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An introduction to faunal remains and environmental studies: a mismatch or a match made in heaven?

Pernille Bangsgaard

Abstract

This paper explores how faunal material can contribute to the field of environmental studies and why this type of evidence is of importance for our general understanding of a site and its social and physical environment.

The potential limitation of the collection and registration methods as well as the general excavation strategy is discussed and it is argued that the understanding of the limitations is instrumental for the result of the following faunal analysis. Furthermore, various methods such as size variation within a population, stable isotopes analysis, modern habitat studies as well as sex and age profiling are all introduced and considered in the context of an environmental study.

The site of Shkarat Msaied, a middle PPNB (Pre-Pottery Neolithic B) site in Jordan, is used as a case study to illustrate the various methods described above as well as exemplify how an environmentally focused faunal study can add to our understanding of a site and its contemporary environment.

1. INTRODUCTION

Animals have been an important factor influencing human existence from the earliest prehistoric periods and remain so even in today's modern world. The importance of animals and the products derived from them is not exclusively utilitarian, although they are essential as food sources, as means of transport, for clothing and for fuel to mention a few (Reitz and Wing 1999). However, animals are also instrumental in the cognitive processes of how we define and describe ourselves and the world that surrounds us (Ingold 1988). With this perspective in mind we can potentially retrieve information regarding many aspects of human existence from the large quantities of preserved faunal remains found on most archaeological sites. The information retractable from faunal material depends to a large extent on the specific context of the find. However, it could potentially include evidence for the basic consumption pattern in a village, for industrial production, for human social responses to environmental variation, as well as evidence for the religious practices identified through temple and grave offerings.

2. FAUNAL ENVIRONMENTAL STUDIES

Environmental studies are one avenue of research that faunal analysis could potentially be utilised for. It is defined by a focus on the interplay between human society and nature, as human society inevitably acts and develops within this context. The interplay is best described as an active relationship wherein human society influenced and was influenced by the local landscape, fauna and flora. There exist several definitions of the term environment, however, it is here to be understood as the study of the biological, physical and social agents and relationships that influence a living being (Dincauze 2000). Due to the topic of this article, the focus is here on the various relationships existing between animal and human. The field of Zooarchaeology has previously focused mainly on the purely biological aspects of environmental studies, where we attempt to understand the development of the changing conditions in the natural environment. However, at present this is no longer the only focus of environmental studies. Instead it has increasingly been recognised that an interdependent relationship exists between human society and animals and the environment that surrounds both. Therefore environmental studies today may well focus on the interplay between two or more components rather than focusing exclusively on a single component, whether this component is human society or animal population history (Reitz and Wing 1999).

The natural environment clearly assumes an active role in the development of any human society as it dictates a framework of natural resources and landscapes that human society has to act within. However, the particular human response to this framework is by no means given and depends on the various characteristics of human society, as the variation in human societies and traditions across the globe so richly illustrates. However, human society also has an effect on the animal populations and the natural environment that it acts within. It can potentially create both small scale and regional changes to fauna as well as create new types of habitats within or immediately around permanent human settlements (Reitz and Wing 1999).

3. THE FAUNAL MATERIAL

An environmental study based on faunal material should start with the question: 'What environment do we want to study?'. The question may seem superfluous, however, it is not without merits. An animal can only disclose information of the specific environment that it interacts with. The definition of this environment is based on the specific ecological demands the animal has, meaning what habitat preferences it has and what other fauna as well as flora does it interact

with. Therefore, it is worth considering what perspective the study should have before the analysis commences.
An example where the context of the find was considered is the site of Caerleon in Great Britain where a Roman bath revealed a large amount of bones from a number of rodent species and a few frogs. Under other circumstances remains from rodents are often interpreted as an event of accidental trapping or death by natural causes without human interference. This means that the identified species potentially could testify to the environment of the site itself. However, the sheer number of bones as well as the specific find circumstances revealed that the accumulation in question was created by owl pellets. Therefore the collection probably originated in the environment that surrounded the site and was accumulated there by owls as a result of their hunting activities (O'Connor 2004).
The faunal evidence we utilise in environmental studies typically consists of a combination of physical evidence from various animal species often in the shape of bone, teeth and shell fragments. These faunal materials all have a high survival rate in most soil conditions. Occasionally the collection may contain other faunal materials such as hair, skin, flesh and dung, however, this requires conditions of extraordinary preservation (Reitz and Wing 1999).
The information retrieved from the faunal material is instrumental for most types of faunal analysis. However, the collection strategies and techniques we utilize when obtaining the faunal material may influence the composition of the collection. As a general rule all faunal material should be collected during excavation. A sampling strategy where only larger and more complete fragments of faunal material are collected is not advisable. The concept of a representatively collected selection of faunal material does not exist, as species composition as well as body part index for each species will always be influenced by such a practice. Therefore, any information retrieved from the analysis of an incomplete faunal selection is potentially flawed and would most likely procure a distorted result of little general use to anyone.
Additionally it is important before and during the excavation to make conscious decisions concerning the kind of information that we want to retrieve from the faunal analysis. These decisions should be reflected in the selected excavation strategy, which includes the decision of when and where sieving or flotation is applied, as well as when selective soil samples are taken for microanalysis or when material is selected for later DNA or stable isotope analysis. The selected strategy is naturally planned within the framework of available time and money that a given project has vs. the amount of information that the faunal analysis can potentially procure.
The time and labour invested in the initial collecting of the faunal material should include the same kind of rigid registration that we apply to other excavated objects or finds. The analysis of a faunal collection can not be carried out in a vacuum and the material should therefore be registered according to the specific strata and unit and include information concerning excavation method, sieving method and mask-size of the sieve in order to insure a good result in the following analysis. In some instances it may also be advisable to register each bone by the exact find coordinates. A good example of where the extra effort is well spent is in situ animal offerings, where a reconstruction of the butchering sequence and rituals performed in connection with the deposit could potentially be revealed if registration permits it (for an example, see Højlund *et al.* 1981).

4. METHOD

I will briefly describe the types of evidence that is routinely registered for each bone or teeth fragment during the initial analysis as they can potentially be utilised for environmental studies.
Generally the mere presence of a particular fauna or species can potentially give evidence to the type of landscape, the availability of water or the overall climatic conditions existing around a site at the time of deposition. All species of animals make inherited demands on the environment that they inhabit and some may be very specific in these demands. The best known example of this is probably the koala, which feeds exclusively on the tree leaves of some eucalyptus species (Cork *et al.* 2000). Other species are less specific in their requirements but may still be utilised for interpreting the environmental fluctuations that occur over extended periods of time. These species are often termed 'generalists'. An example of this are the various studies of species variation throughout Northern Europe during the glacial and interglacial periods, following the marked environmental changes and the expansion and retraction of the northern icecap (Kahlke 1994: 94-124; Aaris-Sørensen 2001).
The information we utilise for environmental studies based on faunal remains invariably includes details of animal habitat preferences, food preferences, social behaviour and birth rate. Information of this type derives to a large extent from observations of animal populations living today. This practice could present a potential problem as we can not ascertain whether the information in all details relates to the studied population of the past. Therefore, one should always be cautious as to the amount of detail that is assumed to be the same. In order to minimise any inaccuracies it is advisable to utilise information that comes from studies of geographically close origin compared to the archaeological material. This is known as the actuality principle. The practice is due to the variation in habitat preferences known to occur between geographically separated present-day populations (see for example Mendelson and Yom-Tov 1999).
Variations in relative species diversity and abundance may also reveal information used to identify fluctuations in the general environmental conditions. However, one should consider the origin of the faunal material we utilise for this type of study. The majority of the faunal material we identify at an occupation site is there as a result of human activities. Therefore, the relative abundance of each species reflects not only what could potentially be hunted or bred around the site but also reflects what the human population chose to hunt and breed. The potential influence of human preferences, cultural taboos and hunting tactics on the selection of faunal material should therefore be considered in the following analysis and a direct correlation between species abundance at a site and its relative availability in the area can not always be assumed. Furthermore, there are also a number of post-depositional and depositional factors which include biological as well as geological ones that

may influence the size and composition of the faunal collection (Meadows 1980). In environmental terms this means that the absence of evidence is not necessarily evidence of absence. It would therefore be advisable to include information from several archaeological sources and preferable also faunal material from other contexts than human occupation, when the primary focus of an environmental study is species and population abundance. In contrast the faunal material from occupation sites is well suited for studying the intricate interplay between human and animal.

The above described considerations of the potential human influence on the composition of the faunal collection should include consideration of possible transport of faunal material away from the original find or killing location, thereby distorting the find in time and space. Small scale movement on an intrasite scale and between two sites of close proximity probably occurs frequently in the archaeological record. This behaviour is exemplified by the transport of meat from American bison kill sites (O'Connor 2004: 133-136) or the gathering and concentration of faunal material utilised for industrial glue production in 18th century AD Europe (West 1995). However, the type of faunal material most susceptible to longer interregional transport, where the faunal material is truly removed from its original context, is material that has additional functions beyond general consumption such as antlers used for tools, shells and teeth used for decoration as well as various worked bone objects (Reitz and Wing 1999).

The registration of the faunal material will often include documentation of size and shape of the bone, as any identified variation in these relates to the size and shape of the animal (Reitz and Wing 1999). Variation in the two parameters could relate to general environmental changes on a broad scale, but factors such as sex, geographical isolation, breeding and dietary changes may also influence the result. Size reduction has for instance been identified for most of the domesticated animal species (Clutton-Brock 1999), although the size variation identified for early domesticated populations appear to have been linked to the relatively higher number of adult females (Zeder and Esse 2000). An example of size reduction was identified for Danish domesticated cattle from the Bronze Age period through to the Middle Ages. The phenomenon was in this case most likely caused by human controlled selective breeding and possible poor and insufficient diet (Møhl 1957).

Another type of information retrievable from the faunal material includes time of death and sex identification, which can be utilised for creating sex and age profiling for a population of animals. Both may be used to identify changes in the intricate relationship between human and animal. An example is the study by Payne of the variation in kill-off-patterns between populations kept primarily for milk or for meat or for wool production (Payne 1973). If detailed sex and age information is available from the archaeological faunal material it becomes possible to indicate the type of subsistence production practised. Additionally, the evidence for time of death based on estimates of teeth eruption are also routinely used for estimating the exact period of occupation at early prehistoric sites where occupation and reoccupation in a seasonal based pattern can often be identified (Carter 2001).

Information originating from the analysis of human and animal coprolites and parasites can potentially also be utilised in environmental studies. The retrieval of coprolites from animals and humans may give direct information of the possible ailments humans and animals suffered from in the past, and thereby indirectly also give evidence to the general health and hygienic conditions in a given society. Due to the very small size of the specimens this type of study is completely dependent on a rigid soil sampling strategy of areas where material may potentially be found (Reitz and Wing 1999). This could include soil near in situ skeletons in a burial context, or soil inside structures that could potentially have functioned as latrines or as animal pens.

Stable isotope analysis is still developing, but the method promises to add a different type of information to the pallet of archaeological evidence. It supplies direct evidence for the dietary composition of both animal and human populations and identifies geographical movement depending on the specific isotope used. Isotopes are atoms whose nucleus contains a different number of neutrons but have the same number of protons, which means it remains the same chemical element. An example of an isotope is carbon (Fig. 1), which is found naturally as two stable isotopes (^{12}C and ^{13}C) and one unstable isotope (^{14}C), the later of which can be used for dating. Isotopes are found throughout the Earth, in oceans, on land and in all living beings, but the quantities of each isotope may vary according to such factors as the environmental conditions, the geographical location, the specific dietary composition of plant or meat, the terrestrial or marine food and it is this fact that we can utilise. However, the factors that can influence the precise ratio of the isotope in a given animal are numerous. Therefore although isotopes may reveal new knowledge, it can potentially also be problematic and does contain pitfalls particular regarding the specific interpretation of the result and it should therefore be used with some caution (Bogaard *et al.* 2007, Hedges and Reynard 2007, Ambrose 1991).

Some of the points made above can be illustrated by investigating the faunal evidence from a single site. The study selected is preliminary and based on a random selection of the mammal and avian fauna.

5. SHKARAT MSAIED

Shkarat Msaied is located in the greater Petra Area, in Southern Jordan, approximately 13 km north of Petra, at an altitude of 1000 m, which positions the site on the edge of the Jordanian Plateau in the southern part of the Levantine Rift Valley system (Henry 1995: 60). Shkarat Msaied is a Middle PPNB site (Pre-Pottery Neolithic) and ^{14}C dates it uncalibrated to around 9000 BP, in the early half of the MPPNB period. The site can be characterised as a small village with clusters of stone built and roughly circular buildings, with small enclosures and partitioning walls subdividing the rest of the available space (Fig. 2). Since 1999 the site has been excavated by a team from Copenhagen University (Jensen *et al.* 2008, Hermansen and Jensen 2002).

At present the faunal analysis includes 16,000 fragments of bones (41,791 g) of which a third has been identified to species or family. The faunal material originates from several buildings and open areas and includes room fills, floors and dump deposits. The conditions for finding bones by hand were good and experiments with sieving during the first season revealed that only small fragments below a size of 1 cm escaped hand recovery. Layers of special interest such as the floors were, however, still sieved. The good find conditions were also illustrated during a visit to the site where rodent bones were found 'by hand' and not during the following sieving.

The fragments represent a large and diverse collection with at least 38 positively identified species. This wide selection is typical of the fauna recovered from an early Neolithic site in Jordan, where a broad based consumption pattern was the norm in this transitory phase of the initial domestication (Hecker 1975, Becker 1991, von den Driesch and Wodtke 1997).

5.1. Mammals

The overwhelming majority of the faunal material derived from goat and sheep. They contribute over 88% of the identified collection and goat dominates 6:1 between the two species. The identification and verification of the onset of domestication is not the topic of this article, and it involves a complex discussion of definitions, criteria used, etc. However, the evidence from Shkarat Msaied does appear to indicate that the majority of the goats and possibly also the sheep consumed at the site were probably in the initial phase of domestication. The evidence includes horn core morphology, and size variation which were utilised for population composition and kill-off pattern analysis (Zeder and Esse 2000). Therefore, the subsistence economy at the site appears to have been based primarily upon these probable domesticated animals and not on hunting. This could have implications for the social structure at the site. However, it may also have implications for the wild herbivorous populations that inhabited the surrounding areas, as the flocks of domesticated sheep and goat would be in direct competition with many of the wild herbivores for the available food.

The remaining collection does include a number of wild mammals and in order to maintain an environmental perspective these species have been divided into groups reflecting their general habitat preferences (Fig. 3). The construction of these groups was based on information from present-day populations that are geographically close to the site of Shkarat Msaied, meaning that studies based on populations from Jordan, Israel and Egypt were preferred to information retrieved from studies of European populations (Uerpmann 1987, Mendelson and Yom-Tov 1999, Groves 1974, Harrison and Bates 1991, Hoath 2003). However, several of the species are not well studied and therefore habitat information as well as diet preferences and daily requirements are only partly accessible or may lack in the amount of details available.

As a general rule, the desert species are to be found exclusively in desert environments today although they may occasionally spread into surrounding desert fringe areas. They can potentially tolerate longer periods without available water in their habitat either by utilising the water contained in their food or by minimising water loss through various physical or social strategies (Groves 1974, Uerpmann 1987).

The arid category consists of two groups as it includes species found exclusively in arid habitats as well as extremely adaptable species which can be found through a broad range of habitats across a wider geographical area, although not in true desert habitats (Mendelson and Yom-Tov 1999, Hoath 2003, Harrison and Bates 1991).

The mountainous group was created to distinguish the species that are especially adapted to a mountainous terrain; these species could otherwise have been placed in the arid category.

The three groups, desert, arid and mountainous, includes both African species and species distributed across a wider area in Southern Europe, the Middle East and in Central Asia. With a few exceptions most of these species are found in the general area today. The few species not present in the area today, are probably not present due to historical hunting pressure (Mendelson and Yom-Tov 1999, Groves 1974, Harrison and Bates 1991, Uerpmann 1987)

The three species in the Mediterranean group may be termed Palaearctic in their distribution pattern. Two of these are today generally to the north of Shkarat Msaied in Mediterranean environments and in Europe and Asia. The final species is the aurochs, the wild progenitor of domesticated cattle and is today extinct. It does, however, appear to have had a similar distribution to the two other species. It is characteristic of all three species that they are generally more demanding regarding the availability of food, shade and particular water availability (Uerpmann 1987, Mendelson and Yom-Tov 1999, Harrison and Bates 1991).

The described distribution of animals indicates an environment with multiple habitats, which was utilised by the human population for hunting as a supplement to the primary herding strategy of sheep and goat. The species collection is similar to the environmental and zoological evidence retrieved from present-day studies of the area although with a slight variation. The fauna found in the area at the present time indicates a dryer and less forested environment, as the Mediterranean species are completely missing from the general Petra area today (Gebel 1992).

5.2. Migratory Raptors

In the Middle East the pattern of bird migration is another possible source of information. Many migratory birds from across Europe and Siberia use the area as a land bridge as they pass through the Middle East en route to and from their wintering grounds in Africa. Among the birds migrating through the Middle East are large numbers of raptors. They tend to fly by day and rely primarily on soaring flight and not on flap flight. Therefore, they are dependent on thermal and mountain updraft (Bieldstein 2006).

Today 43 raptor species funnel through the Middle East every spring and autumn. Many fly along well established corridors and in flocks, in some cases containing over 10,000 individuals, particularly around migration bottlenecks. In the Middle East they often slope soar along the Levantine Rift Valley (Leshem 1985, Porter and Beaman 1985).

A total of 300 fragments were identified as avian in the Shkarat Msaied material, which accounts for just over 5 % of the complete identified collection. For the avian group, all except five fragments were identified as belonged to raptors and include species that are found exclusively as migratory birds in the Middle East (Table 1) (Leshem 1985, Porter and Beaman 1985).

The presence of these migrating raptors at Shkarat Msaied certainly confirms that the general migration patterns were in place at the time of deposit and that the main route was probably through the Levantine Rift Valley. The identification of migrating raptors also suggests that the site was inhabited in spring and fall. However, it is not possible to say whether it was as a year round occupation or whether the site was exclusively occupied in the spring and fall.

6. CONCLUSIONS

The results from Shkarat Msaied are as mentioned preliminary. However, it appears that the inhabitants of the site relied mainly on the herding of goat and probably also sheep. A number of wild mammals were hunted most likely as a supplement to the diet. The collection of wild species suggests that some of the habitats surrounding the site included better access to water and fodder compared to those found in the area today. Finally, the identification of a number of raptors at the site suggests a period of occupation that included spring or fall.

As the examples above have shown there are obvious possibilities, considerations and also limitations to the use of faunal material in environmental studies and it should be stated here that any serious and thorough environmental study would under normal circumstances include evidence from several sources such as pollen, macrobotanical evidence, landscape and geological studies. However, the examples have hopefully illustrated that the information retrievable from the faunal analysis does include information not available from any other source.

The answer to the question posed in the title of this article is therefore that faunal analysis can be utilised for environmental studies. However, the success of the described methods such as presence of species, relative abundance of species, variations in size, sex and age distributions as well as coprolite and stable isotope analysis are all, to some extent, dependant on the strategy of collection and registration used during excavation.

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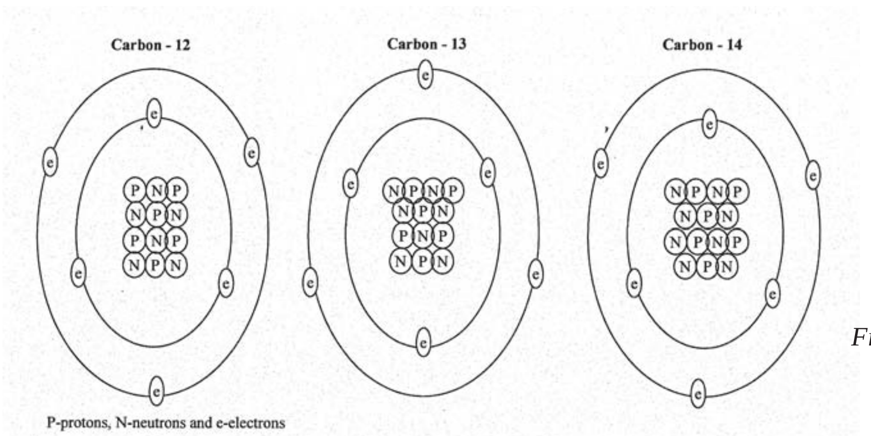

Fig. 1 - Three carbon isotopes.

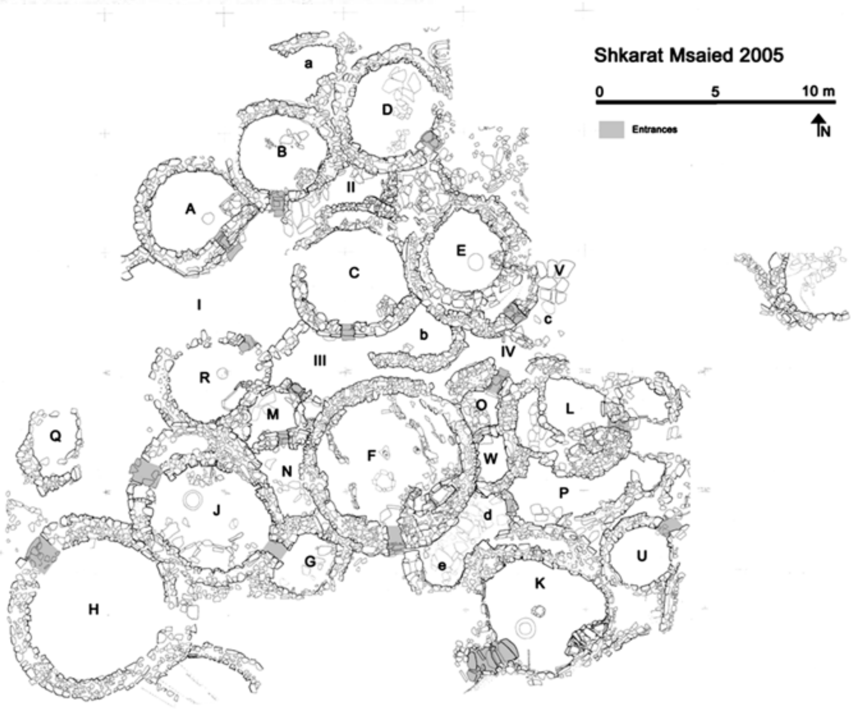

Fig. 2 - Plan of the excavated area at Shkarat Msaied.

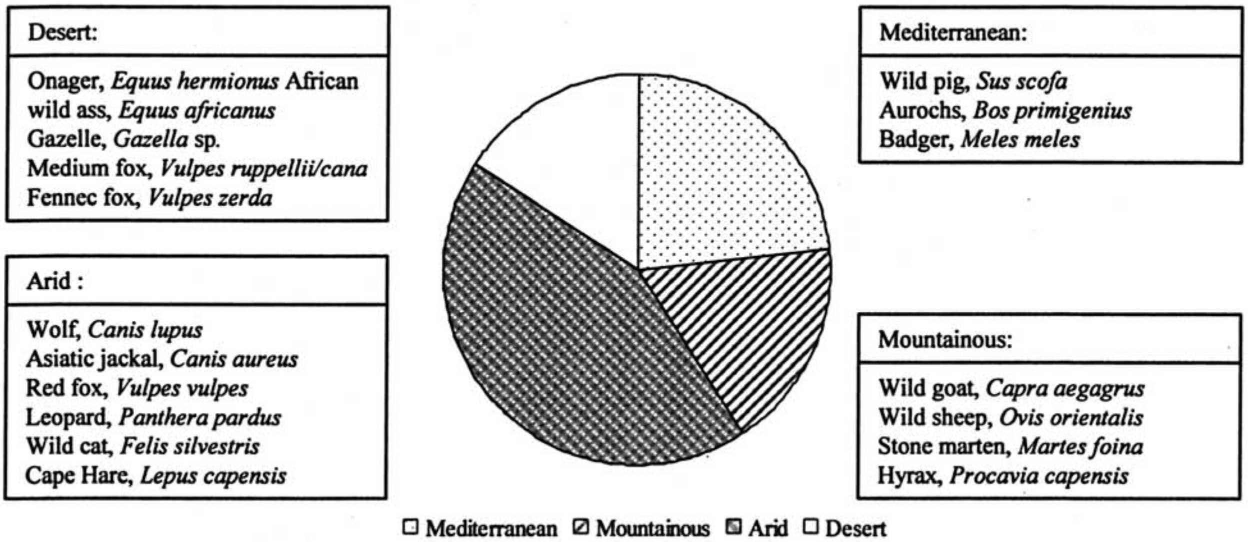

Fig. 3 - The distribution of wild mammals in habitat types.

Black kite, *Milvus migrans*	M
Common buzzard, *Buteo buteo*	M
Imperial eagle, *Aquila heliaca*	W /M
Steppe eagle, *Aquila rapax*	M
Rough-legged buzzard, *Buteo lagopus*	W
Black eagle, *Aquila verreauxi*	R
Lesser spotted eagle, *Aquila pomarina*	M
Golden eagle, *Aquila chrysaëtos*	R
Bearded vulture, *Gyppaetus barbatus*	R
Griffon vulture, *Gyps fulvus*	R
Hen harrier, *Circus cyaneus*	W
Dark chanting goshawk, *Melirax metabates*	R
Falcon, *Falco* sp.	
Hawk, *Accipiter* sp.	

R-resident, W-winterer, M-migrant

Table 1 - The raptors identified at Shkarat Msaied.