva feeds on plant roots; especially those of grasses or cereal crops. The Scarabaeid, *Omaloplia ruricola*, was found in Sample 60. This is an interesting find as it reflects the wider environment. This species is found on downland and it is now scarce (Hyman 1992).

Grain pests had been recovered from both features (Carrott *et al.* 1996). As well as small numbers of *Oryzaephilus surinamensis* and *Sitophilus granarius*, there were also the remains of *Cryptolestes ferrugineus*. This beetle feeds on the damaged mouldy grains (Aitken 1975) and is very common today but has rarely been found in deposits of this period (see Chapter 12).

The bean pest *Bruchus rufimanus* had been present in both pit and tank. All of these most probably had been eaten with contaminated food and the undigested exoskeleton egested (c.f. Osborne 1983).

7.5.3 COMPARISONS WITH THE ARCHAEOLOGICAL RECORD

Similar faunas have been recovered from other late and post medieval cess deposits. In particular the fauna from (60) resembles those from Worcester (Osborne 1981a; 1983), Southampton (Chapter 8) and Moray, Scotland (Buckland 1995), which can be seen in Table 14.7. These are characterised by very large numbers of synanthropes, especially *Tipnus unicolor*, and low numbers of "pit colonisers". This Winchester fauna is unusual in having *Mycetaea hirta* as the most abundant species. This may possibly have been living in the vegetation on the floor, as this beetle is indicative of darker, damper conditions than *T. unicolor*. It was very common in a floor sample from a Viking house in Dublin (Coope 1981).

The fauna from Sample 49 is more like those from the previous period, with more pit colonisers, fewer synanthropic species and more beetles indicating the surrounding environment (see Fig. 7.7).

7.5.4 IMPLICATIONS OF THE FAUNA

The rarity of any beetles from outdoor habitats in the latrine pit (60) and the huge numbers of "house" species suggest that it had been in a very sheltered position. This interpretation was borne out by the archaeological evidence, which suggested that it was a garde-robe pit, which had served an upper room of the house. In this case, there was evidence that flooring materials had been thrown into the pit and this would have increased the numbers of "house" species. It may possibly account for the abundance of *M. hirta.* However, the species, noted as indicating flooring materials in Anglo-Scandinavian York i.e. *Cercyon analis* and *Ptenidium* species (Hall *et al.* 1983b, 200) which had been present in an earlier medieval sample on this site, were not found.

The presence of parasitic *Trichuris* eggs, the remains of edible plants and the whole insect fauna all indicate that the fills (47, 48, 49) from the tank (5013) also contained cess. The plant analysis had revealed food plant remains but nothing likely to have been used for flooring. This may explain the lower numbers of synanthropes, of which the commonest was *T. unicolor*, but does not explain the greater numbers of pit colonising beetles. These factors indicate that this waste did not collect in such enclosed conditions (see Chapter 13). The tank was within the boundaries of Tenement 380 and probably its contents came from a latrine pit at that property, perhaps enclosed in a separate privy building.

The few phytophages and other beetles of non-decomposing habitats in these assemblages indicated surroundings of disturbed ground or gardens.

7.6 CONCLUSION

This study confirms the general trends established by previous work, which was mainly carried out in the north of England. The beetles associated with increasing urbanisation are found within this sequence of samples from Roman to late medieval.

The Roman drainage ditches were filled with rubbish but also contained some species from the surrounding area, which appears to have been disturbed ground. The early medieval pits were cess filled and many species which colonise foul, wet decomposing matter were found in them as well as species which normally inhabit the surrounding buildings and only a few beetles indicative of the wider environment. The later cesspits tended to have even more synanthropes, fewer decomposers and other allochthonous species. *T. unicolor* becomes common as does *M. hirta*, a species that appears to have been particularly frequent in Winchester. These pits are studied further in Chapter 13.

The earliest dates, so far recorded, for the reappearance of the synanthropic *Tipnus unicolor*, and the grain pests, *Oryzaephilus surinamensis, Sitophilus granarius* and *Cryptolestes ferrugineus* come from these assemblages (see Chapter 12). While the first record of *Omalium allardi* in Britain comes from deposits which date to just after the Norman Conquest. As Winchester is close to the port of Southampton, a port, which traded with the rest of Europe, there is a possibility that these beetles were continental imports.

CHAPTER 8: Entomological evidence from Southampton

8.1 INTRODUCTION

This site lay at the corner of Lower High Street and Broad Lane, at the southern end of medieval Southampton (see Fig. 8.1). This area was settled at the beginning of the 10th century after the abandonment of the Saxon settlement of Hamwic, which lay to the East beside the River Itchen. Pits from this period were discovered and one was investigated for insect remains. By the 13th century this district housed the rich merchants who traded in the flourishing port of Southampton.

Houses remained on the site up to the last war but they had been so altered that all above ground evidence of their ancient origins was lost. Then these buildings were destroyed during a massive air raid and the site had been derelict since. Its possible redevelopment prompted the excavation and reconstruction of the collapsed vaults of medieval buildings, which had been exposed by the bombing. The stone vaults of the building, which originally stood at 95-8 High Street, still survived, although in poor condition. This had been a large prestigious establishment, dating to about 1200, originally two storeys high with stone walls and probably a slate roof. It had adjoining courtyard and large garden going back some distance along Broad Lane to the west, and a kitchen at the rear (Platt 1973). Vaults were added at different times and in 1419 it was divided into two tenements. The tenants of this building are well documented and in the 13th century it was the home of one of the wealthiest of Southampton's inhabitants, the wine merchant Walter le Fleming (Kaye 1976). Under the floor of the vault were the remains of an earlier cesspit. Just prior to the construction of the vault, which covered it, the house had been let to a succession of tenants, each only staying for a year or two. Many environmental samples were taken from this pit.

8.2 THE SAMPLES

A number of 1000ml samples had been collected, from each context of the two pits. Processing of some of the samples from the late medieval pit had already been undertaken. The present author had not been involved in the collection or early analysis of the samples. Details of which are in Table 8.1, a list of the Coleoptera from the site is shown in Table 8.2 and the habitats represented by the beetles are shown on Fig. 8.4.

8.3 LATE SAXON PERIOD

At the Broad Street end of the site, late Saxon remains were uncovered. These included evidence of wooden buildings and several rubbish pits (see Fig. 8.2). The contents of the latter proved that trade with the continent was well established, as a hoard of French coins dating to 1030AD was found, as well as French pottery. Viking influence was also seen in the designs on bone combs, which were recovered from the pits.

8.3.1 SAMPLE DETAILS

The Saxon pit (108) was situated in the area under the future Broad Street. It was about 1.5m in diameter and over 2m deep and the pottery within it, dated from the late 10th to early 11th century. Two layers had been sampled from the bottom part of this pit. The upper one had only a few poorly preserved specimens, while, from nearer the base, insect remains were more frequent and in a better condition, although the insect cuticle was thin and fragmented easily. Two sub-samples were examined each of 1000ml in volume, from different areas within the lower context (2165) (see Table 8.1).

These samples had every appearance of being cess; although no parasitic egg counts were taken and neither did the present author have access to a plant analysis. The dark brown material broke up quite easily into a slurry. It contained concretions, some with straw impressions, and small fruit stones. Similar material from Winchester (see Section 7.4.1) had been interpreted as cess.

8.3.2 THE FAUNA

A faunal list is shown in Table 8.2, a list of taxa in rank order is shown in Table 8.3 and the habitats represented by them are illustrated in Fig. 8.4, using the system of classification described in Chapter 7. It is dominated by beetles, which prefer foul rotting matter. The two most abundant species were *Anotylus sculpturatus* and *A. complanatus*. There was no evidence that either were breeding, although, due to the relatively poor preservation of these specimens, it is possible that teneral individuals had not survived. There were other beetles indicative of foul conditions such as more *Anotylus*, *Cercyon*, including *C. haemorrhoidalis*, and *Philonthus* species.

The next commonest group was the 'house species', which included two examples of *Laemostenus terricola,* a beetle, which may inhabit buildings. It also contained relatively large numbers of *Bruchus rufimanus,* a beetle, that feeds on pulses.

This pit was unusual in having high numbers of phytophages, 11% of the total assemblage were from this group. The most numerous were from the genus *Phyllotreta,* all of these feed on crucifers, three types of weevil were present and the nettle eating *Brachypterus urtica.*

8.3.3 COMPARISON WITH THE ARCHAEOLOGICAL RECORD

Pit faunas do not usually contain large numbers of *Anotylus sculpturatus,* but this pit contained half of the total number of this species from the thirty-five assemblages used for the investigation into pit faunas (Table 13.1). Although it is mentioned as being typical in some Anglo-Scandinavian pit fills at Coppergate (Kenward and Hall 1990, 520), it cannot have been common there, as it was omitted from their list of most frequently occurring species in pits and floors (Kenward and Hall 1990, 730). *A. sculpturatus* has been found in some quantity in some rural wells, e.g. the Roman wells from Rudston, Yorkshire (Buckland 1980) and Whitton, Glamorganshire (Osborne 1981b) and the Saxo-Norman feature from Fishbourne (see Chapter 10) which it also resembled in the large numbers of *Phyllotreta. Anotylus sculpturatus* is one of the indicators of pasture (Robinson 1983a) and this is probably the reason for its prominence on Roman rural sites, but in this case none of the other beetles associated with that habitat were found. This site, like the Fishbourne one, is close to the sea and *A. sculpturatus* can be found in tidal refuse (Steele 1952) and in reeds (Donisthorpe 1939).

A. complanatus, also plentiful, is a more typical member of urban pit faunas, in fact its presence in large numbers, is diagnostic of a certain type of pit fauna (see Chapter 13). As are the large numbers of "house" beetles found (see Section 13.7) and the remains of food pests such as *Bruchus rufimanus,* also commonly occur in such situations after accidental ingestion and passage through the gut (Osborne 1983).

8.3.4 IMPLICATIONS OF THE FAUNA

The characteristics of this pit, which are common to other pits, are further considered in the investigation into pit faunas (Chapter 13). Unusual features, such as the dominance of *Anotylus sculpturatus* may reflect its position, which was at the edge of the developing town next to marshland (see Fig. 8.2). The high number of phytophages in the assemblage suggests that the area was surrounded by weeds.

8.4 LATE MEDIEVAL PERIOD

The stone-lined cesspit (4800) was discovered beneath the floor of one of stone vaults underlying 95-98 High Street. This pit would have been connected to a garde-robe via a shaft, which may have been in the upper storey leading off from the bedchamber. Originally it was 2m square and about 3m deep, but only the bottom 1m had survived. The owner, Walter Fetplace, had destroyed the top in 1419 by the construction of a vault (Kaye 1976).

8.4.1 SAMPLE DETAILS

Ten samples each nominally of 1000ml and from different areas in the pit were examined by the present author. The weight ranged from 0.68kg to 1.95kg per sample, giving a total weight for the series of 13kg. Material had been collected from three levels represented by the contexts 4909, 4914 and 4922. Each context had been subdivided into four quadrants and the position of all samples is shown diagrammatically in Fig. 8.3. As no sections were taken of the pit, due to the liquidity of its contents, the thickness of the sampled contexts is not known. All came from near or at the pit sides where the stratigraphy was clearer, and in some cases the location had been recorded exactly and these are marked (see Fig. 8.3). Layers 4914 and 4908 had both been described as "silty," by the excavators.

Subsequently the upper levels, contexts 4908 and 4858, were investigated, but these samples had already been partially treated. All had been sieved over a 500µm mesh and so the smaller insect parts had been lost. The insect parts had been extracted from some retents by paraffin flotation and from others they had been picked out directly from the sieved material without further treatment.

Although, no plant analysis was carried out, the abundance of seeds, such as fig and small fruit stones was typical of cess deposits. The only bones were from small mammals, presumably rodents. There was no obvious evidence of any material, which might have been used for anal wipes.

8.4.1.1 Quantity of fly puparia

The samples contained extremely large numbers of fly puparia, which were not identified or counted but were estimated. This was achieved by separating them out during the sorting process and placing them in standard-sized tubes. The quantity of puparia in each assemblage was, therefore, equivalent to the height of the column in each container.

8.4.1.2 The mineral component of the samples

Like the samples 60 and 49 from Winchester, already described, there was evidence of added soil and it was decided to investigate this element further.

8.4.1.2.1 Method

Soil contains an inorganic faction, chiefly in the form of sand, which is heavy and can be separated out by mixing with water and allowing it to settle. The amount of sand present should be a measure of the amount of added soil. Therefore the residues, after paraffin flotation, were mixed with water in a measuring cylinder, and the size of the lowest level, which was made up of inorganic sand-like material, was calculated. Because of the different weights of residue from the different samples, this was calculated as a proportion of the total column height for each sample.

8.4.1.2.2 Results

The composition of each sample was consistent with the others from the same context. The top context (4909) contained about 60% of inorganic matter, the middle context (4914) had been described as silty, by the excavators, and it was shown to contain around 83% of the mineral component of soil, and the lowest level (4922) had 67%. Sample 11 was especially distinctive because instead of having three clear layers it had four. In the photograph, it can be seen that there is an additional fine layer between the granular separated soil layers and the darker organic layers. This fine layer did not separate out completely from the other soil layers and so it partly obscures them (see Plate 8.1).

8.4.1.2.3 Discussion

The added soil would help to settle the heaving mass and make cleaning out easier. In addition, it has been discovered that soil is a good deodoriser: this property led to the development of the earth closet. Following the practice of medieval Southampton, earth was thrown into a modern experimental cesspit, set up by the author in her garden (see Chapter 11). Although not enough was added to cover the ordure, the pit was remarkably odour-free.

Soil appeared to have been added to the 14th century internal cesspit from Winchester, studied by the author (see 8.5.1.1), but there are no references to this in the literature. Any soil in the Anglo-Scandinavian pits at Coppergate, York was assumed to have been part of a backfilling layer (Kenward and Large 1998). Greig (1982) lists many possible constituents of cesspits, from various sources, but does not include a mineral component. Sabine (1934) stated that flushing with water was recommended to reduce the stench but again no mention of soil. Charcoal was added to the Tudor internal cesspit at Tenby (Murphy 1989), possibly for this purpose, and layers of lime were present in a late medieval cesspit from Doncaster (Buckland *et al.* 1989) but such records are surprisingly rare.

8.4.1.2.4 The implications of the added soil

The presence of different amounts of soil at different levels in the pit suggests that the adding of soil may be an event, which could help in calculating the length of time the deposit took to form. The unusual composition of the deposit material in Sample 11 may indicate an atypical ingredient in that sample. The faunal composition of the different samples and layers should help to elucidate the matter.

8.4.2 THE FAUNA

A list of the Coleoptera in rank order, from contexts 4909, 4914 and 4922 is shown in Table 8.3 and the distribution of habitats represented is shown in Fig. 8.4.

From the 10 samples examined, the remains of a minimum of 1952 beetles, representing at least sixty species, were recovered. There were also huge numbers of fly puparia, which were quantified and some mites and other non-coleopteran material, which was not identified or investigated further. The condition of the specimens was not good.

Many of the elytra were pitted or the layers forming it had become detached and the larger thoraces and heads were mostly fragmented. The species in each sample varied little, with the same thirteen taxa making up the bulk of all the samples.

This fauna was characterised by large numbers of synanthropes. *Tipnus unicolor*, a spider beetle, made up over a quarter of all the recorded individuals. A good selection of the other mould eating synanthropic species were present, e.g. *Mycetaea hirta, Lathridius minutus, Cryptophagus* species, *Atomaria* species and *Dienerella ruficollis* as well as many specimens of the wood pest *Anobium punctatum* and a few of *Xestobium rufovillosum.*

There were also a number of beetles found in decomposing habitats, either feeding on the products of the breakdown of materials or predatory on the saprophytic species. The feeding habits of *Omalium allardi*, which was the second most common beetle in the pit, are unknown. It has been found in modern manure heaps, but it is not now common (Hyman 1994). Even less is known about the other two small staphylinids only identified to the taxon, Aleocharinae. Kenward and Hall (1995) identified the aleocharine, *Crataraea suturalis*, as being associated with buildings, but this species was not present here. Larger staphylinids, which are predatory on fly larvae were plentiful, especially *Quedius mesomelinus, Philonthus cephalotes* and *P. concinnus.*

All these species occurred with regularity in all the sub-assemblages but species described as "pit" colonisers, chiefly *Carpelimus* and oxyteline species, so common in early medieval pits, were few.

The most interesting feature of this pit was the grain pests. These were plentiful, varied and unusual. The three most plentiful were *Sitophilus oryzae, Cryptolestes ferrugineus* and *Rhyzopertha dominica*, while *Oryzaephilus surinamensis, Sitophilus granarius* and a species of *Tribolium* were present in small numbers. Together they constituted over 10% of the total fauna, which was itself unusually large, due to high numbers of decomposer beetles. There were at least one hundred and twenty eight specimens of *S. oryzae*, which with *R. dominica* come from hotter countries. As is evident from its common name of rice weevil, *S. oryzae* feeds on rice, but it can also attack wheat and many other cereals and cereal products (Aitken 1975). *R. dominica*, which is often found in association with it, has similar food preferences. The latter beetle can survive in drier and warmer conditions and it burrows deep into the infested foodstuff (Birch

1945). Both are still serious pests throughout the warmer regions of the world, but in temperate regions only survive in heated buildings or grain stocks.

S. granarius is the grain weevil, it normally feeds on wheat and attacks the whole grains, whereas the other pests *C. ferrugineus, O. surinamensis* and *Tribolium* species are secondary grain pests only found in damaged cereals. The adults of *C. ferrugineus* are associated with mouldy grain, of any variety (Aitken 1975). All these beetles are common in this country at the present day.

Among nearly two thousand beetles recovered from this pit only eleven individuals, from nine taxa, could be regarded as accidental, with no preference for cess or indoor habitats. Even this small number is doubtful as some of these could have been introduced in household materials and one of them, *Gnathoncus nanus,* could have lived in the building in birds' nests in the rafters (Halstead 1963). Today *G. nanus* is rare (Halstead 1963). The other species, e.g. *Ceutorhynchus erysimi*, *Hypera punctata* and *Sitona lineatus* may well have strayed from waste ground or gardens nearby.

8.4.2.1 Variation between sub-samples

It was possible to study variation between samples because of the number taken and their distribution throughout the pit. The aim was investigate inter and intra contextual variation. A similar study had been carried out on a post medieval cesspit fill from York (Hall *et al.* 1993b described in Section 3.2.3.5).

8.4.2.1.1 Standardisation of samples

These samples, when taken, had been of equal volume but varied considerably in weight. Previous work on intra-contextual variation had used samples of equal weight and this is the most common way by which samples are standardised. Neither system is perfect, as the factors, contributing to the formation of the background matrix, are not necessarily connected to the formation of the assemblage. Both studies showed that there was a considerable variation in the concentration of insects in each sample (see Fig. 8.5). Considering each taxon as a percentage of the total number of species in the assemblage, eliminates problems caused by differences in sample and assemblage size, but produces others (see Section 3.2.3). The variations in the taxa, which occurred whether the assemblages were standardised by volume, weight of sample or by a percentage of the total assemblage size were all considered in this study. Only differences strong enough to persist no matter which method was adopted were considered to be significant.

8.4.2.1.2 The taxa used

The same spread of species occurred in each sub-assemblage and only those taxa which made up more than 1% of the total (i.e. contained more than 19 specimens overall) were considered for this exercise. This is because a certain minimum number of individuals of each species in the assemblage is needed before meaningful statistical tests can be carried out (Clarke 1994, 80). However, the eliminated taxa exhibited no obvious biases and after their removal fifteen taxa were left for further analysis. The two *Philonthus* species *P. concinnus* and *P. cephalotes* were considered together.

These fifteen taxa were divided into three habitat groups. These were based on the classification system outlined in Chapter 7, but, because of the location of this sample, some taxa, classified normally as dry decomposers, were incorporated with the house species group. All of these species can live in buildings and it is reasonable to suppose, in this case, that they had. Therefore the three groups were the synanthropes, the decomposers and the grain pests.

8.4.2.1.3 Methods of analysis

The assumption was made that the assemblage from each sample should be about the same size and have roughly the same mixture of species. A proper statistical investigation requires at least thirty samples taken from the total population but in this case there were only ten. The importance of this minimum number was first noted by Gosset (1908) cited in Garvin (1986). Therefore in order to test this hypothesis, the figures for each assemblage were calculated in three ways, firstly using the actual figures (nos./l), secondly expressed as a concentration (nos./kg) and thirdly expressed as a proportion of the total number in the assemblage (%). Next, for all three methods of presentation, the distribution of species was compared across the assemblages. This was achieved by calculating the mean of each taxa in the set. The actual numbers were compared with it and, any values more than twice the mean, were highlighted in red. Further checks were needed to make sure that these figures had some significance. The mean is only useful if the data is normally distributed (Clarke 1994) and in at least two taxa this was not the case. Therefore the median for each taxon was calculated so that the influence of outliers was eliminated, as recommended by Clarke (1994). Values, more than twice the median, were shown in orange. Any value, which was abnormally high on all of the three tables, is emboldened (see Table 8.4).

8.4.2.1.4 Results

Generally the figures were similar across the taxa but some irregularities occurred, no matter how the data were presented (see Table 8.4) for the results from all methods of comparison). The major anomaly was the huge number of *Anobium punctatum*, over half the series total, in Sample 12. The next largest one was of levels of one of the "house" species, *Tipnus unicolor*. Samples 8 and 11 both had high levels of *T. unicolor* although, the percentage figures showed that, in the former case, this was not so remarkable, as it was richest overall in beetle remains. However, they had the affect of elevating the value of the mean, so that it was necessary to look at the median. This showed that the number of *T. unicolor* in Sample 11 was significantly high as it was over twice the value of the median. Otherwise, the assemblages in Samples 8 and 12 were unremarkable, although still slightly above average in total beetle numbers, even when the abnormally abundant species (*T. unicolor* and *A. punctatum* respectively) were omitted. Sample 11 was the most different, not only having the highest number of *T. unicolor* individuals but also of grain pests, both in quantity and variety. Coupled with this were low numbers of decomposer species. Sample 6 was also abnormally high in the levels of one grain beetle, *Rhyzopertha dominica*, but not in other species. The only other consistent abnormality was large numbers of aleocharines in Sample 1.

There was nothing similar about the positions of the anomalous samples. They did not all come from the same quadrant or share a common position and they came from different levels. The investigation of the numbers of the species at different levels of the pit, excluding the anomalous species, showed that some differences were related to depth. The middle layer (4914) was found to be higher in grain pests, lower in decomposers and also in fly puparia, while the top and bottom layers (4909 and 4922) were very similar to each other (see Fig. 8.6). The levels of house pests, excluding *Tipnus unicolor* and *A. punctatum*, were very similar throughout (See Figs 8.7; 8.8).

8.4.2.1.5 Discussion on the faunal distribution

Most species showed a consistency in their numbers across the range of samples, independent of the context. Only slight intercontextual variation was found. This can best be explained by a fairly constant input of beetles from the building, a breeding population in the pit and the mixing of contents, which would have taken place. The fluid fill would have been churned up the addition of new material, by gases forming as the contents decomposed and by the active maggot population. The other study on pit contents showed this process even better, as there were no concentrations of any species, instead they were all fairly evenly spread throughout (Hall *et al.* 1993b).

Sample 12, which contained the very large numbers of *A. punctatum,* was situated at the bottom of the pit. This may indicate that the pit was left empty for a while at midsummer when this species is on the wing (Min. of Technology 1970) and this beetle was attracted into the dark pit. This is possible as at the time being investigated, the house had been let to a succession of tenants, and may have been left empty for a time. However, the other sample from the base of the pit (13) showed no such an increase in numbers.

Interestingly Sample 11, singled out by sediment analysis as different, had the highest numbers of *T. unicolor* and exotic grain pests. Sample 8 also had abnormally high levels of *T. unicolor,* but not grain pests although all the species were present. Possibly the exotic grain pests were introduced into the assemblage in spoiled food and had not been fully mixed in with the other contents. The variations in *T. unicolor* are more difficult to explain.

If the main decomposer species were breeding in the pit, variations in numbers of that group might also be expected, as aggregations of them, might form in certain areas. Although, only the aleocharines in Sample 1 were consistently anomalous, no matter the method of analysis, the decomposers as a group, showed more variation than the remaining "house" species. In addition their distribution roughly followed that of the breeding fly population (see Fig. 8. 9).

8.4.2.1.6 Conclusions on sample size

A sample size of 1000ml should have been sufficient to contain a minimum number of at least one hundred individuals, the number considered by Kenward (1978a) to be the lowest required to be representative. Any single 1000ml sample taken from this pit should have yielded the thirteen most commonly occurring species. The proportions of those species may have been non-representative, as some beetles were not evenly dispersed throughout the pit.

One sample of around 100 individuals would probably not have yielded the rich variety of grain pests present in this pit. The numbers of species of these is closely linked to the numbers of individuals in the sample. In order to have a good chance of recovering at least five of the six species a sample size of around 400 individuals would have been required. This would have necessitated the examination of 4000ml of material.

8.4.3 COMPARISON WITH THE ARCHAEOLOGICAL RECORD

It is usual for indoor deposits to contain some "outdoor" species. They find their way inside either by actively flying, passively borne on the wind, by carriage on feet or in flooring or other materials. The medieval house was much more open and airy than a modern building, but a substantial number of insects infiltrate these too (Kenward 1985a). The smell of cess probably repels many insects even if they have free access, and so the numbers found are never high, but the very small numbers found here suggests a very enclosed environment. They are low compared with other probable indoor cesspits of a similar period (see Section 7.5.3; Colledge and Osborne 1980; Osborne 1983). It has been suggested, above, that *Gnathoncus nanus* might have been present in nests inside the building, thus further depressing the numbers of true “outdoor” species. *G. nanus* was found in an 11th century Viking house in Dublin (Coope 1981) and in a 15th century cesspit in Germany (Koch 1971). The genus, some or all of which may have been this species, has also been found in York (e.g. Hall and Kenward 1990; Kenward and Hall 1995).

The lack of extraneous beetles also suggests that little else had been added with the ordure. There is definite evidence of added soil and an indication of spoilt food, see below. If flooring material, kitchen waste and other rubbish, as proposed by Greig (1982), had been regularly added, then this should have been reflected in a higher number of accidental beetles. The huge number of house beetles is not necessarily evidence of added flooring materials as these beetles may be fatally attracted to cess (see Section 13.7). These beetles are a common ingredient of garde-robe pits (see Section 13.4.2.2.). The fact that there were no bones of domesticated animals found, suggests that kitchen waste was not present.

The decomposer beetles, *Omalium allardi*, *Quedius mesomelinus*, the two *Philonthus* species and the two aleocharines are thought to have been autochthonous because it is difficult to see how they could have been replenished from the wild, without an influx of other species. The pit had large numbers of breeding flies, which would have provided food for the *Philonthus* and *Quedius* species. The pabulum of *Omalium allardi* and the aleocharines is unknown. Further evidence that these beetles were living in the pit comes from the distribution of flies, which were less numerous in the middle layer, the layer with least fly predators.

While the variety of the breeding staphylinids is unusual, the individual beetles have been found before in deposits of similar age and provenance. Large numbers of *Quedius mesomelinus* occurred in similar pits in Winchester (Grove this vol.; Carrott *et al.* 1996), Scotland (Buckland 1995) and Germany (Koch 1971). *Philonthus* species are not so well represented but *P. cephalotes* was common in a garderobe pit from the Bedern, York (Hall *et al.* 1993c). The limited distribution of *Omalium allardi* in ancient cesspits has already been noted (see Section 7.4.4). Today its distribution is restricted to areas in the east and west but it was previously much more widespread and included Scotland (Hyman 1994), the reasons are unknown.

Only three of the six pests found here, namely *Sitophilus granarius*, *Oryzaephilus surinamensis* and *Tribolium* species, are normally found in deposits of this age (see Chapter 12). *Cryptolestes ferrugineus* has also been found, at nearby Winchester (see Chapter 7). *Sitophilus oryzae* and *Rhyzopertha dominica* are unknown in archaeological deposits in this country.

8.4.4 DISCUSSION ON THE GRAIN PESTS

It has been assumed that the main way in which food pests enter cesspits is with faecal matter (Osborne 1983). Grain pests may be eaten as they are small and difficult to see or remove from products made from grain or wholemeal flour and, in low numbers, do not noticeably affect taste. The small numbers of *Sitophilus granarius*, *Oryzaephilus surinamensis* and *Tribolium* species scattered throughout the pit are compatible with this origin. The huge numbers of the exotic pests, with *C. ferrugineus*, which is indicative of mouldy material, suggests an origin in contaminated foodstuff, which was disposed of in the pit. As the exotic pests have not been found before in medieval samples, it is reasonable to assume they had been introduced in an imported product.

8.4.4.1 The evidence for an infested foodstuff

Some evidence for this comes from Sample 11, as it not only had high levels of exotic pests but also appeared different after it was sorted by sedimentation, possibly showing an added ingredient. That assemblage also had the highest levels of *T. unicolor*. If this beetle was also associated with the spoilt foodstuff it might explain why it was the only mould eating "house" beetle to show such fluctuations of abundance across the samples. All these beetles feed on moulds growing on the fabric of the building and, while there are differences in optimum temperature and moisture requirements between the synanthropes, it is difficult to envisage a situation in which the levels of only one species would be affected. Concentrations of *T. unicolor* have been noted in modern starchy residues, such as breadcrumbs, in a larder in Iceland (Lindroth *et al.* 1973) and in an empty granary (Coombes and Freeman 1955). However in the latter case other mould eaters such as *Lathridius minutus* and *Ptinus fur* were also present. The evidence, for the introduction of *T. unicolor* with the spoilt food, is not entirely convincing, as there is not a good relationship between numbers of exotic pests and numbers of *T. unicolor* across the series of samples. Sample 6, which has the next largest concentration of exotic pests, has normal levels of *T. unicolor* and Sample 8, which has the next highest levels of *T. unicolor*, did not have high levels of the exotic pests, although they were both present. From the levels of exotic pests throughout the lower levels of the pit, it must be assumed that spoiled food was added several times.

8.4.4.2 Rice in the Middle Ages

In the early 15th century Southampton traded with Italy and occasional sacks of rice were imported. These are recorded in the Port Books (Foster 1963). The Moors had first brought rice from the east to Spain and it spread from there into Italy. It had been widely exported since the early 13th century (Braudel 1981). This type of rice is the upland variety, which is grown like wheat, requiring high temperatures and rainfall but not paddy fields.

The written archives give the most information about its distribution and usage, as rice is not easily preserved. The earliest record is for 1286/7 when the Royal household account books show that 10,000 lb (4550kg) were purchased that year (Hammond 1993). It was also eaten at Winchester College, as it is listed in the accounts for 1394 (Beveridge 1939). In the early 15th century, the Bryene household in Suffolk used it mainly as a thickening and whitening agent (Dale and Redstone 1931). It was not particularly expensive, in the 13th century it cost 1d/lb, which was the same price as a loaf of bread, although the weight of the loaf depended upon the quality of the flour (Hammond 1993). The evidence seems to be that, at least by the 15th century in Northern Europe, it was more an ingredient than a luxury item in its own right (Braudel 1981). However, there are recipes for rice pudding in medieval cookery books (Austen 1888).

Finds of rice are rare, because it would have been imported in the form of polished rice. This means that all the distinguishing outer membranes would have been removed, leaving a product, which is almost pure starch (Green pers. comm.). It would not normally leave a trace, even in a waterlogged pit. A grain was recovered, fortuitously preserved by charring, from another Southampton site, a house in Upper Bugle Street destroyed during a French raid in 1338 (Green 1983).

The occupier of this house may well have been an importer of rice, who had to dispose of badly contaminated goods.

8.4.4.3 The duration of the infestation

Because of the extraordinary nature of the grain pests discovered in the lower three layers of this pit, it was decided to examine the remaining upper layers (4908 and 4858) for signs of infestation. Due to the prior treatment of these samples small species had been lost. This was proved by the examination of two 1000ml samples from 4918 SW quadrant, namely (2670)[11] and (2669)[F]. One was processed by the author, as described in Chapter 6 and the other had been sieved over a 500μm mesh, floated in water and insect specimens picked out from the dried flot. With regard to the larger beetles, the two samples were very similar, both had, for example, abnormally high levels of *T. unicolor* and many food pests. Nevertheless the smaller beetles such as *C. ferrugineus*, *M. hirta* and *O. allardi* were completely missing from (2669)[F].

The upper levels revealed an interesting story. Layer 4908 contained the same exotic pests as 4909, yet layer 4858, as far as can be ascertained, had reverted to the norm for the period, that is small numbers of *S. granarius* and *O. surinamensis.* Only one other grain pest was found and that was one elytron from a species of *Tribolium.* It is a pity that it is not possible to know whether *C. ferrugineus* persisted here. It appears that the exotic species had died out, providing further evidence that they were the result of an occasional import and not endemic at the time. Possibly a change in tenancy had occurred and the new occupant was not a rice importer. The added soil and the distribution of the fauna may provide clues about the formation time of the deposit.

8.4.5 DISCUSSION ON FORMATION TIME OF THE DEPOSIT

The samples from the three contexts studied in detail were very similar to each other in faunal content, yet they had been separated by layers of soil. Could this mean that the capping was an annual event? Each layer, or possibly each two layers, one containing less soil than the other, would then represent one year's fill. If sealing had occurred more frequently then there should be differences in the numbers of seasonally active beetles either side of the barrier. *Anobium punctatum* is a case in point; the adult emerges at midsummer and lives only ten days (Min. of Technology 1970), yet specimens are evenly dispersed throughout all layers, with the exception of the aggregate discussed above (Section 8.4.2.1.4).

The only mention in the literature about the frequency and timing of emptying cesspits, is from Tusser writing in 1580 (Tusser 1984), who cleaned them out once a year in November and emptied them into a trench in the garden. Excavations ongoing in the Netherlands reveal that large cesspits, under houses, have been unemptied for three centuries (Michiel Bartels, Internet), so it is quite possible that the deposit in this pit took several years to accumulate.

In Kenward and Large (1998) there are calculations about the rate of fill of a pit, based on the volume of faecal material produced by an adult. Rough calculation show that, making allowances for anal wipes and added soil, the output of about eight people would be needed to fill a pit of this size to the depth of 0.5m in one year. That measurement being the calculated depth of one year's fill, assuming that two contexts, one silty, one less so, constitute one year's deposit. This figure seems to be in the right order of magnitude (See Appendix 1).

8.4.6 IMPLICATIONS OF THE FAUNA

The pit collected a large sample of beetles, which had lived in the building as well as others which had lived in the pit fill. It provided very little information about the wider environment, demonstrating that it was very enclosed. The reason for the lack of access of adventitious beetles may have been due to the affluence of the owners. In the early

14th century, Richard of Southwick, had glazed windows in his Southampton house (Platt 1973), so it is quite possible that this house, with equally rich owners, was similarly embellished.

The exotic grain pests were most probably introduced with infested sacks of rice, either bought or traded by the inhabitants of the building. This was not a regular procedure, as these beetles were not found in the top remaining context (4858) of this pit. The anomalies in the numbers of *Tipnus unicolor* may be connected with this practice, but the evidence is not good. The accumulation of *Anobium punctatum* at the base may indicate that the pit was left empty for a while over midsummer.

Soil had been added to the pit, probably at yearly intervals, and the contents remaining in the bottom 1m of this pit probably took three years to form.

8.5 CONCLUSION

These two pits provide more information, which is used to establish a classification of pit faunas (see Chapter 13). Many of the typical medieval urban species were found here. The unusual "rural" features of the early medieval pit may have been due to its position at the edge of the developing town. While the cosmopolitan nature of medieval Southampton, due to it being a flourishing port, is reflected in the beetles from the garde-robe pit. Even today, invasions of exotic organisms are not uncommon in that town.

CHAPTER 9: Entomological evidence from The Vicars' Hall, Chichester

9.1 INTRODUCTION

This chapter describes deposits from a medieval building in Chichester, which contain beetles preserved by desiccation. In 1991, the Chichester District Council's Archaeological Unit had a chance to investigate beneath the floorboards of the late 14th century Vicars' Hall in the city. The part of the building, which was investigated, was built over an early 13th century stone undercroft. Previously it had been a Guildhall but in 1394 it became the property of the cathedral and it was extended and modified to house the members of the Vicars' Choral. The documentary evidence in this chapter comes from Hannah (1914) and Steer (1958). Fig. 9.1 shows the position of the Vicars' Hall in the city and Fig. 9.2 the internal layout of the building.

It is impossible to know what the various parts of the building had been used for. The part of the Hall, from which these samples originate, is known as the Vicars' Parlour, which is raised and separated by a screen from the main area. The central area has a pulpit incorporated at the side so that the vicars could have bible readings during meals instead of "frivolous chatterings, unseemly story tellings, deriding laughter or noisy talking" (Bennett *et al.* 1904 quoting from statutes laid down by Bishop Sherburne in 1534). By 1720, the building had outlived its purpose and it was leased out. It has since been used as a school and a library. It is now open to the public and used for meetings and exhibitions.

9.2 SAMPLE DETAILS AND TREATMENT

Samples were collected from the three areas marked on the plan (Fig. 9.2). The deposit originally had been about 50mm thick and very solid but at the time of the investigation it was broken up into pieces. It was of a yellowy orange colour and looked like brickearth. Further details are shown in Table 9.1.

The first sample was disaggregated in water and sieved over a $300\mu m$ mesh. Although a few stones and small pieces of artefacts were present, the main bulk of the material was extremely fine and very little of the deposit did not pass through the sieve. It was possible to hand sort this retent under a microscope, without the need for separation by paraffin flotation. Insect remains were collected, preserved by desiccation. Their condition was good, many were still partially articulated, although all had taken on the rusty colour of the surrounding substrate.

To determine whether the beetle remains had come from the outside or inside of these deposits, the next sample was washed over a wide mesh sieve and only the cleaned clods of "soil" were processed. It was found that the beetles did, indeed, lie within the material, indicating that the "soil" may have been consolidated dust. Seeds were also fairly common and there were short lengths of twig, with the bark still on. If it was not dust it is difficult to know what it could have been, except possibly a plaster-like material, which had covered the floor at some stage. It was not daub as the vegetative plant remains from the dung component was missing.

9.3 THE FLORA

The seeds in one sample were identified to genus by a specialist from Sheffield University. *Brassica* species, *Chenopodium album, Papaver, Rumex, Urtica* and other genera common in gardens and waste places were represented. All of these are small and may have blown in accidentally. A seed of *Eleocharis* species was also found, which may have been brought in with the plant, as rushes are not thought to have grown near the site.

The twigs were less easy to place. They occurred in all three locations and the simplest explanation was that they were from a besom used to sweep the floor. To test this theory thin sections were taken by the author and examined under the microscope. The configuration of the vascular bundles showed them not to be birch but probably beech. As the normal material for a besom is birch (Amberley Chalk Pits Museum pers. comm.) this idea has been disproved. They may have fallen from birds' nests in the rafters.

9.4 THE FAUNA

An insect fauna of over one hundred specimens was recovered with nearly 3kg of material yielded a minimum of 106 beetles from 42 taxa. There were also the remains of a flea and a fly puparium. The complete list of beetles is shown on Table 9.2 in taxonomic order and in rank order in Table 9.3. The breakdown of the assemblages into subgroups and the proportions of each group are shown in Fig. 9.3. The classification system, which has been used, is the general one described in Section 6.3.1. However, because of the location of the samples, some assumptions have been made about the dry decomposer taxa, and these were included with the "house" fauna.

The largest of the sub-assemblages was the synanthropic group, which formed 48% of total numbers of individuals and when the dry decomposer group was added, the combined group made up 63% of the assemblage *Ptinus fur* was the commonest species, followed by *Tipnus unicolor* and *Mycetaea hirta*. Other mould feeders were present such as lathridiids and cryptophagids and the blind burrowing beetle, *Aglenus brunneus*.

Within this building was a good selection of xylophagous species. As well as the ubiquitous woodworm beetle, *Anobium punctatum*, there were several examples of the death watch beetle *Xestobium rufovillosum*, and two other species, *Ptilinus pectinicornis* and *Lyctus linearis*. The death watch beetle is so called because the tapping sound, it makes to attract a mate, was thought to be the harbinger of a death in the family (Imms 1947). It prefers oak (Palm 1959) and this probably explains its confinement to old churches and other old buildings like this one, which were constructed of oak timbers. It seems most likely that the beetles were introduced into the building, when it was constructed, because large pieces of mature wood are rarely used in modern buildings and so new infestations are rare (Hickin 1963). However once present it is difficult to eradicate and this building was last treated in 1991 (Richard Meynell, Cathedral Architect, pers. comm.), following the work by the archaeological team. *Lyctus linearis* also seems to prefer oak and can attack wood in buildings (Hyman 1992) while *Ptilinus pectinicornis* is recorded as sometimes infesting furniture (Koch 1989).

The second largest sub-assemblage is the decomposer species, this comprises 16% of individuals. This type of beetle may be over represented in an assemblage, as these beetles tend to be very mobile, because of the transitory nature of their substrate. They form a large part of the background rain of insects, which forms a fraction of every death assemblage (Kenward 1978a). The commonest of the decomposers was the tiny *Ephistemus globulus*, which inhabits damp cut vegetation (Johnson 1993). Small numbers of beetles named "pit colonisers" (see Chapter 13) were present, namely *Carpelimus bilineatus* and some *Anotylus* species. There were a few beetles that prefer foul, wet decomposing matter namely, *Cercyon*, *Philonthus* and *Quedius* species, There were also a number, 10% in total, of beetles indicative of outdoor habitats. Many of these were indicative of disturbed ground and could have come from gardens or wasteland. The most remarkable of these was *Orobitis cyaneus* as this is a flightless weevil, which feeds on *Viola* species (Dieckmann 1972) and the commonest was *Sitona lineatus*, which feeds on leguminous plants such as clover and is a good flier.

9.5 IMPLICATIONS OF THE FAUNA

The large number and variety of synanthropic species both of mould and wood-eating types indicated that this fauna formed *in situ* within the building. It had not been imported with the enclosing material, even if that deposit was not dust but was some kind of building material.

The decomposer beetles, which are found in foul, wet rotting matter and many of the phytophages and other beetles of outdoor habitats, probably entered the building by chance. Many of these beetles are noted as being good fliers and they form the background fauna (Kenward 1978a). It is interesting to note that, while this site is in a much drier area, than those from which insect remains are usually recovered, the background fauna is very similar.

9.6 DISCUSSION ON THE AGE OF THE ASSEMBLAGE

Dating the sample was problematical, since there have been many changes to the building over the centuries. It was built of Quarr stone and may originally have had a slate roof, which is not unusual for 14th century Chichester; fragments of slate were found beneath the floor. Today it is tiled. Some of the existing roof timbers, in this section, date from the Tudor period. It is impossible to say whether this part of the floor lying over the undercroft, had been boarded over in medieval times. The part of the building behind it certainly was, as the central oak pillar supporting the floor joists is still in situ. Renewal of floorboards and other alterations would not necessarily involve clearing debris from under the new work, so this deposit may well predate the timbers of the roof above it. Since the beginning of the century, the floorboards have been tongue and grooved (Richard Meynell, Cathedral Architect pers. comm), thus preventing the accidental incorporation of allochthonous insects, since that time.

Much is known about the surroundings of this assemblage but they do not enable it to be dated, except that it is probably not later than late 19th century. A considerable body of information is being amassed about medieval insect faunas, but very little is known from the 16th century, which is beyond the scope of most entomo-archaeological studies, to the 19th century when entomologists began to make insect collections (Hammond 1974). Therefore it is impossible to know how long the typical medieval fauna persisted. Events such as the Renaissance, with an expansion of European trade, the colonisation of America and the Industrial Revolution, must surely have wrought changes in the insect faunas. Modern faunas are characterised by a numbers of Australasian imports dating from the 19th century and later when that region of the world was opened up (Hammond 1974). Surprisingly few beetles have colonised from the New World, instead most of the traffic has been in the opposite direction (Buckland *et al.* 1995).

The following members of the "house" taxa, present in the deposits from Anglo-Scandinavian York (Kenward and Hall 1995, 662), namely *Xylodromus concinnus, Atomaria* and *Cryptophagus* species, *Lathridius minutus, Mycetaea hirta, Aglenus brunneus, Anobium punctatum* and *Ptinus fur* were identified here. The only exception was the aleocharine, *Crataraea suturalis,* which was definitely not found in Chichester. Another member of this group found here was *Tipnus unicolor,* which was absent from Saxon age deposits generally, but very common in buildings from late Medieval times onwards (see Chapter 12). Other lathridiids such as *Dienerella ruficollis* and corticariine species were probably synanthropic, *D. ruficollis* is still sometimes found in damp houses (Hinton 1945) and corticariines were found in cess deposits from Winchester and Southampton (see Chapter 7 and 9).

The beetles found in building now have changed. *Aglenus brunneus* discussed by Kenward (1975b; 1976a), has been "confirmed as a highly characteristic and constant component of the medieval urban fauna" (Kenward 1976a, 276). It was not found in the Victorian houses investigated by Kenward (1985a), and, as it lives in damp accumulations of mouldy, rotting matter in dark places, it is now mainly found in animal houses, greenhouses and other outbuildings (Hinton 1945). The characteristic *Ptinus* species in modern buildings is *P. tectus* (Kenward 1985a; Smith 1996), which has ousted *P. fur,* now more common in warehouses (Kenward 1982; Munro 1966). This beetle was introduced from Australia in 1892 (Hickin 1964) and it is better able to thrive in the drier conditions in modern houses (Solomon and Adamson 1955). Mould beetles, such as *Aridius nodifer* and *A. bifasciatus,* are now widespread in towns (Owen

1991; Chapter 11) and have been found under floor boards in a Victorian house in York (Kenward 1985a). All these beetles are introductions from Australia and so would not have been present earlier than the 19th century.

Many new pests of timber have been introduced as international trade has increased. The Antipodean timber pests *Pentarthrum huttoni* and *Euophryum confine*, are now common in buildings, where they mainly inhabit floorboards (Buck 1948; and see Chapter 11). The species *Lyctus linearis* has now been largely replaced by its congener *L. brunneus* (Alexander 1994a). This latter is thought to be an American import from the early 19th century (Hickin 1964); however there are two records from archaeological sites. The first, from Roman Chichester (Girling 1989), is almost certainly a mistake as the original recording sheets noted *L. linearis*. However the second record shows it to be present by the 15th century (Moffet and Smith 1997). The wood eating beetle *Anobium punctatum* was very common in archaeological assemblages. For example, it was present in every pit sample investigated in the pit faunas examined in Chapter 13. *Xestobium rufovillosum* was also prevalent, for example, it occurred in assemblages from Winchester (Chapter 7), Southampton (Chapter 8) and further north in York (Hall and Kenward 1990; Kenward and Hall 1995). *Ptilinus pectinicornis* occurs rarely in the archaeological record and it is not possible to know, whether in those cases, it had been synanthropic. In Anglo-Scandinavian York it is recorded with other woodland species as "may have lived in timber or wattle on the site," (Kenward and Hall 1995, 658). This beetle can fly, so it may have come from nearby trees.

The composition of the decomposer beetle group is also medieval in nature. *Carpelimus bilineatus,* of which two examples occurred, used to be common in towns. It was also one of three species, which bred in a certain type of pit contents (see Section 13.4.1.1); now it is mainly found by water (Koch 1989). This beetle was listed with *Cercyon analis*, *Anotylus nitidulus* and *Aphodius* species as decomposer species, common in the Viking age floors from Coppergate (Kenward and |Hall 1998). However they are eurytopic and so, although the latter two taxa were found in the Chichester floor sample, they are not diagnostic. There are no examples of *Anotylus tetracarinatus* in these assemblages, which is now a widespread decomposer species, regarded by Hammond (1974) as the commonest European beetle.

The food pest, *Bruchus rufimanus*, the bean weevil, has often been recorded in ancient cesspits, probably arriving there in faeces through accidental ingestion. The adult matures under the testa of the bean and in this case, might have escaped from the storeroom or may have come in from outside. It is an active flier (Jones and Jones 1974).

The phytophagous group is quite large, but they have not necessarily come from outside, but instead they may have been brought in on vegetation. The flightless weevil *Orobitis cyaneus*, which feeds on *Viola* species, most probably was bought in with herbs spread on the floor. Thomas Tusser writing in 1557 (Tusser 1984) lists violets among twenty one herbs using for "strewing" on floors. *Viola odorata* and the scentless *Viola canina* were grown in "herbers", which were small enclosed medieval gardens (Landsberg 1996). They were valued for their flowers and scent as well as their medicinal properties, and were used as a cure for insomnia and also as a laxative (Loewenfeld and Back 1978).

The evidence for vegetation on floors, which would indicate a medieval or early post medieval date comes from several sources although it is not conclusive. The seed of *Eleocharis* may have come from rushes on the floor, the weevil, *O. cyaneus* from violets also spread on the floor and the occurrence of *E. globulus* and *C. bilineatus* which are found in decaying plant material may be further evidence of floor vegetation.

The decomposer beetles, which are found in foul, wet rotting matter and many of the phytophages and other beetles of outdoor habitats, probably entered the building by chance (c.f. Kenward 1985a). Many of these beetles are noted as being good fliers and they form part of the background fauna (Kenward 1978a). It is interesting to note that, while this site is in a much drier area, than those from which insect remains are usually recovered, the background fauna is very similar.

9.7 DISCUSSION ON FLOOR FAUNAS

As this fauna came from a floor, it was compared with other late medieval "house" faunas, which were from internal "garde-robe" cesspits, where they form up to 85% of the individuals present. The "floor" assemblage would not consist solely of individuals, which had lived there, as dead insects from other parts of the house and from outside would be included in its formation. Similarly, it has been suggested (Kenward and Large 1998) that a high proportion of "house" species in cesspits came from discarded floor coverings or sweepings, if this is so there should be few differences between the two types of fauna. Whatever their original microhabitat within the building, all are assumed to be allochthonous in the cesspit (Hall *et al.* 1983b).

A comparison of the synanthropic beetles from three late medieval garde-robe pits is shown in Fig. 9.4. They come from Winchester (Sample 60, Section 7.5.2), Southampton (samples from Pit 4800, Section 8.3.2) and Worcester (Osborne 1981a). The pits from Winchester and Southampton were both situated in substantial buildings, owned by wealthy people, but the evidence of the surrounding structure at Worcester (Osborne 1981a) is not available. The faunas from those sites were made up of broadly the same species, as this one, although the proportions of them varied.

The three samples from cesspits were most similar to each other, with higher levels of the two commonest species *T. unicolor* and *M. hirta.* Numbers of *A. punctatum* was similar in all assemblages. The fauna from the Vicars' Hall shows a much more even distribution of species than the cesspit faunas, but this may have been due to the much smaller size of the assemblage, which had a minimum number of sixty-five specimens, whereas the next smallest had over two hundred. Nevertheless, the percentage of *P. fur, A. brunneus* and *X. concinnus* are higher in the under floor sample. As *A. brunneus* is a blind burrowing species, seeking out dark places (Reitter 1911), it is most probable that this beetle was autochthonous. *Ptinus fur* may also have been commoner under the floor, as it has the most catholic taste of the Ptinids (Zacher 1937) and could have exploited any organic matter accumulating there. *A. punctatum* appears to disperse randomly, or possibly seeks out dark places, whether below floor boards or in a pit. Another possible factor may be that *T. unicolor* and *M. hirta* are over-represented in cess, due to an attraction to it caused by its odour (see Section 13.7), which would be similar to that from nests, their original habitat (Kenward and Allison 1995).

Therefore this study did show differences between synanthropic faunas from floors and cesspits suggesting that the species in cess have not simply been added in flooring materials.

9.8 SUMMARY

This fauna gives a glimpse of the house fauna within a building dating from the late 14th century. It is not possible to say with certainty when the deposit formed but the coleopteran evidence supports a medieval date. The synanthropic species extracted show some differences in frequencies from those collected from ancient cesspits, suggesting origins in different microhabitats in the building. The species in the assemblage were very similar to those from medieval urban areas recorded in the literature. The fact that it was from a drier area of town, than is normally studied, does not appear to have influenced the composition of the background fauna.

CHAPTER 10: Entomological evidence from Fishbourne

10.1 INTRODUCTION

Fishbourne, the site of this investigation, lies between the South Downs and the coastal plain, 2km east of Chichester. The name is derived from the springs (bournes), which emerge here as the area is situated on Reading Beds clay and adjoins Chalk. The latter absorbs rainwater and periodically releases it onto the impermeable clay. Fishbourne is situated at the head of the inlet from the sea known as Chichester Harbour. Although this area was drier in Roman times, the exact relationship of sea to land from that time to this is not known (Cunliffe *et al.* 1997).

An excavation was carried out at the eastern side of the village (see Fig. 10.1). As well as being the site of the Roman Palace, there has been a settlement there from late Saxon times (Drewett *et al.* 1988) and at the time of the Domesday census, there were about 90 inhabitants. By 1244, the area under investigation was called Marshfield and was used for grazing (Blakeney 1984). This land appears to have altered little over the centuries. This is particularly true of an adjacent area now called Fishbourne Roman Palace Meadows, which is managed by the Chichester Harbour Conservancy using traditional methods.

Conditions at the site were not ideal as a stream ran through it and every day the excavation flooded and had to be pumped out before work could begin. Because of the difficulties caused by this, a full excavation was not possible. The main features found were a series of ditches dating from Iron Age to early medieval times. In addition there had been some attempts to raise the ground level, by dumping gravel and other material. Drainage of this area appears to have been going on through the centuries.

A plan of the site is shown in Fig. 10.2. The features of Saxo-Norman date consisted of two parallel drainage ditches (Gullies 7 and 15), two later ones (5 and 3) and a pit (28), in the midst of them. There was inconclusive evidence for some kind of building or structure, above the pit, in the form of possible beam slots. The gravel spread (14), which contained Roman material, including artefacts from the nearby Palace, was probably of Roman date. Above it, between the two parallel gullies (15 and 7), was the probable site of a building contemporary with them, although no evidence of this was found. If a building had been there, it would explain the siting of the gullies, which are too close for field ditches (James Kenny, Site Officer, pers. comm.). The pit contained some domestic rubbish, as well as large amounts of twigs and leaves.

10.2 SAMPLE DETAILS

The present author, who was involved with the excavation of this site, took a number of samples for insect analysis. The only ones, bearing insects, came from the lower reaches of the deepest feature, Pit 28. Five samples were taken from different levels of this feature. The top sample was grey with many small pieces of chalk and some stones. All the rest were alike, consisting of a dark clayey matrix, with large numbers of small twigs and leaves within it, and few stones. Good preservation of insects occurred in the bottom two levels, but the next level had only a few degraded specimens. A large number of seeds, including those of blackberry and hazelnut shells occurred in Samples 2-5 but unfortunately these have not been identified further. Other finds from the pit included small amounts of domestic pot, of Saxo-Norman date, shell and bone, some with signs of butchery, and an ox skull at the level of Sample 4. See Table 10.1 for sample details.

The insect remains from the bottom two layers of the pit were well preserved although some were fragmented.

10.3 THE FAUNA

The coleopteran faunal list is shown in Table 10.2 and Table 10.3 shows the same list in rank order. Because the assemblages from the two levels in the pit (samples 4 and 5) were so similar, they have been considered together. Fig. 10.3 shows the distribution of species by habitat and Fig. 10.4 shows the proportions of carabids and phytophages.

The commonest species in the assemblage was the phytophagous *Phyllotreta nemorum* and the fragmentary insect remains in Sample 3, were also dominated by this species. Other members of this genus were also present. These beetles feed mainly on Cruciferous plants, especially brassicas, which may be cultivated, like cabbages, or weeds of disturbed ground. The next most abundant phytophage was *Batophila aerata,* which feeds on brambles and raspberry (*Rubus* species). There were a variety of other plant-eating beetles; many of marshland plants, including several found on trees of wet areas e.g. *Curculio salicivorus*, which feeds on willow. Altogether trees formed 7% of the assemblage, which is a very high proportion, especially as this group tends to be under represented in thanatocoenosis (Kenward 1978a). Table 10.5 provides a list of the phytophagous beetles found at Fishbourne and their host plants.

Marshy ground with lush vegetation was also reflected by the numerous carabids in the assemblage. There were a variety of *Bembidion* species, e.g. *B. properans, B. biguttatum* indicating wet, clayey ground with trees (Lindroth 1985), and several types of *Pterostichus* namely; *P. nigrita, P. anthracinus* and *P. minor*, again common in wet places. *Bembidion iricolor*, also present is usually found in estaurine conditions, which is appropriate, as the sea is nearby. There were also significant numbers of water beetles, not only *Helophorus* species but also more typically aquatic species such as *Ochthebius minimus* and *Hydraena testacea.* Altogether, the beetles representative of water and damp ground, made up 20% of the beetles in the assemblage.

There were very few beetles in this assemblage, which do not fit in with this picture. *Licinus depressus* is usually found on dry sand, gravel or chalk (Lindroth 1974) and may have come from the nearby downs. Despite its name, *Notiophilus aquaticus,* prefers dry open country and a gravel substrate (Lindroth 1985). *Dromius notatus* is also xerophilous and is often found on near the coast (Harde 1984). *Sitona striatellus* is found on gorse or broom, both plants of dry ground. These beetles are all strong fliers.

Another 20% of the assemblage was made up of decomposer species, excluding those preferring damp mouldy materials. This figure is low, considering that most members of this group are mobile and decaying matter is common. However some species were present in large numbers. The most plentiful of the decomposer species was *Carpelimus bilineatus.* This small, highly mobile beetle was very common in towns during the Saxon period breeding in the plentiful organic matter, but nowadays it is normally found by rivers (Hall *et al.* 1983b). The next most abundant was *Anotylus sculpturatus* a species not common in urban pits (see Section 8.3.2) associated with it here was *A. rugosus.* They are secondary indicators of pastureland (Robinson 1983a), as they may be found in dung, but they are not exclusive to that habitat. In this case, the primary indicators of pasture, dung beetles, were not present in any quantity. The numbers of *Sitona* and *Apion* species recovered from this feature may indicate nearby meadowland (Robinson 1983a).

The most strongly synanthropic beetle present was one individual of *Ptinus fur,* and even this species can live in nests and old wood (Palm 1956). The relatively high number of the furniture beetle, *Anobium punctatum*, probably originated in a building, alternatively they came from structural timbers around the hole or from the nearby trees (Hickin 1963). There were a number of individuals of *Lathridius minutus* but this can exist in the wild in nests, rotting wood and decaying plant debris (Hinton 1945) as can *Xylodromus concinnus*, another species found, which is associated with buildings (Donisthorpe 1939). There is no evidence to suppose that the beetles from the genera *Cryptophagus* and *Atomaria* were synanthropic, especially as these were each represented by a single species, and those found in buildings tend to be a mixture. Similarly the corticarines found may have been outdoor species, living under bark. Together the dry decomposer group and the possible "house" species made up another 20%.

10.4 COMPARISONS WITH THE ARCHAEOLOGICAL RECORD

There are no other pits of a similar age and location in the records. Other rural sites, which in any case are chiefly Roman or earlier, are predominantly agricultural. This pit, in some ways, resembles one of the Iron Age sumps at Farmoor (Robinson 1979). That assemblage also contained many chrysomelids, although the commonest *Phyllotreta* species was *P. vittula. P. nemorum* was found on the site in small numbers but not in that particular feature. The main difference between the two pits was the huge numbers of *Aphodius* species at Farmoor, indicating that that feature had been used as a watering hole for cattle. The numbers of *Anotylus sculpturatus* and of *Phyllotreta* species in the Southampton Saxon pit (Section 8.2.2), made that the most similar feature. Although there was evidence that that pit had held cess, it had been located near marshy land. Likewise, this fauna shows some resemblance to Roman ones from water-filled features. This is especially true of the one from Fishbourne itself (Osborne 1971a), which is compared next.

The Roman sample was taken from the silt-filled Roman deep-water channel at the southern end of the Palace complex (Osborne 1971a). It was thought to date from the time of the first palace, which is within a few decades of the Roman invasion. The assemblage consisted of a minimum of 61 beetles from 34 taxa extracted from about 2.5kg of material. The conclusion was that this channel was "a eutrophic pond or slowly–flowing stream with aquatic plants growing in the shallow water near muddy banks." It had a muddy bottom and "was probably used as a watering place for cattle and other livestock." In the light of later research (Robinson 1983a) the evidence for cattle is not very strong.

This, unfortunately small, fauna was compared with the Saxo-Norman one. Apart from the ubiquitous *Helophorus*, there is no overlap of water beetles, but the aquatic environment is known to be dissimilar. One being a channel, connecting to the sea and the other a pit, collecting drainage water from the land. Some of the "damp ground" species were the same, for example the carabids, *Dyschirius globosus* and *Bembidion biguttatum.* The richness and abundance of phytophages was also missing from the Roman sample, although several species were held in common including *Barypeithes araneiformis*. There were no specimens of *Phyllotreta nemorum.* There was no evidence for meadowland in the Roman assemblage, as there were no *Apion* or *Sitona* species. The commonest decomposers were from the genus *Carpelimus,* but unspecified, and *Anotylus sculpturatus* was missing.

10.5 COMPARISON WITH A MODERN FAUNA

A marshy area adjoining the site consisted of woodland and hay meadows managed in a traditional way, without herbicides, pesticides or artificial fertiliser. An entomological investigation of this reserve, which is called Fishbourne Roman Palace Meadows was carried out one fine day in August 1998 by the present author. The flora was also identified and a full plant species list compiled by the Chichester Harbour Conservancy was consulted.

Willows including osier (*Salix viminalis*), woody nightshade (*Solanum dulcamara*) and nettles (*Urtica dioica*) abounded in the shadier areas with water dropwort (*Oenanthe crocata*) in the stream. In the field, the most obvious plants were docks (*Rumex* species), creeping thistle (*Cirsium arvense*), and various members of the family Leguminosae such as clovers and greater birdsfoot trefoil (*Lotus uliginosus*). At the time of the survey, the grass had not yet been harvested and no cattle were present. The open stream had large swathes of watercress (*Rorippa nasturtium-aquaticum*) as well as sedges (*Carex* species) reeds (*Glyceria* species) and brooklime (*Veronica beccabungae*).

Insects were collected by means of a sweep net. In addition, sediment was taken from two places along the stream, from the shady wooded area and about 200m downstream in the meadow.

10.5.1 RESULTS OF SWEEP NET STUDY

Two species of beetle were captured in the shady part above the stream. *Altica oleracea*, a phytophage was found on the willow-herb (*Epilobium hirsutum*) and a specimen of *Carcinops pumilio.* The latter was something of a surprise, as it lives in decaying matter, but Koch (1989) has recorded this beetle from river meadows. It is carnivorous and so seeks out its Dipteran prey wherever they may be found.

In the meadow, chrysomelids abounded in the plants alongside the stream, but none were common to both modern and medieval samples. *Prasiocuris junci* was found feeding on the plentiful brooklime (*Veronica beccabunga*). *Phyllotreta nigripes* and *P. cruciferae* were collected over the watercress beds (*Rorippa nasturtium-aquaticum*) and this is interesting as they supposedly feed on *brassicas* (Cooter 1991). There are only two crucifers on the official flora list, watercress and Lady's Smock (*Cardamine pratensis*), which had died down by this time of year. Commonest species in the meadow were weevils, mainly *Sitona lineatus* and several species of *Apion,* feeding on vetches and clovers. These are indicators of "mainly meadowland" (Robinson 1983a). The phytophagous beetles, with their host plants are shown in Table 10.5.

This live collection could only sample from a tiny fraction of the coleopteran community, as it was so restricted in time, location and duration, sampling only from only those beetles active on a sunny August afternoon. Further information about the resident beetle population was obtained from samples collected from the stream.

10.5.2 STUDY OF BEETLES FROM THE STREAM SEDIMENT

In order to extend the search for *P. nemorum* and to compare the biocoenosis and thanatocoenosis from the same area, sediment from the stream was examined. Two sites were sampled; a shady area under the trees and downstream in the open field under the watercress. The sediment collected was sieved over a 300μ mesh and hand-sorted under a binocular microscope. A minimum number of 15 beetles were recovered from the downstream sample and 38 from the upstream, a total of 53.

10.5.3 STREAM SEDIMENT FAUNAS

Faunal lists are given in Table 10.4, habitat details and numbers of selected types of beetle in Figs 10.3 and 10.4. It is interesting that there was so little overlap in the assemblages from the two areas and the numbers and variety of beetles was higher in the upstream sample (see Table 10.4).

Few water and wet ground species were found in these samples, which were dominated by phytophages. *Phyllotreta nemorum* was not found but *P. nigripes* was recovered. It had been collected, by sweep net, over the watercress beds together with *P. cruciferae.* Interestingly, this individual was not recovered from the open area but upstream in the wooded part. Some other *Phyllotreta* species, all distinguishable, from the above-mentioned two, by their yellow and black coloration, have been recorded on watercress, whereas eight species of *Phyllotreta,* including all those mentioned in this report, are recorded as pests of *Brassica* crops (Bullock 1993).

Each stream assemblage contained a species newly introduced from New Zealand, namely the timber pest, *Euophryum confine* (Hammond 1974). It feeds on dead wood, both indoors and outdoors, and is now widespread. Another feature of these lists, which are typical of the present time, is the presence of *Barypeithes pellucidus,* which has become much commoner recently (Hammond 1974; see Chapter 11).

10.5.4 IMPLICATIONS OF THE STREAM FAUNAS

It is not known how long the sediment took to form but, in view of the persistent rain earlier in the year, probably only a few months, as the raised water level would have scoured the stream bed. The fewer numbers of specimens in the downstream sample may be because this region, being nearer the sea and affected by the tides may be scoured out more frequently. In addition, the incoming tide causes the stream to flow backwards for certain distance so the beetles from the meadow may have been carried upstream to the wooded area. Conversely, they may have come from higher up, where the water flows through farmers' fields and then between gardens. Most of the water beetles were found in the downstream sample, which suggests that it contained more autochthonous species.

10.6 COMPARISON OF ANCIENT AND MODERN FAUNAS

Due to the much smaller size of the stream assemblage it is likely to be less representative of the available coloeopteran fauna than the pit assemblage. Nevertheless the two were compared. Not only will stochastic differences between the two faunas be large but also taphonomic ones will be significant as the collecting medium, was different (a stream versus a pit) and there were unknown differences in the time scales of their formations.

Only nine of the species on the modern list were the same as those on the ancient one, most similarities occurred between the carabids and the phytophages. There was no overlap of aquatic species and little in common between the lists of decomposer species with the most frequently occurring Saxo-Norman species, *Carpelimus bilineatus* and *Anotylus sculpturatus,* being absent from the modern list. Nevertheless, the overall picture of marshland and meadowland was the same although the species, while suited to the same environment, were mostly different from the ancient ones.

The differences between the ancient and modern water beetles may be due to a number of factors. For example, changes in the rate of flow of the stream and in the composition of the water, which may contain traces of pesticides, herbicides and fertilisers from passage through farmland. The differences in the decomposer element may also may due to environmental differences. The two commonest species from the pit *Carpelimus bilineatus* and *Anotylus sculpturatus* were not found in the stream. The large numbers of these may indicate piles of rotting vegetation, not found by the modern stream at the time of the survey, as any accumulations had probably been removed earlier in the year when the rainfall was heavy. Overall the levels of decomposer species were very similar but only two were held in common. These were *Xantholinus linearis,* which is found in grass tufts, flood refuse and other damp mouldy materials, generally preferring drier areas then these (Buck 1955; Good and Gillar 1991) and *Tachyporus hypnorum,* which is found at the base of grasses and feeds on aphids (Good and Gillar 1991).

The differences in the phytophagous species are shown in Table 10.5, which is a comparison of ancient and modern species with their host plants. The modern flora will not be the same as the medieval due to many factors. One of the most obvious is the affect of rabbits on the herbage. These were introduced to the country by the Normans and did not become established in the wild for some time. The relative abundances of many species of chrysomelidae appear to be related to the type of crops grown (Jones and Jones 1974). For example, *Phyllotreta cruciferae*, has become more common recently, as it is found on the ubiquitous oilseed rape (*Brassica napae*) and the two species found in the modern samples, *P. nigripes* and *P cruciferae*, are supposedly more common in the east of the country (Jones and Jones 1974).

Aphthona euphorbiae has also become common, together with the very small *Longitarsus* species *L. parvulus* (Cox and Campbell 1998), which may have been present. These species are also discussed in the next chapter where they appear in modern garden faunas. Agriculture as it is practised today, with its emphasis on monocultures, is bound to upset the ecological balance and cause fluctations in the numbers of associated pest species. One plant, the nettle (*Urtica dioica*), which is prolific now and probably always was, had not left a trace in the record, despite having a characteristic beetle fauna associated with it (Davis 1973).

10.7 THE IMPLICATIONS OF THE FAUNA

10.7.1 FUNCTION OF PIT 28

The high levels of phytophages, aquatic and wet ground species, including many carabids, and relatively low numbers of decomposer beetles are not typical of an assemblage from a rubbish pit. Pit assemblages normally contain a much greater percentage of decomposer species and provide little information about the surroundings (see Chapter 13). From this large circumadjacent fauna, it appears that the pit filled up with water and surface debris. There is evidence that the pit silted up rapidly as the three levels, each 200mm apart, contained very similar faunas, even of seasonally active beetles like the phytophages. The other alternative is that thorough mixing of the liquid contents occurred. A section of the pit was not possible, but the few pieces of pot and bone found in it, showed no obvious stratigraphy, they may even have been washed in with the other debris. The decomposers, that were present, could have been associated with decaying vegetation on the ground and swept in with the rest of the fauna. The similarities with the modern stream faunas support this interpretation and suggest it filled when the nearby streams flooded.

The most likely reason for digging this hole were, either to extract good quality clay or as a water source, or both. Similar pits of Roman date occurred on the nearby site, which was part of the area associated with the Palace (Cunliffe *et al.* 1997). One particular pit, close to a ditch containing Roman terracotta water pipes, may have provided the clay in which those pipes were laid (James Kenny, site officer, pers. comm.). This medieval extraction may have been for making daub for houses.

Whatever the initial reason for the pit, it may subsequently have been used for water. There was inconclusive archaeological evidence for beam slots and therefore a construction beside it. In addition it contained some domestic rubbish, which had probably been thrown in, suggesting that it was not abandoned immediately after it was dug. There is no evidence for stock using this hole, quite the contrary, for if they had, large numbers of dung beetles, such as were found at Farmoor (Robinson 1979), should have been present. In addition, their trampling would have produced large amounts of organically enriched mud. With one exception, the Aphodiines found here, are not necessarily associated with dung, and beetles preferring clean mud, for example *Platystethus nitens* (Kenward and Hall 1995, 680) are present. Furthermore, the abundant evidence of trees, herbage and marshy ground around this feature, suggest that it was not in constant use.

10.7.2 THE SURROUNDING AREA

There were few synanthropic species, to back up the finds of domestic pot and food bones, which indicated that a settlement might have been close by. Probably, some of the wet ground, was managed as meadows, hence the numbers of *Apion* and *Sitona* species, in the assemblage. The relatively large numbers of *Bruchus* species is interesting because of evidence that the coastal plain area by the late 11th century was producing legumes, the foodplant of this beetle (Green 1994). These beetles are strong fliers and common in archaeological deposits, although they usually occur preserved in faeces after ingestion in pulses (see Section 7.4.2.2). There is also evidence that they are attracted to the flowers of Meadowsweet (*Filipendula ulmaria*) (Osborne 1983), a plant of wet ground. This may be another reason for the frequent occurrence of bruchids in environmental samples, as these are usually extracted from wet areas.

The most plentiful species was the flea beetle, *Phyllotreta nemorum*. This is not unusual in archaeological assemblages, although it has not been found in such large numbers before. There are two wet ground species of *Brassica*, which it might have fed on, i.e. Bargeman's cabbage (*Brassica campestris*) and Black mustard (*B. nigra*). The latter has been used as a flavouring since Roman times (Buckland 1976a, 24) and it is possible that it was cultivated in this area at the time when the pit was dug. The predominance of this beetle suggests that its pabulum was plentiful and close by.

The overwhelming evidence from the beetles is of an area not dissimilar to that which pertains today. This is an overgrown marshy area with trees such as willow (*Salix*) and Poplar (*Populus*), with brambles and marshland plants by the stream and nearby meadows. In addition the numbers of *Bruchus* and *Phyllotreta* species suggest that crops such as leguminous plants for fodder or food (e.g. beans) and cruciferous plants such as *Brassica nigra* (for flavouring) may have been grown in the vicinity.

10.8 SUMMARY

The opportunity existed, for comparing ancient and modern ecosystems, because nearby marshy land has remained unchanged for centuries. While the habitats and types of beetle represented were in similar proportions and in many cases the plants, indicated by the beetles were the same, the actual species of beetle was usually different. However, no clue was obtained, about commonest medieval phytophage, *Phyllotreta nemorum*, as it was not found nor was a likely food plant.

This early medieval assemblage was interesting, as a contrast to the urban ones already described, it appeared to be largely natural. It only showed human influence by the presence of meadowland and some synanthropic species. The pit was classified as a well (closed water feature) and used in the analysis of features described in Chapter 14.

CHAPTER 11: Experimental work

11.1 INTRODUCTION

This chapter describes experimental work carried out by the author to investigate the nature of cesspit faunas. The experiment aimed to resolve some of the statements in the literature. For example: -

> "it appears likely that while some of the Coleoptera may have been attracted to the foul odour of the cess-pit, the greater proportion entered accidentally or incidentally. This is not surprising if the pit contained liquid waste or slurry not suitable for breeding"(Hall *et al.* 1983a, 87).

The supposition that the contents of a cesspit are so foul that it mainly contains background species will be investigated. If some species are shown to be attracted, evidence for breeding will be looked for and evidence for repulsion of certain types of beetles will also be sought. These factors may help to explain why pit faunas have a low diversity: -

> "a rather limited pool of species contributed the great majority of the individuals from the samples as a whole" (Kenward and Large 1995, 36).

A further aim was to investigate how frequently dry decomposer beetles and xylophagous species were present in cess to which no floor sweepings had been added. That is one explanation for their prevalence there.

> "Some groups from Coppergate pits included abundant "house fauna" ... undoubtedly imported with floor sweepings"(Kenward and Large 1998, 37).

Alternatively it has been suggested that *Tipnus unicolor* and *Mycetaea hirta* not only were attracted to the cesspit but also bred in it: -

> "It has been noted that the most abundant beetle, *Tipnus unicolor* is usually found in large numbers in medieval pits which seem to have been cesspits. ...It may be that the decline and virtual disappearance of this means of disposing of human sewage has contributed to the scarcity of this beetle by removing one of its favourable habitats. Exactly the same thing could be said for *Mycetaea hirta*." (Osborne 1981a, 269)

Those who have investigated pit faunas would probably agree with the following statement.

> "The presence of *Anobium punctatum* in cesspits is an enigma" (Osborne

1983, 460.)

Not only is the habitat incongruous, as this beetle is a wood feeder, but also it is seasonal, the adult only lives for about ten days, around midsummer (Blake 1925). Yet it is nearly always present in medieval pit faunas.

The relative dearth of dung beetles of the genus *Aphodius* is another mystery, which was also investigated.

11.1.1 AIMS AND OBJECTIVES OF THE EXPERIMENTS

- To determine whether certain beetles are attracted to the cesspit.
- To find out if other beetle species are repulsed.
- To discover whether any insects breed in the pit.

These aims are to be achieved by building an experimental cesspit and a control pit and comparing the assemblages, which collect in them. In addition choice chamber experiments will be undertaken on species of *Aphodius* dung beetles.

11.2 AN EXPERIMENTAL CESSPIT

11.2.1 PREVIOUS WORK

Prior to this experiment, there are no records of any attempts to reconstruct the conditions surrounding the deposition of cess in the medieval period. The only modern study in the literature is by Osborne (1983), who investigated the coleopteran fauna in his own domestic cesspit. The conditions of use of this pit were rather different to those in which faunas have survived from the more distant past. The effluent was collected in the house in a covered bucket and was treated with disinfectant, although he stated that this did not deter beetles. The cess was not waterlogged and had decayed, so much so, that it was difficult to find the location in the garden where it had been deposited. Therefore, it was not equivalent to a medieval pit containing insect remains, which had been preserved by deposition in wet ground. The preservation of the beetles, which had occurred, could be attributed to their recent burial. Other differences were the modern diet and use of toilet paper, instead of hay or moss, and the lack of any other additions, all of which might alter the texture of the pit contents. It was not possible to know whether beetles entered the Elsan container in the house or had been attracted to the cess in the garden. In order to see which beetles were specific to the cess, a comparison had been made with the assemblages in a nearby compost heap and in the surrounding soil.

That study will be compared with the present one in which attempts were made to reproduce medieval conditions.

11.2.2 EXPERIMENTAL DETAILS

In the experiment carried out by the author, medieval conditions were simulated where practicable. Some attempt was made to follow a medieval diet, with more bran and less sugar. This was because the consistency of the faeces is influenced by the diet, especially by the amount of fibre consumed. However, the experimenter did draw the line at inoculating herself with the gut parasites, *Trichurus* and *Ascaris*, which were endemic in the human gut in medieval times. Toilet paper was not used but hay, which proved to be an excellent alternative.

There is circumstantial evidence of this usage in Saxon times (Hall *et al.* 1983a) and mineralised impressions of grasses occur in the material from Winchester and Southampton (Sections 8.4.1. and 9.2.1). An oblique reference to the use of hay for this purpose in the Middle Ages comes from this story. Abbot Samson (1182 -1212) was visiting his estates when one night he heard a voice urging him to get up. This he did, whereupon he noticed in a necessary place (*privy*) a light; a candle left there through carelessness, and which was about to fall on the straw (*sic*) thus causing a fire in which many could have perished (Jane 1931 cited in Wood (1965, 384). The footnote adds "doubtless 'hay' was meant instead of 'straw', the medieval equivalent of our toilet paper", although no confirmation of that statement is given (Wood 1965).

11.2.3 METHOD

A pit 0.5m^3 was dug at the bottom of a suburban garden in Chichester (see Fig. 11.1) and as it was not dug below the water table, it was lined with a waterproof groundsheet, and water was added to create waterlogging. Human excrement was added daily, from a chamber pot, which had remained securely covered whilst the pot was in the house. To prevent animals accidentally falling in the pit, a few planks and branches were placed over it. Small amounts of garden soil were thrown in, to simulate the conditions in the late medieval cesspits, such as those from Southampton and Winchester (Chapters 7; 8).

A control pit of the same size and construction was dug about 8m away in a similar position in the garden. The intention was simply to keep this pit wet and to differ from the cesspit only in the absence of cess. The position of both pits is shown in Fig. 11.2 and a photograph of the cesspit is shown in Plate 11.1.

11.2.4 SAMPLE DETAILS AND TREATMENT

Taking equal size samples from the two pits proved impossible in practice. The method by which material was obtained was by scraping material from the bottom using a long handled ladle. It was attempted at first, to obtain equal volumes from each pit. However, this was not practical as the cesspit contained an abundance of solid material not only in the form of cess but also added hay and fallen leaves. Although the intention had been for the control pit to contain only water, leaves and soil had fallen in as well and the beetles had sunk to the bottom. There seemed to be no easy way to standardise the two. In any case the samples were so different in nature that comparison by weight or volume would not have been meaningful.

The size of the two assemblages, after the removal of the superabundant, *Anotylus tetracarinatus*, was not very different: 223 in the cesspit as against 157 in the control and so direct comparisons were made. The proportions of the beetles from different habitats were compared, omitting *A. tetracarinatus* and using the system of habitat classification described in Chapter 7.

The total amount of material collected from the cesspit was 735ml weighing about 660gm and from the control, 1700ml, with a weight of around 360gm.

In order to make the cess samples more savoury to deal with, they were left to decompose further before examination. The environment was kept aerobic, to facilitate decomposition, by placing a 300µ mesh over the jar containing the samples. These were left in the garden for a further two months. Due to this treatment the specimens had become partially dismembered, with antennae and limbs most frequently disarticulated. Therefore, they were treated like archaeological assemblages and separated from the substrate by paraffin flotation. Identification could not always be made to species but identification of *Phyllotreta* species were confirmed by comparison with whole specimens collected by sweep net in the same area.

11.2.5 THE FAUNAS

The pits were dug on 10th June 1995 and maintained until 25th July. They were sampled four times at ten-day intervals. That year the weather had remained abnormally cold up to the beginning of this experiment. It continued so until the third week in June when it then became very hot and sunny with occasional rainstorms.

The first samples collected on 21st June contained no beetles in either pit, although there were some dead adult flies in the cess sample. This was probably due to the very cold weather.

Ten days later the weather had become hot and both pits were found to contain insects. Thereafter, each pit attracted a number of beetles. A total of at least 1060 individuals from 52 species were extracted from the cesspit, 837 of which were from one species, and 167 individuals from 42 species from the control pit (Table 11.1).

The proportions of the habitats represented by the beetles is shown in Fig. 11.3 and Fig. 11.4 shows the differences in the proportions of plant feeders, mould feeders and carabids between the two pits.

11.2.5.1 The cesspit fauna

Flies buzzed around the cesspit, but the only dipteran colonisers were drone flies (*Eristalis tenax*). The larvae of these are called rat-tailed maggots, they are able to live in foul water because they have a long breathing tube through which they obtain oxygen from the surface. This fly has been found in cesspits before (e.g Winchester, Carrott *et al.* 1996; York, Kenward and Hall 1995).

The coleopteran assemblage from the cesspit is shown in rank order of abundance in Table 11.2. It can be seen that it contained a large group of decomposer species, excluding "dry decomposers" they formed 56% of the assemblage, 10% of which were species at the foul, wet end of the spectrum. This latter group included the "pit colonisers" beetles (see Chapter 13), which in this case were from the genus *Anotylus*, of which by far the most abundant was *A. tetracarinatus* but *A. complanatus* and *A. sculpturatus* were also common. Perhaps the very wet conditions favoured *A. tetracarinatus*, as this species favours fresh cowpats, whilst *A. sculpturatus* prefers older drier ones (Smith 1991). The only type of animal dung frequented by *A.*

complanatus is cow dung. (Skidmore 1991), which is more like human dung, than the coarser and drier horse and sheep varieties. The large numbers of *A. tetracarinatus* may have been caused by swarming, as no teneral or deformed individuals were found to indicate breeding. This species is known to swarm; Williams (1930) described it once as "blackening" the sweep net and Kenward (1976b) found very large numbers in a modern urban roof gutter. There was no evidence that any of the beetles had bred in the pit, which may have been due to the relatively short period it remained open. Other species of foul, wet decomposing matter in the pit assemblage included *Cercyon haemorrhoidalis, Tachinus* species, fly predators such as Histerids and *Philonthus* species and *Atomaria testacea.* The latter is unusual, as it is found in dung (Skidmore 1991; Koch 1989), whereas the other members of the genus inhabit moist plant debris.

Three species of dung beetle were also present, of these the most numerous was *Onthophagus coenobita.* There were eight individuals, from three samples, of this large bright green beetle. This species has been found in decaying material of various sorts including dung, mushrooms and corpses (Jessop 1986); potatoes and compost (Whitehead 1992); rotten leaves of wormwood (*Artemisia*) but it is said to be most partial to human excrement (Lumaret and Kirk 1991). In Britain its distribution is restricted to the south (Jessop 1986). It may have been living in the fields about 0.5km away from the garden but the speed with which it discovered this pit was remarkable. Two *Aphodius* species were also present, three specimens of *A. rufus* and one of *A. fimetarius.* The former is a feeder on a variety of dung; it is locally common and seasonal with adults occurring in July (Jessop 1986), which is when these specimens were collected. The latter is a more general feeder, including human dung as well as decaying vegetable matter among its pabulum (Jessop 1986).

House species were absent, except for the wood pest *Euophryum confine.* Other dry decomposers were present, forming 6% of the total assemblage, but the only species in any number was *Aridius bifasciatus.* The specimen of *Anthrenus fuscus* recovered from the cesspit is considered by Allen (1956) to be a wholly outdoor species breeding in birds' nests with the adults feeding on flowers.

There were a number of phytophages in the pit, the commonest of which was the weevil, *Barypeithes pellucidus.* Little is known of the biology of this species (Morris 1997) but is becoming more abundant (Hammond 1974). Only two other weevils were present and they were from the genus *Sitona, S. lineatus* and *S. puncticollis.* Unlike many weevils, the members of this genus are active fliers. The other plant eaters were "flea beetles" mainly a very small *Longitarsus* species and *Phyllotreta cruciferae.* All of these could have been living on the surrounding vegetation of vegetables and weeds (Bullock 1993).

11.2.5.2 The control pit fauna

This pit in use did not just contain water, but dead leaves from the covering branches and some soil had accidentally fallen in. No flies were found and the beetle assemblage recovered from it is shown in rank order of abundance in Table 11.3. In contrast to the experimental pit, it had a much larger number and diversity of phytophages. They totalled 51% of the individuals present and indicated a disturbed ground habitat. Three plant-eating beetles occupied the first three ranks of abundance in the control pit. The same species were also found in the cesspit but in lesser numbers, with *Barypeithes pellucidus* the most numerous phytophagous beetle in both.

The percentage of "dry decomposers" was about three times larger than in the cesspit. *Aridius bifasciatus* and *A. nodifer* were much more common at this location and another dry decomposer, *Enicmus transversus,* showed the strongest preference for the control as it had been completely absent from the other pit. On the other hand, a greater number of *Atomaria testacea* occurred in the cesspit. Floating decaying vegetation was present in both pits, which might have attracted such beetles, although no mould was visible in either location. Small numbers of the oxyteline "pit colonisers" were present in the control, but few other foul decomposers were found there.

None of the flightless mould-eating beetles, which inhabit buildings (i.e. Ptinids and *Mycetaea hirta*) were present in either position. The only strongly synanthropic beetles found were timber pests. Two individuals of *Anobium punctatum* were found in the control pit. This beetle can live in the wild in trees (Hickin 1964) as well as in buildings. It is interesting that the shed, nearest to the experimental pit was riddled with this pest, whereas the shed nearest the control pit, was not (see Fig. 11.2). The experiment was conducted while it was on the wing and it is a strong flier. *Euophryum confine,* was found in both locations and it may have emerged from the old planks used to cover the pits or from the sheds, its actual source was not checked.

There was a disparity in the distribution on carabids with four in the control pit and none in the cess. These beetles run along the ground and are the commonest beetles recovered from pitfall traps, which these pits could be considered to be.

11.2.6 COMPARISON WITH OSBORNE'S (1983) CESSPIT FAUNA

The only other modern example is that carried out by Osborne (1983) in his garden in rural Shropshire (described in Section 4.1.2.1). The size of the assemblage was very similar, with a total MNI of 218 against 223 in Chichester, when the superabundant *A. tetracarinatus* was excluded. There were notable differences between the contents of this pit and those of medieval date, as disinfectant and toilet paper had been added and the pit was not waterlogged.

Anotylus tetracarinatus was joint commonest beetle in the pit. It has only sixteen specimens so it was not nearly as abundant as it was in Chichester but it reflects the modern trend of increased abundant for this species. *Omalium rivulare,* not found in Chichester, was the other top ranking beetle. Both these beetles are decomposer species although only *A. tetracarinatus* is specifically found in foul conditions. The other common decomposers were the "pit colonisers" *Oxytelus sculptus* and *Platystethus arenarius,* which are thought to signify particular pit conditions, see Chapter 13.

The other main difference between the two modern examples was the presence of "house species" in the Shropshire pit. These included all the common archaeological ones; *Anobium punctatum, Tipnus unicolor, Ptinus fur, Mycetaea hirta, Lathridius minutus* and *Dienerella ruficollis* as well as the rarely found spider beetle *Niptus hololeucus.* It had been supposed that this spider beetle had been introduced to England from Russia in pig's bristles in 1837, but there are two earlier records. It was found in Roman deposits in York by Buckland (1976a), although there is a possibility that this was a modern contamination. It also occurred in medieval deposits in Germany (Cymorek and Koch 1969).

More "house" species occurred in the cesspit than in the compost heap although both had received material from the house, where at least some of these beetles were known to have resided. Osborne (1983) stated that he had never seen *T. unicolor* indoors and Allen (1956) had occasionally found the flightless *M. hirta* associated with rotten wood in his garden, but never in his house. Thus even these strongly synanthropic species may not be exclusively bound to buildings. The mobile species, such as *Lathridius* *minutus*, are frequently found outdoors. Whatever the source of these beetles, they appeared to show a preference for Osborne's cesspit.

Three individuals of the genus *Aphodius* were found in the cesspit and they were not identifiable to species. A few more individuals of this genus of dung beetle were recovered from the compost heap and soil. The numbers in the cesspit are similar to those in the Chichester pit, but these low numbers are more surprising as the surrounding area was used for sheep grazing. *Onthophagus coenobita* was not found.

The introduced species of mould feeders *Aridius bifasciatus* and *A. nodifer* were both present and more common in compost than cess, reflecting the position in the Chichester pits, where they were commoner in the control. Another species, which was more frequent in the compost heap, was *Megasternum obscurum.* Conversely, this beetle had occurred in the Chichester cesspit in greater numbers than in the control.

Although trees and bushes had surrounded three sides of the disposal area, phytophages of trees were not apparent, as they were restricted to a single specimen of *Epuraea.* Other phytophages were also not common compared to Chichester, perhaps indicting a clearer access to the cess disposal area. Many more plant eaters, especially flightless curculionids (weevils), were present in the compost, presumably introduced with the garden waste. The weevil so common in Chichester *Barypeithes pellucidus,* was absent but its congener *B. araneiformis,* was found only in small numbers in the cess, more in the compost and most in the soil. A few examples of this species had been found in Chichester in the control pit. Little is known about either species (Morris 1997).

Unlike the situation in the Chichester pits, carabids were found in the cess, in compost and in the garden soil in roughly equal amounts. Perhaps these ground beetles were able to run about on the crust, which formed over the cesspit contents, so this difference between the faunas may be attributable to the different treatment of the effluent.

11.2.7 COMPARISON WITH THE ARCHAEOLOGICAL RECORD

Most of the species found in these modern examples have been found in archaeological examples, but not always in the same frequencies. The huge numbers of *Anotylus tetracarinatus* have not been matched in any ancient cesspit assemblage. Neither *A. tetracarinatus* nor *A. sculpturatus* were included among the most frequently found species from Anglo-Scandinavian pits at Coppergate, York (Kenward and Hall 1995).

The latter species has been argued to be a less common urban beetle but more abundant in rural situations, such as Roman villa sites (see Section 8.3.2). Its presence here bears out this argument, as suburban Chichester more closely resembles the ancient rural scene than the urban. The evidence from medieval towns suggests that they were nearly swamped in their own waste products; for example Jorvik (Viking York) is described as: -

> "a town composed of rotting wooden buildings covered by decaying vegetation surrounded by streets and yards filled by pits and middens of even fouler organic waste." Kenward *et al.* (1978, 67).

Therefore large numbers of decomposer beetles were very common, some of which, e.g. *Carpelimus bilineatus* and *Neobisnius villosulus* are now more commonly found in riverside locations.

The Chichester experimental pit most closely resembled the Saxon cesspit from Southampton, described in Section 8.2.3, with four of the first five most abundant species being common to both. The most significant point of similarity was the high numbers of the same species of *Anotylus,* although *A. tetracarinatus* was much less frequent. The abundance of *A. sculpturatus* was interpreted as indicating natural surroundings, which is plausible as this pit lay on the edge of the developing medieval town. *A. complanatus* and *A. tetracarinatus* were also common and have been used to classify this type of fauna (see Chapter 13). In addition both pits had relatively high numbers of phytophages, indicating vegetation around them.

The decomposer species *Megasternum obscurum,* was fairly common in the experimental cesspit, but from Osborne's study, it appeared to prefer compost. This beetle is scarce in the medieval record but was more frequently found in Roman rubbish deposits, which had not contained cess (see Chapters 13; 14). However, it was most frequent in Roman wells (see Section 14.4.1.3), so higher numbers in the control pit might have been expected.

Onthophagus coenobita has previously been found in Roman deposits and earlier, in places where there was evidence of grazing animals e.g. at the Bronze Age Wilsford shaft (Osborne 1986), in Roman York (Hall and Kenward 1990) and also from Chichester itself in a Roman well (Girling 1989), but never in an ancient cesspit.

The main difference between the ancient and the experimental pit was the complete absence of the mould feeding beetles common in houses, namely *Tipnus unicolor*, *Ptinus* species, *Mycetaea hirta* and *Lathridius minutus*, in the recent material. This group was extremely prevalent in ancient cesspits (see Fig. 14.5) and some were present in Osborne's (1983) pit. His house predates the incorporation of a damp course, an innovation that, together with central heating, keeps later houses warmer and drier. Thus modern buildings, such as those around the Chichester pits do not provide suitable conditions for them. In addition there was no chance for beetles to enter the cess whilst it was in the building.

Other "dry decomposer" beetles were fairly frequent in the Chichester as in ancient ones. One of the main species found is a recent introduction to this country, namely *Aridius bifasciatus*. Others, such as unspecified individuals of *Atomaria* and *Cryptophagus*, are commonly present in medieval pit assemblages and are considered to be evidence of species living within buildings. However, *Atomaria testacea* present in the Chichester pit, is one of a few dung inhabiting species in that genus. The members of those genera are rarely specified because of the difficulty of identification from disarticulated remains. Another member of the "dry decomposer" group, *Enicmus transversus*, was only present in the control pit, it was, like *M. obscurum*, commonest in Roman pits and ditches, which did not contain cess (see Fig. 14.6).

Phytophages and carabids are relatively rare in cess, as was seen by the comparison with the control pit, although the latter difference was not found in Osborne (1983) example (see above). The archaeological record bears out the situation found in the Chichester cesspit (see Fig. 14.6).

11.2.8 DISCUSSION ON OTHER ADDITIONS TO THE PIT

Something, which might be considered an essential ingredient of cesspits, namely the material used for cleaning the body after defecation, has been rather neglected in the literature. As well as being a potential source of allochthonous beetles, differences in anal wipes may help to account for the different faunal types described in Chapter 13.

There is good evidence for the use of moss as anal wipes from medieval and later cesspits in Norway (Krzywinski 1988; Kenward 1988) and from Anglo-Scandinavian York (Kenward and Hall 1995). The acknowledgement, that this material may be a source of some of the beetles in the assemblages, is only considered in the Norwegian example: -

> "It is likely, however, that many insects ... were imported in the abundant moss recorded from many of the deposits. No characteristic moss-dwelling insects are abundant, but many of the species can be found in moss, particularly when hibernating, and moss mats with associated soil are a source of abundant corpses from nearby habitats." (Kenward 1988, 119-200).

Grass-like mineralised impressions and grassland plant remains in samples from Winchester and Southampton (see Section 7.4.3; Carrott *et al.* 1996; Section 8.2.1) suggested that hay may have been used for this purpose. There is documentary evidence for hay, as can be seen from the story repeated at the beginning of this chapter, but it is difficult to obtain conclusive evidence from the archaeological record. There are several reasons for this; vegetative remains are not as durable or easy to identify as are the reproductive parts of plants, and the hay may have other origins, such as discarded floor coverings. Although Hall *et al.* (1983b, 92) stated that there was no "good evidence for that which is euphemistically termed toilet tissue", the remains of grass (and grass aphids) in an Anglo/Scandinavian pit were recorded as possibly having been used for this purpose. However, when the full report from this site was published, there was no mention of anal wipes of grassy origin but only of mosses of which there was good evidence (Hall and Kenward 1995). In a discussion on the possible sources of the contents of a 15th century barrel latrine in Worcester (Greig 1981) the remains of hay, sedge and straw were interpreted as flooring material. Why they should have been put in the barrel, using up valuable space, was debated: -

> "Perhaps only small amounts of flooring were used to render the contents of the barrel less offensive, or some of the hay and straw could have been used in place of lavatory paper." (Greig 1981, 279).

Another possible contender is animal hair. Sheep's wool recovered from a Tudor internal cesspit in Tenby (Murphy 1989) was thought to have been used for this purpose as may tufts of hair from various animals found in a pit from Saxon Winchester (see Section 7.4.4.1).

The type of material used for anal wipes may influence the developing fauna as it may affect the texture of the pit contents. The conditions, which might develop in a cesspit with added hay, may well be different to those developing with other materials. In this experiment hay was found to float, providing an aerated microhabitat at the surface. Quite different conditions developed at the other modern pit. Osborne (1983) reported that a crust formed on top and when he added new contents, beetles emerged from the depths to avoid drowning. Toilet paper was used in that experiment, which absorbs water easily, so it would not float. Moss may have similar characteristics.

Due to the lack of good evidence for anal wipes from most pits, the connection with them and the development of different types of pit faunas described in Chapter 13 cannot be proved.

The most surprising thing about the cesspit was the lack of odour, even on hot days, the smell, within a few metres, was slight. Presumably this could be attributed to the addition of soil, which is known to be a good deodoriser (see Section 8.3.4.3). As cesspits are dug into the earth, this affect would have occurred automatically to some extent in the medieval period, especially if pits were unlined. In the case of Osborne's pit, the purpose of the added Elsan fluid was to deodorise the contents of the bucket, but presumably not intended to hamper the breakdown of the material. Although Osborne remarked that it certainly did not deter beetles (Osborne 1983) it must have altered the conditions and thus affected the beetle population. The evidence for added sweetening materials is given in Section 8.4.4.3, but this is another neglected area and insufficient data exists for any conclusions to be drawn.

11.2.9 DISCUSSION ON GARDEN FAUNAS

Most of the species found in this experiment are common in modern suburban gardens and in order to place them in context this habitat was also examined. This environment has been extensively studied by Allen (1951-1964) over forty six years in Blackheath, London; by Henderson (1945; 1946) in Purley, Surrey (1939 and 1944) and in Leicester (1979-86) by Owen (1991). It has proved to be an environment rich in beetles. Allen (1964) found a fifth of the British species of Coleoptera in his garden over the period of his study. The first two entomologists thoroughly searched their gardens for beetles using a numbers of techniques. In the case of Owen (1991) all wildlife was being investigated and the collecting methods were not suitable for all types of beetle.

The huge numbers of *Anotylus tetracarinatus* in the cesspit were not duplicated in the control or in most of the other gardens. Only Henderson (1945) found this to be the most abundant oxyteline c.f. (Thompson 1976). Allen (1951-1964) found this species rather irregularly in Blackheath and Owen (1991) only noted one specimen in her Leicester garden. In the latter case, other minute staphylinids, such as aleocharines, were not recorded either, and this was possibly due to the collecting methods. Flying insects were collected in a Malaise trap, a net over a flowerbed, and night flying ones were trapped by a mercury vapour lamp. *Onthophagus coenobita*, so common in the Chichester cesspit, was not found in any other garden. However this beetle now has a southerly distribution in this country.

It is interesting that these garden faunas include several recent imports to the country. A garden is a disturbed habitat, with a large number of niches, from walls and paving, through short grassland, to trees and shrubs and compost heaps. Disturbed habitats are always more susceptible to immigration as, because of the disruption of the environment, new areas are constantly being opened up for colonisation. Newcomers can gain a foothold (Elton 1958).

Two species, now common in gardens and both found in Chichester, are the mould feeding beetles, *Aridius nodifer* and *A. bifasciatus.* These species are recent introductions from the Antipodes. *A. bifasciatus* was first noted in tobacco from Australia in 1877 (Allen 1951) and by 1945 (Hinton 1945) it had established itself. The dispersal of this species has been plotted and it has been noted that Britain is the only country in the Northern Hemisphere in which it has become established (Hammond 1974). Why this should be is not known. Other mycophagous species have become rarer, *Lathridius minutus*, so common in medieval buildings, was found in the two earlier garden studies (Henderson 1945; Allen 1956), but it was "unaccountably rare; taken singly from time to time since 1951," (Allen 1956). It was not found in the Leicester or Chichester gardens. Over the same period *Aridius* species have become commoner, possibly due to competition or reflecting some environmental change.

Another recent introduction is *Euophryum confine* originally from New Zealand, this feeds on dead wood, especially floor boards. This is an recent import from New Zealand, first reported in this country in 1937 but now widespread (Hodge and Jones 1995). It was not found in Purley (Henderson 1945) but occurred in 1951 in Blackheath (Allen 1956), two specimens were captured in the Leicester garden between 1979-86 (Owen 1991). In 1995 the Chichester garden yielded six, the high number was probably due either to the old planks used to cover the pits or to the proximity of a shed, clad in offcuts of *Pinus* (Pine). This beetle was also found in the modern deposit from the stream at Fishbourne (see Section 11.5.3), which suggests that it has high mobility.

Another interesting observation is that the size of the populations of certain native species may suddenly change. By far the most frequently occurring curculionid encountered during this experiment was *Barypeithes pellucidus*. It had also been found, by the present author, in the stream assemblage at Fishbourne (see Section 8.5.3) and in large numbers in an empty house in Chichester on the windowsills. It was also the commonest weevil in the pitfall trap in the Leicester garden (Owen 1981). These observations concur with Hammond's (1974) description of it as being "generally abundant and increasing in the last fifty years". Allen (1951) described it as being quite common in the south east, although it was considered to be local, he often found *B. pellucidus* under planks in his garden. Osborne (1983) records another species, *B. araneiformis*, in his Shropshire garden, which was also present in small numbers in the Chichester control pit. Little is known of the ecology of this genus. Both species have been recorded in small numbers from archaeological environmental samples from rural locations e.g. *B. araneiformis* from Fishbourne (Chapter 10; Osborne 1971b) and *B. pellucidus* from the medieval moat at Cowick (Girling and Robinson 1989).

The phytophagous Halticinae also fluctuate greatly in numbers. This is true of *Longitarsus parvulus*, a flea beetle, noted in Joy (1932) as rare. This species together with *Aphthona euphorbiae* has became widespread in the post Second World War period. This may be due to changes in agriculture and the increased growth of linseed (Cox and Campbell 1998). *L. parvulus* is a pest of flax and sugar beet (Hyman 1992), but *A. euphorbia* is not restricted to spurge (*Euphorbia*) species but has been recorded from a variety of plants (Lane 1992). A very small *Longitarsus* species, which may have been *L. parvulus* was quite common in the Chichester garden but *A. euphorbia* was not found. Similarly, it may have been present at Fishbourne in the modern assemblage (see Chapter 10).

Similarly, there are variations over recent time, in the numbers of different species of *Phyllotreta* beetles. Many of these are crop pests, and different combinations of species are now common in different parts of the country (Jones and Jones 1974). *P. cruciferae* was found in the Chichester garden, *P. cruciferae* and *P. nigrita* were the two species found in the Fishbourne Roman Palace Meadows (see Section 11.5.2.1) and the same two species were most frequently found in the Blackheath garden investigated by Allen (1951). These two species were stated to be more frequent in the east of the country (Jones and Jones 1974), while the two commonest species in the Leicester plot were *P. nigrita* and *P. undulata*, most frequent in the south according to Jones and Jones (1974).

They stated that the population is a drifting one and crop changes such as the now widespread growth of oil seed rape may favour *P. cruciferae*, which can feed on it (Lane 1992). The members of this genus with black elytra, which includes all those discussed in this paragraph, are difficult to identify and are often only identified to genus, so changes in abundance over long periods of time are difficult to monitor.

Another example is *Monotoma brevicollis*, a mycophagous species found in decaying vegetation, especially in gardens and sheds (Koch 1989). Allen (1956, 216) wrote: -

> "Why this species should be considered rare surpasses my comprehension. I have found it as freely as any of the genus not only here but in other localities in the south-east."

A specimen was found in the Chichester cesspit and two were present in the Shropshire one (Osborne 1983).

Some changes may be the result of increased urbanisation, which affects the beetle population mainly by the reduction of semi-natural habitats such as woodland and open spaces and isolation of remaining pockets by roads, which form a barrier to more sedentary species. These factors have been found to be more important than air quality (Davis 1982). During the period when Allen (1951-1964) collected specimens in his garden, the surroundings changed from rural to suburban as London expanded around it. The changes in the population of carabid beetles collected over that time by Allen have been tabulated by Davis (1982, 129). This family of beetles would be strongly affected by the loss and fragmentation of habitats, because they are ground living and often flightless. Only two carabids were found in the Chichester garden and both are on Davis's list. One of these *Harpalus rufibarbis* is described as becoming increasingly common, the other *Badister bipustulatus* peaked in the 1950s and has since decreased in numbers (Davis 1982). Interestingly, *Pterostichus melanarius* the commonest beetle of that genus in the archaeological record was decreasing in frequency over the recorded period, while *P. madidus*, the commonest modern species decreased at first then increased. This may indicate that these beetles are sensitive to some feature of urbanisation. Much more work involving a much wider range of influencing factors would need to be undertaken before any conclusions could be drawn about any of these changes.

11.2.10 SYNTHESIS

The large differences in species and the habitats they represent, between the experimental and control pits with some species present in large numbers exclusively in one location, indicates good discriminatory powers by the beetles. Osborne's (1983) experiment also demonstrated this fact, although carabid beetles did not appear to have been deterred from the cess, as appeared to be the case in the Chichester pit and in the archaeological examples. The idea that most of the fauna drifted in randomly in the background rain (Hall *et al.* 1983a, 87) has not been borne out.

Decomposer beetles tend to be highly mobile as they need to seek out their often short-lived habitat and so they are an important element of the "background rain". Hence some members of this group are commonly found in all exposed features, but the cesspits attracted a much greater number and diversity of them, especially those favouring wet, foul conditions, than the control pit, compost pit or soil used as comparisons in these experiments. Archaeological pit faunas have been categorised by the "pit colonising" species they contain (see Chapter 13) and these modern pits fit into this system and provide useful supporting evidence. The differences in the "pit colonising" species between pits is further proof of the discriminatory powers of beetles, as it demonstrates that they can distinguish between different conditions within the pits.

Mycophagous beetles, including those common in ancient buildings, are found in large numbers in cesspits and this is more difficult to understand as a suitable habitat is not obviously available for them. This experiment showed that decaying plant material from hay used as anal wipes floating in the surface of the pit might provide such a habitat, although no mould was visible. This may also have been the case in the medieval pits. No such pabulum existed in Osborne's pit, yet several species of "house" beetle were found in it. Most of these beetles had been seen in the house, which was older and damper than the Chichester one. A further discussion on this can be found in Section 13.8.

The commonest weevil caught in pits in modern gardens is *Barypeithes pellucidus*, a polyphagous weevil. Again, more were found in the control pit indicating discrimination. The next commonest phytophage, in both pits, were Halticinae, flea beetles, which jump on being disturbed. By this means they would be likely to land in unsuitable habitats such as cess. Nevertheless, far more individuals and species were extracted from the control pit, showing they do have some powers of discrimination. The Halticinae, especially *Phyllotreta* and *Chaetocnema* species, are the commonest type of phytophage in medieval cesspits.

Both pits should had have acted as pitfall traps and ground living species like carabids might be expected to fall in. However, these were only found in the control pit. This may have been by chance, as this bias against the cesspit, did not occur in the Osborne (1983) atypical pit, for unknown reasons, but possibly because of the hard layer which formed over it. However, it is not known whether such crusts formed on the surface of the medieval pits studied, but carabids were not common there either. As beetles have an extremely good sense of smell and many are repulsed by ammonia (Crowson 1981), it is reasonable to expect that, like the phytophages, carabids might be deterred from such an inhospitable medium.

This experiment did not answer the question of which beetles would reproduce in the cess, as although *Anotylus tetracarinatus* was present in vast numbers there was no evidence that it was breeding. If the pit had been in operation for a longer period of time, more breeding flies may have become established and possibly some beetles also.

The presence of the xylophagous species may indicate a habit of seeking out dark, damp areas irrespective of the odour. This may account for the presence of *E. confine* in both the Chichester pits and go some way to explain the ubiquity of *A. punctatum* in medieval cesspits.

Aphodius dung beetles are scarce in cess deposits. This is surprising considering that not only might they be expected to seek it out as a suitable habitat but because animal dung, with its associated insect fauna, must have been common in the medieval urban environment. Furthermore, most of these coprophagous beetles are more selective of an area, for example open ground or mountainous regions, rather than a type of dung (Landin 1961). Given a choice, most prefer carnivore dung (Hanski and Cambefort 1991). These beetles are very mobile and presumably can seek out their pabulum by smell. It was decided to test their preferences by giving them an equal choice of different micro-habitats.

The cesspit experiment with its control pit also provided an opportunity to study the garden fauna and it showed similarities over a wide geographical area. In addition, the same recently introduced species had become established and fluctuations in the numbers of certain species were also widespread. Crop changes and urbanisation may be responsible. There is scope here for further work, as the exact ecological requirements of beetles are not often known (see Section 4.1), hampering archaeological interpretation.

11.3 APHODIUS CHOICE CHAMBER EXPERIMENT

Choice chamber experiments are used in the investigation of animal behaviour. In the experiment different options are available in the chambers but only one factor is altered and all others, such as temperature, light intensity and humidity are kept constant. Thus if preferences are shown then the reason can be established. A choice chamber experiment was carried out in order to test *Aphodius* dung beetles' food preferences.

11.3.1 PREVIOUS WORK

Although unknown to the present author at the time this experiment was undertaken similar work had been carried out by of Landin (1961). His observations about the experimental set up, such as the necessity of allowing room for the beetles to fly, had been complied with. He also stated that the beetles fly at dusk, in fact they flew in the author's experiment in the afternoon, albeit in low light levels due to the muslin cover and indoor position.

He investigated the affects of light, heat, intra- and interspecific competition as well as dung-type preferences, not including human. In this experiment light and heat had been kept constant between the four choices. Competition was not studied either, as it was made difficult for the insects to move on from their first choice. The differences in the aims of the two experiments meant that comparisons between results could not be made.

11.3.2 METHOD

On 30th May 1996 fresh horse manure was gathered from a field in a valley on the South Downs, at East Dean. The surrounding land was used for as pasture for sheep, cows and horses and the higher ground was either cultivated for cereal crops or was wooded. The dung was collected in a plastic sack and left in the sun. When the sack was opened, beetles emerged from it. Forty *Aphodius* beetles were collected and kept in a container with grass cuttings until the following day. Identification of the living beetles to species was not attempted, due to the difficulty of keeping them still.

The following day a choice chamber experiment was set up, which consisted of a plastic tank 600mm x 350mm x 200mm with a small glass jar set in each corner. The chamber was large enough to allow the beetles to fly (c.f. Landin 1961). The jars contained the choices namely: -

1. Horse manure as collected above.

2. Compost.

3. Human faeces and urine mixed with hay.

4. Boiled water and paper tissue.

The compost and manure were thoroughly checked over for beetles and the water was boiled to remove chlorine. To cut down the likelihood of the beetles escaping from the jars, a funnel was placed over each container. The experimental set up is shown in Plate 11.2.

The experiment commenced at 3.15pm, when the jar containing the beetles and grass cuttings was emptied into the middle of the tank and a piece of muslin was securely fixed over it. A trial run had revealed that plastic sheeting was not a suitable material to use as a cover. Flying beetles became trapped in a film of water, which had condensed onto the sheet.

A 60 watt lamp was placed 100mm above the centre of the choice chamber and, at least for the first hour, the beetles flew actively. Landin (1961) stated that the beetles fly at dusk but, in this case, they may have been stimulated by low light levels in the container. After six hours all activity had ceased and the lids were screwed down on the containers.

11.3.3 RESULTS

The beetles in the jars were counted and identified to species. The results of the experiment are shown in the following table.

Table 11.3: Chichester. Experimental cesspit. Table showing the numbers of *Aphodius* species in each microhabitat

	A. prodromus	*A. sphacelatus*	*A. luridus*	Total
1.Horse manure	10	12		22
2. Compost	10	3		13
3. Human cess	1	1	1	3
4. Water		2		2
Totals	21	18	1	40

It can be seen that most beetles preferred the horse manure and that *A. prodromus* was equally attracted to the compost. The numbers in the other containers were small.

11.3.4 CONCLUSIONS

This experiment demonstrated that *A. sphacelatus* and *A. prodromus* beetles are strongly attracted to horse dung and that *A prodromus* is also strongly attracted to decomposing vegetation. This is interesting as the literature, which states that the two species are commonly found together, also states that they may often be found in vegetable matter as well as dung of all kinds (Jessop 1986). Both are recorded as sometimes being found in human faeces (Koch 1989). However in this experiment, neither showed a particular attraction to human cess or plain water. However the human cess, alone of the four choices, contained urine which might have acted as a repellent. More work would need to be done to investigate fully the preferred pabulum of these beetles. For example, it may have been the amount of water in the compost, which caused it to be rejected and, in retrospect, it would have been interesting to discover the attractiveness of human dung, without added urine.

One individual of species of *A. luridus* was found and this was in the human effluent, but more work would need to be done to see if this is significant. This species is normally found in exposed hilly or mountainous regions and so is unlikely to occur in urban situations. The two species found in the Chichester experimental cesspit, *A. rufus* and *A. fimetarius*, were not found here. One of the problems of knowing whether certain species are attracted to cess, is the fact that *Aphodius* remains in archaeological deposits often cannot be identified to species. One of the named species in the Chichester pit, *A. fimetarius*, is recorded as being found in human excreta (Koch 1989) but this species is not commonly specified in the archaeological record. Another species common in decaying vegetable matter but also recorded in human dung is *A. granarius*. This beetle is the commonest named *Aphodius* found in medieval cesspits.

This experiment indicated that cess was not favoured as highly as horse manure as a pabulum. This might explain why it is not very common in ancient cess deposits, considering that this genus was probably abundant in the medieval urban environment. Conversely the related scarabid beetle *Onthophagus coenobita* had been shown in the previous experiment to be very strongly attracted to human cess.

11.4 SUMMARY

The modern analogue experiment has demonstrated that the cesspit attracted a fauna very different to that, which collected in a similar pit, filled with water. As well as foul decomposer species, mould feeders appear to be attracted to cess whereas plant feeders and carabids were repulsed. Wood feeders were slightly more attracted to the control pit, but numbers were small and may have been due to chance. *Aphodius* species (dung beetles) are not as common as might be expected, and the food choices of two species, explored by means of a choice chamber, showed they were more strongly attracted to horse dung than to cess. However, another dung beetle *Onthophagus coenobita* was very strongly attracted to the pit.

Beetles, found in the garden where the pits were situated, have been compared with those found in other gardens. This habitat is rich in beetle species. The reasons for recent changes in garden faunas have been considered and these may be partly explainable by changing agricultural practises or increased urbanisation.

CHAPTER 12: An investigation into the distribution of selected synanthropic species

12.1 INTRODUCTION

The Access database used in Chapter 5 to determine the distribution of the sites and features, which have been examined for insect remains in England, was extended in order to investigate species relationships. This was achieved by compiling a complementary species table. The species in the list were chosen for a variety of reasons.

1. To investigate the development of the strongly synanthropic faunas inhabiting buildings and stored grain.
2. To examine relationships between the decomposer beetles.
3. To study the distribution of species known to be thermophilic, which are now confined to southern England.
4. To look for other occurrences of certain beetles, found by the author and described in Chapters 7-11, to aid interpretation.

12.2 METHOD

The archaeological data collected by the author, which has been set out in Chapters 7-11, was added to the Sites Table. On the Species Table, thirty three taxa were listed. Then, for each entry on the Sites Table, information was added about the occurrence of each of the species on the Species Table. Each taxon was only labelled as present or absent, actual numbers were not recorded. For some of the species grouped by habitat, i.e. "house" beetles, and decomposer beetles, the most frequently occurring member of the group was also noted for each entry. Where the taxon was listed as a genus, if the species found was named, the name was recorded, see Tables 12.1 and 12.2.

12.3 EVALUATION OF THE DATABASE RESULTS

This system was most useful as a personal source of information for the purposes of interpretation. It was least useful in providing information about decomposer beetles and beetles affected by temperature. The main usefulness of the database was in providing confirmatory evidence about the temporal distributions of certain beetles, namely *Tipnus unicolor* and *Cryptolestes ferrugineus*, which are discussed below.

Little information was gained about the distribution of decomposer species, although the data was sorted so that distribution by period, latitude and frequency in different feature type could be investigated. One interesting point emerged concerning the occurrence of *Anotylus rugosus*, which, although very common outdoors was uncommon in deposits formed in buildings. In other cases because the species investigated were so common the dominance/presence/absence scheme of recording was not sensitive enough to demonstrate differences. Another problem was due to the available data not being evenly spread by period, location or feature type, so that it was often not possible to ascertain which factor was responsible for the results. Another aim, to find evidence for climate change was not practical because of insufficient data both spatial and temporal.

12.3.1 THE DISTRIBUTION OF THE HOUSE FAUNA

12.3.1.1 The species investigated

The synanthropic beetles, most commonly found in houses, are listed in Kenward and Hall (1995, 662). The four least mobile and therefore, most diagnostic in an archaeological context are *Tipnus unicolor, Ptinus fur, Mycetaea hirta* and *Aglenus brunneus.* Only these species will be considered here. This group of beetles has been found from the Roman period onwards, with one exception, *Tipnus unicolor* is largely absent from urban deposits of the early Middle Ages (Hall *et al.* 1983b, Kenward and Hall 1995).

12.3.1.2 Archaeological evidence

All of the above species have been found in prehistoric British records, indicating that they were all native species. *T. unicolor* was found in a secure Iron Age context in a ditch at Hackthorn in Lincolnshire (Dinnin 1992). *P. fur* has been recovered from Bronze Age deposits (Osborne 1969; Buckland 1979b; Robinson 1992) and so has *M. hirta* (Buckland 1981a). *A. brunneus* was originally thought to be a recent North American import (Peyerimhoff 1945) but has since been found not only at the Sweet Track in Somerset, dating from the Neolithic (Girling 1984b) but also at two Iron Age sites (Robinson 1979, Smith *et al.* 1997). The elements of the "house" fauna were already established in the late Iron Age at a hillfort at Breiddin, in Wales. *Tipnus unicolor* and *Mycetaea hirta* were both present (Girling 1991).

The database table (Table 12.1) shows that *P. fur* was the most widespread of these four beetles in Roman times. *T. unicolor* was present in 1st century London and in early Roman Winchester and it was common in 2nd century deposits from York. *M. hirta* was rarely found in early deposits, but was present York although not common enough to have been included in the list of "house" species, recovered from the Colonia at York (Hall and Kenward 1990, 398). *A. brunneus* occurred regularly in the whole period under scrutiny, but is almost always associated with urban developments. There are two exceptions to this, as it was found at the Roman fort at Kirkham (Carrott *et al.* 1995a) and the early Christian rath site in Northern Ireland (Kenward and Alison 1994a). By the later Roman period, all four members of the "house" fauna, under consideration in this chapter, had become established. Although because few deposits from building or containing domestic rubbish have been examined from that period, the extent of this colonisation cannot be properly gauged.

There is a lack of material from the 5th-8th centuries, but by the 9th century, the house fauna, established in the Roman period, was still in evidence, with one exception, *T. unicolor* was absent. It was not found in any of the pre Norman Conquest deposits investigated, from all the sites on mainland Britain. The earliest post Roman urban recording of this species was from early Norman Winchester. It may also have been present at the Norman castle of Hen Domen, two specimens, one from each of two assemblages, from a pit, were recorded as "*Tipnus* or *Ptinus*" species (Greig *et al.* 1982). However *T. unicolor* has been found in rural early medieval deposits. It was found as part of a fully developed "house" fauna in an isolated 8th century farm rath in Northern Ireland and in a 9th century Viking pit on the Orkney Islands (Sadler 1991).

By the 12th century *T. unicolor* was re-established, with the other synanthropic species, in buildings, and with *M. hirta* was the most abundant species found. The "house" fauna remained the same until the very recent period when it changed due to warmer drier buildings and Australian imports (see Chapter 9).

12.3.1.3 Ecological evidence

All four of the house beetles (*T. unicolor, P. fur, M. hirta, A. brunneus*) may be found today in damp buildings, such as sheds and food stores, living in rotten materials like straw, grain or rotten wood and feeding on moulds. With the exception of *A. brunneus*, they may also be found in the wild. *P. fur* is the most polyphagous species, as it will feed on paper, wool and leather in addition to mouldy foodstuffs (Zacher 1927). The Ptinids (*T. unicolor, P. fur*) can survive in drier more exposed areas than the other two species, they occur in birds' nests (Palm 1959), which may have been their original habitat (Kenward and Allison 1995). On the other hand, *M. hirta* has been found in cellars (Kenward 1985a) and other darker, damper situations like thatch (Smith 1996). Allen (1956) found it in his garden feeding on rotten wood in the ground. It may originally have been associated with rodent burrows. Kenward and Allison (1995) considered that it was either a nest living species (either bird or mammal) or a bark living one, but because it is not now common in the wild, it is difficult to determine its origins. The other member of this group, *A. brunneus*, is definitely a burrowing species (Reitter 1911), showing characteristic adaptations such as lack of eyes and wings. It is found today under piles of rotting matter (Koch 1989) and was common in medieval earthen floors (Kenward 1975b; 1976a). Although this species probably originally inhabited a specialised niche in forests under bark or leaf litter, the loss of that habitat now means that it is wholly synanthropic in Britain (Dinnin and Sadler 1999).

Detailed ecological information is lacking about these species, due to the fact that they are not important pests. However, something about *T. unicolor*, not noted in the ecological literature, which might be relevant to its distribution, can be deduced from its morphology. This species has long legs, which is an adaptation for walking. A longer leg allows faster movement, but gives less purchase on the ground, hence rendering it less suitable for burrowing. Yet, in addition to long legs, this beetle has adaptations for burrowing. It has the hooded head, found in the closely related Anobidae (a family of wood borers). *T. unicolor* is known to bore into hard materials to pupate, but probably feeds on the surface. This would distinguish it from the other strongly synanthropic species under consideration and may be a factor in the unusual pattern of its distribution.

12.3.1.4 Discussion on Tipnus unicolor

Only one explanation has been offered for the lack of *Tipnus unicolor* in the early medieval period, which is that buildings of the 8th to 10th centuries in this country were too ephemeral to support it (Hall *et al.* 1983b). In the light of the evidence from 8th century Northern Ireland, where *T. unicolor* was found in similar primitive buildings

(Kenward and Allison 1994) that explanation had to be modified. Kenward (1997) assumed that *T. unicolor* could be introduced, from the wild over time, into a long established settlement. This raises questions about Saxon Age York and Winchester, for example, where colonisation by the beetle did not occur, as these settlements were also long established. Conversely the Viking settlement in Orkney, where *T. unicolor* was found was not.

It is also difficult to agree with Kenward's (1997) statement about the connection between *T. unicolor* and the permanence of the buildings themselves. *T. unicolor* was first recorded, in this country in an urban context, on a site in the Walbrook valley, where the remains of crude wooden shacks had been uncovered (de Moulins 1984). This 1st century civilian settlement lay outside the Roman fort at Cripplegate in London. *T. unicolor* was still there, over a hundred years later, when more opulent houses with mosaic floors had been erected, but its occurrence cannot be linked with any particular type of building. In early Roman York, the appearance of *T. unicolor*, also corresponds with a series of wooden buildings, which were probably stables (Kenward and Hall 1990). The crude wattle buildings found at York during the Viking period, which coincided with the period of absence of *T. unicolor* in this country, stood for about a decade before the posts rotted away (Hall *et al.* 1983b). However, even in York, the remains of later, more durable, possibly two-storey, buildings were found (Kenward and Hall 1995). Timber buildings set directly into the earth, as was the practice in early medieval England, could last for a hundred years (Gray 1996) in drier conditions. In any case, there is no obvious reason why short-lived structures should not be infested with *T. unicolor*, especially if new buildings were constantly being built on the same site, as happened at York. Kenward has studied Jorvik most extensively, yet neither has this beetle been found on Saxon sites, such as at Winchester. Both these towns were large and important at the time and contained many buildings. This beetle has been found in short-lived wattle buildings of the early medieval period in rural contexts in Northern Ireland (Kenward and Allison 1994) and in the Orkneys where stone and turf would have been used (Sadler 1991).

It may have been a feature of the buildings themselves, but it is not obvious what this could be. *T. unicolor* has been found infesting recent thatch (Smith 1996) and this type of roofing material was common in early medieval towns. Thatched buildings in towns were not prohibited until the early 13th century, as a result of a number of disastrous fires, for example in Winchester in 1161 and 1180 and Chichester in 1187 (West 1987). Yet *T. unicolor* became more prolific as the late Middle Ages progressed. Neither did its occurrence fit in with known changes in building techniques. There was not a dramatic change in house styles between the 10th and 12th centuries. Indeed the two breakthroughs in building methods, which might have been expected to favour this beetle, occurred too late to affect its reinstatement. These are the introduction of padstones, which held timber posts clear of the ground, increasing the longevity of buildings, and the development of the chimney, which freed the interior of smoke. These changes took place in the 13th and 15th centuries respectively (Gray 1996).

Since this beetle is a native species, it seems that there was something about the early medieval urban environment that was inimical to it. Lack of material, from contemporaneous rural sites on mainland Britain, means that it is not known whether it was able to survive in those conditions. Possibly the Normans were instrumental in the resurgence of this beetle, as it reappeared in the urban record (see Chapter 7) at the time of the Norman Conquest. However, whether *T. unicolor* was present in Northern France at that time is unknown.

The conclusion must await new evidence both on the distribution and ecology of this beetle.

12.3.2 THE DISTRIBUTION OF GRAIN PESTS IN BRITAIN

12.3.2.1 Species examined

The following grain pests were investigated; *Sitophilus granarius, Oryzaephilus surinamensis*, *Cryptolestes ferrugineus*, *Palorus ratzburgi* and *Tribolium* species. All are strongly associated with stored grain and its products and the first four constitute the main Roman grain pests.

12.3.2.2 The archaeological evidence

The spread of the grain pests by the Romans has been well documented (e.g. Buckland 1981b; 1990; Hall and Kenward 1990). The main pest species *Sitophilus granarius, Oryzaephilus surinamensis*, *Cryptolestes ferrugineus*, *Palorus ratzburgi* occurred repeatedly. They occur in abundance at Roman sites from the 1st century onwards. In York, the remains of a late 1st century granary had been excavated (Kenward and

Williams 1979), identified by the huge numbers of grain beetles. Roman towns were infested with grain beetles and only the villa sites remained relatively free. They are found at the forts erected by the incoming Romans. In view of this, the specimen of *Cryptolestes* found at Fishbourne, in the small faunal list from the Roman harbour deposits, may well have been introduced with grain supplies. At the time of its discovery, before the extent of Roman grain pests was known, it was thought that this specimen of *Cryptolestes* had been a native, living under bark (Osborne 1971a). In addition to the species noted above, there are rare records of other species, i.e. *Cryptolestes turcicus* and two species of *Tribolium confusum* and the more common *T. castaneum* at Towcester (Girling 1983), *P. subdepressus* at Alchester (Osborne 1971b) and occasional *Tribolium,* unidentified to species, elsewhere (see Table 12.2).

There are no undisputed records of grain pests found between the 5th and mid 10th centuries. This gap in the record has been noted and thought to be due to different methods of grain storage and less transportation of food supplies following the departure of the Romans and the cessation of urban living (Buckland 1981b; Kenward and Hall 1997). It is unlikely to be due to the deficiencies of the archaeological record, as, many samples containing cess, have been examined for this period, and that is one place where grain pests would be expected to occur, after accidental ingestion (Osborne 1983).

A very few specimens of grain beetles were found in Anglo-Scandinavian assemblages from the excavations at the Pavement and Coppergate (Hall *et al.* 1983b). These were attributed to contamination with Roman material via a damaged sieve. Similarly, the huge numbers of early medieval samples analysed at Coppergate, York (Kenward and Hall 1995), produced only five records of *S. granarius* and two of *C. ferrugineus*. These were also considered likely to be contaminants, as: -

> "Even allowing for perhaps very different storage techniques, the presence of such small numbers seems odd: there should be many, or none." (Kenward and Hall 1995, 761).

If these pests were endemic in York at that time, they should have been much more widespread. If the few examples that have been found are not contaminants they were possibly introduced in trade and were not able to become established. The earliest post-Roman record is from a late 10th–11th century pit containing cess from Winchester. This pit described as Saxon (Carrott *et al.* 1996), contained single specimens of *S. granarius and O. surinamensis* as well as traces of the exotic foods, fig and grape.

In the late medieval period some of the grain pests common in Roman times reappear. Most of the urban deposits from that time, which have been examined for insect remains, have been interpreted as cess. Only in an assemblage from Hull (Kenward 1979c) were the beetles found in such numbers as to indicate dumped grain. Grain pests from a 13th century moat in Leicester had been thought to have emanated from a grain store (Girling 1981b), but it now seems more likely in view of the fact that sewage was discharged into the moat, that these were also derived from cess. Yet at site after site (see Table 12.2), the grain pests recovered are *S. granarius* and *O. surinamensis* with occasional individuals of *Tribolium* species. *C. ferrugineus* is very poorly represented, only occurring at three sites. It was found in samples from two cesspits from 14th century Winchester (Carrott *et al.* 1996), in a Southampton cesspit (see Chapter 8) and with the other Roman grain pests in some pits from the site of the *Colonia* (Hall and Kenward 1990). Some of these latter assemblages, from 12th and 13th century deposits, contained all four main Roman grain pests, one of them had such high levels of *O. surinamensis* and *C. ferrugineus*, that they occupied the first and second ranks of abundance. Although Kenward (pers. comm.) saw no reason to doubt that these are medieval occurrences, it seems possible in view of the species and numbers involved that they are redeposited Roman specimens. Even if they are not, the lack of these beetles at other sites, even in York, shows that they did not become widely re-established. The Southampton record of *C. ferrugineus* may be considered a special case as it occurred together with several exotic species (*i.e. Sitophilus oryzae* and *Rhyzopertha dominica*). The Winchester examples may also have been imported, as the town had strong links with the continent. One specimen of *Cryptolestes* (species unknown) was found in a cesspit dating from mid 15th-17th centuries in York (Hall *et al.* 1993a) otherwise it is inexplicably absent. The only other post-Roman archaeological record of the genus, again unspecified, comes from 18th century London (Girling 1982), another cosmopolitan town. However post-medieval insect assemblages are so scarce that its resurgence cannot be traced.

Palorus ratzburgi is also absent in post Roman records, the only example comes from 18th century Hereford (Kenward 1985b), in a pit containing food remains and it has not been definitely identified to species. It was considered to have been a contaminant.

The four main Roman grain pests found in England have been found contemporaneously on the continent. For example, in a granary in 2nd century France (Yvinec 1997) and in grain cargoes on board a sunken Roman ship in Holland (Pals and Hakbijl 1992).

The medieval records of grain pests from Northern Europe are similar to those from England. Thus, only *S. granarius* and *O. surinamensis* were recovered in Germany (Koch 1971) and Norway (Kenward 1980), both from cess deposits and just *S. granarius* was found in the remains of charred barley from Denmark (Noe-Nygaard 1982) and in a medieval ship excavated in Southern Sweden (Lemdahl *et al.* 1995). There are no published medieval archaeological records of *Cryptolestes ferrugineus* from the continent of Europe, but all records from this area as very scarce. These pests have been found, dating from the 16th-17th centuries, from the Mediterranean, where a granary at Marseilles was excavated (Ponel and Yvinec 1997). It produced a list of pests, which included not only all the species under investigation, namely *Sitophilus granarius, Oryzaephilus surinamensis*, *Cryptolestes ferrugineus*, *Palorus ratzburgi* and *Tribolium* species, but also the two exotic pests, *Rhyzopertha dominica* and *Sitophilus oryzae/zeamais*, which had been present in 15th century Southampton (see Chapter 8). *T. confusum*, was also present, a species supposedly more cold-hardy than *T. castaneum* which was commoner in archaeological deposits in Britain (see Table 12.2).

12.3.2.3 The ecological evidence

Grain stores are a habitat entirely manufactured by humans. Domestication of cereals produced large grains and their storage created a novel pabulum. This has been exploited by the grain weevil *Sitophilus granarius*, as it, alone of the pest species described here, is able to attack the whole grain. It is an obligate synanthrope, as being flightless, it relies on humans for dispersal. There is a record of it from Windsor Forest, but it was thought to have been introduced in game bird food (Donisthorpe 1939). Its association with humans goes back a long way, possibly even before the beginning of agriculture, exploiting stores of wild foods (Buckland 1990). Its lifestyle is so bound up with cultivated grains that its original foodstuff is unknown, wild grasses are too small to be a pabulum and it has been postulated that its original food was acorns (Howe 1965).

Oryzaephilus surinamensis, Cryptolestes ferrugineus, Palorus ratzburgi and *Tribolium* species are all secondary grain pests and are less dependent on it as a foodstuff. They can only feed on damaged grain and probably originally lived under bark, where some may still, occasionally, be found. *O. surinamensis* is able to overwinter indoors in unheated stores (Solomon and Adamson 1955; Hunter *et al.* 1973), but it is rarely seen outdoors in this country, although it has been found in a bird's nest (Woodroffe 1953). Hunter *et al.* (1973) stated that it is very mobile, whereas (Kislev 1991) wrote that, although it has functional wings, it rarely flies. Today, it is the most serious pest of stored grain in the United Kingdom (Aitken 1975).

Another common pest today is *C. ferrugineus*, which is found in the same range of foodstuffs as the other secondary pests. *C. ferrugineus* has a lower tolerance to dryness than *O. surinamensis* and burrows deep into its food supplies (Munro 1966) but compared to its congener *C. turcicus*, it is less cold hardy and requires drier conditions (Halstead 1993). Horion (1960) stated that it is a fungal and detritus feeder, but, on the contrary (Heinze 1983 cited in Pals and Hakbijl 1992) claimed that it eats damaged wheat and weed seeds, preferring the embryo, and he did not include it in his list of mould feeders. In modern British flour and provender mills, the commonest pest is *C. turcicus* (Halstead 1993), while *C. ferrugineus* is found in mills in warmer countries. All this suggests that it is not native to Britain, despite Solomon and Adamson's (1955) assertion that it is cold hardy here and Hunter *et al.* (1973) statement that it occurs in the wild as far north as Hereford. It is true that this species has been found under bark quite frequently in this country (Solomon and Adamson 1955; Verdcourt 1994; Alexander 1994; Hunter *et al.* 1994). Nevertheless, there is debate about whether these "wild" specimens are native or could have escaped from grain stores (Buckland 1981b). It is a common pest today in grain stores around the world.

The species of *Tribolium* most often encountered in archaeological deposits is *T. castaneum*, which is common in stored grain and cereal products. It is an important pest in well-heated buildings such as provender mills and bakeries, but not flour mills (Brendell 1975). It is less cold-hardy then the closely related *T. confusum*, with which it is easily confused, hence the name. Neither species normally overwinters in unheated buildings in this country (Solomon and Adamson 1955) and therefore are unlikely to live in the wild.

P. ratzburgi is found in large and old accumulations of grain and in grain products, as it feeds predominantly on the faeces of *S. granarius* (Heinze 1983 cited in Pals and Hakbijl 1992) and is not common in this country at the present time (Kislev 1991).

12.3.2.4 Discussion on the origins of the grain pests

The earliest record of *S. granarius* comes from early Neolithic deposits in Germany and dates from 5000-4000 BC (Büchner and Wolf 1997), while *O. surinamensis* dating from the late Neolithic has been recovered from mainland Greece (Valamoti and Buckland 1995). Early records of *S. granarius, O. surinamensis, P. ratzburgi* and *Tribolium* come from areas near the Fertile Crescent, where agriculture is thought to have developed about 9000 years ago. Therefore is likely that these species first became synanthropic in this region (Buckland 1990). These beetles have been recovered from ancient Egyptian tombs (Levinson and Levinson 1985).

There are no pre-Roman findings of *C. ferrugineus* nor of *C. turcicus.* It is possible that the former beetle may have been part of the European Old Forest fauna and discovered the grain store habitat sometime during prehistory (Buckland 1981b), although according to Howe and Lektovitch (1957) it probably originated in North Africa.

The high numbers of grain pest species characteristic of the Roman period are thought to be due to infested cereals being used for animal feed (Kenward 1997). The beetles, displaced from their normal habitat deep in the grain stores, would have dispersed rapidly and ended up in the surrounding deposits. Thus high numbers have been found in stable manure. Some may have first passed through an animal or human gut to be deposited in faeces and this probably explains the specimens found in the Roman sewer at York (Buckland 1976a).

There are differences in agricultural practices involving the cultivation of cereals, which could have affected the spread of the grain pests. The Iron Age practice of storing grain in underground pits killed any insect pests, because of the build up of carbon dioxide. The Romans produced large quantities of grain, which were stored in airy granaries and transported around. These are both factors, which encourage infestations. In medieval times there was more variety in the cereals grown; barley, rye and rivet wheat were added to the Emmer, Spelt and Breadwheat grown by the Romans (Greig 1988). This diversity is more useful to a more self-sufficient type of economy, as there is not a reliance on a single crop. This should not in itself affect the grain pests, which can feed on all these cereal types, but they may have been affected by the smaller grain stores and less transportation implied by such a system. These differences probably explain why *Palorus ratzburgi* never again becomes common in Britain, as it prefers large and old grain stocks. The most puzzling fact is the apparent lack of *C. ferrugineus*, in medieval Britain, especially as it is now common and may even be native.

S. granarius and *O. surinamensis* both reappeared in 10th - 11th century Winchester and it was stated that: -

> The socio-economic changes postulated to have brought about the post-Norman resurgence of grain pests may therefore have begun to take effect by this stage". (Carrott *et al.* 1996, 11).

The Norman Conquest may have hastened the resurgence of these two species. The Normans created good conditions for the importation of species. They rapidly built castles around the country and equipped them with troops and horses. Their method of fighting involved laying waste vast areas and starving out the opposition. All these factors show that they must have had access to a good supply base back in their home country. When the Normans were established in Britain, trade with the continent continued to flourish, as more wine and luxury goods were imported (Walker 1995). *S. granarius* and *O. surinamensis* became widespread by the 13th century, although never as common in archaeological features as they had been in Roman times. This link with the continent assumes that those two beetles were present in northern mainland Europe at that time and that *C. ferrugineus* was probably not. Unfortunately this cannot be proved due to a lack of records.

Apart from the disruption caused by the Norman Conquest, England was largely self sufficient in grain in the early medieval period. In the early 13th century, it even became an exporter (McEvedy 1967), but, by the late 14th century, the disruption, caused by the Black Death and the growth of towns, necessitated some imports. These mainly came from the corn growing region, which had grown up around the Baltic Sea (Girouard 1985; Braudell 1981).

There is no obvious reason why medieval grain supplies should have been unsuitable for *C. ferrugineus*. Although bulk storage and transportation of goods were not practised to the extent they had been in Roman times, grain must have become mouldy at times. The monopoly of the Lord of the Manor over his demesne, insured that all corn, grown in the area, was ground at his mill, thus providing a potential opportunity for the transmission of pests. However, neither has *C. turcicus* been found in medieval deposits from Britain, despite the fact that that beetle is now common in flour mills.

Most of the undisputed medieval occurrences of *C. ferrugineus* could have been introduced in Mediterranean imports. It was known to have been present in southern France by the 16th century (Ponel and Yvinec 1997), together with other species endemic in warmer regions (i.e. *Sitophilus oryzae* and *Rhyzopertha dominica*). These were the same beetles that had been found with *C. ferrugineus* in the cesspit in 15th century Southampton and it was assumed that these had been imported with rice and did not survive long in this country (Section 8.3.5.4). The only other undisputed records come from nearby Winchester (Section 7.5.2) and these could also have been introduced in foreign goods. The case, for this interpretation, is weakened by the fact that this beetle was found in two pits on that site, only one of which was related to a high status household, and, therefore, likely to contain exotic produce. However, rice appears in the account books for Winchester College in 1394 (Beveridge 1939) and may have been eaten locally even in less affluent households. The York example (Hall and Kenward 1990) may also have been from a chance import but it is more likely to be Roman contamination. The few examples of *Tribolium*, which date from that time, are also likely to have been imported from more southerly countries.

As *C. ferrugineus* has not been found in stores of grain, grown in England, in the medieval period, it seems unlikely that it was a native species at that time. It was not introduced in imports of cereals, because these mainly came from more northerly areas around the Baltic, where it may not have been present either. There are no archaeological records from that area at that time to confirm this. Even today there are doubts about whether or not it can live and breed in the wild in Britain, as occurrences may be traceable to grain supplies. If this species can now breed in the wild in this country, and there is some doubt about this, it may be due to higher temperatures today compared with the medieval period. At least for part of that period temperatures were lower due to the "Little Ice Age" (Grove 1988). Its origin is obscure but (Howe and Lektovitch 1957) placed it in Africa. If it spread from there to the Mediterranean, it would explain why it was so common in the Roman period. As this area become less important as an exporter of grain in the Middle Ages, that would explain why it was not reintroduced with the other pests. *C. ferrugineus* awaited the more recent large-scale importation of grain, from that area, before it became reinstated in Britain and Northern Europe.

> "As most pests appear to have originated in the warmer parts of the world, the Mediterranean offers optimal climatic conditions and the storerooms an optimal living environment to provide reservoirs for shipment through the basin after initial introduction," (Ridley and Wardle 1979, 226).

This explains why the Roman Empire, based around the Mediterranean, was so influential in the dispersal of synanthropic species.

12.4 SUMMARY

The species table of the database was found to have a limited use, in determining the occurrences of some species. It would have been more useful if it had been more extensive and included prehistoric and European data. Nevertheless it was helpful in providing reference material for the investigations into the development of synanthropic faunas. The distribution of *T. unicolor* was discussed and while it seems unlikely that this can be solely due to longevity of settlements or to building styles, no other explanation was found. An explanation for the distribution of the grain pest, *C. ferrugineus*, based on cooler temperatures in Northern Europe, was put forward.

The techniques described in the next chapter proved to be far more useful in determining the relationships between the decomposer species.

CHAPTER 13: An investigation of pit faunas

13.1 INTRODUCTION

An investigation, into the variations in the assemblages recovered from pits, is reported in this chapter. The cesspit faunas recovered by the author were very different from each other and, one of them was similar to a type of fauna singled out by Kenward and Hall (1995) as commonly occurring in their environmental pit samples from York. It was hoped that this investigation might uncover reasons for the variation based on differences due to geographical location or on different cultural practices, for example.

The nature of the variability had been described as follows: -

> "The insect assemblages from samples of pit fills varied considerably in composition, but a rather limited pool of species contributed the great majority of the individuals from the samples as a whole. The variation was thus primarily in the *relative abundances* of a set of species believed to have lived on the site." (Kenward and Large 1997, 36).

In the present author's experience the variation was not just accounted for in the relative abundances of species but appeared to be in the actual species present. Kenward and Large (1997) considered that the differences may be seasonal, but their results were inconclusive (see Section 4.2.3). That paper only considered the insects from the numerous Anglo-Scandinavian pits uncovered in the Coppergate excavations at York (Kenward and Hall 1995). Unfortunately these data are unpublished and could not be included in this study.

The restricted nature of pit faunas which results from the attraction of some species and the repulsion of others has already been demonstrated (Chapter 11).

Pit faunas have been recovered from a wide range of locations and periods by a number of workers and in this investigation all this data were combined. Computerisation makes such meta-analysis practical.

13.1.1 AIMS AND OBJECTIVES

1. To determine whether there are any common features in pit faunas of different provenance.
2. To attempt to relate any such findings to the archaeological evidence.

The main method used was to subject the data from a representative sample of pit faunas to examination by correspondence analysis using the CANOCO computer program.

13.2 SELECTION OF ASSEMBLAGES

A list of the chosen sites with details about the samples is shown in Table 13.1. Thirty-five samples of pitfills were selected spanning from 1st to 18th centuries. They were from Carlisle in the north, to Southampton in the south, and included a site from Ireland and one from Wales. The majority (seventeen) were from various sites in York, with the next most productive location being Winchester, which had five from two sites. Twenty-five out of the thirty-five had been analysed by the (EAU) based at York and five by the present author.

Assemblages with fully or semi-quantified species data were used where possible, but, in order to increase the range of material sampled, it included some that had only been rapidly scanned. Some potential samples had to be excluded, due to the publication of insufficient species data. Another group of unused samples was from pits with very large numbers of "house species", specifically two from Worcester (Osborne 1981a; 1983), two from Winchester (see Chapter 7) and one from Southampton (see Chapter 8). The fills were all from late medieval cesspits and, most probably, they had been situated within buildings. The very high numbers of synanthropes and proportionally low decomposers make this group very different from the others. Therefore it was thought that they would have to be eliminated from the CANOCO run as outliers.

The aim was to use assemblages, containing a minimum number of a hundred individuals, but this was not always possible. Three assemblages had between sixty to eighty individuals but these were included because of a lack of choice for the period they represented. Most samples processed by the EAU were only 1kg in weight and did not always contain enough beetle remains. Sometimes, in order to get large enough numbers, adjacent layers in a pit were combined. The dangers of doing this were not appreciated at the time and are discussed in the final chapter. From one pit (25) over 1500 individuals were recovered, the next largest assemblage contained more than 300.

In the collection of assemblages for inclusion, the emphasis was on assemblage size rather than sample size. Indeed, the latter is not always recorded (Greig *et al.*1982;

Osborne unpub.), if it is it may be by weight or by volume. For example, Sample 30 (Grove this volume) had been standardised by volume although the weight was recorded when it was examined. There are problems of correlation and interpretation associated with both (see Section 3.3.4). Assemblages were compared by converting each taxa to the percentage it represented of the whole assemblage. Although there are problems with this approach, which are discussed below, this was felt to be the best way to compare material from a variety of sources. In any case, the CANOCO program, itself, converts each set of figures to percentages of their total size.

13.3 CANOCO ANALYSIS

The large amount of data amassed is too complex to be assimilated by the human mind and so the CANOCO computer program of correspondence analysis was employed (Ter Braak 1988). The advantages of this technique were described in Section 3.4.2.2.

13.3.1 PREPARATION OF DATA

A combined species list was created on an Excel spreadsheet and converted into a form, which could be used for correspondence analysis. This list could also be organised into groups, such as those suggested by the CANOCO analysis, and used to reveal more of their characteristics. Faunal lists, compiled by different authors, using slightly different recording methods, had to be combined together and a number of decisions had to be made about the way this was achieved.

Not all the assemblages used had fully quantified faunal lists. The work from the EAU presented problems as their method of recording varied with time (Kenward *et al.* 1986; Kenward 1991). Sites, from which only the ten most numerous species had been recorded for each feature, had to be eliminated. All other species lists were used, although approximations for species numbers have been used to greater or lesser extent in many cases. For some assemblages, only the numbers of the most abundant species had been estimated but two pit assemblages were used in this survey, in which all the figures were estimates. Only three levels of abundance had been used for the assemblage from number 24 and four for that from 26. This level of recording gave insufficient data for the measurement of species distribution. The numerical equivalents used in this study are shown in Table 13. 2.

Data transcription was further complicated by the fact that the EAU species lists were in rank order and contained Hemiptera interspersed with the Coleoptera. The majority, over 70%, of samples had been analysed by the EAU, so their methods dominated, but adjustments had to be made so they were compatible with data compiled by other workers.

The faunal lists, compiled by the EAU, frequently had queries beside entries. If the query was beside a species, then that entry was placed under the relevant genus, if beside genus, that taxon was placed in a higher taxonomic level, which frequently was family. Few individuals were involved as most genus queries were for single individuals. Another difficulty stemmed from the improvements in identifications made over time. It was decided not to record separately those beetles, which had been recently narrowed down to species, by York workers, but which had been placed in a higher taxon in earlier work. These included the synanthropic aleocharine, *Crataraea suturalis, Atomaria nigropennis* and the burrowing *Trichonyx sulcicollis*. These refinements may well be helpful in diagnoses, but there were insufficient examples of them to be usable. Another aspect of EAU work, which could not be included, concerned the species composition of genera in which the congeners could not be distinguished by name. These workers distinguished these species by letters, not names, and also gave their numbers. This level of identification was unique but, as cross-referencing to the same species on lists by other authors was not possible, they were unusable. This is unfortunate as they make the compiling of species richness data more accurate.

Problems also arose because of the different levels of identification reached by different workers. For example (Coope 1981) identified *C. serrata*, due to insufficient material or for other reasons, other authors only identify the genus, *Corticaria*, some or all of which may be *C. serrata*. The members of this genus prefer similar ecological conditions and so were grouped together. The York team separated out many species of *Cercyon* and *Carpelimus*, which may well be useful in diagnosis, but some other authors e.g. (Osborne 1971a; Girling in Greig *et al.* 1982) were only able to identify these beetles to genera. In these cases habitat differences, which may be useful in diagnosis, do occur between species, and so habitat preferences were used to group some of these species together. The "catch-all" category was also necessary, even though, at least some of the beetles in it, will be the same as those separately listed.

13.3.1.1 Adjustments for abundant and rarely occurring species

Some assemblages had very high numbers of some beetles, which, when the data were converted into percentage figures, represented more than 10% of the total numbers of individuals. These are the "superabundant species", which have been discussed by Kenward (1978a. 16) and he acknowledged that, if numbers are expressed as a percentage of the total numbers, their presence depresses the numbers of all other taxa in the assemblage. Death assemblages, unlike living ones, are not just concerned with species forming an interactive community but also with unconnected species entering from other habitats, brought together by taphonomic processes (Kenward 1978a). In archaeological interpretations this allochthonous component is as important as the autochthonous element, which lived within the deposit. Therefore, the affect of dominant species, which were probably breeding within the feature, needs to be corrected for. This is achieved by adjusting the figures so that no species has more than around 10% of total numbers. The adjustment was achieved by replacing, the figure for the super abundant species, by a number, which was 10% of the total MNI. Due to the subsequent adjustments of the total numbers, brought about by the inclusion of this new value, the final percentage figure varied and was not always exactly 10% but is always below 12%. If the superabundant consisted of more than one species its value was not adjusted. Kenward (1978a), in later analyses often got round the problem of superabundants by using the numbers 15 and 6 for the two most abundant species (see Section 3.3.4.2) but these figures will be too small if the assemblage is very large.

Large assemblages will also tend to have a greater number of rare species, especially if they have been collected from a larger sample. Rarefaction techniques are designed to deal with differences in sample size, but these would not be suitable here, as they calculate the number of species and size of expected categories but cannot distinguish actual species (Magurran 1988). Sample 25 with over 1500 individuals, was much larger than the others and consequently had far more rarely occurring species. Therefore, in this case, each number was divided by ten and all taxa with less than five individuals were not listed. This did not affect the final numbers, as these were expressed as percentages, but made inputting the data easier. In the other cases, all taxa in the lists, with less than 0.4% of the total number of taxa, were eliminated. This measure slightly reduced the total number of taxa on the combined list, but other methods, described below, were employed to reduce its size further.

13.3.1.2 Reduction of taxa

The initial combined list contained 254 separate taxa from 35 pits. In order to obtain meaningful results from the correspondence analysis, it was necessary to considerably reduce these numbers. This is because the greater the correspondence between the number of samples and the number of species, the more accurate the results will be. The methods used were not purely objective but drew on previously formed views about pit assemblages.

1. Entries of rarely occurring species were combined with entries defined to genus, even though habitat details were lost. For example, identified *Philonthus* species from foul, decaying matter were included in the genus category, which could only be classified to a general level of rotting matter. This loss of information was acceptable, as it was not practical to include the large number of rarely identified species, which would otherwise have resulted.

2. Stray members of the families Carabidae and Curculionidae, were grouped together regardless of habitat. This is because the larger group will provide the information required for this survey and there were insufficient data to justify its further sub-division.

3. Some reduction was achieved by combining species with the same habitat preferences into a higher taxonomic group, usually a family. For instance, most of the aquatic species were treated in this way. Two new categories were created; Ce foul and Wetchry. The former was for *Cercyon* species found in foul decaying matter, and the latter was a grouping of phytophages of water plants, which began as a group of Chrysomelids but in the end included two examples from other families.

4. Borderline cases with only two or three entries and with a total of at least three individuals were usually combined in a larger group e.g. *Anthicus* and *Monotoma* species. This was not done if it was thought that the taxon might be significant e.g. species of *Harpalus* and *Hypera* were kept as separate entries. Also unchanged were taxa of that size which did not have a convenient larger group to join e.g. *Silpha* species and *Phymatodes alni*.

5. All remaining taxa with only one or two entries, each less than 1.5% of total size were eliminated.

The original list with the actual numbers of the taxa from each assemblage, is shown in Table 13.3, superabundants are enboldened. The final list of 134 taxa, after adjustments, with values of each taxa expressed as a percentage of the total number of individuals, is shown in Table 13.5. The taxonomic names of the taxa with the abbreviations used for CANOCO are shown in Table 13.4.

13.3.2 RUNNING THE PROGRAM

The final list was subjected to correspondence analysis using the CANOCO program. The first run placed Sample 24 well away from all the others. This was a Roman pit from Copthall Avenue, London (Allison and Kenward 1987). The designation "pit" had been queried by the time the site report was written. On examination of the faunal list, the large numbers of water beetles and few decomposers contained in it were more indicative of a well, therefore it was added to the list for features analysis (Table 14.1). A second run, without Sample 24, produced another anomalous sample. This was 16, a bell shaped pit from the Anglian period in York (Kenward *et al.*1986), which had very high numbers of *Clambus, Orthoperus* and *Corticaria serrata.* The elimination of this highlighted two more outliers, as they were also exceptionally rich in certain species. Sample 25, a pit from Roman Alchester (Osborne 1971b), with large numbers of *Anthicus floralis, Monotoma picipes* and *Leptacinus sulcifrons* and a Saxon pit from Southampton (Sample 29) (Buckland *et al.*1976) which was dominated by *Xantholinus* species. All these beetles are not unusual occupants of pit faunas but typically occur in low numbers. These three samples were also eliminated so that the remaining 31 would be better spread out on the plot.

13.3.3 RESULTS OF CANOCO ANALYSIS

Correspondence analysis of thirty one pits was undertaken and the resulting sample plot is shown in Figs 13.1a; 13.1b. The age of each sample has been coded as shown. It can be seen that the early Roman examples are separated from the rest and occur in Quadrant A. All the early medieval pits are situated below the "x" axis and the late and post medieval pits are, with one exception, clustered around the origin. The distribution of the pits, from the two main sources of material, have also been indicated on the plot by colour rims. The meaning of the colour fills shown will be explained later.

The corresponding species map is shown on Figs. 13 2a-d. As the beetles, which are most characteristic of the assemblages, in a particular region, will be situated at the outer edges of the plot, only those species were identified. The plot was so dense that there was no room for the names of all those at the centre. Species occupying the area within 0.1units of the origin were not considered to be sufficiently diagnostic to be named.

The 31 faunal lists, which had been used in this analysis, were then grouped together on an Excel spreadsheet, according to which of the four quadrants they occupied on the samples plot. It was evident that, the position of some taxa on the species plot was solely due to high numbers in one sample and not characteristic of the group as a whole. Other taxa were non-diagnostic as they were randomly or very patchily distributed. Marked differences in habitat preferences were apparent between the four sectors. The main "x" axis separated the assemblages according to the levels of burrowing species and decomposers and the "y" axis by the numbers of grain pests.

Each scatter plot was divided into four quadrants, as shown in Figs. 13.1-13.2.

13.3.3.1 Quadrant A

This contained four Roman samples (1, 2, 18 and 19) and the late medieval samples 14 and 20. All the grain pests, some aquatic species, and some more common in rural situations, such as *Geotrupes* and several carabids and Curculionids were situated in this quadrant. There were few decomposers, only *Megasternum obscurum* and mould feeding species, such as *Cryptophagus* and *Lathridius minutus* group.

13.3.3.2 Quadrant B

This quadrant contained the following samples 11, 3, 4, 5, 6, 13, 21, 31, 32, and 27 was on the boundary between quadrants B and C.

The post depositional invaders e.g. *Trechus micros, Coprophilus striatulus,* and *Rhizophagus parallelocollis,* identified by Hall and Kenward (1990, 367-8), were situated here. Another member of that group, *Trichonyx sulcicollis,* may have been present, as that species was included in the family Pselaphidae, which also lay in that quadrant. Other taxa with burrowing members namely the Elateridae and *Euplectus* were also present. In addition, the decomposer beetles named by (Kenward and Hall 1995, 464) as the "oxyteline association"; *Carpelimus bilineatus, Anotylus rugosus* and *Neobisnius* were situated in this quadrant. Another *Carpelimus* species of decomposing habitats, *C. pusillus,* occurred with it. The xylophagous beetle *Lyctus*, ground beetles of the genus *Bembidion,* which chiefly inhabit wet ground, and *Ceuthorhynchus* weevils make up the other species present in quadrant B.

This is the most strikingly different group of assemblages. It includes samples from different periods and different places. It is characterised by the members of the oxyteline association and/or by post-depositional invaders.

13.3.3.3 Quadrant C

Sample numbers 5, 8, 10, 21, 23, 26, 30, 32 and 35 occurred here with 17 on the edge.

Foul decomposers in this quadrant were *Anotylus tetracarinatus, Aleochara* species and maggot eaters, *P. politus* and *Q. mesomelinus*, plus the carrion eaters, *Trox scaber* and *Catops. Platystethus cornutus* group indicative of less organic mud and the compost feeder, *Ephistemus globulus,* were the only other decomposers. The only species associated with buildings was *Gracilia minuta* which may feed on wattle or basket work (Harde 1966).

13.3.3.4 Quadrant D

The samples in this area were numbered 7, 9, 12, 15, 22, 28, 33, and 34.

The main decomposers from the species plot were *Acritus nigricornis*, *Oxytelus sculptus*, *Omalium allardi, Carpelimus fuliginosus and Phyllodrepa* species. There were also more beetles from the genera *Philonthus* and *Quedius,* many of which are predatory on fly and beetle larvae. These beetles suggest foul, wet conditions. In contrast to this, there was a large collection of species inhabiting drier conditions, such as those found in buildings or nests namely, *Mycetaea hirta, Ptinus fur, Blaps* and *Tenebrio obsurus.* Another genus present, *Ptenidium,* is also synanthropic, according to Kenward and Hall (1990, 399), while *Aglenus brunneus* burrowed and bred in earthen floors (Kenward and Hall 1995, 729).

13.3.4 INTERPRETATION OF CANOCO RESULTS

The next stage was to investigate the main characteristics of the assemblages as revealed by the CANOCO program. The most well defined groups of beetles occurred in Quadrant B, namely post-depositional beetles and those labelled by Kenward

(Kenward and Hall 1995) as the oxyteline association. All the assemblages were examined to see whether any more examples of assemblages, with these characteristics, could be found in the other sections. This was done by examining the percentage figures, for these species, on the combined species list.

13.3.4.1 Identification of CAN and S faunas

Several assemblages were distinguishable from other assemblages by relatively large numbers of the post-depositional beetles, named above. Apart from Sample 26, which occurs in the adjacent quadrant, all the other examples could be found clustered together in Quadrant B. Sample 26 had only been partly quantified and therefore it may not be in exactly the right position. One member of the post-depositional group, namely *Coprophilus striatulus*, does not appear to be to good diagnostically, as it is not confined to underground habitats. Indeed it is Hall and Kenward (1990, 367-8), who placed it among the burrowers, no other worker have mentioned this tendency (e.g. Koch 1971, Harde 1984). This group of beetles was designated "S" for Subterranean, because of their burrowing habit, it consisted of Samples 3, 4, 13, 26, 31 and was a sub-set of the following group.

The oxyteline association, which characterised this next group, also occurred in Sample 14, in Quadrant A and in Samples 23, 26 and 27 in Quadrant C. All of those examples occurred close to the origin, which indicated that they are not very distinctive members of this selection of pit faunas. The *Neobisnius* species, always appeared to be *N. villosulus* where identified, and will be called this throughout the rest of the paper, it was not always present in these faunas.

This faunal type was designated "CAN", which stands for the initial letters of the three most diagnostic species namely *Carpelimus bilineatus, Anotylus rugosus* and *Neobisnius villosulus.* Samples 3, 4, 5, 11, 13, 14, 23, 26, 27, 31 were in this group.

13.3.4.2 Identification of OP fauna

Quadrant D was examined to see whether there was a characteristic decomposer fauna in those assemblages. It was noted that high numbers of *Oxytelus sculptus*, frequently accompanied by *Platystethus arenarius*, were common in this section. This occurred in Samples 9, 22, 28 and 33. When this characteristic was looked for throughout the assemblages, other examples were detected in Quadrant C, in Samples 8, 17, and 21.

Also, Sample 25, which had been eliminated from the CANOCO analysis because of uncharacteristically large numbers of some species, fitted this faunal type, which was called "OP". As before these letters stand for the initials of the most characteristic species *Oxytelus sculptus* and *Platystethus arenarius* and the following samples namely 8, 9, 17, 21, 22, 25, 28 and 33 belong in this group.

13.3.4.3 Identification of AS fauna

Another smaller group characterised by high levels of *Anotylus complanatus* and other species of *Anotylus* was discovered in Quadrant C. This group had two other representatives in Quadrant B, in Samples 6 and 20. It was called the "AS" type of fauna. These letters stand for *Anotylus* Species and five examples, namely samples 6, 20, 30, 32, and 35 were found.

13.3.4.4 R and U faunas

The four remaining Roman faunas (1, 2, 18 and 19) all situated in Quadrant A, were called R, for Roman and the rest were, so far, unclassified (U).

13.3.4.5 Summary of faunal types classification

The justification for these groups is shown in Table 13.6, included is a fifth type (G) which will be described later. Their distribution on the CANOCO plot is shown in Fig. 13.1 by the different colour fills employed. This classification, into faunal types, was checked by highlighting the highest figures in the columns, of the species which could be described as "pit colonisers", namely; *Carpelimus bilineatus, Oxytelus sculptus* and *Anotylus complanatus.* The highlighted figures corresponded to those already identified as characteristic of that type. Subsidiary species, which had been found to accompany them, usually had the highest figures in their columns as well. The least convincing was that from Sample 4, but this did have a good "S" fauna. Some assemblages have evidence of more than one type, especially those from Samples 6 and 21, which had evidence of all three, but one dominated.

CAN, S and OP faunas were the most distinctive, as their members spread out furthest from the origin. The distinctiveness of the R faunas depended, partly, on the large numbers of grain pests they contained. These faunal types were quite closely connected to a particular quadrant, A to R faunas, B to CAN faunas and D to OP faunas.

The least distinctive was Quadrant C, the outer part of which held three of the AS faunas, but the most characteristic species of this group, the Anotylids were in the central part of the plot. The exception was *A. rugosus*, a species shared with CAN faunas, which was found with them in Quadrant C.

13.4 FAUNAL LIST ANALYSIS

The combined species list, necessary for the CANOCO analysis, was used, to provide confirmation of the correspondence analysis results. It was manipulated by grouping the beetles associated with a particular time or place. This was achieved by arranging assemblages in the required order on an Excel spreadsheet, and calculating the average size of each taxon in each group. These values could then be compared. Taxa, which were more than twice as common or twice as rare in one group than in the others, were deemed to be sufficiently different to be diagnostic. Another criterion, which had to be met, was a reasonable spread of the species within the group, high figures due to exceptionally high numbers in one assemblage were eliminated as were taxa with very small numbers of individuals.

13.4.1 CHARACTERISTIC SPECIES OF THE FAUNAL GROUPS

The CANOCO program only indicates the commonest species in each cluster and also the grouping of the samples was not identical to the groups now interpreted as significant. Therefore, the assemblages were deal with as described above. This investigation confirmed the general picture thrown up by the CANOCO analysis and enabled more characteristics of each faunal type to be added, including species rare in a faunal type as well as those which were unusually common. These taxa are highlighted on Table 13.9.

13.4.1.1 Characteristics of CAN faunas

The dominant species in CAN type faunas corresponded exactly with those picked out by the CANOCO program. There was only one addition, which was that this group was particularly low in the synanthropic beetle, *Ptinus fur*. Many members of this group had been invaded after deposition by the group of burrowing beetles designated S.

The pits from which Samples 3 and 4 were taken were late Roman, not medieval (Hall and Kenward 1990). The decomposer fauna at that time was probably very different to the typical medieval urban one and this may be the reason why they were atypical. Both assemblages lacked *Neobisnius villosulus* and Sample 4 did not contain a strong CAN fauna, as it was also low in *Carpelimus bilineatus*, but it did have a good S fauna.

13.4.1.2 Characteristics of OP faunas

More taxa could be added to the OP type faunas described above. These were several more beetles with a preference for foul matter, namely *Cercyon* species, *Cryptopleurum minutus, Platystethus arenarius* and *Leptacinus* species These beetles suggest foul, wet conditions a state also suggested by the prevalence of the carrion feeder, *Omosita.* The "house" species situated in this quadrant were not exceptionally common in OP faunas but another feeder on mouldy hay, *Monotoma* could be added to the *Ptenidium* and *Anthicus* species already identified.

This group had no *Pterostichus* ground beetles and was very low in *Trechus quadristriatus* or *T. obtusus,* two beetles difficult to separate from their fossil remains, which in any case are not diagnostic of habitat. It was very low in all the species of phytophages normally recovered and there were no specimens of the grain weevil, *Sitophilus granarius.*

13.4.1.3 Characteristics of AS faunas

In addition to the *Anotylus* species diagnostic of AS faunas, this group was characterised by *Gyrohypnus, Creophilus maxillosus, Philonthus politus* and *Quedius mesomelinus,* all beetles predatory on flies. Dung eating *Cercyon* beetles were the least strongly represented in these AS faunas. Another characteristic of AS faunas was high numbers of the compost feeders, *Oxyomus sylvestris* and *Clambus* species. Phytophagous species were common, especially from the genus *Phyllotreta.* While there were very few grain pests, this type had the most *Bruchus* species, which are pests of beans. Some synanthropic species were low, in particular there were no *Tipnus unicolor* or *Typhaea stercorea* and the lowest numbers of *Aglenus brunneus.*

13.4.1.4 Characteristics of R faunas

The Roman faunas, designated R, as well as containing the highest proportions of grain pests, had the most carabids and water beetles e.g. Dysitids and *Helophorus* species. Of the decomposers, only *Megasternum obscurum* was dominant. More taxa connected with grassland, such as *Aphodius* and elaterids were common but there were very few *Phyllotreta* species. The synanthropic genus *Dienerella* was also well represented.

13.4.1.5 Characteristics of U faunas

The seven remaining faunas made up the unclassified group, U, which was less distinctive, although it did have some characteristic taxa.

13.4.2 IDENTIFICATION OF ANOTHER FAUNAL TYPE

Faunas from late medieval cesspits, some of which are known to be garderobe pits from within buildings, were not used in the above analyses. The reason for this was that they had been observed to contain very high numbers, up to 80%, of house species and, therefore, they were considered to be too different for inclusion. After the work was completed on the above thirty four pits, this group was investigated in order to see if they fitted into any of the faunal types already described. The group investigated was expanded to include one from abroad and consisted of six pits, all late or post medieval in date, from Neuss, Germany (Koch 1981), Pluscarden, Scotland (Buckland 1995), two from Worcester (Osborne 1981a and 1983) one each from Winchester and Southampton (Chapters 7; 8).

Another striking feature of these faunas, which became apparent, was very low numbers of all the decomposer species, so prevalent, in most of the other pits, that they had been used by this author to classify into faunal types. In these late medieval pits, the group of decomposers, which could be termed pit colonisers, namely; *Carpelimus bilineatus*, oxytelines, *Platystethus arenarius*, and *Neobisnius villosulus* were scarcely represented. Two of the pits, from whence the above faunas came, are definitely known to have been cesspits, associated with garderobes, and were situated within houses (Sections 8.5; 9.2). Therefore, this faunal type was designated "G" to stand for Garderobe and their characteristics are shown in Table 13.8.

13.4.2.1 Identification of G faunas among the pits in this survey

After distinguishing the characteristics of the above group, the thirty four pit faunas already looked at were re-examined to see if any fitted that description. It was found that Samples 10, 12 and 15 had particularly high levels of synanthropes with corresponding low levels of the common decomposers. These three samples, which were all from large medieval pits in the Bedern area of York (Hall *et al.* 1993c, were therefore moved from unclassified to the G group. The presence of those pits indicated that it was not necessary to have eliminated the garderobe faunas from Winchester, Worcester and Southampton from the CANOCO analysis, but fortunately their characteristics were picked up by this exercise. Three other samples, numbers 28, 33, 34, had very high levels of strongly synanthropic house species but they had slightly higher numbers of pit colonisers. Both Samples 28 and 33 had already been assigned to OP faunas and they were left there but (34) was added to those in the G category. The justification behind this group is shown on Table 13.7 and this category has been added to Table 13.6.

13.4.2.2 Characteristics of G faunas

When these pits had been separated from the others in the unclassified category more details of its nature were revealed. Low numbers of pit colonisers and high numbers of "house species" are the chief characteristics of the G group. They were mainly situated in Quadrant D on the CANOCO plot with the OP faunas. This explains why high numbers of house beetles were found in that quadrant, despite the fact that they were not so characteristic of OP faunas.

Other decomposer species, especially maggot eaters, were present in these pits and the commonest were *Philonthus* species. This genus is not easy to identify to species, but where this had been achieved, *P. cephalotus* was prevalent. Another genus, whose members include fly predators, is *Quedius* and this was present in much higher numbers than occurred in the other groups. They also shared with AS faunas, the occurrence of the occasional individual of the large Staphylinid, *Creophilus maxillosus* and with OP faunas in high numbers of *Ptenidium* species. These pits were also unusual in having the highest numbers of *Omalium allardi*, a beetle, which is now rare, which inhabits decomposing matter and of *Omalium rivulare*, which predates earthworms. All phytophagous species were scarce.

13.4.2.3 The remaining U faunas

The characteristics, outlined above for the G fauna, partly explained the definite character of the unclassified group before its identification and separation from the rest of the U fauna. This reduced the unclassifiable group to three.

13.4.3 CHARACTERISTIC SPECIES OF SPECIFIC SITES OR PERIODS

It was possible by comparing groups of assemblages using the method described above (Section 13.4.1), to ascertain some faunal differences due to site or period. However, the faunal types identified above were not evenly distributed. There were more OP faunas in the early medieval and more CAN faunas in York and in the late medieval, while AS faunas were spread fairly evenly in time and only one was from York. These disparities meant that some of the differences between the groups, may have been due to the factors other than faunal type and so they were investigated.

13.4.3.1 York or late medieval

As half the assemblages were from York, they were contrasted with those from all the other sites, to see if any taxa were particular to that city. Unfortunately, due to insufficient data, it was not possible to distinguish between differences due to locality with those due to time, because most of late medieval pits in the selection were also from York. Excluding pits with R faunas, all fifteen remaining assemblages from York were compared with the remaining fifteen from a variety of places but mainly early medieval in date. The pits, classified only as Roman, were so different in character from the rest (see Section 13.4.1.5) that they were not included.

York pits mainly came from the Bedern area of the city, the assemblages from here had been quantified but little supporting evidence was given and no archaeological details were provided. The data were published in an environmental report and other details will be published separately at a later date. Many of the species differences, between York and the other sites, probably indicate conditions, which just apply to that city rather than to the period as a whole.

It was found that many of the differences were in burrowing species. For example, there were high numbers of Pselaphidae, including *Euplectus* species and *Trichonyx sulcicollis,* no *Clivina* species, many individuals of *Omalium rivulare*, a beetles which feeds on earthworms. Species associated with clean mud, *Platystethus cornutus* group and *P. nitens* were rare. All these factors indicate richly organic ground conditions, which are probably specific to York.

Other decomposer beetles more prevalent in York were *Cordalia obscura* and *Phyllodrepa* species, while *Xantholinus* species were rare, but the significance of this is unknown. The reason for the abundance of *Trechus quadristriatus* or *T. obscurus* (the two are not easy to separate) and Ptiliids was similarly unclear. The low numbers of Halticines probably indicated more bare ground around the pits, while a lack of water beetles and beetles living on aquatic plants, also suggested a more urban environment.

The more frequent occurrence in the York samples of Dermestid beetles, which feed on hair and other animal products, and so attack woollen cloth in dry warm conditions, may be attributable to better houses in the later period. The reason for the rarity of the wattle eating *Gracilia minutus* in assemblages of this age is more difficult to understand as wattle and daub building were still common in late medieval times.

13.4.3.2 Winchester

The town with the next highest number of pits was Winchester, with five. These were all classed as early medieval. In this case, there were sufficient data to distinguish between differences due to place with those due to period. The five Winchester examples were compared with all twelve remaining early medieval pits, which were from a variety of locations.

Particularly high numbers of *Omalium allardi, Philonthus politus, Mycetaea hirta, Oxyomus sylvestris* and *Aphodius granarius* were recorded. There were correspondingly low numbers of *Helophorus* species, *Acritus nigricornis Orthoperus* and *Omalium* species other than *O. allardi.* The predominance of *P. politus* and *M. hirta* had been noted in Chapter 7. *O. sylvestris* is now found only in the south of England (Jessop 1986) and this may explain its predominance here. The reasons for the other differences are unknown and some may be due to chance as the numbers of Winchester samples were relatively small.

13.4.3.3 Lincoln

Although the particular characteristics of the four Lincoln faunas were not investigated, they were unusual, as although fitting into the faunal classification system, with one AS, two OP and one CAN fauna only one of these, from Sample 22 was found in the same quadrant as others of that type. These deposits were from the waterfront at Lincoln and were similar in synanthropic and decomposer species to other medieval sites. However, it had been noted that that there were also abundant insects from aquatic and other "natural" habitats (Carrott *et al.* 1995), possibly due to flooding.

13.4.3.4 Early medieval compared to late

A third selection compared eleven early medieval assemblages, excluding only the anomalous Sample 16 from Anglian York, with all the late ones. The reason for the prominence of *Tipnus unicolor* and the grain pests, *Oryzaephilus surinamensis* and *Sitophilus granarius* in the later samples, is due to their absence in the early Middle ages in urban Britain, which has already been documented (see Chapter 12). The few other differences, which do not appear to be specific to York, were larger numbers of *Helophorus* species, many of which are very mobile water beetles, and of members of the Scydmaenidae, which feed on mites in rotting matter, in the later period, the reasons for these are unknown.

The special features of the early medieval period were easier to distinguish and explain. They were characterised by high numbers of the following synanthropic species, *Ptinus fur, Gracilia minuta* and *Aglenus brunneus.* The predominance of *P. fur* may be connected with the absence of the closely related species *Tipnus unicolor* at that time. *Gracilia minuta* feeds on wattle, possibly commoner in early medieval times as were the earthen floors which harboured *A. brunneus.* Carrion eaters such as *Omosita* species and *Trox scaber* were more common, perhaps indicating the squalid conditions described in Section 5.3.2, before the development of organised rubbish collections. The numbers of *Bruchus* species indicate that more beans were consumed at that time then they were in York in the later Middle Ages. The highest numbers of Halticines (flea beetles) were recovered from this period, which may be due to more weeds or cultivated plants around the rubbish pits.

13.5 COMPARISONS USING ECOLOGICAL GROUPS

The contribution made by beetles from different habitats in different selections of assemblages, was assessed. For this exercise the original species list, adjusted for superabundants and converted to percentage figures, was used, thus any loss of information caused by the reduction of taxa, necessary for the CANOCO analysis, was avoided. The ecological classificatory system used has been described in Section 6.3.1. This system enabled some classification by habit as well as habitat. The size of ecological groups in each group of assemblages was expressed as a percentage of the total size, thus making direct comparisons across the groups easier.

Firstly, samples were grouped by period, which did not show up very distinctive differences (see Fig. 13.3). Next the groupings were ordered by quadrant, as they had appeared in the CANOCO analysis. The results of these are in Fig. 13.4. It can be seen that the samples from the different areas of the CANOCO plot have more distinct characteristics that the arrangement based on period of deposition. Finally, charts were produced, based on the five faunal types, which had been observed in these pit faunas (see Fig. 13.5). These most closely resembled the charts produced by the ordering based on the CANOCO analysis.

13.5.1 A COMPARISON OF HABITAT DISTRIBUTION BETWEEN FAUNAL GROUPS

When the chart showing the proportion of the habitats represented by faunal types is examined, significant differences can be seen. The Roman samples (R) are very different, with the lowest total numbers of decomposers, although with above average foul decomposers, very high food pests, due to the grain beetles, and the highest numbers of carabids and aquatic species. CAN and AS faunas are similar in overall structure, they are both lower in synanthropic beetles (counting House and mouldy decomposer beetles together) and higher beetles representative of surrounding conditions, than are OP and G faunas. CAN faunas have more "wet ground" taxa and more beetles preferring rotting plant material to dung. While the trends shown in OP faunas, higher synanthropes, slightly lower decomposers and "outdoor" beetles are continued in the G faunas.

When the faunal types were compared by the ecological grouping described in Chapter 6, the types showed more similarities (see Fig. 13.6). The biggest difference was in the numbers of burrowing species, not surprisingly as CAN faunas had been found to be susceptible to post depositional invasions of beetles, the largest numbers of burrowers in that group. Otherwise the R, AS and CAN faunas most resembled each other, with roughly equal numbers of phytophages and mould eating taxa but more carabids and no carrion eaters in the R assemblages. OP faunas had more mycophagous beetles, fewer carabids and plant feeders and these trends were continued in the G faunas. Carrion feeders were more abundant than in the other types and there were more burrowers than in AS or R but less than in CAN faunas.

13.6 DISCUSSION ON PIT FAUNAS

Five types of faunas have been shown to develop in the pitfills examined in this survey. Those designated R, which were all of Roman date were the most different from the others. There were similarities between CAN and AS faunas and between OP and G faunas. Those faunal types were not restricted to a particular time or place although some features of them may be.

13.6.1 PREVIOUS THEORIES

13.6.1.1 Random nature of the assemblage

Kenward believes that most of the species found in cesspits are random entrants. He stated: -

> "It appears likely that while some of the Coleoptera may have been attracted to the foul odour of the cess-pit, the greater proportion entered accidentally or incidentally. This is not surprising – if the pit contained liquid waste or slurry it is unlikely that beetles could have bred in it and the entire assemblage would, in the most literal sense, consist of background fauna." Hall *et al.* 1983a, 87).

This statement refers to the pit assemblage, here designated 17, an example of an OP type fauna.

He also wrote: -

> "It is interesting to note the great variation observed in the composition of pit fills confidently regarded as "cess". ...Insect remains may also vary greatly in abundance between cess-pits; while those in York so far examined have yielded few insects, samples from several pits in Oslo, Norway, contained immense numbers (Kenward 1988). Such differences may provide useful clues as to conditions in pits during their use." (Hall *et al.* 1983a, 91-2)

The emphasis of these two statements is that the faunas developing in pits largely by chance. Although the CAN and S faunas are identified in Kenward and Hall (1995), this idea of randomness continues. "There is a random element in the establishment of any colony" (Kenward and Large 1998, 40). However they also state, with respect to the Anglo Scandinavian pits at Coppergate York that: -

> "The insect assemblages from samples of pit fills varied considerably in composition, but a rather limited pool of species contributed the great

> majority of the individuals from the samples as a whole" (Kenward and Large 1998, 36).

Kenward and Large (1998) cited studies on the invertebrate faunas of logs (Fager 1968) to illustrate the types of variation found in pit assemblages. In this study it was found that, the log colonisers, only one of which was a beetle and the rest less mobile invertebrates, fell into specialised groups, favouring particular conditions in the logs. Although these groups could been recognised, the numbers of the particular species within them could not.

This study has shown that, contrary to the assumption that chance plays the main part in the formation of pit faunas, there are patterns of species colonisation. As beetles are highly mobile and have exceptionally good olfactory powers (Crowson 1981) discrimination by them in choosing a suitable type of pitfill should be expected. This point was well illustrated in the experimental pit created by the present author (see Chapter 11). This pit was only open six weeks but, by week four, several individuals of *Onthophilus coenobita* were found within it. In total eight examples, of this large and colourful beetle, were found in 660gm of material from the pit. This beetle has a predilection for human excrement (Lumaret and Kirk 1991), which it cannot normally satisfy in urban Chichester. It may have flown from pastureland a kilometre away. In addition to that specific example the fauna in the cesspit was very different in character from that which developed in the control pit, illustrating the fact that beetles are very adept at seeking out their preferred pabulum.

13.6.1.2 Season of fill

In addition to establishing the maturity of faunas, Kenward and Large (1998) attempted to determine the season of fill. Despite the fact that they found many examples of long lived pits and exposed fills, they made an assumption that "most pit fills would have formed rapidly and have been covered rapidly too, for reasons of hygiene," Kenward and Large (1998, 46). The method used was to identify those species, which are only active at particular seasons, which proved to be difficult. Indeed, the thorny problem of *Anobium punctatum*, very common in their Coppergate pits and present in all the pits in the present survey, was not resolved. The adults only occur at midsummer, indicating that the majority of all pits were open at this time. "This can hardly be true" commented Kenward and Large (1998, 46). It was speculated that *Omalium rivulare* might indicate winter deposition and abundant *Cercyon* a short summer exposure. Their failure to recognise more differences was put down to lack of detailed ecological knowledge of the seasonal activity of the beetles in question.

However, unless there was evidence of much intermingled earth or other layers in cesspits, and none is mentioned, it seems to be inevitable that human excrement will remain exposed for some time because of the slow but continuous way it is produced.

All the pits in this present survey contained at least one specimen of *Anobium punctatum*. No pattern was seen in the distribution of this beetle across the groups of assemblages. There was no evidence to link the faunal types, outlined above, with the seasons. The faunal types tended to be distinct and if they had been formed at particular times of year they might be expected to have merged into each other. It seemed a reasonable supposition that many pits were left open for many months.

Some of the pits used for cess at Hamwic remained open for nearly a century and "either periodically during the filling or when the pit was full, natural brickearth was deposited to seal off the noxious contents" (Andrews 1997, 176). This does not imply a rapid infill as suggested by Kenward and Large (1998). Moreover investigations in Holland have revealed "old cellars used as privies and in constant use for three centuries without emptying them" (Michiel Bartels pers. comm.). In that case is difficult to see how the excrement could have been covered up.

13.6.1.3 Differences in the stage of faunal development

One possible explanation of these different pit faunas, is that there is a succession from one type to the next. This does not appear to be the case as a palimpsest of the earlier stage would be expected to remain in the assemblage and the differences between the types should not then be so clear cut. Some mixing of types is apparent, see, for example, 21 and 6 (Table 13.6). However, if the stage of development of the faunas could be gauged, then this hypothesis could be tested.

Kenward and Large (1998) attempted to measure the state of maturity of pit faunas. The pits they examined were all Anglo/Scandinavian and from Coppergate, York. These pits could not be included in this investigation, because the faunal lists have yet to be published. As part of their investigation, a series of theoretical rank order curves were constructed (Kenward and Large 1998, Fig. 6, 44). The shape of these curves indicated the stage of development of the insect community. The amount of diversity of the faunas was also considered and expressed by the value of Fisher's α (see Section 3.3.3.1). Therefore, using these determinants, it should be possible to distinguish between pits, which had been: -

1. Only open a short while and containing only background fauna. Fisher's α large.
2. Left long enough for invasion by a few pit colonisers. Fisher's α lower.
3. Left longer so that pit colonisers have had time to produce progeny. Fisher's α lowest.
4. Exposed a long while so that a good variety of species are present. Fisher's α rising.

Rank order curves, for a selection of pits in the investigation into pit faunas, were constructed.

13.6.1.3.1 Construction of rank order curves

The adjusted list for this analysis, that is the list with superabundants adjusted to around 10% and rare species eliminated, was used and certain samples were excluded.

The R group, Samples 1, 2, 18 and 19, were not considered as no theories had been put forward about their formation. Due to the method of scan recording, for assemblages from Samples 24 and 26, they could not be used because of the limited information given about species abundances. Other samples i.e. 11-15, processed by the EAU, had estimated numbers, 6 and 15, for the most abundant taxa. As all assemblages had the levels of their most abundant species reduced to around 10% of the total, this was not normally a problem. However it was for Samples 12 and 15, as they had such large total numbers of individuals that their most abundant taxa, which may have been superabundant, fall below 10%. Kenward himself, mentions this as the drawback of this system (Kenward 1992, 86). It could easily have been solved by the EAU by the addition of a higher estimated level. Without this knowledge, about the abundances of the commonest taxa, both these curves were probably more truncated at the left hand side than they should have been. However all the assemblages, which had superabundant species, produced truncated curves, due to the reduction of their size to 10% of the total. This means that in this presentation the differences shown in Kenward and Large (1998, 44) will be less marked.

Difficulties also arose because of the variations in sample size. Samples 3 and 17 were eliminated as they had less than a hundred individuals and so would be less representative. The larger assemblages, even after adjustment, had a larger number of species and, therefore, the rank order curve had a longer "tail".

The problems described above will affect the position, but not the shape, of the curve and no further alterations were made on them. Another problem arose because of the necessity of using higher taxa levels, containing many species e.g. aleocharine indet. and *Cryptophagus* spp. as these often appear in the superabundant category and cause some distortion of the figures. This bias is the same for all assemblages and was unavoidable.

This method was approximate but seemed to be adequate for the purpose, which was to show the differences between the maturity of the assemblages.

13.6.1.3.2 Results of rank order analysis

The rank order curves for twenty seven pits were constructed and they were arranged, by similarities in shape, into three groups (see Figs 13.7). Although the differences are very subtle, they show a progression with the curve becoming less steep at the left hand side and the right hand tail becoming shorter. Thus, they follow the predictions of Kenward and Large (1998), although, as some "pit coloniser" species were present in all of these faunas, the first pure background fauna stage is not present nor is the final stage with many breeding species.

After grouping these assemblages by shape of rank order curve, their diversity expressed by the value of Fisher's α was calculated, using the graph in Kenward (1979b, 28). The group averages also fitted the predictions (Kenward and Large 1998) and these values are shown alongside the curves (Fig 13.7).

13.6.1.3.3 The maturity of the pit faunas

It appears that, despite all the problems outlined above, a categorisation based on maturity of faunas was possible. When these results were related to the faunal types already distinguished, few correlations were found. The main faunal types CAN, OP, and AS were distributed very evenly between the three groups. As might be expected those faunas with post depositional invaders (S) are in the two higher levels, as these have more breeding species. Those faunas predicted to have formed in garderobe pits are also found only in the higher levels. This is consistent with them being left open for a long time, while they filled with cess.

These findings are consistent with the idea of the faunal types developing independently.

13.6.2 SECONDARY DEPOSITION

Kenward (pers. comm.) stated that the York pits showed no evidence of secondary deposition. This is surprising for those pits containing cess as it is usually collected in a special latrine pit, which would need emptying from time to time, unless a fresh pit was always dug. The varied nature of the layers in some of the large and late pits from the Bedern (see Table 13.1 Samples 8 and 9), provides evidence of layers of cess interspersed with other material, and therefore presumably redeposited. If material had been dug out and quickly reburied, the fauna would probably be largely unaffected making secondary fills difficult to spot.

Clues can come from the pits themselves, those without linings are more likely to be secondary dumps, as would reused features such as rubbish filled wells. Evidence of secondary fills, from the beetles as well as the pits, comes from Saxon Winchester (see Section 7.4.4.1).

13.7 DISCUSSION ON THE DIFFERENCES BETWEEN PITS

The different faunas may indicate different conditions in the pits caused by differences in sanitary practices. What these differences might be, will now be discussed. Collaborative evidence from other pits and from other sources has been added, chiefly from the work of Kenward.

13.7.1 THE UNCLASSIFIED FAUNAS

There was nothing in common between the three samples from which the unclassified assemblages were taken. Two of them (from Samples 16 and 29) were so obviously different that they had not been included in the CANOCO analysis. The sample (7) may not even have come from a pitfill.

> "The taxa do not indicate very foul conditions and may belong to a dry

> upper crust or even have originated elsewhere" (Hall *et al.* 1993a, 3).

Similarly it was reported of Sample 16 that: -

> "It appears that Context 19 represents a hiatus in the infilling of pit 21, which probably stood incompletely filled and damp or temporarily flooded...with some accumulation of mouldering plant matter." (Kenward *et al.* 1986, 273).

The very high numbers of *Xantholinus* species in Sample 29 were particularly unusual for pit deposits and it was suggested, from the floral remains that it was collected in late autumn and that consisted of buried pigs' dung. "No other similar pits, with buried dung, have been found and their purpose remains a mystery." (Buckland *et al.* 1976, 66).

13.7.2 R FAUNAS

These pits are clustered together largely because of the high levels of grain pests they contain. They are also unusual as they contain the only rural examples in the survey (Samples 18 and 19), which partly explains the predominance of species associated with farming. None of these pits were thought to have contained cess and there was little evidence that they had contained foul matter, making them rather different from the majority of the pits examined. Two of the samples (1; 19) may even have been of backfill. Further work was carried out in the survey of feature types (see Chapter 14).

13.7.3 OP AND G FAUNAS

The main component of OP faunas is *Oxytelus sculptus,* which is also associated with stable manure (Kenward and Hall 1997) and has been found, in such situations, in deposits going right back to the Neolithic (Nielsen *et al.* 2000). Another member of the "stable manure" community of beetles identified by Kenward and Hall (1997) belong to the genus, *Leptacinus*. This group was also prevalent among these pits. The staphylinid most strongly connected with *O. sculptus,* in these OP faunas, is *Platystethus arenarius,* a dung eater (Skidmore 1991) and an early coloniser of very foul conditions (Kenward and Large 1998, 47). These two staphylinids plus *A. tetracarinatus,* are found in fresh cow pats (Smith 1991). Although on the diagram of the probable habitat ranges of decomposer beetles (Kenward 1982, 73), *O. sculptus* is shown as preferring drier conditions, a similar chart produced by Smith (1991) based on modern farm analogues, gave *O. sculptus* and *P. arenarius* an almost identical range of conditions. These two species are both considered by Kenward and Allison (1995) to be primarily found in dung, but today the congener *O. laqueatus* is more common. Skidmore (1991) does not even mention *O. sculptus* as a dung species. The investigations of decomposer habitats by Kenward (1982) and Smith (1991) both place the *Cercyon* species they investigated, at the foul, wet end of the spectrum and these are another feature of OP faunas.

Other pit colonisers, namely *Anotylus* species are commonly found in dung, so some other factor must distinguish between the development of OP and AS type of faunas. This may be a difference in the levels of ammonia. *Oxytelus sculptus* is a species tolerant of ammoniacal material (Hall and Kenward 1990, 351). It is conjectured that there would be a high concentration of this gas in many latrine pits, especially if the pit was enclosed in a building. Ammonia is produced by the breakdown of urea, a component of urine. This caustic gas is avoided by many beetles (Crowson 1981). An analogous situation would be found in stables, as the urine, produced there, could not drain away as easily as it would in the field and would saturate the bedding material and dung. Kenward and Hall (1997) discuss the characteristics of stable manure, including the differences between it and dung heaps but they fail to mention this point. The amount of liquid present in these situations would also give rise to very foul and smelly conditions, as incomplete breakdown of material occurs due to the lack of oxygen (Begon *et al.*1996, 404-5). There is a very good match between the species given as indicators of stable manure; *O. sculptus, A. nigricornis, Leptacinus, Anthicus* species and *Lithocharis ochracea* and those common in OP pits. The only exception was *L. ochracea* not separately specified on the CANOCO list. *Platystethus arenarius* was also not listed by Kenward and Hall (1997).

Another indicator that these pits were enclosed in buildings comes from the high levels of synanthropic species indicative of drier conditions. The reason why such beetles are found in cesspits are discussed below (Section 13.7). This would also explain the lower levels of beetles indicating outdoor habitats, than in the other faunas (see Fig. 13.5 and Fig. 13. 6 for lower levels of phytophages and carabids). The rarity of carabids might be also be due to the high concentration of ammonia. For example, *Trechus quadristriatus/obscurus* was scarce, although the two species named here cannot be separated in archaeological remains, *T. quadristriatus* is flighted and that is probably the species, normally and quite frequently, found in pits.

The lack of decomposer species in G faunas and the increasing numbers of house species are consistent with similar but more extreme conditions than occurred in the pits with OP faunas, see Figs 13.5; 13.6. It is assumed that the stench from these pits would be high, even if attempts were made to suppress it (see Section 8.4.1.2.3). Urine on the chute walls, if not in the pit itself, would become ammoniacial and this may repel all the normal decomposers. A similar situation develops in deep litter stalls, such as those studied by Smith (1998). He concluded that no beetles could live in these strongly alkaline conditions. The occasional presence of *Oxytelus sculptus* (Samples 28 and 33) may be further proof of this species resistance to such inhospitable conditions.

Another factor influencing the faunal list would be the inaccessibility and darkness of the pit, which may be deep inside a building beneath a long shaft. The lack of pit colonisers may be partly due to this factor. Those species, which do occur may not be deterred by dark conditions. Breeding flies are common and predatory beetles, such as *Philonthus cephalotes* and *Quedius* species, were probably attracted to them. Darkness may be the reason for the prevalence of *Omalium* species in this hostile environment, especially *O. allardi*, which appears to be able to breed and *O. rivulare*, which feeds on earthworms. The assumption that *O. rivulare* represents winter conditions (Kenward and Large 1998) discussed in Section 13.6.1.2 may due to a misunderstanding. The lack of decomposers induced by the inhospitable conditions may have been mistaken for a lack caused by cold weather. *Omalium* species are also quite common in deep wells, as are *Quedius* species. These very different types of assemblages both form deep underground. However the predominance of *O. rivulare* and other congeners, except *O. allardi*, were a feature of late medieval York pits and may reflect the ground conditions there. The G fauna pits described above (Section 13.4.2), which were used to identify this faunal type, were all very low in this species.

In the modern pit investigated by Osborne (1983), one of the two commonest beetles was *Omalium rivulare* while the other was *A. tetracarinatus*, according to Hammond (1974) the commonest beetle seen today. The eurytopic *A. rugosus* were well represented, but the diagnostic *A. complanatus* was not. Instead *Platystethus arenarius* was common and there were three specimens of *Oxytelus sculptus*. This shows similarities with OP faunas, being particularly similar to the assemblages from 17 and 21. In that modern pit, formaldhyde was added to the bucket during use, which must have had an affect on the beetles, but did not totally deter them. The author described the surface of the pit developing a crust, which must have cut down the oxygen supply to the pit, making conditions more foul. Although the ordure was originally deposited indoors into a covered bucket, the pit was outside and it was not known when the beetles invaded it.

This faunal type is very prevalent in medieval York, but it is the only one not mentioned in the work published by the EAU. This is surprising because the analysis of species associations as measured by the Jaccard coefficient (Kenward 1982, Section 4.2.1), showed a strong connection between *O. sculptus* and *P. arenarius* and a large proportion of the material in that study came from York.

The contents of the Jorvik pit, from which sample 17 was taken, was used to show some of the diagnostic features of cess (Hall *et al.* 1983b, 86) and both samples 21 and 22 were thought to have been wet, cess deposits. It was written of Sample 21: -

> "These flies suggest that this was a wet deposit, probably rich in faecal/urea contaminants and in darkness" (Carrott *et al* 1995c, 14)

and of Sample 22: -

> "The intuitively preferred explanation is that the foul matter – presumably faeces on the evidence of the parasitic eggs – was invaded *in situ* and that "House fauna" was introduced as floor sweepings or in some other way," (Carrott *et al.* 1995c, 21).

The pits from which samples 8 and 9 were extracted appear to have been large general rubbish pits, but there was evidence for cess in both of them.

Sample 28 from late Viking Dublin (Coope 1981) was considered by the author to be full of ejectamenta from the house as the assemblage was similar to that from floors. However, it was not that similar, as the foul decomposer *O. sculptus,* was present and the whole profile is indicative of a cesspit. This makes more sense functionally and, the presence of many synanthropic species does not rule this out. In fact, this factor plus low levels of "pit colonisers" suggest that this fauna could also be placed in the category "G".

Another possibly misinterpreted pit is "25", a Roman example from Alcester (Osborne 1971b). This pit was reassessed by Osborne, in 1994, but he made no changes to his interpretation of it being a rubbish pit. This fill contained large quantities of leather, and a nearby building had been interpreted as a leather factory (Osborne 1971b). However, Kenward and Hall (1997) consider that the contents were more likely to have been stable manure. They point out that the leather may have been used as litter. This interpretation also suggests that the ammoniacal conditions indicated are more likely to indicate stable manure than factory waste. This interpretation would also explain the presence of grain pests, if they had been originally introduced in fodder. Despite the fact that some of the frequencies of species in this assemblage were so atypical that it was not included in the CANOCO analysis, it definitely showed the characteristics of an OP fauna.

Most of the assemblages in this category, in this survey, definitely originated in cesspits. Further examples can be found in material from Norway (Kenward 1988, 132). Two pits, identified as latrine pits from the botanical evidence, had OP faunas and at least one of these was enclosed in a building.

> "The exact nature of the material in which assemblages of decomposer species such as those from samples 48, 72 and 200 bred is uncertain, but the balance of evidence suggests rather open textured yet foul matter – moss mixed with urine and faeces above the water table." (Kenward 1988, 119).

Samples 12 and 15 were both thought by the authors, to have developed in stable manure (Hall *et al.*1993c). The high levels of house beetles were explained as originating in sweepings from a stable. However, the presence of faecal matter was acknowledged in Sample 12 and fig seeds were noted in Sample 15. Fig is a luxury food, unlikely to have been given to livestock, but it provides good evidence of cess, as the seeds are resistant to digestion and so pass out with faeces. In any case, whether the deposits were from stables or garderobe pits they would be predicted to exhibit the same type of fauna.

13.7.4 CAN AND AS FAUNAS

The main difference between these two types is in the pit colonisers. Two of the three characteristic species, characteristic of CAN faunas, are now found by watersides and not in pits, namely, *Carpelimus bilineatus* and *Neobisnius villosulus*, the latter is uncommon. Despite this aquatic tendency, there is good evidence that *C. bilineatus* bred in Anglo/Scandinavian floors and that it prefers a damp rather than wet habitat (Hall *et al.*1983b, 212-4). The other member of the group, *Anotylus rugosus*, is eurytopic but its natural habitat is thought to be plant litter, at the dry end of the decomposer spectrum (Kenward and Allison 1995). The faunal type AS is characterised by *Anotylus* species, of which *A. complanatus* is the most abundant, but it is usually accompanied by large numbers of other members of the genus; *A. rugosus*, *A. sculpturatus*, *A. nitidulus* and *A.*

tetracarinatus. According to Kenward and Allison (1995), many of species of *Anotylus* originally came from waterside habitats, as well. This group is adapted "to resist waterlogging, toxic salts, fouling by sticky substances and particulates and temporary oxygen deficiency" (Kenward and Allison 1995, 59). However, resistance to fouling by sticky substances, is particularly useful to coprophilous species and some *Anotylus* species are dung feeders. *A. sculpturatus* and *A. tetracarinatus* are recorded as breeding in dung of various types (Skidmore 1991). *A. sculpturatus* and *A. rugosus* are used by Robinson (1983a) as indicators of pasture. *A. complanatus* is recorded as sometimes found in cowpats but not breeding there and rare in other types of dung (Skidmore 1991). Another modern record for that species is from niches classified by Kenward (1982) as "sweet compost" (Donisthorpe 1939), yet he placed this beetle at the dung and foul matter end of the spectrum (Kenward 1982). *A. nitidulus* is a widespread species, now more common in organic-rich riverside mud (Kenward and Hall 1990) but was more associated with pit faunas in the past. Smith (1991) in his modern farm study, did not distinguish between species, but found the genus associated with cattleyard and dung deposits. The preference of *Gyrohypnus* species for AS faunas might provide a clue, if more details were known about the habits of this decomposer beetle.

It is proposed that the pit colonising species found in AS and CAN faunas indicate pits with lower levels of ammonia. In the field, dung and urine would not be intermingled, so coprophilous species would not necessarily be adapted to high levels of ammonia. *A. complanatus* was the second commonest species in the author's own experimental cesspit, *A. tetracarinatus* being by far the most abundant. In that case little urine had been included and water was added so that the levels of ammonia were much lower.

Some other factor must be involved to account for the two types of fauna. Perhaps CAN deposits were drier. If so, they would be less foul because lower amounts of water would allow increased levels of oxygen to be present, which in turn would cause a faster breakdown of toxic waste. Thus better conditions for colonisation by beetles would pertain. The higher levels of oxygen may be due to the coarser nature of the pit fill, so pits with much straw in them might exhibit this type of fauna. Evidence for rapid breakdown comes from number 27, which stated that: -

> "The flies present, *Musca domestica and Stomoxys calcitrans* need high temperatures to breed induced by rapid fermentation" Greig et al 1982, 68).

Several other pits in this group were thought to have contained a drier fill (i.e. those from samples 3, 4, 5 and 11).

Another reason why the CAN faunas may represent drier conditions is because only members of this faunal type have been colonised by post-depositional invaders. Kenward and Large (1998) stated that these beetles are indicative of particular ground conditions, but they did not specify them. However, Kenward and Allison (1995) stated that *Trechus micros* burrows into damp, not wet, ground and *Rhizophagus parallelocollis* invades corpses in churchyards (Horion 1960), where the ground might be expected to be reasonably dry. As beetles need to breathe air presumably they would be unable to burrow into very wet ground.

However, CAN faunas have the largest proportion of taxa indicating wet ground of all faunal types (see Fig.13.6), and there is other contrary evidence. For example from Sample 23 from Lincoln: -

> "An aquatic influence.....perhaps invaders of open water in situ"..... "This insect assemblage probably included a mixture of invaders of fairly open textured plant litter (?dumped from a building), invaders of a variety of habitats in situ including fairly foul conditions (at least some faeces), and background fauna (Carrott *et al.* 1995c, 22)

Another pit with a CAN fauna, which had evidence of anaerobic conditions, which was not included in the investigation into pit faunas, came from Winchester: -

> "Also abundant were leaf epidermis, fragments of *Allium*, probably leek, *A. porrum*, some of which retained a greenish colour, suggesting that the deposits had been anoxic since the moment of formation." Carrott *et al.* 1996, 4).

In some of the large pits in the Bedern, York e.g. pits 1505 and 1359 (Hall *et al.*1993c), the lower fills have CAN faunas within them and the higher ones OP. This may be explained by the newly dug pits having less urine and more access to oxygen. However, it could be argued the other way, a newly dug pit might be expected to be waterlogged at the bottom and the drier faunal type might to expected to develop at the top, not the bottom, of the sequence. From the varied nature of the layers in the pits in question, it seems likely that they were general receptacles of rubbish, which therefore might have accumulated elsewhere. In which case the enclosed faunas may be giving information about the conditions, where they formed, rather than, where they ended up.

Therefore the evidence is conflicting. Possibly the difference is more to do with texture than wetness. There is much more evidence of coarse material, like straw, among CAN faunas and not all those fills contained cess. For example, it has been written about number 26 : -

> "The ceramic, glass and animal bone finds provide abundant evidence that the pit was used for the disposal of kitchen debris" (Girling and Kenward 1985), microfiche M9 B5.

While all the examples of AS faunas appear to be from pits with a high proportion of cess in the fill. "Stickiness" is a particular feature of dung, which results from the dead gut bacteria and mucus, which form a large proportion of the material. The dung eating Anotylids may be better equipped to deal with this than the species now found by rivers namely *Carpelimus bilineatus* and *Neobisnius villosulus*. Although CAN faunas are found in cesspits.

The lower level of "house species" in both types of pit (see Fig. 13.5) may be further evidence that they were in more open positions, possibly uncovered. Another indication that they were open stems from the prevalence of *Anotylus rugosus* in CAN and AS type pits. This species was shown (Section 12.3) to be uncommon in deposits formed in buildings. A roofless latrine building would also mean that rainwater could get in and dilute any ammonia. It could also explain the higher levels of phytophages in these pits (see Fig. 13.6), if they were surrounded by weeds. The presence of weeds suggests either secondary disposal in a less frequented area, or an uncovered latrine pit, as light would be necessary for plant growth.

Possibly AS faunas developed in pits used for secondary disposal of faecal material, which was originally collected in a small receptacle, like the author's experimental pit. Urine in medieval times could have been disposed of elsewhere, such as in the street. In medieval London, this was allowed, providing it was not thrown (Sabine 1934). Another reason, for low ammonia levels, might be that these pits were flushed with water occasionally. There is evidence for this from one sample. The pit from which Sample 35 was taken, contained some aquatic species, which Osborne (unpub.) cites as possibly being due to the addition of water. However no other pits in the AS group contain evidence of this sort, and the levels of aquatic species overall are lower than for CAN and OP faunas (see Fig. 13.5).

AS faunas, in this survey, were commoner in early medieval pits from southern England. Out of five examples, only one was from York and one from Lincoln. This southern bias may be due to cultural differences in the treatment of human waste between the Viking north and Saxon south. However, Kenward hinted at this group in the Coppergate work from Anglo/Scandinavian York (Kenward and Hall 1995), as he mentioned that there were pit faunas with high numbers of *Anotylus complanatus* and *A. nitidulus*, but there is no evidence in the text and the faunal lists are unavailable. The reason why *Oxyomus sylvestris* was prominent in these pits may be because this beetle has a southern distribution as it is now found only as far north as Cheshire and Lincolnshire (Jessop 1986). The high numbers of the bean pests, *Bruchus* species may indicate regional differences in diet and those of *Philonthus politus* may be due to a local abundance of this beetle in Winchester.

It is difficult to explain why the faunas from a later period, nominated G, shared with AS faunas, in the occasional occurrence of *Creophilus maxillosus*, although not in such large numbers. It would be expected that OP faunas, which are thought to more nearly resemble G faunas, would contain this large predatory staphyline, but they do not. However, this beetle was only found in five of the thirty five pits in this survey.

No reasons could be given either for high levels of *Lyctus* beetles in CAN faunas, most or all of which were *L. linearis* the only native species (Hickin 1963). These beetles burrow into dry wood especially oak palings (Hyman 1992). Or for the low levels of *Ptinus fur* except that "house" beetles generally were less common.

13.7.5 PITS FROM THE BROOKS,WINCHESTER

The four early medieval pits from Winchester, described in Section 7.4, which were so different from each other can now be explained further, as they represent each of the four post Roman feature types outlined in this chapter. Sample 281 (32 in the investigation into pit faunas) contained a typical AS fauna and came from an unlined pit, probably indicating secondary deposition. This was postulated as a possible reason for the particular characteristics of this faunal type. No other details are known. It was interesting that Sample 275 (31 in the investigation into pit faunas) contained typical CAN and S faunas, as it had had a body buried within it, thus providing a second reason for the invasion of *Rhizophagus parallelocollis* (Horion 1960). This beetle burrows down to feed on the fly maggots developing in underground corpses. Several archaeological examples have been found e.g. (Buckland 1979b; Girling 1981a; Stafford 1971). This fauna was found in a timber lined structure, which may have been a designated latrine pit.

Samples 236 and 228 (33 and 34 in the investigation into pit faunas) were close together on the CANOCO plot and they came from two levels of the same disused well. The lower of these samples 236 was noted to contain a number of carabids, forming nearly 5% of the total numbers of individuals present, they may have been in the sump contents, when the feature was a well and have become mixed in. They form a greater proportion of the assemblage than those from the lower levels of the Roman well at Skeldergate (Hall *et al.* 1988), where it was argued that the backfill had mixed with the original well sump. Although, in this present case, few other species typical of wells, were present. There is a single individual of the water beetle *Helophorus*, which is associated with temporary water bodies generally (Friday 1988), but the lack of phytophages may have been due to the built up area surrounding it. The proportions of carabids normally found in different feature types in discussed in Chapter 14. As these were found in an old well, they cannot have been directly deposited there. They both have the characteristics of deposits formed indoors in enclosed pits (G faunas), the upper fill also displaying the characteristics of an OP fauna.

13.8 DISCUSSION ON THE SYNANTHROPIC BEETLES

One surprising finding from this investigation was the relatively high levels of house species in the assemblages. Not only were species designated as being particularly associated with buildings common but also mycophagous species generally (see Fig. 13.6). This was also true of the experimental pit constructed by the author, although the levels were lower, probably because true "house" beetles are much rarer in modern houses. In that case, the levels in the control pit, which contained some dead leaves, were higher. One possible explanation proposed by Osborne (1981a) is that some of these synanthropic species were able to live in cesspits. He was convinced that both *Tipnus unicolor* and *Mycetaea hirta* had been breeding in the barrel latrine he investigated at Worcester. He even found both species in his own cesspit, the only examples from his home he had ever seen (Osborne 1983). He believes that the decline in their numbers in recent times is due to the invention of the water closet.

It does not seem probable that any mould beetle lived and bred in the pit for several reasons. Firstly, waterlogged pits, such as these would not provide suitable conditions for the growth of mould. A modern analogous pit, set up by the author, showed no sign of mould during the period it was in use. The modern pit where Osborne found *T. unicolor* was not waterlogged and the contents were already decomposed (Osborne 1983). Secondly, in all the cesspits studied from the late medieval period, the numbers of mould beetles were high, between 50% and 75% of total numbers of individuals. Some of these pits did not even contain breeding flies. The inference is that the numbers of mould beetles are independent of the condition of the pit, because they originate outside it. Lastly, an external origin is the only possible explanation for the presence of the other synanthropic group, which is regularly found in large numbers in cess, namely the timber pests. The main one of which is *Anobium punctatum*, the furniture beetle or "woodworm". This was present here in all samples and made up 7% of the total number of beetles in the assemblage.

Kenward did not believe that the house beetles lived in the cesspits, as cess is too foul a medium for these species. He stated: -

> "Coppergate pits included abundant 'house fauna' ……undoubtedly imported with floor sweepings." (Kenward and Large 1998, 37).

In almost cases in his work he gives that explanation, but the "house" fauna in Osborne's pit definitely had not been added in floor sweepings, as these had not been disposed of in the pit. In any case, there seems no reason why floor sweepings should be routinely added to cesspits, especially if the pits were at some distance from the house. Medieval floor coverings, consisted of rushes and other plant material, which would have been a bulky addition to a latrine pit, where space would have been at a premium. Although Greig (1982) lists a large number of materials including floor coverings, which may have been added, emptying pits was an unpleasant and costly procedure (Sabine 1934). The presence of fleas is sometimes cited as proof that floor material was added, but it is equally likely they got there from someone grooming themselves whilst on the privy.

Proof from a botanical analysis is difficult, because of the difficulty of identifying vegetative remains, and because the original purpose has to be surmised. It is possible that remains interpreted as floor coverings may have been anal wipes. Evidence of this necessary material in cesspits is often inexplicably absent (see Chapter 11). Other evidence comes from a comparison of the coleopterous fauna from floors with those from pits. The same mix of species occurs but their proportions are very different. This is demonstrated by the comparison of the "house" faunas from three late medieval garderobe pits with those from a similarly aged floor, described in Chapter 9 and illustrated in Fig. 9.3. It is also seen in Table 182 (Kenward and Hall 1995, 730), from Coppergate, York, which lists the proportions of species from floors and pits of the same periods. The differences in the proportions of species, which occur, indicate this was not the only source of these beetles.

The good correlation between enclosed pits and high numbers of house species suggests an alternative explanation. Many of the synanthropic beetles found in houses are mould feeders and are thought to have originally inhabited nests (Kenward and Allison 1995). Nests and the area around them often smell ammoniacal, due to the excreta produced by the young. In any case saprophytic fungi, release this gas from the denaturing of proteins, so that "white mould and an ammoniacal smell" (Hall and Kenward 1990, 351) go together. Therefore, mycophagous beetles may not just have tolerated the smell but may home into it assuming, incorrectly, that it represented a suitable habitat.

Even if this is not the case, they may be drawn instead by a need for moisture. Mould beetles, which can tolerate dry conditions, do need to drink occasionally (Howe 1955). Furthermore, in hot weather they may have been driven from the dry, hot building into the cool moist pit. In other words, the pit may act like a Berlese funnel trap. It is not unusual for insects to be attracted into unsuitable places. This is the theory behind a wasp trap consisting of jam in a jar covered with water.

13.9 THE USE OF INDICATOR SPECIES

The beetles, *Carpelimus bilineatus, Anotylus rugosus, A. complanatus, Oxytelus sculptus, Platystethus arenarius* and *Neobisnius villosulus,* termed "pit colonisers", were all common and were used to diagnose different conditions within pits. *Anotylus rugosus* is listed as a feeder on fly larvae (Coacker and Williams 1963). It is the largest member of the above group and is eurytopic. Whether the other beetles mentioned above are predatory or feed directly on the decaying organic material is not known. They are all good fliers and because of their small size are likely to be rapid breeders. These are useful features for colonisers of temporary habitats such as refuse pits.

These species have been chosen as indicators because they are closely related and similar in size. Other beetles are associated with them, such as some *Cercyon* and *Philonthus* species. Fager (1957) worked on the problem of classifying groups of species, noted that it was difficult to compare species: -

> "The difficulties of interpretation are increased if the species are dissimilar in size, activity etc. It is therefore suggested that determinations of dominance be restricted to species within recurrent groups, which are, or appear to be, similar in regard to size, activity, food requirements etc." (Fager 1957, 592).

Pit colonisers *par excellence* must be the flies and these have been largely ignored. This is because identification is difficult and there are few specialists in the field. In the reports used in this survey only two (Hall *et al.* 1983b and Carrott *et al.* 1995c) identified flies to species. There are two main reasons why they are likely to be better indicator of conditions. Firstly because the dipterans are the most accomplished of insects in the air, thus they must be the most adept at reaching ephemeral habitats. Secondly, many species colonise refuse and leave positive proof of breeding, as it is the puparia, which remain and are used for identification purposes.

13.10 SUMMARY

This exercise has thrown much light on the faunas, which develop in pits.

- The conditions in the pits appear to attract a particular group of colonisers.

- The main determining factor appears to be the level of ammonia. High levels give rise to OP faunas and even higher, G faunas. Both types of faunas probably developed in buildings and the more enclosed position of the G fauna is demonstrated by more house beetles and fewer beetles from other habitats.

- AS and CAN faunas developed in lower levels of ammonia due to a greater amount of water being present and an open position. The reasons for the differences between the two have not been ascertained but may be due to different levels of water or textural differences in the deposit.

- There is no evidence for foul matter being rapidly covered, as postulated by (Kenward and Large 1998), instead most layers appear to be open long enough to collect seasonal beetles like *Anobium punctatum*.

- All types of “house” beetles are very common, possibly attracted by the smell or moisture. They do not necessarily indicate that floor coverings have been added.

CHAPTER 14: Comparison of assemblages from different feature types

14.1 INTRODUCTION

The purpose of this exercise was to compare insect faunas from different types of feature, in order to ascertain the affect of the particular characteristics of that structure on the composition of the death assemblage. This taphonomic factor has been largely ignored, by most workers in the field. For example, in the Jaccard analysis of species associations (Kenward 1982) described in Section 4.2.1, there was no consideration of the features from which the assemblages were obtained. Another example concerns the changing proportions over time of the habitats represented by the faunas, from the site at Tanner Street, York described in Section 3.3.4.5. Only in the later report from Coppergate, York is feature type considered in habitat distribution calculations (Kenward and Hall 1995, 663; 669). The assumption appears to be that death assemblages, irrespective of their origin, are a representative subset of the total available fauna.

Some work has been carried out on the bias caused by the trapping methods on the sample obtained from living communities. Differences in Icelandic faunas from modern live assemblages with their ancient counterparts have been considered by (Buckland *et al.* 1991). They speculated as to how much the differences between the two could be due to the methods of collection. The characteristic faunas of middens and floors, both ancient and modern, have been considered (Smith 1991; Buckland *et al.* 1993). His attempts at comparison of farm faunas from a wide variety of ancient and modern sites, using multivariate analysis, were unsuccessful (see Section 3.4.2.2). Smith (1991) also discussed the differences between archaeological deposits and modern farm deposits. This assessment was intuitive but did include a consideration of the differences caused by the different ways in which the beetles had been trapped. It was not backed up by statistical analysis as he had already concluded, from the inaffectiveness of multivariate analysis on farm faunas, that these samples would be too disparate to achieve meaningful results.

This approach has rarely been taken further to identify the differences in archaeological assemblages caused by their formation within different feature types. One influencing factor, which has been widely recognised, is the ability of wells to act as pitfall traps (e.g. Osborne 1981b; Buckland 1986) as they usually contain large numbers of ground living carabid beetles. Some workers have relied solely on the carabids in their interpretation of well faunas (e.g Ervynck *et al.* 1994). Another recognised feature is that cesspit faunas lack variety (Osborne 1983; Kenward and Large 1997).

14.1.1 AIMS AND OBJECTIVES

The main purpose of the exercise was: -

- To identify differences in faunas caused by the characteristics of the feature they developed in.

This was to be achieved by using correspondence analysis from the CANOCO computer program on a representative selection of assemblages from different feature types, sites and periods. This wide range of assemblages would enable the most ubiquitous beetles, to be recognised. Hence a second aim was: -

- To identify the main species in the "background rain."

14.2 SELECTION OF ASSEMBLAGES

This analysis only investigated differences between three of the five types of features which had been used in the database (see Chapter 5). These were labelled wells, ditches and pits. The two other main types, deposits formed above ground, indoors (e.g. floors) and outdoors (e.g. middens), could not be included due to a lack of a suitable range of samples.

The three feature types are defined as : -

Wells = Enclosed water-bearing features, designed to contain water. Due to the Roman practice of infilling disused wells with inorganic material, the well sump is preserved. Otherwise well assemblages would not survive uncontaminated.

Ditches = Open water-bearing features, again, primarily designed to contain water, thus drainage ditches and moats are included in this category.

Pits = Excavations defined by their usage, which is to contain materials other than water, thus all pits and disused rubbish filled wells fit in this category.

A total of forty two assemblages were selected, twelve from wells, fourteen from ditches and sixteen were from pits. Details are given in Table 14.1. The selection was chosen to be as representative as possible and involved using almost all the available material. A good spatial and temporal range was aimed for. While the pits used in that investigation (Chapter 13) were predominantly urban, in this case there were much greater numbers of rural features. The assemblages were unevenly dispersed by period with the Roman predominating, but the range of sites sampled was greater. There is much less emphasis on work from York. Assemblages from York, Carlisle and London were the main contribution from the EAU, these comprise half the total number, eight examples from the Thames Valley had been examined by Robinson and five were from southern England sites studied by the present author.

All the wells, bar one, were Roman. They included Sample 24, which had been moved from the investigation of pits (Chapter 13), because it was so different from them, and reclassified as a well. The practice of infilling wells with inorganic material was not continued after the Roman period and so post Roman well faunas are very rare. Most of the ditches were drainage or boundary ditches from towns, again mainly Roman, or medieval moats, some of which were rural. Most of the pits were added from those used for the analysis of pits already carried out. Some structures classed as wells in the site reports were filled with rubbish and therefore fitted the pits category. In this way some more Roman examples were found, as true pits with insect remains, have rarely been examined from that period. Four features were included from Roman Farmoor, namely two wells, a ditch and a pit. If there are strong differences between feature types, these should demonstrate them.

None of the assemblages had significantly fewer than one hundred individuals but there were many more with much higher numbers. One sample had nearly 1500 individuals the next largest had over 600, there were six more with over 300 and a further seven had more than 200.

14.3 PREPARATION OF DATA

These assemblages were examined using CANOCO correspondence analysis. The rationale for this is the same as for the investigation of pit faunas and is described in Section 13.3. The methods of preparing the combined faunal list were basically the same as has been already described (Section 13.3.1).

The same methods were used to correct for large assemblages, superabundants and scarce species. There were two assemblages, numbers 24 and 36 both from London, which had been rapid scanned (see Key to Table 14.1 and Section 13.3.1 for further details). Treatment of the taxa from all assemblages was the same as before, except that there was an additional problem. In several of the assemblages recorded by Robinson, the Aleocharinae were uncounted. These are a large group of very small and difficult to identify staphylinids, and many are unclassifiable to species. Although the group is undiagnostic because it contains so many species, it is large, found in nearly all assemblages and therefore would cause distortions if omitted. Therefore an estimated number was given, which was 5% of the total assemblage size. This was chosen because it was the average size in the other assemblages. The assemblages so treated are noted on Table 14.1.

The completed list was reduced using the methods set out in Section 13.3.1.2. A far greater reduction of numbers was required, as many more taxa were involved, originally there were over 500 taxa, which were reduced by two thirds to 172. It was less easy to identify significant taxa with such a disparate group and far more taxon combining was necessary. In order not to lose habitat data, more ecologically based groups were used in this study. The catch-all large taxa, such as "carabid" was still present but others such as "car wet" and "car dry" (for carabids found in wet or dry ground conditions) were created. After the initial list had been reduced, several more assemblages were added, therefore it is not possible to give a complete original species list. The CANOCO list is shown in Table 14.2, and the key to abbreviations is shown in Table 14.3.

14.4 RESULTS OF THE CANOCO ANALYSIS

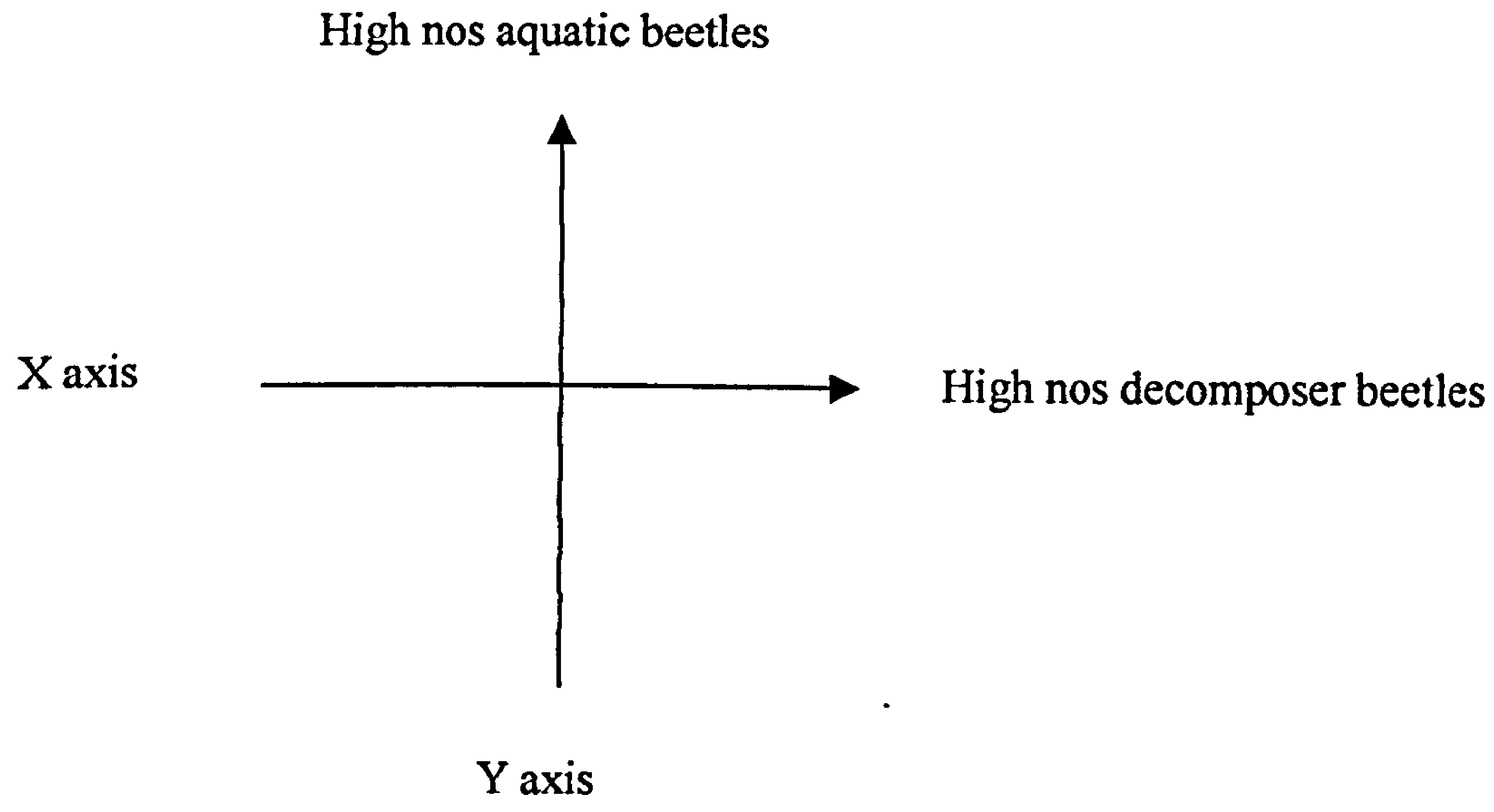
14.4.1 ANALYSIS OF ALL FEATURES

Correspondence analysis, of all forty-two samples, was carried out by the CANOCO program. The results of the samples are shown in Figs 14.1a-b and of the species in Figs 14. 2a-e. Each plot has been divided into four quadrants, as in the pits analysis (Chapter 13), Each quadrant has been further divided into two sectors. This analysis separated all but one of the pits into Quadrant B, the majority of the wells into Quadrant D and left the ditch samples scattered in all quadrants but centrally placed. The exceptions are ditch sample (44), which was far out in Quadrant A and the four Farmoor samples (59-62), which remained tightly clustered together.

When the species distribution was examined (Figs 14.2a-e) it could be seen that, once again, the separation of species followed ecological lines. The classification into habitat types, showed that there was a marked tendency for different habitat types to occur in each semi-quadrant.

The main factor used to separate the assemblages is the quantity of decomposer species and this factor spreads out the assemblages along the "x" axis. The "y" axis used the quantity of aquatic species as a determining factor. This is shown diagrammatically below. The different feature types grouped together reasonably well using these criteria.

Diagram showing the main factors used by the CANOCO program to order taxa



14.4.1.1 Pit distribution and their associated taxa

Pit assemblages are clustered around the "x" axis in Quadrant B, which is in keeping with the domination of these assemblages by decomposer and "house" species. The lack of aquatic species in these assemblages, prevented further separation on the vertical axis. When the categories of pit assemblages described in Chapter 13, are applied to the pits, which are included from that study, it could be seen that those with like faunal types are clustered close together, thus further justifying the classificatory system. The exception is Sample 21, the mixed nature of which had already been noted (see Section 13.3.4.5). The faunal type, that is least obvious in this analysis, is the one most noticeable in the examination of pits, namely the CAN type, with its associated S faunas. Assemblages of this type were the most spread out, of the five. This is due to the separation of the main elements; (*Carpelimus bilineatus*, *Anotylus rugosus* and

Neobisnius villosulus) because of differences in their frequency of occurrence in the three feature types. This is also true of the S fauna, the beetle, *Trechus micros*, for example, is also common in wells.

Roman assemblages with high numbers of grain pests are located below the "x" axis in Quadrant B and this factor helped to cluster the Roman examples together. The assemblages, from three features originally designated wells (46, 47 and 52), also occurred in this group. These all contained rubbish and so may have functioned as pits, but none fitted into a category based on pit colonising species. The only anomalous pit assemblage is Sample 60 from Farmoor.

14.4.1.2 Distribution of ditches and their associated faunas

The ditch samples are not clustered together in one area but are mainly in the middle of the plot. The largest concentration is of samples from the four ditches in Quadrant A1, Sample 44 is the most far out example of this group, followed by 37, 62 and 43. Two of these ditches were medieval (44 and 43), one from a Roman fortress ditch (37) and one from the Romano-British farm at Farmoor (62). All these ditches are characterised by high levels of water species and low levels of decomposer species. The position of *Rhizophagus*, *Dienerella* and Ptiliidae species in this section are solely due to their prominence in the assemblage from Sample 44, and so should be discounted. Samples from the Roman ditches (35, 36, 38, 57 and 58) had high numbers of grain pests. Like the majority of pit samples, these were of urban provenance and they were situated with the pit samples in Quadrant B2 but all near the origin. The other ditch samples (40, 41; 42), which are all medieval, are scattered throughout the quadrants.

14.4.1.3 Distribution of wells and their associated faunas

The well assemblages are all to the left of the "y" axis, with the majority in Quadrant D. This demonstrated that they were low in decomposer species and had varying amounts of aquatic beetles. The beetles associated with agricultural or disturbed ground were also evident in Quadrant D, with beetles indicative of drier ground conditions were below the "x" axis. Quadrant C, Sector 1, where most of the beetles indicative of damp ground were positioned, had only one well sample, from Roman Chichester (49).

There is a split between assemblages from deep wells (48, 49, 50 and 54) and those which had probably been water holes or ponds (24, 45, 55, 56, 61, 59). The former are situated in Quadrant D1, with (49) in the adjacent quadrant C2. Three of these were villa wells and 49 was from a town and they were situated in D2 and A1.

14.4.2 ANALYSIS OF WELLS, DITCHES AND ROMAN PITS

The very distinctive medieval and post-medieval pit faunas were eliminated from the next run of the CANOCO program, as the high levels of decomposer species they contained, may have been obscuring a pattern in the remaining assemblages. The program appeared to have used the same factors in its analysis, namely levels of decomposers, and house species against aquatic species, although the main (x) axis changed to the aquatic one showing that this was now the most important factor distinguishing the assemblages. This group was analysed twice, with and without grain pests, and, as before, the elimination of that category made little difference to the position of the samples. Only the findings when grain pests were omitted, will be considered here (see Figs. 14.3; 14.4).

14.4.2.1 Distribution of Roman pits and drainage ditches

Removal of the grain beetles from the analysis, changed the positions of the Roman ditches, which had contained large numbers of them, only very slightly. With the exception of the Farmoor samples, the Roman pits and filled wells all lay in the sector of Quadrant C, left of the "y" axis, together with the Roman drainage ditch assemblages.

14.4.2.2 Distribution of other ditches

The other ditches are not clustered together. The assemblage from the Roman fortress ditch and all the medieval examples are widely spread in each of the other quadrants. The sample from the medieval manor house moat (44) remained in the sector (D1), which contained most aquatic species, with the wells (24, 45). The Roman fortress ditch (37) and the medieval priory drains (Sample 43) moved, with the four Farmoor samples to Quadrant D2. While the priory moat sample (42) aligned with the Appleford wells in the sector on the opposite side of the y axis (Quadrant A2). This area had no very characteristic taxa on the species plot. Two other medieval examples (40 and 41) were isolated in sectors on their own.

14.4.2.3 Distribution of wells

This is interesting, as it further separated the deep well assemblages from the others, placing them in Quadrant B. Most shallow wells are in Quadrant A, with those from Appleford in Sector A2 nearest to the true wells and the Farmoor examples on the other side in Sector D2.

14.4.2.4 Distribution of urban/rural features

Urban features were coloured red and rural ones green. It can be seen from Fig. 14.3 that almost all rural samples occupy the top half of the plot (sectors D2, A1, A2, and C1) while the urban are in the remaining part.

14.5 CHARACTERISTIC SPECIES OF THE SECTORS

The taxa, characteristic of the sectors were determined by an examination of the CANOCO species plots, see Fig. 14.4. Those beetles within 0.1 units of the origin were not counted as they will be much less diagnostic. Also species only prominent in one assemblage have been discounted.

14.5.1 SECTOR C2

This was the area, which contained most of the Roman pits and drainage ditches. Decomposer beetles were common, including some those found in fouler waste, such as certain *Cercyon* and *Cordalia* species. *Neobisnius villosulus*, *Oxytelus sculptus* and *Anotylus complanatus* were present but the full range of "pit colonising" species (see Chapter 13) found in post-Roman urban pits, was not in evidence. *C. pusillus*, not *C. bilineatus*, was the commonest *Carpelimus* species. Towards the outer edge of the sector, drier decomposers were found including members of the *Orthoperus*, *Ptenidium*, *Acrotrichus*, *Cryptophagus*, *Atomaria* and *Anthicus* genera. At the inner part some "house" beetles were situated (e.g. *Tipnus unicolor* and *Anobium punctatum*). The only phytophagous taxa were Halticinae (flea beetles).

14.5.2 SECTOR A1

In this area are found most of the shallow wells and two ditches. This area was characterised by high numbers of a variety of aquatic species. The area near the origin contained the "house" beetle *Mycetaea hirta*. No other diagnostic beetles were present.

14.5.3 QUADRANT B

This quadrant contained all the villa wells and the only town well. Most of the carabid beetles such as those indicating dry ground, e.g. *Amara* and *Calathus* species, and wet ground indicators such as *Bembidion* species and "car wet" carabids from wet habitats were situated here. It also had many phytophagous species both "flea" beetles, e.g. "chrweed" a composite group of chrysomelids and weevils such as the composite "Apiweed" a group of Apion species feeding on weeds of disturbed ground weed and "curweed" miscellaneous weed feeders of the Curculioniidae family. Other indicators of damp ground were present, such as *Platystethus cornutus* group and *Platystethus nitens* Decomposers were not common but *Anotylus rugosus* and *Megasternum obscurum* are present. There was an interesting cluster at the outside edge of the plot, of the two burrowing species, *Trechus micros* and *Coprophilus striatulus* together with *Lathrobius* species.

14.5.4 REMAINING SECTORS

Sector D2, which contained the four samples from the Romano-British farm at Farmoor (59-62), did not separate out to cluster with others from the same feature type, but remained closely associated. As well as having reasonable numbers of aquatic species associated with them (the group simply labelled "water") they also had highest numbers of tree feeding species. These factors distinguish this group.

Sector A2 contained the Appleford wells (55; 56) and a priory moat from Leicester (42). The only taxa dominant in this sector was *Sitona*, a weevil which eats leguminous plants, like clovers, therefore used by Robinson (1983a) as an indicator of meadows. In each of these cases there was much more similarity between the assemblages from the same site then with the medieval ditch assemblage grouped with them, the other medieval ditches were placed on their own. In Sector C1, only the ditch assemblage from Durham (40), was located and the main species of the sector were, *Anotylus nitidulus*, *A. tetracarinatus*, *Falagria* and *Megarthus* species, all types of decomposer beetle, but the last two in that list are not so frequently found. In Sector D1, which contained the town ditch from Oxford (41), *Ptinus fur*, a strongly synanthropic species, the food pest *Bruchus* and *Monotoma*, which feeds on mould hay, were situated.

14.6 FAUNAL LIST ANALYSIS

Some of the more puzzling features of ordination, obtained by using CANOCO analysis, were studied in more detail by using the combined species list as described in Section 13.4. This method was used to see whether it was possible to distinguish between the Roman pits and wells in the cluster on the samples plot and to understand the scattered distribution of the medieval moat samples.

14.6.1 ROMAN PIT COMPARED WITH ROMAN DRAINAGE DITCHES

The CANOCO analysis had not separated the Roman ditches and pits and so these assemblages were compared directly to see whether there were any differences not picked up by that exercise. There were seven drainage ditches and only four in the pit category, two of which were filled wells. Because of this discrepancy in numbers, two more Roman pits (1 and 19), were added from the investigation into pit faunas. The results are shown in Table 14.4.

The results confirm those obtained by correspondence analysis as very few differences were found. The ditches, not unexpectedly, had higher levels of some water beetles and species associated with damp ground, such as *Platystethus nitens* and members of *P. cornutus* group. They also had fewer synanthropic beetles than were in the pits. In addition the frequencies, with which the decomposer species occurred, were different. The ditches had more species from the wet, foul end of the spectrum, namely *Carpelimus pusillus*, *Oxytelus sculptus* and *Anotylus sculpturatus* and the pits more *Neobisnius villosulus*. It is interesting that only the ditches contained the nettle feeding, *Brachypterus* species. in addition, while the pits had higher numbers of the strongly synanthropic and less mobile *Tipnus unicolor* and *Ptinus fur*, surprisingly it was the ditches that contained many more individuals of *Aglenus brunneus*, a blind flightless species particularly associated with medieval floors.

Using the same technique, the assemblages from the two filled wells, were also compared with those from the true pits. There is remarkably little to distinguish between them. Despite the fact that assemblages from rubbish filled wells may have contained some beetles from the well sump, in addition to those introduced with the fill, the proportion of carabids, so common in well assemblages, were not higher in these examples.

14.6.2 MEDIEVAL MOAT ASSEMBLAGES

Two medieval town ditch samples merited their own sector on the CANOCO plot, so their assemblages were examined in an attempt to discover the reason. Neither was unusual, in taxa or relative abundances from the other assemblages, and only the outermost species on the species plot occurred in them. The other two were both from medieval monastic establishments and they showed few similarities with the taxa in the other assemblages in their sectors. The placement of these assemblages remained unclear.

14.7 COMPARISONS USING ECOLOGICAL GROUPS

The beetles in each assemblage were combined into ecological groups and the assemblages were then further combined in different ways. The method used was described in Section 13.5, except that the list of assemblages prepared for CANOCO analysis (Table 14.2) was used instead of the original list as used in the pits' study. Because of the very large size of the original list it had not been completed for all assemblages and therefore could not be used. The reductions in taxa took account of habitat, where practical and so little information has been lost. Grain pests were also omitted from the calculations, because they were so large in some cases, that they obscured the picture.

First the assemblages were combined according to the quadrant they occupied on the CANOCO plot. This demonstrated the characteristics of the faunas in the various sectors more clearly, in particular with respect to the medieval ditch assemblages.

When the features are analysed by habitat preferences rather than species then the position of the medieval ditches becomes clearer. The position of the Durham sample (40) is justified by the high levels of decomposers, yet low levels of house species and phytophages with in. The position of the town ditch (41) is determined by high levels of house species and some aquatics together with lower levels of decomposers. The priory drains (43) shares with the Farmoor samples in the same sector, moderate numbers of aquatics, high levels of "house" taxa and few decomposers and the priory moat from Leicester, like the Appleford wells associated with it, has a scarcity of both decomposers and synanthropic species and an intermediate quantity of aquatic species.

Based on the similarities of habitat distribution, which can be seen in the column chart (Fig. 14.5), some further combining was carried out to form three new groups. A column chart showing the proportions of taxa from different habitats with assemblages grouped by the new feature types described above, is shown in Fig. 14.6. In addition, the proportions of the species in the ecological groups described in Chapter 6, namely carabids, phytophages and mycophages were compared in these new feature groupings (see Fig. 14.7).

14.7.1 TRUE WELLS

It can be seen that the configuration produced by Quadrant B, is the most distinctive. This section contained deep well sump assemblages from villas and a town (assemblage numbers 48, 49, 50, 54). It has been labelled "true wells".

This group has the most species providing information about the immediate environment, mainly due to it having the largest numbers of carabids and high levels of phytophages and the smallest proportion of species associated with buildings. It has a reasonably large percentage of decomposers.

14.7.2 OPEN WATER FEATURES

Quadrant A and the adjoining Sector D2 are similar to each other and so were combined. This area contained faunas from medieval moats (44, 43, 42), the Roman Fortress ditch (37), wells from London (24) and Romano-British farms (45, 55, 56, 59, 61) and a pit and a ditch assemblage from one of these (60, 59). This group was designated "open water features".

Not surprisingly, it had the highest number of aquatic species, but also the lowest number of decomposers, especially of the so-called "compost" group. Numbers of carabids were lower and plant and mould eating species slightly higher than found in true wells.

14.7.3 ROMAN WASTE

Quadrant C was combined with the adjacent Sector D1. All the urban Roman features fit into this category, plus some medieval ones. The numbers are 2, 18, 35, 36, 38, 39, 41, 46, 47, 51, 52, 53 and 58, it is called Roman waste. The only non-urban example in this group is the rural "well" (51) from Saxo-Norman Fishbourne.

The distribution of habitats in this group is most similar to that for the medieval pits, but the habitats, relating to the surroundings, are better represented and the decomposer and synanthropic elements are not so strong. Compared to the water bearing features, levels of carabids and phytophages were both lower and mycophages higher.

14.7.4 MEDIEVAL PITS

The distribution of habitats in the medieval pits, which had been omitted from the analysis, was added. As with that analysis the grain pests were excluded. These pits showed the highest levels of synanthropic species and decomposer species together with the lowest levels of species providing information about the surroundings, as the trend shown by the Roman waste examples continued.

14.8 DISCUSSION ON THE DIFFERENCES BETWEEN FAUNAS DUE TO FEATURE TYPE

The expected differences between the three main groups based on the physical properties of the collecting device, including the affect of the fill on its attractiveness to beetles, is described below.

Often the reason for digging a pit is to dispose of foul matter. This may be attract some beetles and repulse others. Although the pit would not be open for as long a period as the other two features, this attractiveness, plus trapping by burial which would occur when new material is added would ensure that many beetles remain to form a thanatocoenosis. Pits, especially if waterlogged would be less likely to attract scavengers than rubbish left on the surface but animals such as rats may pick over the contents, removing some of the larger species but adding others in faeces. Many cesspits would be enclosed in buildings or yards with little space for plants, a factor, which further explains the lack of species diversity.

Wells, being deep and often enclosed by a lid and wellhead machinery, provide less opportunity for insect access. However, they may be open for a number of years. The developing death assemblage is secure in the preserving medium and unlikely to be disturbed by predators, except perhaps newts. (The bones of one were found by the present author in a Roman well in Chichester). Presumably passage through the gut of a newt would not affect the beetle's exoskeleton. The straight shaft would act as a pitfall trap for ground living predatory beetles and would itself be a microhabitat for certain beetles. Another source of insects may be from bird droppings. There would presumably be a bias in the fauna towards beetles attracted to moisture and/or darkness. The immediate surroundings would probably be bare and hard surfaced for ease of access around the well, which should be reflected in the pitfall fauna.

The category of ditch is rather wide as it includes shallow intermittently wet drainage channels and moats, which may last for centuries. They are more accessible to insect predators and will contain bird and mammal droppings, which may contain imported insect remains. There are likely to be autochthonous aquatic species in the death assemblage plus allochthonous ones swept in from the neighbouring area. These features are likely to be surrounded by vegetation. Rubbish from buildings may be added with associated synanthropic species.

14.8.1 ROMAN WASTE

It was assumed that pits would have foul contents, which was amply justified in the case of medieval and post-medieval examples, but was not so for the Roman pits. Only one example of a really foul Roman pit (25) was found and this was one of the assemblages in the analysis of pits described in Section 13.4.2. The habitats, represented by the faunas of the pits in this survey, were almost indistinguishable to those from filled wells and very similar to those collected from Roman drainage ditches (see Fig. 14.8). These were all urban assemblages and it appears that rubbish was thrown in ditches as well as in pits. Kenward who analysed the contents of the filled well (47) concluded that it had been filled with stable waste (Kenward *et al.* 1986) and he considered that this was the main type of rubbish left exposed in Roman towns (Hall and Kenward 1990, 391). This can be foul, if allowed to become urine soaked, but this would leach out if left in the open. The assemblages from the Roman Waste group, collected many more species from the immediate environment, than did the medieval equivalent, which also suggests that the rubbish was less foul, as does the composition of the decomposer group, which differs from that found in medieval pits. The "pit coloniser" beetles, which have been used to classify the post-Roman pits, were not very common. *Neobisnius* was present but it was not associated with *Anotylus rugosus* or *Carpelimus bilineatus*. The commonest *Carpelimus* species was *C. pusillus* and *A. rugosus* was more strongly associated with species from farmland and not with the decomposer beetles found in rubbish. Species predatory on maggots, which develop in foul wet conditions, were few. The presence of many mould feeders, which prefer drier, less foul conditions may have come from hay or straw used in stabling. However, many mould feeders are very mobile and find their way into unsuitable habitats, such as the control pit in the experiment described in Chapter 11.

As predicted, the drainage ditches had higher levels of damp ground species based on the assumption that drainage ditches would collect more species from the surrounding area, as these would be transported in the drainage water. This difference is not very marked, possibly for two reasons. Firstly the pits, in which the insect contents have been preserved, are also more likely to be in damp areas and secondly they would, like the ditches, collect the runoff from rainwater.

Only the Roman ditches showed evidence of nettles around them, these may have been cleared from the areas where pits were dug. Precise information about the position and function of the Roman pits was lacking. This group demonstrated that it was less foul than the group containing the medieval pits by the higher numbers of carabids and phytophages it contained (see Chapter 13). Although the reason for the greater numbers of phytophages may also be due to the presence of more vegetation around the features.

These features indicate good waste management practices in Roman towns. Noxious refuse, like cess, was not in evidence, as it had not been left exposed in pits nor thrown in ditches. Nearly all these assemblages had *Anobium punctatum* in them, showing that this rubbish was exposed at midsummer, when these beetles are on the wing. This suggests that these pits, like their later counterparts had not been rapidly sealed.

The inclusion of the Saxo-Norman feature (51), described as a well (see Chapter 10) in this sector with the Roman waste examples, is unexpected. It appeared to have acted as a collector of surface water, so perhaps could be more accurately described as a functional drainage ditch. Although rural, it contained many decomposers associated with detritus, such as rotting leaves, which presumably had been swept in from the surrounding area. This factor accounted for its position with urban waste deposits.

There was only one sample in the adjacent sector (C1), which was the assemblage from medieval Durham (40). It was the most unlike any of the other groups. In levels of decomposers, it is similar to the Roman waste group of assemblages, but there were more of the "pit coloniser" group. It was extremely low in "house" species. On archaeological, pedological and entomological grounds this feature was considered to have been a storm drain, which was situated at the base of a steep slope (Kenward

1978), behind the buildings. Thus it was similar to a drainage ditch but, because of its position, lacked domestic refuse.

The apparent lack of foul waste, robbed this group of those characteristics deemed to be typical of pits, and made them more like the group termed open water features, than their medieval equivalents.

14.8.2 MEDIEVAL PITS

The medieval pits fitted the theoretical description very well and the different types of pit faunas described in Chapter 13 showed up in this survey also. Although some of the faunas of Roman pits and drainage ditches intermingled with this group, in the more central areas, they differed from them in not having large numbers of the pit colonising species.

The foul contents of the medieval pits, most of which had contained cess, was demonstrated by the low numbers of allochthonous species.

14.8.3 TRUE WELLS

This group is distinctive but only contained deep wells. Its characteristics could be deduced from the theoretical situation outlined above.

They operated as giant pit fall traps and so contained the highest numbers of carabids. These beetles, being ground living, provide much useful information about the surroundings, so much so that some workers have only examined this element of the fauna. However, because many carabids are large, there are fewer of them in a given area. The method of analysis used in this paper treats each individual beetle the same regardless of size and, in addition, the assemblage numbers are converted to percentage figures. Both these factors meant that the importance of the carabids was underrepresented in this analysis. It would have been possible to weight larger beetles in the analysis but this was not done. Nevertheless this feature of true wells was demonstrated.

The occurrence of some autochthonous species, which probably lived in the well shaft, was noted by Girling (1989) with regard to *Trechus micros*. Another beetle with burrowing habits is the dung eating species, *Coprophilus striatulus* (Hall and Kenward 1990, 367-8) and this may be why it is common in wells. Another genus, commonly found in wells, is *Silpha,* which includes several snail-eating species (*S. obscura, laevigata*, or *atrata*). These may feed on snails in the well shaft.

As, the members of the group of beetles, which feed on decomposing material, tend to be highly mobile because of the temporary nature of their habitat, the numbers of them are usually quite high. The size of this group, excluding the decomposers found in drier waste material, is the same as for the "Roman waste" group, but the component species are different. Those in high numbers, compared to other feature types, are *Megasternum obscurum, Lathrobium* and *Quedius* species, and *Aphodius granarius.* Perhaps a common factor is a behavioural one, an inclination to enter dark spaces. It is interesting that, although so different in other ways, garderobe pits, are also deep and dark and also attract *Quedius* species. *Megasternum obscurum* is found underground in *Talpa* (mole) burrows (Hansen 1987). It appears to have been particularly common in Roman times generally, as it featured in the Roman pits, used in the investigation into pit faunas (see Section 13.4.1.4).

Some of the phytophagous species were also present in high numbers, particularly those in the combined group curweed, which consisted of various weevils, which feed on plants of disturbed ground, and those of the genus *Longitarsis.* While this may reflect conditions around the wells, it seems unlikely, as the ground around the well would probably be hard and weed-free for ease of use. It is possible that these beetles migrated to the well for hibernation.

The other features, described as wells in the original survey, were shallower and therefore did not share the particular characteristics of true wells, merging instead with the next group of open water features. However, the two wells from Appleford were intermediate in character (see below).

14.8.4 OPEN WATER FEATURES

The open water section contained the shallow wells and the large long-lasting moats. These were more likely to be continuously filled with water, which is demonstrated by the abundance of aquatic species within them. The other main difference between this group and that, termed Roman waste, stems from the fact that these are nearly all rural features whereas the latter were urban. Theoretically they fit the same model. They differ from the true wells in the accessibility of the water within them.

They probably collected the most representative sample of the surrounding fauna, and often contained some rubbish, which originated in buildings, but had the lowest proportion of decomposer species. This latter fact may be due to the rural nature of nearly all the examples in this survey as organic waste would have been a less dominant part of that environment. Outside towns, space would have been at less of a premium, and so rubbish would not have been concentrated into a small space. As might be expected this group of open water features, contained the highest numbers of phytophages, although only slightly higher than "true wells" and only slightly fewer carabids than that group. However, apart from the highest numbers of *Phalacrus* species, which simply indicated the presence of grasses, wild or cultivated, or sedges, this group is not characterised by high numbers of any other particular taxa used in this survey. Significant taxa may have been lost, by combining species.

Assemblage 44 was from a manor house moat in North Yorkshire, this was well separated from the others on the plot and had the most natural of the assemblages. It had the most aquatic species and there was good evidence of trees. This fauna dominated its sector and was responsible for the inclusion of Rhizophagids, Ptiliids and *Dienerella* species in this section. These could all be species living in trees. The diversion into rural and urban assemblages, seen in the CANOCO, did not hold for three urban open water assemblages and these were from monastic or military sites. These establishments have a reputation for cleanliness and as the main distinguishing feature between urban and rural is in the numbers of species of rotting matter, these two facts may be connected. However, the other military ditch sample (39), from a Roman fort, fitted with "Roman waste" as did the filled well from the fort in York (47).

14.8.5 THE SAMPLES FROM FARMOOR AND APPLEFORD

The sites at Farmoor and Appleford were both situated on the first gravel terrace of the River Thames. Although Robinson (1981b) considered that the wells at Farmoor and Appleford were very similar, this analysis did not bear this out. The Appleford wells had fewer aquatic and arboreal species, more beetles characteristic of dry ground and less synanthropic types. The habitat profile (Fig. 14.5) showed them to be more akin to true wells than the Farmoor examples. This observation was borne out in the site report Robinson 1981a), as these wells were further away from the river than the Farmoor examples and therefore, presumably deeper.

In addition, the site report explained the puzzling fact of the clustering of the three different feature types at Farmoor. The shallow pit was fairly large and clay-lined and apparently had been filled with wheat chaff. It had very large numbers of *Cercyon* species, and *Micropeplus fulvus,* which indicated that the contents had become mouldy. However, these decomposer beetles had not separated this pit from the other features examined from that site. All features also had arboreal species in them, which were rare at other sites. However, the site report revealed that all these features had been flooded, which explained why aquatic species were found in all samples and why they were clustered, as the multivariate analysis had used the quantity of aquatic species as the main determining factor.

14.8.6 THE RAPID SCANNED ASSEMBLAGES

Although the assemblages from samples 24 and 36 had only been rapid scanned there positions on the CANOCO plot appeared to be correct. Number 24 was a well, which had been confused with a pit, at one stage. Thus indicating that it was not likely to have been a true, deep, well. It was an urban well among rural features but it was early in date, before the town had become established. Sample 36 was a ditch from the same site and it fitted in with the other Roman ditches.

14.9 RECLASSIFICATIONS BASED ON CANOCO ANALYSIS

The ability of the CANOCO program to separate the component species by habitat was very good (see Fig. 14.2; Fig. 14.4.). It showed that Kenward's classification of *Anotylus nitidulus,* as a riverside species (Hall *et al.* 1983b), is probably incorrect and conversely that *Neobisnius,* now found near water was, like *Carpelimus bilineatus,* a common member of the urban decomposer taxa. The *Platystethus cornutus* group is associated with damp ground and *Anotylus sculpturatus* shows more affinities with farmland than its congeners. The moorland species *Lochmaea suturalis,* was closely associated with the domestic rubbish species, showing that it was most probably imported in peat or heather used for bedding.

14.10 BACKGROUND RAIN SPECIES

By adding up all the beetles present in wells, ditches and pits and placing them in rank order, it was possible to determine the most abundant and widely dispersed taxa. Only those taxa forming at least 10% of the total number in its category, were considered. Furthermore each taxa had to have a place on all three lists, so that an average rank order position could be calculated. This list of "background rain" species will be biased by the assemblages involved, particularly because all the well assemblages are Roman. The typical urban medieval environment would probably contain more decomposer species.

The commonest group is the sub-family aleocharinae, which contains a large number of different species, most of which are small and found in decomposing matter, but which is too diverse to be useful diagnostically. The two most abundant species were *Lathridius minutus* and *Anobium punctatum*, both in the top seven places on all three lists. These were followed by *Anotylus nitidulus* and *A. rugosus*, which were in the top fourteen in all lists. Seven genera were very common, namely, *Cryptophagus, Atomaria, Aphodius, Philonthus, Stenus* and *Carpelimus*. Below them came *A. sculpturatus* and *Platystethus arenarius*, with them were the only carabid genus in the list, *Bembidion*, and the only weevil genus, *Apion*.

All the species involved are small and highly mobile but otherwise there is a great variety in the habitats and food preferences of these beetles and in the families to which they belong. Damp ground, pastureland and built up land are all indicated. The highest numbers of taxa are associated with decomposing materials either directly (i.e the dung species *Aphodius* and *Cercyon*) or indirectly by feeding on the larvae of dung breeding flies (i.e. *Anotylus rugosus, A. sculpturatus* and *Philonthus* species). *A. nitidulus* and *Platysthethus arenarius* are found in the same situations but whether predatory or coprophagous is not known. Many *Carpelimus* species are associated with decomposing materials found in wet areas or in environments created by humans. Damp ground is the habitat of the predatory flighted ground beetle *Bembidion* and many *Helophorus* species seek out standing water everywhere, as they are attracted to shiny surfaces. Mouldy materials often accumulate in human settlements and three of the most ubiquitous taxa are mycophagous, namely *Lathridius minutus*, and *Cryptophagus* and *Atomaria* species. *Anobium punctatum* is the well known timber pest and many *Apion* species feed on clover, or other leguminous plants which were common because they were grown as crops and were also common weeds around human habitations.

The most frequently represented family in this list is the Staphylinidae (rove beetles) with six members, which is not surprising as this family has the most species of all the Coleoptera in Britain and its members are particularly well adapted to flight. The remaining nine taxa come from seven families, but there was only one representative from the next two most successful British groups; the Curculionidae (weevils) and Carabidae (ground beetles). These were *Apion* and *Bembidion* respectively. Many members of those two families are large and flightless, both reasons why they are underrepresented in assemblages.

14.11 CONCLUSIONS

Contrary to the experience of Smith (1991), who advised against comparing such a disparate group of assemblages, the exercise proved to be informative.

- Distinct types of assemblages were found to be dependent on the type of feature they were formed in, although the categories had to be reclassified.

- Four main categories of feature types were distinguished: -

1. "Medieval" pits, which are more typical pits, with foul contents, which were examined in Chapter 13 and classified into distinct faunal types.

2. Roman waste, in this group was placed Roman features containing rubbish whether from pits, disused wells or ditches. The contents were less foul.

3. Open water features, this contained not only medieval moats but also features, originally described as wells which were shallow and operated as water holes.

4. True wells contained only the deep Roman wells, these were features in which the water had to be drawn up.

- The main differences were caused by: -

1. Foul smelling waste, which had a deterrent affect on many species. This separated out Category 1 from the other waste containing group (2).

2. The presence of a long shaft between the surface and the point of collection. This distinguished the "true" wells from the other water-containing feature type (3).

- The "open water features" (Category 3) appeared to collect the least biased sample of the available coleoptera.

From such a large collection of Coleoptera it was possible to identify "background rain" species. This was achieved by selecting the most frequently occurring taxa, common to all features types.

- The background rain was found to consist of a surprisingly diverse group of beetles from many habitats.

CHAPTER 15: Conclusion

15.1 ENTOMOLOGICAL EVIDENCE

The material from sites in Winchester, Southampton and Chichester provided additional data from southern England. The faunas found were broadly similar to those, which had been investigated before from comparable localities and periods. However, some differences were apparent and some of these may be due to the particular features of the towns, and some, may provide evidence of different customs, in the Viking north compared with the Saxon south. For example, the faunal type AS, which appears to be characteristic of a type of cesspit, was found in Saxon Winchester and Southampton. It may reflect differences in sanitary practices, between Saxons and Anglo-Scandinavians.

From Winchester came the earliest medieval occurrences of the synanthropic *Tipnus unicolor* and the grain pests, *Sitophilus granarius*, *Oryzaephilus surinamensis* and *Cryptolestes ferrugineus* for mainland Britain. The earliest recorded occurrence of *Omalium allardi* in this country also comes from that town. Exotic grain pests were found in late medieval Southampton, which probably reflected its status as a busy and wealthy port in the Middle Ages. Similarly, Winchester was an important medieval town. Extensive trade with the Continent makes these towns a likely source of imported beetles.

Dates of introduction and archaeological associations between species can never be confirmed but they will be strengthened by more data. The record is sufficient to provide a workable basis but it is biased towards the north and very patchy (see Chapter 5). The investigation of more medieval deposits, especially from southern England must be a high priority. There ares also, for example, no early medieval data from rural areas.

15.2 EXPERIMENTAL WORK

The experimental work on a cesspit was useful in showing how attractive the pit was to many species and how others discriminated against it. The environmental conditions today are different to those that pertained in the medieval period and the beetle fauna also has changed. Nevertheless these studies were instructive. The choice chamber experiment showed that different species of *Aphodius* beetle have markedly different preferences to different types of pabula. This method could be used further to augment the ecological data, which is often not very detailed or comprehensive. Experiments could be devised to test the theory about ammonia and its role in the development of pit fauna, by examining the reaction of "pit colonising" and synanthropic beetles exposed to that gas. For example, the preferred microenvironment of *Anotylus complanatus* could be examined and this should throw light on the difference between a CAN and AS fauna. Choice chamber experiments could be employed to investigate why *Anobium punctatum* is so common in pit faunas.

15.3 INVESTIGATION OF FEATURES

The decision to combine data from a number of sources to look for associations between species and to relate them to the archaeological data proved to be very successful. The methods used were largely non-standard and many decisions had to be taken in order to achieve results.

15.3.1 CRITIQUE OF METHODS USED IN ANALYSIS

Due to a lack of other material, some small assemblages had to be used in the statistical analysis. Some, originally examined by the EAU, were small due to their policy of only taking 1kg. samples from each context. It was often necessary to combine assemblages from adjacent contexts, as one sample did not contain enough individuals for comparison. In retrospect, this was not a good idea, as these might have been of different faunal types. It was more a matter of luck than judgement that they were not.

CANOCO correspondence analysis proved to be extremely successful in analysing assemblages, particularly because the ordination of species lined up with the ecological evidence. This has not been the experience of a previous worker using DECORANA (Smith 1991). However, the interpretation was not always straightforward and consideration of the source data was necessary. The arrangement of the assemblages on the samples plot did not always correspond to the configuration of species on the species plot. If a species distribution was very unevenly distributed across the assemblages, an occurrence, which was quite rare, then the species plot was not an exact guide to its position. Samples, which had high levels of a taxon, unique to it, produced distorted results, and it would have been better to eliminate those taxa before running the program. However the associations between samples were remarkably robust, removal of specific samples or taxa, such as the grain pests, which were in high numbers, made little difference to the associations. Even through it sometimes altered their orientation about the axes, because the dominant species, used for ordination changed. There was also little noticeable effect on the positioning of samples, with incomplete species data, caused by using only partially quantified data or by poor recovery of specimens. While it was not possible to prove the effect of these limitations, their positions were in the predicted areas. Presumably the stability of the associations was due to the large number of taxa, and therefore the cross connections, between the assemblages.

The combining of taxa, which was necessary to order to run CANOCO, was necessary to reduce the large species lists. This was more successful with the pits investigation. This was due to a far smaller combined list and a greater familiarity with pit faunas, so significant species were less likely to be combined in a less specific group. The formation of many groups, on ecological grounds, meant that details about many species were lost in the feature types investigation. This was unfortunate but seemed inevitable.

Combining taxa into groups, based on ecological considerations, provided some further evidence. There were problems with the system caused by a lack of detailed ecological knowledge and an inability to identify everything to species, so that labels could not always be very informative. In any case, beetles are often not good indicators of habitat but of conditions, which may occur in rather different situations. Thus in retrospect, the use of categories such as "house" and "disturbed ground", is not advisable, because the beetles do not indicate them, but aspects of those environments, which may be found elsewhere. In the light of experience, fewer groups would have been used in the habitat categories. The decomposer group would have not included a "compost" category and the "water" category would have been undivided. This is because few taxa can be definitely placed in these smaller groups, either due to lack of specificity by the beetles themselves or to a lack of ecological knowledge.

The use of two systems, habitat and habit, circumvented these problems to some extent. The habit categories are much less ambiguous and could be extended to include aquatic beetles, for example. Two systems would still be needed particularly for the very important "decomposer" group. They would be difficult to place in a "habit" group due to lack of detailed ecological knowledge. It is not known for example, whether many are detritivores or carnivores. The same applies to other categories, which could be useful in interpretation, such as degree of mobility. Another neglected factor important in interpretation is size. Large beetles tend to be less abundant than small. Kenward's indoor/outdoor category is quite useful, but the "habit" system is more informative.

More work could have been done with CANOCO using different combinations of samples and species. Instead manipulation of the combined list was used. This proved to be an invaluable research tool, as it was a relatively easy matter to combine faunal lists from different samples in various ways and sum the totals of each taxon to see how the numbers of the different species varied across the particular selection. By only considering taxa to be significant, if they were more than twice as common or twice as rare as the others in the group, chance variations hopefully, were eliminated. For a valid result, a reasonably even spread of examples across the groups was also necessary, as is the case with the CANOCO results. This method provided data about low occurrences as well as high, which is not possible with CANOCO.

15.3.2 FURTHER WORK

CANOCO has proved to be a powerful research tool in the interpretation of archaeological beetle assemblages and it could be used more widely. It could be used, for example, to analyse water-bearing features to determine the conditions indicated by the aquatic species, which might have archaeological implications. It would also be possible to construct "templates" from a suitable range of examples to aid interpretation of new assemblages.

The last word should go to Kenward: -

> "The paleoentomology of occupation sites has until now been a largely descriptive and deductive process. However it is now time to move on and attempt meta-synthesis and the development of general theory if the discipline is to increase its relevance to the wider academic world." (Kenward 1997, 146)."