CONTENTS

FIGURES

TABLES

Appendix Tables

ACKNOWLEDGEMENTS

I would like to thank Magdalene College, Cambridge for providing the financial support for my Ph.D. research, from which this book is derived. Likewise I thank the European Commonwealth Trust, the British Institute of Archaeology at Ankara, and the Department of Archaeology, University of Cambridge for financial assistance. I wish to thank my Ph.D. supervisor Charly French. I am indebted to my external advisor Peter Andrews not only for his help with this work but also for igniting and encouraging my interest in microfauna. I am also grateful to John Stewart for all his assistance and advice and to Preston Miracle who acted not only as an advisor, but also as my internal examiner, and who along with my external examiner, Terry O'Connor, provided helpful suggestions for improvements.

I wish to thank Ian Hodder, Louise Martin and Nerissa Russell for entrusting me with the Çatalhöyük microfauna and members of the Çatalhöyük team for help with various aspects of this research. Likewise, I am grateful to Trevor Watkins for allowing me to analyse the Pınarbaşı material and to Douglas Baird for his help, advice and for commenting on parts of this text. Denise Carruthers and Eleni Asouti provided much needed contextual information. I am grateful to the staff at the Karaman Museum for providing access to the Pinarbaşı assemblage and I am indebted to the staff at the Harrison Institute, Sevenoaks and the Mammal Section, Natural History Museum, London for allowing me to use their comparative collections. I would like to thank Jessica Rippengal and David Redhouse for technical assistance and Sam Smith for help with the map. I am grateful to Ron Pinhasi and the late Eitan Tchernov for introducing me to the field of small mammal commensalism . I wish to acknowledge Simon Stoddart and Caroline Malone for all the support they have given me over the years and Steve Mithen for his more recent backing.

I am grateful to my friends from the Grahame Clark Zooarchaeology Laboratory, McDonald Institute, University of Cambridge who brightened up the many hours spent at the microscope. I would also like to thank Jackie and Chris Jones for their support and I also acknowledge the memory of their son Matthew, without whom I would never have become an archaeologist. I am extremely grateful to Georgie Howarth and Lisa Yeomans for reading entire drafts of this book and also to Louise Jones, Darko Maričević, Sandy Pullen, Donna Sharpe and Yvette Wakeman for commenting on various chapters. I thank Harriet Strickland for practical assistance. Finally I wish to thank my family.

1 INTRODUCTION

This book is concerned with exploring the types of information that can be obtained from analysing Neolithic microfaunal assemblages. Microfaunal analysis is frequently conducted on assemblages from caves or rockshelters. Such environments lend themselves to the accumulation of microfaunal assemblages because they are often used by owls as roosting sites or as latrinal areas by small carnivores. Microfauna provide valuable palaeoenvironmental information where macrobotanical remains are scarce or absent and are often used as an environmental proxy because microfaunal communities are more susceptible to environmental fluctuations than macrofaunal communities (Andrews and O'Brien 2000; Avery 1982). Smaller mammal species have less tolerance for temperature change than larger species as they have lower energy reserves, and are relatively inefficient in maintaining their body temperature. Furthermore, microfauna tend to have a shorter life cycle than larger species and are able to evolve as a response to change more quickly (Avery 1982; 1996). Microfauna can provide information about the vegetation, temperature and precipitation and can often provide specific information about the local environment. However, microfauna can be introduced into an archaeological site by a variety of predators that may have been capable of travelling over much greater distances than their prey.

In addition, it is believed that certain microfaunal species can be indicators of sedentism. This is understood here as being a situation where the majority of inhabitants of a settlement occupy it on a permanent basis. In the past, sedentism has been viewed as part of the 'Neolithic package' along with other developments, for example agriculture, pottery and social complexity. However, in more recent times it has become apparent that sedentism is a process that can occur independently of other factors and must be investigated in its own right (Marshall 2006, 153). With the adoption of sedentism, humans greatly altered the local environment, with some microfaunal species successfully exploiting this niche. Commensalism occurs when two species co-exist in the same environment with the first species deriving benefit from the second while the second species experiences neither benefit nor harm. This term is often used to describe the relationship between humans and various animal species, for example house mouse and black rat. It is debatable that humans experience neither benefit nor harm from the commensalism of small mammals and perhaps it would be better to describe them as kleptoparasitic (MacDonald & Fenn 1994, 5). It has been reported that commensal rodents in Turkey decimate 5% to 15% of grains and legumes in

storage and foul much more than they eat (McCormick 2003, 1). Small mammals can also spread disease; for example the black rat was a carrier of fleas which transmitted the Black Death causing devastation and death in Britain from 1348 to 1350 (Gottfried 1983, 36, 77). Rats also spread *trichinosis*, *tularaemia*, and *leptospirosis*, as well as carrying bacteria, viruses, protozoa, fungi, mites, lice and ticks (Sullivan 2005, 11). Mice are not free of disease being carriers of *salmonella* which they often transmit to stored food and livestock (Lund 1994) and rodents can also cause structural damage to buildings (Meyer 1994, 274).

Commensalism is an interesting phenomenon not only because it allows us to see how humans affected their local faunal community but also because it is one of the first instances where we find a mutualistic relationship emerging between humans and other species (Tchernov 1991a, 316). In the case of small mammal commensalism one can see that small mammals have much to gain from sedentism; firstly, it provides them with the opportunity to scavenge food, either from human refuse or from food storage areas; secondly, a humanly constructed habitat provides some protection from predators; and thirdly once successfully adapted to this niche the commensals experience reduced competition from other small mammal species (Tchernov 1991b, 153).

The house mouse (*Mus musculus*) as an indicator of sedentism was first proposed by Hesse (1979) who argued that the increase in house mice in the occupation layers at Tepe Ganj Dareh, Iran, indicates a change from irregular use, with winter abandonment, to continuous, year-round occupation (Hesse 1979). In his seminal study on commensalism, Tchernov (1984) further explored this issue by looking at nine different commensal species: *Mus musculus*, *Rattus rattus* (black rat), *R. norvegicus* (brown rat), *Acomys cahirinus* (Egyptian spiny mouse), *Passer domesticus* (house sparrow), *Columba livia* (rock pigeon), *Canis aureus* (common jackal), *C. lupus* (grey wolf), and *Vulpes vulpes*(red fox). Tchernov (1984) studied their relative frequencies and densities to determine the intensity and duration of occupation of various southwest Asian sites ranging from the Mousterian period to recent times. Despite including nine species in the study he found that the house mouse was the most useful for indentifying sedentism. The results showed that at Eynan-Mallaha and Hayonim Cave the numbers of house mice increased dramatically with the Natufian, leading Tchernov to conclude that this reflected a change to a more sedentary lifestyle (Tchernov 1984). House mice from the Epipalaeolithic levels of Hayonim dated to 11 950 BP, remain the earliest found in the Middle East (Auffray et al 1988). There are records of *Mus macedonicus* (Macedonian mouse), the other species of *Mus* found in this region, in Acheulean levels in several different sites in Israel including Oum Qatafa, Qafzeh, Tabun and Hayonim. Archaeological

findings are supported by biological research which suggests that the house mouse arrived in the Middle East 12 000 years ago (Auffray 1990a, b; Boursot et al 1993; Britton-Davidian 1990; Cucchi et al 2005).

It has been suggested that commensalism arose from competition between species that inhabited overlapping niches (Auffray *et al* 1990b 19). In the case of the house mouse in Anatolia it may have been competition with the Macedonian mouse that was the trigger for the house mouse to adopt commensalism. Prior to this, the house mouse and the Macedonian mouse probably inhabited the same areas. It is likely that the house mouse was a more sociable species than the Macedonian mouse and, as a result, adapted well to living in close proximity to humans (Auffray *et al* 1990b 19; Tchernov 1991a 317).

The microfaunal assemblages from two archaeological sites in south-central Anatolia, Çatalhöyük and Pınarbaşı will be analysed in this book. This will be done partly to aid in the palaeoenvironmental reconstruction by looking at fluctuations in the species present through time but also to assess if sedentism does lead to commensalism and to determine how useful microfauna are for informing about the use of space and in identifying phases of occupation and abandonment. By comparing microfaunal assemblages from these two very different sites, the large Neolithic and permanently occupied site of Çatalhöyük with the smaller more transitory site of Pınarbaşı, we can gain an understanding of how the intensity of occupation and the size of settlement may affect small mammal commensalism. The precise duration and nature of occupation at Pınarbaşı has yet to be established but the structures found demonstrate that occupation was on a much smaller scale than Çatalhöyük. Baird (in press) suggests that there is some evidence that the 11th Millennium Cal BP inhabitants of the open site may have been 'sedentarising' that is in the process of adopting sedentism but not necessarily occupying the site on a year round basis. This theory is based on the floral and faunal remains which suggest occupation during different seasons and with comparisons of the structures and material culture with earlier Natufian settlements. Occupation during the 9th Millennium Cal BP appears to have been seasonal and it has been suggested that 9th Millenium Cal BP Pınarbaşı was a camp site used by mobile hunting and herding groups (Baird in press). This conclusion is based on: the ephemeral nature of the 9th Millennium Cal BP structures, the floral and faunal evidence which indicates that the site was occupied seasonally in this period (in the spring, autumn and late autumn to winter) and the lack of cereals and legumes (Baird in press; Carruthers 2003; 2004). This is further supported by the discovery of perinatal remains and the shed deciduous teeth of lambs suggesting that animals were being kept close to the site. Baird (in press) proposes

that 9th Millennium Cal BP Pınarbaşı may have been repeatedly occupied on a seasonal basis for perhaps hundreds of years (Baird in press).

In contrast to this, it appears that Çatalhöyük was continually occupied by at least some, if not all, members of the community from approximately 9350 to 7950 cal BP (Cessford 2005a). This theory is based on many lines of evidence which point to continuous occupation and even suggest that there were certain seasonal patterns of activity. For example, the mud brick structures at Çatalhöyük were continually re-plastered on an annual basis, probably between May and September (Matthews 2005). Furthermore, the botanical and faunal remains indicate that there were certain seasonal patterns of behaviour that would have required some members of the Çatalhöyük community to have been present throughout the year (Fairbairn *et al* 2005a; Russell and Martin 2005). The crops were sown in the autumn and harvested in the summer with the processing taking place shortly after harvest. These crops would have been weeded in the spring and early summer. The faunal evidence indicates that some of the animals were penned over the colder winter months, whilst others must have been over-wintered some distance away from the site where conditions were drier. Evidence from duck and goose shells suggests that the inhabitants collected these during the spring and early summer, while the discovery of unshed deer antlers indicate that some hunting took place in the late summer to early autumn. It is possible that there may have been periods of short-term mobility by some members of the community for foraging or hunting purposes and that some members may have been shepherds who looked after animals during the winter months (Fairbairn *et al* 2005a). Indeed, Baird (2006; in press) has suggested that Pınarbaşı may have been a camp site used by the people of Çatalhöyük. This is based upon his evidence from the Konya Plain survey which has not found any other substantial settlement in the region, though it is possible that there were groups of nomadic people also occupying the Konya Plain during this period who have not left any structural evidence behind (Baird in press). If commensal species are found at Çatalhöyük and not at Pınarbaşı it will add strength to the argument that commensal species can be indicators of sedentism, an argument that does not convince all researchers (Tangri & Wyncoll 1989; Wyncoll & Tangri 1991; Boyd 2006).

Finally, by comparing the sizes of samples from different contexts this book explores how useful microfauna can be for identifying the use of space, and phases of occupation and abandonment. For instance, are there concentrations of small mammals that derive from predator scats in buildings that could only have accumulated during a period of abandonment? Do we find a greater number of small mammals in and around areas that may have been used for food storage? How well did our

Neolithic ancestors manage pest control and did they use any other mammals to help keep micromammal numbers to a minimum? These are all important questions, particularly in the context of the Neolithic of southwest Asia where we first see the emergence of agriculture and large scale sedentism.

To help realise these objectives, it is necessary to consider past research that has been conducted on related topics. Therefore, Chapter 2 will look at the methodology of using microfauna for environmental reconstruction and provide a review of the literature relating to this topic. Chapter 3 provides an overview of the small mammals likely to be encountered in this research with animals included being based on present day distributions of fauna. Chapter 4 discusses the predators that could have been responsible for the accumulation of the microfaunal assemblages, again based on present day distributions. Chapter 5 gives an overview of the study area and sites and provides information about the history of excavation at the two sites, including the phasing of the archaeological deposits and other contextual information. Chapter 6 discusses the assemblages analysed and gives a description of the methodology used. Chapter 7 is a presentation of the results with Scanning Electron Microscope images (SEM), which illustrate the various taphonomic modifications found on the bones. Chapter 8 is the discussion and interpretation of these results and the final chapter, Chapter 9, provides the conclusions of this analysis. Finally there is a short appendix with tables summarising the results of analyses not included in Chapter 7.

2 PALAEOENVIRONMENTAL RECONSTRUCTION AND TAPHONOMY

INTRODUCTION

Environmental reconstruction is an important aspect of archaeological research and allows archaeologists to gain an understanding of the living conditions that past humans would have experienced. The necessity of studying past environments has long been recognised (Steward 1953, 1955). However, archaeology has evolved greatly since the environmental determinism, conceptualised by J. Steward's 'Cultural Ecology', and it is now understood that humans are not just puppets whose actions are the result of external environmental stimuli, but are conscious actors who have a complex relationship with the environment. Humans both affect and are affected by the environment and therefore an understanding of the environmental conditions prevalent during the time of occupation of a site is essential. Many forms of evidence can be used to reconstruct past environments. These can be divided into three basic categories: (1) sedimentary evidence; (2) plant remains, such as charcoal, seeds, pollen, diatoms and phytoliths; and (3) faunal remains, for example molluscs, insects, macrofauna and microfauna (Evans & O'Connor 1999, 132-147).

TYPES OF ENVIRONMENTAL EVIDENCE

Sediments

Useful information about past climatic and environmental conditions can be derived from sediments. The physical, biological and chemical make-up of sediments can provide information about the environments in which they were formed. Changes in sediment accumulation may be the result of a change in climate and provide a proxy record of climatic change. Furthermore, sediments are a record not just of natural climatic change but also of human-induced changes. However, although sediments are informative on past climatic conditions they are less useful for reconstructing former vegetation (Bell & Walker 1998, 29).

Plant remains

Charcoal can become incorporated into archaeological deposits in a number of ways. Sometimes charcoal samples are the remains of wood that was used to create fires. In other cases, the charcoal is from artefacts or structures that have been burnt at some time in the past. It is usually possible to identify charcoal to genus level and in some instances to species. Charcoal is a useful environmental

indicator because it can provide information about the local vegetation, tree migration rates and the variations in the altitudinal limits of different species of trees (Bell & Walker 1998, 139). However, one must be careful when using charcoal samples to reconstruct past environments, because the wood from which it was derived may have been brought to the site from some distance and may not be a true reflection of the site's immediate vegetation. Furthermore, a charcoal sample may be biased by the selection processes employed by humans (Evans & O' Connor 1999, 139). Charcoal is usually found in very wet or very dry conditions (Bell & Walker 1998, 23).

Seeds can provide information about the local vegetation, the temperature and precipitation, and can be indicators of environmental fluctuations. Seeds are usually identifiable to species level. They can be transported by wind or water, or may have been brought to the site for nutritional or medicinal purposes. If the latter is the case, the seeds may not be a true reflection of the local environment but could have been brought in from some distance. As with charcoal, seeds survive best in water-logged or desiccated conditions (Bell & Walker 1998, 23-24).

Pollen is produced by all spermatophyte plants in varying amounts (Evans & O'Connor 1999, 134). Pollen analysis involves the study of the exines of the pollen which have a particular shape and pattern; this allows them to be identified quite accurately to species or genus level. Pollen can be brought to a site by wind, water, insects or animals and can be transported over a distance of many kilometres (Evans & O'Connor 1999, 134). Although pollen is a valuable environmental indicator, providing information about vegetational history and environmental change, it is likely that this may be of a regional rather than a local nature. In addition, the abundance of different species of pollen is directly relational to the rate of pollen production by the various plant species and may reflect the proliferation rather than the abundance of a plant species (Evans & O'Connor 1999, 70-71). Pollen survives best in anaerobic conditions such as peat bogs and lake sediments (Bell & Walker 1998, 26).

Diatoms are microscopic unicellular algae that have cell walls of silica instead of cellulose that are known as frustules. These frustules survive long after the algae die and are distinctive enough in shape and ornamentation to allow them to be identified to species or genus level. Diatoms usually have a narrow habitat requirement and live in lakes, ponds, estuaries, and the sea and their remains are found in many aqueous sediments (Evans & O'Connor 1999, 136). A diatom assemblage can provide information about: the floristic composition of the body of water from which they are derived; the water's alkalinity and nutrient status; lake water levels; climate change; and human

activity around water edges (Bell & Walker 1998, 28). The main disadvantage with diatom analysis is that it is limited to sites that are located close to bodies of water.

Phytoliths are microscopic bodies of opaline silica that are formed in and around plant cells. They are extremely durable and in pH values of eight or less are insoluble. The silica bodies form precise replicas of the cells in which they are formed and can be found both in isolation as *single-cells* and conjoined as *multi-cells.* Single-cells frequently provide information about which parts of the plants are represented and are therefore used as evidence for crop-processing and seasonality (Rosen 1999, Fuller & Harvey 2005). As well as being informative about plant parts, multi-cells can sometimes be identified to genus level providing valuable taxonomic information. Furthermore, it has been demonstrated that large multi-celled phytoliths which are composed of more than 100 single cells conjoined (often known as silica skeletons) can be indicators of irrigation (Rosen & Weiner 1994).

In addition to the single cell/multi-cell division there is also a clear morphological distinction between phytoliths formed in monocotyledons (monocots) and those formed in dicotyledons (dicots). Monocotyledons are a group of plants, which include grasses, whose seed has the embryo of one flowering leaf, whereas dicotyledons (typically consisting of 'woody' types such as shrubs and trees) have the embryos of two flowering leaves. Phytoliths can be further classified into a range of morphological categories for both monocots and dicots. The main disadvantage of using phytoliths for palaeoenvironmental reconstruction is that most forms are not usually taxonomically identifiable, with only multi-celled forms being identifiable to genus level. In addition, many species do not produce phytoliths making any reconstruction based on phytoliths alone limited.

Faunal remains

Mollusc shells are often found preserved in alkaline deposits. Land molluscs are easily identifiable to genus or species level and provide information about the local environment. Temperature and rainfall are thought to be the dominant factors to which they respond, although they are also responsive to changes in vegetation cover. The rate of response to environmental change is species dependent and some species can have a wide tolerance range and their response to environmental change can be slow. Another problem with molluscs is that they do not survive well in acidic deposits (Preece 1986).

Insect remains are often found in water-logged deposits and it is possible to use them as indicators of climate and in some cases of vegetation. Although some insect species can be specific in their environmental preferences it is more reliable to use an array of species for reconstruction. Generally

insects reflect the microclimate of the region and will usually respond quickly to any environmental change. Beetles are good environmental indictors and the head, thorax and wing cases of these creatures can be well preserved. On the basis of these parts, it is possible for a specialist to ascertain the family, genus or even the species of the beetle. Beetles are sensitive to temperature and are therefore good indicators of past climatic conditions (Evans & O'Connor 1999, 140-141). The main problem with using insects to reconstruct the past environment is that they provide little information about the vegetation and are usually only found in wetland environments (Evans & O'Connor 1999, 80).

Macrofauna are frequently found in archaeological sites and survive well in a wide range of deposits. Macrofauna can be used to reconstruct the environment by determining: the presence/absence of animals with well-understood ecologies; the abundance and diversity of the various species within the samples; the body size; and the morphology of the animals (Davis 1997, 61). There are two main problems with the use of macrofauna as an environmental indicator. The first is that larger animals are not particularly sensitive to environmental change, and the second is that the assemblage may be biased by human procurement strategies.

Fish remains provide evidence about local ecological conditions because fish have specific habitat preferences and provide information about the type of water source exploited in the past. For example, some fish favour fast-flowing well oxygenated streams whereas others prefer still, poorly oxygenated water. Fish also provide important information about trade and economy at a site. However, fish do not provide much information about past vegetation (Wheeler & Jones 1989: 10-11).

Microfauna can be a useful form of environmental evidence because their bones are able to survive in a wide range of deposits and they are more sensitive to environmental oscillations than larger animals (Andrews & O'Brien 2000). In this work, small mammals and anurens up to the size of, and including, weasels were considered as microfauna whereas larger species were defined as macrofauna. Fish were not included in this analysis. As stated in Chapter 1, microfauna can be introduced into a site by a predator that may have been capable of travelling over much greater distances than their prey. As a result, any environmental reconstruction should be accompanied by a taphonomic analysis to ensure that the history of the assemblage is understood and that any possible biases are accounted for. Microfauna as a form of environmental evidence are frequently used in the fields of palaeoecology and palaeontology and have proved to be a useful tool for the archaeologist.

Taxonomic analysis is largely based on analogy and assumes that the environmental preferences of the species found in the archaeological assemblage were the same in the past as they are in the present. This can be problematic, particularly in older sites, where the animals found in the assemblage are now extinct. In these cases the analogy is stretched by assuming that the environmental preferences of the extinct species were the same as those of its closest modern relation. This is a problem for palaeontologists and for archaeologists working on Palaeolithic sites due to the greater time depth involved (Avery 1982).

TAPHONOMY

Environmental reconstruction must consider the taphonomic history of the assemblage. The term *taphonomy* is derived from the Greek words *taphos,* meaning burial and *nomos* meaning laws and was first introduced by the Russian Palaeontologist Efremov (1940, 81-93). Taphonomy is an important consideration for archaeologists, particularly zooarchaeologists and palaeobotanists, because it aims to gain an understanding of the processes that have affected biological remains from the time of death to the point of analysis (Lyman 1994, 1). Taphonomy is frequently considered in two parts: the first *biostratinomy* considers the processes that have affected the organic remains from death to burial; the second *diagenesis* is concerned with the processes which have affected the remains from burial to recovery (Lawrence 1979a, 1979b).The analytical theory behind taphonomy is known as *uniformitarianism*, a theory that was largely popularised by Charles Lyell (Lyell 1834). This assumes that the natural laws are both temporally and spatially invariable and that the forces we see acting on properties in the present would have been identical to those in the past.

MICROFAUNAL TAPHONOMY

Causes of death and their taphonomic significance

Pit falls

Accumulations of microfauna are not usually the result of death from illness but are more likely to represent death by accident or predation. Pit falls are one way in which a number of individuals may meet an accidental death. These can range from simple holes and pits in the ground to specifically constructed pits that are well camouflaged and from which it is hard for the animal to escape. Pit falls tend to be more treacherous for insectivores than rodents because insectivores have poor eyesight and frequently do not see them. In addition, pit falls are also effective in capturing invertebrates such as beetles which attract insectivores. Pit falls are more effective at trapping less agile small mammals that are not able to jump or climb out (Gilbert & Allwine, 1991, 270).

Older animals are less likely to fall into pit falls than younger animals, suggesting that immaturity makes capture more likely (Andrzejewski & Rajska, 1972). Rackham (1982) observed that the type of species falling into a pit fall trap is determined by the vegetation immediately surrounding the trap and believes this explains the absence of bank voles from two archaeological sites in England, Whitton and Droitwich. In this instance the pit fall traps were wells, and the vegetation surrounding them was open. Rackham (1982) suggests that it is the reluctance of the bank voles to cross open ground that may explain their absence in these features (Rackham 1982, 91). It would appear that man-made features frequently act as pit falls in urban sites. Armitage (1985) discusses how pits, drains and wells acted as pit falls in the late fifteenth century site of Greyfriars (Armitage 1985, 69).

Researchers from the Pacific Northwest Research station, USDA Forest Service, USA, conducted a series of pit fall trapping experiments to sample small mammals in the coastal ranges of Oregon, USA, in 1984 and 1985. The pit fall traps constructed for this purpose were elaborate and were made from cans, buried in the ground, with a short plastic funnel nested in the top of the trap. These were then disguised with vegetation cover. In total thirty-six pit fall traps were installed fifteen metres apart on a square grid. Trapping took place for fifty days in 1984 and thirty days in 1985 and began in the first week of October (Corn & Bury 1991, 242). In 1984, 1514 individuals were caught and in 1985, 1533 making a total of 3047 individuals over the two year period. These individuals represented twenty different species of small mammals. Insectivores were the most common type of small mammal captured, with a total of 2217 individuals, and comprising 73% of the total number. Of this group, by far the most abundant species caught was the Trowbridge's shrew, with 1690 individuals, comprising 49% of the total caught. Rodents made up 27% of the total with 824 individuals and there were six ermine, making 0.2 % of the total (Corn & Bury 1991, 244).

Death by Drowning

When small animals fall into pit falls they sometimes die by drowning in water that has accumulated in the bottom. However, death by drowning can occur in other circumstances. For example, small burrowing animals can find themselves the victims of a flood and it is not unheard of for small animals to become trapped in their nests through other catastrophes, such as minor landslides. Hibernation and aestivation deaths also occur but in all of these situations the microfaunal assemblages produced are usually small (Andrews 1990, 3-4).

Death by Predation

Frequently, accumulations of microfauna are the result of predator activity. Predators of small animals are owls, diurnal birds of prey or small mammalian carnivores, although humans also eat

small animals (Brothwell & Jones, 1978). When microfaunal remains accumulate as a result of predation the assemblages can be large. This is because, in the case of owls or diurnal birds of prey, the microfaunal remains accumulate under nest and roost sites where they have been ejected in pellet form. Owls and diurnal birds of prey swallow their prey whole and later regurgitate the unwanted parts in pellet form. These pellets consist of the fur, feathers and skeletal remains of the prey and an owl usually regurgitates about one to two pellets every twenty-four hours (Burton 1992). These pellets can be comprised of 40% to 50% bone, much of which consists of complete skeletal elements making them an excellent source of microfauna (Andrews 1990, 26). Diurnal raptors such as buzzards, kestrels and peregrines also produce pellets but these contain less bone than those produced by owls. Sometimes, pellets produced by diurnal raptors will contain as little as 5% to 10% bone. This is partly due to the higher levels of acidity in the gastric juices of the diurnal raptor but also because, unlike owls, diurnal raptors rarely swallow their prey whole. The fact that diurnal raptors tear apart their prey causes high levels of breakage, some loss of bone, and increases the surface area of the bone making it more susceptible to digestion (Andrews 1990, 26).

Many methods are used to assist in determining the predator responsible for accumulating microfaunal assemblages. Digestion is the most useful and can be seen in the form of acid etching on the teeth or bone. This is apparent on the enamel of the tooth, and, in more extreme cases, the dentine. The tips of the incisors are particularly vulnerable to digestion and the enamel is sometimes completely corroded in this area. Incisors are the best indicators of digestion because although there is some inter-species variation in their morphology, it is less pronounced than in molars. Molars are slightly more problematic because the design of microtine or arvicoline (vole) molars makes them more susceptible to digestion than those of murids (mouse, rat, and gerbil). Similarly, the digestion of the dentition of soricids (shrews) is difficult to compare to that of murids or microtines (Andrews 1990; Williams 2001, 2005). This makes inter species comparison difficult when based on the digestion levels of molars alone. Post-cranial elements can be useful in determining the level of digestion and this takes the form of a distinctive pitting of the bone surface and rounding of broken edges (Andrews 1990, Williams 2001, 2005).

Research into the effects that predators' stomach acid has on the remains of prey was conducted as early as the 1970s (Mayhew 1977; Korth 1979). Andrews explored the signatures that different taphonomic processes and agents have on small mammal assemblages in his book *Owls, Cave and Fossils* (1990). In this work he studied a great number of pellets from birds of prey and scats from small mammalian carnivores. He found digestion to be one of the most useful ways of determining the predator because it is not emulated by other taphonomic effects. Andrews categorised digestion

levels as: light, moderate, heavy or extreme and based these levels on the percentage of elements with evidence of digestive corrosion in the assemblage as a whole. He discovered that owls, particularly the barn owl, tended to cause the least digestion to their prey whereas small carnivores could cause extreme damage (see Andrews 1990, 89). Fernandez-Jalvo and Andrews (1992) made some modification to this system in their work on the Olduvai microfauna. They created levels of digestion for teeth based on the extent to which each element was corroded. These levels ranged from light to extreme for both the incisors and the molars (Fernandez-Jalvo and Andrews 1992).

Breakage can aid in determining the predator. The level of breakage caused by the various predators is dependent upon the ingestion, mastication and digestion methods of that particular animal and modern pellet studies have shown that different predators produce different breakage patterns (Andrews 1990). Unfortunately, breakage is not as reliable as digestion in identifying the predator because there are other taphonomic processes that can lead to the breakage of bone assemblages (Andrews 1990, 64).

Another method sometimes used to identify the predator is skeletal element representation. This involves calculating the proportion of elements present in relation to the number of elements expected in the assemblage based on the MNI (**M**inimum **N**umber of **I**ndividuals). Again, this is not as reliable as digestion for identifying the predator because many taphonomic factors can affect skeletal element representation (Dodson & Wexlar 1979, 280; Kusmer 1986, 20).

Finally, the species composition of an assemblage can be indicative of the predator. Modern owl studies have demonstrated that owls will favour certain prey species and this may vary from one species of owl to another (Burton 1992). This may represent the different hunting techniques and habits of the owl, or more particular dietary preferences. Frequently, owls are seen to prefer voles and murids to other prey items and the preferred prey of the predators found in the study area will be discussed in more detail in Chapter 3. However, species composition alone can be problematic as there are examples of owls taking advantage of a situation where a particular prey species is common, leading to owls hunting prey not normally found to be abundant in their diet. One study has shown an example of a Eurasian eagle owl in Switzerland that learnt to specialise in hunting frogs, with a total of 2937 bones of frogs being found in its pellets. The abundance of prey in an owl's diet can vary seasonally, for example, one study conducted in East Asia showed that the pellets of a Eurasian eagle owl consisted of 30% bat during the period when bats migrated through its territory (Fogden 1992, 66). Similarly, a study conducted by Saavedra and Simonetti (1998) compared two barn owl assemblages one from Chile and one from North America, and found that

the species taken by the two barn owls varied considerably (Saavedra & Simonetti 1998). Therefore, changes in the species composition of an owl assemblage may not necessarily reflect environmental change. Small mammalian carnivore assemblages often comprise a greater array of species than do those of owls because they are generally less selective predators. However, this varies between species of carnivores.

It is important to determine the mode of death of the animals represented in the faunal assemblage under consideration because predation can lead to biases within the assemblage. These biases are introduced for a number of reasons. Firstly, predators tend to have particular hunting habits and prey preferences that lead to only aspects of the microfaunal community being selected, with the type of prey taken perhaps varying with the season, location, or from one year to the next. Secondly, the hunting range of the predator can vary dramatically between predators and so the assemblage may not reflect the immediate environs of a site but could, in fact, represent a much wider geographical area. Thirdly, it has been demonstrated that predators can cause significant amounts of breakage and digestion to the skeletal elements of their prey that can cause problems with the identification of prey to species level (Andrews 1990, 26).

Mellett (1974) believed that most microvertebrate fossil assemblages had first passed through the digestive tract of some kind of predator and felt that an environmental reconstruction based on small mammals from a predator assemblage was of little or no value (Mellett 1974, 349-350). However, if the predator responsible for the accumulation can be identified then this bias can allowed for in the subsequent reconstruction. Taking into consideration the habits and behaviour of the predator (for example whether the predator is nocturnal or diurnal), the hunting techniques and selectivity of prey, and the territoriality of the predator, can all assist in alleviating possible biases from the reconstruction (Andrews & Nesbit Evans 1983).

Modifications occurring from death to burial

Decay and Scavenging

Decay can set in quickly after death, particularly in warm climates and this process is accelerated by the scavenging activities of insects. This was demonstrated by Payne (1965) who conducted an experiment where the decomposition of a piglet protected from insects was compared to one that was not protected. This experiment showed that the pig which was protected from insects decayed slowly and still retained its form after a matter of months, while the unprotected pig was largely decomposed after six days (Payne 1965, 592). These findings are supported by the work of Nabaglo (1973) who found that a vole took anything from ten days to approximately three and a half months

to decompose depending on the temperature and level of insect activity (Nabaglo 1973, 254-261). Andrews (1990) conducted experiments in Wales and found that the decay process does not cause significant modification to bones (Andrews 1990, 5).

Harvester ants (*Messor barbarus)* are capable of accumulating large numbers of small vertebrate bones. Shipman and Walker (1980) excavated an ant hill and discovered 1167 bones derived from at least nine different species of small vertebrate. These species included: pygmy mouse *(Mus minutoides);* grey-bellied pygmy mouse *(Mus triton);* unstriped grass rat *(Arvicanthus niloticus);* narrow footed thicket rat *(Thamnomys [Grammomys] dolichurus);* a species of white-toothed shrew (*Crocidura);* a lizard and at least two different species of bird. This comprises approximately two-thirds of the species of small mammals that weigh less than 120 grams which were thought to inhabit the study area (Shipman and Walker 1980).

Dodson (1973) conducted experiments to investigate the time it took a mouse, a frog and a toad to decompose in water. A difference was noticed in the rate of deterioration between the mouse and the frog and toad in the initial stages of decomposition. Whereas the muscle of the frog and toad took ten days to decompose, and the skin twenty-one days, the mouse muscle took eighteen days and after seventy-seven days the skin of the mouse experienced no obvious signs of deterioration (Dodson 1973, 15-16). Generally, it would appear that carrion deposited in water took longer to decay than carrion exposed to non-aquatic insects.

A small mammal left unprotected for any length of time is likely to become the focus of scavengers and it can be difficult to distinguish between predation and scavenging (Andrews 1990, 6). Small animals can be opportunistic and feast on the remains of animals that they would never be capable of predating. For example, shrews frequently scavenge the carcasses of much larger animals if given the chance. Andrews observed this when trapping small mammals that had infested his attic. A vole had become caught in a trap and had been scavenged whilst still in the trap. The small gnaw and tooth marks suggested that the scavenger was a shrew (Andrews 1990, 6; Peter Andrews pers. comm. 2002).

Transport

Scavengers and predators frequently transport bodies, or parts of bodies, of the animals they wish to consume to more convenient locations for consumption. Research has shown that spotted hyenas regularly remove bones from sites and that their choice is entirely dependent upon bone size and nutritional value (Blumenschine 1988, Blumenschine & Selvaggio 1991, Marean & Spencer 1991).

Voorhies (1969) and Dodson (1973) demonstrated that water movement leads to the transportation and dispersal of small animal remains. Voorhies conducted his experiments using dog and sheep bones whilst Dodson used those of a mouse and a frog. Voorhies found that the vertebra, rib, sacrum and scapula were the most susceptible to dispersal (Voorhies 1969, 69), whereas Dodson found that the thoracic vertebra and maxilla, closely followed by the pelvis and the rest of the vertebral column, were most easily transported by water (Dodson 1973, 19). Dodson observed that only a low velocity of water was needed to move bones and that they could be widely dispersed by both sporadic and continuous water flow (Dodson 1973, 17). Korth (1979) conducted similar experiments to those of Voorhies and Dodson but his findings were somewhat different. In his experiments Korth (1979) used the bones of a shrew, a mouse, a rabbit, a racoon, a sheep and a horse. He found that the rib was the most susceptible to water transport followed by the atlas, the radius, the ulna and the pelvis (Korth 1979, 255).

Andrews (1990) observed the effects of water transportation on the scats of a bat-eared fox in Kenya. The scats were deposited at the top of a hill with a steam running from it. As the scats disintegrated some of the bones were washed down-stream. Andrews noted distinct differences in the bones that were washed down-stream and those that were not. The bones that remained at the top of the hill and were least susceptible to water transportation were mainly teeth and mandibular fragments whereas those that were most likely to be washed down-stream were vertebrae (Andrews 1990, 17). A similar phenomenon was observed with scats from the white-tailed mongoose. These scats were deposited in water and the number of isolated teeth and jaws was low compared to the number of vertebrae, pelves and scapulae (Andrews 1990, 17). These experiments suggest that there is a relationship between the shape and degree of surface area of the bone and its susceptibility to transportation by water.

Pinto Llona and Andrews (1999) investigated the effects of water transportation on amphibian bones. In this experiment the bones were placed in a rotary tumbler to simulate the action of naturally free-flowing water. Two sets of bones were used: complete bones, and fractured bones. The latter were included in order to assess the effects of fluvial action on the fractures (Pinto Llona & Andrews 1999, 419-420). It was noted that the primary modification observable on the bones was abrasion in the form of rounding and polishing of the bone surface, particularly on prominent ridges and the surface of pre-existing fractures (Pinto Llona & Andrews 1999, 422).

Weathering

Marti (1974) conducted a weathering experiment exposing owl pellets to the natural environment of Colorado. He found that after two months some of them had totally disintegrated and after ten months only a few bones remained (Marti 1974). Andrews (1990) undertook a similar experiment with two barn owl pellet assemblages which he left exposed in Wales for five years. One pellet assemblage was left on a dry ledge next to a south-facing wall and after two years they were still largely intact. In contrast to this, the second pellet assemblage was left in a damper environment and after ten months no trace could be found of either the pellets or the small mammal bones (Andrews 1990, 10).

However, analysis of a barn owl assemblage from Pınarbaşı, south-central Anatolia, illustrated that it is possible for bones to be weathered whilst still encased in the pellet. In this assemblage bones were found with surface flaking and damage indicative of weathering (pers. observation). Unfortunately, it is not known how much time had passed between these pellets being deposited by the owl and their collection.

Andrews recorded the effects of weathering on bones over a five year period. These five years were split into four different stages based on those of Behrensmeyer (1978): *stage zero*, zero to two years; *stage one*, one to five years; *stage two*, three to five years plus; *stage 3*, four to five years plus. During stage zero, no modification was visible on the bones. In stage one, slight splitting of the bone parallel to the fibre structure was observed, and there was some chipping of the teeth and splitting of the tooth dentine. Stage two showed more extensive splitting of bone but little flaking and splitting of teeth which in some instances led to the loss of parts of the crown. In the final stage, there was deep splitting of the bone that resulted in the loss of the surface bone between the splits. There was also extensive splitting of the teeth (Andrews 1990, 11).

Pinto Llona and Andrews (1999) looked at the effects of weathering on amphibian bones from Dolina, Atapuerca. The experiments were conducted using amphibian bone from barn owl pellets and the bones were exposed for a period of eighteen months. The experiment took place in Tarragona, Spain and two sets of bones were exposed. The first set was exposed to the south and the second set to the north. The south facing bones split longitudinally and experienced some slight surface erosion. The north facing bones appeared less affected and there was no splitting of the long bones, although SEM analysis showed that some micro-flaking of the bone surface had occurred (Pinto Llona & Andrews 1999, 422).

Trampling

Trampling by birds, larger animals or humans can cause severe breakage of microfaunal assemblages. This can be minimised to some degree if the bones are protected within an owl pellet. Andrews demonstrated this in an experiment conducted to determine the effects of trampling by large animals on owl pellets. His results showed that fresh and moist pellets broke down more quickly than older and dryer pellets and that isolated bones (rather than those protected in the pellet), particularly cranial elements such as skulls and mandibles, were easily broken (Andrews 1990, 8).

Modifications occurring during burial and recovery

After burial, bones can experience modifications due to the pH range of the soil in which they are buried. Acid environments can cause etching on tooth enamel and in more extreme cases can also lead to etching of the dentine. Fortunately, this tends to be distinct from digestion which occurs in specific areas of the element and has a unique pattern. Highly alkaline environments also cause modifications to elements, although this is normally found on the bone and dentine rather than on the enamel (Fernandez-Jalvo & Andrews 1992, 411).

Bones can be vulnerable to root etching, where the patterns of the living plant roots are visible on the surface of the bone. There has been some disagreement as to the exact cause of root etching, with some researchers arguing that it is the fungi associated with the roots that causes it rather than the roots themselves. However, this debate does not affect the identification of these marks by the analyst (Morlan 1980, 56-57; Grayson 1988, 30).

The recovery process can greatly modify the overall faunal assemblage. This is particularly true for microfaunal remains which are so small they are often hard to locate with the naked eye. Therefore, unless some form of screening process is practised microfaunal remains will not usually be recovered. However, the screening process needs to be carefully considered because the excavator must ensure that the minimum mesh size used is small enough to recover elements such as isolated teeth, which are particularly important for species identification. Usually a mesh size of 500 microns is the minimum that should be used to ensure that even the smallest elements are recovered. However, despite the necessity of using some form of screening process to recover microfaunal remains, some damage is usually caused to the bones during this procedure. Wet sieving is less destructive than dry sieving, although this partly depends on the scale to which each is undertaken. Even after recovery an assemblage is not free from modification and can be altered

by the sampling and sorting procedures employed by the individual researcher and subsequent storage and conservation (Andrews 1990, 3).

MICROFAUNA AS A PALEOENVIRONMENTAL INDICATOR

The use of microfauna for palaeoenvironmental reconstruction from sites in southwest Asia is limited. Tchernov (1968, 1984, 1991a, 1991b) studied microfaunal assemblages from many sites but his work tended to focus on the cultural implications of species rather than on palaeoenvironmental reconstruction. In this section there will be a discussion of some of the key research which influenced and shaped the development of a methodology for the use of microfauna as a palaeoenvironmental proxy.

Andrews *et al* (1979) used ecological diversity to demonstrate that habitat types can be determined on the basis of their mammal community structure in East Africa. They studied twenty-three modern mammalian communities using the following criteria: species diversity, size, locomotor zonal adaptation, and feeding adaptation (Andrews *et al* 1979, 177). Their analysis showed that it was possible to differentiate between five habitats: lowland forest, montane forest, woodland-bush, flood plain and short grass plains (Andrews *et al* 1979, 177). They then applied this methodology to fossil faunas from: 1) the early Miocene locality of Songhor, Kenya; 2) the middle Miocene locality of Fort Ternan, Kenya; and 3) the Pleistocene deposits from bed 1 Olduvai Gorge, Tanzania. Their results suggested that the past habitat of these three sites is similar to that found at present with Songhor occupying a lowland forest, Fort Ternan a woodland-bushland region, and Olduvai a woodland-grassland environement (Andrews *et al* 1979, 201). Andrews (1983) subsequently re-interpreted the small mammal assemblage from Olduvai Gorge, Tanzania taking into account the possible agent of accumulation. His analysis demonstrated that the assemblage was accumulated by an unknown small mammalian carnivore, leading to an under-representation in rodent diversity, especially murids. Andrews (1983) suggested that the environment at Olduvai was not, as he previously thought, woodland-grassland but would have been wetter with denser woodland (Andrews 1983, 83-84).

Similar methods were developed to reconstruct the environment from small mammal faunas with the focus being on species diversity and size diversity. Species diversity has two components, species richness and species abundance or equability. Species richness can be determined either by calculating the number of species in different groups of fauna or habitats or by using a species diversity index which allows for sample size (Andrews 1995, 63; Andrews & O'Brien 2000). Size diversity has also been used as a palaeoenvironmental indicator. Perhaps the best known example of

this is the Bergman Rule which states that species living in colder climates are more likely to have a greater body mass than their counterparts living in warmer climates (Kurtén, 1973).

Avery uses the Shannon-Wiener index, which takes into account both the numbers of species represented in a sample and the degree to which they are represented (Avery 1982, 237). The general principle behind this index is that a harsh environment will lead to a community dominated by a small number of species, whereas a more equable environment will give rise to a community that has a greater total number of species, none of which is dominant (Fleming 1973). Generally, woodlands have a greater diversity of species than grasslands but grasslands have more individuals per species (Andrews & Nesbit Evans 1983). Avery (1982) includes individual size diversity in her analysis and found that individuals of *Crocidura flavescens* (Greater red musk shrew) had a greater overall body mass in the Upper Pleistocene than in the relatively warmer Holocene and that a trend towards a smaller body mass was apparent from 14 000 BP onwards (Avery 1982, 280-281). However, the reverse was found to be true with the species *Myosorex varius* (Forest shrew) and *Aethomys namaquensis* (Namaqua rock rat) both of which demonstrated a negative response to the Bergman Rule and were generally larger in the Holocene than in the Upper Pleistocene (Avery 1982, 294). The remaining two species included in this analysis, *Tatera afra* (Cape gerbil) and *Cryptomys hottentotus* (African mole rat), either displayed no evidence of change as a result of environmental fluctuation or the evidence for change was ambiguous (Avery 1982, 277-307). A similar approach was used by Tchernov (1968), who, in his study of Israeli faunas, found that *Spalax ehrenbergi* (Middle East blind mole rat) experienced an increase in body mass as a result of an increase in rainfall (Tchernov 1968, 39).

Avery (1982) used microfauna to reconstruct the late Quaternary environment in the Southern Cape province, South Africa. In this study, micromammalian assemblages from five sites were analysed, Boomplaas A, Byneskranskop 1, Die Kelders 1, Klasies River Mouth 1A and Nelson Bay Cave. In addition, Avery analysed modern microfauna to establish if the microfaunal community had altered since the latest layers of the sites, approximately 2000 years ago (Avery 1982, 185). Avery found that microfauna provided detailed information about the natural environment. The species composition of the small mammal community was informative about vegetation change whilst climatic changes where apparent from the fluctuations found in the mean size of the individual in different populations both geographically and temporally.

Avery has continued to work in this field and has used microfaunal analysis to reconstruct Pleistocene and Holocene environments in South and central Africa (Avery 1990, 1991, 1996,

2000). Her approach has remained similar to that outlined above. However, Avery no longer considers the mean size of individual in such detail and instead uses this to determine the openness of the vegetation (Avery 1992, 1996). No reference is made to the use of an intra-species change in mean size as a direct result of environmental change. Despite the excellent work Avery conducts in this field, her reconstructions are limited by her lack of consideration of the taphonomic histories of her assemblages, beyond stating that an unknown predator probably accumulated them (Avery 1992, 1996).

Valverde (1964, 1967) pioneered the use of cenograms, another form of environmental reconstruction which is dependent upon size, which was subsequently developed by Legendre (1986, 1989). A cenogram is a graphical representation of the body size distribution and involves plotting the logarithm of the mean body weight of each species on the *y* axis against the classification by decreasing size on the *x* axis. The weight of the fauna is assessed by measuring the first molar (M_1) of each animal and using an allometric relation between the surface area of the tooth and the weight of the animal (Montuire 1999, 129). Legendre (1989) established four different types of environment: humid, arid, closed and open. In a closed environment, the distribution of species is continuous, whereas in an open environment the medium weight species (500 grams to eight kilograms) are less common or even completely absent. In a humid climate, the large species (plus eight kilograms) are plentiful, whilst in arid conditions they are rare (Montuire 1999, 129).

Andrews (1990, 1995) reconstructed the palaeoenvironment for the Pleistocene cave site of Westbury, taking into account the taphonomic bias caused by the agent of accumulation. Andrews found that in the depositional sequence excavated, at least six different predators had accumulated the small mammal assemblages. Andrews (1990) identified that the bottom layer in the sequence was a warm, temperate fauna, which underlay an assemblage that was taphonomically different but was similar ecologically. Above this, were two layers with fauna representative of a colder climate, whilst succeeding this were two more layers with temperate fauna. The most recent layer appeared to be even colder than the cold layers that had preceded it. Andrews argues that this pattern of warm-cold, warm-very cold is supported by other environmental evidence for the last stages of the Cromerian interglacial (Andrews 1990, 1995).

Fernandez-Jalvo and Andrews (1992) use the methodology of Andrews (1990), to help reconstruct the environment of La Trinchera, a cave sequence in Atapuerca, Spain. Fernandez-Jalvo and Andrews (1992) studied the micromammalian remains from the Gran Dolina site and identified the taphonomic processes which they had undergone. Their results demonstrated that at least three

different species of owl had been responsible for the accumulation of the assemblages through time. This was important for the environmental reconstruction because one of the stratigraphic layers showed a lower diversity of species than the other layers. The taphonomic analysis demonstrated that this was attributable to predation by the long eared owl, which is a highly selective predator and was not a result of environmental change (Fernandez-Jalvo & Andrews 1992).

Fernandez-Jalvo (1995) also analysed the small mammals from another part of La Trinchera, the Penal site. A connection had been proposed between Gran Dolina and Penal due to the similarities in sediment between the two sites (Fernandez-Jalvo 1995, 170). The taphonomic analysis suggested that there had been no direct connection between these two sites in the past. The diversity of small mammals from both the Dolina and the Penal sequence suggested that deciduous woodland was the primary habitat during the time of occupation (Fernandez-Jalvo 1995, 193).

Kersten (1992) re-examined the microfauna from the Palaeolithic rockshelter of Ksar 'Akil, Lebanon in order to reconstruct the local environment. This proved problematic due to the small assemblage size resulting from taphonomic processes such as water movement and limited sampling. However, despite the small assemblage size, a wide array of species was found and Kersten (1992) was able to determine that the assemblage from the Mousterian levels of the rock shelter was probably accumulated by a barn owl or a long-eared owl and suggested that the environment was damper and more wooded than at present. The earlier deposits proved less informative and did not aid in reconstructing the environment for this time (Kersten 1992).

SUMMARY

This chapter has given a review of how environmental proxies and demonstrated how microfauna can be used for palaeoenvironmental reconstruction. It has been illustrated that without a taphonomic analysis reconstruction may be unreliable and that various taphonomic agents and processes may cause a microfaunal assemblage to be biased or modified. Chapter 4 will take a more in depth look at the various predators that could be responsible for accumulating the microfaunal assemblages from Çatalhöyük and Pınarbaşı and the effects that their hunting practices and consumption methods may have on the microfaunal assemblages.

5 THE STUDY AREA AND ARCHAEOLOGICAL BACKGROUND

THE STUDY REGION

Çatalhöyük and Pınarbaşı lie in the Konya Plain, in the southern range of the Central Anatolian Plateau, which is at an elevation of *c*. 1000 metres above sea level (masl) and has an area of 10 000 kilometres squared. It is bordered by the Taurus Mountains to the south and by the Anatolides in the south and west (Driessen & de Meester 1969, 5). In the east, the plain narrows and is known as the Ereğli Basin. The city of Konya lies in the western part of the plain which is rectilinear and extends approximately fifty kilometres toward the east from the city of Konya (De Ridder 1965, 226). Continental climatic conditions prevail with average temperatures ranging from minus two degrees celsius in winter to twenty-four degrees celcius in summer. Annual precipitation is around 250 millimetres to 300 millimetres (van Zeist & Bottema 1991, 20), 30% of which falls in the spring (Kuzucuoglu *et al* 1998, 260).

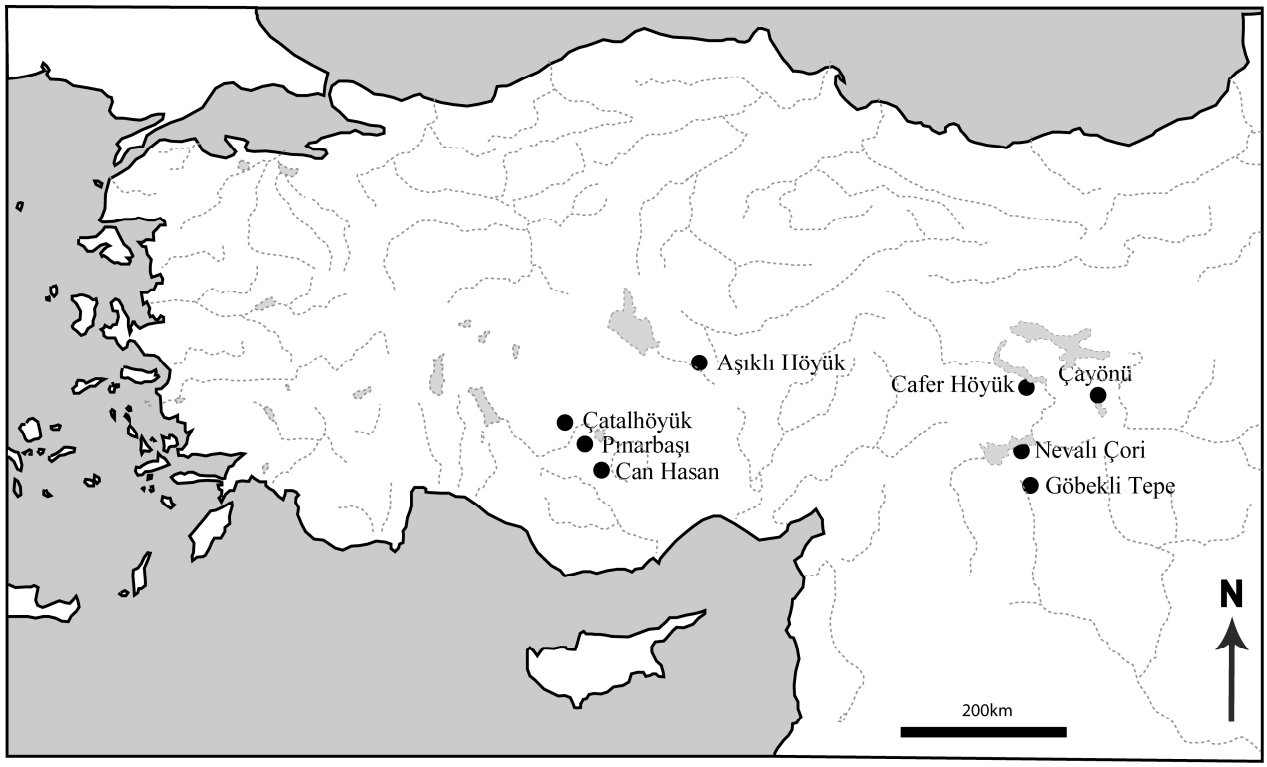


Figure 5.1 Map of Anatolia showing archaeological sites mentioned in text

The present day vegetation in the Konya Plain is predominantly steppe, with the occasional dispersed poplar plantation (de Meester 1970, 34-35; Zohary 1973). On the north side of the mountains, to the south of the plain, is oak woodland, and a *Juniperus-Pinus nigra* forest and an *Abies cilicica* forest which occur naturally depending upon the elevation, though much of this vegetation is being diminished by human agency. Trees are felled for fuel, whilst modern irrigation methods and over-grazing are destroying the natural steppic vegetation (van Zeist & Bottema 1991, 73). This has largely been replaced by Irano-Turanian ground flora characterised by *Stipa-Brometum* (Zohary, 1973). At present, the plain is mainly dry, apart from a series of small, shallow, saline lakes; karstic springs and sinkholes; and marshes. Water enters the basin through a series of water flows, largely from the southern Taurus Mountains. The Konya Plain does not have a surface outlet for the removal of water and so the water level is controlled mainly by evaporation, although some water is lost through groundwater outflow which occurs mainly northwards towards Tuz gölü (Reed *et al,* 1999, 632).

Chaput (1936) was the first to note that the Konya Plain had, in recent geological history, been a lake. He observed physical evidence of this in the form of shell-rich, sand and gravel deposits, river terraces along the sides of the River Sille near Konya, and erosion surfaces on the slopes of the mountains that surround the Konya Plain. Other researchers were soon to notice evidence of past shore-lines and attributed these to the existence of a lake sometime during the last glacial period (Erol 1978, 112). Lahn (1948) suggests that the Quaternary lakes were formed within the secondary basins of primary Neogene basins. Erol (1978) supports this view and notes that in the Central Anatolian pluvial lake basins, in particular, the Konya, Suğla, Tuz Gölü and Burdur basins, more shore-lines and sediments were apparent than had been noted by previous researchers and were higher and most probably older than these Quaternary features (Erol 1978).

Research by Roberts (1983) demonstrated that the Konya Lake had been present from approximately 35 000 to 17 000 BP, although smaller residual lakes existed as late as 13 000 BP (Roberts 1983; Roberts 1998, 149-150). During its maximum expansion the lake would not have been deep, probably not exceeding twenty-five metres and perhaps not more than fifteen metres in its shallower parts (Roberts 1983; Fontugne *et al,* 1999). Using the molluscs found within beach sand and gravels, Roberts identified three main paleolake phases: 1) the Upper Terrace, prior to 30 000 BP and above a height of 1017 metres; 2) the Main Terrace between 23 000 and 17 000 BP and at a height of between 1004 and 1017 metres and finally; 3) the Lower Terrace, sometime after 17 000 BP and at a height of below 1004 metres (Roberts 1983).

The Konya Palaeolake would have covered an area of approximately 4340 kilometres squared, with a potential catchment of 20 000 kilometres squared. During the Main Terrace phase the lake level was probably at its highest from 22 000 to 19 000 BP. However, sometime after 19 000 BP these levels began to drop. A second fall in level occurred with the shore at 1014 metres, followed by a gradual but constant decrease to 1010 metres. Radiocarbon dates suggest that this final regression occurred at around 17 000 BP. Five smaller residual lakes represent the Lower Terrace: Yarma in the west of the basin, Hotamış in the centre, Hamidiye to the south, and Karapınar and Akgöl in the east. The molluscan evidence indicates that these lakes were shallow and would have supported rich and dense aquatic vegetation. These were probably in existence up until around 13 000 BP (Roberts 1983). However, it would appear that there were fluctuations in the levels of these sub-lakes and the evidence from Karapınar indicates that there was a marshy environment during the Holocene that did not dry up until 8100 bp (uncalibrated), followed by a resurgence between 6400 to 5700 bp (uncalibrated). When the lake dried out, a flat plain was formed into which a number of rivers flowed during the later Pleistocene and early Holocene. The activity of these rivers led to the formation of large alluvial deposits (Roberts 1983).

Before 12 000 BP a largely steppic vegetation could be found in the Konya plain with some isolated tree cover in the higher regions. An increase in tree cover was found from 12 000 BP onwards, indicated by higher levels of pollen from deciduous oak and cedar and an increase in grass pollen. This increase of arboreal pollen is in contrast to a decrease in steppic pollen such as *Artemisia.* This is probably the result of an increase in temperature and humidity (Bottema & Woldring 1984).

This increase continued between approximately 11 000 BP and 10 000 BP with an expansion of *Betula*, with a possibility of a birch forest at higher altitudes and a predominance of the shrub *Hippopae* (van Zeist and Bottema 1991, 175). Around 9000 BP arboreal pollen values steadily increased and there was a particular increase in oak and juniper, with other deciduous elements such as *Carpinus* and *Ostrya,* entering the Konya plain for the first time (van Zeist and Bottema 1991, 76). There is also a further increase in grass pollen suggesting that the climate was becoming less humid during this period. Around 8000 BP there was a re-entry of coniferous elements such as pine, cedar and fir in the mountainous regions (van Zeist and Bottema 1991).

This situation continues until around 3000 BP when human occupation began to affect the pollen record (Eastwood *et al,* 1999, 671). Bottema and Woldring (1984) note that at around 3000 BP at Pınarbaşı, Kemer (near Lake Burdur) there was an increase in pollen that may have been associated with cereal cultivation and pollen of deciduous and evergreen species completely new to the area

were found. These include: deciduous oak, *Pistacia, Olea* and *Fraxinus ornus.* At the same time, they found that there was a decrease in the herbaceous elements of the vegetation. At around 1400 BP oak was replaced by pine and aquatic pollen increased (Bottema & Woldring 1984, 137-140).

ÇATALHÖYÜK

Introduction

Çatalhöyük consists of two mounds: the East mound which measures 500 by 300 metres by 17.5 metres and the West mound which is smaller with a diameter of 400 metres and a height of seven metres (Mellaart 1962; 1963; 1964; 1966; Hodder, 1996, 2). It is the larger, East mound which dates from approximately 9350 to 7950 Cal BP which is the focus of this study (Cessford 2005a). The site was first discovered in 1958 during a field survey of the Konya Plain but excavations did not commence until 1961. These were directed by Dr James Mellaart and further field seasons took place in 1962, 1963 and 1965. Altogether, Mellaart excavated about 160 buildings, spread over the various levels. During these excavations the importance of Çatalhöyük as an early sedentary site was established.

The stratigraphy comprises eighteen building levels, fifteen of which were designated by Mellaart and still form the basis of the site's chronology (Cessford 2001). The site consists of a series of mud-brick structures, with entrances through the roofs, and crawl-holes connecting the rooms within. The majority of buildings have a similar layout, each typically containing: ovens, storage bins, raised platforms and a ladder which provided the means of entering and exiting the building. It is these structures and the external areas with middens that formed the basis of the excavations. The site is renowned for its Mother Goddess figurines, wall paintings, and reliefs and sculptures incorporating animal remains. The dead were buried under the floors of occupied buildings, with many buildings yielding multiple burials. Skeletons with beads and ochre have been found and neonates were frequently buried in baskets. It is estimated that between 3500 and 8000 people would have inhabited the site at any one time (Cessford 2005b).

At Çatalhöyük, adult burials are often found under a platform in the main room of the house, while babies and infants are usually buried in side or storage rooms. They are usually of a fully-fleshed, single individual placed in a flexed position. Sometimes the bodies are buried with grave goods but these are not common. Burials containing pottery have not been found. Traces of phytoliths were discovered suggesting that the bodies were sometimes buried with matting and that neonates were often buried in baskets. The baskets and mats are not made from the same plant material indicating

that different plants were deliberately chosen to bury the neonates than those used for the matting for the adults (Rosen 2005).

During the period of occupation, the climate was wetter than at present, with moist winters, dry summers and seasonal flooding of the area during the spring time. It has been suggested that precipitation would have been 25% greater than at present (Jones *et al* 2007). A reconstruction of the site during the seasonal floods can be seen in Figure 5.2. Cereals and pulses were cultivated (Fairbairn *et al* 2005b) and it has been suggested that it was the water retentive soil at Çatalhöyük that allowed the production of cereal crops despite the lack of rainfall during the summer months (Roberts 1998; 149). However, this theory was disputed by Rosen (2005) whose study of the Çatalhöyük phytoliths led her to conclude that the cereals had been grown on well-drained soils, possibly located in higher regions some distance from the site (Rosen 2005; see also Rosen & Weiner 1994). In addition to crop cultivation, animal husbandry was practised at Çatalhöyük. Contexts have been found that are rich in animal dung and contained shed fourth deciduous premolars (dp4s) and it is believed that these contexts represent animal penning areas. Sheep are the most abundant taxa at Çatalhöyük, although wild cattle and wild ass may also have been important elements of the diet, with occasional remains of wild boar and cervid also being found (Russell & Martin 1998; Frame *et al* 1999).

Excavation was renewed at Çatalhöyük in 1993 under the direction of Ian Hodder. Phase one of excavation began in 1995 and ended in 2000 and it is the microfauna found during this phase which is included in this study. The first three field seasons at Çatalhöyük, 1993 to 1995, focused on determining the extent of the distribution of the architectural and artefactual remains on the East mound and involved: a topographic survey, the collection of surface artefacts, field walking, subsurface scraping, planning and a magnetometer survey. In addition, fifty-one metres of field sections from Mellaart's 1960's excavations were cleaned, photographed and drawn, and environmental samples taken. The results from these investigations assisted in determining which areas of the East mound should be opened up for excavation and allowed a conservation strategy to be developed for the paintings and sculptures.

During phase one of excavation five main areas were excavated: 1) the South area (formerly known as the Mellaart area because it included the area excavated by Mellaart in the 1960s), 2) the North area, 3) the Summit, 4) the BACH area (**B**erkley **A**rchaeologists at **Ç**atal**h**öyük) and an off-site trench, 5) the KOPAL area, which was opened up to study formation processes and to gain information about the off-site activities and geomorphology. The North and South areas were

excavated by a British team, the BACH area by an American team, and the Summit area by a Greek team. These teams were joined by TP, **T**eam **P**oznan (a Polish team) who opened up a ten metre by ten metre area at the crest of the southern part of the East mound. During phase one, excavation was largely focused on the detailed recording of buildings to gain an understanding of the types of activities that took place within individual structures. This contrasted with the excavation methods of Mellaart who exposed many buildings during each excavation season (Mellaart 1962, 1963, 1964 and 1966). Only excavation units from the South and the North areas are included in this analysis. An aerial photograph of the Çatalhöyük East mound showing the different excavation areas can be seen in Figure 5.3

Excavation was conducted using a single-context recording approach and each distinct archaeological context was referred to as a *unit*. A nested system of recording was employed with units, where appropriate, being grouped into features which pertain to groups of related units, for example all of the units comprising a particular hearth or burial. The term *space* was employed to refer to spatially defined areas within buildings or an external area. *Building* is everything making up a particular structural entity and areas refer to distinct areas on the mound that were excavated such as the North and South areas. To ease post-excavation analysis, the excavation units are grouped according to unit categories. This allows the specialists to determine if any types of units have a particular significance. Fifteen unit categories are used in this work: artefact/cluster; floor/surface/occupation; burial fill; wall; midden; pit fill; posthole fill; feature fill; building fill; feature use; external deposits; makeup/construction/packing; inter-building; fill of cut; and skeleton.

1. *Artefact/cluster* is any unit composed of a single object or groups of objects that appear to have been deliberately placed or their association seemed important during excavation. For example, a collection of clay balls would be defined as a cluster.
2. *Floor/surface/occupation* includes all units from inside buildings which are interpreted as floors, surfaces or occupation deposits.
3. *Burial fill* refers to all units from within a burial cut, excluding the actual skeleton.
4. *Wall* includes all units that compose the major structural external or internal walls of buildings including the brick, mortar, brick/mortar composite, wall plaster, and wall paint. In addition, it includes all wall features such as niches, crawl holes, and obvious pieces of collapsed wall.
5. *Midden* consists of small lenses of dirty layers of dumped rubbish in the large external areas that often build up into large deposits.

6. *Pit fill* includes all units from within a defined pit cut and includes the units from the post-retrieval pits.
7. *Posthole fill* covers all units from within a posthole cut. Postholes are generally smaller and shallower than pits.
8. *Feature fill* includes units that are the fill of a feature such as an oven, a bin or basin that had gone into disuse.
9. *Building fill* consists of the layers of well sorted, homogeneous, and relatively sterile fill which are placed in a building after it has been abandoned and preceding the construction of the next building. Also, it includes some dirtier deposits that might have been defined as a midden if they had been found externally.
10. *Feature use* is comprised of units that are believed to relate to the primary *in situ* use of a feature such as an oven or a bin. This category is sub-divided into three further categories: *oven use* includes oven bases and primary ashy fills; *bin use* includes floors in the base of bins; and *other feature type*, these are primarily units from the fills of basins or other unspecified features.
11. *External deposit* includes all units found outside or between buildings that are not middens.
12. *Makeup/construction//packing* is comprised of deposits that are believed to have been laid within a building in preparation for a floor or a feature above. These deposits are often similar to building fills but are thinner and occur within the occupational sequence of a building. This category includes the makeup for platforms.
13. *Inter-building* includes all units from the narrow gaps between the walls of the buildings.
14. *Fill of cut* consists of units from the fill of any cut that is not covered by a more specific category.
15. The final category is *skeleton* (Hodder 2007a).

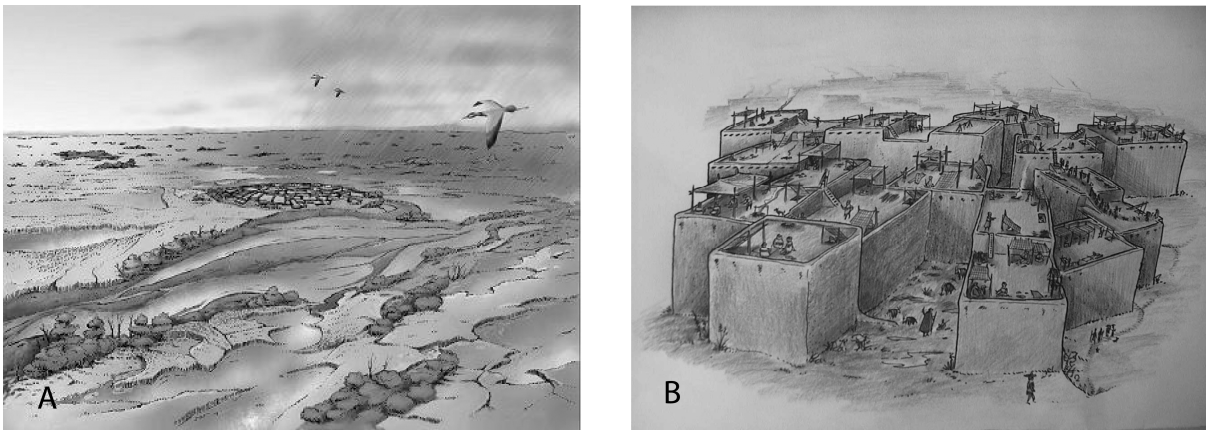


Figure 5.2 Artist's reconstructions of Çatalhöyük A: Çatalhöyük during the seasonal floods. B: the mud brick structures (Artist John-Gordon Swogger, courtesy of the Çatalhöyük Project)

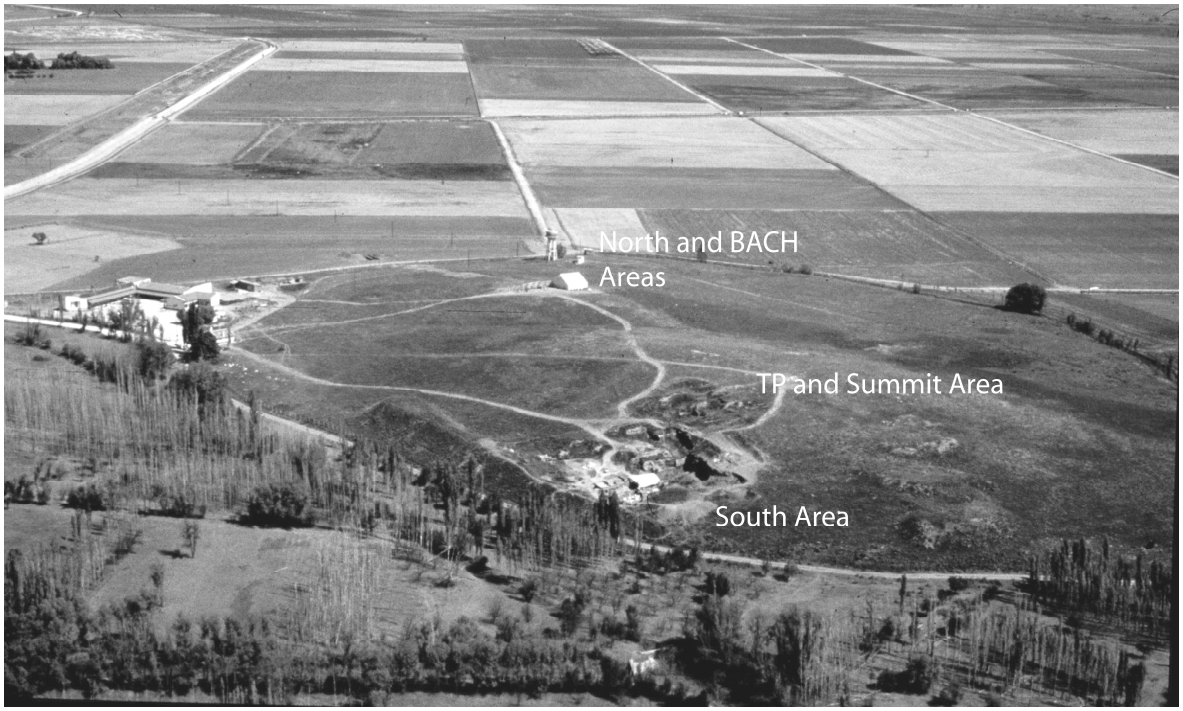


Figure 5.3 Aerial view of the East mound showing the excavation areas (courtesy of the Çatalhöyük Project)

Phasing of the South area

Pre-level XII

Mellaart phased Çatalhöyük according to the levels of the buildings excavated and these were numbered from 0 for the latest through to XII for the earliest. Level VI was divided into two further phases A and B. Despite his desire to do so, Mellaart did not reach the base of the mound during his excavations, and it was not until 1999, with the excavation of the deep-sounding (a twenty metre by twenty metre trench in the centre of the South area in Space 181, see Figure 5.4), that this aim was finally realised by the British team. The deep-sounding was located in the South area beneath Mellaart's Levels XI and XII. There was no evidence for buildings in this area and so Mellaart's system for phasing could not be extended. However, five further phases were identified: Pre-level XII.E, Pre-level XII.D, Pre-level XII.C, Pre-level XII.B, and Pre-level XII.A.

Pre-level XII.E, represents the earliest activity in this level, the quarrying of the natural lake marl. This level was devoid of any cultural material and consisted of only one unit, unit 4522. This is followed by Pre-level XII.D which consists of refuse dumps alluviated from seasonal flooding from the river that ran along the western edge of the settlement. This level was excavated in six arbitrary spits and contained cultural material in the form of animal bone, fired clay objects, charcoal, stone, obsidian, and flint. Pre-level XII.C also consisted of dumps but these had clearer depositional layers that were less affected by water activity. Twenty-eight units were excavated from this phase. The

only real evidence of activity was in the form of a firm mortar-like material. Pre-level XII.B contained a homogeneous dump, which was believed to have been deliberately cut from somewhere off-site. Gnawed animal bones and evidence of dog coprolites were found in this phase. Overlying the dump were a series of lime burning deposits and cutting activities as well as the continued dumping of refuse. In addition to animal bone, obsidian, clay balls, charcoal and shell were found. This phase consisted of nine excavation units. Finally, Pre-level XII.A was a series of finely accumulated ashy layers and lenses of debris, which were characteristic of the midden units found throughout the South area of the site. These layers were interspersed with *in situ* burning activity and small cuts (Cessford 2007a).

Level XII

Level XII overlies Space 181 and consists of an area that became known as Space 199, as shown in Figure 5.4. It measured 7.4 metres E-W by 3.2 metres N-S. Arbitrary sections defined the limitations of the trench on the north, east and southern sides, whilst the walls of Levels XII and XI demarcated the western edge. The western wall was constructed on top of the midden deposits of Space 181, and the deposits that abutted the external side of this eastern wall were interpreted as penning deposits. These consisted of animal coprolites, dung pellets, spherulites, and concentrations of plant material (represented by phytoliths) which suggest that material such as straw was being deliberately placed there. Shed deciduous sheep/goat teeth were found as well as articulated bones of at least two stillborn or neonate lambs. On the western side of Space 199 a human neonate burial was found which had been placed in a basket, within a shallow cut (Cessford 2007a).

Level XI

Level XI consists of Space 198, shown in Figure 5.5, which was located directly over Space 199, Level XII and is a continuation of the penning deposits found in Level XII. This space measured approximately 9.1 metres E-W by 5.0 metres N-S. It appears that this space was originally enclosed on three sides by walls. An arbitrary section defined the northern edge of the excavated space. Animal bone, clay balls, stone, and charcoal were all found in this space. At the interface of the last penning deposit and Level X were two cut features, one large pit cut and a smaller, shallower cut (Cessford 2007a).

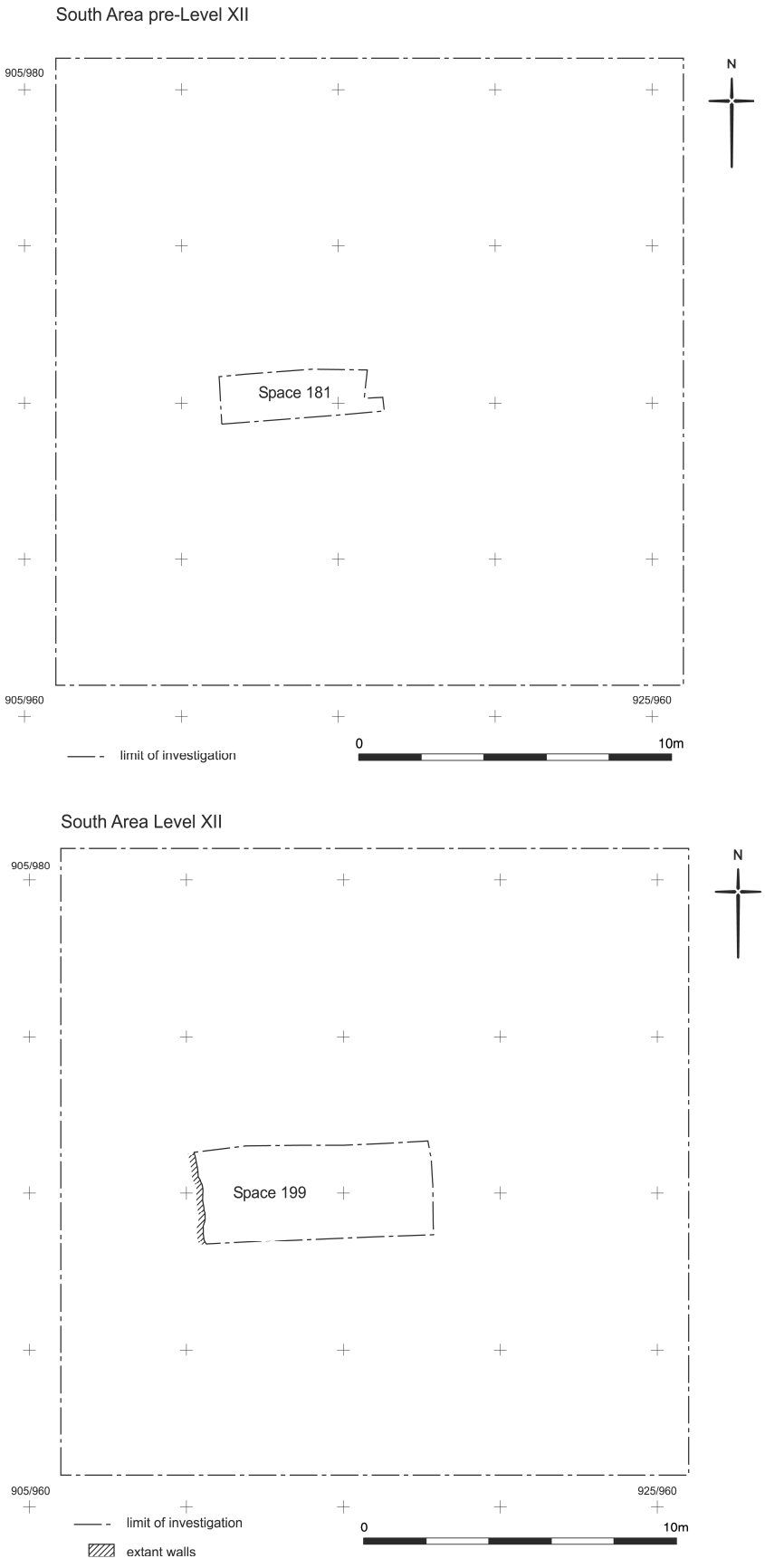


Figure 5.4 Plans of pre-Level XII and Level XII (courtesy of the Çatalhöyük Project)

Level X

Three buildings were found within Level X: Building 9, Building 18, and Building 23 as shown in Figure 5.5. Building 18 was located at the eastern end of Space 198. It was originally excavated in 1963 and was known as Shrine X. 8. It was rectangular in shape and measured 5.9 metres N-S by 4.7 metres E-W. The internal area was truncated by the excavation of the 1963 deep-sounding. The internal area to the north of the deep-sounding was Space 172, and the internal area to the south was Space 171. In Space 172 three small bins were found, whilst in Space 171, a sequence of hearth or oven bases were uncovered with associated rake-out deposits. In addition, the crouched burial of a human neonate was found cutting through a rake-out deposit. Building 18 shared a party wall with Building 23 with a crawl hole connecting the two buildings indicating that they were constructed at the same time. Both buildings had the same floor plan with larger rooms at their south end and smaller, narrower rooms at their northern ends (Farid 2007a).

Building 23 was located to the west of Building 18. This was excavated in 1963 by Mellaart and was known as Shrine X.1 (Mellaart 1963, 70). Building 23 was approximately 5.6 metres N-S by 3.9 metres E-W. Internally it was divided into three spaces: Space 179 corresponded with Space 172 in Building 18, being the smaller, northern room; Space 178 was the equivalent of Space 171 in Building 28, the larger southern room. To the west was a semi-partition which created Space 200 which was two metres long by one metre wide. A series of hearths and ovens were found in Building 23 as well as two infant burials in baskets. In Space 200, Burial 543 and Burial 544 were discovered (Farid 2007a). Building 9 was directly beneath Building 2, Level IX and consisted of two rooms; a larger one to the west known as Space 166, and a smaller one to the east known as Space 116 (Farid 2007a).

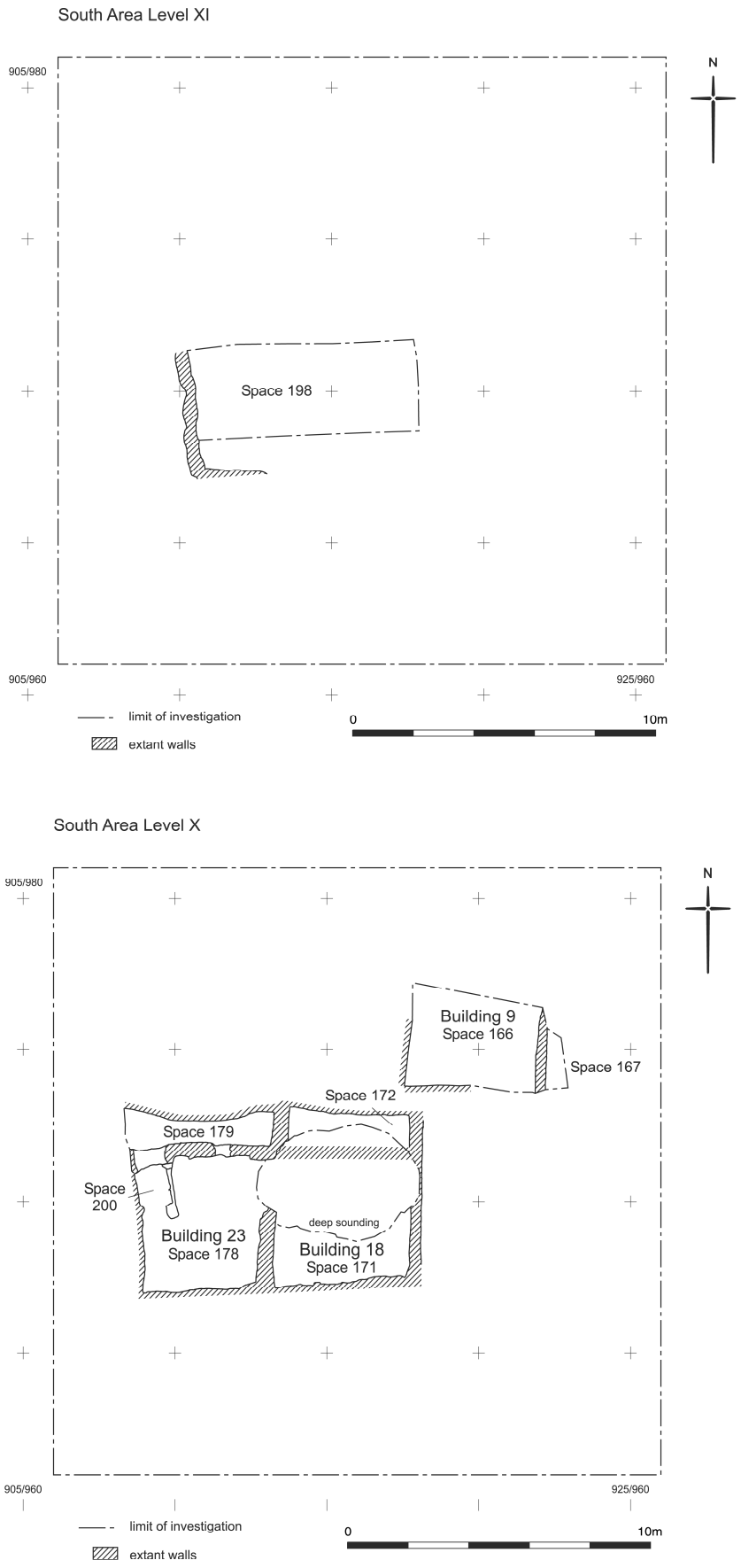


Figure 5.5 Plans of Level XI and Level X (courtesy of the Çatalhöyük Project)

Level IX

Four buildings were found in this level, Building 2, Building 16, Building 17, and Building 22, as illustrated in Figure 5.6. Building 2 was located at the eastern edge of the South area and consisted of two rooms, Space 117, and Space 116, which were connected by a crawl hole in the party wall. Space 117 was the larger of the two rooms and was approximately 4.9 metres long. It was located on the western side of the building. Space 116 was on the eastern side of Building 2 and measured approximately two metres by two metres. Building 2 was north of Building 17 and northeast of Building 16. Space 117 contained a series of plastered floors and associated hearths, ovens, platforms and bins. A small painting consisting of red on white plaster, with black lines on either side of the painting was found in the northeast corner of Space 117. The main bulk of the painting consisted of a repeated pattern of red lozenge shapes (Farid 2007b). Space 116 was accessed via a crawl-hole in the east wall of Space 117. An indeterminate feature was found in this space which consisted of many layers of plaster and marl and moulded layers of chaff-tempered clays. It is believed that this feature may represent the collapse of a bin. Above this feature a deposit was found that was rich in microfauna (unit 2091) (Farid 2007b).

Building 17 consisted of a large room to the east (Space 170), and a narrower room to the west (Space 182). These were connected via a crawl-hole in the party wall (Feature 484). Three phases of occupation were uncovered in Space 170. The first phase consisted of a series of plastered floors. In the second phase two infant crouched burials in baskets (Burials 564 and 576) were found adjacent to the east wall and an adult burial sealed by a plaster floor (Burial 563) was found on the west side. A change in the layout of Space 170 was seen in the third and final phase of occupation. The features in the southwest corner were filled in and a platform was constructed along the west wall. Areas of red paint were observed along the southeast facing wall. Space 182 had a series of accumulated occupation horizons overlain by debris such as obsidian and flint artefacts, bone, pottery, evidence of basketry and other domestic waste. At the end of the occupation period of this building the crawl hole was filled with broken bricks prior to the removal of the roof. The roof posts were then removed and the building was infilled. The fill of Space 182, differed from that of Space 170 with distinct tip lines running from west to east in Space 184. A redeposited human skull was found in a post retrieval pit (Farid 2007b).

Building 16 was originally excavated by Mellaart in the 1960s and Space 164 of the building, corresponds with Mellaart's Shrine IX.8. The majority of this building was excavated by Mellaart but an *in situ* area of deposit approximately 2.4 metres N-S by 1.2 metres W-E remained in the south east corner of the building. In addition some floors had survived along the northern and eastern walls. These areas were excavated by the British team in 1999. Building 16 measured

approximately 5.7 metres N-S by 4.5 metres E-W. In the southeast corner a sequence of four fire installations were found. Two clean plaster floors were also discovered (units 4343 and 4319) which had the antler of a red deer and a clay ball lying on their surface. Two obsidian clusters (units 4305 and 4317) were also found in this area. The earliest feature found was a wall which ran east to west and divided the area of ovens and 'dirty areas' from the cleaner areas. These two rooms were connected by a large crawl hole. The surviving deposits in this area were of a 'dirty' or domestic nature (Farid 2007b).

Building 22 was located to the west of Building 16. The internal deposits of the building had all been removed by Mellaart in the 1960s leaving only the outer walls. Mellaart's backfill was removed from this building which revealed the archaeological deposits of Building 23 (Farid 2007b).

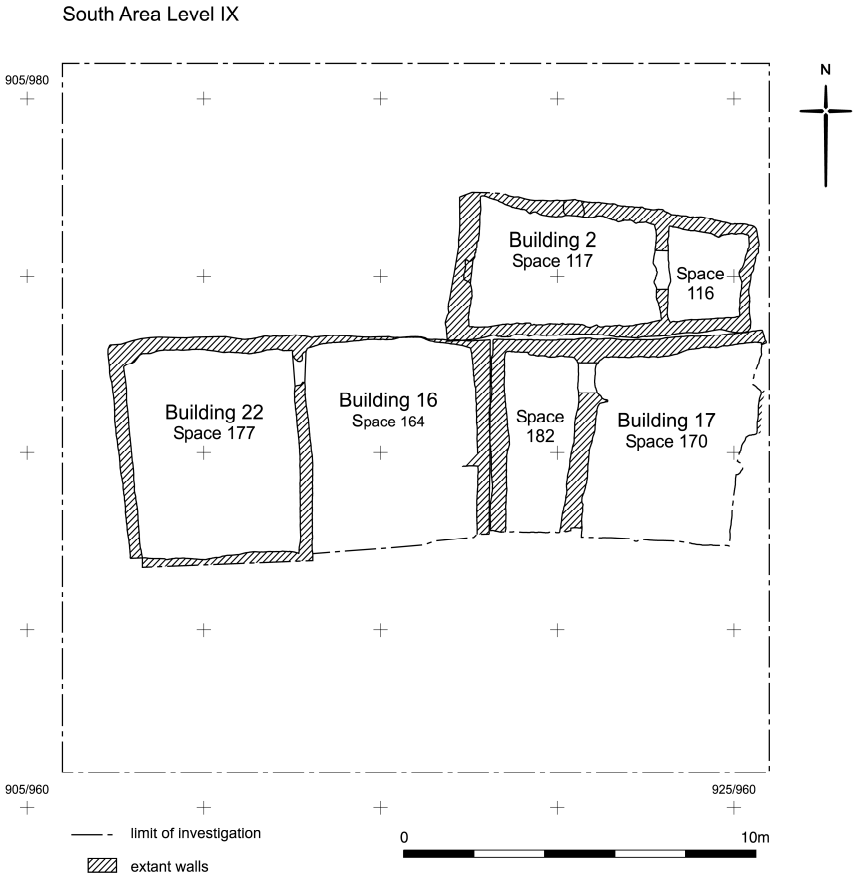


Figure 5.6 Plan of South Area Level IX (courtesy of the Çatalhöyük Project)

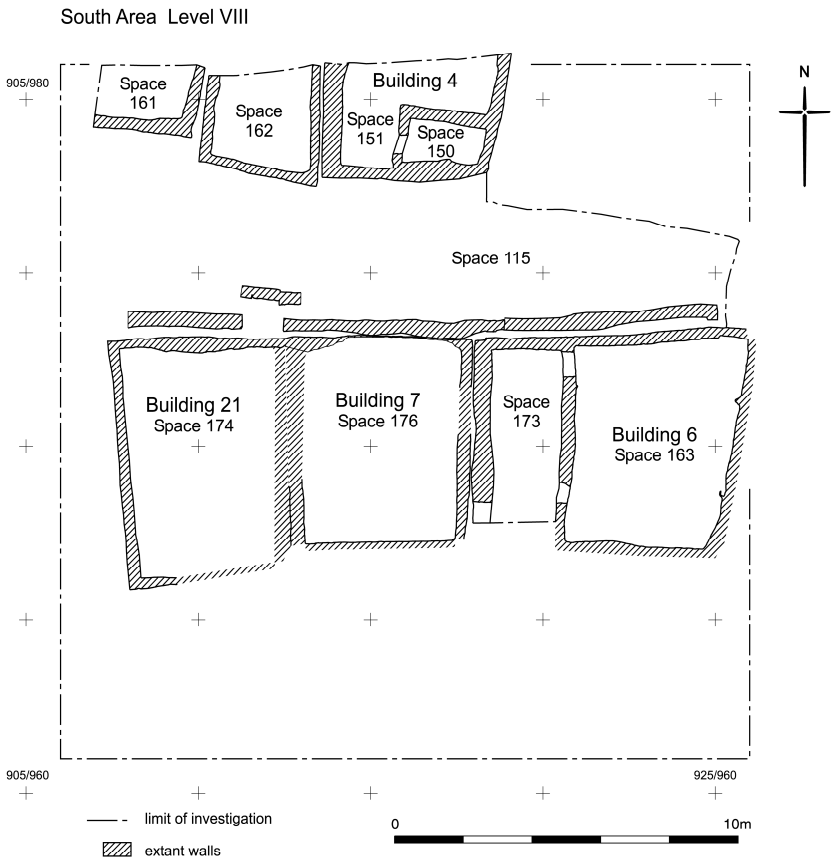


Figure 5.7 Plan of Level VIII (courtesy of the Çatalhöyük Project)

Level VIII

As illustrated in Figure 5.7 there are four separate buildings in Level VIII: Building 4, Building 6, Building 7, and Building 21. Building 4 consisted of two internal spaces, Space 150 and Space 151. It was a rectangular building measuring approximately 3.1 metres N-S by 4.5 metres E-W. Space 150 was the smaller of the two rooms and was located in the southeast corner of the building and Space 151 was L-shaped which comprised the remaining part of the building. These two spaces were separated by a wall (Features 97 and 99) although they were connected by a crawl hole in the southwest corner of Space 150 (Feature 250). The relationship between these two spaces is shown in Figure 5.7. Space 162 represents a building which was contemporary with Building 4 and the external midden area was known as Space 115 (Farid 2007c).

Building 6 lies directly over Building 17, Level IX, and below Building 24 of Level VII. It consisted of the same floor plan as Building 17, with one large room to the east (Space 163) and a smaller, narrower room to the west (Space 173), although the south wall in Space 163 was set slightly in from that of the corresponding wall in Building 17**.** Space 163 was excavated by Mellaart during the 1960s and was known at Shrine 10. The central floor area had already been excavated,

which left only the fragmented remains of some features next to the north and south walls. Because of this, the stratigraphical sequence is not fully understood (Farid 2007c). To the north of Space 163, a series of storage bins or basins were found, which overlay some features that were identified as ovens. In the south of Space 163 the truncated remains of a platform were found. Next to this was a platform with the remains of a hearth which was overlain by an oven. Nine human burials were also found in Space 163, three adults and six children (Farid 2007c).

Two of these adult burials contained concentrations of microfauna. The first was Burial 460 which was located in the centre of Space 163. The skeleton was a young adult male and was found in a semi-crouched position with its head raised slightly higher than its body. The body had been placed in a relatively large grave cut and a concentration of phytoliths was found close to the rib cage and over the right femur. The skeleton was still articulated, though it was noted that some of the bones, such as the phalanges and teeth, had been removed by rodents (Andrews *et al* 2005). The remains of micromammals were also found in the fill of this burial (unit 4397) and were described as being in "pockets" rather than being a continuous spread. The northern edge of this burial was truncated by an infant burial (Burial 442).

Burial 513 was the second burial found with a concentration of microfauna and this burial is illustrated in Figure 5.9. This burial was located to the east of Burial 460 close to the eastern wall of Space 163. This was the skeleton of an adult female, which had been placed in a crouched position (Farid 2007c). The body was flexed with the head pushed towards the chest and a large amount of black carbon was found within the upper ribs (Andrews *et al* 2005). There were traces of red ochre at the base of the grave cut, and a large concentration of microfauna was found over the torso (unit 4619). This concentration was contained within a deposit that had an orange tinge, which is possibly the result of the decomposition of the organic matter in which the microfauna were encased. This was noted by the excavator when it was uncovered and so the concentration was excavated using a one centimetre squared grid consisting of fifteen squares. In addition, an abundance of carbonised cereal grains was also found in this burial (Farid 2007c).

Burial 492 was a decapitated adult male, which was lying on its back with a wooden board made of hackberry covering most of the torso and is also shown in Figure 5.9. The skeleton (unit 4593) had been placed on a mat and had a concentration of red ochre over the upper part of the body. The cervical vertebrae were close to the grave cut which left little room for the head of the skeleton. However, the head had been cut off at the atlas vertebrae which would have been a difficult undertaking. Therefore, it has been suggested that the removal of the head would have had to have

occurred after some of the tissue had decayed. Alternatively, the head could have been pushed up against the grave cut so that the grave could be re-opened and the head removed at a later date. The rest of the skeleton was not disturbed in any way. This may account for the placement of the hackberry board which could have been used to protect the rest of the body when the burial was reopened. Alternatively, a very small hole may have been dug to extract the head so as not to disturb the body. This latter theory would have meant that the position of the head would have had to have been recorded in some way at the time of burial (Andrews *et al*, 2005). Located over the wooden plank was a concentration of phytoliths (Farid 2007c). Images of all these burials can be seen in Figure 5.9. Building 7 corresponds with Mellaart's Shrine 8 and was full of the backfill from the 1960s excavations. It was located to the west of Building 6 and south of Space 115. Building 21 was also full of 1960s backfill and lay to the east of Building 7 and south of Space 115 (Farid 2007c).

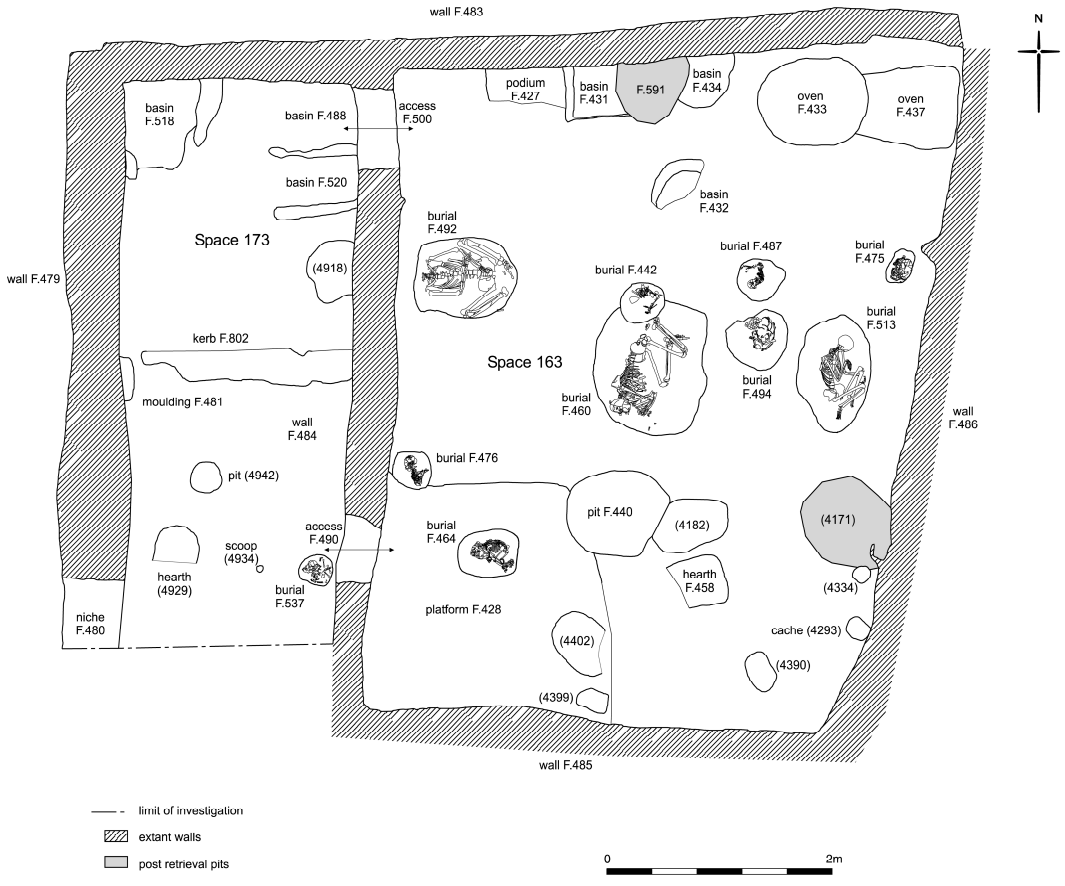
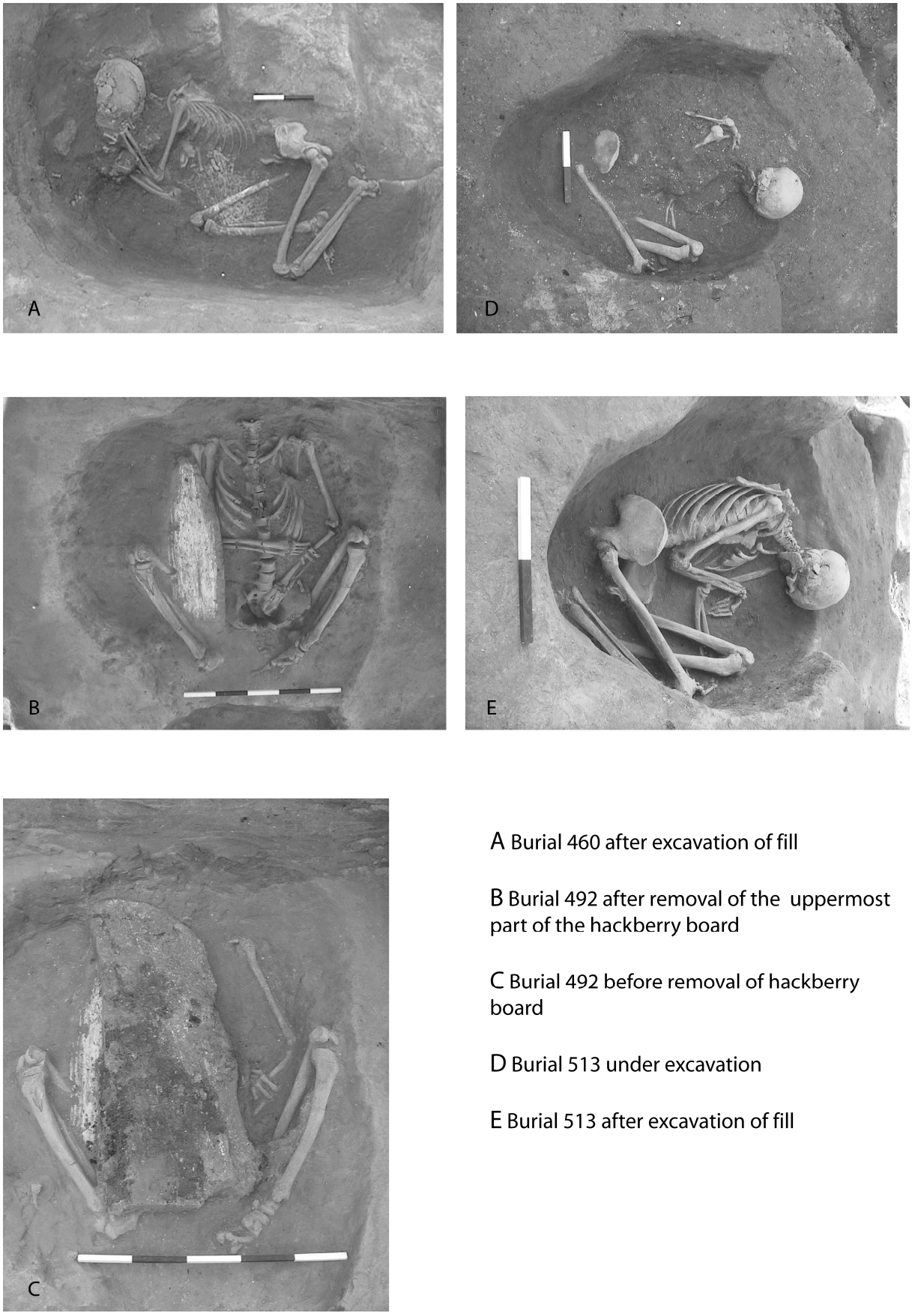


Figure 5.8 Plan of Building 6 Level VIII showing Burial 460 and 513 (courtesy of the Çatalhöyük Project)



A Burial 460 after excavation of fill

B Burial 492 after removal of the uppermost part of the hackberry board

C Burial 492 before removal of hackberry board

D Burial 513 under excavation

E Burial 513 after excavation of fill

Figure 5.9 Human burials from South Area Level VIII (courtesy of the Çatalhöyük Project)

Level VII

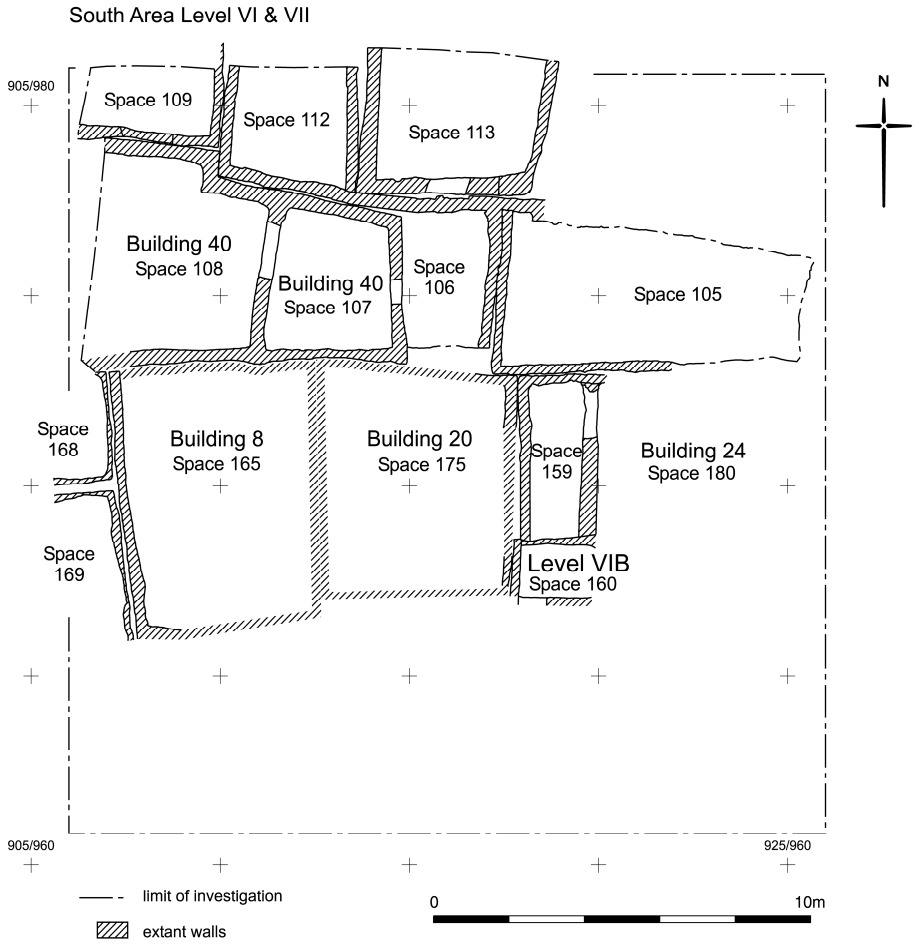


Figure 5.10 Plan of Level VII and VI (courtesy of the Çatalhöyük Project)

Four buildings were found in Level VII: Building 8, 20, 24 and 40. In addition, a number of external spaces were also found. Space 113 is believed to be the earliest construction in this phase. It is located over Building 4 in Level VIII and it had previously been excavated in the 1960s and was known by Mellaart as House VII.7. The presence of a plaster rendering on the outside of the west wall of Space 113 indicates that there was a period of time between the construction of Space 113 and the adjacent Space 112. The construction of the latter space appears to have been contemporaneous with the construction of Space 105. Space 112 had also been excavated in the 1960s and was known as Shrine VII.9. A number of isolated hearths and burials were found in this space (Farid 2007d). Space 109, was built directly to the west of Space 112, in the top northwest corner of the South area. The plan of this building had been exposed during Mellaart's 1960s excavations and it would appear that some excavation occurred during this time. An infant burial in a basket (Burial 264) was found in this area which was sealed by a floor deposit. This was followed by Building 40 directly to the south. The exact sequence of construction of the southern row of buildings is unclear but it is believed that these were constructed before Building 40 and Space 106

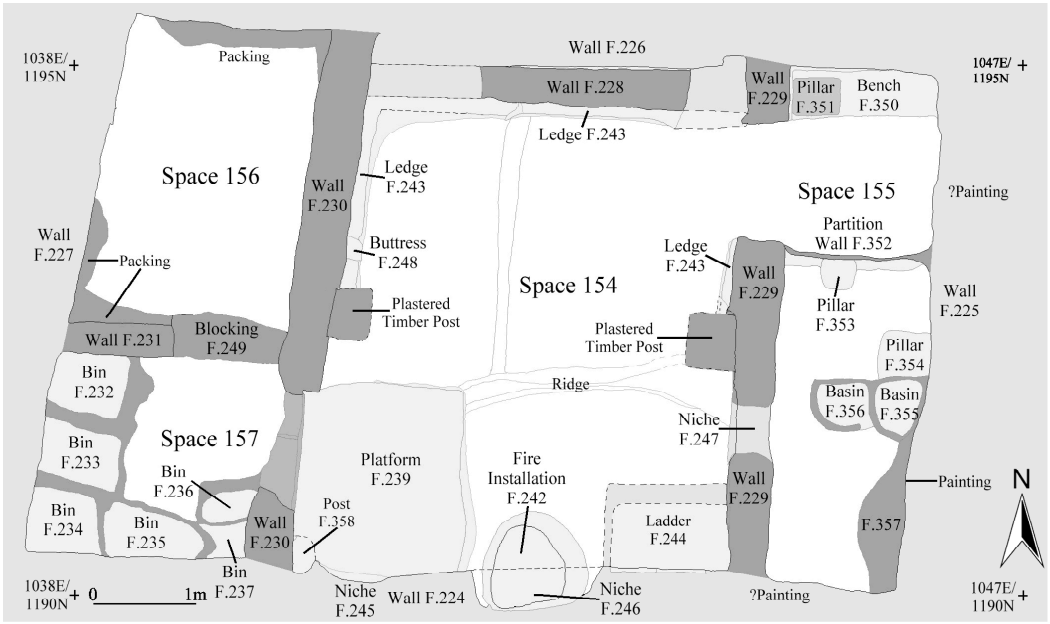
and possibly before Spaces 112 and 105. Building 24 consisted of two spaces, Space 180 and Space 159. Space 180 was the larger of the two and was located on the eastern side of the building. Mellaart had excavated this space in the 1960s. The smaller space, Space 159, was a small narrow room to the west of Space 180 that Mellaart had interpreted as the 'antechamber' to Shrine 10 at Level VII. Spaces 180 and 159 were connected via a crawl hole at the northern end of the building. A smaller room, Space 160 which is part of Level VI, lay to the south of Space 159. Space 159 had been partially excavated by Mellaart in the 1960s but a sequence of infill, floors and two postholes remained (Farid 2007d).

Level VI. B

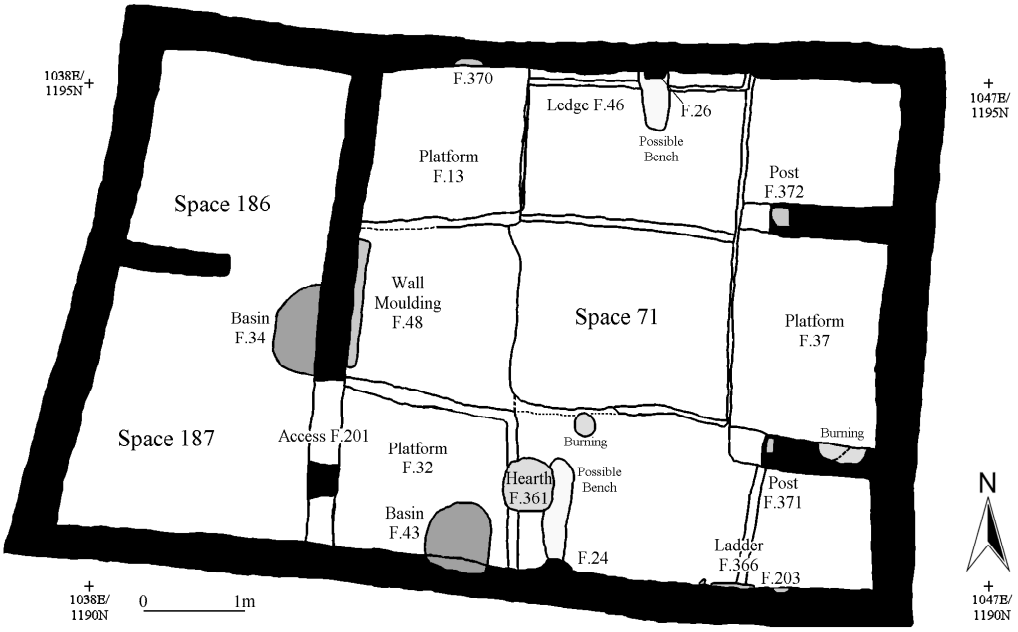
Very little of Level VI is within the South area and Space 160 was the only space excavated from Level VI. It was originally uncovered during the 1960s excavations and was then known as House 11. It was a small space and measured approximately 2.6 metres by 1.6 metres (Farid 2007d).

North Area Level VI-V

The North area of the site is approximately 200 metres away from the South area and had not been excavated by Mellaart during the 1960s. In the first phase of the project (from 1993-1995) a range of techniques were used to find the outline of buildings in this area. These included: topographic survey, magnetometric survey, surface material collection and surface scraping and planning (Cessford 2007b). Two buildings were excavated from the North area: Building 1 was the uppermost building and Building 5 which lay directly underneath Building 1. Building 5 was split into three phases: 1). *Phase B5.C* deposits pre-dating final occupation; 2) *Phase B5.B* final occupation; 3) *Phase B5 A* abandonment. Similarly Building 1 was split into five phases: *1) Phase B1.1* deposits marking the transition from building 5 to Building 1; 2) *Phase B1.2* primary occupational sequence; *3) Phase B1.3* burning, partial infilling and internal modification; 4) *Phase B1.4* secondary occupation; 5*) Phase B1.5* abandonment and later events; *Phase B1. E* deposits external to Building 1 (Cessford 2007b, 354-359). Comparison of the cultural assemblages from these buildings with material from Mellaart's excavations and with other areas of the site suggests that Building 1 corresponds to Levels VI-V and Building 5 to Level VI. AMS dating of lentils from Building 1 places it within Level VIII. This difference is not unexpected as the levels are no longer thought to represent contemporary site wide events (Cessford 2007b). Plans of Buildings 1 and 5 can be seen in Figure 5.11.



A



B

Figure 5.11 North area buildings: A; Building 5, B; Building 1 (courtesy of the Çatalhöyük Project)

PINARBAŞI

Location and discovery of Pınarbaşı

The site of Pınarbaşı is located in the centre of the Konya plain at the end of a ridge of limestone hills at the northwest edge of the Kara Dağ volcanic massif. It is close to the Süleymanhacı village, adjacent to the northwestern boundary of the Karaman province. It lies at an elevation of approximately 1000 metres above sea level and is 24.5 kilometres southeast of Çatalhöyük. It consists of a series of small rockshelters within an area of these hills (Watkins 1996, 47) and an open site in front of the limestone ridge (Baird in press). Tree cover is limited to the adjacent Kara Dağ mountains and consists of open deciduous oak forests. The site itself was once adjacent to a lake. However, this has diminished over the last decade due to a combination of environmental change and intensive irrigation practices. The lake has gradually dried up and the reed marshes, which can be seen in the left hand side of Figure 5.12, which were associated with the lake are fast disappearing (Asouti 2002).

The presence of a possible prehistoric site in this area was first noted by Dr David French while he was conducting his excavations at Can Hasan in the 1970s (French 1996). However, the definite identification of an early prehistoric site was not made until 1993 by Dr Douglas Baird and Prof. Trevor Watkins during a preliminary season of survey work. Further investigation of the area revealed that there were a number of small-scale occupations, constructions and tombs which ranged in date from the early Bronze Age to the Byzantine period. Furthermore, there also appeared to be a great deal of evidence for prehistoric occupation, and concern was expressed over the safety of these remains because it appeared that some looting of the site had taken place. Therefore, an application was made for permission to conduct excavations in this area which was granted and work commenced in 1994. The assemblages included in this work are from the first phase of excavation at the site which took place in 1994 and 1995. Work recommenced at the site in 2003 and continued until 2005 with new trenches being opened uncovering earlier occupation at the site.

Area A

The microfauna included in this study are from the 1994 and 1995 excavation seasons and are from two separate excavation areas: Area A and Area B. Area A is on a small mound on a peninsula which extends down from the rockshelter towards the former lake. Here masonry tombs and pottery dating from a variety of periods were found. At the beginning of the 1994 season, a three metre by three metre trench was excavated which was later extended westwards to include a 1.5 metre by 1 metre area. In the upper-most levels, well-preserved deposits were found dating to the Early Bronze Age. These included mud-brick walls, floors, and burials that intruded into earlier deposits. Below

this was a mixed deposit which appeared to be contaminated by burrowing animals and by intrusive digging in the Early Bronze Age. The levels below date to the late 11th Millennium Cal BP and had a lithic assemblage consisting primarily of obsidian but also of some flint and chert (Baird in press). Faunal remains were abundant in these earlier levels consisting predominantly of caprines and equids (Carruthers 2003; 2004) but we now know this sample was not particularly representative of this period of occupation overall (Baird in press). Carbonised plant remains were relatively scarce. The deepest part of the trench excavated into 11th Millennium Cal BP deposits was confined to a one metre by three metres area and contained the crouched burial of a child. This area of the site produced radiocarbon dates contemporary with the Neolithic of the Levant and southeast Anatolia (see Table 5.1) (Watkins 1996, 52). Samples from three contexts were analysed for microfauna: ABJ, ABR and ABU. ABJ is described as: a thin layer of silty brown soil into which the grave of the child had been cut. ABR is below ABJ and above ABU. It consists of a thin lens of reddish-brown soil. ABU is the earliest and consists of dark grey-brown soil (Watkins 1996). These contexts seem to represent generalised depositional processes unrelated to specific features or structures (Douglas Baird, per comm.).

Figure 5.12 The site of Pınarbaşı prior to excavation showing the rockshelter in the background

Area B

Area B is a small trench in the west-facing rockshelter. Two trenches were dug in Area B, trench 1 in 1994 and trench 2 in 1995. Both trenches have dimensions of 4.5 metres by two metres. The two trenches are parallel to one another and at a right angle to the rock face (Watkins 1996, 51). In trench 1 a curvilinear feature was discovered which was made out of large blocks of limestone which appear to have been a revetment wall of a semi-subterranean structure (Baird in press). The

fill of this feature consisted of thin, charcoal rich layers. These were interspersed with thicker layers that were siltier than the thinner layers but were still rich in charcoal. The lack of slumping on the sides of the cut and between the layers, and the lack of weathering on the animal bones suggests that it filled quickly rather than over a period of time (Watkins 1996 52; Asouti 2002). This fill was split into six arbitrary contexts: BAT, BAW, BAX, BAZ, BBA, and BBH and dates to the late Neolithic. The results of the microfaunal analysis of the samples from these fill contexts will be combined due to the fact that the distinctions between the deposits is arbitrary rather than stratigraphic. Baird (in press) argues that this curvilinear feature is a habitation structure, based on evidence from inside this feature which contained several reconstructed hearths and an oven. Additionally, a concentration of reed phytoliths was found associated with this structure which could have been used as a construction material (pers. observation). Further deposits were found surrounding this curvilinear feature. These consisted of thin strata that all contained considerable amounts of charcoal and animal bones. In total, eight contexts were found surrounding this curvilinear feature: BAV, BAY, BBC, BBE, BBG, BBI and BBJ.

Three of the latest prehistoric contexts so far excavated at Pınarbaşı consist of the fill of a fire installation, BAD, BAM, and BAI, the latter of which has been radiocarbon dated to 6630 to 6440 Cal BP placing it in the Chalcolithic. Adjacent to this fire installation at the western end of the trench, a shallow pit was found filled by two contexts BAJ and BAK. The chronological inter-relationships of these features needs to be finally established but BAJ/BAK may precede the fire installation BAD, BAM and BAI (Douglas Baird, pers. comm.).

Pınarbaşı Area A is an important site because it is the earliest occupied site in this region, pre-dating Çatalhöyük. There is then a break in occupation before its re-occupation in Pınarbaşı Area B which overlaps with the occupation of Çatalhöyük. Interestingly, there is no evidence for cereal cultivation at Pınarbaşı A or in the late 9th Millennium Cal BP occupation of Area B (Baird in press). Based on comparisons with Natufian sites and their associated material culture, Baird (in press) suggests that the 11th Millennium Cal BP occupation has a sedentarising character, although the precise duration of occupations remains to be established. The late Neolithic 9th Millennium Cal BP occupation contemporary with Çatalhöyük East is probably a seasonal hunting and herding campsite (Baird in press).

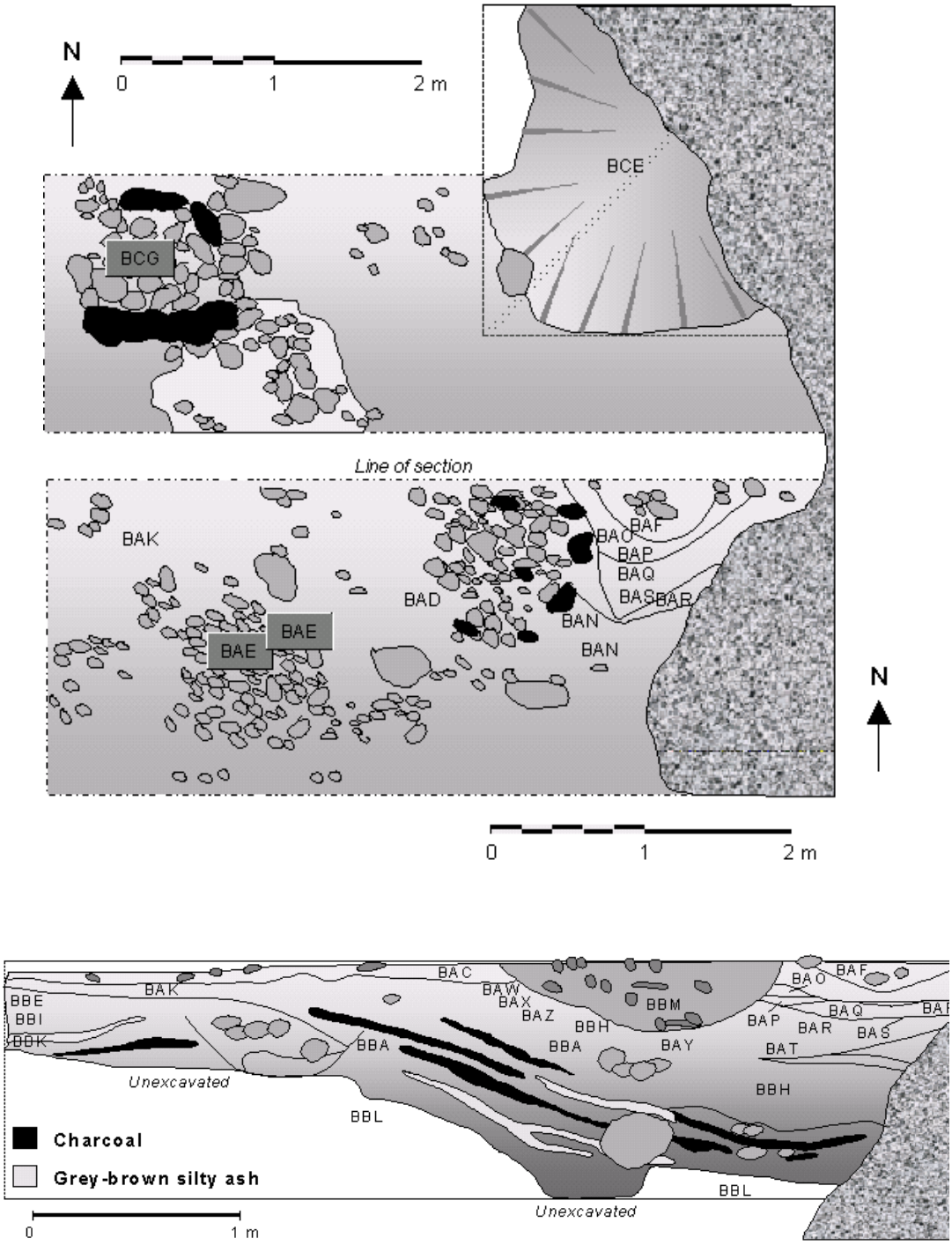


Figure 5.13 Plan and west-facing section for Area B (courtesy of the Pınarbaşı Project)

Dating of Pınarbaşı

Area A at Pınarbaşı produced seven contexts in total, but only three of these, ABU, ABR and ABJ, provided secure dates. The remaining four contexts appeared to have experienced some mixing and therefore, were excluded from this analysis. Contexts, ABU, ABR and ABJ were radiocarbon dated and the results are given in Table 5.1. The contexts from Area B were more secure and less mixed

than those from Area A. Contexts from this site have been radiocarbon dated to the middle to late Neolithic/Chalcolithic period.

LAB. REF.	*CONTEXT*	*MATERIAL DATED*	*CONVENTIONAL AGE BP (BC)*	*CALIBRATED AGE BP*
Ox-5499	ABJ	Charcoal	9050±80 (7100±80)	10380-9960
Ox-5500	ABR	Charcoal	9290±80 (7340±80)	10590-10300
Ox-5501	ABU	Charcoal	9140±80 (7190±80)	10410-10220
Ox-5502	BAI	Charcoal	5725±65 (3775±65)	6630-6440
Ox-5503	BAT	Charcoal	7145±70 (5195±70)	8030-7870
Ox-5504	BBA	Charcoal	7450±70 (5500±70)	8350-8200

Table 5.1 Radiocarbon dates from Pınarbaşı (After Watkins 1996, 52 & the CANeW website)

THE SITES IN CONTEXT

A key question in Epi-palaeolithic/early Neolithic sites in southwest Asia is when did humans first make the transition from nomadism to sedentism? It has been suggested that this transition began in southwest Asia in the Epi-palaeolithic with the cultural phase known as the Natufian (*c.* 14600-11700 cal BP). The Natufian was first identified by Dorothy Garrod in her work on cave sites in northern Palestine (Garrod 1932) and is not homogeneous either culturally, temporally or spatially. It is split into Early, Late and Final phases and stretches from the southern Levant (e.g Ein Mallaha, Hayonim, and Nahal Oren) through into modern day Syria (e.g Abu Hureyra). Originally it was argued that the Natufian period represents the first occurrence of sedentism (Garrod 1957; Bar-Yosef & Belfer-Cohen 1992) and Garrod proposed that the Natufians were the first farmers (Garrod 1932). The latter theory has since been disproved and it appears that the Natufians were hunter-gatherers who intensively exploited wild plants, although the discovery of weeds associated with cultivation at Epi-palaeolithic sites suggests that there was pre-domestication cultivation (Willcox 1999, 2004; Tanno & Willcox 2006; Colledge 2001).

However, the debate concerning the duration of occupation of Natufian sites is still on-going with some researchers fervently arguing that there is no firm evidence for sedentism during the Natufian period (Edwards 1989; Boyd 2006). Edwards (1989) highlights some of the key problems with identifying sedentism. He discusses how ethnographic evidence demonstrates that nomadic people, such as Australian Aborigines and Northwest Coast American Indians, can leave behind substantial sites and structures that are only occupied on a temporary or seasonal basis while sedentary people, such as settled Bedouin who live in traditional tents, leave behind little evidence for sedentism (Edwards 1989, 18-21). Edwards (1989) also discounts the presence of human burials at Natufian sites as evidence for sedentism and sites ethnographic and historical examples of people returning to a particular location to bury their dead and argues that a shift in burial practices rather than a change

in lifestyle may explain the increase in burials during the Natufian period (Edwards 1989, 24-25). Edwards (1989) also discounts storage facilities as evidence of sedentism and again looks to ethnographic accounts of hunter-gatherers who horde food at fixed points along their usual nomadic route to which they frequently return. However, the ethnographic examples that Edwards (1989) provides are all of hunter-gatherers who live in cold environments, such as the Nunamiut, where long-term food storage would be more practical (Edward 1989, 25).

Edwards (1989) also questions the use of commensal species as indicators of sedentism. He cites examples of non-sedentary sites where commensal species are found, demonstrating that the presence of commensals does not always indicate sedentism and provides a critical examination of Tchernov's work (Edwards 1989, 28-31. Edwards (1989) points out that there are commensal species in recent levels at Hayonim Cave that are associated with shepherds who over-winter in the cave and cannot be classed as sedentary. In addition, he highlights weaknesses in Tchernov's methods namely that Tchernov (1984) assumes that the microfaunal assemblages discussed are predator assemblages, probably from a barn owl. Tchernov (1984) claims that the predator activity was constant through time and represents an unbiased sample of the microfauna from the vicinity of the sites. Edwards (1989) argues that Tchernov's (1984) hypothesis is invalid because if these assemblages are predator assemblages then the microfauna were not attracted to the cave by human refuse and storage but were brought there as prey (Edwards 1989, 29). However, Tchernov (1984) only assumes that the microfauna are derived from predator assemblages and does not support this assumption with taphonomic analysis. Therefore, it remains unknown whether the microfauna originate from predator assemblages or were naturally occurring in the vicinity of the site.

The Epi-Palaeolithic was followed by the Neolithic which in the Levant is split into different phases: the **P**re-**P**ottery **N**eolithic **A** (PPNA), the **P**re-**P**ottery **N**eolithic **B**, and the **P**ottery **N**eolithic (**PN**), with some Archaeologists also recognising a PPNC. The term Pre-Pottery Neolithic was coined by Kenyon who invented this term to describe early phases of settlement at Jericho which were similar to Neolithic sites found in Europe but without pottery. Instead she found vessels made from stone and bitumen-covered wickerwork (Kenyon 1957). The approximate dates for these phases are given for the southern Levant in Table 5.2 and for the regional terminology proposed for Central Anatolia in Table 5.3 (Özbarşaran & Buitenhuis 2002).

Cultural phases	Conventional 14C years BP	Calibrated 14C years BP
Pre Pottery Neolithic A (PPNA)	10200-9400	11700-10500
Pre Pottery Neolithic B (PPNB)	9500-7900	10500-8700
Pre Pottery Neolithic C or Final Pre Pottery Neolithic B (PPNC/Final PPNB)	7900-7500	8700-8250

Table 5.2 Approximate dates for the Pre Pottery Neolithic in the southern Levant (after Kujit & Goring-Morris 2002, 366)

Cultural phases	Calibrated 14C years BP	Type sites
ECA I	12800-10050	
ECA II	10050-9540	Aşıklı Höyük, Can Hasan III
ECA IIIA: ECA IIIB	9540-8650/8550: 8650/8550-7050	Çatalhöyük East
ECA IV	7050-7450	Çatalhöyük West, Can Hasan I
ECA V	7050-5950	Güvercinkayasi

Table 5.3 Approximate dates for the Early Central Anatolian (ECA) Regional terminology (Özbaşaran and Buitenhuis 2002)

According to these terminologies Çatalhöyük is contemporary with late PPNB/PPNC and would be defined as an ECA III site according to the Early Central Anatolian chronology. Pınarbaşı, Area A is a PPNB/ECAII, and Pınarbaşı Area B is a final Pottery Neolithic/ ECAIII site. This highlights the problems of fitting sites into strict cultural chronologies and of expanding the southern Levantine chronology to fit Anatolia because some of the structures and cultural assemblages found at Pınarbaşı are more in keeping with those found in earlier sites in this region. In addition, while Çatalhöyük may be designated as a PPNB/PPNC site according to the Levantine chronology it has pottery from Level XII onwards which dates to somewhere between 9010 and 8770 Cal BP (OxA-9947) (Last 2005, 127). Çatalhöyük and Pınarbaşı are amongst a number of Neolithic sites that have been found in Central Anatolia. Pınarbaşı is the earliest site so far excavated in south-central Anatolia but the latter part of its occupation may overlap with Aşıklı Höyük which was occupied from approximately 10908 to 10350 Cal BP (dates from CANeW website). The occupation of Can Hasan III, 9550 to 8595 Cal BP (dates from CANeW website) begins approximately two hundred years before Çatalhöyük and ends over 600 years before the abandonment of Çatalhöyük East.

Generally, it is in the PPNA that the earliest villages are found such as Netiv Hagdud, Jericho, Tell Aswad and WF16 (Kujit & Goring-Morris 2002; Finlayson & Mithen 2007). These sites are characterised by small circular structures (sometimes semi-subterranean) clustered closely together around permanent water supplies. The earliest PPNA sites overlap with the Younger Dryas (a stadial which saw a return to cold, dry glacial conditions which occurred from approximately 12 800 to 11 500 14C Cal BP), while later sites were founded towards the end of the Younger Dryas through to the beginning of the Holocene. Bar-Yosef (2001) argues that it was the deteriorating climatic conditions during the Younger Dryas that prompted the development of agriculture. However, there is on-going debate as to whether wild or domesticated cereal grains are found in the PPNA.

There are a number of problems with identifying domestication from archaeobotanical assemblages. The first is that wheat and barley can be difficult to identify to species level on grain morphology alone, making the classification of them as wild or domestic problematic. For example, modern wild barley (*Hordeum spontaneum*) has large grains which are similar to those from domesticated barley (Nesbitt 2002, 116). This is exacerbated by the fact that grains can become distorted with charring. Another problem is that domestic type grains can occur in low frequencies in wild assemblages and so a large sample size is needed to gain a reliable assessment of whether an assemblage is predominantly wild or domestic. Chaff is a more reliable indicator of domestication than grains but again domestic type chaff can be found in wild assemblages. Willcox (1999) estimates that you need over 10% of domestic type chaff in an assemblage to reliably identify it as domesticated. Coupled with the problem of identifying domestication morphologically is the problem of lack of secure dating at some PPNA sites and the intrusion of later archaeobotanical material into PPNA deposits, for example as suggested for Iraq ed-Dubb (Nesbitt 2002, 121). However, in this period we find a large number of mortars, pestles and grinding stones as well as silos suggesting that grain processing and storage occurred.

It is not until the PPNB that we find substantial and unequivocal evidence for plant and animal domestication (Colledge et al 2004; Nesbitt 2002; Willcox 2002). We also find a general shift in architecture from round houses to multi-roomed, rectangular structures, often with lime plastered floors, covering large areas such as the PPNB levels at Beidha (Byrd 2005), although large circular structures which are associated with ritual activities have also been found for example at Göbekli Tepe, Nevalı Çori and Çayönü. Although Pınarbaşı Area A is contemporary with earlier examples of these PPNB 'villages' it is apparent that the structures are not typical of PPNB settlements and

are very different in settlement design to Çatalhöyük and the published later phases of Aşıklı Höyük (Baird in press).

During the PPNB we find elaborate funerary practices and an expansion in the use of art and ritual (Cauvin 1994). Cauvin (1994) discusses the 'skull cult' where skulls are removed after primary burial and reburied in groups. Skull removal is seen on a large scale at Çayönü, southern Turkey, where a cache of over seventy human skulls were found inside a building which has aptly come to be known, as the 'skull building'. Skull removal was also found in the PPNB at Ain Ghazal, northeast Jordan, where, as at Çatalhöyük, bodies were buried beneath plastered floors, and their heads subsequently removed (Rollefson 2000). In the second phase of excavation at Pınarbaşı, the decapitated skeleton of a young adult male was found in the Epipalaeolithic levels of Area B. The presence of teeth in the grave fill suggests that decapitation occurred after the primary burial. In addition to Burial 492, Çatalhöyük (the decapitated skeleton covered by the hackberry board shown in Figure 5.9), another burial was found which contained an adult female with a skull in her arms (Hodder 2006). The skull had been plastered many times and painted red with ochre. This is a poignant burial; the skull is cradled in the arms of the woman and much love and tenderness can be seen in this burial which is not evident in the caches of skulls found at other sites. It would appear that a close relationship existed between the two individuals buried here and between them and the people who buried them. Plastered skulls are often found in the Neolithic of southwest Asia. Plastered skeletal remains are found at the PPNA site of WF16 in Jordan (pers. observation), and more famously in the PPNB layers of Jericho and Ain Ghazal (Kenyon 1957; Rollefson 2000). The transition from the pre-pottery Neolithic to the pottery Neolithic is not associated with the abrupt change in architecture that is characteristic of the change from the PPNA to the PPNB in the southern Levant, and pottery Neolithic sites in Anatolia are generally similar to those found in the final PPNB with conjoined small rectilinear buildings.

Other ritual practices of the Neolithic involve the depiction of animals. Çatalhöyük is famous for its bull imagery with bucrania plastered into the walls and floors of buildings and depicted in paintings and reliefs. Bull imagery is found in other Neolithic sites in southwest Asia, one of the earliest being Mureybet where bucrania were found within the walls of buildings in the PPNA levels. Bucrania were also found at Tell 'Abr 3 within a bench, and at Jerf el Ahmar where four were found in a building; excavators believed these would have originally been suspended on interior walls (Cauvin 1994; Hodder 2007b, Stordeur 2000). Plastered animal bone has been found in the Late Neolithic deposits at Pınarbaşı. These include a range of animals including sheep, aurochs and equids (Baird in press).

Carnivores are portrayed in the art at Çatalhöyük. The feline is frequently depicted, with leopards found in wall art and also in mobiliary art, for example, the famous figurine of a 'mother goddess' flanked by two felines. It was not until 2004 that a leopard bone was found at Çatalhöyük which was perforated and had probably been used as a pendant. It was found incorporated into the burial of the adult female and the plastered skull (Hodder 2007b). Weasel and fox skulls were found plastered into the walls of what Mellaart called Shrine VII, 21. The fox skull was placed above the weasel skull and both had been covered in plaster. Mellaart believed that these 'protuberances' represented breasts (Mellaart 1964). Foxes and lions are shown in the art during the PPNA and early PPNB at Göbekli Tepe in southeast Turkey demonstrating that carnivores were depicted in art across Anatolia in the Neolithic.

Perhaps the most evocative symbols of Çatalhöyük are the female figurines. These were originally seen as Mother Goddesses and were used to argue that Çatalhöyük was a matriarchal society. This theory still prevails among some groups such as the Eco-feminists who regularly visit the site but is losing favour amongst others. Hodder (2007) downplays the importance of these figurines and argues that they are only a small part of the overall symbolism found at the site. Baked clay female figurines are commonly found in Anatolia, for example at Cafer Höyük, Göbekli Tepe, and Nevalı Çori and are in no way unique to Çatalhöyük.

CONCLUSION

This section has given a brief overview of the sites and the region in which they are located. The microfaunal assemblages from Pınarbaşı and Çatalhöyük are useful not only as palaeoenvironmental proxies but also because they allow us to test the hypothesis that commensal species are indicative of sedentism and to assess how useful microfaunal communities are in determining the use of space at archaeological sites, for example in identifying storage areas or periods of abandonment. These issues are particularly pertinent in the Neolithic which is the first period to see the establishment of large sedentary communities with multiple structures on a scale not previously encountered in the Natufian period. Unfortunately, many Neolithic sites in southwest Asia were excavated before the screening of sediments became routine and microfauna were not recovered. Indeed, in many sites in southwest Asia screening is still not employed and so the assemblages from Pınarbaşı and Çatalhöyük offer us the opportunity to study microfaunal assemblages from this critical time period in Anatolia.

6 MATERIALS AND METHOD

MATERIALS

The Pınarbaşı assemblage includes samples excavated from Areas A and B. In total 805 identifiable elements were analysed, which represents all the identifiable microfaunal remains recovered in the first phase of excavation but not the material from the recent excavations. Due to the more extensive nature of the excavations at Çatalhöyük, 9863 identifiable elements were analysed. These were from the first phase of excavation in the South and North areas of the site.

METHOD

Sorting and Sampling

The Çatalhöyük material was sorted during the summer season of 2000. All material sorted was generated by the flotation process, the protocol for which was in place since the beginning of Phase one of excavation. A list of samples was selected which was largely based on 355 priority units that were to be studied by all laboratory specialists working at the site. These samples were selected during the course of 1999 through a series of meetings and discussions by all archaeologists working at the site and did not all contain microfauna. They included a selection of units from each unit category and also some that were chosen because of their special interest to various laboratory specialists. Statistical analysis by Sarah Cross May suggests that these are a good representation of the overall units found at Çatalhöyük during the first phase of excavation (Cross May 2005). In addition to units selected from the 355 priority units, a small number of units were selected which seemed to have interesting concentrations of microfauna. In total eighty-two units were analysed from Çatalhöyük. Both small mammal and amphibian remains were selected for export from Çatalhöyük to Cambridge. Only taxonomically identifiable elements were selected or those elements which displayed interesting taphonomic modifications. This is because exporting faunal material from Çatalhöyük can be problematic and only a limited amount of fauna had been exported prior to this for specific types of research such as isotope analysis. All macrofauna has to be studied on site. Therefore, material chosen for export was kept to a minimum to limit the chances of permission for export being refused. Unfortunately, time constraints meant that it was not possible to count all of the unidentifiable bone fragments while at the site and so the level of fragmentation could not be determined.

Some units that were identified as being rich in microfauna during the excavation process had a complete soil sample taken and were not passed through the flotation machine. Initially, it was hoped that a micro-excavation could be done on these soil samples. Unfortunately, the nature of the sediment meant that the soil had dried together in large clumps and so it was difficult to break these up without damaging the bones. In the end, it proved less destructive to hand float these samples using a 0.34 millimetre mesh and a bucket. Once this had been done the samples were gently sieved through a series of small stacking sieves which were four millimetres, two millimetres, one millimetre and 0.5 millimetres in size. The use of the 0.5 millimetre sieve meant that even the small elements could be recovered. The residue from this flotation process was saved and sorted to check that no small bones had been missed. Once this was done, the identifiable bones were picked out for export.

All other units were processed using the flotation machines on site. Samples are taken for flotation in order that organic remains can be retrieved and it is in the heavy residue resulting from this procedure that the majority of the microfauna included in this study are derived. The first flotation machine was used on site in 1995. This is a motorised flotation machine based on the Ankara design system, named because it was developed at the British Institute at Ankara (French 1971). This consists of an A3 horsepower motor attached to a fifty-five gallon oil drum. Initially the aim was to take and process sixty litres of soil from each unit excavated wherever possible. In 1996 this procedure was modified and instead of sixty litres of soil being collected, samples of either twenty or forty litres were taken from each unit. Occasionally, a second sample was taken from specific midden and fill units. In order to keep up with the number of samples excavated, a second flotation machine was built based on the Shell Mound Archaeological Project machine (SMAP) (Watson 1976). This is slightly larger than the usual flotation machine and has a drum with a seventy-five centimetre diameter as opposed to a fifty-six centimetre diameter. It is pump driven and has a more powerful motor to aid in the breaking down of soil which means that larger soil samples can be processed. Both machines have a 0.5 millimetre mesh to recover the heavy residue and 0.34 millimetre mesh for recovering the light fraction. Recycled water is used and each machine is cleaned out once or twice a week, depending on how much silt has settled in them and each machine undergoes partial cleaning at the end of each day. Samples smaller than one litre are not put through the flotation machine but instead are floated in a bucket. This is done by clipping a chiffon mesh to the edges of the bucket. The sample is then sprayed with water to encourage the silt to pass through the mesh. The heavy residue and the light fraction are extracted by washing out the silt. These samples are dried in the normal manner, which involves tying up the edges of the chiffon and hanging them on the line.

The heavy residue is transported from the flotation area to the sorting area in a plastic bag where it is processed according to its priority status. The heavy residue from each unit is passed through a twelve inch or an eight inch geological sieve and then through a stack of four millimetres, two millimetres, and one millimetre sized sieves. The various organic material is selected from the sieves by a group of local women, who are supervised by a member of the botanical team. The sorters begin with the largest size fraction and work their way down through the sequence. A heavy residue form is filled out for each flotation sample which records the date, the archaeologist responsible for excavation, and the provenance of the sample (Hastorf 1996).

The amount of heavy residue sorted varies from sample to sample. The workwomen are very diligent sorters and return to the site to do the same job year after year and so the sorting remains consistent. One hundred percent of the four millimetre fraction is sorted while the amount sorted for the 2mm and 1mm fractions varies according to the amount of heavy residue produced from 100% to 6.25%. These fractions are split into fourths using a metal sample splitter, or riffle box (Pearsall 2000). All samples are then weighed. Furthermore, some samples, for example, 25%, would be sorted for 'all bone', whilst another fraction, for example a further 25%, is sorted for diagnostic bone only. This is the bone that the local women deem to be identifiable. The method employed by the workwomen to determine which elements are diagnostic is to pick out elements which are 'shaped'. The diagnostic elements are recorded on the flotation label using the Turkish word, *şekili* meaning shaped, while the undiagnostic is recorded as *hepsi* meaning everything. Although this situation is unsatisfactory, it is uniform and this bias is present throughout the various units analysed from Çatalhöyük and does not cause a bias that could affect intra-unit comparisons. This procedure was changed after the first phase of excavation and now all bone is sorted to the same percent from the one millimetre and two millimetre fractions.

Sorting the Pınarbaşı assemblage was less complicated than sorting the Çatalhöyük assemblage. This was largely because fewer contexts had been excavated and because the macrofauna specialist had already separated the microfauna from the macrofauna. The ten millimetres, four millimetres, two millimetres and one millimetre samples were sorted in order to ensure that no microfaunal elements had been missed and the microfauna was identified on site at the Karaman museum using my own comparative collection. A small number of elements were exported to UK, either because their identification was problematic or because they displayed interesting taphonomic modifications which could be better examined using a **S**canning **E**lectron **M**icroscope (SEM).

One hundred percent of the Pınarbaşı assemblage was analysed. However, five of the samples from the Çatalhöyük assemblage (units: 2091, 4614, 4515, 4619, and 4623) were so large that sub-sampling was necessary. In these instances 100% of the cranial elements were analysed because these are the elements that allow identification to species level. The postcrania from units 2091, 4614, and 4619 were analysed to 50% and 4623 was sampled to 25%.

Species Identification

Species identification was largely restricted to cranial elements. The exceptions to this were the postcranial elements from the species' *Suncus etruscus* (Pygmy white-toothed shrew) and *Arvicola terrestris (*water vole*).* The former is so small that it is unlikely to be any other insectivore, and the latter is so large it is unlikely to be any other rodent. Identifications were made using the comparative collections of: the Harrison Institute, Kent; the Natural History Museum, London; the Grahame Clark Zooarchaeology Laboratory, McDonald Institute, University of Cambridge; and my own personal collection that I obtained by trapping live micromammals in and around Çatalhöyük and from specimens obtained from owl pellets collected in Turkey. Specimens of the sub-species *Mus musculus* (house mouse) were identified following the methodology developed by Harrison and Bates (1991, 250). This involves comparing the relative width of the malar process with the zygomatic arch. In the case of *Mus musculus* the malar process is narrower than the zygomatic arch. In the case of *Mus macedonicus* (Macedonian mouse), the other species of *Mus* occurring in the study area, the malar process is wider than the zygomatic arch. Incisors were usually identified as 'rodent' although *Mus* upper incisors are distinctive because they have a notch and could be identified to genus. Furthermore, shrew incisors are morphologically distinct from rodent incisors. Murid molars were usually easily identifiable to species unless chipped or broken. However, microtine molars were problematic and frequently could only be identified to genus.

NISP and MNI

As mentioned above all elements were recorded in an Access database and the NISP (**N**umber of **i**dentifiable **sp**ecimens) by element was calculated. This was based on the number of identifiable elements in each unit and the term 'specimen' was used to describe both complete elements and fragments of elements. The use of NISP has been criticised for many reasons. However, perhaps the most pertinent criticism is that when the NISP is used to compare the abundance of taxa in a sample the result can be biased by the fact that some taxa have more elements in their skeleton than others. For example, the genus *Sorex* has forty teeth (eight incisors, four canines, eight pre-molars, and twelve molars) whilst most rodents have only sixteen (four incisors and twelve molars). In this way,

if all teeth of both creatures were preserved within an assemblage the NISP would give the appearance that there were twice as many of the *Sorex* than rodent (O'Connor 2000, 56-57).

The MNI (**M**inimum **N**umber of **I**ndividuals) was also calculated. Shotwell (1955) describes the MNI as being the smallest number of individuals which is necessary to account for all of the skeletal elements of a particular species found on a site (Shotwell 1955, 350). It is generally believed that White (1953) introduced the MNI method to Archaeology, although it had been used in Palaeontology for many years before this (Casteel 1977). For large units the NISP per litre of sediment was calculated so that the different unit densities could be compared. This was done by assuming that 100% of the sample had been analysed, multiplying the results up accordingly and then dividing this figure by the number of litres of sediment sampled. This is to provide an idea of the density of microfauna and allow a rough comparison of density between units to be achieved. The assemblages from both sites had been sampled during the heavy residue sorting and the larger units from Çatalhöyük were sampled again during analysis. The percentage of the context sampled is given for all contexts in the NISP table in Chapter 7.

Relative Proportion of Elements

The relative proportion of elements refers to the relative proportions of elements to one another. This is the actual number of elements and divided by the number of each element in the skeleton. For example, if there were forty-eight humeri the figure for the relative proportion for this element would be twenty-four as there are two humeri in the skeleton and if there were eighty-four rodent molars the figure for the relative proportion would be seven as there are twelve molars in a rodent skull. Symmetry was not taken into account when assessing relative proportions but bone part was taken into consideration. Therefore if there was a distal end of a humerus and a proximal end of humerus this would only be counted as one specimen. This analysis is done to establish if any one part of the skeleton is more abundant in the assemblage than another and included only micromammalian remains. For the units that were postcranially sub-sampled: 2091, 4619, and 4623 the figures for the post-crania are adjusted up to 100% so that they are comparable with the crania and comparable with other units.

Breakage

Small mammal skulls are rarely found intact within owl pellets because most owls kill their prey by swooping down upon the animal, and grasping and breaking the back of its neck. Fortunately, this does not affect the usefulness of the skull for species identification, because the teeth are usually not damaged. However, skulls may endure more damage than this and often only isolated maxillae are

found with or without molars. The mandible is a robust element and is frequently preserved in predator assemblages (Andrews 1990, 55). Usually when breakage occurs, it is the coronoid and the condyloid processes, followed by the inferior border, that are most affected. The teeth may or may not be present. The cranial breakage categories devised by Andrews (1990) were used in this analysis for murid and microtine remains (Andrews 1990: 51, 53, 56). Insectivore crania were not included in this analysis because insectivores have a different cranial structure and so breakage occurs in different ways. The post-cranial breakage methodology of Andrews was also followed which records breakage patterns for humerus, ulna, femur and tibia (Andrews 19990, 51). The radius was discounted because it is fragile and breaks easily and the fibula is not a separate bone in small mammals but is fused to the tibia. A complete major limb bone was defined as a bone that has the majority of both the proximal and the distal parts of the bone attached to the shaft. Breakage at the epiphyses is not counted as a true break (Andrews 1990, 50).

Identifying and Recording Digestion

As noted in Chapter 2, digestion is the most useful criterion in determining the predator responsible for accumulating a microfaunal assemblage. When identifying digestion the analyst must be careful not to confuse digestion with any other taphonomic process, for example, weathering. Fortunately, much research has been done into the effects of digestion and these have been well documented and illustrated (For example, Andrews 1990, Fernandez-Jalvo & Andrews 1992). Furthermore, the analysis of modern owl pellet assemblages allows one to gain familiarity with the effects of digestion because the elements have usually been protected from weathering by the protective shell of the pellet or scat.

Digestion was recorded for the following elements: loose teeth, skulls, maxillae, mandibles, distal humeri and proximal femora. The digestion was recorded as light, moderate, heavy or extreme and was based on the methodology developed by Andrews (1990) and Fernandez-Jalvo and Andrews (1992). The digestion categories used for the post-crania are shown in Figures 6.1 and 6.2. Digestion was initially identified using a standard light Leica microscope (Leica MZ75). Further, analysis was conducted using an SEM (Philips XL30 FEG) located in the Department of Anatomy, University of Cambridge.

Digestion is most frequently found on the tips of incisors. However, in the Çatalhöyük assemblage digestion was often seen on the developing end. On some specimens this looked like digestion and on others, small parallel striations could be seen which looked like gnaw marks. Due to the fact that little research has been done into the effect that digestion has on this area of the incisor, incisors

with this form of digestion are not grouped with the other digested incisors but will be discussed separately in Chapter 7. Discounting this, incisors were recorded following the methodology developed by Fernandez-Jalvo and Andrews (1991: 413).

Fernandez-Jalvo and Andrews (1992) also established digestion categories for microtine molar digestion. This worked well for the Pınarbaşı assemblage but was less appropriate for the Çatalhöyük assemblage. This is because the tooth used to illustrate the digestion categories is a microtine molar whereas the Çatalhöyük assemblage primarily consists of murine remains. Figure 6.3 illustrates the digestion categories for murid molars that were used in this study. Recent research has demonstrated that there may be some intra-specific variation in the level of digestion found on teeth. Williams (2001, 134), compared the percentage of digestion for total molars, *in situ* incisors, and loose incisors for six different species of small mammals, three murids (*Apodemus sylvaticus, Micromys minutes, and Rattus* sp.) and three microtines (*Arvicola terrestris*, *Clethrionmys glareolus*, and *Microtus agrestis*) from modern barn owls pellets.

Williams (2001) found that the levels of digestion were consistently higher for the microtines (voles) species than for murids (mice, rats and gerbils). The species with the highest digestion rate is the water vole (*Arvicola terrestris*), followed by the field vole (*Microtus agrestis*) and the species with the lowest is the wood mouse (*Apodemus sylvaticus*). It is not surprising that the microtine molars have higher digestion levels. This is largely because the morphology of microtine molars allows a greater area of enamel to be exposed to digestion. Furthermore, Williams (2001, 279-280), explains the higher rate of digestion found in the water vole as being attributable to the fact that the enamel is absent in certain areas of the teeth. However, there is little difference in morphology between microtine and murid incisors and thus there is no obvious reason why murid incisors should be more susceptible to digestion than those of microtine. Further research is needed to determine if this is a recurring trend. In the results, the digestion for the teeth will be displayed by species group as created by Williams (2001; 2005). Group A represents the murids, group B water vole and group C the remaining vole species. The hamsters were placed in group A for the purpose of digestion analysis because the tooth morphology more closely resembles murids than microtines. This allows within species digestion variation to be identified.

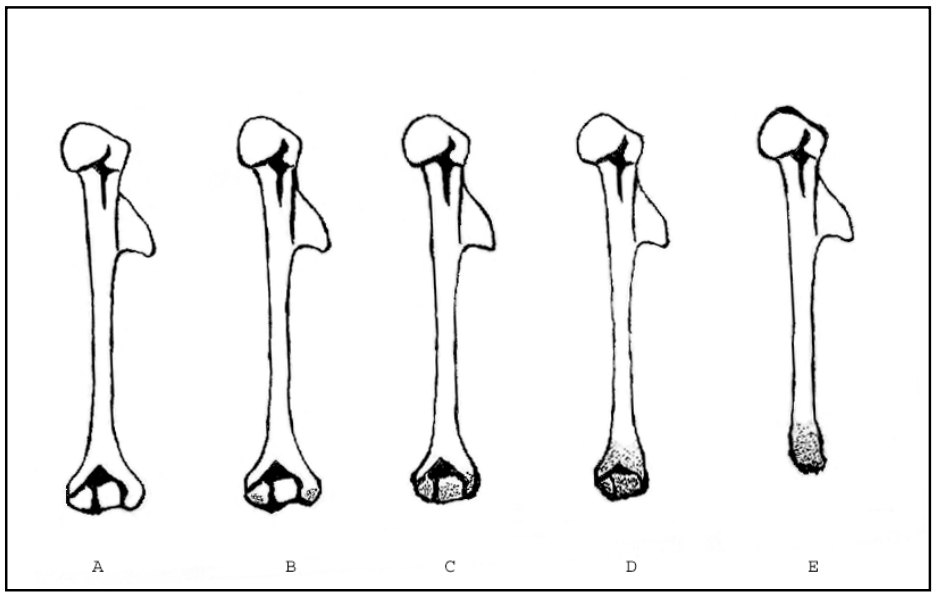


Figure 6.1 Humerus digestion categories

A is an **undigested** humerus. **B** is a humerus with **light digestion**. Slight pitting caused by acid corrosion can be seen on the epicondyles. **C** is a humerus with **moderate digestion**. More extensive pitting is found on the epicondyles and this affects a larger surface area of the distal end. **D** is a humerus with **heavy digestion**. The edges of the distal end are corroded and the pitting extends up the shaft of the element. E is a humerus with **extreme digestion**. The distal end is almost unrecognisable due to the extent of the corrosion.

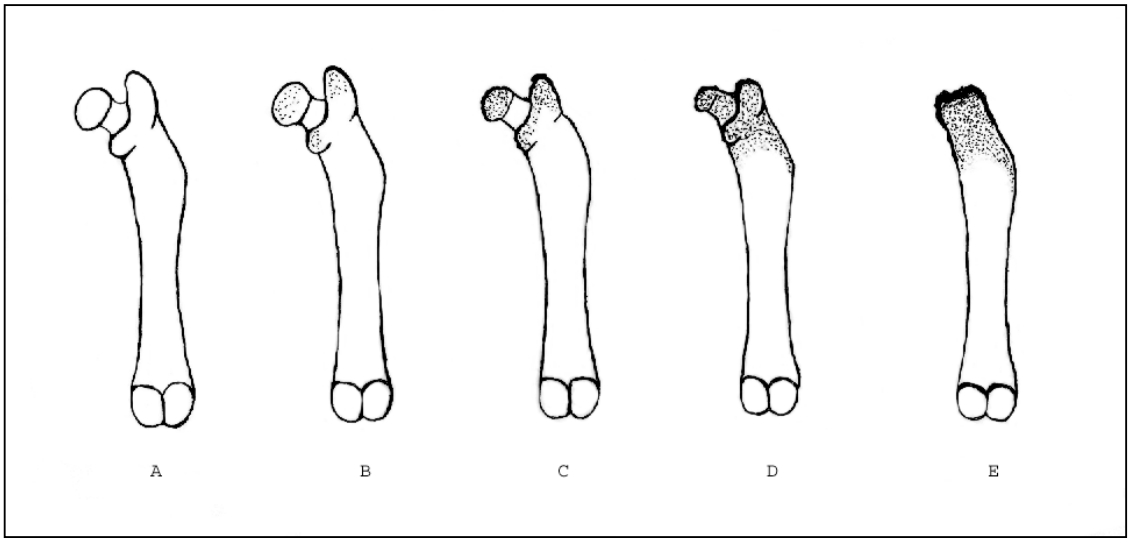
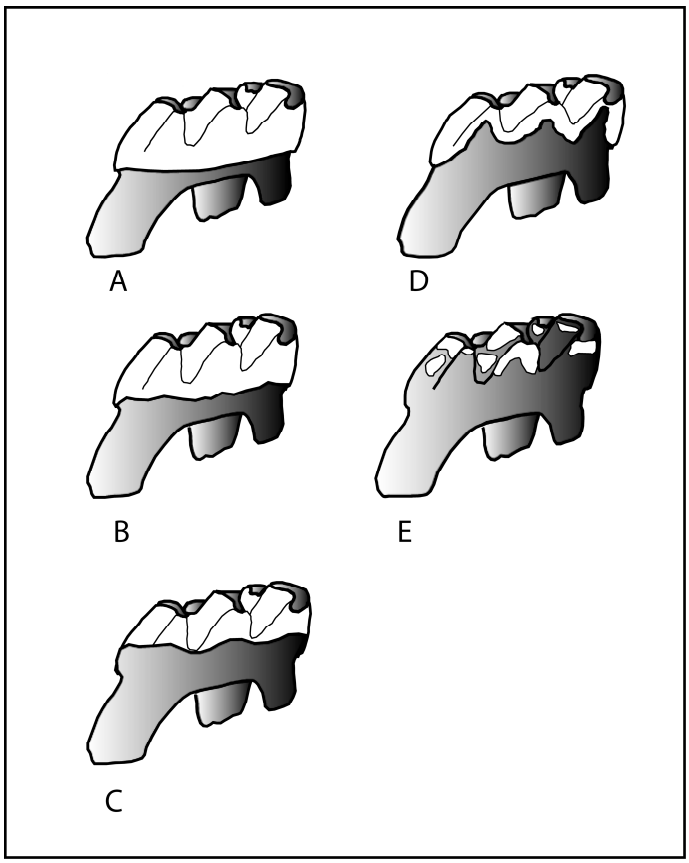


Figure 6.2 Femur digestion categories

A is an **undigested** femur. **B** is a **lightly** digested femur with slight pitting acid corrosion on the femoral head and the greater and lesser trochanters. **C** is a **moderately** digested femur. The pitting is more severe and more extensive and the outline of the femoral head has been corroded slightly. **D** is a **heavily** digested femur. The pitting has affected the whole of the proximal end and the edges of femoral head and the greater and lesser trochanters have been corroded. **E** is an **extremely** digested femur. The proximal end is unrecognisable due to the extent of the corrosion, which has completely destroyed the femoral head and the greater and lesser trochanters and extends down to the third trochanter.



A. Undigested murid molar- enamel is shown in white, dentine in grey

B. Light digestion- the junction between enamel and dentine has a 'wavy' appearance and is less defined than in the undigested molar

C. Moderate digestion- more of the enamel is digested and the enamel/dentine junction is found higher up the crown of the tooth

D. Heavy digestion-a limited amount of enamel remains on occlusal surfaces

E. Extreme digestion. Enamel is nearly completely absent from the tooth and in some instances corrosion of the dentine is visible

Figure 6.3 Digestion categories for murid molars

Identifying and Recording Gnawing and Puncture marks

Elements with gnawing and puncture marks were present in both the Pınarbaşı and the Çatalhöyük assemblages but considerably more were found in the Catalhöyük assemblage. As a result, although the elements with gnaw and/or puncture marks are mentioned in the Pınarbaşı results they are not discussed in detail. However, in the Çatalhöyük results, a table outlining the element type and the number of elements affected is provided for the units with gnawed and punctured elements. In addition to this, a further table shows the average size of the puncture marks found on the elements. These measurements were done using a graticule in the Leica (MZ75) microscope that was used to analyse the whole of the Catalhöyük assemblage. In this table, the element type, the number of puncture marks measured and the average length of the puncture mark is shown. This analysis was undertaken after the main analysis of the Catalhöyük assemblage. Therefore, not all of the elements with puncture marks outlined in the first table have been measured. Some of the elements had more than one puncture mark; in these instances all of the puncture marks visible on the element were measured. Therefore the number of marks measured refers to the number of puncture marks and not to the number of elements with puncture marks. Puncture marks were defined as deep depressions that penetrate through the surface of the bone and leave clear and regular surface pits. Any marks that were ambiguous and could have been caused by another taphonomic process were not included

in the analysis. In addition, an analysis of the marks by bone type rather than by element was also conducted. This is because tooth mark sizes are related not only to the size of the carnivore tooth but also to bone density and puncture marks tend to be larger on cancellous bone than on dense cortical bone (Selvaggio & Wilder 2001). As a result, this analysis included the following types: puncture marks on bone shafts, puncture marks on split shafts, and puncture marks on articular ends of bones.

7 RESULTS

THE RESULTS FROM PINARBASI

The contexts from Area A

Three contexts were analysed from site A: ABJ, ABR and ABU. ABJ was a thin layer of silty brown soil into which the grave of a juvenile human had been cut. ABR was below ABJ and above ABU. It is described as a thin lens of reddish-brown soil. ABU consisted of dark grey-brown soil. These deposits were not directly associated with any structures or features and result from generalised depositional processes (Douglas Baird, pers. comm.). The results for NISP and MNI for all three contexts from Area A are shown in Table 7.1. From this it is clear that these contexts were dominated by amphibians with micromammals being largely comprised of water vole. All of the contexts produced small samples. ABU was the only one which could be assessed for digestion level and relative proportion of elements was not calculated for any of the contexts. Results for breakage analyses can be found in Tables 7.2 and 7.3, while tooth digestion for ABU is shown in Table 7.4. In addition, both of the humeri in this context were digested, one was lightly digested and the other was extremely digested.

	NISP			*MNI*		
Taxon	**ABU**	**ABR**	**ABJ**	**ABU**	**ABR**	**ABJ**
% of context analysed	42%	42%	42%	42%	42%	42%
Micromammal	14	1	3	0	0	0
Rodent	1	1	0	1	0	0
Arvicola terrestris	4	5	1	1	2	1
Amphibian	99	71	67	27	19	18
Snake	12	2	1	1	1	1
Turtle	0	2	0	0	1	0
Total	**130**	**82**	**72**	**30**	**23**	**20**

Table 7.1 NISP and MNI for Area A

Skull breakage category	**ABU**		**ABR**		**ABJ**	
	No	**%**	**No**	**%**	**No**	**%**
Complete	0	0	0	0	0	0
Broken skull with zygomatic intact	0	0	1	100	1	0
Maxilla fragment lacking the zygomatic process	0	0	0	0	0	0
Mandible breakage category						
Complete	0	0	0	0	0	0
Broken ascending ramus	0	0	0	0	0	0
Ascending ramus missing	0	0	0	0	1	100
Ascending ramus missing and inferior border broken	1	100	3	100	0	0

Table 7.2 Cranial breakage for the contexts from Area A

	ABU		**ABR**		**ABJ**	
POST-CRANIAL BREAKAGE	**NO**	**%**	**NO**	**%**	**NO**	**%**
Humerus						
Complete	2	50	0	0	0	0
Proximal	0	0	0	0	0	0
Shaft	1	25	0	0	0	0
Distal	1	25	0	0	0	0
Ulna						
Complete	0	0	0	0	0	0
Proximal	1	33	0	0	0	0
Shaft	1	33	0	0	0	0
Distal	1	33	0	0	0	0
Femur						
Complete	0	0	0	0	0	0
Proximal	3	60	0	0	0	0
Shaft	2	40	0	0	0	0
Distal	0	0	0	0	0	0
Tibia						
Complete	0	0	0	0	0	0
Proximal	0	0	0	0	0	0
Shaft	0	0	0	0	0	0
Distal	2	100	1	100	1	100

Table 7.3 Post-cranial breakage for context ABU

	No of *in situ* maxillary molars digested	**No of *in situ* mandibular molars digested**	**Total no of *in situ* molars**	**No of digested isolated molars**	**No of isolated molars**	**% of molars digested**
Group B	0	0	2	2	3	40

Table 7.4 Molar digestion for context ABU

The contexts from Area B

The results from the contexts surrounding the curvilinear feature (contexts BAV, BAY, BBC, BBE, BBG, BBI, and BBJ)

Although the NISP for the snake is high, it is apparent from Table 7.5 that this represents only one individual. This is attributable to the fact that fifty-three snake vertebrae were found and a snake can have between 130 and 500 vertebra (Arnold *et al* 1978). Breakage is illustrated in Tables 7.6 and 7.7 and shows that there are no complete elements in this assemblage. Digestion results can be found in Tables 7.8 and 7.9 and demonstrate that the level of digestion is high for this assemblage. In addition, a micromammal rib was found with puncture marks.

Taxon (60% of context sampled)	**NISP**	**MNI**
Micromammal	53	0
Medium micromammal	13	0
Large micromammal	4	0
Rodent	11	0
Crocidura suaveolens	1	1
Spalax microphthalmus	1	1
Meriones tristrami blackleri	1	1
Apodemus mystacinus	1	1
Mus sp.	1	1
Muridae	2	0
Arvicola terrestris	2	2
Microtus sp.	13	4
Microtine	10	4
Amphibian	10	2
Snake	53	1

Table 7.5 NISP for the contexts surrounding the curvilinear feature

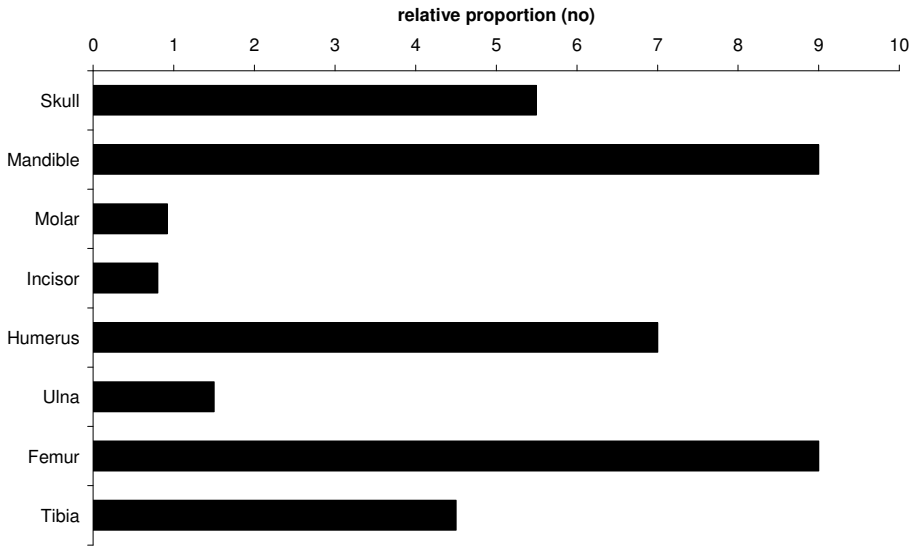


Figure 7.1 Relative proportion of elements from the area surrounding the curvilinear feature

Skull breakage category	**No**	**%**
Complete	0	0
Broken skull with zygomatic intact	3	25
Maxilla fragment lacking the zygomatic process	9	75
Mandible breakage category		
Complete	0	0
Broken ascending ramus	3	17
Ascending ramus missing	2	11
Ascending ramus missing and inferior border broken	13	72

Table 7.6 Cranial breakage for the assemblage from the area surrounding the curvilinear feature

POST-CRANIAL BREAKAGE	**NO**	**%**
Humerus		
Complete	3	17
Proximal	3	17
Shaft	6	33
Distal	6	33
Ulna		
Complete	0	0
Proximal	1	33
Shaft	2	67
Distal	0	0
Femur		
Complete	1	4
Proximal	12	52
Shaft	6	26
Distal	4	17
Tibia		
Complete	0	0
Proximal	3	30
Shaft	5	50
Distal	2	20

Table 7.7 Post-cranial breakage for the assemblage from the area surrounding the curvilinear feature

Incisors	**No of *in situ* maxillary teeth digested**	**No of *in situ* mandibular teeth digested**	**Total no of *in situ* teeth**	**No of digested isolated teeth**	**No of isolated teeth**	**% of digested incisors**
Incisors Group A	0	0	2	1	1	25
Incisors Group B	0	0	1	0	0	0
Incisors Group C	0	0	2	1	2	20
Total	**0**	**0**	**5**	**2**	**3**	**25**
Molars Group A	0	0	7	0	0	0
Molars Group C	0	0	0	6	11	55
Total	**0**	**0**	**7**	**6**	**11**	**33**

Table 7.8 Tooth digestion for the assemblage from the area surrounding the curvilinear feature

	Humeri		Femora	
Humerus digestion category	**No**	**% of total humeri with distal ends**	**No**	**% of total femora with proximal ends**
Light	3	33	2	15
Moderate	2	22	2	15
Heavy	1	11	5	39
Extreme	0	0	0	0
Total	**6**	**67**	**9**	**69**

Table 7.9 Post-cranial digestion for the assemblage from the area surrounding the curvilinear feature

Results from the fill of the curvilinear feature (contexts BAT, BAW, BAX, BAZ, BBA, and BBH)

Of the six contexts that make up the fill of this feature, only three, BAW, BAZ, and BBA, were floated to a minimum screen size of one millimetre. The remaining three contexts, BAT, BAX, and BBH were screened to three millimetres, limiting the retrieval of skeletal elements to the larger bones or to elements from larger species of microfauna. Results from the NISP and MNI provided in Table 7.10, show that this assemblage had an array of species with microtines being the most abundant. The results from the relative proportion of element analysis, illustrated in Figure 7.2, demonstrates that teeth and ulnae are under-represented, possibly as a result of these small elements not being retrieved, and in the case of ulnae, being more susceptible to breakage. Breakage results can be found in Tables 7.11 and 7.12 Digestion levels are high as shown in Table 7.13 and Figures 7.3 and 7.4. In total, 72% of humeri and 70% of femora are digested.

Taxon (44% of context sampled)	**NISP**	**MNI**
Micromammal	88	0
Medium micromammal	10	2
Large micromammal	3	1
Insectivore	3	0
Crocidura suaveolens	1	1
Crocidura leucodon	1	1
Rodent	15	0
Microtine	16	4
Microtus sp.	26	5
Gerbil	2	0
Meriones tristrami blackleri	3	1
Cricetulus migratorius	1	1
Mus sp.	3	2
Amphibian	13	2
Snake	20	1

Table 7.10 NISP and MNI from the fill of the curvilinear feature

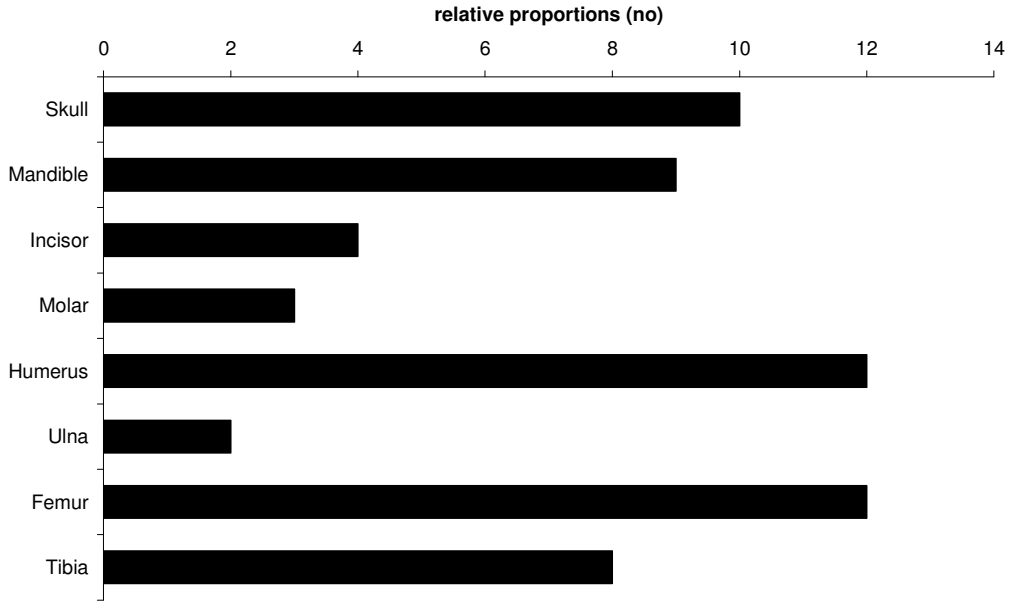


Figure 7.2 Relative proportion of elements in the assemblage from the curvilinear feature

POST-CRANIAL BREAKAGE	*NO*	*%*
Humerus		
Complete	7	18
Proximal	4	11
Shaft	16	42
Distal	11	29
Ulna		
Complete	1	14
Proximal	3	43
Shaft	2	29
Distal	1	14
Femur		
Complete	2	5
Proximal	21	50
Shaft	15	36
Distal	4	10
Tibia		
Complete	3	11
Proximal	2	7
Shaft	11	39
Distal	12	43

Table 7.11 Post-cranial breakage for the assemblage from the curvilinear feature

Skull breakage category	**No**	**%**
Complete	0	0
Broken skull with zygomatic intact	6	50
Maxilla fragment lacking the zygomatic process	6	50
Mandible breakage category		
Complete	0	0
Broken ascending ramus	3	17
Ascending ramus missing	2	11
Ascending ramus missing and inferior border broken	13	72

Table 7.12 Cranial breakage for the assemblage from the curvilinear feature

Incisor	**No of *in situ* maxillary teeth digested**	**No of *in situ* mandibular teeth digested**	**Total no of *in situ* teeth**	**No of digested isolated teeth**	**No of isolated teeth**	**% of digested teeth**
Group A	0	0	1	1	2	33
Group B	0	0	0	0	0	0
Group C	0	0	4	2	9	15
Total	**0**	**0**	**5**	**3**	**11**	**19**
Molar						
Group A	0	0	9	0	2	0
Group B	0	0	0	0	1	0
Group C	0	0	2	11	24	42
Total	**0**	**0**	**11**	**12**	**27**	**32**

Table 7.13 Tooth digestion for the fill of the curvilinear feature

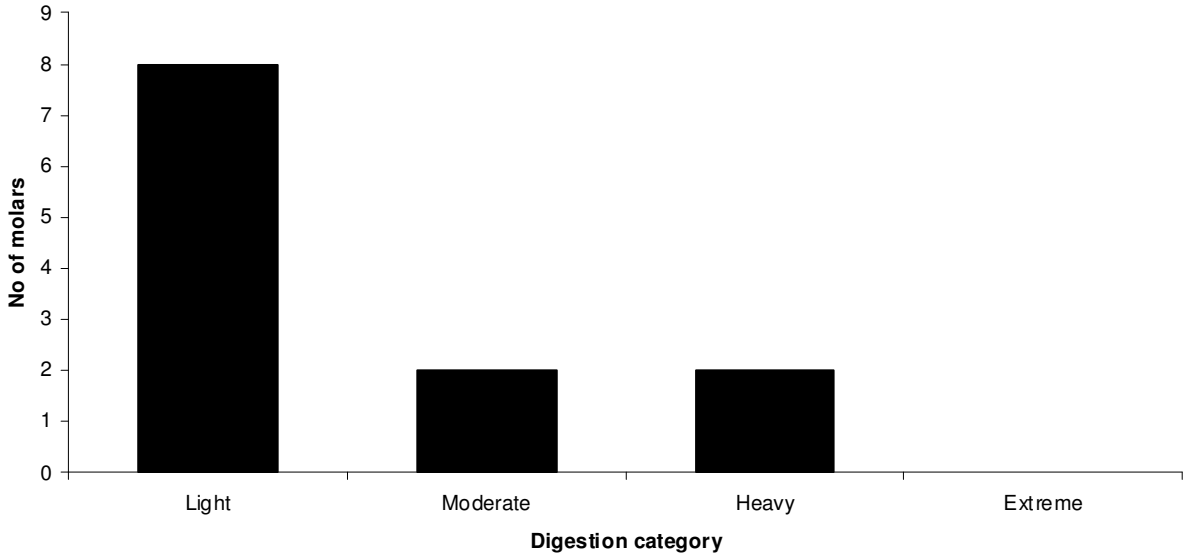


Figure 7.3 Number of digested molars by digestion category from the fill of the curvilinear feature

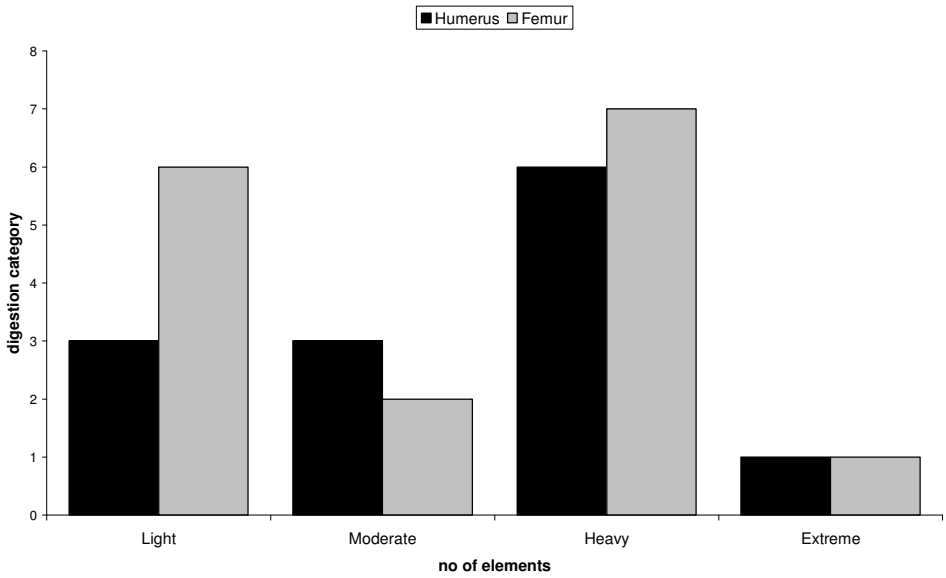


Figure 7.4 Post-cranial digestion by digestion category

Results from the fill of the fire installation (contexts BAD, BAI, and BAM)

The results from the MNI, given in Table 7.14, demonstrate how NISP can be misleading with snakes dominating the NISP, while the MNI shows that they are no more abundant than any other taxa. As the sample size was small the relative proportion of elements was not analysed. There is only one skull, a broken skull with the zygomatic process still intact, and two mandibles both of which have the ascending ramus missing and inferior border broken. Post-cranial breakage is given in Table 7.15. Table 7.16 shows molar digestion and in addition there is a lightly digested humerus and three elements which have evidence of carnivore tooth puncture marks: a bird tibiotarsus with two puncture marks, a humerus with a single puncture mark, and a mandible with a single puncture mark.

Taxon (44% of context sampled)	**NISP**	**MNI**
Micromammal	23	5
Medium micromammal	4	1
Erinaceus concolor	1	1
Rodent	2	0
Microtine	3	0
Microtus sp.	2	1
Gerbil	1	
Meriones tristrami blackleri	1	1
Mesocricetus auratus	1	1
Amphibian	1	1
Snake	455	1
Bird	1	1

Table 7.14 NISP and MNI from the fill of the fire installation

POST-CRANIAL BREAKAGE	*NO*	*%*
Humerus		
Complete	1	25
Proximal	0	0
Shaft	0	0
Distal	3	75
Femur		
Complete	1	20
Proximal	4	80
Shaft	0	0
Distal	0	0
Tibia		
Complete	0	0
Proximal	2	67
Shaft	1	33
Distal	0	0

Table 7.15 Post-cranial breakage for the assemblage from the fill of the fire installation

	No of *in situ* maxillary molars digested	**No of *in situ* mandibular molars digested**	**Total no of *in situ* molars**	**No of digested isolated molars**	**No of isolated molars**	**% of digested molars**
Group A	0	0	1	0	1	0
Group B	0	0	0	0	0	0
Group C	0	0	0	1	3	33
Total	**0**	**0**	**1**	**1**	**4**	**20**

Table 7.16 Molar digestion for the assemblage from the fill of the fire installation

The results from the fill of the pit adjacent to the fire installation (contexts BAJ and BAK)

The fill of this pit consists of only two contexts, one of which, BAJ, contains no microfauna. The other context, BAK, has a small assemblage. The lack of microfauna from context BAJ may be attributable in part to the fact that only a small amount of sediment was floated from this context, only sixteen litres in total. This is less than most of the other contexts and considerably less than BAK which had a sample of 340 litres. The NISP and MNI for context BAK can be found in Appendix Tables 1.1. There is one lightly digested humerus in this sample and in total there are three humeri with distal ends. Therefore, 33% of the humeri are digested. No femora or molars were retrieved from these contexts so post-cranial digestion levels could not be determined. Similarly, there is only one incisor which is not digested.

SUMMARY OF SPECIES COMPOSITION

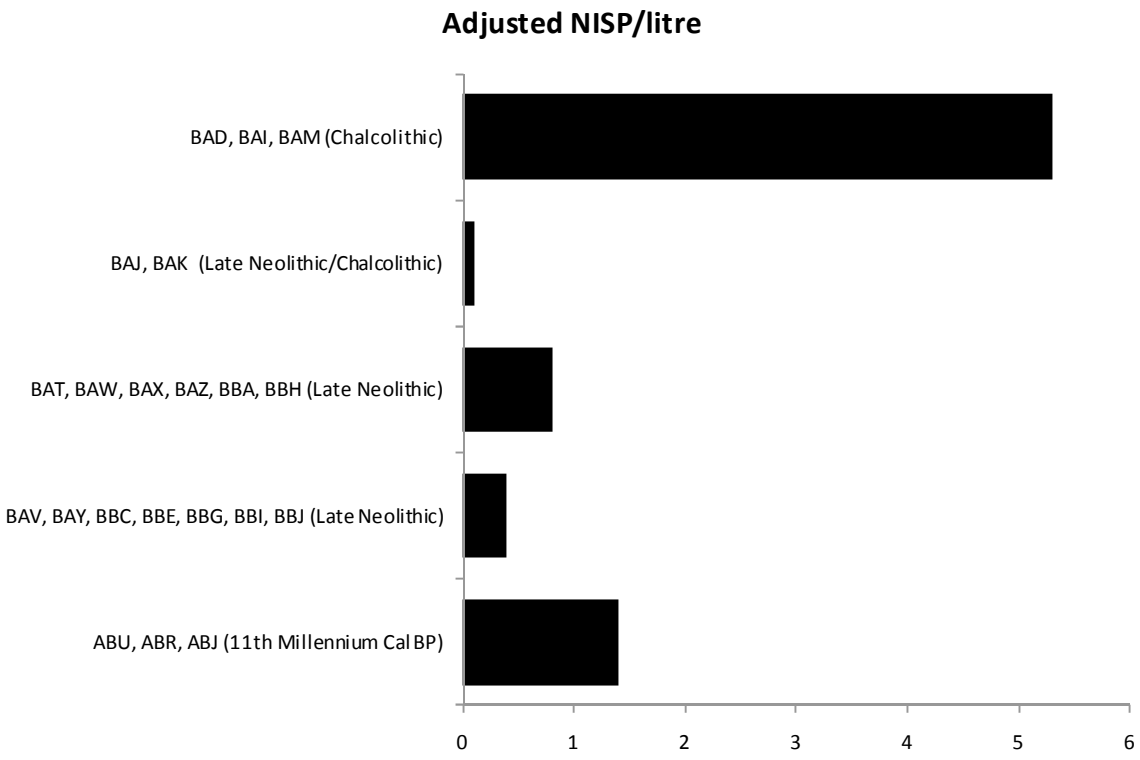


Figure 7.5 Adjusted NISP/litre for the different context groups from Pınarbaşı

Figure 7.5 shows the adjusted NISP for each of the groups of contexts at Pınarbaşı. This approach should only be used with NISP, assuming that the NISP and sediment volume are linearly related, and even then with caution. However, although the highest NISP is found in contexts BAD, BAI and BAM this result is biased by the high number of snake vertebra. Figure 7.6 is a series of bar charts showing MNI per taxon. These charts illustrate that there are few taxa in the Early Neolithic contexts (ABU, ABR, and ABJ) and that this assemblage is dominated by amphibians. There is an increase in the variety of taxa in the Late Neolithic but a decrease in the number of amphibians. Finally, there is a decrease in the number of taxa found in the Chalcolithic, although East European hedgehog (*Erinaceus concolor*) occurs for the first time. No amphibians or snakes are present in the Chalcolithic assemblage.

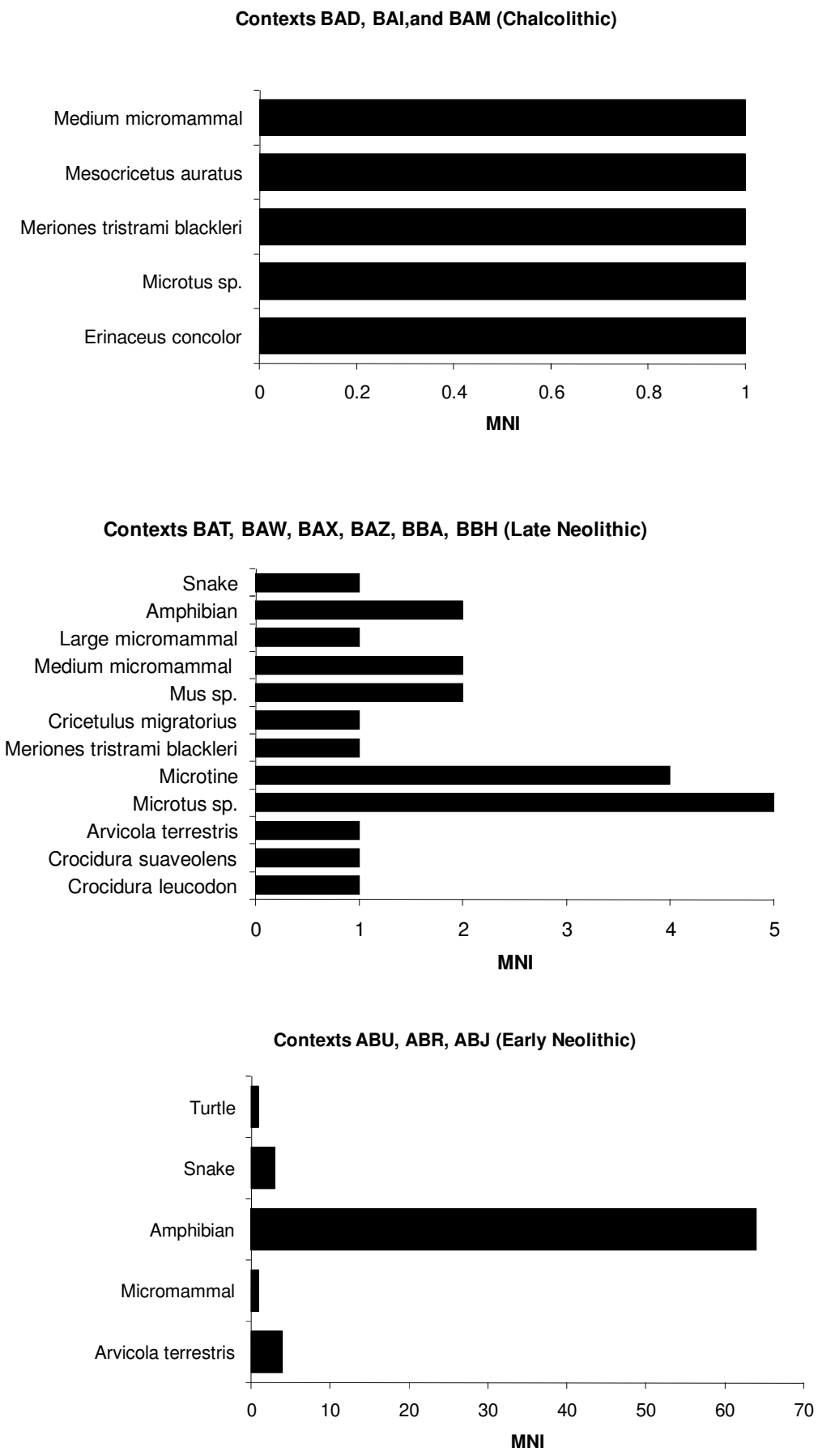
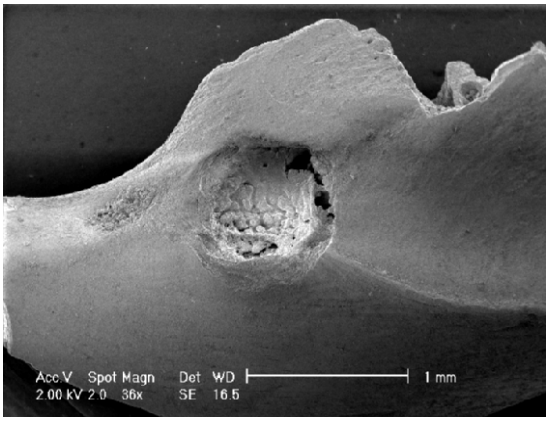
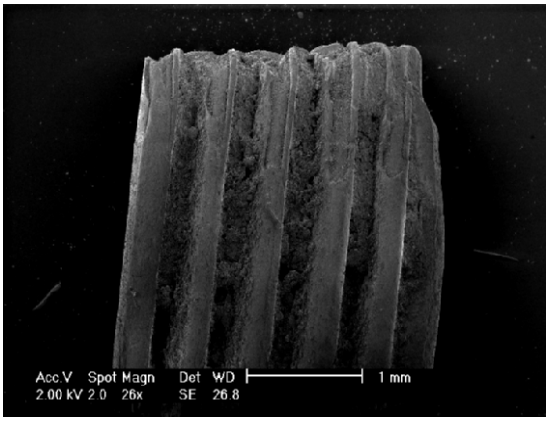
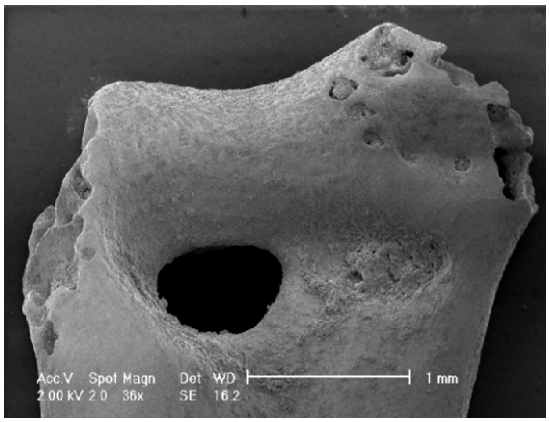
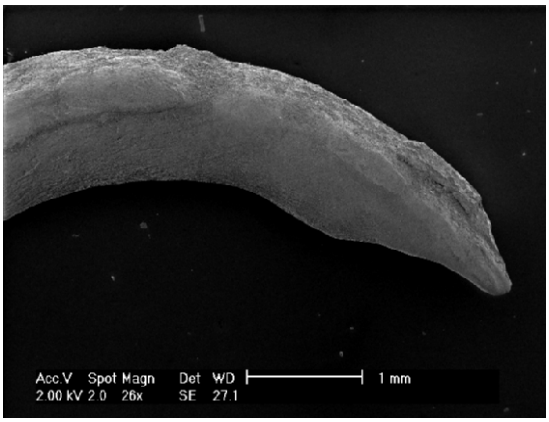


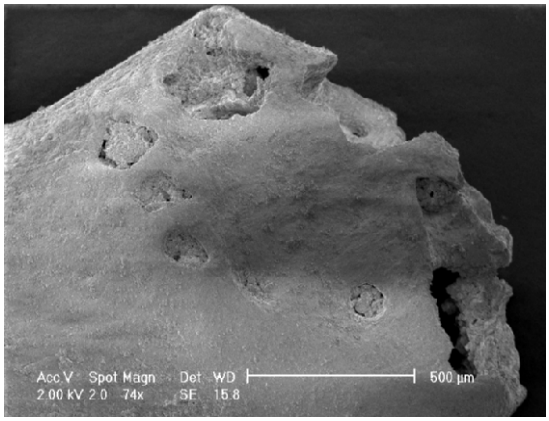
Figure 7.6 MNI per taxon for context groups from Pınarbaşı











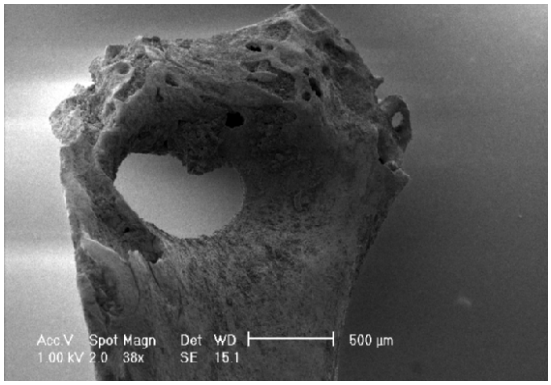


Figure 7.7 SEM micrographs from the Pınarbaşı assemblage
From top left to bottom left:
1. Microtine mandible with puncture mark from context BAM
2. Humerus with puncture marks from context BBA
3. Close-up of above
4. Humerus with heavy digestion from context BAT

From top right to bottom right:
1. Microtine upper molar with moderate digestion from context BBH
2. Upper rodent incisor with heavy digestion from context BBG

RESULTS FROM ÇATALHÖYÜK

Results by Level

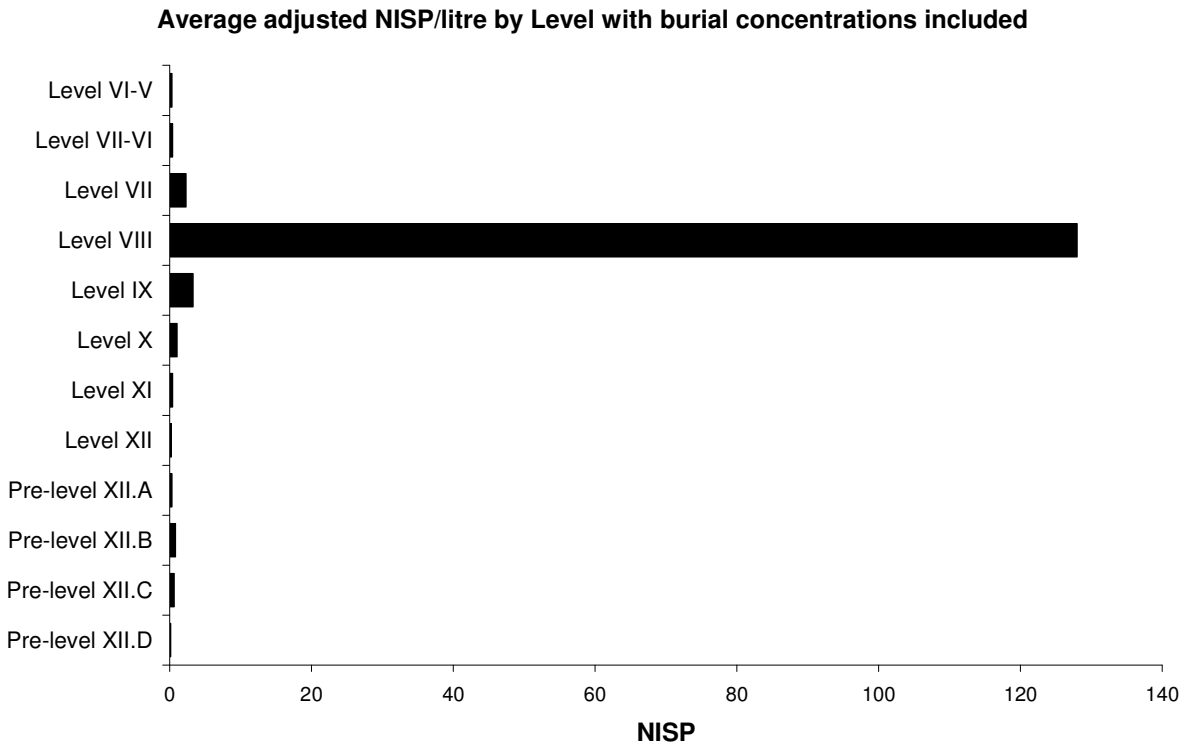
A summary of NISP and MNI by unit can be seen in Appendix Table 2.2. In this chapter, Table 7.16 shows the NISP by taxon for the units by level. This demonstrates that Level VIII has the greatest NISP, far out-numbering any of the other units, followed by Level IX. However, this result is skewed by the presence of five units from Level VIII (all from burial fills) which had far denser samples than any of the other levels. Similarly, the result for Level IX is biased by unit 2091 which also had a greater sample of microfauna than the other units in that level. Figure 7.8 shows the average adjusted NISP per litre by level with the dense burial fills included and then with them excluded. This shows that when the concentrations are excluded, Level VII has the greatest number of elements per litre of sediment. Figure 7.9 shows the percentage change of taxa by level, with the small carnivores excluded. The earliest two levels (Pre-level XII.D and C) consist entirely of amphibians. *Mus* sp. is first found in Pre-level XII.B (categorised here under murine) and is presumably *Mus musculus* as *Mus macedonicus* is not found at Çatalhöyük. The first positive identification of *Mus musculus* was not made until Level X. The percentage of amphibians generally declines through time whereas micromammals increase. However, Figure 7.10 shows the NISP for amphibians by level. This shows that the decrease is not as great as would be imagined from looking at ratios of taxa alone because the amphibians decrease in proportion to the huge number of micromammals found in later levels. As it is not always possible to identify microfauna to species or even genus level many of the elements were only identifiable as micromammal or rodent. However, from the elements that could be identified it is apparent that murines are more abundant than microtines or insectivores. As *Mus musculus* is the only murid found at Çatalhöyük, and the elements that could be identified as micromammal or rodent were small, it is probable that all of the murines found were *Mus musculus*.

Results by Unit Category

As with the results by level this analysis is biased by the presence of large concentrations of microfauna, particularly the burial units. Therefore, Figure 7.11 shows the results with artefact/cluster, burial fill and skeleton categories present and then with them omitted. When these categories are excluded it is apparent that middens have the greatest density of microfauna, followed by make-up/construction/packing. The other categories have low densities of microfauna. Figure 7.12 shows the proportion of taxa by unit category. From this it is clear that micromammals dominate most of the unit categories with the exception of external deposits, feature fills, and cut fills which consist predominantly of amphibians/snakes.

Taxon	South Pre-level XII.D	South Pre-level XII.C	South Pre-level XII.B	South Pre-level XI.A	South Level XII	South Level XI	South Level X	South Level IX	South Level VIII	South Level VII	South-Level VII-VI	South-Level VI-V	Total
Microfauna	0	0	0	0	0	0	0	0	0	0	1	0	**1**
Small carnivore	0	0	0	0	0	0	0	0	1	0	0	0	**1**
Mustela nivalis	0	0	0	0	0	0	0	1	61	0	0	0	**62**
Large micromammal	0	0	0	0	0	0	0	1	0	0	0	0	**1**
Medium micromammal	0	0	0	0	0	0	0	0	2	0	0	0	**2**
Micromammal	0	0	10	1	1	2	17	372	3472	158	16	48	**4097**
Insectivore	0	0	0	0	0	0	0	0	19	0	0	1	**20**
Rhinolophus eurayle	0	0	0	0	0	0	0	0	1	0	0	0	**1**
Erinaceus concolor	0		0	0	0	0	0	1	0	0	0	0	**1**
Suncus etruscus	0	0	0	0	0	0	0	4	10	1	0	1	**16**
Crocidura sp.	0	0	0	0	0	0	0	0	4	0	0	0	**4**
Crocidura suaveolens	0	0	0	0	0	0	0	3	12	0	0	0	**15**
Crocidura leucodon	0	0	0	0	0	0	0	0	10	1	0	0	**11**
Rodent	0	0	5	0	2	4	18	158	1957	85	23	65	**2317**
Microtine	0	0	0	0	0	0	0	0	8	0	0	0	**8**
Microtus sp.	0	0	0	0	0	1	2	0	7	1	0	0	**11**
Microtus guentheri	0	0	0	0	0	0	0	0	1	0	0	0	**1**
Arvicola terrestris	0	0	0	0	0	0	0	0	1	0	0	0	**1**
Murinae	0	0	0	0	0	0	0	9	82	4	0	0	**95**
Mus sp.	0	0	8	0	0	3	12	158	2708	84	5	8	**2986**
Mus musculus	0	0	0	0	0	0	1	3	68	7	0	0	**79**
Amphibian	3	9	35	4	3	1	4	26	13	7	0	7	**112**
Snake	0	0	5	0	0	0	0	2	11	1	0	2	**21**
Total	**3**	**9**	**63**	**5**	**6**	**11**	**54**	**738**	**8448**	**349**	**45**	**132**	**9863**

Table 7.16 Çatalhöyük taxa by level according to number of identifiable specimens



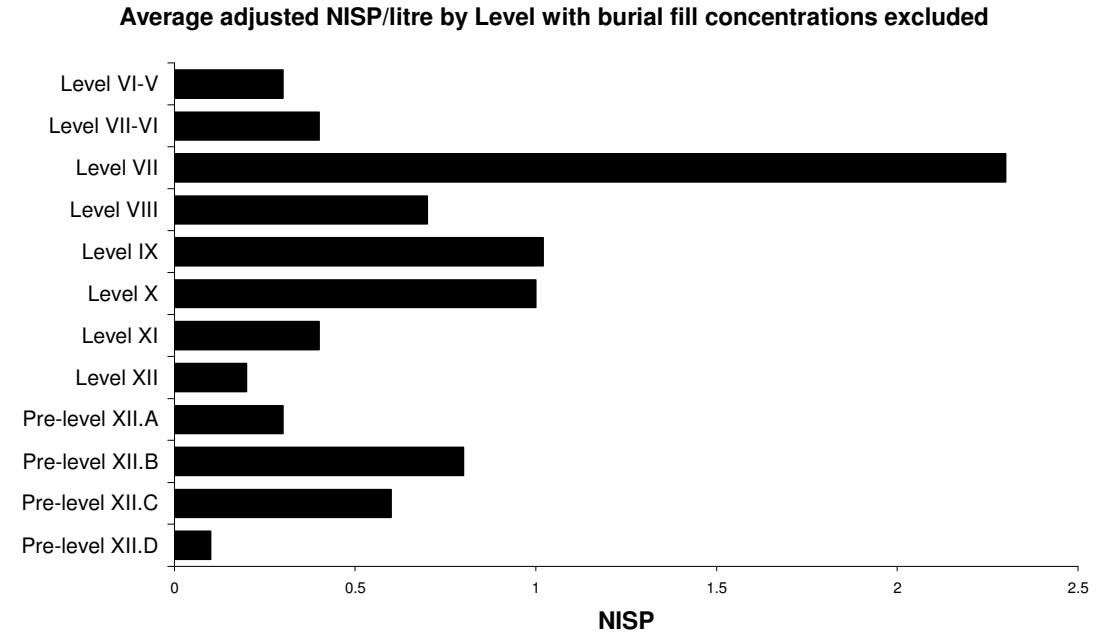


Figure 7.8 Average adjusted NISP/litre by level in the Çatalhöyük assemblage

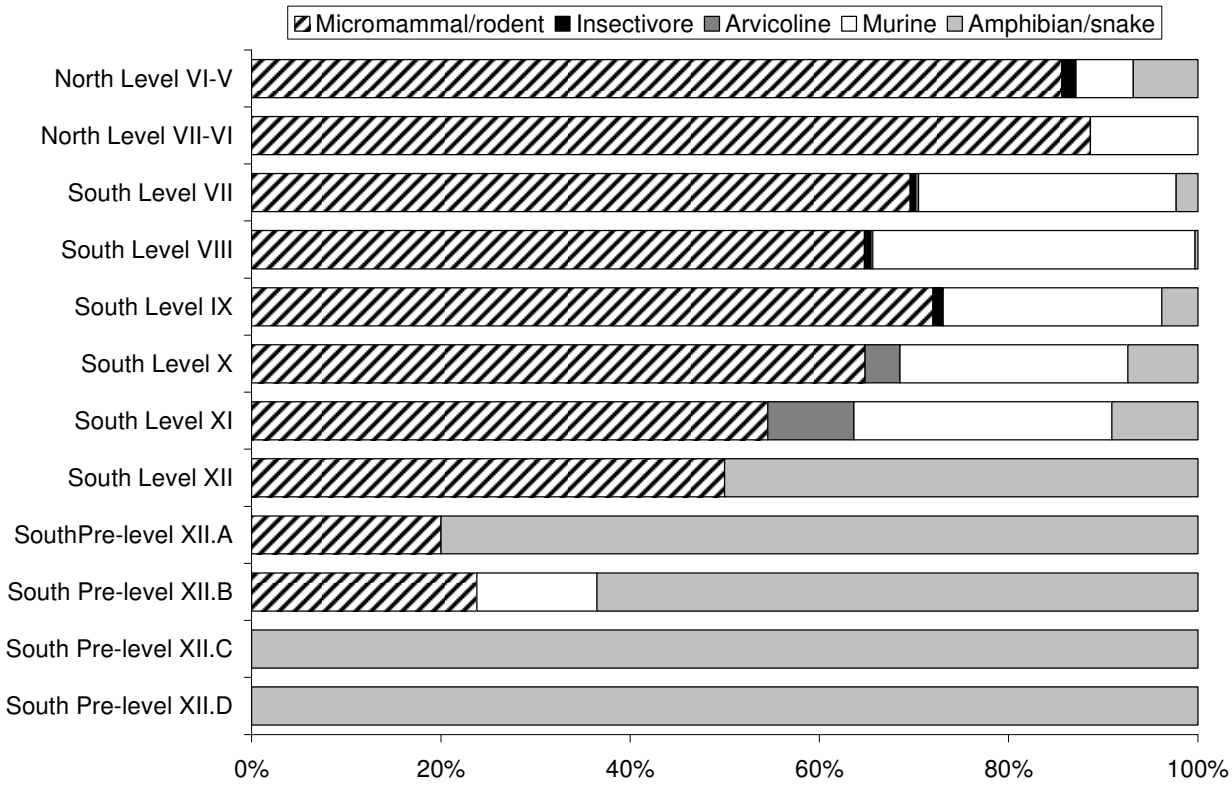


Figure 7.9 Proportions of NISP by level in the Çatalhöyük assemblage

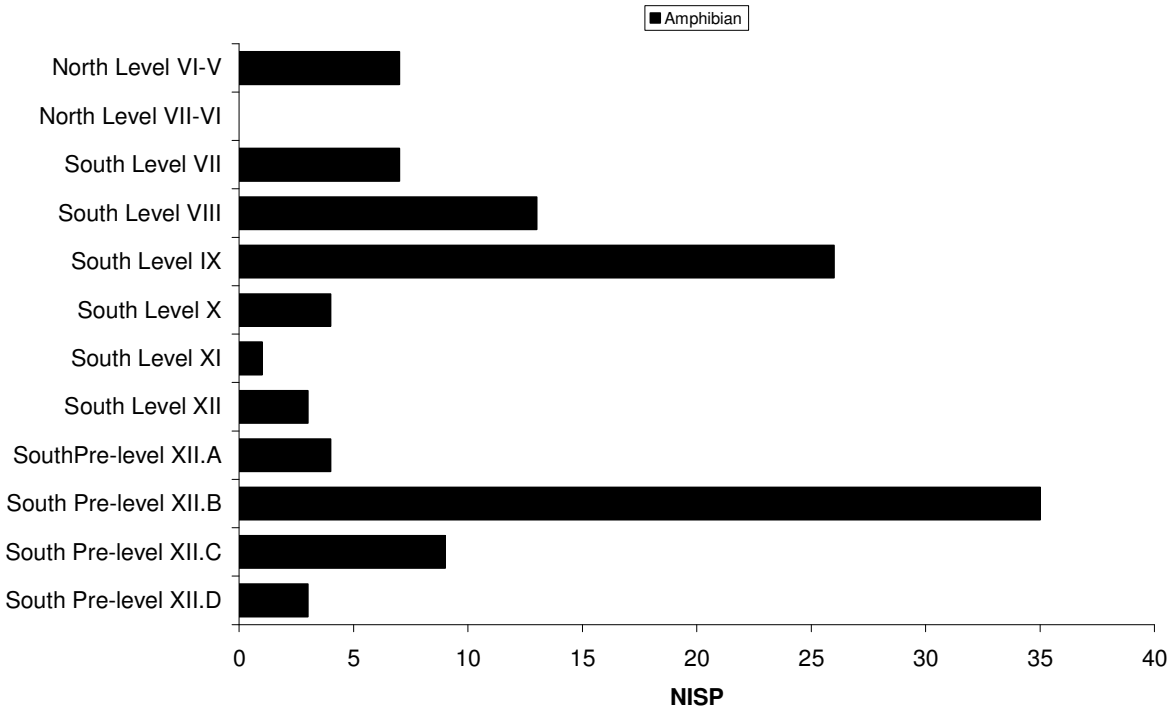
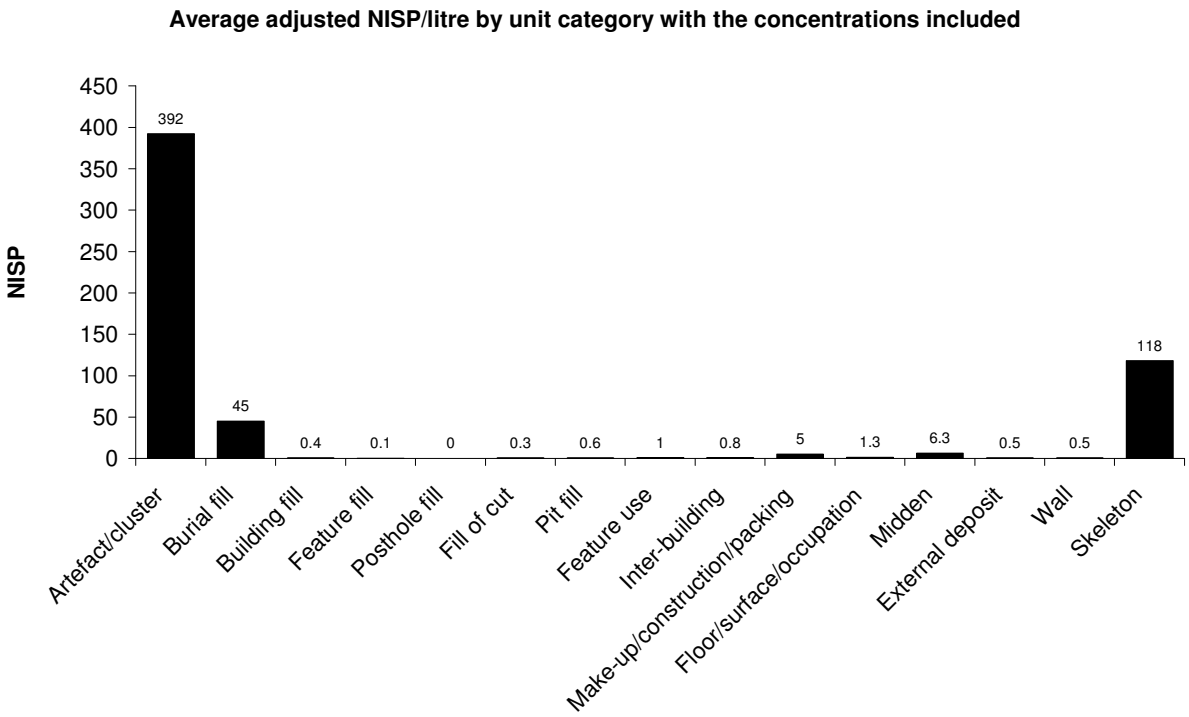


Figure 7.10 Amphibians by level in the Çatalhöyük assemblage



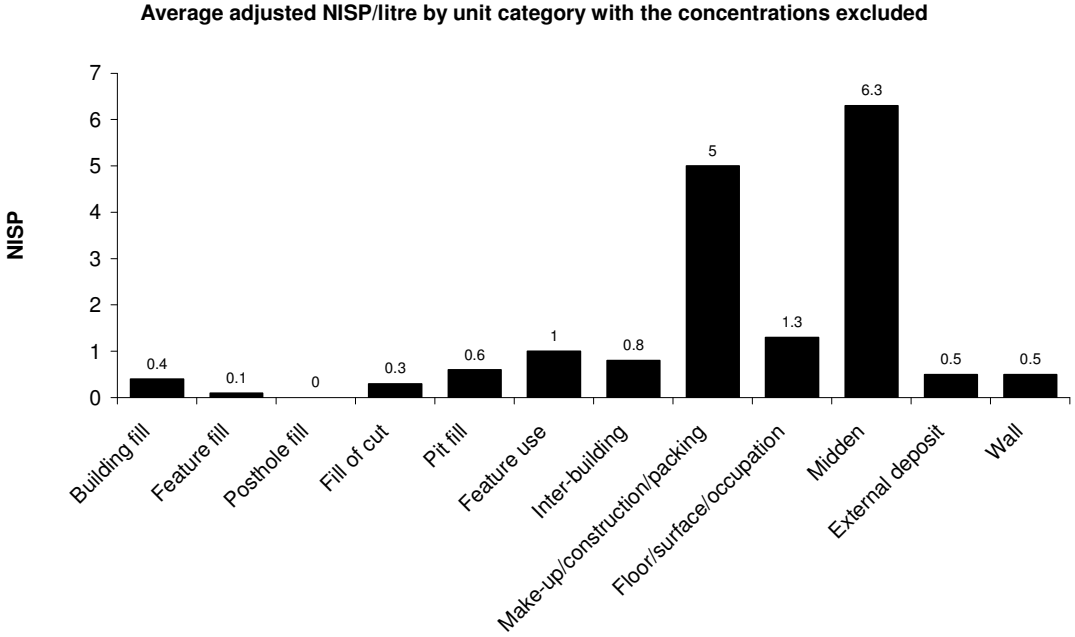


Figure 7.11 Average adjusted NISP/litre by level

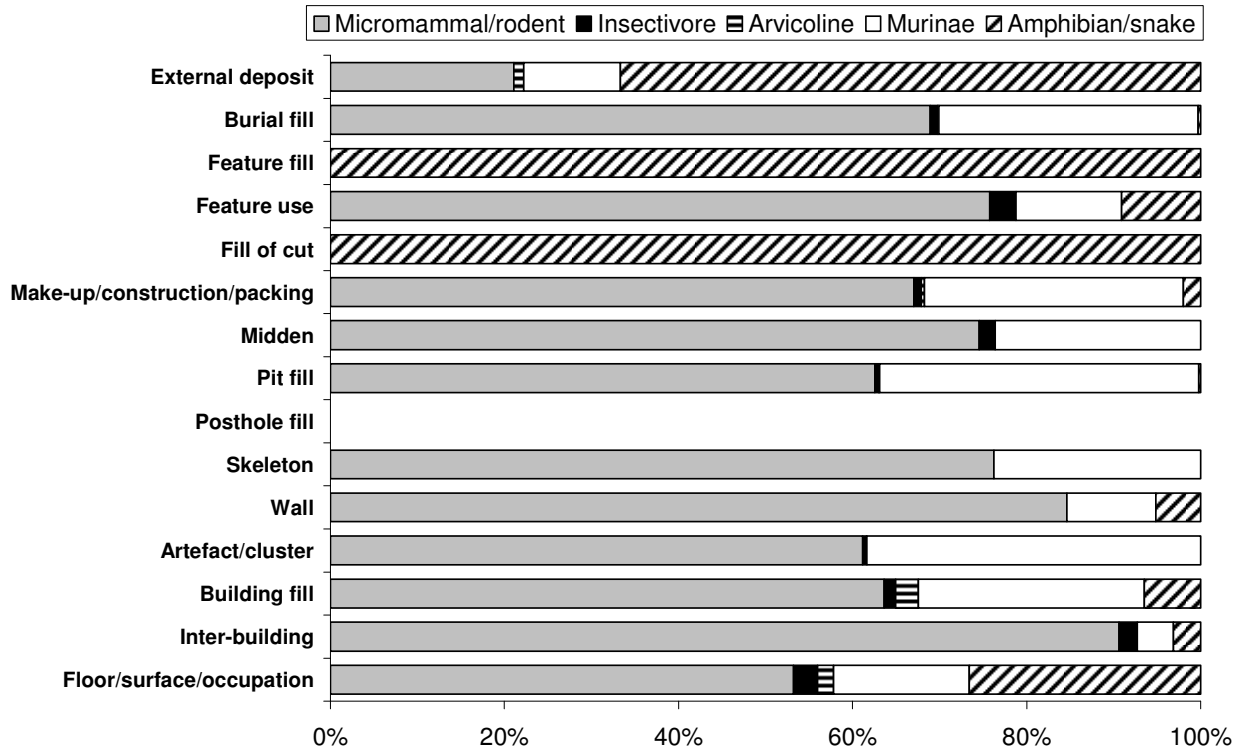


Figure 7.12 Proportions of NISP by unit category

Units with Microfaunal Concentrations

Level X-Unit 4205

Unit 4205 is from Building 9, Space 167, in the South area of the site, as shown in Figure 5.5. The excavator interpreted this unit as a general infilling deposit beneath Space 117 that was deposited prior to construction/occupation. The deposit was mixed in nature, with moderate brick and plaster lumps, occasional small to medium sized bone, clay balls, occasional charcoal, and obsidian (information from the original unit sheet). NISP and MNI for this unit are shown in Appendix 2.1 and 2.2. This unit has two digested isolated lower rodent incisors and one moderately digested *in situ* lower incisor. Of the two isolated incisors one is lightly digested and the other is heavily digested. The heavily digested incisor has interesting striations on the enamel that may have been caused by a small carnivore. Furthermore, the dentine of this incisor has been corroded in a manner that is usually indicative of alkaline corrosion. Alkalinity has the opposite effect of acid on rodent incisors, and research has shown that this leads to the corrosion of the dentine rather than enamel as is the case with acid corrosion (Fernandez-Jalvo & Andrews 1992, 411). The dentine on this specimen has been corroded so that it is less prominent than the enamel. As a result, instead of the enamel and the dentine being on the same level where they meet, the dentine is lower than the enamel. The results of incisor digestion for unit 4205 are provided in Table 7.17 and an isolated rodent incisor with heavy digestion is shown in Figure 7.13. There are no digested post-crania.

	No of *in situ* maxillary incisors digested	**No of *in situ* mandibular incisors digested**	**Total no of *in situ* incisors**	**No of digested isolated incisors**	**No of isolated incisors**	**% of digested incisors**
Group A	0	1	1	2	7	38
Group B	0	0	0	0	0	0
Group C	0	0	0	0	2	0
Total	**0**	**1**	**1**	**2**	**9**	**30**

Table 7.17 Incisor digestion for unit 4205

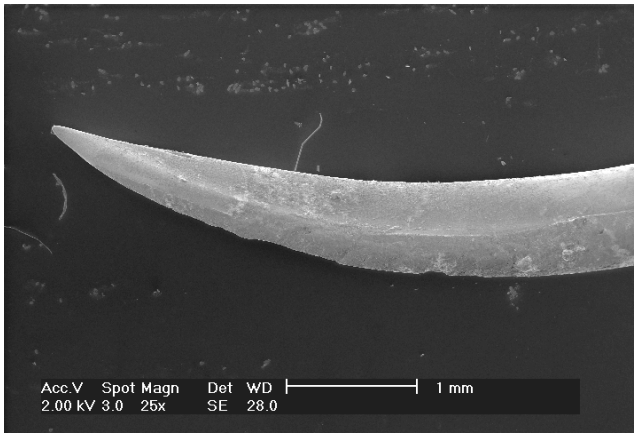


Figure 7.13 SEM micrograph showing isolated lower rodent incisor with heavy digestion and striations on the enamel from unit 4205

Unit 2091-Level IX

Unit 2091 was defined as an artefact/cluster due to the concentration of microfauna found during excavation. The excavator observed that the density of microfauna varied from 5% to 30% throughout the unit. In addition, phytoliths and charred plant remains were found in this unit. The sediment consisted of a light brownish-grey silty loam. It was initially thought that the microfaunal concentration may represent a cluster of owl pellets. Unit 2091 measured 0.5 metres long by 0.5 metres wide by 0.14 metres deep, and was located within Building 2 in the South area of the site. It was located next to the crawl hole between Space 116 and Space 117 (see Figure 5.6) and was excavated using a ten centimetre grid. NISP, MNI, digestion and gnawing will be considered for each square but the relative proportion for the unit as a whole will be given.

Table 7.18 shows the NISP for each of the individual squares excavated. Four of the squares (squares 1, 2, 5 and 8) do not contain any microfauna. Squares 9, 15 and 16 have the greatest NISP. The majority of the identifiable elements are post-cranial and could only be identified as micromammal, but *Suncus etruscus* is found in this unit. The full NISP by taxon is shown in Appendix 2.1 and the NISP and MNI without micromammals and rodents is shown in Figure 7.15

to give a clearer idea of how the taxa by NISP breakdown without being overwhelmed by these larger groups. Amphibians were not found in this unit. Unit 2091 has a NISP of 661, an adjusted NISP of 1043, and an adjusted NISP per litre of thirty. Post-crania from unit 2091 were sampled to 50%. In the calculations for the relative proportion of elements the results for the post-crania have been doubled to make them comparable with the crania.

All of the diagnostic cranial elements in this assemblage are *Mus* so lower rodent incisors are designated to group A for digestion analysis. Incisor digestion by square is given in Table 7.21. There are twenty incisors with digestion on the developing end. Of these, fourteen are upper *Mus* sp. incisors, two are upper rodent incisors, one is a lower rodent incisor, and two are *in situ* upper *Mus* sp. incisors. Two incisors were found that appeared to have gnawing on the developing end. SEM micrographs showing examples of gnawed and modified incisors can be seen in Figure 7.17. Results for molar digestion by square can be found in Table 7.22 and Table 7.24 shows the tooth digestion broken down into digestion category. The results for post-cranial digestion are provided in Table 7.23 and from this it is clear that three of the excavation squares have digested humeri: square 3, 9 and 16 and 33% of the total humeri are digested. There are digested femora in two of the excavation squares: square 3 and 4 and 15% of the total femora are digested. Fifty-five elements in this unit have carnivore gnawing or puncture marks. The number of gnawed elements and the NISP per square are listed in Table 7.25. Results for the breakage analysis are shown in Tables 7.19 and 7.20 while results for the gnawing analysis can be found in Tables 7.26, 7.27 and 7.28. The results for the relative proportion of elements analysis is shown in Figure 7.16.

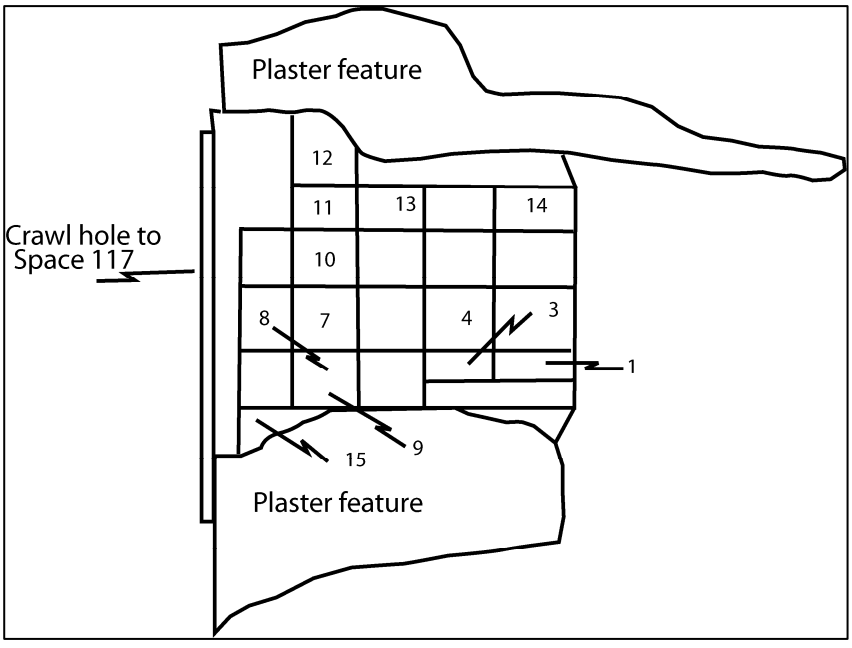


Figure 7.14 Sketch plan of the grid used to excavate unit 2091 (not to scale)

Square number	*NISP*
1	0
2	0
3	61
4	31
5	0
6	40
7	2
8	0
9	183
10	5
11	19
12	25
13	15
14	2
15	88
16	190
Total	661

Table 7.18 NISP by excavation square for unit 2091

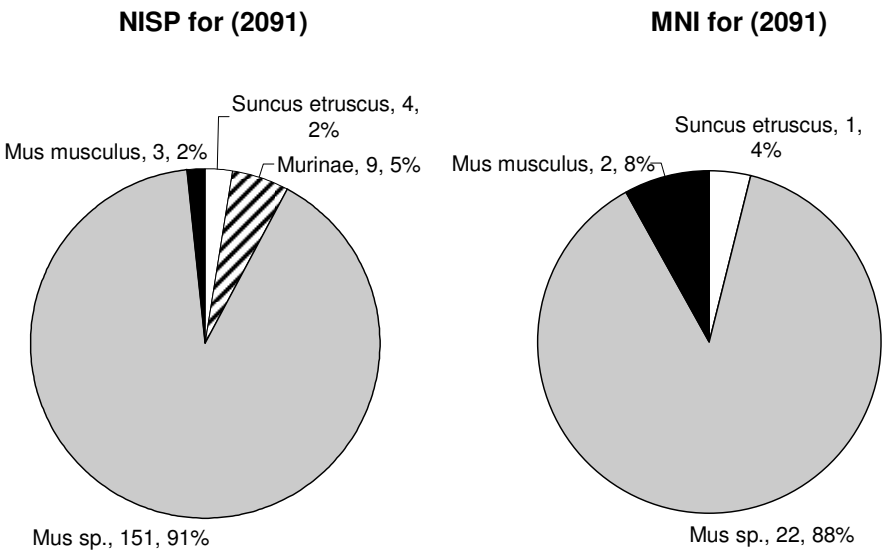


Figure 7.15 NISP and MNI for unit 2091 (micromammals and rodents excluded)

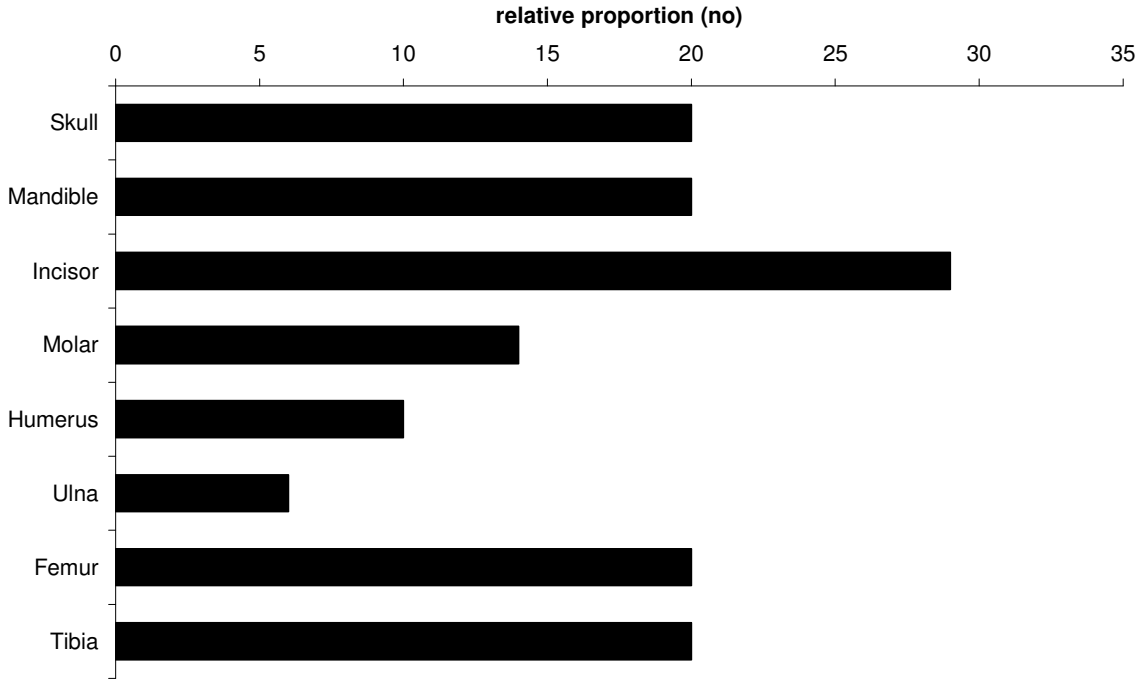


Figure 7.16 Relative proportion of elements for unit 2091

POST-CRANIAL BREAKAGE	*NO*	*%*
Humerus		
Complete	1	5
Proximal	7	37
Shaft	3	16
Distal	8	42
Ulna		
Complete	1	10
Proximal	3	30
Shaft	2	20
Distal	4	40
Femur		
Complete	2	7
Proximal	18	58
Shaft	4	13
Distal	7	23
Tibia		
Complete	1	3
Proximal	6	19
Shaft	6	19
Distal	18	58

Table 7.19 Post-cranial breakage for unit 2091

Skull breakage categories	**No**	**%**
Complete	0	0
Broken with zygomatic process intact	0	0
Maxilla lacking the zygomatic process	40	100
Mandible breakage	**No**	**%**
Complete	0	0
Ascending ramus broken	1	3
Ascending ramus missing	5	13
Ascending ramus missing and inferior border broken	34	85

Table 7.20 Cranial breakage for unit 2091

Square no	*No of in situ maxillary incisors digested*	*No of in situ mandibular incisors digested*	*Total no of in situ incisors*	*No of digested isolated incisors*	*No of isolated incisors*	*% of digested incisors*
1	0	0	0	0	0	0
2	0	0	0	0	0	0
3	0	0	2	4	11	31
4	0	0	1	0	5	0
5	0	0	0	0	0	0
6	0	0	1	4	10	36
7	0	0	0	0	0	0
8	0	0	0	0	0	0
9	0	0	3	3	21	13
10	0	0	0	0	1	0
11	0	0	0	0	4	0
12	0	0	2	0	8	0
13	0	0	1	1	9	10
14	0	0	0	0	1	0
15	0	0	3	1	5	13
16	0	0	4	8	25	28
Total	0	0	17	21	100	21

Table 7.21 Incisor digestion by square for unit 2091

Square no	*No of in situ maxillary molars Digested*	*No of in situ mandibular molars digested*	*Total no of in situ molars*	*No of digested isolated molars*	*No of isolated molars*	*% of digested molars*
1	0	0	0	0	0	0
2	0	0	0	0	0	0
3	0	0	15	0	4	0
4	0	0	5	0	0	0
5	0	0	0	0	0	0
6	1	0	5	2	3	38
7	0	0	0	0	0	0
8	0	0	0	0	0	0
9	1	0	34	7	20	15
10	0	0	0	0	1	0
11	0	0	2	0	0	0
12	0	0	7	0	1	0
13	0	0	5	0	0	0
14	0	0	0	0	0	0
15	0	0	10	0	11	0
16	0	2	27	8	12	26
Total	2	2	110	17	52	13

Table 7.22 Molar digestion by excavation square for unit 2091

Square no	*No of digested humeri*	*No of digested femora*
1	0	0
2	0	0
3	1	2
4	0	1
5	0	0
6	0	0
7	0	0
8	0	0
9	1	0
10	0	0
11	0	0
12	0	0
13	0	0
14	0	0
15	0	0
16	1	0
Total	3	3
Digestion category	*Humerus (no)*	*Femur (no)*
Light	1	2
Moderate	1	1
Heavy	1	0
Extreme	0	0
Total	3	3

Table 7.23 Post-cranial digestion for unit 2091

Digestion categories	Incisor	Molar
Light	15	21
Moderate	3	0
Heavy	5	0
Extreme	0	0
Total	**23**	**21**

Table 7.24 Tooth digestion by category for unit 2091

Square no	*No of gnawed elements*	*NISP*	*% of elements gnawed*
1	0	0	0
2	0	0	0
3	6	61	10
4	4	31	13
5	0	0	0
6	6	40	15
7	0	2	0
8	0	0	0
9	14	183	8
10	0	5	0
11	1	19	0
12	2	25	8
13	1	15	7
14	0	1	0
15	5	88	6
16	16	195	8
Total	55	665	8

Table 7.25 Gnawing by excavation square for unit 2091

Element	*No*
Molar	1
Incisor	5
Maxilla	7
Mandible	16
Vertebra	2
Scapula	2
Humerus	1
Radius	1
Pelvis	3
Femur	1
Tibia	4
Astragalus	1
Calcaneus	4
Long bone	1
Metatarsal	5
Phalange	1
Total	55

Table 7.26 Elements with gnawing in unit 2091

Unit 2091 *Element*	*Number of puncture marks measured*	*Average length in mm*
Maxilla	5	0.40
Mandible	8	0.28
Isolated incisor	4	0.37
Vertebra	3	0.59
Pelvis	3	0.50
Femur	1	0.60
Tibia	2	0.36
Calcaneus	2	0.25
Metatarsal	1	0.48

Table 7.27 Number of marks measured in unit 2091 and the average length

Unit 2091 ***Bone type***	***No of puncture marks measured***	***Smallest length of mark (mm)***	***Longest length of mark (mm)***	***Average length of mark(mm)***
Puncture marks on shafts	2	0.56	0.58	0.57
Puncture marks on split shafts	1	0.22	N/A	N/A
Puncture marks on articular ends	5	0.26	0.4	0.33

Table 7.28 Puncture marks by bone type for unit 2091

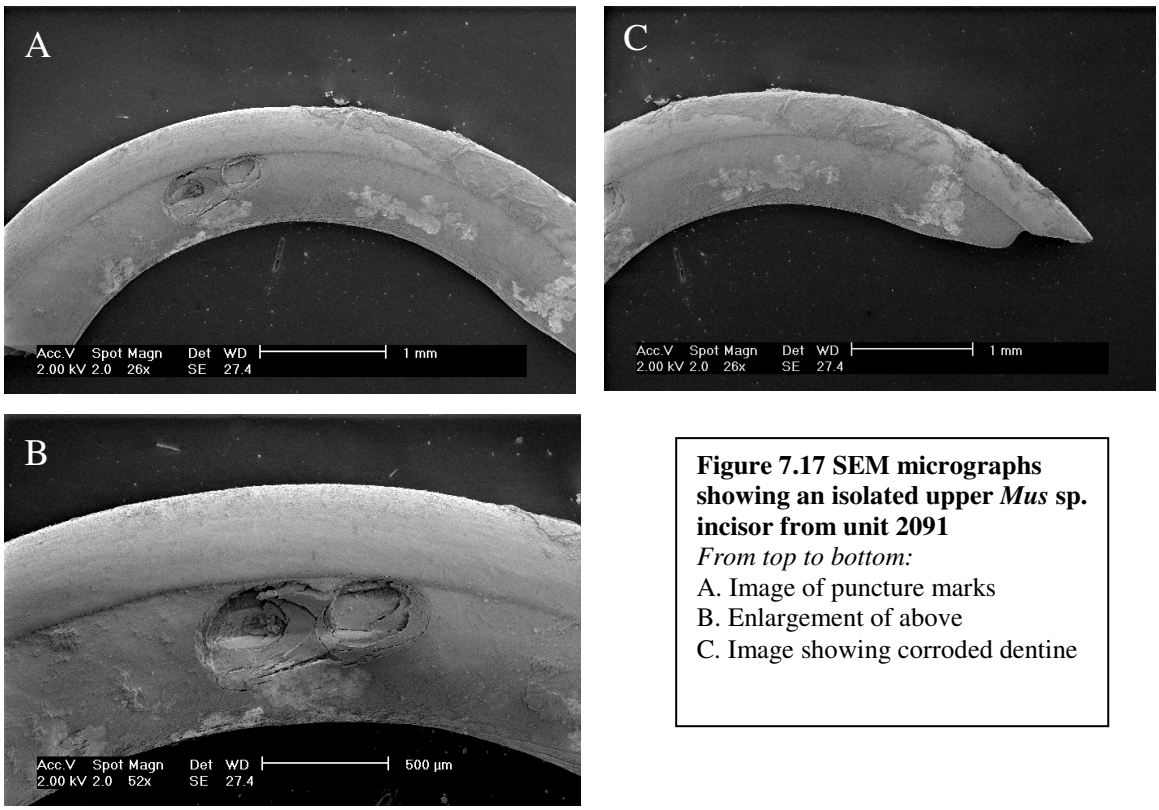


Figure 7.17 SEM micrographs showing an isolated upper *Mus* sp. incisor from unit 2091
From top to bottom:
A. Image of puncture marks
B. Enlargement of above
C. Image showing corroded dentine

Unit 4397-Level VIII

Unit 4397 is the grave fill unit from Burial 460, which contained skeleton 4394 and is shown in Figures 5.8 and 5.9. The grave cut was sub-rectangular in plan and unevenly cut through to a relatively flat base. The burial appears to have been cut deeply into the infill unit 4325 and may have been cut from the floor in Space 163. This would have been a depth of approximately eighty centimetres, although only fifty-two centimetres of cut were recovered by the excavators due to disturbance by the earlier 1960s excavations. The skeleton was male and lay on its right side with the head to the south and with both hands drawn up over the face. The right knee was raised up in front of the ribcage with the right foot positioned in front of the pelvis. The distal end of the left femur lay at a ninety degree angle to the torso with the lower half of the left leg flexed back so that the left foot lay just below the pelvis (see Chapter 5, 78 to 79). A concentration of phytoliths was found over the right leg and may represent a reed mat that was placed over this part of the body. Around the skeleton and in the overlying grave fill concentrations of microfauna were found and some of the bones were still in articulation (information from original unit sheet).

Unit 4397 has a NISP of 1835 and an MNI of 71. The adjusted NISP is 2708 and the adjusted NISP per litre is twenty-two. The breakdown on the NISP and MNI by taxa can be found in Table 7.29. There were few microtines and *Mus* sp. has the greatest number of individuals followed by *Mus musculus*. The results for the analysis of the relative proportion of elements are shown in Figure 7.18 and demonstrate that the cranial elements are more abundant than the post-cranial ones. Breakage results can be found in Tables 7.30 and 7.31. Tooth digestion is shown in Table 7.32 and 7.33. In addition, there are four *Mus* sp. upper incisors, one rodent upper incisor, and two rodent lower incisors with digestion on the developing end. In total, thirteen of the humeri are digested and four of the femora. There are thirty-two humeri from unit 4397 with distal ends and so 41% are digested; there are seventy-one femora with proximal ends and in total 6% of these are digested. There are not only fewer digested femora than humeri but the severity of their digestion is also lower than humeri. Femora digestion is restricted to the light and moderate categories, with three femora being lightly digested, and one femur moderately digested. In addition, to these digested elements, a humerus was found that had surface flaking. It is not clear if this is the result of digestion or some other taphonomic process. There are sixty-two elements in unit 4397 that have gnawing or puncture marks, all of which are rodent. Gnawing results are displayed in Tables 7.34, 7.35, and 7.36. This unit has an actual NISP of 1835 and so 3% of the total elements have gnaw or puncture marks. Furthermore, two incisors were found that had gnawing on the developing ends; one is an upper *Mus* sp. incisor and the other is a lower rodent incisor.

Taxon	NISP	MNI
Small carnivore	1	1
Micromammal	1027	0
Insectivore	8	0
Crocidura suaveolens	5	2
Crocidura leucodon	6	3
Rodent	428	8
Microtine	1	0
Microtus sp.	1	0
Arvicola terrestris	1	1
Murine	1	0
Mus sp.	325	43
Mus musculus	17	11
Amphibian	6	1
Snake	8	1

Table 7.29 NISP and MNI by taxon for unit 4397

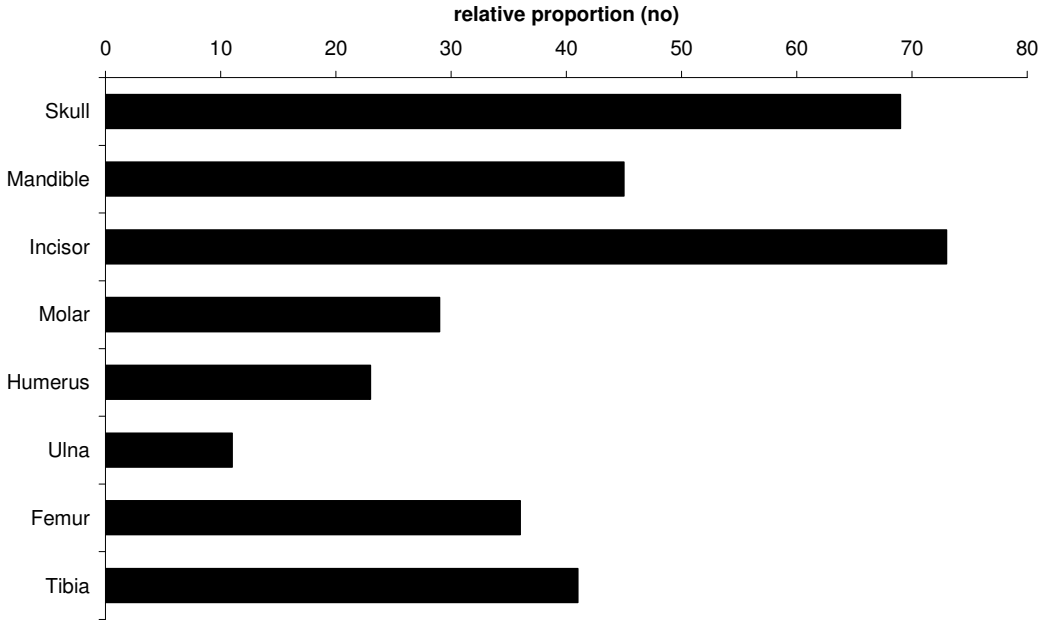


Figure 7.18 Relative proportion of elements for unit 4397

Skull breakage categories	**No**	**%**
Complete	0	0
Broken with zygomatic process intact	0	0
Maxilla lacking the zygomatic process	137	100
Mandible breakage	**No**	**%**
Complete	0	0
Ascending ramus broken	0	0
Ascending ramus missing	15	17
Ascending ramus missing and inferior border broken	74	83

Table 7.30 Cranial breakage for unit 4397

POST-CRANIAL BREAKAGE	*NO*	*%*
Humerus		
Complete	5	6.3
Proximal	40	51
Shaft	7	9
Distal	27	34
Ulna		
Complete	1	2
Proximal	15	34
Shaft	8	18
Distal	20	46
Femur		
Complete	6	7
Proximal	65	75
Shaft	3	3
Distal	13	15
Tibia		
Complete	4	4
Proximal	6	6
Shaft	23	21
Distal	77	70

Table 7.31 Post-cranial breakage for unit 4397

Unit 4397	**No of *in situ* maxillary teeth digested**	**No of *in situ* mandibular teeth digested**	**Total no of *in situ* teeth**	**No of digested isolated teeth**	**No of isolated teeth**	**% of digested teeth**
Incisors Group A	0	0	11	25	282	8.5
Molars Group A	0	0	260	15	85	4.3

Table 7.32 Tooth digestion for unit 4397

Digestion categories	**Incisor (no)**	**Molar (no)**
Light	10	12
Moderate	9	2
Heavy	5	1
Extreme	1	0
Total	**25**	**15**
	Humerus (no)	**Femur (no)**
Light	8	3
Moderate	3	1
Heavy	2	0
Extreme	0	0
Total	**13**	**4**

Table 7.33 Digestion for unit 4397

Element	*No*
Maxilla	8
Mandible	17
Isolated incisor	11
Isolated molar	1
Vertebra	9
Humerus	4
Ulna	1
Femur	3
Tibia	2
Calcaneus	1
Metapodial	5
Total	62

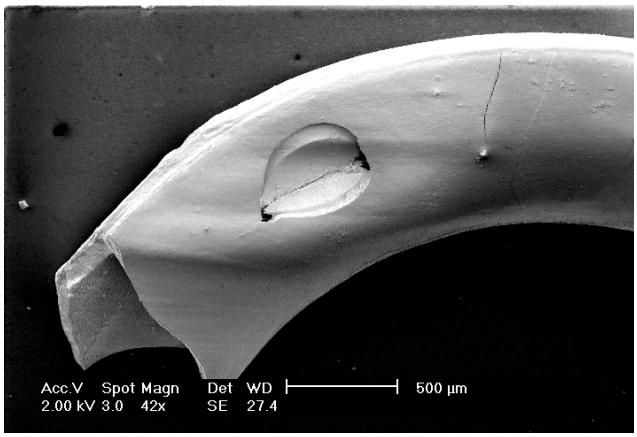
Table 7.34 Elements with gnawing or puncture marks in unit 4397

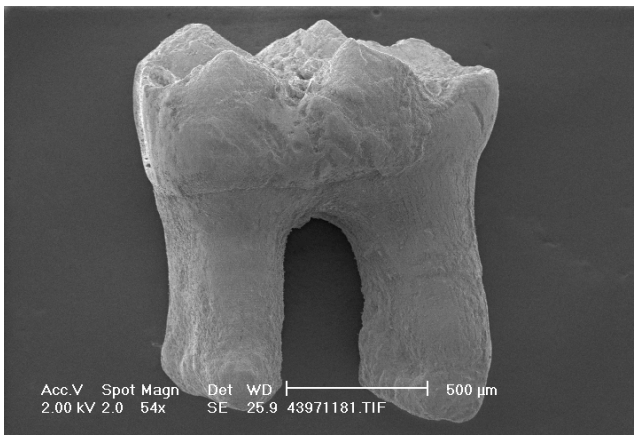
Unit 4397 *Element*	*Number of puncture marks measured*	*Average length in mm*
Maxilla	8	0.34
Mandible	12	0.38
Isolated incisor	1	0.50
Vertebra	1	0.48
Humerus	4	0.70
Femur	4	0.48
Tibia	3	0.37
Metapodial	1	0.40

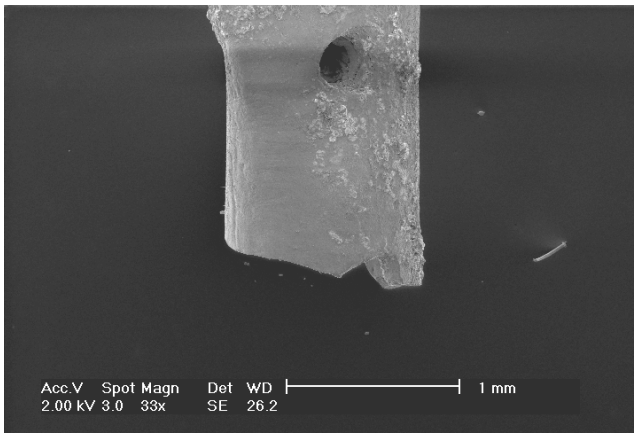
Table 7.35 Number of marks measured in unit 4397 and the average length

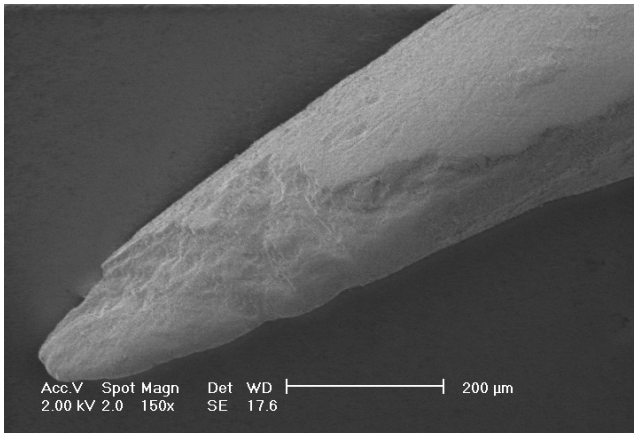
Unit 4397 ***Bone type***	***No of puncture marks measured***	***Smallest length of mark (mm)***	***Longest length of mark (mm)***	***Average length of mark(mm)***
Puncture marks on shafts	4	0.32	0.70	0.50
Puncture marks on split shafts	2	0.48	0.60	0.54
Puncture marks on articular ends	2	0.36	0.44	0.40

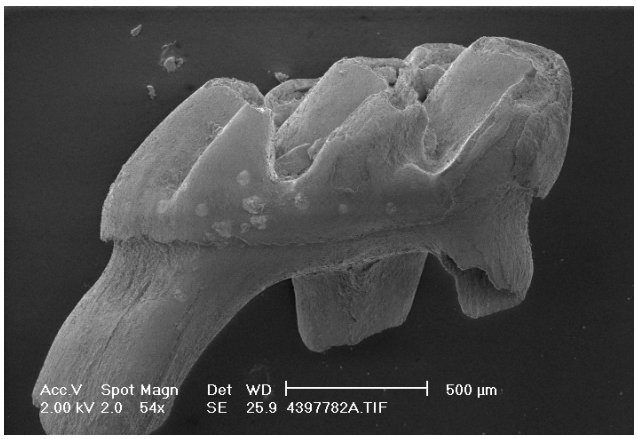
Table 7.36 Puncture marks by bone type for unit 4397

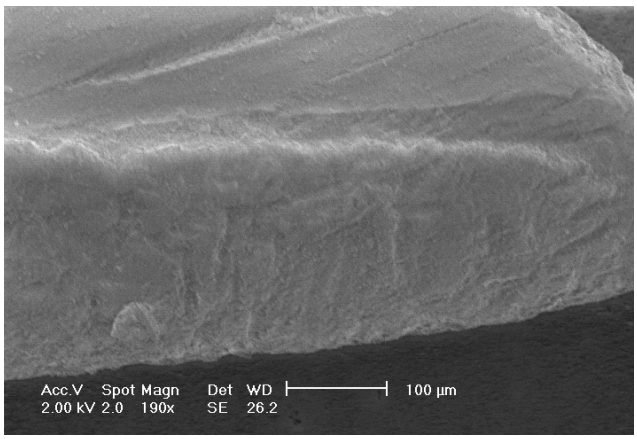












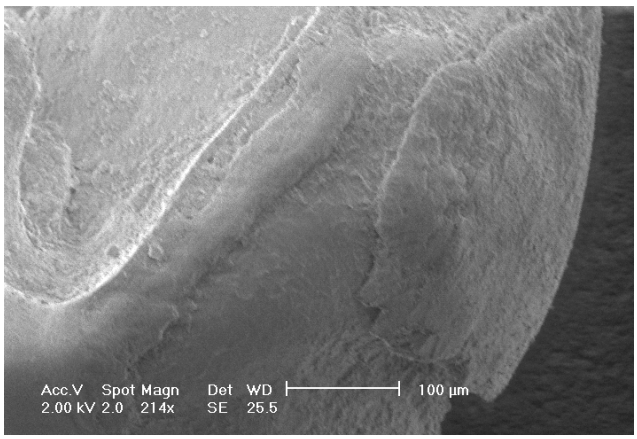
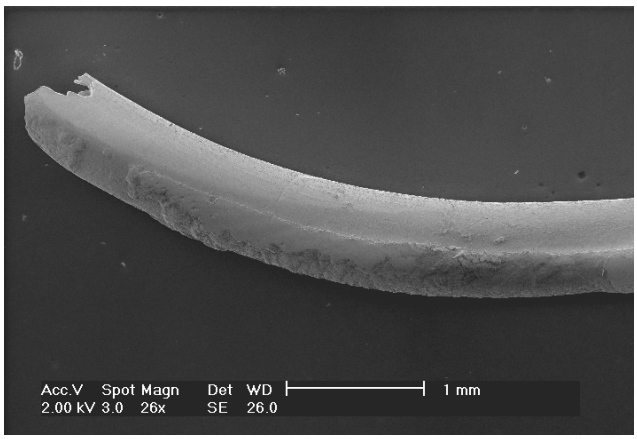
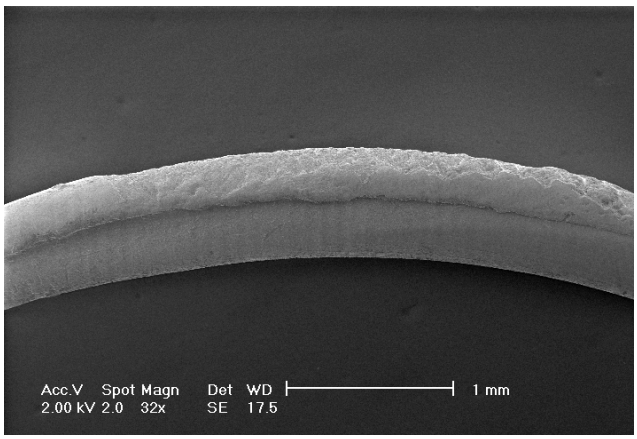
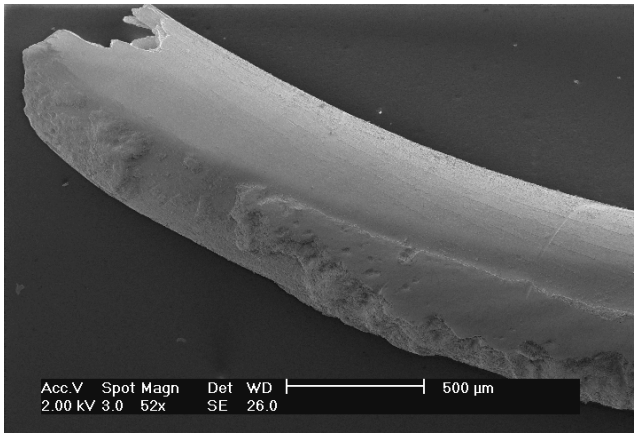
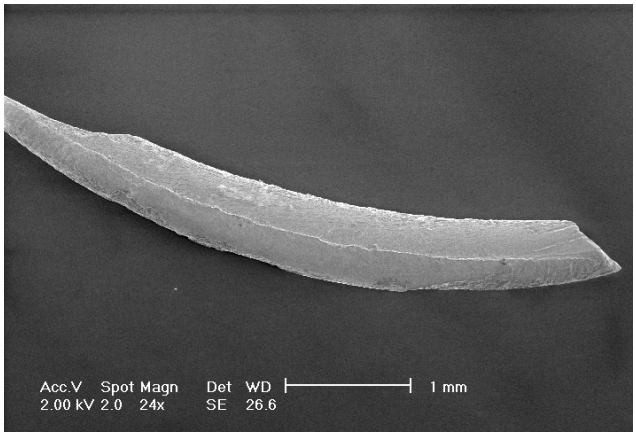


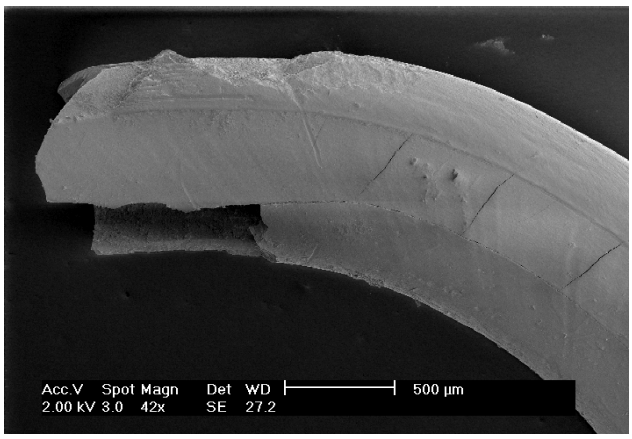
Figure 7.19 SEM micrographs showing elements with modifications from Burial 460 (unit 4397)
Left hand column from top to bottom:
1. Isolated upper *Mus* sp. incisor with a puncture mark
2. Broken rodent femur with puncture marks
3. Isolated upper *Mus* sp. molar with moderate digestion
4. Enlargement of above showing corroded enamel
Right hand column from top to bottom:
1. Isolated lower *Mus* sp. molar with heavy digestion
2. Isolated lower rodent incisor with heavy digestion
3. Isolated lower rodent incisor with modification on the developing end











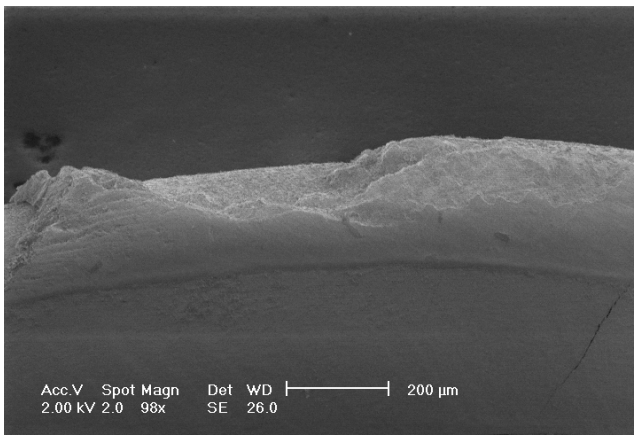


Figure 7.20 SEM micrographs showing incisors with modifications from Burial 460 (unit 4397)
Left hand column from top to bottom:
1. Isolated lower rodent incisor with modification on the developing end
2. Enlargement of above
3. Isolated upper rodent incisor with modification on the developing end
4. Isolated upper rodent incisor with modification on the developing end
Right hand column from top to bottom:
1. Isolated lower rodent incisor with heavy digestion and corroded dentine
2. Isolated lower rodent incisor with modification on the developing end

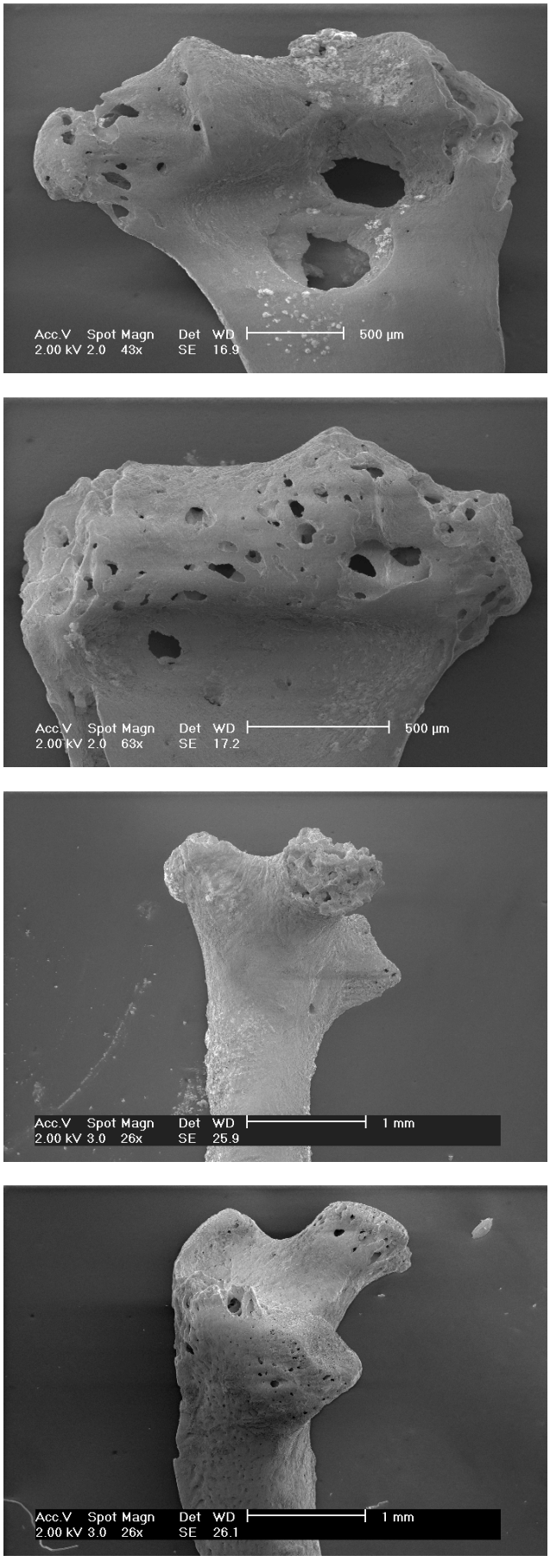


Figure 7.21 SEM micrographs showing postcranial elements with digestion from Burial 460 (unit 4397)
From top to bottom:
1. Humerus with moderate digestion
2. Humerus with moderate digestion
3. Femur with moderate digestion
4. Femur with heavy digestion

Unit 4464-Level VIII

Unit 4464 is the grave fill from Burial 492, which contained skeleton 4593 (see Figures 5.8 and 5.9). This was a crouched burial of a young adult male cut into the infill in space 163. The skeleton was orientated east to west and was lying on its back. Both legs were flexed with the knees raised up level to the lower rib cage and spread wide with the feet positioned just below the pelvis. The right humerus lay parallel with the torso and the right ulna and radius were bent at a ninety degree angle across the lower torso. The left humerus lay almost parallel to the torso with the left ulna and radius flexed so that the left hand lay over the pelvis. The right hand was positioned over the left ulna and radius. The skull had been removed. Under the left side of the ribcage and the right proximal femur were concentrations of phytoliths (unit 4617) suggesting that a woven textile once lay under the body and possibly lined the cut (unit 4612). Lying over most of the skeleton was a large hackberry plank that was part carbonised, part mineralised (See Chapter 5) (Information from original unit sheet). The NISP for unit 4464 is shown in Figure 7.22. Two upper *Mus* sp. incisors were found in this unit with digestion at the developing end. There are no digested post-crania. There is one lower isolated rodent incisor with a puncture mark which measured 0.24 millimetres.

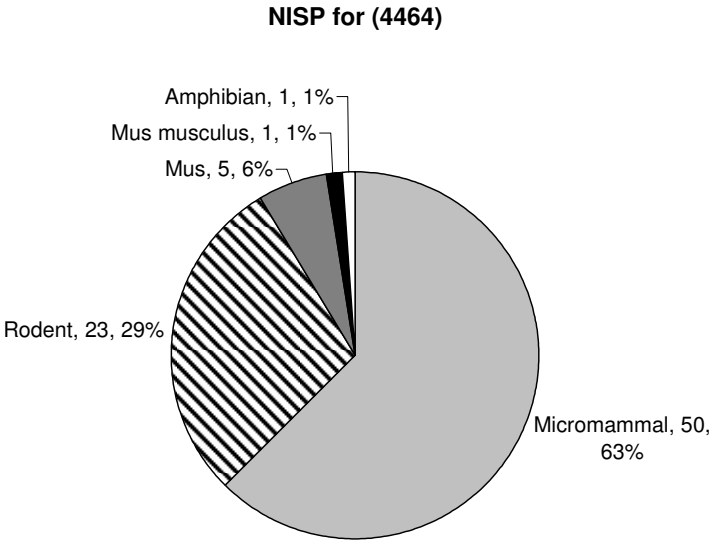


Figure 7.22 NISP for unit 4464

Unit 4614-Level VIII

Unit 4614 is the upper grave fill unit from Burial 513 (see Figure 5.9D and E). This burial contained a crouched skeleton of an adult female which was facing eastwards. A black carbon deposit within the upper ribs of the skeleton and red ochre (unit 4620), was found underneath (Andrews *et al* 2005). Unit 4614 was a greyish-brown, clayey-silt deposit with a concentration of microfauna

within it and a higher than normal concentration of burnt cereals and tubers (see Chapter 5, 79). Table 7.37 shows the NISP for unit 4614 by taxon which leads to a total of 2233 and the MNI is 161. This assemblage was sampled during heavy residue sorting to 47% and the post-crania were sampled to 50% during analysis. The adjusted NISP is 6649 and the adjusted NISP per litre is fifty-seven. The results of the relative proportion of elements show an erratic pattern as illustrated in Figure 7.23. The skull, mandible and incisor are all well represented whereas the molars, upper post-crania and femora are all under-represented. There are no complete or broken skulls in this unit but there are 254 isolated maxillae, demonstrating that skull breakage is high. There are 293 mandibles, none of which are complete. Breakage is illustrated in Tables 7.38 and 7.39.

In addition to the tooth digestion shown in Tables 7.40 and 7.41, there was one isolated upper *Mus* sp. incisor and eight lower rodent incisors that appeared to have been gnawed at the developing end. Twenty-three per cent of humeri and 10% of femora were digested. There are 212 elements with gnaw or puncture marks in unit 4614. The numbers of individual elements with gnawing are listed in Table 7.42 and it is apparent that the mandible is the most frequently gnawed element. The majority of gnawed elements are rodent, *Mus* sp.*,* or *Mus musculus* but mustelids are also affected. The measurements of some of the puncture marks and their location on the bones are shown in Table 7.44. Eight elements were found from this unit that had black marks on their surfaces typical of manganese staining and one element was discovered that was partly encrusted with calcium carbonate. Furthermore, two elements were discovered that have corrosion on their surfaces that seemed to have been caused by weathering.

Taxon	NISP	MNI
Micromammal	838	0
Large micromammal	2	1
Insectivore	9	0
Suncus etruscus	3	1
Crocidura sp.	1	0
Crocidura suaveolens	2	1
Crocidura leucodon	1	1
Mustela nivalis	38	1
Rodent	612	37
Microtine	3	0
Microtus sp.	2	1
Murinae	29	0
Mus sp.	667	99
Mus musculus	26	19

Table 7.37 Breakdown of the NISP by taxon for unit 4614

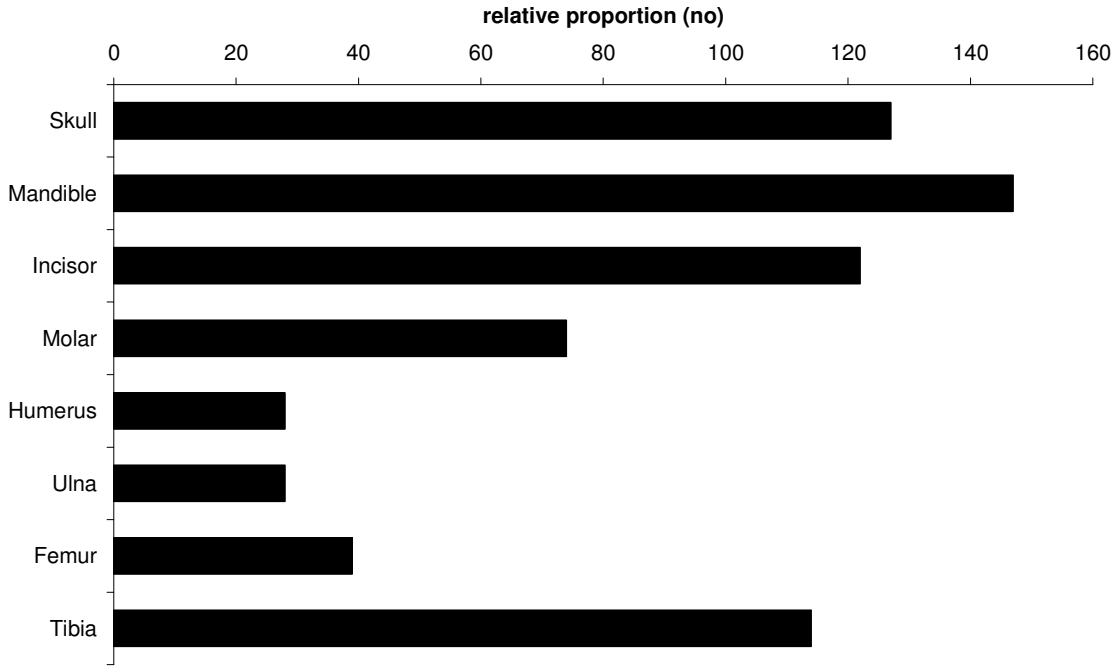


Figure 7.23 Relative proportion of elements for unit 4614

POST-CRANIAL BREAKAGE	*NO*	*%*
Humerus		
Complete	11	22
Proximal	13	26
Shaft	7	14
Distal	19	38
Ulna		
Complete	8	13
Proximal	12	20
Shaft	21	3
Distal	20	33
Femur		
Complete	15	19
Proximal	22	28
Shaft	16	21
Distal	26	33
Tibia		
Complete	8	5
Proximal	8	5
Shaft	34	21
Distal	113	69

Table 7.38 Post-cranial breakage for unit 4614

Skull breakage categories	**No**	**%**
Complete	0	0
Broken with zygomatic process intact	0	0
Maxilla lacking the zygomatic process	254	100
Mandible breakage	**No**	**%**
Complete	0	0
Ascending ramus broken	6	2
Ascending ramus missing	68	23
Ascending ramus missing and inferior border broken	219	75

Table 7.39 Cranial breakage for unit 4614

Unit 4614	**No of *in situ* maxillary teeth digested**	**No of *in situ* mandibular teeth digested**	**Total no of *in situ* teeth**	**No of digested isolated teeth**	**No of isolated teeth**	**% of digested teeth**
Incisors Group A	0	0	29	18	458	4
Molars Group A	4	8	777	15	107	3
Molars Group C	0	0	0	0	3	0

Table 7.40 Tooth digestion for unit 4614

Digestion categories	**Incisor (no)**	**Molar (no)**	**Humerus (no)**	**Femur (no)**
Light	13	24	7	3
Moderate	4	1	0	0
Heavy	1	2	0	0
Extreme	0	0	0	1

Table 7.41 Digestion by digestion category for unit 4614

Element	*No of gnawed elements*
Isolated molar	1
Isolated incisor	31
Maxilla	17
Mandible	108
Vertebra	12
Humerus	8
Radius	1
Ulna	2
Pelvis	2
Femur	17
Tibia	10
Metatarsal	2
Phalanx	1

Table 7.42 Number of gnawed elements in unit 4614

Unit 4614 *Element*	*Number of puncture marks measured*	*Average length in mm*
Maxilla	3	0.45
Mandible	69	0.40
Isolated incisor	9	0.35
Vertebra	8	0.48
Pelvis	2	0.70
Femur	3	0.58
Tibia	3	0.60
Metatarsal	1	0.36

Table 7.43 Number of marks measured in unit 4614 and the average length

Unit 4614 ***Bone type***	***No of puncture marks measured***	***Smallest length of mark (mm)***	***Longest length of mark (mm)***	***Average length of mark(mm)***
Puncture marks on shafts	1	0.50	N/A	N/A
Puncture marks on split shafts	1	0.60	N/A	N/A
Puncture marks on articular ends	10	0.26	0.70	0.50

Table 7.44 Puncture marks by bone type for unit 4614

Unit 4615-Level VIII

Unit 4615 was defined as a skeleton and the microfaunal assemblage analysed, derives from the soil found within the skull of the skeleton. This skeleton was within Burial 513, which contained the burial fill units, 4614, 4619, and 4623. Unit 4615 has a NISP of 141, a NISP per litre of 118 and an MNI of six based on 100% sample as shown in Table 7.45. This demonstrates that there was a dense concentration of microfauna within the skull of this skeleton. As with unit 4614, the mandible, and the incisors are abundant as is apparent from the analysis of the relative proportion of elements (see Figure 7.24). However, unlike unit 4614, unit 4615 has a relatively high proportion of humeri. Results from the breakage analyses are provided in Tables 7.46 and Tables 7.47. Tooth digestion is shown in Table 7.48. In addition, 29% of humeri are digested and 100% of femora. There are seven gnawed elements in this assemblage. As this unit has a NISP of 141, 5% of the elements are gnawed. The punctured femur in this unit is located on the articular end of the element and the results from the gnawing analysis are shown in Tables 7.49 and 7.50.

Taxon	*NISP*	*MNI*
Micromammal	79	0
Rodent	29	0
Mus sp.	33	6

Table 7.45 NISP and MNI by taxon for unit 4615

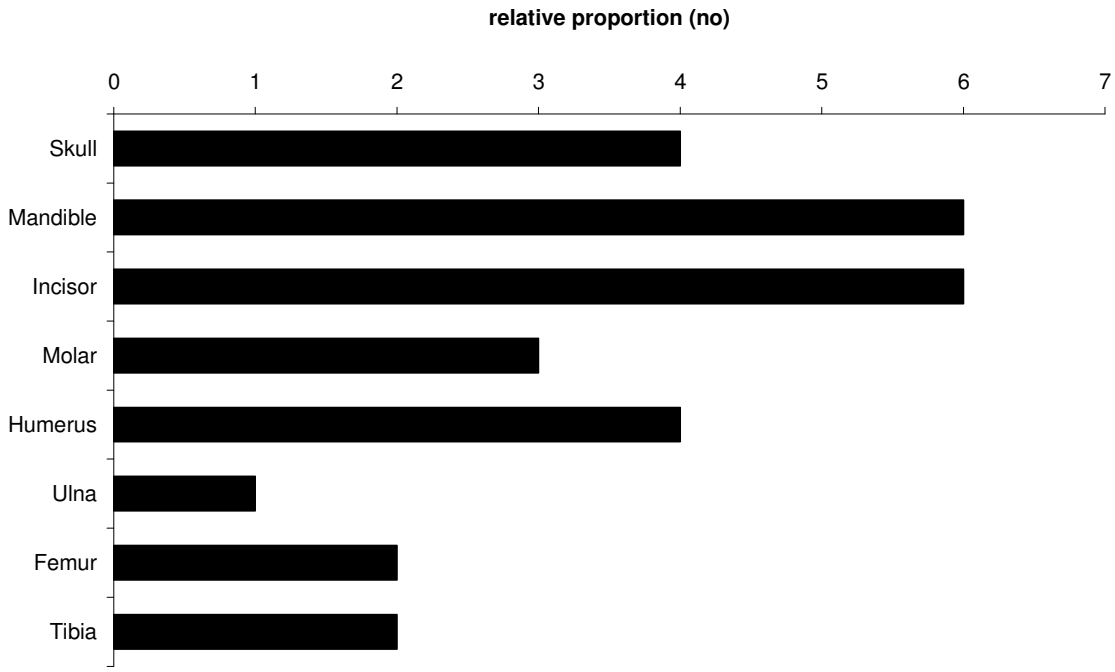


Figure 7.24 Relative proportion of elements for unit 4615

POST-CRANIAL BREAKAGE	*NO*	*%*
Humerus		
Complete	0	0
Proximal	7	78
Shaft	0	0
Distal	2	22
Ulna		
Complete	0	0
Proximal	1	100
Shaft	0	0
Distal	0	0
Femur		
Complete	1	25
Proximal	0	0
Shaft	0	0
Distal	3	75
Tibia		
Complete	1	13
Proximal	1	13
Shaft	3	38
Distal	3	38

Table 7.46 Post-cranial breakage for unit 4615

Skull breakage categories	**No**	**%**
Complete	0	0
Broken with zygomatic process intact	0	0
Maxilla lacking the zygomatic process	7	100
Mandible breakage	**No**	**%**
Complete	0	0
Ascending ramus broken	1	9
Ascending ramus missing	4	36
Ascending ramus missing and inferior border broken	6	55

Table 7.47 Cranial breakage for unit 4615

Unit 4615	**No of *in situ* maxillary teeth digested**	**No of *in situ* mandibular teeth digested**	**Total no of *in situ* teeth**	**No of digested isolated teeth**	**No of isolated teeth**	**% of digested teeth**
Incisor	0	1	5	3	19	17
Molar	5	0	29	4	11	23

Table 7.48 Tooth digestion for unit 4615 (all group A)

Element	*No of gnawed elements*
Isolated incisor	2
Mandible	3
Vertebra	1
Femur	1

Table 7.49 Elements affected by gnawing in unit 4615

Unit 4615 *Element*	*Number of puncture marks measured*	*Length in mm*
Mandible	1	0.60
Femur	1	0.70

Table 7.50 Number of marks measured in unit 4615 and the average length

Unit 4619-Level VIII

Unit 4619 was assigned to the unit category artefact/cluster and represents the microfaunal concentration found over the torso of the skeleton. This unit was distinctive due to the orange discolouration of the sediment. It is likely that this staining was caused by broken down organic matter in which the microfaunal elements were originally incorporated and is often associated with owl pellet or small carnivore scat assemblages (Peter Andrews pers. comm.). This unit was directly

below unit 4614 and above unit 4615. The concentration of microfauna was restricted to the torso of the skeleton and the excavator believed that it had been deliberately placed rather than becoming accidentally incorporated within the burial. As a result, this unit, like unit 2091, was excavated using a 10 cm grid. The grid was laid over the unit, which extended from the head of the skeleton down to the pelvis (see Figures 7.25 and 7.26).

This unit has a NISP of 3443, an adjusted NISP of 4838, and an adjusted NISP per litre of 1536, confirming the excavator's opinion that this unit was very dense in microfauna. The majority of the unit consisted of microfauna and there were only 3.15 litres of accompanying sediment. NISP results per square demonstrate that square 12 has the greatest concentration of elements. This square was located next to the skull, and over the neck and left humerus of the skeleton. Table 7.51 shows the distribution of taxa by square while Table 7.52 provides a breakdown of the MNI in unit 4619 by taxon. The analysis of the relative proportion of elements given in Figure 7.28 demonstrates that the incisor if the most abundant element. All of the skulls, 179 in total, have been broken into isolated maxillae, and mandible breakage by square is shown in Table 7.53. Table 7.54 shows the post-cranial breakage for unit 4619 as a whole. It is evident from this table that few of the major limb bones are complete.

Table 7.55 shows the breakdown of incisor digestion for unit 4619 by excavation square and in total, 24% of the incisors in this unit are digested. The level of digestion for each square varies although it appears to be largely attributable to difference in sample size. Square 6 and square 12 both have a sample size of over 100 incisors and these two squares have high level of digestion with 27% and 31% respectively. The other squares have samples of below 100 incisors. Table 7.56 illustrates the digestion by category for each of the excavation squares in unit 4619. Square 6 has a greater number of digested incisors in the higher digestion categories than the other squares but the majority of incisors in this unit are lightly digested. In addition, there is one isolated upper rodent incisor that has erosion on the dentine rather than on the enamel. The molars have a lower overall level of digestion than the incisors as shown in Tables 7.57 and 7.58. The results of the analysis of the humeri digestion shows that a high percentage of the distal humeri in this assemblage are digested. Square 6 has the highest rate of digestion. The percentage of femora digested in unit 4619 is far lower than the humeri. In total, 15 (18%) of the femora are digested as shown in Table 7.60. Table 7.61 shows the number and percent of the total elements gnawed for each excavation square in unit 4619. Squares 1, 2, and 3 are not affected by gnawing. The majority of the elements with gnawing are rodent or *Mus* sp. However, there are three mustelid elements with gnawing and puncture marks. Two isolated incisors were found in this assemblage with black staining on their

surfaces, characteristic of manganese staining and there were two metapodials encrusted with calcium carbonate similar to those found in unit 4614.

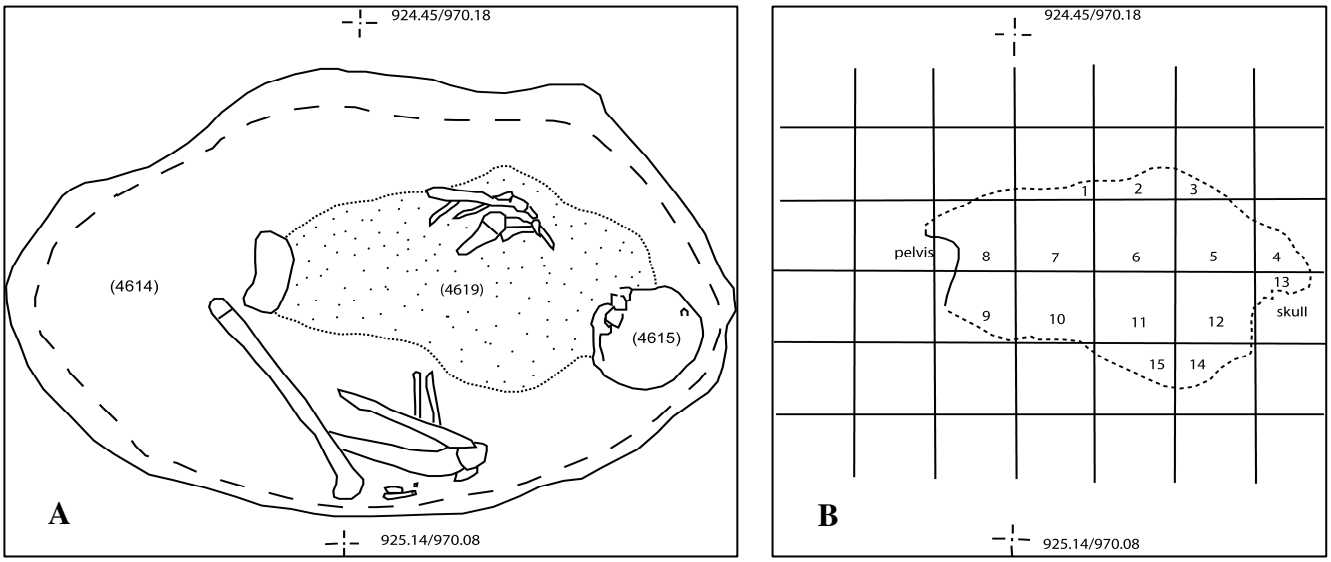


Figure 7.25 A: plan of Burial 513 with unit 4619 overlying the torso B: the grid used to excavate unit 4619

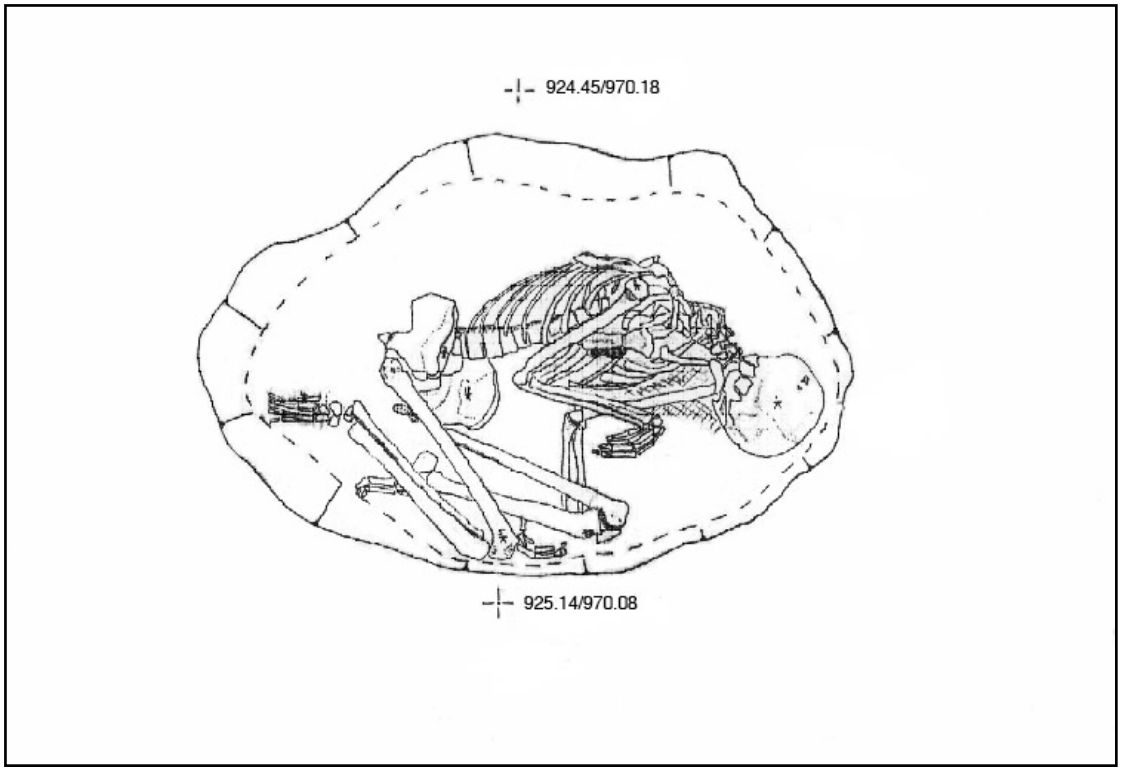


Figure 7.26 Plan of skeleton in Burial 513

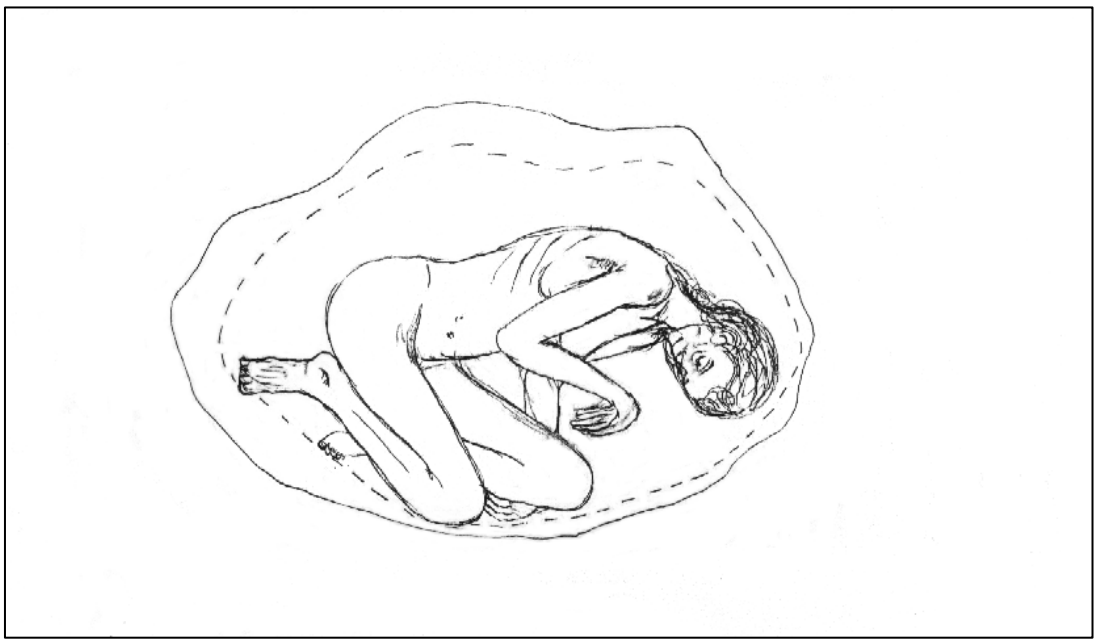


Figure 7.27 Artist's reconstruction of Burial 513

Square number	NISP	Taxa found
1	0	None
2	24	Micromammal, rodent, *Mus* sp.
3	17	Micromammal, rodent, *Mus* sp.
4	155	Micromammal, rodent, *Mus* sp.
5	271	Micromammal, rodent, *Mus* sp., *Mus musculus*, *Crocidura* sp., *Crocidura suaveolens*
6	768	Micromammal, rodent, *Mus* sp., *Mus musculus*
7	307	Micromammal, rodent, *Mus* sp., *Mus musculus*
8	119	Micromammal, rodent, *Mus* sp.
9	167	Micromammal, rodent, *Mus* sp., *Crocidura suaveolens*
10	260	Micromammal, rodent, *Mus* sp., *Mustela nivalis*
11	321	Micromammal, rodent, *Mus* sp.
12	616	Micromammal, rodent, *Mus* sp., *Microtus* sp.
13	59	Micromammal, rodent, *Mus* sp.
14	249	Micromammal, rodent, Mus sp., *Mus musculus*
15	80	Micromammal, rodent, *Mus* sp., *Mustela* sp.

Table 7.51 Adjusted NISP per square for unit 4619

Taxon	MNI
Crocidura suaveolens	2
Crocidura leucodon	1
Microtus sp.	2
Mus sp.	184
Mus musculus	5
Mustela nivalis	1
Total	**195**

Table 7.52 Breakdown of MNI by taxon for unit 4619

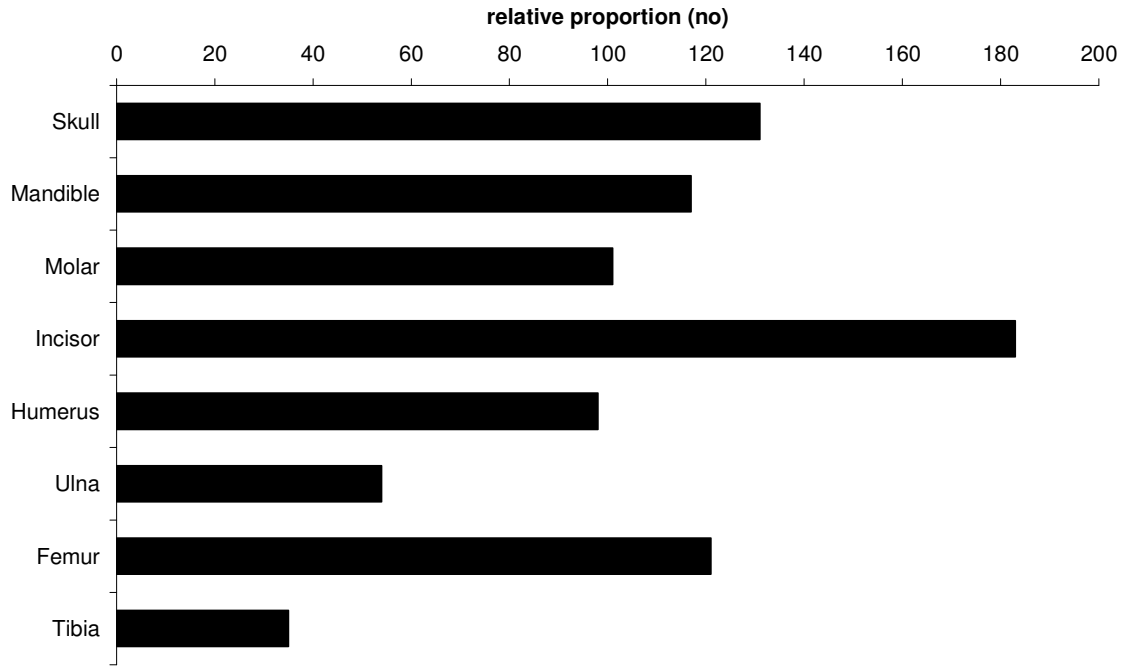


Figure 7.28 Relative proportion of elements for unit 4619 as a whole

Mandible breakage	*Complete*	*Ascending ramus broken*	*Ascending ramus missing*	*Ascending ramus missing and inferior border broken*	*Total*
Square no					
1	0	0	0	0	0
2	0	0	1	4	5
3	0	0	0	0	0
4	0	0	0	4	4
5	0	2	1	16	19
6	0	0	4	34	38
7	0	0	3	18	21
8	0	0	0	7	7
9	0	1	4	14	19
10	0	1	3	11	15
11	0	0	1	17	18
12	0	0	4	44	48
13	0	0	0	7	7
14	0	0	1	16	17
15	0	0	1	5	6
Total	0	4	23	197	224

Table 7.53 Mandible breakage for unit 4619 by excavation square

POST-CRANIAL BREAKAGE	*NO*	*%*
Humerus		
Complete	3	2
Proximal	98	53
Shaft	11	6
Distal	72	39
Ulna		
Complete	0	0
Proximal	55	59
Shaft	22	24
Distal	16	17
Femur		
Complete	2	1
Proximal	124	76
Shaft	5	3
Distal	32	20
Tibia		
Complete	4	5
Proximal	26	33
Shaft	16	21
Distal	32	41

Table 7.54 Post-cranial breakage for unit 4619

Square no	*No of in situ maxillary incisors digested*	*No of in situ mandibular incisors digested*	*Total no of in situ incisors*	*No of digested isolated incisors*	*No of isolated incisors*	*% of digested incisors*
1	0	0	0	0	0	0
2	0	0	0	1	4	25
3	0	0	0	1	1	100
4	0	0	1	4	20	19
5	0	1	9	17	54	29
6	0	1	9	36	126	27
7	1	1	11	15	56	25
8	0	0	4	6	22	23
9	0	0	7	4	30	11
10	1	0	17	9	41	17
11	0	1	6	6	60	11
12	0	0	6	52	161	31
13	0	0	0	6	13	46
14	0	0	6	8	54	13
15	0	0	4	0	0	0
Total	2	4	80	165	642	24

Table 7.55 Incisor digestion by excavation square for unit 4619

Digestion category	*Light*	*Moderate*	*Heavy*	*Extreme*
Square no				
1	0	0	0	0
2	1	0	0	0
3	1	0	0	0
4	3	0	1	0
5	13	3	2	0
6	21	7	7	2
7	12	2	2	1
8	5	1	0	0
9	3	0	0	1
10	9	0	1	0
11	6	1	0	0
12	44	6	2	0
13	0	3	2	1
14	6	1	1	0
15	0	0	0	0
Total	124	24	15	5

Table 7.56 Incisor digestion by excavation square and category

Square no	*No of in situ maxillary molars digested*	*No of in situ mandibular molars digested*	*Total no of in situ molars*	*No of digested isolated molars*	*No of isolated molars*	*% of digested molars*
1	0	0	0	0	0	0
2	0	0	4	0	1	0
3	0	0	0	0	2	0
4	0	1	19	7	23	19
5	0	0	40	4	45	5
6	2	2	103	22	117	12
7	0	0	54	4	61	4
8	0	0	17	1	9	4
9	0	0	45	0	34	0
10	1	1	62	11	54	11
11	0	0	62	0	68	0
12 (Group A)	0	0	91	5	146	2
(Group C)	0	0	0	1	2	50
13	3	0	14	0	16	10
14	0	0	43	0	37	0
15	0	0	10	0	0	0
Total	6	4	564	55	615	6

Table 7.57 Molar digestion by excavation square for unit 4619

Digestion category	*Light*	*Moderate*	*Heavy*	*Extreme*
Square no				
1	0	0	0	0
2	0	0	0	0
3	0	0	0	0
4	6	1	1	0
5	3	1	0	0
6	25	1	0	0
7	4	0	0	0
8	1	0	0	0
9	0	0	0	0
10	12	0	1	0
11	0	0	0	0
12 (Group A)	5	0	0	0
(Group C)	1	0	0	0
13	3	0	0	0
14	0	0	0	0
15	0	0	0	0
Total	60	3	2	0

Table 7.58 Molar digestion by excavation square and digestion category

Digestion category	*Light*	*Moderate*	*Heavy*	*Extreme*	*Total digested humeri*	*Total distal humeri*	*% of humeri digested*
Square no							
1	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0
4	1	1	0	0	2	3	67
5	0	1	0	0	1	3	33
6	6	4	6	0	16	19	84
7	1	4	0	0	5	8	63
8	0	0	0	0	0	0	0
9	0	0	0	0	0	1	0
10	0	0	0	0	0	2	0
11	2	1	0	0	3	7	43
12	7	2	1	0	10	24	42
13	0	0	0	0	0	1	0
14	0	1	1	0	2	4	50
15	0	0	0	0	0	0	0
Total	17	14	8	0	39	72	54

Table 7.59 Humerus digestion by excavation square and digestion category

Digestion category	*Light*	*Moderate*	*Heavy*	*Extreme*	*Total digested femora*	*Total proximal femora*	*% of femora digested*
Square no							
1	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0
4	1	0	0	0	1	3	33
5	0	0	0	0	0	2	0
6	1	3	2	1	7	29	24
7	1	0	0	0	1	8	13
8	0	0	0	0	0	2	0
9	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0
11	1	1	0	0	2	11	18
12	0	1	2	0	3	19	16
13	0	0	0	0	0	2	0
14	0	1	0	0	1	8	13
15	0	0	0	0	0	0	0
Total	4	6	4	1	15	84	18

Table 7.60 Femur digestion by excavation square and digestion category

Square no	*No of gnawed elements*	*Actual NISP*	*% of elements gnawed*
1	0	0	0
2	0	24	0
3	0	17	0
4	6	155	4
5	23	271	8
6	62	776	8
7	16	312	5
8	9	119	8
9	12	166	7
10	29	258	11
11	18	311	6
12	47	635	7
13	3	59	5
14	8	260	3
15	9	80	11
Total	242	3443	7

Table 7.61 Number and percent of elements in gnaw and puncture marks in each square in unit 4619

Unit 4619 *Element*	*Number of puncture marks measured*	*Average length in mm*
Maxilla	5	0.39
Mandible	12	0.50
Humerus	9	0.46
Ulna	2	0.38
Vertebra	3	0.66
Pelvis	1	0.54
Tibia	1	0.64
Astragalus	1	0.26

Table 7.62 Number of puncture marks measured in unit 4619 and the average length

Unit 4619 ***Bone type***	***No of puncture marks measured***	***Smallest length of mark (mm)***	***Longest length of mark (mm)***	***Average length of mark(mm)***
Puncture marks on shafts	1	0.70	N/A	N/A
Puncture marks on articular ends	5	0.26	0.50	0.36

Table 7.63 Puncture marks by bone type for unit 4619

Unit 4623-Level VIII

Unit 4623 is the lower burial fill from Burial 513 and has a NISP of 660, an adjusted NISP of 2434, an adjusted NISP per litre of 187 and an MNI of fifty-nine. Table 7.64 shows the NISP by taxon and demonstrates that *Mus* sp. is the most abundant taxon in this unit. Figure 7.29 shows the relative proportion of elements for unit 4623. From this figure it is apparent that the cranial elements are more abundant than the post-cranial elements. Results for breakage analyses are shown in Tables 7.65 and 7.66. There are no complete or broken skulls in this unit. However, there are 110 isolated maxillae. In addition, there are 114 mandibles in unit 4623; none of these are complete.

Table 7.67 shows tooth digestion. From this table, it is apparent that there is one lightly digested *in situ* mandibular incisor and twenty-three digested isolated incisors. All of the digested teeth are group A taxa. In addition to these incisors there are fifty-five incisors that are digested at the developing end; one of these is an isolated upper rodent incisor, thirty are isolated upper *Mus* sp. incisors, twenty-one are isolated lower rodent incisors, one is an *in situ* upper *Mus* sp. incisor and there are two lower *in situ Mus* sp. incisors. Furthermore, there is one isolated upper rodent incisor that has corroded dentine. Table 7.68 shows the results from the digestion analyses by category. In total, 75% of humeri are digested; there are no digested femora. In addition to these elements, there are two incisors that have been gnawed at the developing end. There are eighty-eight elements in unit 4623 that have been gnawed; thirty-nine of these are mandibles and a further thirty-six are cranial elements.

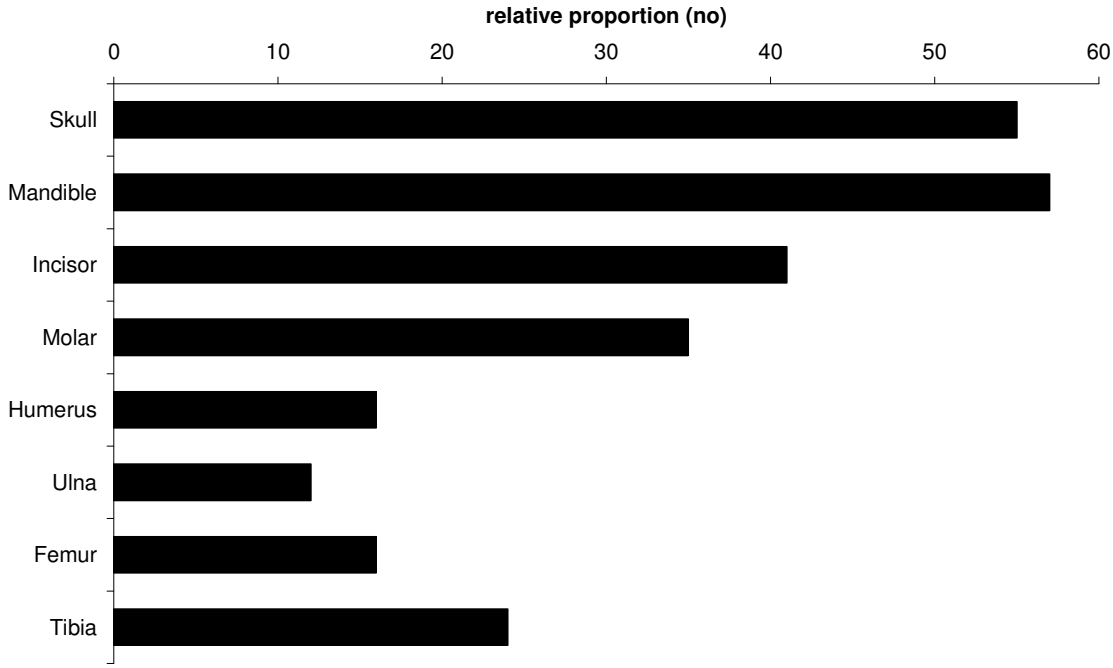


Figure 7.29 Relative proportion of elements for unit 4623

Taxon	**NISP**	**MNI**
Micromammal	132	0
Suncus etruscus	5	2
Rodent	178	0
Murinae	20	0
Mus sp.	313	50
Mus musculus	12	7

Table 7.64 NISP by taxon for unit 4623

Mandible breakage	**No**	**%**
Complete	0	0
Ascending ramus broken	6	5
Ascending ramus missing	32	28
Ascending ramus missing and inferior border broken	76	67

Table 7.65 Mandible breakage for unit 4623

POST-CRANIAL BREAKAGE	*NO*	*%*
Humerus		
Complete	1	6
Proximal	5	29
Shaft	4	24
Distal	7	41
Ulna		
Complete	0	0
Proximal	5	42
Shaft	4	33
Distal	3	25
Femur		
Complete	0	0
Proximal	6	40
Shaft	2	13
Distal	7	47
Tibia		
Complete	1	6
Proximal	0	0
Shaft	6	35
Distal	10	59

Table 7.66 Post-cranial breakage for unit 4623

Unit 4623	**No of *in situ* maxillary teeth digested**	**No of *in situ* mandibular teeth digested**	**Total no of *in situ* teeth**	**No of digested isolated teeth**	**No of isolated teeth**	**% of digested teeth**
Incisor	0	1	37	23	127	15
Molar	7	10	359	16	64	8

Table 7.67 Tooth digestion for unit 4623

Digestion categories	*Incisor (no)*	*Molar (no)*	*Humerus (no)*	**Femur (no)**
Light	13	28	3	0
Moderate	8	2	2	0
Heavy	3	2	1	0
Extreme	0	1	0	0
Total	**24**	**33**	**6**	**0**

Table 7.68 Digestion by category for unit 4623

Element	*No*
Pre-maxilla	3
Maxilla	8
Mandible	39
Isolated molar	1
Isolated incisor	24
Humerus	2
Scapula	1
Vertebra	4
Femur	2
Tibia	3
Long bone	1
Total	88

Table 7.69 Elements with puncture or gnaw marks in unit 4623

Unit 4623 *Element*	*Number of puncture marks measured*	*Average length in mm*
Mandible	16	0.41
Humerus	1	0.66
Scapula	3	0.96
Tibia	1	1.34
Vertebra	1	0.44

Table 7.70 Number of marks measured in unit 4623 and the average length

Unit 4623 ***Bone type***	***No of puncture marks measured***	***Smallest length of mark (mm)***	***Longest length of mark (mm)***	***Average length of mark(mm)***
Puncture marks on shafts	1	1.34	N/A	N/A
Puncture marks on articular ends	2	0.34	0.66	0.50

Table 7.71 Puncture marks by bone type for unit 4623

Summary of the units from Burial 513

The NISP for all of the fill units from Burial 513 is 8942, the adjusted NISP is 17813 and the MNI is 518. Although combining MNIs from multiple units is problematic due to the possibility of the same individual being present in more than one unit, it does give us an idea of the overall MNI. This illustrates the density of microfauna found within this burial. Table 7.72 shows the MNI by taxon for the four burial units. It is clear that they are largely dominated by *Mus* sp. The only elements that can be identified to species level have all proved to be *Mus musculus*, suggesting that the other elements are probably also *Mus musculus*.

Figure 7.30 shows the relative proportion of elements for the units in Burial 513. The cranial elements are more abundant than the post-cranial elements and the molar is the least abundant of the cranial elements. This is to be expected because *Mus* sp. third molars are very small, and are more easily lost during the screening process, and missed during analysis than other elements. The humerus and ulna are under-represented in comparison to the femur and tibia. Table 7.73 gives the results of the breakage analyses for all four units. None of the units have any complete or broken skulls only isolated maxilla and they all have high levels of mandible breakage. The third column of Table 7.73 shows the percentage of mandibles in the last and most severe breakage category. From this it is apparent that although all the units have a high percentage of mandible breakage, units 4614 and 4619 have the highest percentages. The final column has the percentage of complete major limb bones. Units 4614 and 4615 have higher percentages than units 4619 and 4623 which both have very low values. Table 7.74 shows the percentage of digested elements for the units from Burial 513. From this it is apparent that unit 4614 has the lowest percentage of digested elements and the humerus has a higher percent of digestion than the femur. This pattern is also evident in the other units. Table 7.75 shows the percent of elements with gnawing and puncture marks form Burial 513.

Unit	***4614***	***4615***	***4619***	***4623***
Insectivore	0	0	0	0
Suncus etruscus	1	0	0	2
Crocidura suaveolens	2	0	2	0
Crocidura leucodon	1	0	1	0
Rodent	37	0	0	0
Arvicola terrestris	0	0	0	0
Mus sp.	99	6	184	50
Mus musculus	19	0	5	7
Microtine	1	0	0	0
Microtus sp.	0	0	2	0
Small carnivore	0	0	0	0
Mustela nivalis	1	0	1	0
Amphibian	0	0	0	0
Total MNI	**161**	**6**	**195**	**59**

Table 7.72 MNI by taxon for the units from Burial 513

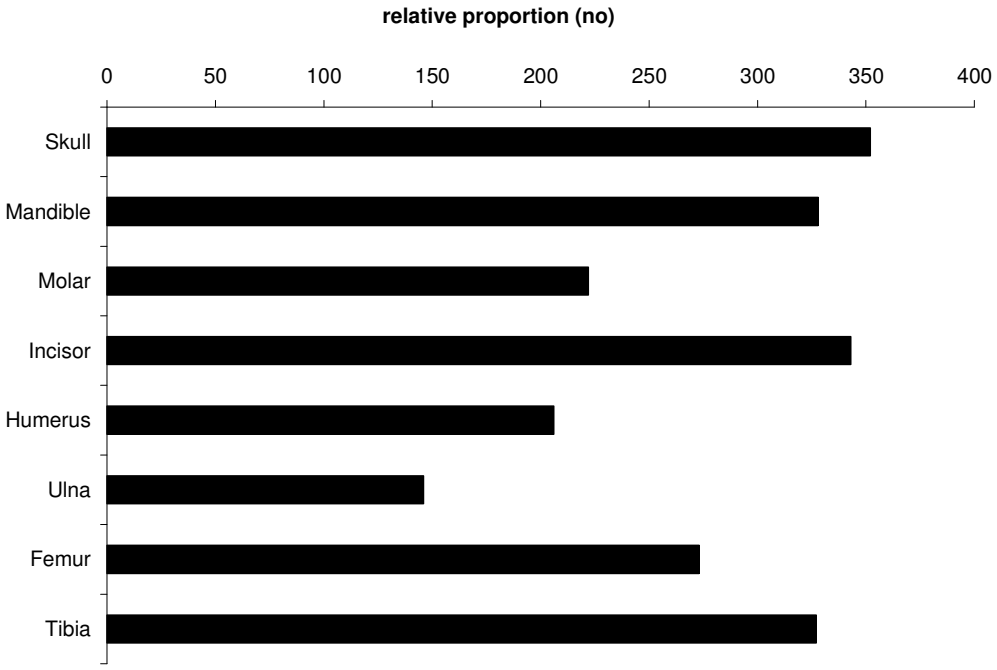


Figure 7.30 Relative proportion for all units from Burial 513

Breakage	**Skull** (% of maxillae lacking the zygomatic process)	**Mandible** (% with the ascending ramus missing and the inferior border broken)	**Post-crania** (%) complete
Unit 4614	100	75	15
Unit 4615	100	55	10
Unit 4619	100	88	2
Unit 4623	100	67	3

Table 7.73 Breakage for all units from Burial 513

Percentage Digested	**Incisors**	**Molars**	**Humeri**	**Femora**
Unit 4614	4	3	23	10
Unit 4615	17	23	29	100
Unit 4619	24	6	54	18
Unit 4623	15	8	75	0

Table 7.74 Percentage of digestion for all units from Burial 513

Gnawing	**Unit 4614**	**Unit 4615**	**Unit 4619**	**Unit 4623**
% of elements with gnaw or puncture marks	9	5	7	13

Table 7.75 Gnawing and puncturing for all units from Burial 513

Unit 1073-Level VII

This was defined as make-up/packing unit, although it was arbitrarily divided from unit 1072 because of a cluster of macrofauna. The deposit consisted of olive-brown, sandy/silty clay. It was located in Space 105 which was to the north of Building 24 and east of Space 106, shown in Figure 5.10. The NISP and MNI broken down by taxon are given in Table 7.76, while the results for the analysis of the relative proportion of elements are illustrated in Figure 7.31. There are no complete or broken skulls in this unit but there are twenty-two isolated maxillae. The results for post-cranial breakage analyses can be found in Tables 7.77 and shows that there are few complete elements. Table 7.78 shows the results for tooth digestion; there were no digested post-cranial elements. The results for the gnawing analyses can be found in Tables 7.79, 7.80 and 7.81; Figure 7.32 shows SEM micrographs of a punctured maxilla.

Taxon	*NISP*	*MNI*
Micromammal	109	1
Crocidura leucodon	1	1
Suncus etruscus	1	1
Rodent	56	0
Murinae	4	0
Mus sp.	64	12
Mus musculus	6	4
Microtus sp.	1	1
Amphibian	5	1

Table 7.76 NISP and MNI by taxon for unit 1073

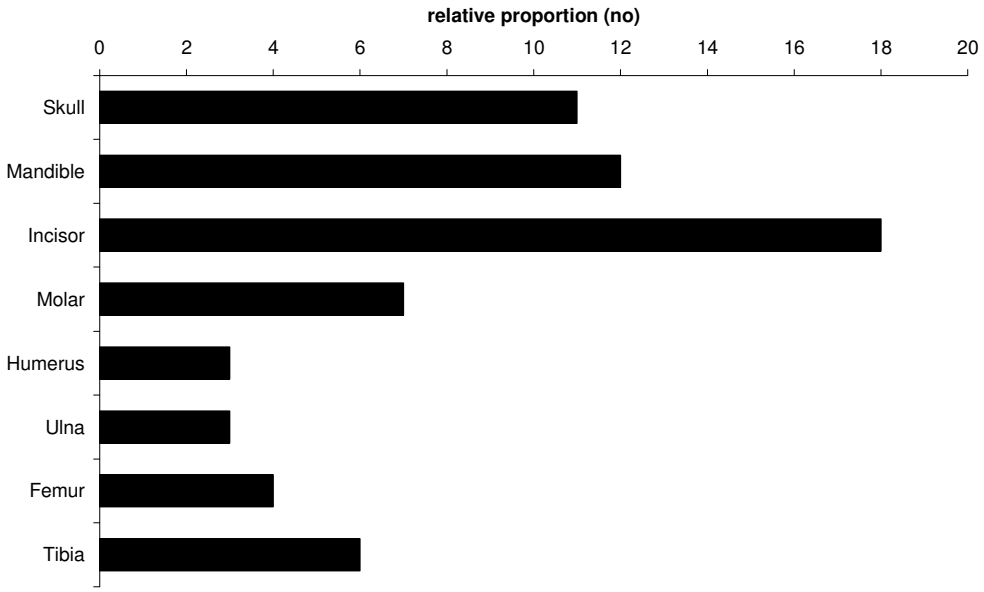


Figure 7.31 Relative proportion of elements for unit 1073

POST-CRANIAL BREAKAGE	*NO*	*%*
Humerus		
Complete	1	20
Proximal	0	0
Shaft	0	0
Distal	4	80
Ulna		
Complete	1	10
Proximal	2	20
Shaft	3	30
Distal	4	40
Femur		
Complete	0	0
Proximal	7	58
Shaft	5	42
Distal	0	
Tibia		
Complete	0	0
Proximal	1	5
Shaft	7	35
Distal	12	60

Table 7.77 Post-cranial breakage for unit 1073

Unit 1073	**No of *in situ* maxillary teeth digested**	**No of *in situ* mandibular teeth digested**	**Total no of *in situ* teeth**	**No of digested isolated teeth**	**No of isolated teeth**	**% of digested teeth**
Incisor	0	0	10	2	60	3
Molar	0	0	70	1	12	1

Table 7.78 Tooth digestion for unit 1073 (all group A)

Element	*No*
Maxilla	1
Mandible	4
Molar	1
Incisor	1
Humerus	1
Femur	1
Tibia	2
Supra-scapula (amphibian)	1

Table 7.79 Gnawed elements from unit 1073

Element	*No of puncture marks measured*	*Average length (mm)*
Maxilla	1	0.64
Isolated incisor	1	0.39
Humerus	2	0.38
Femur	4	0.42

Table 7.80 Length of puncture marks on elements in unit 1073

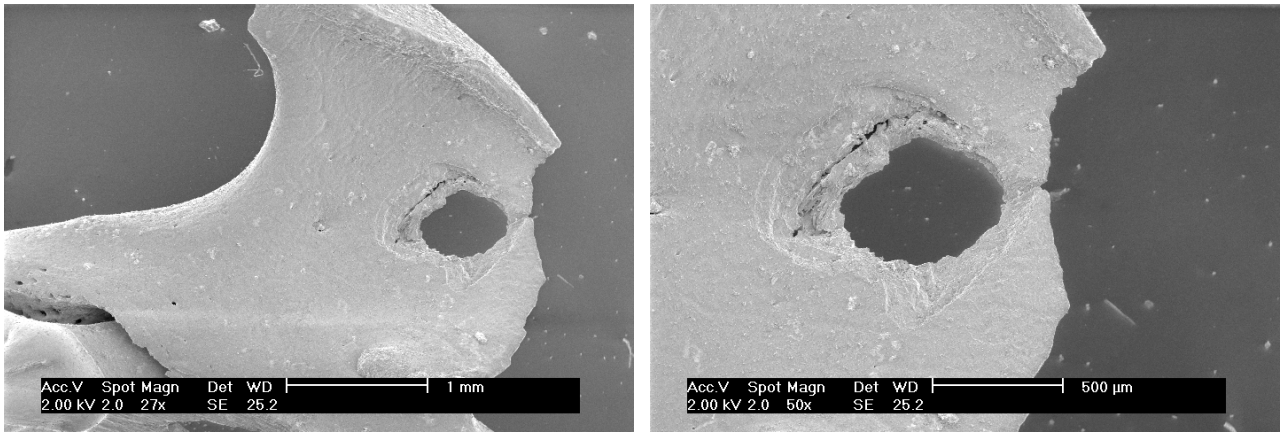


Figure 7.32 SEM micrographs showing the maxilla with puncture mark from unit 1073

Unit 1073 Bone type	***No of puncture marks measured***	***Smallest length of mark (mm)***	***Longest length of mark (mm)***	***Average length of mark(mm)***
Puncture marks on shafts	3	0.20	0.44	0.32
Puncture marks on articular ends	4	0.30	0.46	0.38

Table 7.81 Puncture marks by bone type for unit 1073

Unit 3044-Level VI-V

This unit is an inter-building unit from Level VI-V in the North area. Results for NISP and MNI are given in Table 7.82 while the results for the analysis of the relative proportion of elements are provided in Figure 7.33. There are thirty-five incisors in this sample two of which (6%) are digested, both are upper rodent incisors and one is lightly digested and the other is moderately digested. There are no digested molars or post-crania. However, one isolated rodent incisor was found with a puncture mark. This mark measured 0.46 millimetres. All of the elements, with the exception of one vertebra, are burnt.

Taxon	*NISP*	*MNI*
Micromammal	22	0
Insectivore	1	1
Suncus etruscus	1	1
Rodent	49	11
Mus sp.	1	1
Amphibian	2	1

Table 7.82 NISP and MNI by taxon for unit 3044

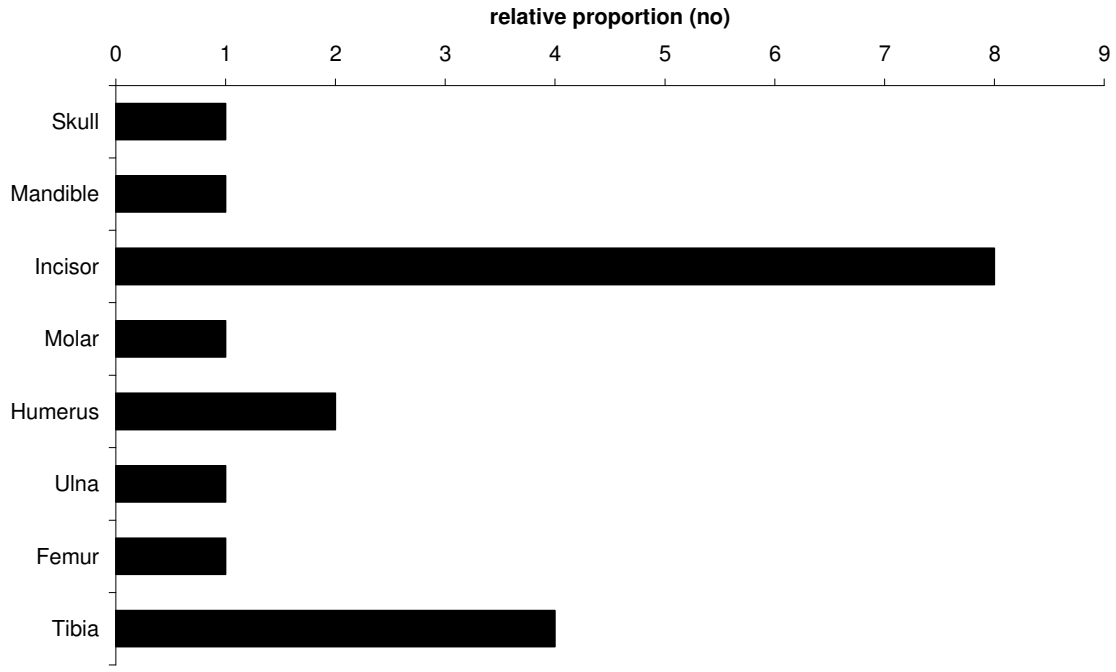


Figure 7.33 Relative proportion of elements from unit 3044

Other Units with Taphonomic Modifications

Digestion and gnawing

Other units were found from Çatalhöyük that had digestion and are shown in Tables 7.83 and 7.84. In addition to the digested incisor in unit 1184, there is a rodent incisor with corroded dentine and the digested incisor in unit 1368 also has corroded dentine. Units 1368 and 1411 have a rodent humeri with gnawing, unit 4708 has one amphibian vertebra with gnawing, and unit 1213 has a *Mus* sp. mandible with gnawing

Unit	No of *in situ* maxillary incisors digested	No of *in situ* mandibular incisors digested	Total no of *in situ* incisors	No of digested isolated incisors	No of isolated incisors	% of digested incisors
4871	0	0	0	2	4	50
4879	0	0	0	1	1	100
4708	1	0	1	0	4	25
4261	0	1	1	0	1	50
1368	0	0	0	1	1	100

Table 7.83 Incisor digestion for units with small assemblages

Unit	No of *in situ* maxillary incisors digested	No of *in situ* mandibular incisors digested	Total no of *in situ* incisors	No of digested isolated incisors	No of isolated incisors	% of digested incisors
4716	0	0	0	1	0	100
1888	0	0	0	1	3	33
1184	0	0	0	1	7	14
1368	0	0	0	1	1	100

Table 7.84 Incisors with digestion on the developing end for units with small assemblages

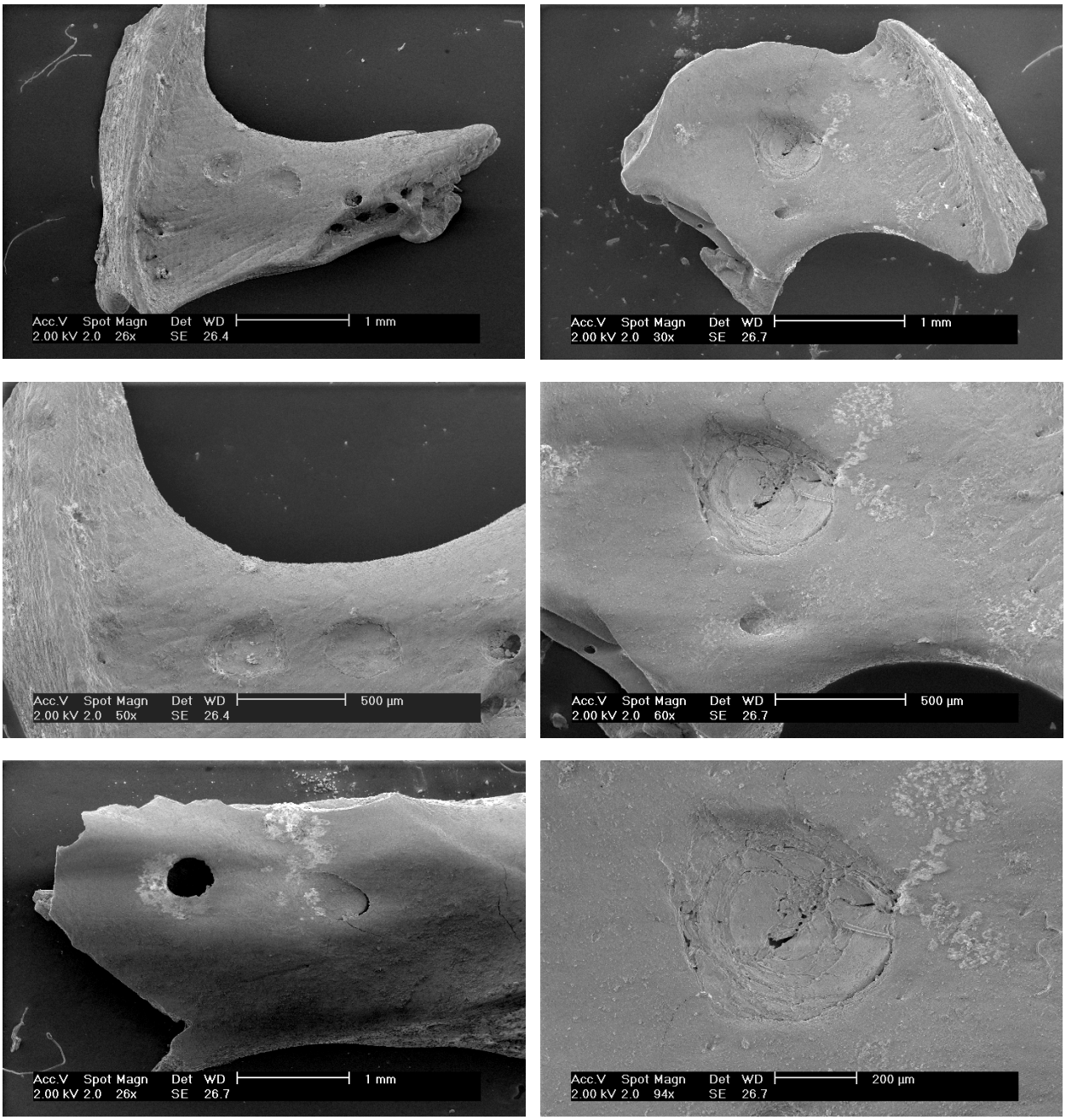


Figure 7.34 SEM micrographs showing elements with puncture marks from Burial 513
Left hand column from top to bottom:
1. Rodent maxilla with puncture marks from unit 4619
2. Enlargement of above
3. Murine mandible with puncture marks from unit 4619

Right hand column from top to bottom:
1. Rodent maxilla with puncture mark from unit 4619
2. Enlargement of rodent maxilla from unit 4619
3. Enlargement of above

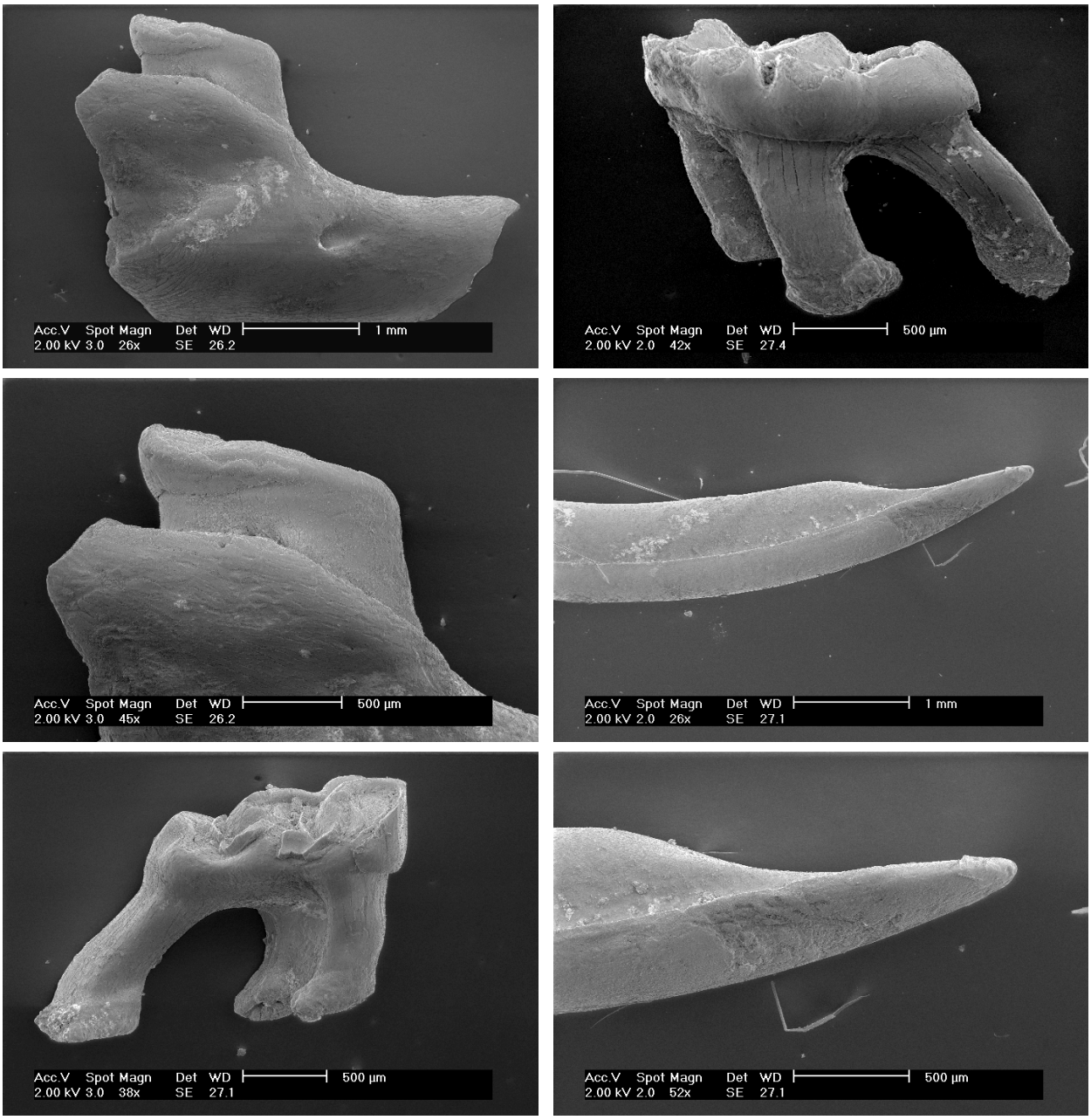


Figure 7.35 SEM micrographs showing rodent teeth with modifications from Burial 513

Left hand column from top to bottom:

1. *Mus* sp. mandible with extreme digestion on the M_1
and surface alteration on the bone surface from unit 4623
2. Enlargement of above
3. Upper *Mus* sp. isolated molar with extreme digestion from unit 4623

Right hand column from top to bottom:

1. Upper *Mus* sp. upper isolated molar with moderate digestion from unit 4619
2. Lower isolated rodent incisor with light digestion on the tip from unit 4619
3. Enlargement of above

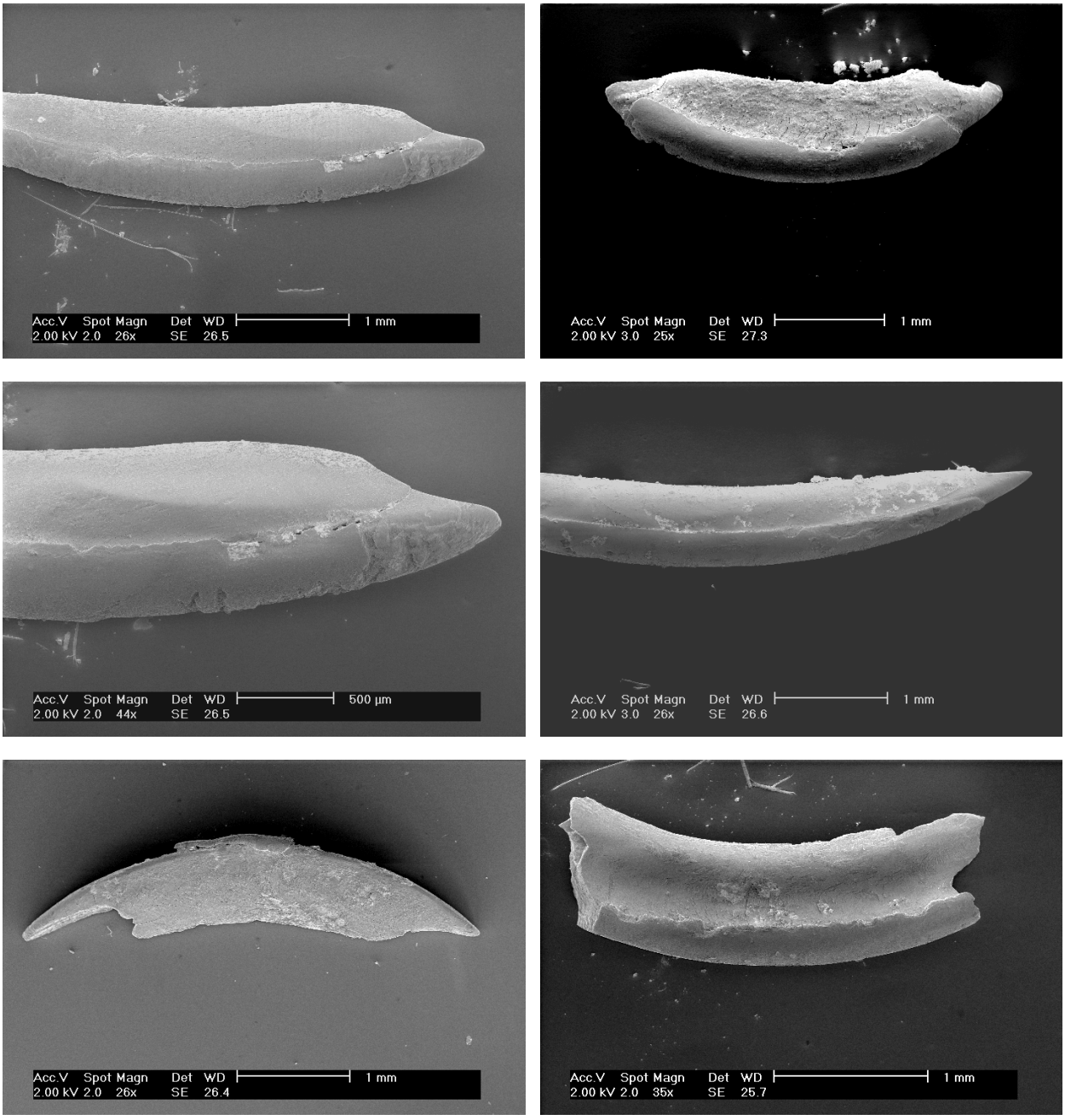
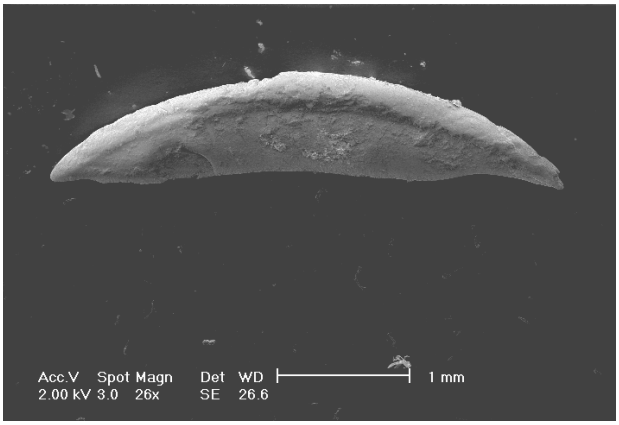
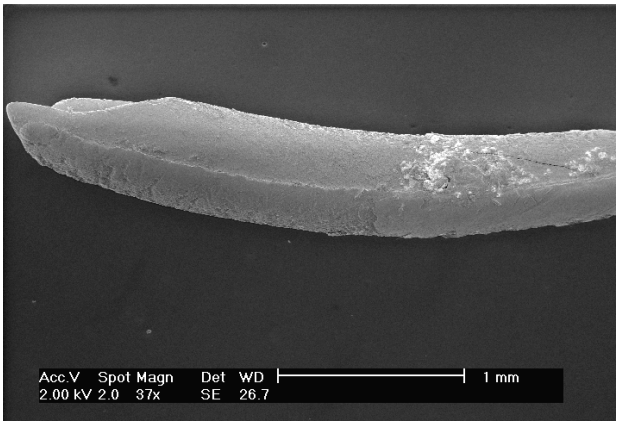
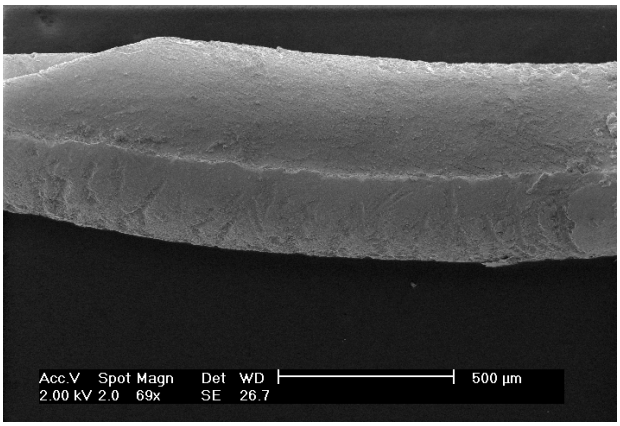


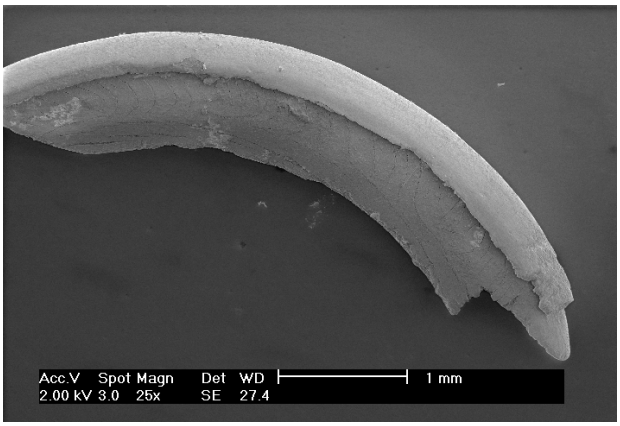
Figure 7.36 SEM micrographs showing incisors with modifications from Burial 513
Left hand column from top to bottom:
1. Lower isolated rodent incisor with moderate digestion from unit 4619
2. Enlargement of above
3. Upper isolated rodent incisor with extreme digestion from unit 4619

Right hand column from top to bottom:
1. Upper isolated *Mus* sp. incisor with corroded dentine from unit 4619
2. Lower isolated rodent incisor with light digestion from unit 4619
3. Upper rodent isolated incisor with corroded dentine from unit 4619









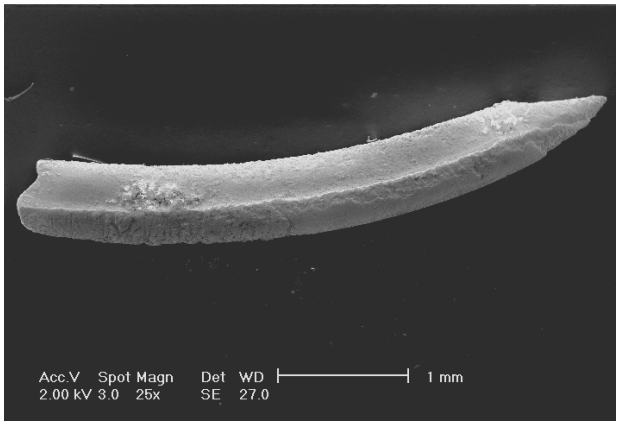


Figure 7.37 SEM micrographs showing incisors with modifications from Burial 513
Left hand column from top to bottom:
1. Isolated upper rodent incisor with heavy digestion from unit 4619
2. Isolated lower rodent incisor with corroded dentine and striations on the enamel from unit 4619
3. Isolated lower rodent incisor with moderate digestion and striations on the enamel from unit 4619
Right hand column
1. Isolated lower rodent incisor with striations on the enamel from unit 4619
2. Upper isolated rodent incisor with corroded dentine from unit 4623

8 DISCUSSION

THE PINARBAŞI ASSEMBLAGE

The Contexts from Area A

It can be seen from the results that the samples from Area A are small. The MNI for Area A demonstrates that the three contexts from this area, ABU, ABJ and ABR are dominated by amphibians, which make up 88% of the MNI. Water vole (*Arvicola terrestris*) is also present in all three contexts and comprises 6% of the total MNI. In addition, there are three snakes, one rodent and one turtle. These findings suggest that the environment around the site during this period of occupation must have included elements of wetland as indicated by the presence of amphibians, water voles, and turtle. This correlates with what is known of the environment during this time from other environmental studies. The large palaeolake Konya had dried up by this period but a smaller residual lake, with surrounding marshland could be found adjacent to the site of Pınarbaşı. Indeed, this sub-lake has existed until recently but environmental changes and modern irrigation methods have caused the lake to dry up and the surrounding marshlands to diminish (Roberts 1998, 149-150).

Analyses show that element loss and breakage occurred but it is not possible to determine which taphonomic processes were responsible for this. Contexts ABJ and ABR did not have any digested elements, while context ABU had two digested isolated water vole molars (40% of the total molars), and two digested distal humeri (67% of the total humeri with distal ends). This demonstrates that these elements had passed through the digestive tract of a predator or scavenger but it is not possible to identify which predator or scavenger this might have been.

The Contexts from Area B

The contexts surrounding the curvilinear feature

A decline in the number of amphibians can be seen from the results for Area B. The contexts found surrounding the curvilinear feature are thought to date to the 11th Millennium BP (Baird in press). These contexts have a combined MNI of eighteen and a greater diversity of species than was found in Area A. Only two of the eighteen individuals are amphibian, one is a snake and the rest are micromammals. The most abundant taxonomic group of micromammals are voles. Again the water

vole is present and two individuals of this species are found. The presence of both water vole and amphibians suggest that the environment was still moist at this time. *Microtus* sp. and microtines each have an MNI of four making them the most abundant group in the assemblage. Generally, they are indicative of open environments. The same is true of the greater mole rat and Tristram's Jird (Harrison & Bates 1991, 294; MacDonald 1996, 239). However, in addition to these, one rock mouse and one lesser white-toothed shrew were also found and both of these species prefer closed, woodland environments, suggesting either that there was tree cover in the immediate vicinity of the rockshelter or that they were brought to the site from a covered area by a predator. Finally, one individual of *Mus* sp. was found and unfortunately it was not possible to identify this individual to species level. However, both the house mouse and the Macedonian mouse tend to avoid woodland or forested areas. The reduction in the abundance of amphibians compared to micromammals that inhabit open environments could indicate that the region was becoming less moist and grassland more prevalent.

The results of the analysis of the relative proportion of elements show that there has been some element loss, particularly teeth, humeri and tibiae. However, this assemblage is small and a larger assemblage would be needed to gain a better idea of the full extent of element loss. Some of the elements in this assemblage have been digested. Only group C molars (microtines) were digested correlating with the results of Williams who found that microtine molars, due to their morphology, were more prone to digestion than those of murids (Williams 2001, 281). In addition, a high percentage of post-crania were digested. These high levels of breakage and digestion as well as the presence of a gnawed micromammal rib and the poor skeletal element proportion suggest that a small mammalian carnivore may have accumulated this assemblage. The puncture marks found on the micromammal rib are small. However, this does not aid in identifying the scavenger or predator because the larger of the carnivores can make small puncture marks by applying less pressure and only using the tip of the tooth to pierce the bone. Perhaps no one predator was responsible for accumulating these assemblages and these elements may be the result of a mixed assemblage. It is possible that the majority of the individuals derive from an owl pellet assemblage while others may be the results of natural deaths which were scavenged by a carnivore or omnivore. Unfortunately, due to the small size of the assemblage from the contexts surrounding the curvilinear feature it is not possible to identify which predator was responsible for its accumulation. As a result, it is also not possible to determine if the decrease in the abundance of amphibians in proportion to micromammals is attributable to a change in the environment or to the method of accumulation. It is often the case that small assemblages are derived from a number of sources and do not represent an

ongoing accumulation by a single predator and it is probable that this is the case with this assemblage.

The contexts from the fill of the curvilinear feature

It is believed that this group of contexts date to the Late Neolithic period (Watkins 1996, 52). Micromammals are the most abundant group of fauna in the contexts from this fill, although amphibian and snakes were also found. Again this assemblage is small and probably does not represent the prolonged activity of a single species of predator. Two of these are amphibians, one is a snake and the rest are micromammals. However, despite the small number of individuals, there is some diversity in the species found which is usually indicative of an equable environment (Odum 1971, 144). The most abundant small mammal group are the voles which are found in open environments as are Tristram's Jird and the grey hamster. However, two shrews were found (the bi-coloured white toothed shrew and the lesser white-toothed shrew) which both prefer covered, woodland environments and the finding of amphibians suggests some wetland. It is not possible to say whether these were from the immediate vicinity of the rockshelter or transported over some distance by a predator.

The analysis of the relative proportion of elements shows that there have been some significant element losses, particularly of teeth, ulnae and tibiae. This is a similar pattern of element loss to the assemblage from outside the curvilinear feature. The teeth are small elements and are likely to have passed through the larger mesh sizes used at Pınarbaşı, ulnae and tibiae tend to be more fragile and more susceptible to loss through breakage than humeri and femora. The breakage analysis found no complete skulls or mandibles.

The level of tooth digestion in this assemblage is similar to that found in the contexts surrounding the curvilinear feature. A lower proportion of the incisors are digested, only 19% of the total, and murid incisors have a higher level of digestion than microtine incisors. There are a greater number of molars in this assemblage, 38 in total and of these the results show that 32% are digested. All of the digested molars are group C molars (microtines excluding *Arvicola terrestris*), which supports the findings of Williams (2001). There is a high level of digestion and the levels are comparable with the contexts surrounding this feature but no elements were found with carnivore gnawing. It is difficult to identify which predator was responsible for this assemblage and it could be derived from a number of different taphonomic agents and processes.

The contexts from the fill of the fire installation

Radiocarbon dating of this feature produced a date of 6630 to 6440 Cal BP placing it in the Chalcolithic period. The species composition of this feature is interesting with the East European hedgehog being present which prefers deciduous woodland and moist pastureland (MacDonald & Barrett 1993, 24; Harrison & Bates 1991, 2). The water vole is not found but one individual of each of the following were: *Microtus* sp., Tristram's Jird, golden hamster and an amphibian. The presence of these four taxa suggests that the environment during this period was open grassland with areas of wetland.

The breakage analysis produced very limited information due to the small number of elements. The results of the digestion analysis are more informative. As stated in Chapter 7, there were only two undigested incisors in this assemblage and only five molars, one of which was digested. The presence of digestion indicates that an unknown predator played a role in the accumulation of at least one individual in this small assemblage.

The contexts from the fill of the pit adjacent to the fire installation

This assemblage consists of only two contexts, BAJ and BAK, and dates to the Pottery Neolithic period. These contexts have an MNI of only five and only *Crocidura* could be identified to genus. Both species of *Crocidura* found in this region prefer well-covered habitats (Kryštufek & Vohralík 2002, 78). The finding of an amphibian indicates that the environment was moist and the presence of digestion suggests that a predator played a role in the taphonomic history of at least one individual in this assemblage, either as a predator or as a scavenger.

Summary of results for Pınarbaşı

The results from the site as a whole indicate that the assemblages found are unlikely to have been accumulated by an established predator, such as a long term roosting barn owl, but are more likely to have been derived from a variety of sources. As a result, this makes it difficult to identify the biases that may have been introduced into the assemblage as a result of predation and to determine if changes in species composition are attributable to environmental change or predator change. However, the results of the adjusted MNI per litre show that the density of microfauna decreased through time and that amphibians are the most abundant microfaunal group in Area A but are less abundant in Area B. This could suggest an environmental shift towards drier conditions between the occupation of Area A and Area B with the drier conditions providing a more suitable habitat for micromammals.

THE ÇATALHÖYÜK ASSEMBLAGE

RESULTS BY LEVEL

Pre-level XII

The assemblages from Pre-level XII were the earliest excavated and were located in the deep-sounding in the South area of the site. All of the units in this level were excavated from external areas. Pre-Levels XII.D, C, and A all have small NISPs and MNIs and there are no elements that showed signs of digestion. Therefore, it is possible that these levels represent natural death assemblages rather than predator accumulated assemblages. Both Pre-Level XII.D and Pre-Level XII.C consist entirely of amphibians. Pre-Level XII.B has a larger assemblage as a result of a greater number of units being excavated from this level. Both Pre-Level XII.B and XII.A are dominated by amphibians. This finding could suggest that the area around the site was moist during this time but it is important to bear in mind that all of the units analysed in this level were from external units which are more likely to produce amphibians than internal units. There were three individuals of *Mus* sp. found in Pre-Level XII.B. Individuals from this genus can be found in a variety of environments but tend to avoid dense woodland (MacDonald & Barrett 1993, 271). It is unfortunate that it was not possible to identify these elements more precisely but it is likely that these elements were house mice because Macedonian mice were not found at Çatalhöyük. Moreover, house mice are more commonly found in human settlements than Macedonian mice and these two species do not usually occupy the same areas. Only Pre-Level XII.B has any digested elements. The evidence is not sufficient to allow an identification of the predator to be made but it does indicate that some species of predator or scavenger was active in the vicinity of the site.

Level XII and Level XI

Level XII has a small microfaunal assemblage, with only one micromammal and one amphibian and there are no digested elements. All of the units in these levels are from external deposits. Amphibians are less dominant in Level XI. *Microtus* sp and *Mus* sp. are present, both of which tend to be indicative of open environments. The finding of an incisor with digestion at the developing end indicates that predation or scavenging affected one individual in this assemblage but again does not allow an identification of the predator or scavenger to be made.

Level X

Level X is the first level in which the house mouse could be identified. In addition, it is the first level in which the internal areas of buildings were excavated and it is probable that there is a correlation between these two factors. The exact processes that lead to house mouse commensalism are not fully understood. It has been suggested that prior to human sedentism the house mouse

would have occupied a similar ecological niche to other species of *Mus*, in this instance the Macedonian mouse. It is thought that competition between house mice and other species of *Mus* drove the house mice out of the open fields and led it to exploit human built settlements (Auffray *et al* 1988, 518). House mice would have experienced many benefits from living among humans; not only would they have been free from competition with other small mammal species, but they would have been able to scavenge from human refuse and stored food and would have been largely protected from predators. It is probable that a more sociable nature allowed the house mouse to adapt well to commensalism (Tchernov 1991a, 316).

Amphibians are present but not dominant and generally the taxa found in this level are suggestive of a moist, open environment. Two units from this level contain elements with evidence of digestion but neither of these units have dense accumulations of microfauna. Unit 4205 is a building fill from Space 167, Building 9 in the South area of the site (see Figure 5.5). This unit has an incisor with corroded dentine, which is particularly interesting and may have been caused by the presence of lime in the deposits which has a high alkaline content (Fernandez-Jalvo & Andrews 1992, 411). However, I carried out an experiment where micromammal elements, including incisors, were placed in a soil deposit from Çatalhöyük with a high pH value, dampened with water and left for eight months. No changes were seen in the composition of the bone, dentine or enamel of these elements. It is probable that this was because eight months was not long enough to affect such modifications. Many incisors from the Çatalhöyük assemblage have a distinctive type of corrosion, typically on the developing ends, that has not been previously seen on incisors from any other assemblages. In some cases this corrosion has a similar affect to digestion whereas on other specimens it looks as though a carnivore with small teeth has gnawed the surface. This type of corrosion was only evident on the incisors and was not found on the molars. Unit 4708 is a building fill unit from Space 171, Building 18 in the South area of the site. This unit has digested elements but again the assemblage is small and no firm conclusions about its taphonomic history can be drawn.

Level IX

A greater number of units were analysed from Level IX than from the earlier levels. Possibly as a result of this increase in sample size, a greater diversity of taxa was found. Micromammals are more common than amphibians and *Mus* sp. is the dominant micromammalian taxa. House mice were identified at this level and it is likely that the remaining *Mus* sp. specimens are also house mice. In addition, three different species of soricid, and the Eastern European hedgehog are found in this level. Although the latter species is often found in woodland it also likes moist, open environments.

The same is true of the pygmy white toothed shrew which can be found in woodland as well as in open terrain. However, the lesser white toothed shrew generally prefers more wooded environments (MacDonald & Barrett 1993, 24; Harrison & Bates 1991, 2). The species composition of this level suggests that the environment was open, with areas of wetland and some tree cover in the vicinity of the site. The dominance of house mouse reflects its commensal nature and suggests that this species was beginning to take advantage of this human built environment. The presence of digestion and gnawing demonstrates that these house mice are being predated upon by an unknown carnivore.

Level VIII

Level VIII has the greatest array of taxa of all the levels at Çatalhöyük. Small mammals are the most abundant group in this level, although there are also seven amphibians and three weasels. *Mus* is the dominant genus with *Mus* sp. and the house mouse comprising 84% of the total MNI. As stated above, it is likely that the individuals identified only to genus level are also house mice. The increase in prevalence of house mice may reflect a growth in commensalism as the site became larger and more established. In addition, there are post-cranial elements that could be identified only as rodent but which came from a small micromammal such as a mouse rather than a larger micromammal such as a vole. If the elements that were identified as rodent are omitted from the analysis, *Mus* sp. and house mouse comprise 93% of the total MNI. The other species found in this level all comprise one percent or less.

The discovery of one individual of the Mediterranean horseshoe bat (*Rhinolophus euryale)* is significant. This species can be found in a variety of habitats ranging from forested to non-forested areas and roosts in caves, abandoned buildings, and foliage (Walker 1983, 231). This species was found in unit 1066, from Space 115 which is an external space located between Building 4, and Buildings 21, 7 and 6 in the South area of the site, as shown in Figure 5.7. Unit 1066 is described as an ash/charcoal dump possibly from a domestic oven or hearth, which is believed to have been buried rapidly. A moderate amount of macrofauna was recovered from this context and weathering, gnawing and digestion of the macrofaunal elements are all minimal. It is possible that the bat was living in a nearby abandoned building. The remaining taxa found in this level all have differing habitat preferences. Both *Microtus* sp. and pygmy white-toothed shrew prefer open environments, while the remaining species prefer covered environments with dense vegetation. In addition, the water vole requires areas of fresh water, while the bi-coloured white-toothed shrew is normally found in dry environments (MacDonald & Barrett 1983; Mitchell-Jones *et al* 1999).

To summarise, the dominance of house mice in this level probably reflects their adaptation to commensalism and shows how greatly humans affected the microfaunal community in the area they inhabited. The presence of amphibians and water voles suggest that there must have been areas of wetland around the site, while *Microtus* sp. and pygmy white toothed shrew are indicative of open environments. The two species of insectivore suggest that there was some vegetation in the vicinity of the site. However, it should be borne in mind that some of these species could have been brought to the site by predators.

Level VII

There are no units in Level VII that show the dense concentrations of microfauna found in Level VIII. However, *Mus* is still the most dominant taxon with individuals of *Mus* sp. and house mouse comprising 77% of the total MNI. In addition to house mice, 3% of the MNI are *Microtus* sp. and another 3% are pygmy white-toothed shrews. These two taxa are generally indicative of open environments. A further 3% are bi-coloured white-toothed shrews which prefer dry habitats, dense vegetation and the edges of woodlands (MacDonald & Barrett 1993, 34; Harrison & Bates 1991, 14). There is a greater percentage of amphibians in this level than in Level VIII and in total they comprise 11% of the MNI. As with the earlier levels, Level VII demonstrates how dominant house mice were at Çatalhöyük. The amphibians are the second most prevalent taxon and indicate that there were wetland areas around Çatalhöyük at this time. The remaining species suggest that the environment was mainly open, although there may have been more covered areas within the vicinity of the site.

Level VII-VI

Only four units from this level were analysed and all of the elements found are micromammal. Only two individuals could be identified beyond micromammal or rodent and both of these are *Mus* sp. Only one unit, unit 3272, showed any signs of digestion but the small sample size means it is impossible to identify which predator may have been responsible for this digestion.

Level VI-V

Many of the elements in this level could not be identified to genus or species level. Of the elements that could be identified more precisely, eight are *Mus* sp. one is a pygmy white-toothed shrew and four are amphibians. The individuals that were identified as *Mus* sp. are likely to be house mice, and this species probably reflects the sedentary nature of Çatalhöyük. The presence of amphibians indicates that the environment at Çatalhöyük at the time included areas of wetland, while the pygmy

white-toothed shrew suggests that the environments was largely open (MacDonald & Barrett 1993, 37; Walker 1991, 161).

Summary of results by Level

Figure 7.11, Chapter 7 shows the results for the density of microfauna by level. With the burial concentrations included it is clear that Level VIII is by far the densest level. However, when these are excluded it is apparent that Level VII has the greatest density of microfauna, although the overall levels are low. The density of microfauna is not as high as is often found in cave assemblages where owl pellet production has allowed vast numbers of pellets to be produced, often over long periods of time. Instead it suggests a site where rodents (predominantly mice) were a nuisance. This result demonstrates that mice were relatively quick to adapt to the niche that was Çatalhöyük and that perhaps as early as Pre-Level XII.B house mice were found at the site. This level has been dated with 95% probability to: earliest beginnings 9110 to 8950 Cal BP, earliest end 9030 to 8760 Cal BP (Cessford 2005b, 77). The finding of large numbers of house mice in archaeological sites of this date is significant and is one of the earliest records of commensalism we have in this region. House mice were also found at Cafer Höyük at around 9950 to 9450 Cal BP but in this assemblage the house mouse had an MNI of only thirty-four (Cucchi *et al* 2005). Prior to this the earliest record of house mice at Çatalhöyük was from the burial found in Level VIII during Mellaart's excavations. Although there is a decline in the percentage of amphibians this decline is not borne out by the NISP which shows that low numbers of amphibians are found throughout the various occupation levels at Çatalhöyük.

THE RESULTS BY UNIT CATEGORY

The results by unit category demonstrate that the majority of the various unit categories have a low density of microfauna. The exceptions are artefact/cluster, burial fill, and skeleton. However, these results are greatly biased by the burial fill units with high concentrations of microfauna. The artefact/cluster group contains unit 4619, the burial fill category includes unit 4614 and unit 4623, and the skeleton category includes unit 4615. Therefore, it is apparent that overall Çatalhöyük has a generally low density of microfauna with the exception of a few units that have large concentrations. There are three unit categories that consist of only one taxon: the skeleton category consists entirely of *Mus* sp.*,* and the feature fill category and the feature use category consist entirely of amphibians. Furthermore, the external deposit category is dominated by amphibians, which suggests that amphibians were more commonly found outside the buildings, while micromammals were more frequently found inside the buildings. All of the units associated with the burial fill concentrations (skeleton, artefact/cluster and burial fill) are dominated by *Mus.*

Units with Microfaunal Concentrations

Unit 2091-Level IX

Unit 2091 largely dominated Level IX. As stated in Chapter 5 (see Figure 5.6), this unit was located in Building 2, Space 116, adjacent to the crawl hole leading to Space 117. This unit was initially thought to represent an owl pellet assemblage but the discovery of puncture marks on some of the elements calls this theory into question. Figure 7.16 shows the grid used to excavate the concentration. Unfortunately, it is only a sketch plan and so is not very clear with some square numbers being omitted. Squares 9, 15 and 16 have the highest NISPs. Squares 9 and 15 are marked on the grid and are located directly next to the crawl hole. It would appear that this is where the assemblage was concentrated. This assemblage consists entirely of micromammals. The majority of individuals are *Mus* sp. and there are two individuals of pygmy white-toothed shrew. The species composition provides little information about the likely accumulator of the assemblage. There are many predators that will opportunistically take the most abundant species within their hunting range and there are few predators that show an active dislike of mice (see Chapter 4). Therefore, mice were probably selected because they were the most abundant taxon.

The relative proportion of elements in the assemblage from unit 2091 varies and there has been some element loss particularly of the ulnae and humeri. However, it is interesting to note that the metacarpals and metatarsals are almost equal in abundance with there being twenty-two metacarpals and twenty-one metatarsals. Molars are also under-represented, yet the incisor is the most abundant element. The skulls have undergone much breakage and the maxillae are present as isolated maxillae rather than intact in skulls. Mandible breakage is extensive as is post-cranial breakage and only 6% of the major limb bones in this unit are complete. There are many processes that could have affected the assemblage prior to burial such as trampling, weathering and transportation. In addition, soil compaction and post-depositional soil movement may have caused further breakage after burial. However, it is not known how long the assemblage is likely to have remained exposed before burial occurred.

Some of the elements in this assemblage have been digested and it is probable that unit 2091 represents an *in situ* small carnivore scat assemblage. The breakdown of incisor digestion by excavation square indicates that squares three, six and sixteen have the highest levels of digestion with 31%, 36% and 28% respectively. These squares have a greater number of incisors than most of the other squares, although square six has the greatest number of incisors, only 13% of them are digested. However, if the incisors with digestion at the developing end are included in the analysis, 25% of the total incisors in this unit are digested. A similar pattern can be seen with the molar

digestion. Squares six, nine and fifteen also have higher levels of molar digestion, although square three does not have any digested molars. In total, 15% of the molars are digested. There are only four squares (3, 4, 9, and 16) with digested post-crania. With the exception of square four, these are the same squares that have high levels of tooth digestion.

Although many elements are under-represented and the level of breakage is quite high, these modifications are less severe than one would typically expect of a small carnivore assemblage, so the presence of gnawing and puncture marks is perplexing. The first possible explanation is that the lower than average amount of breakage and digestion and the higher than average skeletal element representation could be due to the fact that the prey found in this assemblage are small and so the predator did not need to tear the prey apart before consumption. The second explanation is that this is a mixed assemblage derived from at least two different sources, one is a predator that causes a low degree of modification such as an owl and the other is a small carnivore. This theory is unlikely as dense microfaunal assemblages are more commonly the result of one predator species. In addition, the patterns of modification in the assemblage from unit 2091 are the same as the other microfaunal concentrations from Çatalhöyük suggesting that they were all accumulated by the same species of predator. It is unlikely that all of the microfaunal assemblages are mixed source assemblages from exactly the same combination of sources. The third explanation is that this is an owl pellet assemblage and that the elements found in the pellets have been gnawed by a predator after ejection. This seems improbable because there would be no meat at all left on the bones of the prey. The fourth explanation is that the marks recorded are not puncture marks but have been caused by a taphonomic process which produces a similar result. However, it is difficult to think of any process which would so perfectly emulate tooth puncture marks and so the most reasonable explanation is that these assemblages were accumulated by a small carnivore.

There are three small carnivores which could have been responsible. The first is some kind of mustelid. Weasels, badgers and possibly polecats have all been found at Çatalhöyük, although badgers are the most common. As stated in Chapter 4, Andrews and Nesbit-Evans (1983) analysed mustelid scats and found that none of the cranial or post-cranial elements were intact and the post-cranial elements far-outnumbered the cranial ones (Andrews & Nesbit-Evans 1983, 301-302). The level of breakage seen in this assemblage is lower than usual for a mustelid assemblage and the cranial elements are well-represented in comparison to the post-cranial elements. However, Andrews and Nesbit-Evans (1983) attributed this disproportionate number of cranial elements to post-cranial elements to the feeding behaviour of the mustelid, which removes the head of larger prey items before consumption, but smaller prey items, up to the size of a mouse or a vole, may be

eaten in their entirety (Andrews & Nesbit-Evans 1983, 202). Most of the small mammals found in the assemblage from unit 2091, and in the other large microfaunal assemblages from Çatalhöyük, are small microfaunal species such as mice and these species are small enough to have been eaten whole. If this assemblage is a mustelid assemblage, this may explain why the breakage is lower than in the assemblages analysed by Andrews & Nesbit Evans (1983, 202). The puncture marks found on the bones from these assemblages are small and none of them exceeds the length of the base of a weasel canine. The analysis of the puncture marks shows that they range in size from 0.20 millimetres on a mid-shaft bone from unit 2091 to 1.34 millimetres for a mid-shaft puncture for a bone from unit 4397. Measurements were made of upper and lower weasel canines from eight weasels from the comparative collection of the Grahame Clark Zooarchaeology Laboratory, McDonald Institute, University of Cambridge. The results demonstrate that the lower canine length at the base of the tooth ranged from 1.7 millimetres to 2.2 millimetres and that the upper canine length at the base ranged from 1.8 millimetres to 1.9 millimetres. The size of the puncture marks found on the bones in this assemblage are small suggesting that the weasel was the most likely predator.

Weasel elements with extensive gnawing were found in units 4614 and 4619 (two of the burial fill units from Burial 513). Other mustelids will predate upon weasels but I have not come across records of weasels predating upon each other. In addition, weasels do not usually scavenge, although it is possible that a weasel may scavenge upon another weasel. If other prey were available around the site, one would expect a weasel to choose live mice over a dead weasel. The elements found in these units were from adult weasels rather than juveniles, ruling out infanticide.

Badgers are larger than weasels and the upper and the lower canines from three modern badgers from the comparative collection at the Grahame Clark Laboratory were taken. The results ranged from 5mm to 9mm for the base of the upper canine and from 6mm to 7mm for the base of the lower canine. This demonstrates that the puncture marks found on the bones in the Çatalhöyük assemblage are considerably smaller than a badger canine. However, it is possible for a large carnivore to make a small puncture mark by applying less pressure to the bone and piercing it with the tip of the tooth rather than using the base of the tooth. I have observed wild badgers in South Wales regularly feeding in the presence of humans and even examples of wild badgers being hand fed by humans, demonstrating that they will live and feed in close proximity to humans.

The second possible predator is a felid, probably the wildcat. As with mustelids, wildcats would undoubtedly have been attracted to the site by the presence of house mice. Wildcats cause high

levels of breakage and poor levels of skeletal element representation and their teeth are larger than those of mustelids. However, this factor alone does not rule out the wildcat as a possible predator. In his analysis, Andrews (1990) found that the most commonly preserved element in a wildcat assemblage was the isolated tooth of the rodent, which matches the results of this analysis (Andrews 1990, 208-209). However, although felid remains are found at Çatalhöyük, the evidence found so far suggests that they were brought to the site as skins rather than were living in or around the site (Nerissa Russell pers comm.).

The third possible predator is some form of canid, such as the red fox. The red fox causes a high level of breakage and digestion to the remains of its prey and has larger teeth than either the weasel or the wildcat (Andrews 1990, 65-88). Andrews & Nesbit Evans (1983) found that the post-cranial elements far-outnumbered the cranial elements in their analysis and it appeared that, like weasels, canids remove the head of their prey before consumption. In addition, they found a high-level of breakage but it is interesting to note that the post-cranial elements found intact were all rodent. Andrews & Nesbit Evans (1983) observed that larger prey were more extensively broken than the smaller prey and that the level of breakage was clearly related to prey size. Furthermore, they demonstrated that the level of digestion was related to the type of prey and that rabbit bones were more affected by digestion than were rodent bones (Andrews & Nesbit Evans 1983, 300). The fact that the Çatalhöyük assemblage consists almost entirely of rodents may explain why the level of breakage and digestion are lower than is usual for a canid assemblage and why the level of skeletal elements representation is higher. Canids are opportunistic hunters and will usually take the most prevalent prey type in the area (Andrews & Nesbit Evans 1983, 300).

Unit 4397-Level VIII

Unit 4397 is the first of a series of burial fills containing microfauna that were found in Level VIII. This fill comes from Burial 460, which was located in Building 6 in the South area and is illustrated in Figure 5.8 and 5.9. A concentration of phytoliths was found in front of the rib cage and over the right leg which is thought to be the remains of matting that was placed over the body. The concentration of microfauna was found around the body and in the grave fill (unit 4397). The grave cut for this burial was uneven and the body did not appear to have been placed into the cut with any care (Farid 2007c). As stated in Chapter 7, this unit has an adjusted NISP of 1835 and an MNI of seventy-one based on a 67% sample. This unit has an array of taxa but *Mus* is the most prevalent genus with *Mus* sp. and the house mouse comprising 77% of the total MNI. The other species found in this unit are the water vole, the bi-coloured white-toothed shrew, and the lesser white-toothed shrew. In addition, there is one small carnivore (most probably a weasel) and one amphibian.

The relative proportion of elements in this unit is erratic. The majority of the cranial elements, with the exception of the molar, are more abundant than the post-cranial elements. It is not surprising that the molar is under-represented because *Mus* molars are small and can be easily lost even when using a fine screening mesh. The lower post-cranial elements, namely the femur and the tibia are better represented than the upper ones; this is an unusual pattern. It is not uncommon to see a disproportion in numbers between cranial and post-cranial elements which can be caused by the consumption practises of the predator but it is not so common to see different parts of the post-crania being disproportionate to one another. The ulna is particularly affected and only eighteen were found in comparison with seventy-three incisors. The ulna is a slender bone which can slip through the mesh vertically. However, there is no explanation for the lower proportion of humeri. The humerus is a relatively robust element, and is not more susceptible to loss than the tibia. Therefore, although this explanation may explain why there are fewer ulnae than humeri in the sample it does not explain why there are fewer humeri and ulnae compared to femora and tibae. The loss of the upper post-cranial elements is also reflected in the proportion of metacarpals to metatarsals. In total, there are 212 metatarsals but only nineteen metacarpals. Although the metacarpals are more susceptible to loss than the metatarsals due to their smaller size, the huge difference in numbers between these two elements suggests that the whole of the upper limbs are absent from this unit.

The breakage for unit 4397 is relatively high. There are no complete or broken skulls only isolated maxillae and there are no complete mandibles. As stated in Chapter 7, the majority of the mandibles (83%) fall into the last breakage category, with the ascending ramus missing and the inferior border broken. A similar situation was observed with the post-cranial elements and only 5% of them are complete. The ulna is the most frequently broken element, which is not surprising considering it is a slender and relatively weak bone in comparison to the other major limb bones. It is difficult to assess how much of the breakage of the elements was caused by processes other than predation. The burial cut showed no signs of slumping on its edges suggesting that the burial was not left open for a long period of time (Shahina Farid, pers comm.). However, it is not known from where the assemblage was originally derived. It is likely that this is a small carnivore assemblage due to the presence of puncture marks but nothing of the pre-burial history of the small carnivore scats is known. Pre-burial taphonomic processes such as transport and trampling could have caused breakage and soil compaction could have occurred after burial causing further breakage. However, the humerus shows an interesting breakage pattern with proximal ends being more abundant than distal ends. This is an unusual pattern because distal ends are nearly always more abundant than proximal ends in predator assemblages (Andrews 1990). It is probable that this pattern is the result

of predator consumptive practices, although it does not match any pattern so far observed for modern day predators (Andrews 1990). In addition, it is likely that this breakage pattern may be related to the disproportionate numbers of upper post-cranial elements to lower post-cranial elements. When analysing the gnaw and puncture marks on humeri, two parallel puncture marks were often found just below the epicondyles on the distal end of the humerus suggesting that this breakage pattern was predator induced.

The digestion for this unit is low. The teeth are not frequently digested and in total, only 9% of incisors are digested and 4% of molars. However, if the incisors with digestion at the developing end are included in the analysis, 11% of the incisors are digested. In addition, only 6% of femora are digested but, in contrast, 41% of humeri are digested. The humeri are not severely digested and the majority fall into the lower digestion categories as do the femora. The difference in the digestion percentages between humeri and the femora is an uncommon pattern because, unless the sample size is small, the humerus and the femur are usually digested to a similar degree (Andrews 1990). Furthermore, this is interesting when considered alongside the pattern of skeletal element representation which shows that there are fewer humeri than femora. All of the digested teeth in this assemblage are group A teeth and there are no digested *in situ* incisors or molars. The majority of the incisors fall into the light and moderate digestion categories indicating that the severity of the digestion was limited. There is only one extremely digested incisor, which shows signs of having corroded dentine as well corroded enamel. Similarly, most of the molars are lightly digested and there are none that showed signs of extreme digestion.

The level of skeletal element representation and breakage found in this assemblage is reminiscent of a predator that causes a moderate to high degree of modification to the remains of its prey, such as a small carnivore (Andrews 1990, 90). However, as stated above, these two types of modification can occur as a result of other taphonomic processes. The level of digestion is a more reliable method for identifying the predator. With the exception of the humerus, the level of digestion is low and is suggestive of a predator that causes little to moderate modification to the remains of its prey. The level of digestion found on the humeri does not fit with this interpretation and instead is indicative of a predator that causes a higher degree of post-cranial digestion (Andrews 1990, 89). As stated in Chapter 7, there was one humerus with evidence of flaking that is often caused by weathering. It is interesting to note that Andrews found flaking on some of the post-cranial elements in his small carnivore scat assemblage (Andrews 1990, 88).

As well as the difficulties faced in identifying the predator, there is the challenging problem of accounting for the incorporation of the assemblage into the burial fill. The burial was located within the floor of Building 6. As stated above, the excavator saw no sign of slumping in the grave cut and therefore it is unlikely that the burial was left open for a significant length of time. The building would presumably have had a roof because the body in question was buried during the life use of the building (Farid 2007c). These two factors would make it unlikely that an owl roosting above the burial accumulated the concentration. Firstly the burial would have had to have been left open for a prolonged period of time for an assemblage of this density to accumulate and secondly an owl would not roost in such a small building, whilst it was occupied by humans. Also, this theory would not account for the presence of gnawing and puncture marks on some of the bones found in the assemblage.

Another possible explanation is that the burial acted as pit fall trap for microfauna that were subsequently scavenged upon by a small carnivore. It is possible that the grave was left open and that micromammals were attracted by the human body. For this explanation to be possible, the grave would have had to have been left open for some time for this number of small mammals to have become trapped and as stated above there is no evidence to suggest that this occurred. Furthermore, although the grave cut was quite deep (it is believed that the cut was originally made through the floor of space 163 and would have been in excess of eighty centimetres) it was gently sloping on the east side and stepped and uneven on the west side. The small carnivore and house mice found in this assemblage would have been capable of climbing out of such a pit. House mice are agile and can jump approximately 0.5 metres. They have relatively good eye sight and are less frequently caught in pit falls than shrews (MacDonald & Barrett 1993, 270-271). If this burial did act as a pit fall, the digestion and gnawing could have been the result of a small carnivore or omnivore scavenging on the microfaunal remains. However, although most small carnivores have latrinal areas it would seem unlikely that a small carnivore would defecate in an area with a rich food source (MacDonald & Barrett 1993, 98-99). However, the human bone specialists note that some of the phalanges and teeth of the skeleton had been removed and they suggest that rodents were responsible for these small element losses (Andrews *et al* 2005).

It is also possible that the small mammals found in this assemblage burrowed into the grave. However, despite the fact that burrowing activity has been identified in some units at Çatalhöyük, the excavator did not see any signs of burrowing within the grave cut or in the base of the grave in this instance, which would have been evident if a creature the size of a small carnivore had burrowed into the burial. The presence of digestion and puncture marks on the remains of some

elements also makes this explanation improbable because it demonstrates that the microfauna did not enter the burial as live animals but had already been through the digestive tract of a predator

This burial may have been used as a latrinal area by a small carnivore. In this way it is possible for accumulations of microfauna that were present in the scats of the small carnivore concerned to build up (MacDonald & Barrett 1993, 98-99). This would mean that Building 6 would have had to have been abandoned for some time for this density of microfauna to accumulate and all other evidence suggests that the burial occurred during an occupation phase rather than a period of abandonment (Farid 2007c). The burial may have been a small carnivore den and it is documented that large numbers of scats can build up in mustelid den sites (Sleeman 1989, 84). Weasels and wildcats do not excavate their own dens but take over those of other creatures while foxes and polecats will dig their own den if nothing else is available (Harris & White 1994, 8; MacDonald & Barrett 1993, 134; Sleeman 1989, 67-70). It is possible that this burial was used as a den by a small carnivore. The main argument against this is the lack of disturbance or burrowing evident in the burial cut which was specifically looked for by the archaeologist during excavation and are often found at Çatalhöyük.

Another theory is that the grave was used by a small carnivore to cache food. As stated in Chapter 4, small carnivores frequently store food to eat at a later time. This behaviour has been observed with red fox, and with various species of mustelid who will cache between thirty and fifty small mammals when they are in abundance. There is one account of a stoat in New York that hunted tagged voles that were part of a study. It took over a vole nest, lined it with fur, killed over half the tagged voles in the study and took them back to its nest (Madison 1984). There is another report of a stoat who cached 150 lemmings under a rock and there are even records of polecats caching live toads and frogs and storing them in underground chambers. The consumption of cached rather than fresh prey is resorted to only if food is scarce (King & Powell 2007, 127; MacDonald & Barrett 1993, 98-99; Sleeman 1989, 18-34). For this to have been the method of accumulation, the grave would either have had to have been left open or the small carnivore would have had to have burrowed into the grave and for the reasons outlined above this seems improbable.

The assemblage may have become incorporated into the material used to backfill the burial. A comparison of the underlying room fill for Space 163 (the space in which Burial 460 and Burial 513 were found) and for the fills in Burials 460 and 513 show that the lithics, the clay ball assemblages, and the botanical remains found in the two deposits were identical, indicating that the burial fills were excavated from the under-lying room deposit rather than being floor surface debris. The only

difference between the burial fills and the under-lying room deposit was the microfaunal concentrations. It is possible that the under-lying room fill did contain carnivore scats and that these were all swept into the burial fill deposit. However, it would seem likely that some scats would have remained in the under-lying room fill which was not the case (Farid 2007c).

Perhaps a human deliberately placed the small carnivore scats in the burial. There is no known reason why this would have occurred and there is no evidence to suggest that this may have been the case except for the lack of any other feasible explanation. In addition, Burial 513 contained a concentration of microfauna as did a burial excavated by Mellaart during the 1960s (Mellaart 1966, 182). Burial 460 and 513 were found in the same building and the burial with microfauna found in the 1960s is also from Level VIII (Mellaart 1966, 182).

Unit 4464-Level VIII

Unit 4464 is a burial fill unit from Burial 492. The human bone specialists observed that there were some microfaunal elements in this fill but the results of the analysis have shown that this assemblage was not dense. This unit had a NISP of eighty and there are two *Mus* sp. incisors with digestion at the developing end and an incisor with a puncture mark, suggesting that a small carnivore played a role in the accumulation of this assemblage. It is interesting that this burial was also found in Level VIII.

Unit 4614-Level VIII

Unit 4614 is the upper grave fill unit from Burial 513. This burial was located in Building 6, Space 163 and would have been placed there during the life use of the building (Farid 2007c). The composition of species found in this unit is similar to the assemblage from unit 4397. Species from the genus *Mus* are the most prevalent taxon. If individuals identified as rodent or micromammal are discounted, *Mus* sp. and the house mouse comprise 96% of the total MNI. The only taxonomic difference seen between this unit and unit 4397 is that this unit has one pygmy white-toothed shrew, which was not found in unit 4397 and does not have any amphibians, which were found in unit 4397.

Another similarity between this unit and unit 4397 is the pattern found in the analysis of the relative proportion of elements. Again, with the exception of the molar, all of the cranial elements are well represented. The humerus and ulna are under-represented. However, in this assemblage the femur is also under represented, while the tibia is one of the most abundant elements. The number of metacarpals to metatarsals demonstrates that the upper limb as a whole is under-represented. In total

there are sixteen metacarpals and forty-two metatarsals. As with unit 4397, it is likely that the consumptive practises of the small carnivore responsible for the accumulation of this assemblage are the cause of element loss. The level of breakage found in unit 4614 is also similar to unit 4397. There are no complete or broken skulls in unit 4614, only isolated maxillae, and the majority of the mandibles (75%) are in the last breakage category with the ascending ramus missing and the inferior border broken. However, the post-cranial elements from unit 4614 have suffered less breakage than those from unit 4397 and 15% of the major post-cranial elements are complete. Again it is not possible to evaluate how much breakage was sustained by elements prior to burial because it is not known from where these small carnivore scats were derived. The presence of soil containing microfauna within the skull of the skeleton in this burial shows that there was post-depositional soil movement which could have caused bone breakage.

The level of digestion for this unit is lower than in unit 4397 with only 4% of incisors digested and 3% of molars. In addition, most of the tooth digestion falls into the light digestion category. If incisors with digestion at the developing end are included, the percentage of digested incisors increases to 32%. As with unit 4397, humeri are more frequently digested than femora. These digestion levels, excluding the incisors with digestion at the developing end, are low and are usually the result of a predator that causes little modification to the remains of it prey. This result does not correlate with the result from the breakage analysis. However, if the incisors with digestion at the developing end are included, the digestion level suggests that the accumulator of this assemblage is a predator that causes moderate levels of digestion.

In addition, to the digested elements there are 201 elements with gnawing and puncture marks, which is 9% of the total. Gnawing and puncture marks could only have been caused by a small carnivore but the level of digestion is lower than usual for a small carnivore assemblage (Andrews 1990, 90). It is interesting to note that the mandible is the most frequently gnawed element in this assemblage. As with the under representation of upper post-cranial elements this factor may be attributable to the consumptive practices of the predator or scavenger responsible for these gnaw and puncture marks. The possible methods of accumulation discussed for unit 4397 are also valid methods for the accumulation of this assemblage.

Unit 4615-Level VIII

Unit 4615 consists of the soil from the skull of the skeleton found in Burial 513 and has a dense concentration of microfauna. This unit has a NISP of 141 but an MNI of only six, all of which are *Mus* sp. However, it has a very high density of elements per litre of soil. The relative proportion of

this unit differs from the pattern seen in units 4397 and 4614. Again crania, with the exception of the molars, are better represented than post-crania, but in this case, the humerus is well represented and has a higher relative proportion than the femora and tibiae. The ulna is the least well represented of all the elements as is the case for unit 4397 and unit 4614. There are no complete or broken skulls in unit 4615 only isolated maxillae but the mandible breakage is less severe than in units 4397 and 4614. The post-crania have a high level of breakage; the humerus and ulna have a higher level of breakage than the femur and tibia and the humerus has a greater proportion of proximal ends than distal ends which is a similar pattern to that seen in unit 4397 and unit 4619. Therefore, although the lower post-crania are less well represented they are less broken than the upper post-crania. As with the other units from this burial the pre-burial taphonomic history of the assemblage is not known and therefore the extent of the non-predator induced breakage cannot be assessed.

In this unit 17% of incisors 23% of molars are digested. However, if the incisors with digestion at the developing end are included in this analysis, 33% of the incisors are digested. The overall level of digestion is higher than was seen in unit 4614 which may be because this unit had a smaller sample of teeth. In total, this unit had twenty-four incisors and forty molars, and all of the digested teeth were lightly digested indicating that although a large proportion of the teeth are digested they are not severely digested. This unit also has gnawed elements. These bones must have become incorporated into the skull some time after the brain of the skeleton had decayed and would presumably have occurred after burial.

Unit 4619-Level VIII

Unit 4619 is another of the units found within the fill of Burial 513. It was defined as an artefact/cluster and given a separate unit number due to the concentration of microfauna. The excavator felt that this concentration was separate from the other fill units and that the microfauna had been deliberately placed in the burial. It was also noted that this unit had an orange tinge and, as a result, was distinct from the surrounding units. This orange tinge noted by the excavator probably represents residual organic matter. In addition, this unit contained elements, particularly pes, that were still articulated (Information from the original unit sheet). This concentration was restricted to the torso of the human skeleton, as demonstrated by the grid that was laid out for excavation, and was not spread over other areas of the burial. Square 12 had the greatest concentration of elements, followed by square 6 with 892. As illustrated in Chapter 7, square 12 is adjacent to the skull over the upper cervical vertebrae and the left humerus of the skeleton and square 6 is diagonally across from this on the grid and is over the lower cervical vertebrae of the skeleton. The density of

microfauna is astounding considering the small area from which it is derived and the adjusted NISP per litre of sediment for this unit is 1536.

The assemblage from unit 4619 is largely dominated by *Mus* with *Mus* sp. and the house mouse accounting for 97% of the total MNI. The remaining species each comprise 1% or less of the total MNI. This demonstrates how the house mouse was becoming increasingly dominant in and around the site of Çatalhöyük. Weasel elements were also found in this unit. It is likely that weasels would have been attracted to the site by the house mice, particularly as rodents are the favoured prey of weasels comprising 60% to 80% of animals taken (MacDonald 1993, 112-113).

The relative proportion for this unit shows some element loss, particularly of the ulna and tibia. The incisor is the most well represented element and is nearly twice as abundant as the molar. The incisor is a small element and one would expect this element to be more easily lost than other larger elements such as the mandible or femur. The apparent abundance of incisors may be partly attributable to the fact that breakage was not taken into account for this element while it was for most other elements. So for example a distal end and a proximal end of a humerus were counted only as one humerus while two pieces of a broken incisor were counted as two incisors. However, incisors are not usually broken as frequently as the major limb bones and the incisors from this unit did not appear to be extensively broken. Therefore, while this method of recording may have slightly inflated the number of incisors it probably would not have lead to twice as many incisors being recorded than were originally present. In total, 58% of the elements are represented in this assemblage. This figure was reached by assuming the total number of individuals to be 183 based on the proportion of the incisor and calculating the average loss for each element based on the assumption that each element should also have had a proportion of 183.

There are no complete or broken skulls in this assemblage, only isolated maxillae. The mandible breakage was displayed by excavation square. It is apparent from these results that the level of mandible breakage was consistent throughout the various excavation squares. The post-cranial breakage for this unit is also high and on average, only 2% of the major limb bones are complete, with the tibia most frequently found complete and no complete ulna. In this unit, the proximal end of the humerus is more abundant than the distal end which is the same pattern as in unit 4397 and unit 4615. The results from the analysis of the breakage and relative proportion of elements are typical of a predator that causes great to extreme modification to the remains of its prey (Andrews 1990, 90). However, as with the other burial units, the influence of post-depositional processes on

bone breakage are not appreciated and it is probable that some of the breakage was caused by other taphonomic processes.

The incisors in unit 4619 have experienced a higher degree of digestion than those in units 4614, 4615 and 4623. In total 24% of the incisors in this unit are digested, compared with 4% in unit 4614, 17% in unit 4615 and 15% in unit 4623. All of the digested incisors are group A incisors which is not surprising considering the greater proportion of group A incisors to group C. The majority of incisors (54%) are lightly digested and there are no extremely digested incisors, showing that they were not severely digested. However, if the incisors with digestion at the developing end are included in this analysis, 37% of incisors are digested. This shows that although the percentage of digested incisors is relatively high compared to other grave fill units the degree to which the incisors are digested is not that great. No pattern can be seen in incisor digestion for different excavation squares. The molar digestion in this unit is higher than was found in unit 4614 and unit 4623 but not as high as in unit 4615. However, it is possible that the molar digestion in unit 4615 is inflated because it is based on a small sample of molars, only forty in total. In this analysis, squares 4, 10 and 13 seem to have higher than average percentage of digested molars for their sample size but this pattern is not matched by incisor digestion. Results from analysis of post-cranial digestion does not aid in identifying whether these findings are significant because there is only one distal humerus and two proximal femora in squares 13, none of which are digested. The percentage of digested post-crania is high, with 54% of humeri being digested and 18% of femora. As with the other units in this burial, there are a higher percentage of digested humeri than femora. This level of digestion suggests that this assemblage was accumulated by a predator that causes a moderate amount of digestion to the remains of its prey and is characteristic of some kind of owl rather than a small carnivore (Andrews 1990, 75). However, as with the other units from this burial, puncture and gnaw marks were found on some of the elements making a small carnivore the most likely predator.

Unit 4623-Level VIII

Unit 4623 was located under the skeleton in Burial 513 and was excavated after the skeleton had been lifted. The excavator felt that this unit was somewhat different in nature to unit 4619. It was noted that unlike unit 4619, unit 4623 did not contain articulated elements and that the microfauna was less dense than in unit 4619 (Shahina Farid, pers comm). As with the other units in this burial, the species composition of unit 4623 is dominated by the genus *Mus* with *Mus* sp. and the house mouse comprising 97% of the total MNI.

The relative proportion of element analysis for unit 4623 mirrors that seen in the other units from Burial 513; crania are more abundant than post-crania and, as with unit 4614, the lower post-crania are more abundant than upper post-crania. This is supported by the findings from the metapodial analysis with there being one identifiable metacarpal as opposed to thirteen identifiable metatarsals. This indicates that the upper limb bone is under-represented in this unit. The level of cranial breakage is high but the results of post-cranial breakage are less severe. Again, as with the other burial units the pre-depositional history of the scats is unknown and other taphonomic processes probably caused some of the bone breakage. The level of digestion is similar to that found in the other units, with the exception of unit 4615 which had higher levels of digestion. The digestion for unit 4623 is indicative of a predator that causes moderate digestion to the teeth of its prey, although humeri digestion is high and is more in line with the level of digestion characteristic of a small mammalian carnivore (Andrews 1990, 90). The majority of teeth are in the light digestion category showing that the severity of tooth digestion is not high. In unit 4623 13% of elements have gnawing or puncture marks.

Burial 513

Although the excavator assigned four different unit numbers to the fills found in Burial 513 and felt that they were different in some aspects, it is probable that they are all representative of one event and that units 4614, 4615 and 4623 are the result of post-depositional bone movement from unit 4619. The results demonstrate that in many ways the microfaunal assemblages from all of these units are similar; all are dominated by species of *Mus*, which are most likely to be house mice, all have similar patterns of skeletal element proportions with the cranial elements being more abundant than the post-cranial elements, and all have digestion and gnawing. The breakage pattern for these units is similar but some differences can be seen in the levels of post-cranial breakage. A higher level of post-cranial breakage is found in unit 4614 and unit 4615, compared to unit 4619 and unit 4623. In addition, a difference was seen in the level of digestion in unit 4614, which was generally much lower than the other units in this burial.

The number of individuals found in this burial as a whole is remarkable. The total NISP for these four burial units is 6477 while the total MNI is 421. This is based on a proportion of the total assemblage and so the actual figure would have been even greater. It has been noted that a calculation of the MNI based on an aggregation of the values for each sedimentary context often leads to an inflated MNI (Watson 1979, 137; O'Connor 2000, 60). However, if contexts are in fact true archaeological contexts, this should not be an issue as the sample from each context would be a discrete entity. As all of burial fill units from Burial 513 may represent one event (as stated above)

the problem of an exaggerated MNI may be an issue in this case. However, even if this is taken into account it is clear that the assemblage from the burial as a whole is large, even if the MNI provided by combining the four units is a gross approximation.

If this burial had acted as pit fall trap it would have had to have been left open for a considerable amount of time. It is difficult to estimate how long it would take for this number of small mammals to have fallen into the burial because the variables differ from one situation to the next. However, it would probably have had to have been left open for months if not years for this number of individuals to have accumulated. This would have been long enough for slumping of the grave cut to have been visible. In addition, unlike Burial 460 the skeleton found in this burial does not show any signs of disturbance which should have been apparent if the burial was left open for a matter of months (Andrews *et al* 2005). The idea that this was a pitfall trap does not account for the concentration of small mammals found over the torso of the skeleton (unit 4619). In addition, there were no signs of animal burrows in the burial cut so it is unlikely that the microfauna burrowed in and this would not account for the digestion and gnawing found on the bones. The lack of evident burrowing in the burial cut also makes it unlikely that this was a den site, particularly when the density of small mammals for unit 4619 is compared with the other units in this burial. There seems to be no logical explanation for this concentration of small mammals over the torso. If this burial was a pit fall trap or if the microfauna or the predator had burrowed into the burial and used it as a den site one would expect the microfauna to be more evenly distributed throughout the burial fills rather than restricted to the torso. Indeed, mustelids often line their den sites with the fur of their prey for insulation and so one would not expect such a great concentration of microfauna in one area but a more general spread with perhaps a more visible spread over the area which would have had the small mammal fur lining. Also, if a predator had been repeatedly entering and exiting the burial some disturbance of the human remains would probably have been visible. In addition, there are three burials that contained microfauna and it seems coincidental that predators would chose only burials as den sites.

As was stated in Chapter 5, Mellaart (1966) found a well-sealed burial with a concentration of microfauna during his excavations in the 1960s, which was analysed by Brothwell (1981). It was found in Level VIII and was located under a platform. It contained the skeletal remains of around seventy-five house mice and a single shrew (Mellaart 1966, 182; Brothwell 1981, 2). It was a burial of a female, covered in red ochre and although the body was disarticulated it had originally been placed in an upright seated position. It was covered in fibre, which Mellaart (1966) suggests was the remains of some kind of basket. Mixed up in these fibres were the remains of the house mice and

shrew. The skeleton was adorned with a black, white and red bead necklace and two bone rings. In addition, a mace-head was found in the burial just north of the body. Mellaart suggests that the grave goods included in this burial imply that this woman may have had some authority or social standing within the community in which she lived. Furthermore, he strongly believes that these small mammal remains did not become incorporated into the burial by accident but were deliberately placed there (Mellaart 1966, 182). He goes as far as to suggest that due to the lack of certain elements such as the vertebrae, ribs, scapulae and pes that these mice may have been used as a personal adornment and puts forth the theory that the mice may have been turned inside-out and used as small purses that may have been attached to the body with a belt (Mellaart 1966, 182; Brothwell 1981, 5).

Brothwell (1981) found that the cranial elements and the tibiae were well represented. Figure 8.1 shows the relative proportion of elements based on the results of Brothwell (1981). It is not clear from Brothwell's results if his figures for the teeth include isolated and *in situ* teeth or just isolated teeth. It would appear more likely that they include only isolated teeth (Brothwell 1981, 2). However, similarities can be seen between the relative proportion of elements from this burial and from Burial 460 and Burial 513. Generally the cranial elements are more abundant than the post-cranial elements and the lower post-cranial elements are more abundant than the upper post-cranial elements. Brothwell (1981) also notes that the ribs, scapulae and the vertebrae are under-represented (Brothwell 1981, 4-5). Mellaart believed that these small mammal remains did not become incorporated into the burial by accident but were deliberately placed there and Brothwell concludes that the bones were derived from skins that were used for ritualistic purposes (Mellaart 1966, 182; Brothwell 1981, 4).

In fact this pattern of skeletal element representation is the opposite of the pattern that is found in small mammal skins that have been turned inside out. When an animal has been turned inside out it is usually the metapodials, phalanges, vertebrae and ribs that remain. This is frequently seen with mole skins. Moles have particularly tough skins and owls frequently turn them inside out during consumption. When this occurs the elements listed above are usually the only ones that remain attached to the skin (Peter Andrews, pers comm.). Brothwell (1981) does not provide information on the breakage or digestion of the elements found in this burial (Brothwell 1981). However, the discovery of this burial in the same level as Burials 460 and 513 (Level VIII), and with a similar microfaunal concentration as these two burials suggests that a specific method of accumulation is associated with them. Furthermore, these burials are conspicuous in that they are unique in containing large quantities of microfauna. Mellaart does not note any other burials with microfauna

being uncovered during his excavations (Mellaart 1962, 1963, 1964, 1966). Similarly none of the other burials in the first phase of excavation (a total of 114 from all areas) had such concentrations. In total these burials account for 84% of the number of identifiable specimens found at Çatalhöyük during this phase of analysis.

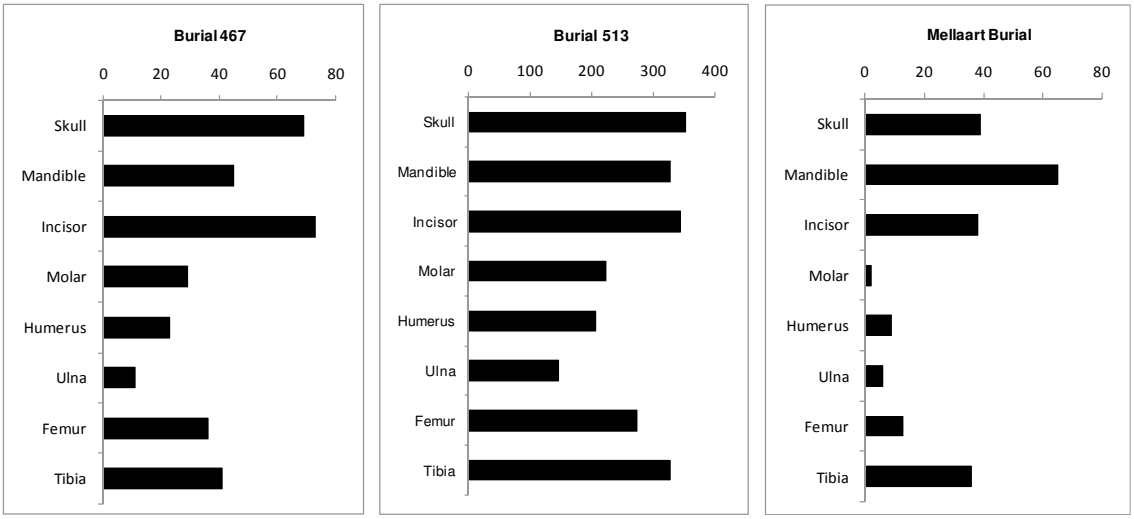


Figure 8.1 Relative proportion of elements for the burials (Mellaart Burial results taken from Brothwell 1981, 4)

Why put scats in human burials?

The presence of digestion and gnawing, as well as the orange tinge to the sediment which is indicative of organic matter, suggests that the microfauna were in scat rather than carcass form. The two most convincing explanations for the microfauna in the burials is either that all three burials were used as den sites by small carnivores or that the scats were deliberately placed there by humans. There are four main arguments against the burials being used as den sites: 1) there are no evident burrow marks in the burial cuts which are found in other units at Çatalhöyük, 2) the burials were relatively undisturbed, 3) it is coincidental that the three burials are the only den sites found at the site, 4) this does not account for the exceptional density of microfauna over the torso in Burial 513.

If the scats were deliberately placed there by humans the reason for this is hard to comprehend. They may have served a functional purpose and could have been used as a type of preservative for the bodies. In the Medieval and post-Medieval periods, faeces were often mixed with urine and used as tanning solutions (Denison 1998) and the scats in these three burials may reflect a similar kind of practice. It could have been that these three individuals were highly regarded in their society and their descendants wished to preserve their bodies for as long as possible or that the scats were used as markers of skills that the dead had shown as tanners while living. Scats may also have been

used in the past for medicinal use. In Medieval times it was believed that all parts of the cat, excluding the brains but including their scats, could be used for medicinal purposes (Bobis 2000). Similarly, there is modern evidence from Mozambique that elephant scats are used as a medicine for many illnesses and that they are often burnt to repel mosquitoes (De Boer & Baquete 1998).

An alternative theory is that the inhabitants of Çatalhöyük may have practised pest control and encouraged weasels to enter the site to predate upon the house mice in an attempt to control the house mice population. The individuals found in these burials may have been responsible for monitoring this activity. These concentrations of microfauna suggest that house mice were to be found in or around Çatalhöyük. One would imagine that Çatalhöyük would have been a haven for house mice. It was densely occupied with a plethora of food remains providing excellent opportunities for scavenging. It would also have offered shelter, and the walls and roofs of the houses would have made ideal hideaways for mice. As such, the site would have provided easy hunting grounds for small carnivores and it is possible that they were encouraged to enter the site in order to keep mice levels down. Indeed, there is evidence that ancient Egyptians kept weasels before the domestication of the cat, in order to control the number of rodents in their settlements. In some parts of modern Egypt, weasels are encouraged to occupy houses to such an extent that Osborn and Helmy claim they are "almost completely commensal" (Osborn & Helmy 1980, 409). Weasels were found in the faunal assemblage from Pompeii and were studied by Adrienne Powell. Powell (forthcoming) argues that due to the urban nature of the site it would have been an unlikely habitat for wild weasels and suggests that weasels were kept by the inhabitants of Pompeii and used for pest control. This interpretation is supported by the presence of house mouse and other rodent bones in the assemblage and the discovery of a house mouse pelvis with puncture marks (Powell forthcoming). In more recent times, the first professional rodent exterminator in New York city, Walter "sure Pop" Isaacsen, used ferrets (a domesticated Mustelid) which he bred himself on a farm in the countryside to help catch rodents (Sullivan 2005, 97). Evidence of relationships between humans and weasels can be found in reports of fur trappers from North America who sometimes shared their camps with weasels, with one account of a trapper who took one home and kept it for a week (King & Powell 2007, 6). Not only would weasels have been useful for pest control they would have been a good source of fur after death.

The encouragement of predators into settlements during the Neolithic period is not without precedent. A cat (*Felis silvestris*) burial was found in close proximity to a human at the Neolithic site of Shillourokambos on Cyprus which was inhabited from the end of the 11th Millennium BP to the end of the 10th Millennium BP. The excavators argue that cats may have had special status in

Neolithic societies in southwest Asia and argue that the cat burial probably demonstrates evidence for the taming of cats, which was necessary to control the mice attracted by grain storage (Vigne *et al* 2004). In addition, a cat (*Felis silvestris*) burial was found in a Predynastic burial at Hierkonplois, Upper Egypt, which has the relative date of approximately 5650 BP. Analysis of the remains revealed that the cat had suffered a fractured humerus and femur suggesting that it had been kept in captivity for at least four to six weeks prior to its burial, almost 2000 years prior to the time that domestic cats were thought to have been present in Egypt (Linseele *et al* 2007, 2081). A cat burial was also found at from the Roman site of Quseir on the Red Sea Coast. This burial was interesting because the animal was nearly complete, with the remains of fur, the stomach and the lower intestinal tract preserved, and had been wrapped in a type of woollen cloth, wrapped in what the authors describe as a 'linen shroud', and buried in a building (von den Driesch & Boessneck 1983, 205). Smaller elements such as the ribs had been placed in a bag alongside the cat together with coprolites. Contained within the stomach were the remains of five rats (*Rattus rattus*) and a further rat was found in the coprolites. The breakage of the rat bones from the stomach of the cat is minimal as evident from images of the bones found on page 210 (von den Driesch & Boessneck 1983, 210). However, von den Driesch and Boessneck (1983) do not discuss the rat bones at length so it is unclear if this is a true representation of the entire assemblage. Despite this uncertainty, the elements shown demonstrate that small carnivores do not always cause high levels of breakage to all the bones of their prey.

Some form of pest control would probably have been necessary at Çatalhöyük because any form of refuse or stored food would presumably have attracted mice and mice populations can increase in number very quickly. Mice by evolution are r-selecting which means that they breed frequently and have lots of off-spring. They can breed from six to eight weeks of age and a female mouse is pregnant for nineteen days and can re-mate one to three days after giving birth. Litters typically contain five to ten young and one breeding pair of mice and their offspring have the potential to produce five hundred mice in just twenty-one weeks (MacDonald & Fenn 1994, 7).

Outbreaks of house mice occur in the grain belts of Australia, usually after periods of high rainfall which stimulates vegetation growth, providing food for the mice and prolonging breeding (Buckle 1994, 301). They are known as 'mouse plagues' and it has been estimated that there has been a mouse plague somewhere in the grain belt every four years since 1900, increasing to one every couple of years in the past twenty years. The number of mice constituting these plagues varies and, due to their exceptional density, normal methods of population estimation, such as trapping, fail to give an accurate estimation of mice numbers. Estimates by trapping conducted by Saunders and

Robards (1984) suggested that there were approximately 2716 mice per hectare in a sunflower crop. Saunders later checked the technique used (frequency of capture) on an enclosed population and concluded that the original study had under-estimated the population by 33% and the true figure was probably closer to 3530 mice per hectare (Saunders 1986). In non plague years this figure would be around sixty per hectare (Caughley *et al* 1998, 11-12). In the mouse plague of 1969 to 1970 almost 200 000 tons of cereals were destroyed (Lund 1994, 27) and in 1979 it was estimated by the World Health Organisation that thirty-three million tons of cereal were lost to rodents worldwide (Meyer 1994, 276). Evidence from the monitoring of weasel numbers demonstrates that weasel numbers increase when mice are abundant indicating their dependence on rodent prey (Sleeman 1989, 72).

One of the problems of using predators for pest control is that their generation time is usually longer then that of the prey and so it is difficult for the predator to keep up with the ever increasing prey numbers (Smith 1994, 121). One of the most eminent biologists of the 1930s to 1950s, Paul Errington, did not believe that rodent populations in temperate climates could be controlled by predation. This view was disputed by a group of Scandinavian ecologists who found that predation could have a profound effect on northern lemmings and voles. In a study of lemming nests in Barrow, Alaska, between 1968 and 1969 they found that 35% of the nests had been raided by weasels and by 1970 the number of nests had dropped from 770 to zero (MacLean *et al* 1974, cited in King & Powell 2007, 142). In more moderate climates Errington is probably correct and during the summer when rodents are breeding and food is abundant predators may have little impact on the rodent population. However, in the winter when the rodents stop breeding and food is scarce predators can have a significant impact on rodent numbers until they become so scarce that the predators die out as a result of starvation giving the rodents time to grow in number. This repeated event is known as a 'cycle' and differs in extent between different years and places (King & Powell 2007, 142).

One effective example of predators being used to control rodent numbers was in Malaysia in oil palm plantations which were being invaded by the Malaysian wood rat (*Rattus tiomanicus*). Barn owls quickly adapted to this new prey, eating nothing else but wood rats and in this way the numbers of wood rats were controlled (Lenton 1980 cited in Smith 1994, 121-122). If pest control was practised, it is plausible that the predator would have been viewed as a positive addition to the fauna, being preferable to mice with their potential to decimate and contaminate food stores. We know from reliefs, sculptures and mobiliary art that animals played an important role in the ritual life at Çatalhöyük and scats may have been viewed in a positive rather than a negative way. It is

even possible that the predator was a totemic symbol. Although it is frequently 'wild' animals that are depicted in the reliefs and sculptures at Çatalhöyük, the only human burial found with an animal was from Level VII and was of a human with a lamb (Russell & Düring 2006). In this case the human was separated from the lamb by some kind of matting as evidenced by the phytoliths found in the deposits. This demonstrates that although the inhabitants of Çatalhöyük may have had great respect for wild animals they had the most intimate relationship with the less threatening, more domestic animals, that were common in and around the site. In this way, the burial of the three individuals with scats could demonstrate that the individuals in question may have had a special relationship with the producer of the scats that protected the inhabitants from the unwanted nuisance of house mouse infestation. And it would explain why overall house mice numbers are low around the site in general when mice are found in such huge numbers in these presumed scat assemblages. These buried individuals could have been responsible for encouraging the small carnivores to enter the settlement and may have had a closer connection with them than other people from the site.

A weasel and fox skull were found plastered into the walls of Shrine VII, 21 during the Mellaart excavations. The fox skull was placed above the weasel skull and both had been covered in plaster. Mellaart believed that these 'protuberances' represented breasts (Mellaart 1964). This interpretation is debatable but it is significant that small carnivores appeared to have a symbolic or ritual role at Çatalhöyük.

Another interpretation is that the placement of scats could have been motivated by a feeling of dislike or hatred of the dead. However, other indicators, such as the incorporation of grave goods and the placement of the bodies, make this unlikely and suggest that the individuals buried were held in high regard. Burial 460 had been placed in a large cut and was not disturbed by later burials. There was a concentration of phytoliths close to the rib cage and over the right femur that may represent the remnants of matting covering the body. Burial 513 was in a crouched position and red ochre was found on the base of the grave cut (Andrews *et al* 2005).

Similarly, the burial of a young adult female excavated by the Mellaart project was wrapped in some kind of basket or matting and covered in ochre. Two necklaces had been placed around her neck, one made of beads and perforated deer-teeth and the other made of beads, with a mother of pearl pendant. Two bone rings and a limestone mace head had also been included in the burial (Mellaart 1966). Mellaart believes that these small mammal remains did not become incorporated into the burial by accident but were deliberately placed there (Mellaart 1966; Brothwell 1981).

Figure 8.2 Artist's reconstruction of Burial 513 (John-Gordon Swogger)

This is not an isolated example of small mammal bones being found in human burials. A burial containing a female skeleton which became known as 'Cille Phedair Kate' was found on South Uist, Hebrides which was dated to the Middle Iron Age. This burial was found in a cairn and was devoid of grave goods except for a small pebble which had been placed over the groin. Fortunately, the grave fill was sieved by the excavators and mice bones with digestion were found. They attribute the digestion to owls and suggest that the grave was left open for some time, possibly with "a loose arrangement of slabs on top" and that an owl had roosted on these slabs (Parker-Pearson *et al* 2004: 117-119). Another example of pellets being found in burials is a Beaker period burial found at Bredon Hill in Worcestershire. A central pit was found beneath a barrow that contained the remains of two individuals, a male and a female. Within the skull of the female a single pellet was found which they identified as being either from a buzzard or a kite. The excavator suggests that the corpse was exposed for a short time prior to burial and that the pellet had become incorporated into the fill. They further propose that the body had been decapitated, the brain removed and the pellet had worked its way into the skull through the foramen magnum (Thomas 1965).

In addition, an unusual human burial of an elderly female containing much faunal material, including the skulls of two stone martens (*Martes foina*), which from the lack of skinning marks

appear to have been buried with the fur in place, was found at the Natufian site of Hilazon Tachtit. Found within the burial fill were: over fifty complete tortoise shells and tortoise limb bones from the Mediterranean spur-thighed tortoise (*Testudo graeca*); wing bones from a golden eagle (*Aquila chrysaetos*); articulated vertebra from the tail of an auroch (*Bos primigenius*), the pelvis of a leopard (*Panthera pardus*), the radius and ulna of a wild boar (*Sus scrofa*) and finally a male gazelle horn core (*Gazella gazella*). As well as the faunal material the burial contained a complete human foot which did not belong to the buried individual (Grosman *et al* 2008). The presence of the two marten skulls in this burial demonstrates that in the Natufian of the Levant mustelids held some specific ritual significance. Such an unusual burial has led (Grosman *et al* 2008) to suggest that this burial may be of shaman.

Unit 1073-Level VII

Unit 1073 is a make-up/packing unit from Space 105. All of the taxa found in this level are represented in this unit but *Mus* is the dominant genus with *Mus* sp. and house mouse accounting for 76% of the total MNI. The relative proportion of elements has a similar pattern to many of the other assemblages at Çatalhöyük. Cranial elements are more abundant than post-cranial ones and the lower post-cranial elements are more abundant than the upper ones. In addition, the incisor is the most abundant element. The breakage levels of the elements in this unit are high. There are no complete or broken skulls and the results show that the majority of the mandibles are in the last breakage category with the ascending ramus missing and the inferior border broken. The breakage of the post-crania is severe. It is interesting that all of the femora and tibiae are broken, while 20% of the humeri and 10% of the ulnae are complete. However, although this unit is defined as a make-up/packing unit it was derived from a midden and it is possible that these scats may have been deposited in the midden from elsewhere. As a result it is difficult to estimate how much of the breakage was caused by taphonomic factors other than predation. These scats may have lain on the midden for some time and been affected by pre-depositional factors such as trampling and weathering. The pattern of the relative proportion and the level of element breakage are indicative of a predator that causes a high level of modification to the remains of its prey (Andrews 1990, 90).

The level of digestion seen on the teeth in this assemblage is low, with only 3% of incisors and 1% of molars being digested. If the incisors with digestion at the developing ends are included then 4% of incisors are digested. The digestion of the post-crania is based on a small sample of humeri and femora and as such is somewhat unreliable, with 80% of humeri being digested and no femora. The digestion results are indicative of a predator that causes minimal digestion to the remains of its prey (Andrews 1990, 90). However, as with many of the other assemblages from Çatalhöyük gnaw

marks were found on some of the elements from this unit and in total 5% of them were modified in this way. This suggests that the predator was a small carnivore.

Unit 3044-Level VI-V

Unit 3044 is a make-up/packing unit from the North area of the site. The majority of the elements from this unit could not be identified to genus or species level although pygmy white-toothed shrews, amphibians and *Mus* sp were all found. These species are indicative of an open, wetland environment. The analysis of the relative proportion of elements demonstrates that there has been some element loss. As with many of the other units at Çatalhöyük, unit 3044 is most abundant in incisors, while the remaining elements are under-represented. However, generally the post-crania are not under-represented in comparison to crania. The presence of digested incisors shows that these elements have been through the digestive tract of some animal. The botanical analysis produced additional information about this particular unit. Small mammal faeces were found and hackberries with evidence of gnawing, believed to be by small mammals, were also found (Fairbairn *et al* 2005b). This may suggest that there may have been post-occupation, small mammal activity in this unit.

Summary

The results for the assemblage from Çatalhöyük show that the assemblage is largely dominated by a few units that have dense concentrations of microfauna, probably derived from carnivore scats. When these units are excluded it is apparent that two unit categories have a greater NISP and MNI than the others, namely, the midden category and the make-up/construction/packing category. It is not surprising that middens should have a greater concentration of microfauna than the other categories. The middens are a dumping area where waste matter is discarded and micromorphological analysis has shown that the inhabitants of Çatalhöyük swept the floors of the mud brick structures and thus were concerned with the cleanliness of their dwellings. In addition, that they sometimes covered their floors with mats or rugs (Matthews *et al* 1996, 306). Therefore, one would imagine that these people would not tolerate the presence of dead mice or other rodents in the vicinity of their houses and would have taken care to ensure that such remains were retrieved and discarded, probably in the middens.

It is interesting that a greater number of micromammals are found in the make-up/construction/packing unit category. At Çatalhöyük new houses were constructed over the razed remains of former houses, leading to the distinctive mound shape that is so characteristic of this type of settlement. The make-up/construction/packing category consists of material which was used

to build a level surface over the remains of the old house in order that the next house could be constructed on a level surface. Analysis of this material has shown that it is the mud brick material from the lower parts of the walls of the former house and the roof material of the former house that is used to construct this base. Occasionally some midden material may also be incorporated (Shahina Farid, pers. comm.). The roofs and the walls of houses are the areas one would expect to find small mammals. It is believed that the roof of the houses would have included some kind of straw-like material which would have provided the perfect refuge for house mice. Coupled with the occasional inclusion of midden material it is not surprising that this category also has a higher number of micromammals than many of the other categories. The fact that the wall category does not have a higher number of micromammals may be a result of a sampling bias, with only two wall units being analysed compared to five make-up/construction/packing units. This discrepancy can be resolved by the analysis of a larger sample of wall and make-up/construction/packing units. Most notably the results show that the house mouse was becoming more prevalent at Çatalhöyük through time, suggesting that this species was becoming increasingly commensal. This finding suggests that commensalism is an indicator of sedentism and that this species was ideally suited to inhabiting human settlements.

9 CONCLUSIONS

RECONSTRUCTING THE NATURAL ENVIRONMENT AT ÇATALHÖYÜK AND PİNARBAŞI DURING THEIR PERIODS OF OCCUPATION

One of the aims of this work was to reconstruct the local environment around the sites of Çatalhöyük and Pınarbaşı. This has proved challenging with the assemblages from both of these sites because the Pınarbaşı assemblage was small and the Çatalhöyük assemblage was dominated by house mice. The results from the Pınarbaşı assemblage suggest that the environment was becoming drier between the 11th Millennium Cal BP and the 9th Millennium Cal BP as indicated by the decline in the number of amphibians. The taphonomic pathway of these assemblages was impossible to unravel and it would seem that many of the samples could have come from a variety of sources. This conclusion has been drawn because the samples from these contexts are small and often only one or two individuals are present. It is unlikely that the samples from these contexts were accumulated by an established predator because predator accumulated assemblages tend to be relatively large and usually represent the ongoing activity of a predator over a long period of time. The small size of these samples means that a positive identification of the predator cannot be made and that the environmental reconstruction is limited.

The assemblage from Çatalhöyük was limited in its usefulness for environmental reconstruction not because of small sample sizes but because the assemblage was dominated by house mice. The conclusion to be drawn from this is that the microfaunal assemblage is a reflection of the humanly constructed, sedentary environment with the consistent presence of amphibians suggesting that Çatalhöyük was surrounded by some wetland areas, at least for part of the year. With the Çatalhöyük assemblage it is interesting to note that the larger samples have the same pattern of modification suggesting that they are not mixed source assemblages, but are likely to be accumulated by a single species of predator. The units are characteristic because they have a greater ratio of cranial to post-cranial elements, a high level of breakage and a low to moderate level of digestion. In addition, they all have elements with gnawing and puncture marks and some of the units have a higher proportion of lower post-crania to upper post-crania. The following units display this pattern: unit 2091, unit 4397, unit 4614, unit 4615, unit 4619, unit 4623, and unit 1073. With the exception of unit 2091 and unit 1073, all of these units are from burials.

The various possibilities for the accumulation of these assemblages have been discussed in Chapter 8. It would seem that the most probable agent of accumulation was a small carnivore. This conclusion is drawn largely because of the presence of small tooth marks found on the bones. The main argument against a small carnivore being responsible for the accumulation is that the level of breakage and digestion is not as high as was found in modern small carnivore scat assemblages (Andrews & Nesbit Evans 1983, 301-302, Andrews 1990, 90). However, it is possible that the elements from these samples are less broken than those from other small carnivore assemblages because all the elements in these samples are from small microfaunal species. As a result, it may not have been necessary for the small carnivore to masticate these remains so heavily before consumption. The lower levels of digestion on the post-cranial elements may be related to these lower levels of breakage. The broken edges of bones tend to be more prone to digestion than complete bones and the reduction in broken edges may have lowered the overall level of digestion of the postcranial elements.

In addition, the majority of the teeth in these assemblages are murid teeth. It has been proven that murid molars are less susceptible to digestion than microtine molars, which could account for the lower level of molar digestion (Williams 2001). Furthermore, it would appear that there were a consistent number of house mice around Çatalhöyük, possibly from Pre-Level XII.B, but certainly from Level X, providing a constant and secure food source for a predator. It has been demonstrated that the level of digestion found on the prey remains is directly proportional to the amount of time spent in the predator's stomach. If there are sufficient small mammals for the predator to hunt they will digest prey quickly. If prey is scarce the predator will keep prey in its stomach for longer and thus cause a higher level of digestion (Andrews & Nesbit Evans 1983, 300). It is possible that these lower than usual levels of digestion are the result of sufficient numbers of suitable prey to sustain the predator. It is also possible that the level of incisor digestion may be lowered by the exclusion of incisors with digestion on the developing end from the main analysis. It was demonstrated in Chapters 7 and 8, that if these incisors are included in the main analysis, then the level of digested incisors is greatly increased. Finally, the excavators noted that in unit 4619, Burial 513 some of the metapodials and phalanges were still in articulation and this lead them to conclude that the mice were placed there in carcass form. However, articulated phalanges and metapodials are characteristic of small carnivore scat assemblages (Andrews & Nesbit Evans 1983).

Due to the small size of the puncture marks found on the elements from Çatalhöyük it was originally believed that the perpetrator was a mustelid, probably a weasel as their remains have been found at the site. I attempted to procure weasel scats for analysis to determine if this was the case

but obtaining suitable carnivore scats was problematic. Firstly the feeding behaviour of a captive weasel may vary from that of a wild weasel, and secondly weasel owners were reluctant to feed their weasels mice because weasels routinely cache their food and mice remains emit an unpleasant smell after a couple of days. If the theory that the large units from Çatalhöyük were accumulated by a small carnivore is correct, it is likely that the prey found in the assemblages are a reasonably accurate representation of the small mammals that were to be found in the area (Andrews 1990, 206-209).

However, an explanation for how the assemblages became incorporated into the human burials is necessary. The cumulative evidence of three burials with microfaunal concentrations (two from the 1990s excavations and the one from the 1960s excavations) demonstrates that this phenomenon was encountered in more than one burial. The fact that there are only three such burials amongst over a hundred found at the site in the first phase of excavation suggests that some specific form of activity is associated with them. In addition, the dense concentration of microfauna (unit 4619) found restricted on the torso of the skeleton in Burial 513 implies that the scats were placed there by humans. This may seem unfeasible but it is no stranger than many of the other forms of ritualistic activity found at Çatalhöyük.

Another aim of this book was to establish if concentrations and distributions of microfauna in the spaces and buildings at Çatalhöyük can provide information about periods of use and abandonment at the site. Three microfaunal concentrations (units 1073, 2091, and 3044) appear to be small carnivore accumulations. Unit 2091 was located in Building 2, Space 166, adjacent to the crawl hole leading to Space 117. The presence of this microfaunal concentration suggests that Building 2 must have been abandoned to allow a sufficient density of small carnivore scats to build up. This is useful information because the phases of occupation and abandonment at Çatalhöyük are not fully understood and if it were not for the presence of this concentration this phase of abandonment would not have been identified. Unit 1073 was not found within a building but was part of a dump from Space 105. This concentration may have been an *in situ* deposit and could have been used as a latrinal area by a small carnivore. It is equally possible that this concentration became incorporated into the dump from another area. Unit 3044 is problematic due to the fact that there may have been some post-depositional small mammal burrowing into this unit. However, the fact that all of the elements, with the exception of one, were burnt suggests that none of these later small mammals died there and became incorporated into the assemblage. Unit 3044 is an inter-building unit from the North area of the site and was probably accumulated by a small carnivore. It is likely to have been an *in situ* deposit and demonstrates that the inhabitants of Çatalhöyük were willing to tolerate

the presence of what were probably small carnivore scats adjacent to their houses. This result is not surprising for while the inhabitants appeared to have swept their houses (Matthews 2005), they were tolerant of what are to us, abhorrent smells, as is evidenced by the presence of human burials under floors.

The differences found in the species composition between the sites of Pınarbaşı and Çatalhöyük demonstrates that humans greatly influence the species composition of the microfaunal community found in the area of habitation. It would appear that the factor that most affects this change is sedentism, which, in the case of Çatalhöyük, led to the commensalism of the house mouse in this area. Although Baird (in press) describes 11th Millennium Cal BP Pınarbaşı as being "sedentarising" this does not imply full sedentism as defined in this work, that is when the majority of inhabitants of a settlement occupy it on a permanent basis. It would seem that this 'sedentarising' process was not intense enough to bring about the changes to the microfaunal community that are found at Çatalhöyük.

This is seen in the dominance of the house mouse at Çatalhöyük, while Pınarbaşı has a much more balanced array of taxa. Even though the majority of the Çatalhöyük assemblage is derived from specific units, namely the burial fills, the results show that from Level X onwards house mice were a consistent presence at Çatalhöyük. While Edwards (1989) used Tchernov's (1984) assumption that the microfauna in his study were from a barn owl assemblage to argue that commensal species are not a good indicator of sedentism, small carnivores, particularly mustelids, have a much smaller hunting range than owls or diurnal birds of prey. As stated in Chapter 4, the male weasel generally has a territory of seven to fifteen hectares and females have smaller territories of approximately one hectare to four hectares (Sleeman 1989, 18). While it remains possible that the house mice found at Çatalhöyük were hunted some distance away from the site, it seems unlikely that the carnivores would deliberately come to the site to use it as a denning or latrinal area. It is feasible that if the scats found in the burials were put there by humans they could have been brought from further afield. However, other units such as unit 2091 appear to represent naturally occurring small carnivore scat assemblages and they are similar in species composition and taphonomy to the burial fill units. This indicates that the same species of predator was responsible for all of the dense concentrations of microfauna at Çatalhöyük and suggests that they lived close to the site.

Furthermore, it is unusual to find small carnivore scat assemblages that consist almost entirely of one species. Small carnivores will often favour small mammals but their scats will usually comprise a number of different species. Many of the bones analysed from Pınarbaşı have gnaw and puncture

marks similar to those found on the elements from Çatalhöyük but the density of microfauna found in the Pınarbaşı assemblage is much less and the species composition more balanced than at Çatalhöyük. I believe that the assemblage from Çatalhöyük was dominated by house mice because they were the most abundant prey in the small carnivores hunting territory. I conclude that this is because house mice had adapted to commensalism at Çatalhöyük and small carnivores were attracted to the site by the abundance of suitable prey.

The human inhabitants of Çatalhöyük may have practised pest control. Mustelid, felid, and canid remains are all found at Çatalhöyük and these creatures may have been encouraged to enter the site to predate upon mice. If this was the case it is significant because it would be one of the earliest sedentary sites with evidence of actively encouraged commensalism. However, it is noteworthy that a greater number of mice were not found in the majority of units from Çatalhöyük. One would expect to find more from the units between the walls of the buildings, under the floors and in the midden and general dumping areas. Some mice would have escaped predation and their remains are likely to have become incorporated into the units from these locations. It is possible that the people of Çatalhöyük would have periodically removed dead mice from the site, although this would have been difficult for all areas of the settlement.

The study of these two microfaunal assemblages has demonstrated that the sedentary site of Çatalhöyük, which was occupied by vast numbers of people for a prolonged period of time, produced a very different type of microfaunal assemblage to Pınarbaşı. Assemblages with high diversities of species are usually interpreted as indicating a more equable environment (Fleming 1973). The domination of the Çatalhöyük assemblage by house mice shows that this was a very specific type of environment and that few taxa were able to adapt to living there. This book has demonstrated that important information can be gained from studying microfaunal assemblages, not only about past environmental conditions at a site, but also about the domestic and ritual behaviour of its people and how this behaviour impacted upon aspects of the mammal community.

BIBLIOGRAPHY

Andrews, P. 1990. *Owls, Caves and Fossils*. Natural History Museum Publications, London

Andrews, P. 1995. Mammals as Palaeoecological Indicators. *Acta Zoologica Cracoviensia*. 38:59-72

Andrews, P. 1983. Small mammal faunal diversity at Olduvai Gorge, Tanzania. In (eds. J. Clutton-Brock & C. Grigson) *Animals and Archaeology*, Volume 1, 77-85, British Archaeological Reports, International Series, Oxford

Andrews, P., Lord, J. M. & Nesbit Evans, E. M. 1979. Patterns of Ecological Diversity in Fossil and Modern Mammalian Faunas. *Biological Journal of the Linnaen Society* 11: 177-205

Andrews, P., Molleson, T. & Boz, B. 2005. The Human Burials at Çatalhöyük. In (ed. I. Hodder) *Inhabiting Çatalhöyük: Reports from the 1995-99 Seasons.* Çatalhöyük Project Volume 4, 261-278, McDonald Institute Monographs/BIAA 38, Cambridge and London

Andrews, P. & Nesbit Evans, E. M. 1983. Small Mammal Bone Accumulations Produced by Mammalian Carnivores. *Paleobiology* 9: 289-307

Andrews, P. & O'Brien, E. 2000. Climate, Vegetation, and Predictable Gradients in Mammal Species Richness in Southern Africa. *Journal of Zoology (London)* 251: 205-231

Andrzejewski, P. & Rajska, E. 1972. Trappability of Bank Voles in Pitfalls and Line Traps. *Acta Theriologica*, Bialowieza 17: 41-56

Armitage, P. L. 1985. Small Mammal Fauna in Late Mediaeval towns. *Biologist* 32: 65-71

Arnold, E. N., Burton, J. A. & Ovenden, D. W. 1978. *Collins Field Guide to the Reptiles and Amphibians of Britain and Europe*. HarperCollins, London

Asouti, E. 2002. Woodland Vegetation and Fuel Exploitation at the Prehistoric Campsite of Pınarbaşı, South-Central Anatolia, Turkey: the Evidence from the Wood Charcoal Macro-remains. *Journal of Archaeological Science* 30: 1185-1201

Attenborough, D. 2002. *The Life of Mammals*. BBC Consumer Publishing (Books), London

Auffray, J-C., Tchernov, E. & Nevo, E. 1988. Origine du Commensalisme de la Souris Domestique (Mus musculus domesticus) vis-à-vis de L'homme. *Les Comptes Rendus de L'Académie des Sciences* 307: 517-522

Auffray, J-C. , Tchernov, E., Bonhomme, F., Heth, G., Simson, S. & Nevo, E. 1990a. Presence and ecological distribution of *Mus "spretoides"* and *Mus musculus domesticus* in Israel Circum-Mediterranean Vicariance in the genus *Mus. Mammalian Biology - Zeitschrift für Säugetierkunde* 55: 1-10

Auffray, J-C., Vanlerberghe, F. & Britton-Davidian, J. 1990b. The House Mouse Progression in Eurasia: a Palaeontological and Archaeozoological approach. *Biological Journal of the Linnean Society* 41: 13-25

Auffray, J-C., Marshall, T., Thaler, L. & Bonhomme, F. 1991. Focus on the Nomenclature of European species of *Mus. Genome* 88: 7-8

Avery, D. M. 1982. Micromammals as Palaeoenvironmental Indicators and an Interpretation of the Late Quaternary in the Southern Cape Province, South Africa. *Annals of the South African Museum* 85: 183-374

Avery, D. M. 1990. Holocene climatic change in Southern Africa: the contribution of micromammals to its study. *South African Journal of Science* 86: 407-412

Avery, D. M. 1991. Micromammals, Owls and Vegetation Change in the Eastern Cape Midlands, South Africa during the Last Millennium. *Journal of Arid Environments* 20: 357-369

Avery, D. M. 1996. Late Quaternary Environmental Change at Mumbwa caves, Zambia. In (ed. G. Pwitit & R. Soper) *Aspects of African Archaeology, Papers from the 10th Congress of the Pan African Association for Prehistory and Related Studies,* 63-70, University of Zimbabwe Publications, Harare

Avery, D. M. 2000. Past and Present Ecological and Environmental Information from Micromammals. In (ed. L. Barham), *The Middle Stone Age of Zambia, South Central Africa*, 63-72, Western Academic & Specialist Press Limited, Bristol

Baird, D. Forthcoming. Pınarbaşı; From Epipalaeolithic Camp-site to Sedentarising Village in Central Anatolia. In, (ed. M. Ozdoğan and N. Başgelen) *The Neolithic of Turkey; New Excavations, New Discoveries*

Bar-Yosef, O. 2001. From Sedentary Foragers to Village Hierarchies: the Emergence of Social Institutions. In (ed. W. G. Runciman) *The Origin of Human Social Institutions, Proceedings of the British Academy* 110, 1-38, Oxford

Bar-Yosef, O. & Belfer-Cohen, A. 1992. From Foraging to Farming in the Mediterranean Levant. In (eds. A. B. Gebauer & T. D. Price), *Transitions to Agriculture in Prehistory*, 21-48, Prehistory Press, Madison

Behrensmeyer, A. K. 1978. Taphonomic and Ecologic Information on Bone Weathering. *Paleobiology* 4: 150-162

Bell, M. & Walker, J. C. 1998. *Late Quaternary Environmental Change: Physical and Human Perspectives.* Longman, Harlow

Berry, R. J. & Scriven, P. N. 2005. House Mice and Evolutionary Understanding. *Biological Journal of the Linnean Society* 84: 355-347

Blumenschine, R. J. 1988. An Experimental Model of the Timing of Hominid and Carnivore Influence on Archaeological Bone Assemblages. *Journal of Archaeological Science* 15: 483-502

Blumenschine, R. J. & Selvaggio, M. M. 1991. On the Marks of Marrow Bones by Hammerstones and Hyenas: their Anatomical Patterning and Archaeological Implications. In (ed. D. Clark), *Cultural Beginnings*, 17-32, Dr. Rudolph Habelt GMBH, Bonn

Bobis, L. 2000. *Le chat: Histoire et Légendes*. Fayard, Paris

Bonhomme, F. 1986. Evolutionary relationships in the genus *Mus. Current topics in Microbiology and Immunology* 127: 19-34

Bottema, S. & Woldring, H. 1984. Late Quaternary Vegetation and Climate of Southwestern Turkey, Part II. *Palaeohistoria* 26: 123-149

Boursot, P., Auffray, J-C., Britton-Davidian, J. & Bonhomme , F. 1993. The Evolution of House Mice. *Annual Review of Ecology and Systematics* 24: 119-152

Boursot. P., Din. W., Anand. R., Darviche. D., Dod. B., Von Deimling. F., Talwar. G. P. & Bonhomme. F. 1996. Origin and Radiation of the House Mouse; mitochondrial DNA phylogeny. *Journal of Evolutionary Biology.* 9. 391-415

Boyd, B.V. 2006. On 'Sedentism' in the Later Epipalaeolithic (Natufian) Levant. *World Archaeology* 38: 164-178

Britton-Davidian, J. 1990. Genetic Differentiation in *M. m. domesticus* populations from Europe, the Middle East and North Africa: Geographic Patterns and Colonization Events. *Biological Journal of the Linnean Society* 41: 27-45

Brothwell, D. 1981. The Pleistocene and Holocene Archaeology of the House Mouse and Related Species. *Symposia of the Zoological Society of London* 47:1-13

Brothwell, D. & Brothwell, P. 1969. *Food in Antiquity*. London, Thames and Hudson.

Brothwell, D. & Jones, R. 1978. The Relevance of Small Mammal Studies to Archaeology. In, (ed. D. Brothwell, K. Thomas & J. Clutton-Brock) *Research Problems in Zooarchaeology*, 47-57, Institute of Archaeology, Occasional publications, London

Buckle, A. P. 1994. Rodent Control in Practice: Temperate Field Crops and Forestry. In (eds. A. P. Buckle & R. H. Smith) *Rodent Pests and their Control*, 291-312, CAB International, Cambridge

Burton, J. A. 1992 (ed.) *The Owls of the World, their Evolution, Structure and Ecology*, Peter Lowe, Italy

Byrd, B. 2005. *Early Village Life at Beidha, Jordan: Neolithic Spatial Organization and Vernacular Architecture: The Excavations of Mrs Diana Kirkbride-Helbak*, Oxford University Press/British Academy, Oxford and London

Carruthers, D. 2003. *Hunting and Herding in Central Anatolian Prehistory: The 9th and 7th Millennium BC sites at Pınarbaşı* . Unpublished Ph.D Thesis, Department of Archaeology, University of Edinburgh

Carruthers, D. 2004. Hunting and Herding in Central Anatolian Prehistory: the 9th and 7th Millennium site at Pınarbaşı. In (eds. H. Buitenhuis, A.M. Choyke, L. Martin, L. Bartosiewicz & M. Mashkour) *Archaeozoology of the Near East VI: Proceeding of the Sixth International Symposium on the Archaeozoology of Southwestern Asia and Adjacent Areas*. ARC Publicaties 63, Groningen

Casteel, R. W. 1977. Characterization of Faunal Assemblages and the Minimum Number of Individuals Determined from Paired Elements: Continuing Problems in Archaeology. *Journal of Archaeological Science* 4: 125-134

Caughley, J., Bomford, M., Parker, B., Sinclair, R., Griffiths, J. & Kelly, D. 1998. *Managing Vertebrate Pests: Rodents.* Bureau of Rural Sciences, Australia

Cauvin 1994. *The Birth of the Gods and the Origins of Agriculture*. Cambridge University Press, Cambridge

Cessford, C. 2001. A New Dating Sequence for Çatalhöyük. *Antiquity* 75: 717-725

Cessford, C. 2005a. Absolute Dating at Çatalhöyük. In (ed. I. Hodder), *Changing Materialities at Çatalhöyük: Reports from the 1995-99 seasons*: Çatalhöyük Project Volume 5, 65-100, McDonald Institute Monographs/BIAA 39, Cambridge and London

Cessford, C. 2005b. Estimating the Neolithic Population at Çatalhöyük. In (ed. I Hodder), *Inhabiting Çatalhöyük: Reports from the 1995-99 seasons.* Çatalhöyük Project Volume 4, 323-328, McDonald Institute Monographs/BIAA 38, Cambridge and London

Cessford, C. 2007a. Level Pre-XII.E-A and Levels XII and XI, Spaces 181, 199 and 198. In (ed. I. Hodder). *Excavating Çatalhöyük, South, North and KOPAL Area: reports from the 1995-1999 seasons.* Çatalhöyük Project Volume 3, 59-102, McDonald Institute Monographs/BIAA 37, Cambridge and London

Cessford, C. 2007b. History of Excavation of Buildings 1 and 5 and Summary of Phases. In (ed. I. Hodder). *Excavating Çatalhöyük, South, North and KOPAL Area: reports from the 1995-1999 seasons.* Çatalhöyük Project Volume 3, 345-360, McDonald Institute Monographs/BIAA 37, Cambridge and London

Chaput, E. 1936. Voyages d'Etudes Géologiques et Géomorphogénétiques en Turquie. *Mémoires de l'Institute Français d'Archéologie, Istanbul* II: 1-132

Colledge, C. 2001. *Plant Exploitation on Epi-palaeolithic and Early Neolithic Sites in the Levant*, BAR International Series. British Archaeological Reports, Oxford

Colledge, S., Conolly, J. & Shennan, S. 2004. Archaeobotanical Evidence for the Spread of Farming in the Eastern Mediterranean. *Current Anthropology* 45, Supplement: S35-S58

Corn, P. S. & Bury, R. B. 1991. Small Mammal Communities in the Oregon Coastal Range. *Wildlife and Vegetation of Undamaged Douglas Fir Forests, General Technical Report*, PNW, GTR 285: 241-254

Crandall, B. D. & Stahl, P. W. 1995. Human Digestive Effects on a Mammalian Skeleton. *Journal of Archaeological Science* 22: 789-797

Cross May, S. 2005. Statistical Integration of Contextual Data. In (ed. I . Hodder), *Changing Materialities at Çatalhöyük Reports from the 1995-99 seasons*. Çatalhöyük Project Volume 5, 23-44, Cambridge, McDonald Institute Monographs/BIAA 39, Cambridge and London

Cucchi, T., Vigne. J-D. & Auffray, J-C. 2005. First Occurrence of the House Mouse (*Mus musculus domesticus* Schwartz & Schwartz, 1943) in the Western Mediterranean: a Zooarchaeological Revision of sub-fossil Occurrences. *Biological Journal of the Linnean Society,* 84, 429-445

Davis, J. M. 1987. *The Archaeology of Animals*. Yale University Press, New Haven and London
Day, M. G. 1968. Food habits of British Stoats *(Mustela erminea)* and Weasels *(Mustela nivalis).* *Journal of Zoology, London* 155: 485-497

De Boer, W. F. & Baquete, S. 1998. Natural Resources Use, Crop Damage and Attitudes of Rural People in the Vicinity of the Maputo Elephant Reserve, Mozambique. *Environmental Conservation* 25, 3: 208-218

Denison 1998. Remains of Early Modern Industry found in Reading. *British Archaeology* 37: 4

Dodson, P. 1973. The Significance of Small Bones in Paleoecological Interpretation. *Contributions to Geology* 12:15-19

Dodson, P. & Wexlar, D. 1979. Taphonomic Investigation of Owl Pellets. *Paleobiology* 5: 275-284

Driessen, P.M. & de Meester, T. 1969. *Soils of the Çumra area, Turkey*. Centre for Agricultural Publishing and Documentation, Wageningen

Eastwood, W.J**.,** Roberts, N., Lamb, H.F. & Tibby, J.C. 1999 Holocene Environmental Change in Southwest Turkey: a Palaeoecological Record of Lake and Catchment-Related Changes. *Quaternary Science Reviews* 18: 671-695

Edwards, P. C. 1989. Problems of Recognising Earliest Sedentism. *Journal of Mediterranean Archaeology* 2 (1): 5-48

Efremov, I. A. 1940. Taphonomy: a New Branch of Palaeontology. *Pan-American Geologist* 74: 81-93

Erol, O. 1978. The Quartenary History of lake basins of Central and Southern Anatolia. In (ed. Brice, W. C), *The Environmental History of the Near and Middle east since the last Ice Age*, 111-139, London Academic Press

Evans, J. & O' Connor, T. 1999. *Environmental Archaeology*. Sutton Publishing Limited, Somerset

Fairbairn, A., Asouti, E., Last. J., Martin. L., Russell, N. & Swogger. J. G. 2005a. Seasonality. In (ed. I. Hodder), *Çatalhöyük Perspectives: reports from the 1995-99 seasons.* Çatalhöyük Project Volume 6, 93-108, McDonald Institute Monographs/BIAA 40, Cambridge and London

Fairbairn, A., Near, J. & Martinoli, D. 2005b. Macrobotanical Investigation of the North, South, and KOPAL Area Excavations at Çatalhöyük East. In (ed. I. Hodder), *Inhabiting Çatalhöyük: Reports from the 1995-99 seasons.* Çatalhöyük Project Volume 4, 137-202, McDonald Institute Monographs/BIAA 38, Cambridge and London

Farid, S. 2007a. Level X Relative Heights, Buildings 23 & 18 and Building 9. In (ed. I Hodder), *Excavating Çatalhöyük, South, North and KOPAL Area: reports from the 1995-99 seasons.* Çatalhöyük Project Volume 3, 103-138, McDonald Institute Monographs/BIAA 37, Cambridge and London

Farid, S. 2007b. Level IX Relative Heights, Building 2, Buildings 22 & 16 and Building 17. In (ed. I Hodder), *Excavating Çatalhöyük, South, North and KOPAL Area: reports from the 1995-99 seasons.* Çatalhöyük Project Volume 3, 139-226, McDonald Institute Monographs/BIAA 37, Cambridge and London

Farid, S. 2007c. Level VIII: Space 161, Space 162, Building 4, Space 115, Buildings 21 & 7, Building 6 and Relative heights of Level VIII. In (ed. I. Hodder), *Excavating Çatalhöyük, South, North and KOPAL Area: reports from the 1995-99 seasons*. Çatalhöyük Project Volume 3, 227-282, McDonald Institute Monographs/BIAA 37, Cambridge and London

Farid, S. 2007d. Level VII: Space 113, Space 112, Space 105, Space 109, Building 40, Space 106, Spaces 168 & 169, Buildings 8 & 20, Building 24 and Relative Heights of Level VII. In (ed. I. Hodder), *Excavating Çatalhöyük, South, North and KOPAL Area: reports from the 1995-99 seasons.* Çatalhöyük Project Volume 3, 283-338, McDonald Institute Monographs/BIAA 37, Cambridge and London

Ferguson-Lees, J. & Christie, D. A. 2001. *Raptors of the world.* Helm identification guides. Christopher Helm, London

Fernandez-Jalvo, F. & Andrews, P. 1992. Small Mammal Taphonomy of Gran Dolina, Atapuerca (Burgos), Spain. *Journal of Archaeological Science* 19: 407-428

Fernandez-Jalvo, F. 1995. Small Mammal Taphonomy at la Trinchera de Atapuerca (Burgos, Spain). A remarkable Example of Taphonomic criteria used for Stratigraphic Correlations and Palaeoenvironmental Interpretations. *Palaeogeography, Palaeoclimatology, Palaeoecology* 114: 167-195

Finlayson, B. & Mithen, S. 2007 (eds.). *The Early Prehistory of Wadi Faynan, Southern Jordan. Archaeological Survey of Wadis Faynan, Ghuwayr, and al-Bustan and Evaluation of the Pre-Pottery Neolithic A Site of WF16*. Oxbow Books/British Academy, Oxford and London

Fleming, T. H. 1973. Numbers of Small Mammal Species in North and Central American Forest Communities. *Ecology* 54: 555-563

Fogden, M. 1992. Fishing Owls, Eagle Owls, and the Snowy owl *Ketupa, Scotopelia, Bubo, Nyctea.* In (ed. J. A. Burton), *The Owls of the World, their Evolution, Structure and Ecology*, 51-83, Peter Lowe, Italy

Fontugne, M., Kuzucuoğlu, C., Karabiyikoğlu, M., Hatte, C., & Pastre, J.-F. 1999. From Pleniglacial to Holocene. A 14C Chronostratigraphy of Environmental Changes in the Konya Plain, Turkey. *Quaternary Science Reviews* 18: 573-591

Frame, S., Russell, N. & Martin, L. 1999. Animal Bone Report. *Çatalhöyük 1999 Archive Report*. Available at: http://catal.arch.cam.ac.uk/catal/Archive_rep99/framemartin99.html

French, D. 1971. An Experiment in Water Sieving. *Anatolian Studies* 21: 59-64

French, D. 1996. The Site of Barata and Routes in the Konya Plain. *Epigraphica Anatolica* 27: 93-114

Garrod, D. 1932. A New Mesolithic Industry: The Natufian of Palestine. *Journal of the Anthropological Institute* 62: 257-269

Garrod, D. 1957. The Natufian Culture: The Life and Economy of a Mesolithic People in the Near East. *Proceedings of the British Academy* 43: 211-277

Gilbert, F. & Allwine, R. 1991. Small Mammal Communities in the Oregon Cascade Range, *Wildlife and Vegetation of Undamaged Douglas Fir Forests, General technical report*, PNW, GTR 285: 241-254

Glue, D. E. 1971. Avian Predator Pellet Analysis and the Mammologist. *Mammal Review* 1: 53-62

Gottfried, R. S. 1983. *The Black Death: Natural and Human Disaster in Medieval Europe.* Robert Hale, London

Gündüz, I., Rambau. R. V., Coşkun, T. & Searle. J. B. 2005. Mitochondrial DNA Variation in the Western House Mouse (*Mus musculus domesticus*) Close to its Site of Origin: Studies in Turkey. *Biological Journal of the Linnean Society*. 84. 473-485

Grayson, J. P. N. 1979. The Estimation of the Relative Frequencies of Mammalian Species: Khirokitia 1972. *Journal of Archaeological Science* 6: 127-137

Grayson, D. K. 1988. Danger cave, Last Supper Cave, and Hanging Rock Shelter: the Faunas. *American Museum of Natural History Anthropological Papers* 66: 1-30

Grosman, L., Munro. N. & Belfer-Cohen, A. 2008. A 12, 000-Year-Old Shaman Burial from the Southern Levant (Israel). *Proceedings of the National Academy of Sciences of the United States of America* 105: 17659-17664

Hammond, N. & Pearson, B. 1993. *Birds of prey*. Hamlyn, London

Harris, S. & White, P. 1994. *The Red Fox*. The Mammal Society, S. P. Press, Somerset

Harrison, D. L & Bates, P. J. J. 1991. *The Mammals of Arabia*. Harrison Zoological Museum, Sevenoaks

Harvey, E.L. & Fuller, D. Q. 2005. Investigating Crop Processing using Phytolith Analysis: the Example of Rice and Millets. *Journal of Archaeological Science* 32: 739-752

Hastorf, C. 1996. Botanical Report. *Çatalhöyük 1996 Archive Report*. Available at: http://catal.arch.cam.ac.uk/catal/Archive_rep96/hastorf96.html

Henshilwood, C. S. 1997. Identifying the Collector: Evidence for Human Processing of the Cape Dune Mole-rat (*Bathyergus suillus*), from Blombos Cave, Southern Cape, South Africa. *Journal of Archaeological Science* 24: 659-62

Hesse, B. 1979. Rodent Remains and Sedentism in the Neolithic: Evidence from Tepe Ganj Dareh, Western Iran. *Journal of Mammology* 60: 856-857

Hodder, I. 2006. *The Leopard's Tale, Revealing the Mysteries of Çatalhöyük*, Thames & Hudson, London

Hodder, I. 2007a. Introduction to Methods and Approach. In (ed. I Hodder), *Excavating Çatalhöyük, South, North and KOPAL Area: reports from the 1995-1999 seasons.* Çatalhöyük Project Volume 3, 3-24, McDonald Institute Monographs/BIAA 37, Cambridge and London

Hodder, I. 2007b. Çatalhöyük in the Context of the Middle Eastern Neolithic. *Annual Review of Anthropology* 36:105-120

Jacobs, L.L. & Pilbeam, D. 1980. Of Mice and Men: Fossil-based Divergence Dates and Molecular 'Clocks'. *Journal of Human Evolution* 9: 551-555

Jaeger, J. J. 1975. The Mammalian Fauna and Hominid Fossils of the Middle Pleistocene of the Maghreb. In (eds. K. W. Butzer, G. Ll. Isaac, assisted by E. Butzer, B. Isaac), *After the Australopithecines*, 398-399, Mouton Publisher, The Hague

Jones, M.D., N. Roberts & M.J. Leng. 2007. Quantifying Climatic Change through the Last Glacial Interglacial Transition based on Lake Isotope Palaeohydrology from Central Turkey. *Quaternary Research* 67: 463-473.

Kenyon, K. 1957. *Digging up Jericho*. London, Benn

Kersten, A. M. P. 1992. Rodents and Insectivores from the Palaeolithic Rock Shelter of Ksar 'Akil. *Paléorient* 18: 27-45

King, C. M. 1980. The Weasel *Mustela nivalis* and its Prey in an English Woodland. *Journal of Animal Ecology* 49: 127-159

King, C. 1989. *The Natural History of Weasels and Stoats*. Christopher Helm, London

King, C. M & Powell, R. A. 2007. *The Natural History of Weasels and Stoats. Ecology, Behaviour and Management*. Oxford University Press, Oxford.

König, C. Weick, F. & Becking J-H. 1999. *Owls, a Guide to the Owls of the World*. Pica Press, Sussex

Korth, W. W. 1979. Taphonomy of Microvertebrate Fossil Assemblages. *Annals of the Carnegie Museum of Natural History* 48: 235-285

Kroeber, A. 1925. *Handbook of the Indians of California.* Scholarly Press, St Clair, Michigan

Kryštufek, B. & Vohralík, V. 2002. *Mammals of Turkey and Cyprus*. Knjižnica Annales Majora, Koper

Kujit, I. & Goring-Morris, N. 2002. Foraging, farming and Social Complexity in the Pre-Pottery Neolithic of the Southern Levant: A Review and Synthesis. *Journal of World Prehistory* 16: 361-440

Kurtén, B. 1973. Geographic Variation in Size in the Puma (*Felis concolor*). *Commentationes Biologicae* 63: 3-8

Kusmer, K. D. 1986. *Microvertebrate Taphonomy in Archaeological Sites: an Examination of Owl Deposition and the Taphonomy of Small Mammals from Sentinel Cave, Oregon*. Unpublished M.A. Thesis, Department of Archaeology, Simon Fraser University, Burnaby, British Columbia.

Kuzucuoglu, C., R. Parish, R. & M. Karabiyikoglu. 1998. M. The Dune Systems of the Konya Plain Turkey: their Relation to Environmental Changes in Central Anatolia during the Late Pleistocene and Holocene: *Geomorphology* 23: 257–271

Lahn, E. 1946. Les Dépots Pliocènes et Quaternaires de la Région de Konya-Burdur. *İstanbul Üniveritesi Fen Fakültesi Mecmuası B* 11: 85-106

Last, J. Pottery from the East Mound. In (ed. I. Hodder), *Changing Materialities at Çatalhöyük Reports from the 1995-99 seasons*: Çatalhöyük Project Volume 5, 101-138, McDonald Institute Monographs/BIAA 39, Cambridge and London

Laurie, W. A. 1971. The Food of the Barn Owl in the Serengeti National Park, Tanzania. *Journal of East Africa Natural History Society and National Museum* 28: 1-4

Lawrence, D. R. 1979a. Biostratinomy. In (ed. R. W. Fairbridge & D. Jablonski), *Encyclopedia of Paleontology*, 99-102, Stroudsburg, Dowden, Hutchinson & Ross Inc

Lawrence, D. R. 1979b. Diagenesis of Fossils-Fossildiagenese. . In (ed. R. W. Fairbridge & D. Jablonski), *Encyclopedia of Paleontology*, 245-247, Stroudsburg, Dowden, Hutchinson & Ross Inc.

Lenton, G. M. 1980. The Ecology of Barn Owls (*Tyto alba*) in the Malay Peninsula with Reference to their use in Biological Control. Unpublished Ph.D. Thesis, University of Antwerp

Legendre, S. 1986. Analysis of Mammalian Communities from the Late Eocene and Oligocene of Southern France. *Palaeovertebrata*. 16: 191-212

Legendre, S. 1989. Les Communautés de Mammifères de Robiac (Eocène supérieur et Oligocène) d'Europe Occidentale: Structures, Milieux et Evolution. *Münchner Geowissenchaftliche Abhandlngen.* 16 (A): 1-110

Libois, R. M., Fons, R. & Saint-Girons, M. C. 1983. Le Régime Alimentaire de la Chouette Effraie, *Tyto alba*, dans les Pyrénees-Orientales. Etude des Variations Ecogéographiques. *Revue Ecologie (Terre Vie)* 37: 187-217

Linseele, A., Van Neer, W. & Hendrickx, S. 2007. Evidence for Early Cat Taming in Egypt. *Journal of Archaeological Science* 34: 2081-2090

Lund, M. Commensal Rodents. In (eds. A. P. Buckle & R. H. Smith) *Rodent Pests and their Control*, 22-43, CAB International, Cambridge

Lyell, C. 1834. *Principles of Geology, Being an Inquiry How Far the Former Changes of the Earth's Surface are Referable to Causes Now in Operation.* Murray, London. 4 vols.

Lyman, R. L. 1994. *Vertebrate Taphonomy,* (Cambridge Manuals in Archaeology). Cambridge University Press, Cambridge

MacDonald, D. W. & Fenn, M. G. P. 1994. The Natural History of Rodents: Preadaptations to Pestilence. In (eds. A. P. Buckle & R. H. Smith) *Rodent Pests and their Control*, 1-22, CAB International, Cambridge

MacDonald, D. & Barrett, P. 1993. *Mammals of Britain and Europe*. HarperCollins, London

Madison, D. M. 1984. Group Nesting and its Ecological and Evolutionary Significance in Overwintering Microtine Rodents. In (ed. J. F. Merritt) *Winter Ecology of Small Mammals*, 267-274, Carnegie Museum of Natural History, Pittsburgh

Marshall, Y. 2006. Introduction: Adopting a Sedentary Lifeway. *World Archaeology* 38: 153-163

Marshall, J. T. & Sage, R. D. 1981. Taxonomy of the House Mouse. *Symposium of the Zoological Society of London.* 47. 15-25

Matthews, W. (2005). Micromorphology and Microstratigraphy : Contextual Studies. In (ed. I. Hodder) *Inhabiting Çatalhöyük: Reports from the 1995-99 Seasons.* Çatalhöyük Project Volume 4, 553-572, McDonald Institute Monographs/BIAA 38, Cambridge and London

Matthews, W., French. C., Lawrence. T. & Cutler. D., 1996. Multiple Surfaces: the micromorphology. In (ed. I. Hodder), *On the surface: Çatalhöyük 1993-95*. Çatalhöyük Project Volume 1, 301-342, McDonald Institute for Archaeological Monographs/BIAA 22, Cambridge and London

Marean, C. W. & Spencer, L. M. 1991. Impact of Carnivore Ravaging on Zooarchaeological Measures of Elements Abundance. *American Antiquity* 56: 645-658

Marti, C. 1974. Feeding Ecology of Four Sympatric Owls. *Condor* 76:45-61

Mayhew, D. F. 1977. Avian Predators as Accumulators of Fossil Mammal Material. *Boreas* 6: 25-31

McCormick, M. 2003. Rats, Communications and Plague: Toward an Ecological History. *Journal of Interdisciplinary History* XXXIV:I: 1-25

Mellaart, J. 1962. Excavations at Çatal Hüyük, First Preliminary Report, 1961. *Anatolian Studies* 12: 41-65

Mellaart, J. 1963. Excavations at Çatal Hüyük, Second Preliminary Report, 1962. *Anatolian Studies* 13: 43-103

Mellaart, J. 1964. Excavations at Çatal Hüyük, Third Preliminary Report, 1963. *Anatolian Studies* 14: 39-119

Mellaart, J. 1966. Excavations at Çatal Hüyük, Fourth Preliminary Report, 1965. *Anatolian Studies* 16: 15-191

Mellet, J. S. 1974. Scatological Origin of Microvertebrate Fossil Accumulations. *Science* 185: 349-350

de Meester, T. 1970. *Soils of the Great Konya Basin, Turkey*. Centre for Agricultural Publishing and Documentation, Wageningen

Meyer, A. N. 1994. Rodent Control in Practice: Food Stores. In (eds. A. P. Buckle & R. H. Smith), *Rodent Pests and their Control*, 273-290, CAB International, Cambridge

Mikkola, H. 1992. Wood Owls*, Pulsatrix, Ciccaba, Strix, Asio.* In (ed. J. A. Burton), *The Owls of the World, their Evolution, Structure and Ecology*, 108-140, Peter Lowe, Italy

Mikkola, H. 1992. *Owls of Europe*. Poyser Natural History, London

Mitchell-Jones, A. J., Amori, G., Bogdanowicz, W., Kryštufek, B., Reijnders, P. J. H., Spitzenberger, F., Stubbe, M., Thissen, J. B. M., Vohralík, V. & Zima, J. 1999. *The Atlas of European Mammals*. Poyser Natural History, London

Montuire, S. 1999. Mammalian Faunas as Indicators of Environmental and Climatic Changes in Spain during the Pliocene-Quaternary Transition. *Quaternary Research* 52: 129-137

Morlan, R. E. 1980. *Taphonomy and Archaeology in the Upper Plesitocene of the Northern Yukon Territory: a Glimpse of the Peopling of the New World*. Archaeological Survey of Canada Paper No. 94, Mercury Series. Ottawa: National Museum of Man

Morris, B. 2000. *The Power of Animals an Ethnography.* Berg, Oxford

Musser, G. G. & Carleton, M. D. 1993. Family Muridae. In (ed. D. M. Reader) *Mammal Species of the World,* 510-755, Smithsonian Institution Press, Washington D.C.

Nabaglo, L. 1973. Participation of invertebrates in decomposition of rodent carcasses in forest ecosystems. *Ekologia Polska-Polish Journal of Ecology* 21: 251-270

Nesbitt, M. 2002 When and Where did Domesticated Cereals First Occur in Southwest Asia. In (ed. R. T. J. Cappers & S. Bottema) *The Dawn of Farming in the Near East*, 113-132, Ex Oriente, Berlin

O'Connor, T. 2000. *The Archaeology of Animal Bones*. Sutton Publishing Limited, Stroud.

Osborn, D. J & Helmy, I. 1980. The Contemporary Land Mammals of Egypt (including Sinai). *Fieldiana Zoology* 1309: 1-579

Özbaşaran, M. & Buitenhuis, H. 2002. Proposal for a Regional Terminology for Central Anatolia. In (ed. F Gérard & L. Thissen) *The Neolithic of Central Anatolia. Internal Developments and External Relations during the 9th-6th Millenia Cal BC. Proceedings of the International CANeW Table Ronde*, Istanbul, 23-24 Novermber 2001, 67-77, Eye Yayinlari, Istanbul

Parker-Pearson, M., Sharples, N. & Symonds, J. 2004. *South Uist Archaeology and History of a Hebridean Island*. Tempus Publishing Limited

Payne, J. A. 1965. A Summer Carrion Study of the Baby Pig *Sus scrofa* Linnaeus. *Ecology* 46 (5): 592-602

Pearsall, D 2000. *Paleoethnobotany*. Academic Press, Orlando

Pinto Llona, A. C. & Andrews, P. J. 1999. Amphibian Taphonomy and its Application to the Fossil Record of Dolina (middle Pleistocene, Atapuerca, Spain). *Palaeogeography, Palaeoclimatology, Palaeoecology* 149: 411-429

Powell, A. Forthcoming. Pompeii Small Vertebrates. In (ed. M. G. Fulford, & A. Wallace-Hadrill) *The House of Amarantus: Excavation and Survey* 1995-1999

Preece, R. C. 1986. Faunal remains from Radiocarbon-dated Soils Within Landslip Debris from the Undercliff, Isle of Wight, England. *Journal of Archaeological Science* 13: 189-200

Rackham, D. J. 1982. The smaller mammals in the Urban Environment: their Recovery and Interpretation from Archaeological Deposits. In (ed. A. R. Hall & H. K. Kenward), *Environmental Archaeology in the Urban Context,* 86-93 The Council for British Archaeology, Research report, 43, London

Raczyński, J. & Ruprecht, A. L. 1974. The Effects of Digestion on the Osteological composition of owl pellets. *Acta Ornithologica* XIV (2): 27-36

Reed, J. M., Roberts, N., & Leng, M. J. (1999). An evaluation of the diatom response to Late Quaternary Environmental Change in Two Lakes in the Konya Basin, Turkey, by Comparison with Stable Isotope Data. *Quaternary Science Reviews* 18: 631-646

de Ridder, N.A., 1965. Sediments of the Konya basin, Central Anatolia, Turkey. *Palaeogeography Palaeoclimatology Palaeoecology* 1: 225–254.

Roberts, N. 1983. Age, Palaeoenvironments and Climatic Significance of Late Pleistocene Konya Lake, Turkey. *Quartenary Research* 19: 154-171

Roberts, N. 1998. *The Holocene, an Environmental History*. Blackwell, Oxford

Rollefson, G. 2000. Ritual and social structure at Neolithic ‘Ain Ghazal. In (ed. I. Kujit), *Life in Neolithic Farming Communities*, 163-190, Kluwer, New York

Rosen, A. M. 1999. Phytolith Analysis in Near Eastern Archaeology. In (ed. S. Pike & S. Gitin), *The Practical Impact of Science on Aegean and Near Eastern Archaeology,* 86-92, Archetype London

Rosen, A. M. (2005). Phytolith Indicators of Plant and Land Use at Çatalhöyük. In (ed. I. Hodder), *Inhabiting Çatalhöyük: Reports from the 1995-99 seasons.* Çatalhöyük Project Volume 4, 203-212, McDonald Institute Monographs/BIAA 38, Cambridge and London

Rosen, A. M. & Weiner, S. 1994. Identifying Ancient Irrigation: a New Method using Opaline Phytoliths from Emmer wheat. *Journal of Archaeological Science* 21. 125-132

Russell, N. and Düring, B. S. 2006. Worthy is the Lamb: A Double Burial at Neolithic Çatalhöyük (Turkey). *Paléorient.* 32.1

Russell N. & Martin, L. 1998. Çatalhöyük Animal Bone Report. *Çatalhöyük 1998 Archive Report*. Available at: http://catal.arch.cam.ac.uk/catal/Archive_rep98/martin98.html

Russell N., & Martin, L. 2005. Çatalhöyük Mammal Remains. In (ed. I. Hodder), *Inhabiting Çatalhöyük: Reports from the 1995-1999 seasons.* Çatalhöyük Project Volume 4, 33-98, McDonald Institute Monographs/BIAA 38, Cambridge and London

Saavedra, B. & Simonetti, J.A. 1998. Small mammal taphonomy: intraspecific bone assemblage comparison between South and North American barn owl, *Tyto alba*, populations. *Journal of Archaeological Science* 13: 260-267

Sage, R.D., Prager, E. M., Tichy, H. & Wilson, A. C. 1990. Mitochondrial DNA Variation in the House Mouse, Mus domesticus (Rutty). *Biological Journal of the Linnean Society* 41: 105-123

Saunders, G. 1986. *Plagues of the House Mouse in South Eastern Anatolia*. Vertebrate Pest Conference (California) 12: 173-176

Saunders, G. & Robards, G. F. 1984. *Mice and their Control*. Agdex 672. Agfact A9.0.1. Department of Agriculture, New South Wales, Orange

Selvaggio, M.M. & Wilder, J. 2001. Identifying the Involvement of Multiple Carnivore Taxa with Archaeological Bone Assemblages. *Journal of Archaeological Science* 28: 465-470

Shipman, P. & Walker, A. 1980. Bone-collecting by harvesting ants. *Paleobiology* 6(4): 496-502

Shotwell, J. A. 1955. An Approach to the Paleoecology of Mammals. *Ecology* 36(2): 327-337

Sleeman, P. 1989. *Stoats & Weasels, Polecats & Martens.* Whittet Books, London

Smith C.R. & Richmond, M.E. 1972. Factors Affecting Pellet Egestion and Gastric pH in the Barn Owl. *Wilson Bulletin* 84: 179-186

Smith, R. H. 1994. Rodent Control Methods: Non-chemical and Non-lethal Chemical. In (eds. A. P. Buckle & R. H. Smith), *Rodent pests and their Control*, 109-125, CAB International, Cambridge

Southern, H. N. 1979. The Stability and Instability of Small Mammal Populations. In (ed. D. M. Stoddart), *Ecology of Small Mammals*, 103-134, Chapman & Hall, London

Steward, J. 1953. Evolution and Process. In (ed. A. L. Kreber), *Anthropology Today,* 316-326, University of Chicago Press, Chicago

Steward, J. 1955. *Theory of Culture Change: the Methodology of Multilinear Evolution*. University of Illinois Press, Urbana

Stordeur, D. 2000. New Discoveries in Architecture and Symbolism at Jerf el Ahmar (Syria), 1997-1999. *Neo-lithics* 1/00:1-4

Sullivan, R. 2005. *Rats, A Year with New York's most Unwanted Inhabitants*. Granta Publications, London

Tangri, D. & Wyncoll, G. 1989. Of Mice and Men: is the Presence of Commensal Animals in Archaeological Sites a Positive Correlate of Sedentism? *Paléorient* 15: 85-94

Tanno, K.-I. & Willcox. G. How fast was Wild Wheat Domesticated? *Science* 311: 1886

Taylor, I. 1994. *Barn Owls*. Cambridge University Press, Cambridge

Tchernov, E. 1968. *Succession of Rodent Faunas during the Upper Pleistocene of Israel*. Mammalia Depicta 3 P. Parey, Hamburg and Berlin

Tchernov, E. 1984. Commensal Animals and Sedentism in the Middle East. In (ed. J. Clutton-Brock & C. Grigson), *Animals in Archaeology 3. Early herders and their flock*, 91-115, BAR International Series 202, Oxford

Tchernov, E. 1991a. Biological Evidence for Human Sedentism in Southwest Asia during the Natufian. In (eds. O. Bar-Yosef & F. R-Valla), *The Natufian Culture in the Levant*. International Monographs in Prehistory, 315-340.Ann Arbor, Michigan

Tchernov, E. 1991b. Of Mice and Men. Biological Markers for Long-term Sedentism; A Reply. *Paléorient* 17 (1):153-160

Thaler, L. 1986. Origin and Evolution of Mice: An Appraisal of Fossil Evidence and Morphological Traits. In, (ed. M. Potter, J. H. Nadeau, & M. P. Cancro), *The Wild Mouse in Immunology*, 2-11, Springer-Verlag, Berlin

Thomas, N. 1965. A Double Beaker Burial on Bredon Hill, Worcestershire. *Birmingham Archaeological Society Transactions and Proceedings* 82: 58-76

Thomas, P. 1986. *The Year of the Weasel: the story of Beale of Dildawn*. Souvenir, London

Tucker, P. K., Sanstedt, S. A. & Lundrigan, B. L. 2005. The genus *Mus* as a model for evolutionary studies. *Biological Journal of the Linnean Society*, 84, 653-662

Valverde, J-A. 1964. Remarque sur la Structure et l'Evolution des Communautés de Vertébrés Terrestres. I. Structure d'une communauté. II. Rapport entre prédateurs et proies. *Terre et Vie* 18: 121-154

Valverde, J-A. (1967). Estructura de una Communidad de Vertebrados Terrestres. *Mongrafias de la Esacion Biologica de Doñana* 1: 1-129

van Zeist, W. & Bottema, S. (1991). Late Quaternary Vegetation of the Near East. *Beihefte zum Ttibinger Atlas des Vorderen Orients, Reihe A*, Nr. 18. Dr Ludwig Reichert Verlag, Wiesbaden.

Vigne, J-D., Guilaine, J., Debue, K., Haye, L. & Gérard, P. 2004. Early Taming of the Cat in Cyprus, *Science*, 304, 9: 259

von den Driesch, A. & Boessneck, J. 1983. A Roman cat Skeleton from Quseir on the Red Sea Coast. *Journal of Archaeological Science* 10: 205-211

Voorhies, M. R. 1969. Taphonomy and Population Dynamics of an Early Pliocene Vertebrate Fauna Knox County, Nebraska. *American Midland Naturalist* 91:492-498

Walker, E. P. 1983. *Walker's Mammals of the World*. The John Hopkins University Press, Baltimore

Watkins, T. 1996. Excavations at Pınarbaşı : the Early Stages. In (ed. I. Hodder), *On the Surface: Çatalhöyük 1993-95*. Çatalhöyük Project Volume 1, 47-58, Cambridge, McDonald Institute Monographs/BIAA 22

Watson, P. J. 1976. In Pursuit of Prehistoric Subsistence: A Comparative Account of some Contemporary Flotation Techniques. *Mid-Continental Journal of Archaeology* 1 (1): 77-100

Weissbrod, L., Dayan, T., Kaufman, D., & Weinstein-Evron, M. 2005. Micromammal Taphonomy of el-Wad Terrace, Mount Carmel, Israel: Distinguishing Cultural from Natural Depositional Agents in the Late Natufian. *Journal of Archaeological Science.* 32: 1-17

Wheeler, A. & Jones, A. K. G. 1989. *Fishes*. (Cambridge Manuals in Archaeology). Cambridge University Press, Cambridge

White, T. E. 1953. A Method of Calculating the Dietary Percentage of Various Food Animals utilized by Aboriginal Peoples. *American Antiquity* 18: 396-398

Willcox, G. 1999. Agrarian Change and the Beginnings of cultivation in the Near East: Evidence for Wild Progenitors, Experimental Cultivation and Archaeobotanical Data. In (ed. C. Gosden & J. Hather). *The Prehistory of Food. Appetites for Change*, 479-500, Routledge, London

Willcox, G. 2004. Measuring Grain Size and Identifying Near Eastern cereal domestication: Evidence from the Euphrates Valley: *Journal of Archaeological Science* 31: 145-150

Williams, J. P. 2001. *Small Mammal Deposits in Archaeology: a Taphonomic Investigation of Tyto alba (barn owl) Nesting and Roosting sites*. Unpublished Thesis, Department of Archaeology and Prehistory. University of Sheffield

Williams, J. P. 2005. Predator Bias and Fluctuating Prey Populations. In (ed. T. O'Connor), *Biosphere to Lithosphere: New Studies in Vertebrate Taphonomy* - Proceedings of the 9th Conference of the International Council of Archaeozoology, Durham, 46-50, Oxbow Books, Oxford

Wood, B. J. 1994. Rodents in Agriculture and Forestry. In (eds. A. P. Buckle & R. H. Smith) *Rodent Pests and their Control*, 45-83, CAB International, Cambridge

Wyncoll, G. & Tangri, D. 1991. The origins of Commensalism and Human Sedentism. *Paléorient* 17: 157-159

Yalden, D. W. 1980. Notes from the Mammal Society. 40, (ed. D. M. Stoddart). *Journal of Zoology, London* 191: 403-433.

Zohary, M. 1973. *Geobotanical Foundations of the Middle East:* Vol.1, Gustav Fischer Verlag, Stuttgart, Berlin