Animals in the Steppe

A Zooarchaeological Analysis of Later Neolithic Sabi Abyad, Syria

Chiara Cavallo

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List of abbreviations

SAB	= Sabi Abyad
E	= Early Halaf phase
T	= Transitional phase
P	= pre-Halaf phase
M	= mixed phase
SI	= size index
SM	= small mammals
MM	= medium mammals
LM	= large mammals
UF	= unfused
F	= fused
p.	= proximal
d.	= distal
D	= deciduous premolar/milktooth
P	= premolar
M	= molar

Skeletal elements:

CORNU	horncore/antler
CRAN	cranium
MAX	maxilla
MAND	mandibula
DENTES	loose teeth
HYOID	hyoid
ATLAS	atlas
AXIS	axis
CERV	vertebrae cervicales
THOR	vertebrae thoracales
LUMB	vertebrae lumbales
CAUD	vertabrae caudales
VERT	vertebrae
SACR	sacrum
STERN	sternum
COSTA	rib
SCAP	scapula
HUM	humerus
RAD	radius
ULNA	ulna
CARP	carpalia
MC	metacarpus
MC1	metacarpale 1
MC2	metacarpale 2

MC3	metacarpale 3
MC4	metacarpale 4
MC5	metacarpale 5
PELV	pelvis
FEM	femur
PATEL	patella
TIB	tibia
FIB	fibula
ASTR	astragalus
CALC	calcaneum
TARS	tarsalia
MT	metatarsus
MT1	metatarsale 1
MT2	metatarsale 2
MT3	metatarsale 3
MT4	metatarsale 4
MT5	metatarsale 5
MP	metapodium (metacarpus or metatarsus)
PH1	phalanx 1
PH2	phalanx 2
PH3	phalanx 3
SESAM	sesamoidea
CORAC	coracoid
CMC	carpometacarpus
PHM	phalanges manus
TIBT	tibiotarsus
TMT	tarsometatarsus
PHP	phalanges pedis

Chapter 1. Introduction

This research deals with the zooarchaeological analysis of the faunal remains found at the north-Syrian site of Tell Sabi Abyad. The research, carried out during the years 1991-97, is part of a wider and ongoing regional research project of survey and excavations in the Balikh valley, which has the purpose to build a chronological and a cultural sequence of occupation of the valley. After the research conducted by Mallowan in the 1930s, the interest in the valley abated, and often it was seen as a region of secondary importance when compared to the neighbouring valleys of the Euphrates and the Khabur. From 1981 onwards the University of Amsterdam has conducted a series of archaeological investigations in the valley, starting with the survey and the excavation at Tell Hammam et-Turkman. The first excavation at Sabi Abyad was carried out in 1986 by the Institute for Pre- and Protohistory of the University of Amsterdam under the direction of Peter Akkermans. The following campaigns were conducted in 1988 by the University of Amsterdam and subsequently by the National Museum of Antiquities of Leiden, which is now responsible for the continuation of the research at the site.

This research has revealed that the site of Sabi Abyad, and the Balikh valley in general, occupied an important, even crucial chronological position in the prehistory of the region and, less specifically, of the Jezira - the region between the rivers Euphrates and Tigris - in northern Syria. The site is particularly important for the comprehension of the late Neolithic phase and the origin of the Halafian culture, in the second half of the 6th millennium B.C. The accurate archaeological investigation has unearthed a continuous sequence of late Neolithic occupation without any major hiatus, allowing the recognition of separate phases of occupation on the one hand, and elucidating the gradual transformations of the local Neolithic community on the other. In order to adjust to the already existing chronological frameworks and other publications on Sabi Abyad (and so to avoid general confusion) all dates will be used in a 'traditional' manner, i.e. uncalibrated. See table 2.2 for calibrated dates.

Knowledge about the faunal remains and subsistence strategies adopted by the late Neolithic communities of the valley is rather scarce. Only a few zooarchaeological studies have been carried out until so far. Apart from a small report on the faunal remains from Tell Assouad and a very recent study on the remains from Sabi Abyad II, a first attempt on the animal remains from Sabi Abyad was carried out by van Wijngaarden-Bakker (1989). Although the sample was very small, the promising results together with the further archaeological investigation stimulated a further and more detailed study of a larger number of faunal remains from the site. This research therefore deals with a large number of fragments and contains a more detailed study of the faunal remains and the subsistence strategies of the Neolithic population in northern Syria, providing a large corpus of data for comparison with other sites.

The main aim of the research is to reconstruct the importance of animals within the economy of the late Neolithic - Halafian community, and to see whether according to the archaeological results the subsistence strategies adopted by that community were the results of a development and transformation within local communities.

The animals are the starting point of the research, or rather, what is left of them; the final point is the understanding and reconstruction of their meaning and their importance for the Sabi Abyad community. In other words, which animals were used and how, in relation to the possibilities and constraints both of the environmental resources and of the technological and cultural level of the community. In doing so, it is necessary first to understand the animals in themselves, their biology and physiology, behaviour, etc. and to reconstruct the environmental setting in which they lived, and then to put them into the archaeological and cultural context of the site as well.

The approach used in this reconstruction is the zooarchaeological analysis, i.e. the study of animal bones within their archaeological context. The research presented a series of interesting challenges. In the first place, due to the poor knowledge of the ancient geographical distribution of the different species in addition to their heavy reduction or even extinction in recent years, the determination of the species present in the area at that period is an important purpose in itself. Secondly, because only recently an interest has developed in the area and period here concerned the previous archaeozoological studies were rather few and mainly concentrated on historical periods or on very early domestication, so that the development or further stadia of the domestication was rather neglected. It is therefore an important aim of this research to examine what degree of domestication, or human control, and for which species was attained by the inhabitants of the site. In particular it is important to recognize whether the exploitation of domestic animals for their secondary products had already developed, and if it had, what kind of secondary products they were and which species they were related to. Finally, another goal of the research was to evaluate the role of the wild faunal component.

According to the approach and the aims described above, the book is structured in three parts:

I. the archaeological, environmental and zooarchaeological backgrounds;

II. the analysis of the faunal remains from Sabi Abyad;

III. the interpretations.

The following (second) chapter will summarize the archaeological context of Sabi Abyad. The purpose of this chapter is to present the results of the archaeological investigations at Sabi Abyad with emphasis on what can be relevant for the comprehension of the ancient community and animal utilization in relation to the analysis and interpretation of the faunal remains. The third chapter will provide a reconstruction, based on pollen, botanical and faunal evidence, of the palaeoenvironmental setting, in which men and animals interacted. In the fourth chapter the present state of the zooarchaeological research will be reviewed and evaluated, in order to place the results of the analysis of the faunal remains from Sabi Abyad in a more general Neolithic context. In the fifth chapter the zooarchaeological methods used in this research will be defined with emphasis on preservational aspects, on the specific Middle Eastern problems of identification of small herbivores as well as the more general zooarchaeological aspects of quantification, the criteria of ageing and of measuring.

Chapter six consists of the body of the research: the direct analysis of the Sabi Abyad animal remains. The analysis comprises the faunal remains excavated during the 1986, 1988, 1991 campaigns (see table 6.1). Parts of previous publications (Cavallo 1995, 1996) have been included in the present work. In the last chapter (seven) a general evaluation and interpretation of the data and the role of the animals at the site within a more general context will be attempted.

Chapter 2. Settlement archaeology of Tell Sabi Abyad

2.1 The site

The site of Tell Sabi Abyad - "Mound of the White Boy" in Arabic - is located in the upper Balikh in northern Syria at 30 km from the Syro-Turkish border, close to the modern village of Hammam et-Turkman (fig. 2.1). The tell is actually part of a cluster of mounds locally known as Khirbet Sabi Abyad or "the Ruins of the White Boy". The site from which the animal material is here analyzed constitutes the largest of these mounds.

The mound of Sabi Abyad measures ca. 5 ha at its base and rises about 5 to 10 m above the level of the surrounding undulating plain. The natural soil however is present at a depth of 4.5 m below modern field level showing how the ancient surface has been covered by a considerable accumulation of aeolic-fluviatile deposits (Wilkinson 1996).

The present mound of Sabi Abyad actually consists of a group of four small mounds which have merged together through time to form one large mound. The first excavation campaigns (1986-88/University of Amsterdam) were carried out on the northeastern and southeastern part of the mound, and on its top. They concentrated on the Halaf occupation levels dated to the end of the 6th millennium. The subsequent excavation campaigns (1991-1993/Netherlands National Museum of Antiquities) focused more on the broad horizontal exposure of the Transitional levels and on stepped trenches aimed to establish the general stratigraphic sequence and to reach the virgin soil (Akkermans 1993).

2.2 Stratigraphy and architectural features

The excavation campaigns at Sabi Abyad have revealed a continuous series of superimposed levels of occupation dated in general between 5700 B.C. and 5000 B.C. (fig. 2.2). In total eleven occupation levels were recognized. The earliest levels (11-7) were only reached in a narrow trench (P15) 9 m long and 2 m wide along the southern slope of the southeastern mound where the virgin soil was reached. The topmost levels (6-1) were investigated in broad horizontal exposures, up to 800 m^2 in several squares. For each square (9 x 9m) different strata were recognized, which were grouped in levels valid for all the squares. Here a general description for each level will be given. For a more detailed account on the stratigraphy and the correlation between the different strata of the various squares see the comprehensive work of Verhoeven and Kranendonk (1996), as well as Akkermans (1989a), Akkermans and Le Mière (1992), Akkermans (1993), Akkermans and Verhoeven (1995).

Level 11. This level represents the earliest stratum excavated at Tell Sabi Abyad and lies directly upon the virgin soil found at a depth of ca. 4.50 m below the level of the surrounding fields. It consists of a layer of pebbles and cobbles and of compact and homogeneous loamy deposits. The layer of pebbles has been interpreted as a kind of stone pavement placed purposely by men.

Level 10. This level is represented by a layer of sherds laid down on their flat side and by a deposit of hard grey-brown loamy soil (stratum 10). The layer of sherds is interpreted as a sherd pavement intentionally made by man. Above this there is a very distinct deposit (stratum 9) which separates the lower strata in which no architectural features were found (probably due to the limited area of excavation) from the others with architectural features.

Level 9. Level 9 consists of strata with architectural features and intermingled layers of debris accumulation. The architecture is represented by a wall and its related floorlevel and an oven with its floorlevel.

Level 8. This level is represented by layers in which architectural features consisting of a wall, a floorlevel and pits were found intermingled by debris layers. Most of the animal remains ascribed to this level come from the pits. One of them (pit AD) has an oblong shape measuring ca. 3.80 x 1.50 m with a depth of ca. 1.00 m) and has a homogeneous fill (grey-brown loam) while another (pit AG) with a diameter of ca. 1.90 m and a depth of 1.20 m has clear stratigraphic deposits indicating a gradual accumulation probably over a long period.

Level 7. Besides in the P15 trench, this level was also exposed in a trench of P14 and in a limited area of squares P12, Q14 and R14. Evidence of two rectangular buildings erected next to each other were found.

Level 6. This level gave evidence of a series of well-preserved architectural structures, representing the so-called "Burnt Village" because of its destruction by a violent fire. Eight rectangular and multi-roomed buildings, four circular structures (tholoi) and several ovens were unearthed. The material from this level should be considered largely in situ. The village related to this level was partly built in terraces on the slope of the mound so that roofs were on the same levels as the floor of the houses from the upper layers.

Level 5. Level 5 consists of two rectangular multi-roomed buildings exposed in squares P14, Q14, Q15 (building I) and in squares R14 and Q14 (building II). In the courtyard around building I households structures such as ovens and hearths were found.

Level 4. This level is characterized by the presence of a well-preserved large tholos with antechamber in square Q15. North of the tholos a small rectangular building was found in squares

P14, Q14 and the northern part of squares P15 and Q15. The presence of architectural remains belonging either to level 4 or 5 in the northern squares P12 and Q12, indicates that the lack of strata related to these levels in the central squares P13, Q13 and S13 is due to the levelling of this area for the construction of the later level 3 buildings.

Level 3. This level is represented by well preserved architectural remains found in an extensive area (ca. 875 m^2) on the highest part of the mound where the settlement seems to have been concentrated in the last phase of habitation. Level 3 is divided into levels 3C, 3B and 3A. Level 3C is characterized by the construction of an impressive stone wall which functioned as a retaining wall supporting a terrace on top and along the northern slope of the southeastern mound. Level 3B is represented by a multichambered building (building I), which incorporated the stone wall, and by related circular structures (tholoi). Many different means of access to the building were present, the main entrance being that from the small courtyard in the northeastern part of square Q13, which was in turn accessible from the terrace in the north. The building probably had two storeys, which would explain the lack of a passage at floor level in some rooms, these most presumably being accessible from the upper storey. From the kind of finds found in some rooms, such as large storage vessels and clay objects with seal impressions, it seems that the lower storey consisted of storage rooms while the upper storey contained the living areas. Besides some tholoi surrounding building I on the slopes, level 3B is characterized by the presence of numerous pits, most likely used as fireplaces, which yielded large quantities of bones. Level 3A is mainly represented by the construction of a rectangular building (building IV) south of the main building, which still continued to be in use in this level.

LEVEL	BALIKH	DATE(B.C.) (uncalibrated)	PHASE
1	IIIB	ca. 5000	Early Halaf
2	IIIB	5050/5000	Early Halaf
3	IIIB	5100/5050	Early Halaf
4	IIIA	5150/5100	Transitional
5	IIIA	ca. 5150	Transitional
6	IIIA	5200/5150	Transitional
7	IIC	5250/5200	pre-Halaf
8	IIC	ca. 5300	pre-Halaf
9	IIC	ca. 5400	pre-Halaf
10	IIC	ca. 5500	pre-Halaf
11	IIA	ca. 5700	pre-Halaf

Table 2.1 Relative chronology of the separate levels of occupation of Sabi Abyad in relation to the regional chronological framework of the Balikh valley

Level 2. No dwellings were attributed to this level. The residential architecture probably moved westward as suggested by a tholos found in squares O13-O14. The area of the buildings of the previous levels, largely filled by mudbricks and occupational debris, was re-used in this period for open-air domestic activities as documented by the numerous pits, ovens, kilns, fireplaces and white-plastered basins.

Level 1. This level is characterized by three multi-roomed rectilinear buildings divided from each other by narrow alleys surrounded by large open areas. These structures appeared immediately below the surface of the tell and they have been heavily damaged by erosion.

2.3 Chronology

The long and virtually uninterrupted occupation of Sabi Abyad lasted for more than 500 years and is generally dated to the second half of the 6th millennium B.C. The only possible exception is represented by level 11, the oldest, which might have an earlier date of around 5800-5700 B.C. The date of the separate levels is reported in table 2.1. The numerous archaeological investigations based both on surveys and archaeological excavations in the Balikh valley led to the compilation of a regional chronological framework (Akkermans 1993). In terms of this chronology at Sabi Abyad the Balikh IIA (level 11), the Balikh IIC (levels 10-7), the Balikh IIIA (levels 6-4) and the Balikh IIIB (levels 3-1) are attested.

A series of radiocarbon dates were obtained from charcoal, burnt grains, seeds and wood samples both from the northeastern and southeastern excavation areas at Sabi Abyad (table 2.2) (Akkermans 1991, 1996). The radiocarbon dates are all but two in accord with the stratigraphic sequence. The samples GrN-16801 and UtC-1010 are too old or too young respectively, probably due to contamination of the samples or presence of out-of-context material from earlier or later levels. The C-14 dates confirmed the importance and the uniqueness of Sabi Abyad, as no comparable sites had been excavated with so early Halaf levels directly related to preceding Neolithic levels of occupation.

2.4 Pottery

With the help of the large quantity of pottery retrieved from Sabi Abyad a typological sequence could be constructed which constitutes the basis of the relative chronological sequence of the occupational levels. Its analysis constitutes evidence for a long and continuous sequence, which essentially enables us to see how the Halaf 'culture' developed from an 'earlier locally founded Neolithic tradition' (Akkermans 1989b: 140). For a more detailed presentation of the description and chronology the reader is referred to Akkermans (1989d, 1993) and Le Mière and Nieuwenhuyse (1996).

Lab. No.	Material	Level	Conventional date B.P.	Conventional date B.C.	Calibrated date B.P. 1 sigma	Calibrated date B.P. 2 sigma
GrN -16804	Burnt grain	1	6975±30	5025±30	5842-5762	5934-5916 5866-5730
GrN -16800	Charcoal	2	7005±30	5055±30	5936-5916 5870-5802	5944-5910 5884-5764
GrN -16801	Burnt seeds	3	7465±35	5515±35	6362-6318 6306-6276 6256-6224	6370-6210 6206-6192
GrN -16802	Burnt seeds	3	7065±30	5115±30	5954-5936 5916-5870	5964-5844
GrN -16803	Burnt seeds	4	7075±25	5125±25	5956-5942 5912-5880	5966-5932 5918-5858
GrN -1008	Charcoal	4	6930±80	4980±80	5925-5924 5848-5684	5950-5906 5890-5620
GrN - 19367	Burnt grain	6	7075±25	5125±25	5956-5942 5912-5880	5966-5932 5918-5858
GrN - 19368	Burnt seeds	6	7100±60	5150±60	5985-5934 5916-5860	6024-5780
UtC - 1009	Burnt seeds	8	7080±80	5130±80	5984-5828	6044-5730
GrN - 16805	Burnt wood	8	7145±30	5195±30	5990-5958	6008-5950 5906-5888
UtC - 1010	Burnt wood	(Halaf NE mound)	6670±100	4720±100	5595-5480	5700-5430 5400-5390
UtC - 1011	Burnt wood	(pre-Halaf NE mound)	7150±90	5200±90	6110-6096 6052-5936 5914-5872	6168-6134 6130-6080 6072-5786
UtC - 1012	Charcoal	(pre-Halaf NE mound)	7170±90	5220±90	6116-6092 6056-5942 5910-5882	6174-5820
GrN -16806	charcoal	(pre-Halaf NE mound)	7225±30	5275±30	6105-6098 6048-6000	6116-6090 6056-5984

Table 2.2 List of radiocarbon dates from Tell Sabi Abyad (from Akkermans (1996: X)

The locally manufactured coarse ware of the **pre-Halaf** levels (11-7) is generally characterized by simplicity, irregularity and unevenness, associated with an extreme variability in shape and decoration. However, a general trend towards an increasing fineness in both technological and decorative aspects could be observed from the earliest to the latest levels of the pre-Halaf phase. Some characteristics such as large plant inclusions and the presence of handles are largely restricted to level 11. For the pottery of this level (Balikh IIA) comparisons are present in the Balikh valley. Although it seems to be somewhat younger, the pottery of level 11 largely resembles that of Assouad and Damishliyya, two other sites in the Balikh valley with very early ceramic. For the later levels (10-7; Balikh IIC) only a few comparisons can be found. Despite the possible importation of certain types, the ceramic assemblage of the pre-Halaf phase does not present any correlation with other areas such as northern Mesopotamia or northwestern Syria and Cilicia. Its distribution is restricted to a rather limited area, viz. the western Jezira between the Balikh and the Euphrates (Le Mière and Nieuwenhuyse 1996: 12-15).

A category of pottery from the pre-Halaf phase possibly related to food preparation is the 'Mineral Coarse Ware'. This pottery contains large quantities of mineral inclusions and has extremely thick walls. These features together with traces of burnishing on the inner and/or outer surface, the probably closed vessel shape and the presence of lugs suggest their use as cooking pots.

The ceramic assemblage of the **Transitional** layers (6-4) is characterized by the combination of old and new characteristics. All the previous pre-Halaf types are still found but new types of ware appear, such as the finely made and painted Samarra style pottery. This pottery is represented by bowls and small jars with a matt, reddish-brown to black painted decoration organized in linear bands, often of two alternating motifs. For the pottery from the Transitional phase not many parallels can be found either. Although in some aspects comparable to that from the Samarra sites in central Iraq and eastern Syria, the Sabi Abyad Transitional pottery maintains its own originality.

Although clearly emerging gradually from the previous levels, the **Early Halaf** (levels 3-1) ceramic assemblage is very distinctive. The majority of the pottery is represented by the carefully manufactured and painted Halaf pottery or 'Halafian Fine Ware', which virtually constitutes a local transformation of the Samarran type of the previous levels. The decoration, almost completely represented by painting involves broader areas and is more variegated, including both geometrical and, in smaller quantities, stylized zoomorphic and human representations. While the importance of the 'Halafian Fine Ware' increases through time, the frequency of the 'Vegetal Coarse Ware' decreases. 'Mineral Coarse Ware' characterized by dense mineral temper, a hole-mouth shape and lack of decoration is also present in the Early Halaf levels. It shows traces of burnishing which reduces permeability during cooking of liquid substances.

Few sites have yielded ceramics comparable to those of the Early Halaf levels of Sabi Abyad. So far, it seems that the fine painted Halaf ceramic was distributed in an area delimited by the Balikh in the west and by the Tigris in the east (upper Jezira north of Jebel Sinjar in Iraq and Khabur valley in Syria). The first known early Halaf ceramics from Arpachiyah (north Iraq) and Tell Aqab (north Syria) belong to a later stage compared to the Early Halaf pottery of Sabi Abyad (Akkermans 1993: 123-132). This would indicate that the Balikh valley must not be considered a marginal area, but must be included in the homeground of the Halaf society of northern Iraq and northeastern Syria or even be considered preceding its development in these areas.

2.5 Flint and obsidian

The lithic assemblage from Sabi Abyad can be considered a 'long virtually unbroken sequence of stone industrial traditions', in contrast to the pottery. The only exception is the material from level 11 that typologically speaking seems to be a unit apart (Copeland 1996). The lithic assemblage of this level can be considered to occupy an intermediate position between two very different areas, i.e. Mesopotamia in the east and the Levant in the west. This enlightens the important role of Sabi Abyad located in a central zone between different areas not only on an east-west but, as we shall see later, also on a north-south route.

The lithic assemblage from Sabi Abyad is almost completely constituted of flint and obsidian tools and debris. Flint is the main material used for the fabrication of stone implements. It consists mainly of river pebbles commonly found on the fossil Pleistocene terraces bordering the Balikh flood plain. Nodular flint obtained from seams in limestone bedrocks was also locally exploited while the thin honey-coloured slabs especially used for 'Tile Knives' were probably imported. Obsidian, most likely imported from eastern Anatolia, represents less than one-fourth of the lithic assemblage.

Within the different types of tools the "heavy duty types" are worth mentioning in this context in relation to their possible use on animal bones. This category is represented by large pebbles fashioned into choppers, axes, roughouts and by unworked flint balls used as hammerstones and some polishers. These types of tools are rare in all levels.

Arrowheads are another category of implements directly related to animals. They are represented by (a) the large tanged Byblos point, characteristic of the 7th and early 6th millennium and found in the oldest levels of Sabi Abyad, by (b) the tiny transverse arrowheads found as cache (26 complete + two fragments) in one room of a level 5 buildings, and by (c) the short tanged "Ubaid" or desert arrowheads, widely found in the Levant and in Arabia in the 5th and 4th millennium, and also known as "Haparsa Point". In addition, a few arrowheads both of transverse and of tanged type were made in obsidian. In general, arrowheads were scarce in all levels. From level 6 onwards they became very rare and their role seems to have been in part replaced by sling missiles, which increase in importance from level 6 onwards (Akkermans, pers. comm.). Changes in typology in level 6 towards a smaller type might be related to a different hunting technology, probably with the use of poison, and for hunting birds. Other categories of lithic tools, such as scrapers, blades, "bifacial knives" etc., were certainly meant for food processing and preparation. They would have been used for cutting, scraping, to remove meat and thereby leaving traces of small sometimes repeated cutmarks on the bone surface. These tools could of course also have been used for skin and leather processing as well as hair cutting, besides burins and borers.

2.6 Small finds

Among the small finds the numerous worked bone objects that have been found are worth mentioning (Spoor and Collet 1996: 452-453). They mainly consist of awls and needles. In addition, spatulas, gauges and notched 'talley sticks' were found, but on a limited scale.

Sixteen very poorly preserved animal figurines, considered to represent bovines, were found in level 6, and one in level 3 (Collet 1996: 406-407). Other animal representations were found among the stamp-seal impressions from level 6. They usually represent a goat-like animal with long backwards curved horns, bent hindlegs and stretched forelegs (Duistermaat 1996).

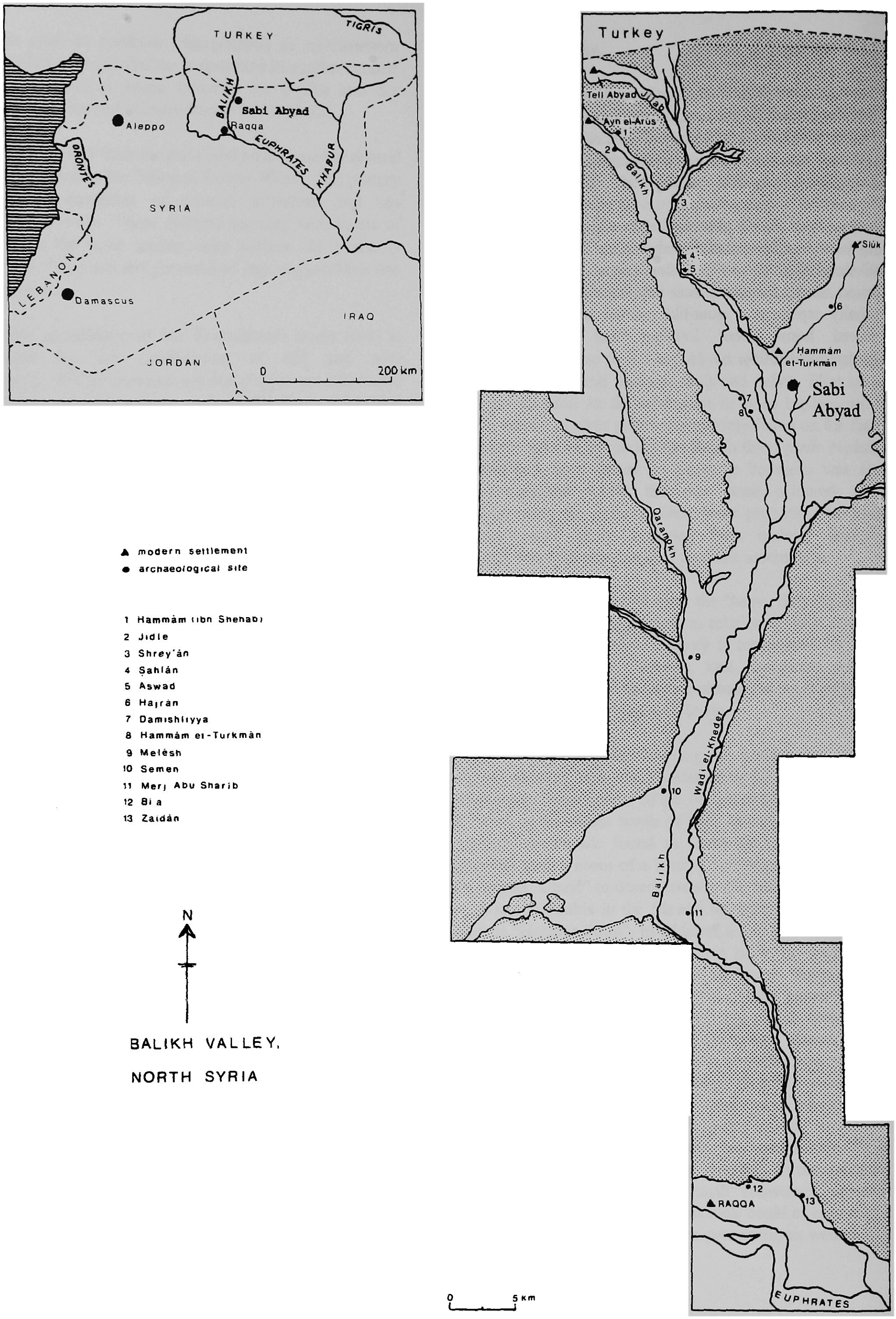

Figure 2.1 Map of the Balikh valley with the location of Sabi Abyad (from van Loon 1988, plate 1)

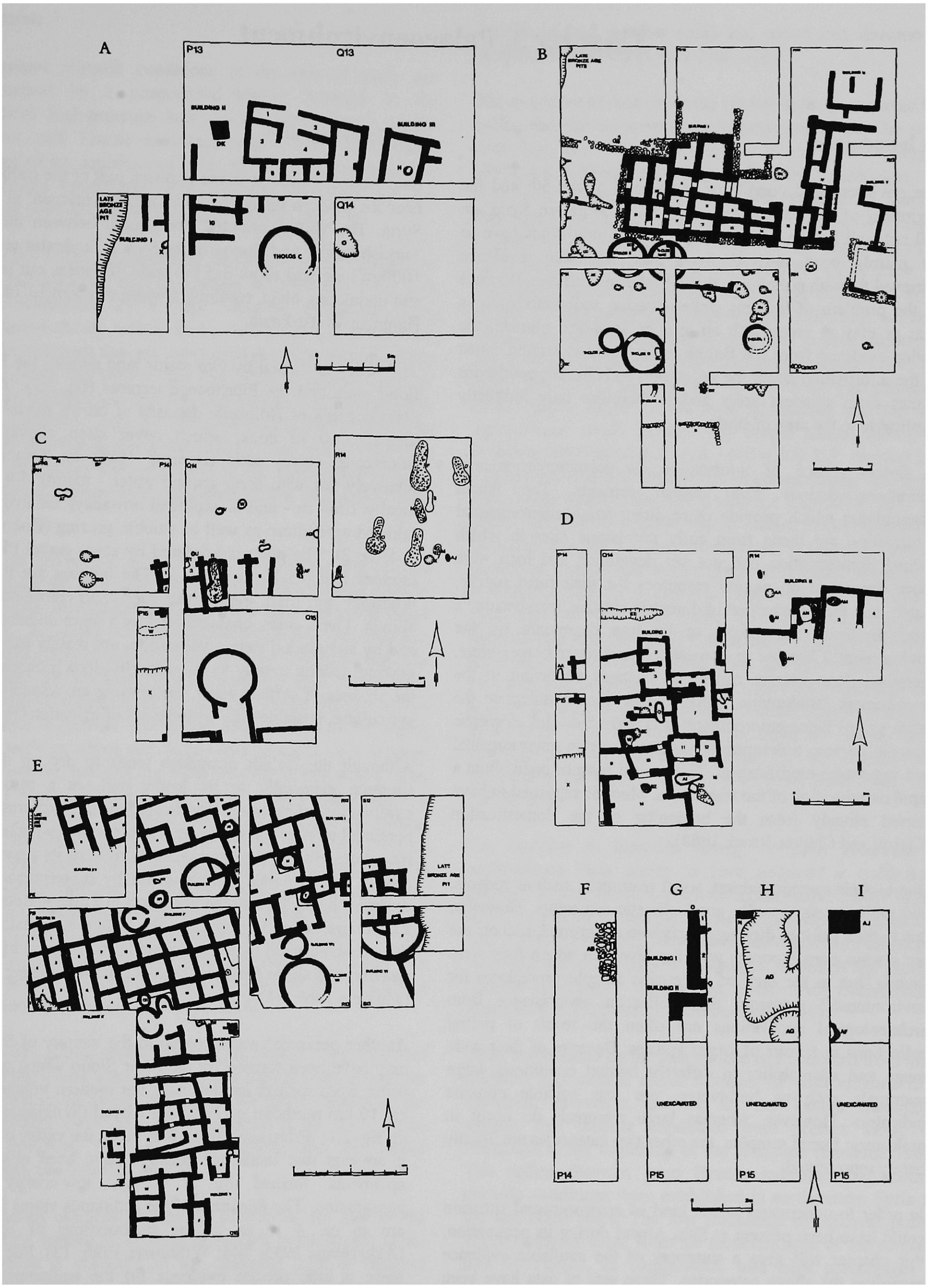

Figure 2.2 Sabi Abyad: architectural plans of level 1 (A), of level 3C-3B (B), of level 4 (C), of level 5 (D), of level 6 (E), and architectural remains found in the test trenches (F and G: level 7; H: level 8; I:level 9) (from Verhoeven and Kranendonk 1996)

Chapter 3. Palaeoenvironment

3.1 Introduction

The environmental conditions at the end of the 6th and the beginning of the 5th millennium B.C. in Northern Syria are still not well known. Palaeoenvironmental indications have so far mainly been derived from past vegetation evidence retrieved through pollen and macrobotanical analyses. Because of the problem of locating pollen-bearing sediments such as peat or clay in areas with an arid or semi-arid climate, the pollen evidence from the Balikh valley itself is limited. Most of the information about the vegetation and climatic conditions comes from adjacent areas and is therefore only indirectly applicable to the area of study.

A further source of information on palaeoenvironmental conditions derives from animal remains. The faunal assemblages which provide more direct palaeoenvironmental information are those from early prehistoric sites in which animal domestication had not yet developed and men were more dependent on natural resources for their meat supply. Later, with the introduction of domestic animals 'man became a food producer' and began to be less dependent on the environment. Changes in domestic faunal assemblages were, therefore, less directly related to changes occurring in the environment (Buitenhuis 1990). Under human influence the relationship fauna-environment was inverted and domestic animals became a determinant active factor in environmental and vegetation modification. This would have brought about a rapid deterioration of the vegetation, which is supposed to have started already from the beginning of the domestication (Clason and Clutton-Brock 1982).

Due to their specific habitat, small mammals, such as rodents, and molluscs are usually good climatic indicators. However, due to their habit of digging deeply into the ground, rodents are not always contemporary with the layers in which they were found. Due to the lack of systematic sample procedures for environmental research, the molluscan assemblages from archaeological excavations are often the result of partial collections in favour of larger species. Because of their wide range and adaptability to different habitat conditions, large mammals such as herbivores, are less suitable climatic indicators. However, whereas large mammals do occur in prehistoric faunal samples, the other two categories are usually barely represented.

In order to understand which kind of environmental situation could have been present at Sabi Abyad during its occupation, this chapter will give a summary of the available evidence regarding the above categories. Three sets of data have been used, namely pollen, botanical and faunal samples in addition to a comparison to the modern situation.

3.2 Geomorphology

Sabi Abyad is located in the northern part of the Balikh valley near the modern village of Hammam-et-Turkman, in northern Syria. The valley, oriented north-south between the Syrian-Turkish border and Raqqa in the Syrian Euphrates area, is ca. 100 km long and about 3-5 km wide. It widens out in a broad and undulating plain, reaching a width of about 13/14 km near Hammam-et-Turkman.

The valley is shaped by two major land masses, the Holocene flood plain and the Pleistocene terraces (fig. 3.1). The flood plain consists of Holocene deposits of brown fluviatile-aeolic loams, 5-10 m thick, which cover deep alluvial, highly calcareous, clayey soils (Boerma 1988: 6). This region is relatively flat with deep ground water - mainly 4-9 m deep, locally 1.5-4 m - and is exploited nowadays for irrigated and rain-fed agriculture as well as stubble grazing (Boerma 1988: 5, table 2). The plain is bordered by steep gravel Pleistocene terraces rising 5-10 m above it. The terraces are formed by limestone and marl, gypsiferous rocks and cemented gravelly alluvia. These areas, characterized by a more undulating relief and by a degraded steppe vegetation, are mainly exploited for grazing. Owing mainly to its generally deep groundwater and the absence of surface water, the terraces are scarcely used for agriculture, possible only with the aid of irrigation (ibid.).

Although the Balikh nowadays tends to dry up during the summer, especially in its lower part, as a result of the exploitation of its water for irrigation, it represents the only perennial river of the valley. It originates in the Turkish Taurus mountains around Urfa and receives most of its water from the spring 'Ain al-Arous' which is fed by subterranean streams, draining the piedmont area near Urfa in Turkey (Boerma 1988: 2). Compared to the Euphrates the Balikh is a relatively small river characterized by a tight meander course and by a modest discharge of about 6 m^3/sec. up to 12 m3/sec. during the winter (Mulders 1969: 54).

Another perennial water source in the vicinity of Sabi Abyad may have been formed by the Nahr Slouq which received its water from springs located near the modern village of Slouq ca. 10 km northeast of Tell Sabi Abyad (Wilkinson 1996: 23; cf. fig. 2.1). From several profiles along the valley of the Slouq it appears that landscape features have been obliterated by sediments formed by a steady, low-energy silt-plain aggradation. The thickness of the sediments varies from ca. 80 cm to ca. 4 m as in the surroundings of Sabi Abyad (Akkermans 1993: 144; Wilkinson 1996: 13). For this reason there is little precise evidence for the landscape in the 6th millennium at the time of occupation of Tell Sabi Abyad.

3.3 Climate

The present climatic conditions of the area of study are characterized by a pronounced aridity. Situated in the subtropical high-pressure belt, in the rain shadow of the Lebanese and Taurus mountain ranges, and open to the influence of the Arabian peninsula, the climate of inland Syria is generally continental with hot and dry summers and relatively cold and humid winters (Mulders 1969: 15).

The Balikh valley, in particular, is located in an area of low annual precipitation with an average of little more than 300 mm. Characterized by a large variation during the year, precipitation occurs mainly in the forms of cloud bursts and (heavy) rainstorms that are concentrated in the winter months, January being the wettest one (fig. 3.2). In summer there is almost no precipitation and July and August are completely dry months (Mulders 1969: 17-18; table 1). Rainfall is moreover unevenly distributed along the valley, being almost twice the amount in the northern part close to the Turkish border (275 mm) when compared to the southern area of Raqqa (183 mm) (ibid.).

Almost in the middle of the valley, in the same area as Tell Sabi Abyad, the isohyet of 250 mm which is generally taken to represent the limit of rain-fed agriculture runs nowadays. More precisely, according to pedological researches this limit has been located approximately 5 km south of Tell Sabi Abyad in the vicinity of Tell Zkero (Wilkinson 1996: 22). The average annual rainfall around Sabi Abyad ranges from 250 mm to 400 mm which in general still allows local cultivation of winter cereals such as wheat and barley and of millet as a summer crop. However, hot and dry years may result in intensive crop failures (Wirth 1971: 20-21). These conditions will also have a direct and indirect influence on the availability of fodder, through limitation of the growth of natural vegetation and of stubble. The duality between the northern and the southern part of the valley was still visible in the patterns of population distribution in the nineteenth century, the north-western part of the valley being more permanently populated and used for rain-fed agricultural purposes while the southern part was less densely occupied by tent-villages of bedouins and agriculture necessitated irrigation (Lewis 1988: 688).

The average annual temperature in the Balikh valley is about 20°C. In the winter it is about 8°C and increases in the summer to a maximum of about 28° during the driest months of the year (Mulders 1969: 20; fig. 2 reported in fig. 3.2). These values, however, are extremely variable and the actual temperature can be much higher.

An important characteristic of the climate in this area is the aperiodicity, especially in terms of rainfall, in the course of the years, which is reflected in the changing limit of rain-fed agriculture, and in the intensity of animal husbandry, determining a high degree of risk. With only a few subsequent dry years the line of the 250 mm isohyet must be traced much further north (Wirth 1971, p.92) (figs. 3.3, 3.4) while a few months of bad weather (cold and snow) can threaten and destroy whole flocks (Lewis 1988: 689).

The major set of data about the climate in the past comes from pollen samples retrieved from mountainous areas. The pollen data from the three core samples of the Ghab valley, in Northwestern Syria, about 250 km from the Balikh valley (fig. 3.5), give evidence of a consistent increase in humidity represented by an increase in arboreal pollen - especially *Quercus cerris*-type/deciduous oak - at the beginning of the early Holocene, from about 10,000 B.P.[1] (Van Zeist and Woldring 1980). From this date until almost 9000-8000 B.P. a period of maximum humidity for the Holocene occurred. Another increase in humidity is suggested to have occurred in the mid-Holocene period (Van Zeist and Woldring 1980: 117-120). This view is supported by studies on the past climate of Saudi Arabia based on sea level fluctuations and the wadi aggradations which indicate two humid phases during the Holocene 9000-8000 B.P. and 7,000-4,500 B.P. divided by a drier period and characterized by an abrupt change to a hyper-arid climate about 6000 B.P. (Hötzl and Zötl 1978: 303). The pollen diagram from Lake Van in eastern Turkey indicates a period of dryness and low temperature, which prevented the growth of trees in favour of a steppe vegetation characterized by Chenopodiaceae, *Ephedra* sp . and *Artemisia* sp . from ca. 9800 B.P. to 6400 B.P. (Van Zeist and Woldring 1978; Bottema and van Zeist 1981). After this period, a considerable increase in humidity probably due to higher temperatures influenced the expansion of forest vegetation (especially oak) at the expense of steppe vegetation. The diagram from Bozova, in southern Turkey at about 100 km from the Balikh valley, indicates that no important changes in the climate have occurred in the last 3000-4000 years (Van Zeist et al. 1968 (1970): 37).

The increase in humidity during the early Holocene in southwestern Asia seems to have followed a south-north gradient. It occurred first in northern Israel (ca. 15,000- 11,000 B.P.), then in the Syrian part of the Mediterranean coastal area (ca. 11,000-9000 B.P.), followed by the Anatolian Plateau (ca. 7000 B.P.) and the Zagros Mountains, in which the modern climatic conditions - 'Zagros oak forest'- were established at about 5500 B.P. (Gremmen and Bottema 1991).

Other information on the past climate was collected from more southern and eastern areas. Remains of wild einkorn from Mureybit, nowadays growing on the Taurus mountains, suggest that moister conditions were present along the Euphrates at the beginning of the Holocene (Bottema 1989). The pollen diagram from Bouara indicates that modern climatic conditions were established in northeastern Syria for the last 6000 years. The low percentage of arboreal pollen, which probably came from the mountain area of the southern part of Turkey, in combination with high percentages of

[1] According to the original articles, uncalibrated (conventional) B.P. dates will be used only in this chapter.

Gramineae, Chenopodiaceae and *Plantago* sp., indicates a treeless environment characterized by steppe and desert-steppe vegetation (Gremmen and Bottema 1991: 110).

Similar conclusions, indicating a fairly constant climatic condition, were drawn from a pollen sample from the east bank of the Balikh (Gremmen and Bottema 1991: 111). This probably dates back to the Ubaid period but unfortunately due to the poor preservation of the organic content no precise chronological indications are available and correlation with the Bouara core is not possible. The pollen spectrum shows high values for non-arboreal pollen, mainly Chenopodiaceae (25-50%) together with Gramineae and Cyperaceae, whereas the percentage of arboreal pollen is very low (5%), *Pinus* being the most frequent taxon (2-4%). Another pollen sample was retrieved from the layer below the Ubaid occupation of the site of Tell Hammam (Gremmen and Bottema 1991: 111). This differs from the former (on the Balikh-east bank) in the dominance of *Artemisia* and in the low presence of Chenopodiaceae. The value of arboreal pollen is again low, consisting mostly of *Pinus*.

3.4 Vegetation

The Balikh valley is situated in an area of sparse steppe vegetation characterized by the presence of *Artemisia herba-alba*, Chenopodiaceae (*Noaea* sp.), Gramineae (*Stipa* sp.), Poaceae (*Poa bulbosa*, *Poa sinaica*) Leguminosae (*Astragalus* sp.), Compositae (*Plantago* sp., *Helianthemum* sp.) (Wirth 1971: 123; 133; Van Zeist and Bottema 1991: 31;45) (fig. 3.6). The present vegetation is the result of a marked degradation of the original natural steppe vegetation, principally due to overgrazing and human influence such as fuel gathering and extensive ploughing, which led to the disappearance of palatable plants in favour of *Artemisia*, Chenopodiaceae and other dwarf shrubs such as *Poa sinaica* and *Carex stenophylla* (Wirth 1971: 131-134; Bottema 1989: 4; Van Zeist and Bottema 1991: 45). The deterioration of the vegetation under human influence is a progressive, long-term process which started already in prehistory but mainly took place in the last 100-150 years. Guest (1966: 81) reports discussions of Bedouins from central Jezira in Iraq, who remember how the vegetation was much denser and lusher during their youth, the ground being covered by thickets of *Artemisia herba alba*, *Achillea* and *Haloxylon*, while salt bushes were in general more abundant.

The natural steppe vegetation covering the bordering plateaus of the valley was probably differently distributed in the past just as it is today. The most lavish vegetation is nowadays found on the northern and northwestern limestone plateaus while the gypsiferous eastern plateau is almost barren. The gypsiferous plateaus in the southern part of the valley are supposed to have been originally covered by a thicker steppe vegetation with grasses of about 50 cm height such as *Stipa*, *Agrophyrum* and *Festuca*, in which the presence of a sparse forest vegetation of *Pistacius* was probably favoured by more suitable edaphic and climatic conditions (Wirth 1971: 130).

Palaeobotanical investigations indicate that along the Balikh itself the natural vegetation during the early Holocene was represented by a riverine forest, dominated by poplar (*Populus euphratica*), willow shrubs (*Salix* sp.), tamarisk (*Tamarix* sp.) and dense reeds beds (Van Zeist et al. 1988; Gremmen and Bottema 1991: 106). Few remnants of this vegetation were till recently encountered in the Balikh valley which is nowadays extensively cultivated (Gremmen and Bottema 1991: 106; Bottema 1989). Apart from poplar, at Sabi Abyad charcoal of elm (*Ulmus* sp.) and ash (*Fraxinus sp.*) were found. This would indicate that these trees were present in the riverine forest. Remains of tamarisk were not encountered suggesting that this tree was not a common part of the natural vegetation of the Balikh valley (Van Zeist and Waterbolk-van Rooijen 1996: 539-540). Tamarisk was, however, a major constituent of the river-valley forest on the Syrian Euphrates (Van Zeist and Waterbolk-van Rooijen 1985). Sedge (*Carex* sp.) and club-rush (*Scirpus maritimus*) certainly constituted the herbaceous undergrowth along the Balikh together with spike-rush (*Eleocharis* sp.) (Van Zeist and Waterbolk-van Rooijen 1996: 540).

3.5 Fauna

Like the vegetation, so was the fauna drastically reduced in the last century. Until the first decades of this century one could still encounter in the Jezira onager (*Equus hemionus hemippus*), gazelle (*Gazella* sp.), Arabian oryx (*Oryx leucoryx*) and wild goat (*Capra aegagrus*) as well as wolf, (*Canis lupus*), Asiatic jackal (*Canis aureus*), striped hyena (*Hyaena hyaena*), cheetah (*Acinonyx jubatus*), desert lynx or caracal (*Caracal caracal*), Asiatic lion (*Panthera leo persica*), jungle cat (*Felix chaus*) and wild boar (*Sus scrofa*) (Hatt 1959; Talbot 1960; Harrison 1968; Thalen 1979). Onager, Asiatic lion, and Arabian oryx are nowadays completely extinct. Small herds of gazelle may be encountered in remote areas, cheetah disappeared. The other animals survived in low numbers. While the large mammals have been almost completely hunted to extinction, the smaller wild animals have largely survived. Fox (*Vulpes vulpes*), hare (*Lepus capensis*) jerboa (*Jaculus* sp.), gerbil (*Gerbillus* sp.) and hedgehog (*Erinaceus* sp.) are still common (ibid.). Large numbers of species of snakes and lizards also characterize the steppe animal life (Thalen 1979: 104; Krupp and Schneider 1991). In addition, a rich bird life, including birds of prey and large flocks of sandgrouse (*Pterocles* sp.), is still present (ibid.).

The early Neolithic (PPNA) sites of Mureybit and Abu-Hureyra are located along the Euphrates in the steppe area with a rainfall today of less than 200 mm a year. The faunal analysis of these sites revealed that the major game species were two typical steppe species: onager and gazelle (Ducos 1978; Legge 1975; Legge and Rowley-Conwy 1978). The dominance of onager followed by gazelle at Mureybit, compared to the absolute dominance of the gazelle at Abu Hureyra (up to 80%), is supposed to reflect an exploitation of different local environments (Buitenhuis 1990: 198). At these sites wild sheep, wild boar, aurochs and fallow deer are far less important species. While in the past the distribution of the wild sheep extended further south, its natural habitat has been located in the Taurus-Zagros mountains (Harrison 1968; Uerpmann 1987). This species is, therefore, present in sites such as Çayönü and Çafer Höyük located further north along the upper Euphrates and Tigris in the Turkish Taurus mountain (Lawrence 1980, 1982; Helmer 1985a, 1991). Although aurochs are more adaptable to various environments, they demand moister environments than the ovicaprids, onagers and gazelles, and a habitat with continuous vegetation (Ducos 1991a). They should have found their suitable habitat in the riverine forest along the Euphrates together with wild boar and fallow deer.

The percentage of onager and gazelle is abruptly reduced in later Neolithic sites (PPNB). Hayaz Höyük, Gritille, Abu Hureyra, Tell es-Sin and Bouqras show a high percentage of ovicaprids (up to 80%), independently from the area in which they are located (Clason 1979-80; Buitenhuis 1988, 1990; Stein 1989). In these sites a more direct relation with the environment can be seen in the spectrum of wild animals. Within these one still finds mainly onager and gazelle as typical steppe species and a variety of other animals from moister environments such as aurochs, wild boar, roe deer, red deer, and fallow deer. The combination of these varies according to the latitude. Therefore, at Hayaz Höyük located in the foothills of the Taurus Mountains, pig comprises 5% of the total assemblage, gazelle is scarcely represented (1 fragment), and deer 0.3%. At Bouqras pigs are less than 1%, gazelle is better represented (4.2%) and deer has a percentage 0.2% (Buitenhuis 1990: 199).

According to Bökönyi (1982: 154-5) a process of deforestation started in Anatolia during the 7th millennium and continued in the 6th millennium as indicated by the relative frequency of wild animals from northern Mesopotamian sites such as Abu Hureyra (ceramic neolithic level, beginning of the 6th millennium), Umm Dabaghiyah in western Iraq (middle of the 6th millennium), and Tell es-Sawwan on the right bank of the Tigris (end of the 6th millennium - beginning of the 5th millennium). At these sites, besides the predominant grassy steppe species such as gazelle and onager, species of the open forest or forest steppe (mainly aurochs) are still present while those typical of the dense forest such as red deer, roe deer and brown bear are remarkably reduced or are completely absent.

There are only a few faunal studies of sites from the Balikh valley itself which can provide palaeoenvironmental information. At the preceramic Neolithic of Sabi Abyad II[2], dated to the 7th millennium, hunting concentrated on gazelle while equid remains are completely absent (Van Wijngaarden-Bakker and Maliepaard, in press). At Tell Assouad situated on the east bank of the river Balikh and occupied in the late 7th and in the early 6th millennium shortly before Sabi Abyad, the percentage of gazelle is relatively high with ca. 40% of the assemblage, and onager is rare (Helmer 1985b). Late Halaf sites show a general increase of wild animals; Shenef has 32% onager and 3% gazelle remains, and Shams ed-Din on the Euphrates 42% onager and 7% gazelle (Uerpmann 1982; Hendrichs 1990). These differences may indicate local environmental changes towards a moister climate such as in the case of the absence of onager at Sabi Abyad II (Van Wijngaarden-Bakker, pers. comm.) and more aridity such as in the case of the increase of onager in the later period at Shenef and Shams-ed Din. At Shenef rodent remains were found that could be identified as *Meriones* and *Spalax* (Cavallo, forthcoming). The presence of *Meriones* at Shenef might indicate a drier climate (or an increasing human impact causing a drier vegetation) at the beginning of the 5th millennium, as suggested for the Tepe Ali Kosh sequence in which *Meriones crassus* is restricted to the latest phase while *Tatera indica* is distributed in the entire sequence with major incidence in the preceding phase (Redding 1978).

Birds are represented by a wide variety of species, although found in rather small numbers. Thus they can not furnish information in terms of relative percentage through time. The majority of them found in prehistoric sites on northern Syria are indicative of a moist environment such as heron (*Ardea* sp.), gargany (*Anas querquedula*), white-headed duck (*Oxyura leucocephala*), which live in dense undercovers, marsh and swamp pools bordered with willows and wet meadows (Clason and Buitenhuis 1978, Clason 1981). Indicative of wooded environments are sparrow hawk (*Accipiter nisus*), stock dove (*Columba oenas*), song thrush (*Turdus philomelos*) magpie (*Pica pica*), rook (*Corvus frugilegus*) whose preferred habitat must have been the dense cover of the riverine forest rather than the steppe (ibid.).

Although potentially good indicators of local environmental conditions, molluscs are also a category of finds usually poorly represented in faunal assemblages. At the prehistoric sites of Northern Syria freshwater bivalves, mainly *Unio tigridis*, and few freshwater gastropods are commonly found.

Summing up, the information about the Holocene climate in the Middle East, taken with caution because of the regional differences, indicates: (a) a moister period from the beginning of the Holocene until ca. 8000 B.P., i.e. before Tell Sabi Abyad was inhabitated; (b) establishment of the modern conditions since ca. 6000 B.P., i.e. after the inhabitation of Tell Sabi Abyad; and (c) lack of information for the period concerned, i.e. 6th and 5th millennium.

[2] Sabi Abyad II should not be confused with the Sabi Abyad (or Sabi Abyad I) which is the subject of this study. Both sites are part of a group of mounds which all bear the same general name (Khirbet Sabi Abyad) (cf. chapter 2.1). The archaeological sites are distinguished by a progressive number added to this name.

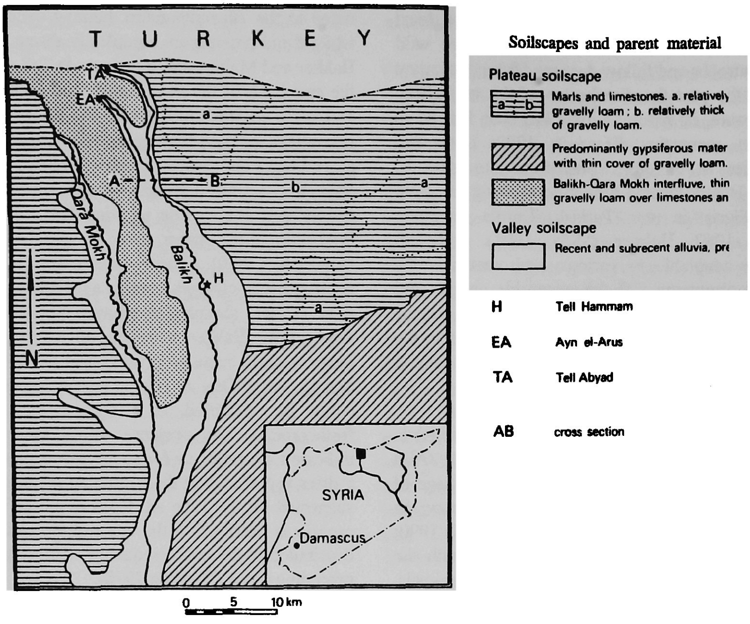

Figure 3.1 Map of the northern Balikh valley with soilscapes (from Boerma 1988, plate 3)

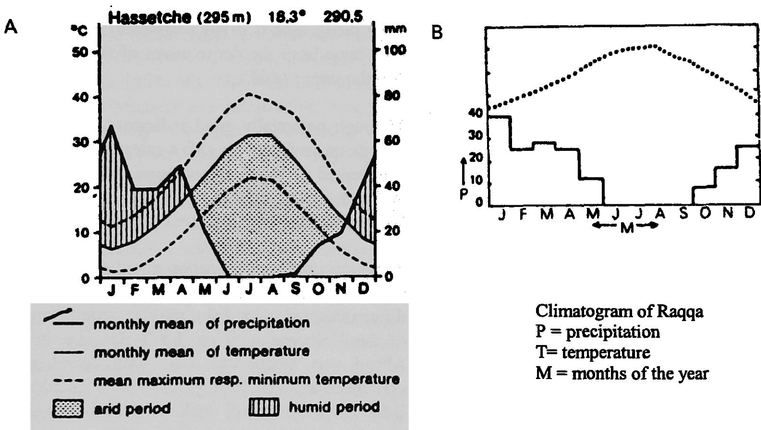

Figure 3.2 Temperature and precipitation histograms (from: A. Rösner and Schäbitz 1991, fig. 2; B. Mulders 1969, fig.2)

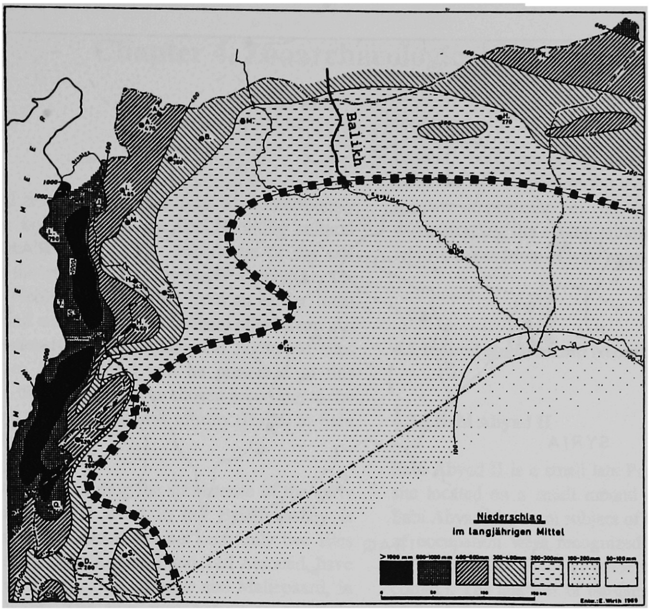

Figure 3.3 Long-term average precipitation in Syria (from Wirth 1971: map 3)

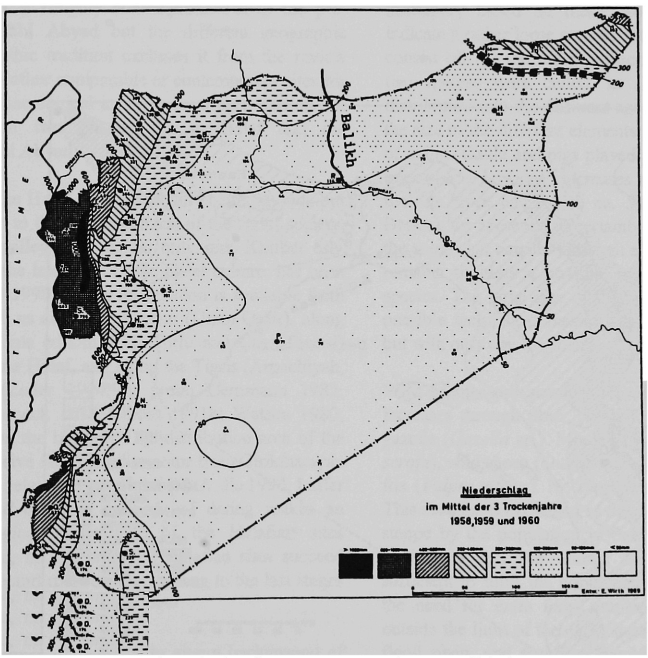

Figure 3.4 Average precipitations during three consequent dry years (1958, 1959 and 1960) in Syria (from Wirth 1971: map 4)

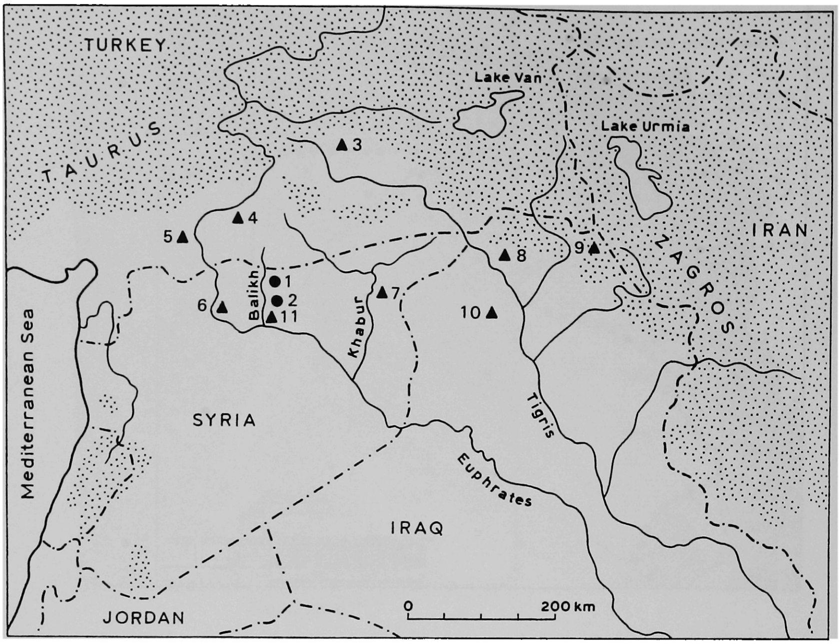

Figure 3.5 Location of pollen-core sites mentioned in the text

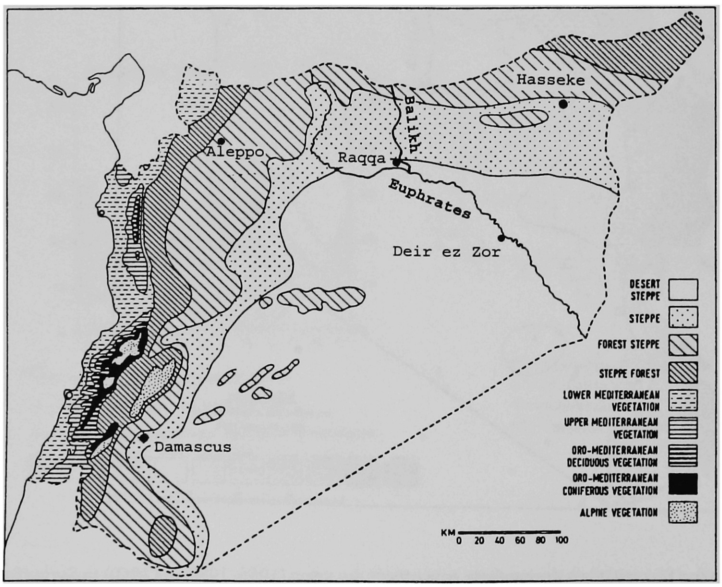

Figure 3.6 Map of the vegetational zones (from Bottema and Barkoudah 1979, fig.2)

Chapter 4. Zooarchaeological background

4.1 Introduction

The archaeological research at Sabi Abyad have enormously contributed to the knowledge of the late Neolithic cultural development in the Near East. The importance of the site consists mainly in the evidence that the Halaf society (i.e. the final stage of the Neolithic) developed from an earlier local Neolithic context and was not introduced from other areas. An overview of the extensive zooarchaeological studies of sites somehow related to Sabi Abyad will be presented in this chapter. Therefore, the sites have been chosen according to the area (Balikh valley) and their 'cultural' affinity (Halaf) to Sabi Abyad (fig. 4.1, table 4.1).

The present knowledge regarding the subsistence of the early Neolithic communities who lived in the Balikh valley is extremely poor as so far faunal remains from only two sites from the Balikh valley, Sabi Abyad II and Tell Assouad, have been analyzed (Van Wijngaarden-Bakker and Maliepaard, in press; Helmer 1985b). The two sites belong to an early Neolithic context, in which pottery is still completely absent (Sabi Abyad II) or has just been introduced (Tell Assouad). Therefore, they chronologically just precede Sabi Abyad. The site of Tell Aray 2 (Hongo, 1996) in the Orontes valley in northwestern Syria is roughly contemporaneous to the pre-Halaf levels of Sabi Abyad but the different geographic location and Neolithic tradition excludes it from the review here presented. No other comparable or contemporary sites for which also zooarchaeological analyses have been carried out exist for the first two phases, the pre-Halaf and the Transitional, of Sabi Abyad.

Faunal studies of the Halaf sites are slightly better known, but still few in relation to the vast expansion of the Halaf society. From the Balikh valley itself so far only one, Khirbet esh-Shenef, related to the late stage of the Halaf culture, has been studied (Hendrichs 1990). More information is available from adjacent areas such as along the Khabur (Umm Qseir), along the Euphrates (Shams ed-Din, Tell Turlu and Çavi Tarlasi) from middle and late Halaf, and along the Tigris (Arpachiyah, Yarim Tepe II) (Zeder 1994, in press; Uerpmann 1982; Schäffer and Boessneck 1988; Ducos 1991b; Watson 1980; Bibikova 1981). On the border of the distribution area of the Halaf culture extensive faunal studies come from Girikihaciyan and Banahilk, both related to late Halaf (McArdle 1990; Laffer 1983). The use of different methods of dating makes an absolute chronological comparison of the Halafian sites difficult. In general, all the analyzed Halafian sites succeed Sabi Abyad in time and most of them belong to the last stages of the Halaf culture.

The aim of this chapter is therefore to give a background of faunal studies and to place the material from Sabi Abyad in its context, both preceding and succeeding. For this reason attention will be paid to the identification of species and their relative importance in the assemblage, to the state of domestication, the ageing pattern, and to the presence and the relative importance of wild animals.

4.2 Faunal studies from Neolithic sites of the Balikh valley

4.2.1 Sabi Abyad II

Sabi Abyad II is a small late Pre-pottery Neolithic B (PPNB) site located on a small mound close to the larger mound of Sabi Abyad, the main subject of this dissertation. Three phases of occupation were recognized which lasted from ca. 6500 B.C. to 6000 B.C. (Verhoeven 1994; Akkermans, pers. comm.). The analysis of the faunal material consists of a total of 2821 fragments of which 53.5% could be identified (Van Wijngaarden-Bakker and Maliepaard, in press). The domestic species amount to more than 90% of the identified material. Sheep and goats are largely predominant in all phases (85-90%). This high percentage points to a well established animal husbandry based on these two species, but other aspects indicate a rather loose control of the herds. These other aspects consist of: (1) the rather indiscriminate fashion in which the two species were culled, as shown from the fairly even distribution into the different age groups; (2) the variability of the size of the different elements; (3) the fairly high proportion of males. Cattle and pigs played a definitely minor role. Their importance, however, increases throughout the occupation of the site from ca. 2% to ca. 5% of the identified remains. Besides the presence of certainly two specimens of wild boar, the somewhat smaller although still rather large size of the pig remains suggests a possible incipient domestication for this species. The large size of the bovid remains also points to a possible incipient domestication of cattle. The dog is present but with only one fragment.

Wild species are scarcely represented, but their importance increases through time. The wild spectrum comprises mainly gazelle (*Gazella* sp.). Minor game animals are wild boar (*Sus scrofa*), wild sheep (*Ovis orientalis*), badger (*Meles meles*) and fox (*Vulpes vulpes*). No remains of equids were encountered. This absence is explained as a lack of direct exploitation of the steppe by the population of Sabi Abyad II. The local cereal cultivation and the animal husbandry would have been sufficient to fulfil the population's food requirements without the need for extra food supplement. The steppe would lie outside the limit of the agricultural activities, conducted in the flood plain, and therefore would not have been part of the normal agricultural patterns.

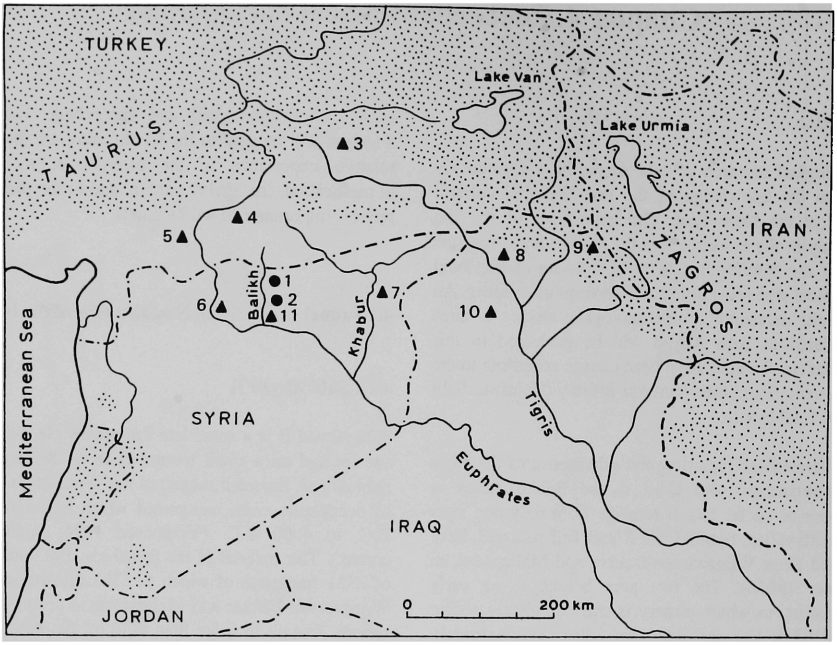

Figure 4.1 Localization on the sites reviewed
1 Tell Assouad; 2 Sabi Abyad II; 3 Girikihaciyan; 4 Çavi Tarlasi; 5 Tell Turlu; 6 Shams ed-Din; 7 Umm Qseir; 8 Arpachiyah; 9 Banahilk; 10 Yarim Tepe II; 11 Khirbet esh-Shenef
● early Neolithic site
▲ Halaf site (late Neolithic)

site	time of occupation	period(1)
Çavi Tarlasi	middle 5th mill.	Late Halaf
Khirbet esh-Shenef	middle 5th mill.Late	Late Halaf
Banahilk	middle 5th mill.Late	Late Halaf
Girikihaciyan	5000-4500 B.C.	Late Halaf
Tell Turlu	first half 5th mill.	Late Halaf
Shams ed-Din	first half 5th mill.	Late Halaf
Umm Qseir	mid-5th mill.	Late Halaf
Yarim Tepe II	early half 5th mill.	Middle-Late Halaf
Arpachiyah	early half 5th mill.	Middle-Late Halaf
Assouad	half 7th mill.(2) late 7th-begin.6th mill.(3)	PPNB-Ceramic Neolithic
Sabi Abyad II	7th mill.	PPNB

(1) mainly based on Akkermans (pers. comm. and 1993)
(2) Cauvin 1974
(3) Akkermans, Le Mière 1992

Table 4.1 Chronological and "cultural" sequence of the sites reviewed

4.2.2 Tell Assouad

Tell Assouad is located in the Balikh valley at about 10 km northwest of Sabi Abyad. The site was first excavated by Mallowan (1946) in the thirties and re-excavated a few decades later by Cauvin (1972). The latter investigation revealed levels (VIII-VII) with ceramics but without architecture, covered by levels (VI-I) with architectural features on a limited scale (test-trenches only) but without ceramics. The site is dated to the middle of the seventh millennium (Cauvin 1974). According to Akkermans (1991, 1993) more recent radiocarbon dates from the nearby site of Damishliyya with identical ceramics point to contemporaneity between the two sites, thereby dating Tell Assouad to the end of the seventh millennium and the very early part of the 6th millennium. Until now, apart from Sabi Abyad II, Tell Assouad is the only other site of the Balikh valley prior to Sabi Abyad from which the faunal material has been studied (Helmer 1985b).

However, the animal remains of the Mallowan expedition were analyzed by Bate and only a small account of her analysis was reported by Mallowan (1946: 124). Bate identified sheep and/or goat, pigs, medium to large-size ox and a small *Equus*. Except for the small Equus, which was related to the Syrian small onager *E. hemionus*, the other species were thought to be domesticated.

According to Helmer, on the contrary, domestication could be established only for a few species. Goats, and most likely sheep as well, were the only two domesticated species, with a slightly stronger representation of the former. Together they represent 60% in the first levels (VIII-VII) and their percentage increases in the later levels, up to 79.5% in level I. The determination of their domestic status was obtained in a different way for the two species: on the basis of the morphological characteristics of the horncores, which show a torsion typical of domestic animals, and on the reduction in size of the animals due to the domestication in the case of the goat; and on the basis of the statistical evaluation of the age classes for the sheep (ibid.: 279; 281).

The domestic status of bovids and suids is not attested. The size of the bovid and suid bones points to the presence of the wild counterparts, the aurochs and the wild boar. However, the latter seems to be of quite a small type and for this reason it is hypothesized that it could represent an initial stage of domestication.

The scenario of the wild game is completed by the other animals such as cervids, deer (*Cervus elaphus*) and fallow deer (*Dama sp.*), one species of antelope, the gazelle (*Gazella sp.*), and equids, tentatively identified as wild ass (*Equus* cf. *africanus*). In addition two small carnivores, the badger (*Meles sp.*) and the fox (*Vulpes vulpes*) are present, as well as remains of canids (*Canis sp.*). The importance of hunting seems to have increased and to have been especially important in the levels VI and V. Hunting was based particularly on gazelle, followed by wild boar and aurochs. However, from 40% of the level VI-V sample, gazelle was reduced to 3.9% in level I.

Summing up, the faunal study (based on 815 identified specimens) of the Tell Assouad bones gives a picture of an animal economy in which the domestic process has not reached all the potentially domesticable species and the ovicaprids assume a definitely predominant role in the later levels of occupation at the expense of the gazelle, which remains the species hunted most (Helmer 1985b: 283; fig. 3).

4.3 Faunal studies from Halafian sites

4.3.1 Arpachiyah

Arpachiyah is a small Halafian site on the east bank of the Tigris in the Mosul region in Iraq and dated to the early half of the 5th millennium B.C. The site was first excavated in 1932 by Mallowan (Mallowan and Rose 1935) and subsequently re-excavated by Hijara in 1976 (1980). From this last season of excavation a short account on the faunal remains has been published by Watson (1980).

Domestic sheep, goat, cattle and pigs, which constitute the largest part of the sample, were identified. The wild vertebrates are represented by a few gazelle bones and a single tooth of ass or onager. In addition a few bones of large canids, a single fish vertebra and a large quantity of frog bones in a jar were found. No absolute number of fragments is given and therefore no ratio between domestic and wild animals could be calculated. The domestic species, however, predominate to a large extent over the scarcely represented wild species.

Within the four domestic species, the faunal sequence shows a sharp increase first of pigs followed by cattle. However, the proportions were calculated for a very small sample of selected parts of the skeleton: in total 248 fragments divided in four phases!

A different preservation between the "work" and the "residential" (tholoi) areas of phase C was observed. Cattle bones were less frequent in the latter areas indicating that this part of the settlement was cleaned regularly.

Information on the age at death of the domestic species is also available. Some sheep and goats were killed at an age of more than three years, but half of the mandibles belong to individuals younger than two years. Cattle were killed before their third year, pigs mainly younger than one year and only few above this age.

4.3.2 Yarim Tepe II

Yarim Tepe II is situated on the western bank of the Wadi Joubara Diariasi in the Sinjar plain in northern Iraq. Several

Russian excavations have unearthed a number of rounded and rectangular buildings of a permanently occupied Halafian settlement dated to the early half of the 5th millennium (Munchaev and Merpert 1981). The faunal sample amounts to 2184 identified mammal fragments with a low percentage of unidentified fragments (15%) (Bibikova 1981).

Although four occupational levels were found, the faunal sample was considered as a whole because the same type of conservation and no differences in the numbers and percentages of species existed between the different levels.

Sheep, goat, cattle, pig, dog and donkey represent the domestic species, which amount to 87.5% on the basis of the number of fragments. The last species, however, is a questionable identification: donkey appears only in the third millennium B.C. and has been identified in no other Halafian or Neolithic fauna assemblages.

Among the domestic animals, sheep and goats are the more numerous with a ratio of 2 sheep for 1 goat. The low percentage of pigs (14.7%) has been correlated to the bad state of conservation because they are represented by young individuals. Cattle are only slightly less frequent than pigs, 11% and ca. 12% respectively in the number of fragments.

The high percentage of cattle killed young (40%) excludes their role as beasts of burden. It has been calculated that 35% of the meat production derived from sheep and goat. Due to the low representation of young individuals these two species were interpreted to have been used for their secondary products as well, among others wool, milk and leather.

The occurrence of wild animals is rather low. Among them onager (*Equus hemionus*) was the predominant species, followed by the gazelle (*Gazella subgutturosa*). Wild sheep (*Ovis ammon*) and goats (*Capra aegagrus*) were present in a lower quantity. In addition a few remains of jackal (*Canis aureus*), tiger (*Panthera tigris*), badger (*Meles meles*) and porcupine (*Hystrix leucura*) were found. Only one bone of a bird (*Anser sp.*) was found.

4.3.3 Umm Qseir

Umm Qseir is a small Halafian site located on the middle Khabur basin in northeastern Syria. The occupation probably lasted for not more than 200 years in the first half of the 5th millennium (Hole and Johnson 1986-87). Three phases of occupation were recognized: 1) an ashy midden deposit 25 cm thick directly on the virgin soil; 2) a middle level with traces of a round structure (tholos); 3) another midden layer above the tholos no longer in use (Hole and Johnson 1986-87). The site was first interpreted as a small temporarily occupied pastoralist site (Hole and Johnson 1986-87). However, this interpretation has been questioned on the basis of the study and interpretation of the faunal remains, in particular of the culling patterns of ovicaprids and pigs, which suggest a year-round occupation of the site (Zeder 1994).

The faunal assemblage (2446 identifiable fragments, of which 35% have been identified) is characterized by a low representation of domesticated animals (37%-54%). Domestic cattle are completely absent. The percentage of sheep and goats, which are the best represented domestic species, remains constant but with a slight decline in the last two phases. In contrast, pig bones clearly increase in the last two Halafian levels.

The size of the ovicaprids is reported to be similar to contemporary sites in the region, whereas the size of pigs is definitely small. The mortality curve of the ovicaprids gives an indication of all-year-round occupation: a low mortality in the first 6 months and a first peak between 6-12 months old (17%) and a second peak between the 2.5 and 4 years old (54%), followed by a gradual decline of animals killed at an older age. This pattern was correlated to the period of the year in which the animals would have been killed: some sheep and goats were killed in the summer/autumn season around the end of their first and the second year. The remaining ovicaprids would have been raised for their meat and killed at the age of major meat yield (2.5-4 years old), at the moment when pasture became scarcer in the late dry summer and early rainy season (autumn).

The presence of pig remains and their mortality pattern suggest that these animals were reared at the site, ruling out the hypothesis of a pastoralist community. In particular, pigs were killed in all seasons of the year and mostly young: between birth and two years old with peaks around six months old and in the first half of their second year, whereas fewer, but still present, are those killed in their third and fourth years and beyond.

Remarkable is the heavy dependence on wild game rather than domestic flocks, which increases through time, from 46% in the first phase to more than 60% in the last two phases. The gazelle, reaching almost 50% of the primary meat species, dominates the large spectrum of wild animals. The other main hunted species was the onager (*Equus hemionus*). Aurochs (*Bos primigenius*) and cervids, mostly fallow deer (*Dama mesopotamica*) and red deer (*Cervus elaphus*) were also hunted, but less frequently. Surprisingly the wild boar, which probably inhabited the same riverine-humid environment as cervids and aurochs, was not hunted. Carnivores comprise fox (*Vulpes* sp.), wolf (*Canis lupus*), hyaena (*Hyaena* sp.). Hare (*Lepus capensis*) was hunted as well. Birds, turtle, fish and molluscs are present but in small quantities. Riverine resources have played only a minor role in the diet.

The study of the mortality pattern of the gazelle provided information on the hunting habits of the population who inhabited Umm Qseir. It has been calculated that 40% of the gazelle were killed as adults, which corresponds to a generalized hunting strategy pattern. Early spring hunting of gazelle is suggested by the presence of almost all lower fourth milk premolars in an advanced wear stage, which corresponds to about one year of age, and is confirmed by the pattern obtained from the fused state of growth of the calcaneum.

4.3.4 Shams ed-Din

The site of Shams ed-Din is located on the left bank of the middle Euphrates on a lower river terrace on the border of the now flooded area of the Tabqa Dam. The ancient village, characterized by round houses, was occupied for a short time towards the end of the Halaf period, as indicated by the pottery, which is wholly assignable to the late phase of the Halaf culture (Davidson 1977: 223).

The faunal sample accounts for a small amount of identified bones (1396) with a rather low percentage of unidentified fragments (19.3%) (Uerpmann 1982).

The percentage of domestic animals is rather low (46% of the identified remains). The domestic species are dominated by sheep and goats, followed by cattle and pigs. The small size of the sample limits the information about the characteristics of these domestic herds. Sheep and goat, as well as cattle, are considered to have been a uniform population of animals of rather large size comparable to that of contemporaneous sites in the same area. The size of the pigs could not be assessed because of their young age.

Age indications are provided only for the ovicaprids. These animals were slaughtered mostly in their fourth year. This mortality pattern points to a rearing of these animals mostly for meat. However, even if there is not definitive bone evidence, this does not exclude the possibility of another utilization such as for wool production as suggested from other archaeological finds.

The faunal assemblage is characterized by a high percentage of wild animals (ca. 54% of the identified bones), mostly onager and to a lesser extent gazelle, followed by fallow and red deer, and wild boar. The presence of aurochs is not definitive, even if some large specimens most likely belong to this species. Unique is the identification of water buffalo (*Bubalus sp.*). Fox and wild cat are the only carnivores present in the assemblage. Some bird remains were found, probably belonging to the white stork (*Ciconia cf. ciconia*). One single specimen of freshwater mussel (*Unio tigridis*) was retrieved.

4.3.5 Tell Turlu

Tell Turlu is situated on the upper Euphrates in southwestern Turkey. The site is dated to the first half of the 5th millennium and is related to the middle and late phase of the Halafian culture (Breniquet 1991). The site, which represents one of the most northwestern Halafian sites, is characterized both by circular architecture (tholoi, levels I-II-VI) and by rectangular architecture (level V).

A small amount of faunal remains (123 identified) were studied (Ducos 1991b). The domestic species are represented most (95%).The sample shows a predominance of ovicaprids, which amount to ca. 50% of the sample. The other domestic animals such as pig and cattle are also well attested with a percentage of 25% and 10% respectively. In addition, a few fragments of *Canis* (0.8%) were identified.

Within the ovicaprids, goat remains predominate. However, because no systematic methods for distinguishing *Capra* from *Ovis* were applied, the identification of *Capra* is based on the horncores while that of *Ovis* is based on the metacarpi. Given the better preservation of goat horncores versus sheep ones, this ratio is hardly reliable.

The size of *Capra* horncores is slightly inferior to that of the wild *C. aegagrus* whereas the size of sheep metapodials is definitely smaller than that of the wild *O. orientalis* (cf. Mureybit).

Most of the ovicaprids were killed between their second and third year. The small number of bovid fragments could not provide any information about the age of death whereas the pig remains give an interesting and unusual evidence of animals killed quite old at the age of 2 to 5 (ca. 50%).

Among the wild animals few species are represented: *Bos primigenius*, *Dama mesopotamica*, *Gazella* sp.. No equid remains were found.

4.3.6 Girikihaciyan

The site of Girikihaciyan is a settled farming village located on the upper part of the Tigris in southeastern Turkey which was occupied around the middle of the 5th millennium (Watson and LeBlanc 1990).

The faunal sample (2132 fragments) is predominated by domestic ovicaprids (ca. 60% of the identified sample), followed by pigs (17%) and cattle (15%) (McArdle 1990). Domestic dogs were fairly common.
Almost half of the ovicaprids were killed young, before the end of their second year. Additionally almost 40% was killed at an adult but not advanced age. The small percentage which survived was killed mainly in their advanced age (11%) and only few old animals (4.4%) were kept, probably as breeding stock.

A mortality pattern similar to the ovicaprids is shown by pigs, two-thirds of which were killed before the end of their second year. In contrast, cattle shows a different pattern. These were killed mainly (51%) at an adult age, when they were probably three years old or more. It is tentatively suggested that this pattern might reflect a keeping of cattle for other purposes than larger meat/protein yield. Although no clear evidence is available, it has been suggested that they could have been used for traction and milk.

Hunting definitely played a minor role. The wild spectrum is characterized by the presence of fox (*Vulpes vulpes*), probably hunted mainly for its fur, and of red deer (*Cervus elaphus*). The equids are scarce, probably represented onager (*Equus hemionus*), whereas gazelle is completely absent. Wild goat, wild sheep and aurochs (*Bos primigenius*) were also hunted. Hares (*Lepus*), birds (probably partridge), tortoises (*Testudo graeca*), fish and molluscs (*Unio tigridis*) completed the diet.

4.3.7 Banahilk

Banahilk is a small late Halafian site dated to the middle of the 5th millennium. The settlement is located on a plain along the Zagros mountains in northern Iraq. It represents the most eastern Halafian site. Although small, the village is considered to have been permanently occupied because the mortality patterns do not show any evidence of seasonal occupation (Braidwood et al. 1983). A small faunal sample has been studied. It consists of 962 bones, from which 810 were identified, resulting in a low percentage of unidentifiable fragments (15.8%) (Laffer 1983).

People at Banahilk strongly relied on domestic animals, which comprised more than 90% of the identified remains. The four main species (sheep, goat, cattle and pigs) are considered to have been fully domesticated. Their domestic status is mainly based on the size and on the survivorship patterns: 47.5% of the ovicaprids survived beyond approximately four years old, 14% of pigs beyond their third year as did 25% of the cattle. The domestic status of the canids is excluded, because of the small number of specimens and the lack of a positive identification and of any gnawing evidence.

Within the wild species, few wild sheep and goat were identified on the basis of the horncore shape. Although with some uncertainty a few specimens of wild cattle were identified. There is evidence of the presence of red deer (*Cervus elaphus*), roe deer (*Capreolus capreolus*), red fox (*Vulpes vulpes*), brown bear (*Ursus arctos*), leopard (*Felis pardus*), and hedgehog (*Erinaceus* sp.), birds and fish. A considerable amount of shells of a land snail (*Helix salomonica*) were found in large concentrations in different parts of the settlement.

The absence of both gazelle and onager is not surprising because the site is located on a plain accessible only through narrow gorges or over high mountains, representing an unlikely area for wild equids.

4.3.8 Khirbet esh-Shenef

Khirbet esh-Shenef is a small site located at ca. 5 km southwest of Sabi Abyad in the Balikh valley. The small trench excavations have revealed only round buildings (tholoi). The site was repeatedly but shortly occupied around the middle of the 5th millennium, corresponding to the late Halaf phase. Two main phases of occupation were recognized. So far only the faunal remains of the 1988 campaign have been studied (Hendrichs 1990). The sample amounts to 485 fragments, of which 99 belong to a partial skeleton of a badger, *Meles meles*.

The faunal assemblage of Shenef is characterized by a small spectrum of species. Among the identified remains which correspond to 28.4% of the total sample, sheep and goat, pig and badger could be identified to species level. *Bos* is represented by only three fragments and their degree of fragmentation hampered a further identification. The equid remains were attributed to the onager (*Equus hemionus*). As both horncores and measurable bones were absent, the species level of the gazelle could not be established.

Although ovicaprids predominate (44% of the identified sample), the percentage of wild animals is rather high (36%). Hunting seems to have been concentrated mainly on the onager, whose remains correspond to 32% of the identified assemblage, and to a lesser extent to the gazelle (17%). Completely missing are carnivores, rodents, birds and fish. However, the reason of this absence can be attributed to the recovery methods as well as to the rather small size of the sample.

4.3.9 Çavi Tarlasi

The site of Çavi Tarlasi is located on the upper Euphrates in southwestern Turkey. It is dated to the middle of the 5th millennium and it is related to the late Halaf culture. Çavi Tarlasi is a large settlement permanently inhabited for 200 years by ca. 100-150 persons (Schäffer and Boessneck, 1988).

A detailed study of more than 5000 remains, of which ca. 70% could be identified, has been carried out. The animal economy seems to have been based on husbandry, whereas hunting, despite the rich list of species, played a minor role (only ca. 2%).

The animal husbandry was focused on cattle of large to middle size. The mortality data of the bovids indicate that these were kept for meat production and not for milk or traction. They were killed mostly at a young and subadult age; only a few were kept into adulthood and killed after their third year.

Among the ovicaprids, sheep seem to have been outnumbered by goats, but this is based on the horncores. On the basis of the shape of horns and occipital bones, it could be established that predominantly males were killed and that, therefore, the live herds consisted to a large extent of females. They were primarily reared for their meat and skin, whereas milk production seems to have played a secondary role. Almost 50% of the ovicaprids were killed young before they reached their second year. Of this 50%, almost 30% were lambs and 15% yearlings. Of the other 50% older than two years, the majority were killed with the third molar showing a low degree of wear, a few at an older or at a very old age.

The domestic pigs, clearly distinguished from the wild ones by their size, were reared for their meat as could be concluded from the age at which they were killed: at least half of the pigs were killed at an age of 6-9 months; the rest was killed in equal quantities in their second and in their third year. The sample revealed a high quantity of females, probably killed after having had at least one litter.

Hunting played a minor role in the economy of the site. The animal hunted most was the wild boar, followed by onager (*Equus hemionus*) and gazelle (*Gazella subgutturosa*) of equal importance. Except for the genus *Ovis*, the wild counterparts of the domestic animals were also identified, i.e. wild goat, aurochs and wild boar. Compared to other Halafian sites, fallow deer (*Dama mesopotamica*) and red deer (*Cervus elaphus*) are relatively well represented.

The wild spectrum is enlarged by several other species, such as fox, brown bear, wild cat among the carnivores, and hare (*Lepus capensis*), Persian squirrel (*Sciurus anomalus*), beaver (*Castor fiber*), white-toothed mole-rat (*Spalax leucodon*), among the rodents. In addition, water tortoise (*Mauremys caspica*) and land tortoise (*Testudo graeca*) were identified as well as a crab (*Potamon sp.*) and two species of molluscs (*Unio crassus* and *Unio tigridis*).

4.4 Summary

The faunal assemblages from the reviewed sites show extreme variability. They vary in the size of the samples, from more than 5,000 to a few hundred fragments, generally resulting in a small amount of identified remains. The relative percentage of identified versus unidentified fragments also varies considerably, from 15% to almost 90% (fig. 4.2). The estimation of the representativeness of the material and its interpretation are highly subjective and may differ from author to author. The major factor which contributes to a high percentage of unidentified remains is the high degree of fragmentation, as was the case at Girikihaciyan, where, despite the 'excellent' preservation of the material, ca. 85% of the faunal material could not be identified. Sites from more arid (steppe) areas are also characterized by a high percentage of unidentified fragments, such as Shenef (71.7%) and Umm Qseir (65%). Shams ed-Din, from the same kind of environment, has a much lower percentage (19.3%) of unidentified fragments. Other factors influencing the nature of the sample and the consequent degree of identification are certainly the methods of recovery. Apart from sites excavated at the beginning of this century, selection during excavation, pre-sorting, sieving etc. might still play an important role. Also the subjectivity, experience and confidence of the analyst in attributing the fragments to a more specific or more general category probably cannot be completely ruled out. Most likely the expected and normal percentage of unidentified remains for a site from the studied area lies around 70%, if we take the site of Umm Qseir as an example, where the material was sieved with a 1/4 inch mesh, but had been pre-sorted at the site.

The majority of identified fragments belong to domestic species. However although attested at all the sites, the importance of husbandry is rather variable. The Pre-pottery Neolithic site of Sabi Abyad II shows a rather constant high percentage of domestic ovicaprids and possibly cattle and pigs. Nearby Assouad, however, presents more fluctuations within the separate levels, with a generally lower percentage of domestic animals than at Sabi Abyad II, and the restriction of the domestic status to *Capra* and possibly *Ovis* and *Sus*. Whereas the domestication of the ovicaprids is well attested, the domestication of cattle and pigs at these two sites is at an incipient level.

Surprisingly enough, where one would expect a well established agrarian economy with fully domesticated ovicaprids, bovids and suids, the importance of husbandry at the 6th and 5th millennium sites is sometimes reduced and at sites such as Umm Qseir and Shams ed-Din wild species are even predominant (fig. 4.3). A kind of dichotomy is observable especially in the late Halaf, with sites in which domesticated species definitely predominate and sites with a relatively high percentage of wild species such as Shenef. This distribution seems to be correlated to the location of the sites and consequently to their environment (fig. 4.3). Sites located more in the north are those characterized by a high percentage of domesticated animals. Sites situated in the more arid southern steppe present a higher hunting component (cf. chapter 7.6).

The relative frequency of domestic species varies considerably (fig. 4.4). The dominant domestic species are sheep and goats. Sheep seem to predominate over goats with a ratio varying from circa two to four sheep for one goat. The exception is Sabi Abyad II with a ratio of sheep to goat of ca. 13:1. Cattle are not always present (Umm Qseir) or their status is not defined (Shenef). At other sites the importance of cattle is very high, as in Çavi Tarlasi, or as in Shams ed-Din, where their occurrence largely outnumbers that of pigs. Sabi Abyad II and Shams ed-Din are the only sites with a low percentage of pig remains. At the other sites the percentage of pigs is fairly constant (18-22% of the domestic species). Where a difference in phases was present, the number of pigs increased through time, as at Sabi Abyad, Umm Qseir and Arpachiyah.

When it is attested, the exploitation of the domestic animals is mainly for their meat. There is no specific evidence for the use of milk or wool. The considerations about the principal use of the domestic animals are drawn from their mortality patterns. More information is present for sheep and/or goats, for which in most cases a mortality curve could be reconstructed (summarized in fig. 4.5). However, the comparison of the mortality patterns is hampered by the different methods of evaluating the age at death. The common characteristic is that ovicaprids were not kept to old age, but that the majority of them was killed probably before their fourth year. More variations are present in the younger age classes, i.e. the very young and subadult ones. The difficulty in comparing these categories is also enlarged by the different age class divisions. Due to the small sample, the mortality data of cattle are rarely given. With the exception of Tell Turlu in which ca. 50% were killed between 2-5 years, pigs are usually said to have been killed young.

Estimation of the size of the animals is usually hampered by the sample size and the state of fragmentation of the material, which often results in limited osteometric data. Ovicaprid sizes are rarely defined. Cattle are generally of middle-large size. Pig size is variable. The possible occurrence and consequent overlapping of the wild counterparts makes it difficult to establish with certainty the ratio between wild and domestic animals and the limit of the size of the two populations.

There is also considerable variation in the importance, number and type of wild species (fig. 4.3, table 4.2). Already from the early Neolithic of the Balikh valley, Assouad shows a relatively high percentage, whereas for Sabi Abyad II it is low. More unexpected is the relatively high percentage of wild fauna at later sites such as Shams ed-Din, Umm Qseir, Shenef, in a general pattern in which a high state of domestication is reached and agriculture is widely attested and predominant. This variation might be related to the kind of sites, occupied permanently and for a long period, such as Tell Turlu and Çavi Tarlasi, or briefly occupied such as Shenef, as well as to the environment. The sites with higher percentages of wild animals are those in the more arid areas. Within the large and variable spectrum of species, gazelle and onager are the main hunted species. Their relative importance, however, varies and sometimes one of them is completely absent. This cannot always be explained as related to the environment, as these are steppe species. The areas exploited as hunting grounds were probably also determinated by the type of economy and the location of the site. Other wild species were also variable and probably were not all part of the diet as some carnivores as well as hare and bear might also have been hunted for their fur.

	Gazella	Equus	Bos	Sus	others
Çavi Tarlasi	-	sp.	+?	-	+
Shenef	+	+	sp.	-	+
Banahilk	-	(sp.)*	+?	-	+
Girikihaciyan	-	+	+	-	+
Tell Turlu	+	-	+	-	+
Shams ed-Din	+	+	+	+	+
Umm Qseir	+	+	+?	+	+
Yarim Tepe II	+	+	-	-	+
Arpachiyah	+	sp.	-	-	+
Assouad	+	+	+	+	+
Sabi Abyad II	+	-	-	+	+

* probably intrusive

Table 4.2 Wild species distribution at the early Neolithic and Halaf sites reviewed

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Çavi Tarlasi	+	+	-	-	-	-	+	+	-	-	-	-	+	+
Shenef	-	-	-	+	-	-	-	-	-	-	-	-	-	-
Banahilk	-	+	+	-	sp.	-	-	+	-	-	+	-	-	-
Girikihacyan	-	+	-	-	-	-	+	-	-	-	-	-	-	+
Tell Turlu	+	-	-	-	-	-	-	-	-	-	-	-	-	-
Shams ed-Din	+	+	-	-	-	-	-	-	-	-	-	-	+	-
Umm Qseir	+	+	-	-	+	-	sp.	-	sp.	-	-	+	-	+
Yarim Tepe II	-	-	-	+	-	+	-	-	-	+	-	-	-	-
Arpaciyah	-	-	-	-	?#	-	-	-	-	-	-	-	-	-
Assouad	sp.	+	-	sp.	-	-	+	-	-	-	-	-	-	-
Sabi Abyad II	-	-	-	+	-	-	+	-	-	-	-	-	-	-

"large canids"

1 *Dama mesopotamica/dama*, fallow deer
2 *Cervus elaphus*, red deer
3 *Capreolus capreolus*, roe deer
4 *Meles meles*, badger
5 *Canis lupus*, wolf
6 *Canis aureus*, jackal
7 *Vulpes vulpes*, fox
8 *Ursus arctos*, brown bear
9 *Hyaena*, hyaena
10 *Panthera tigris*, tiger
11 *Felis pardus*, leopard
12 *Felis lynx*, lynx
13 *Felis silvestris*, wild cat
14 *Lepus capensis*, hare

Table 4.2 (continued) Wild species distribution at the early Neolithic and Halaf sites reviewed

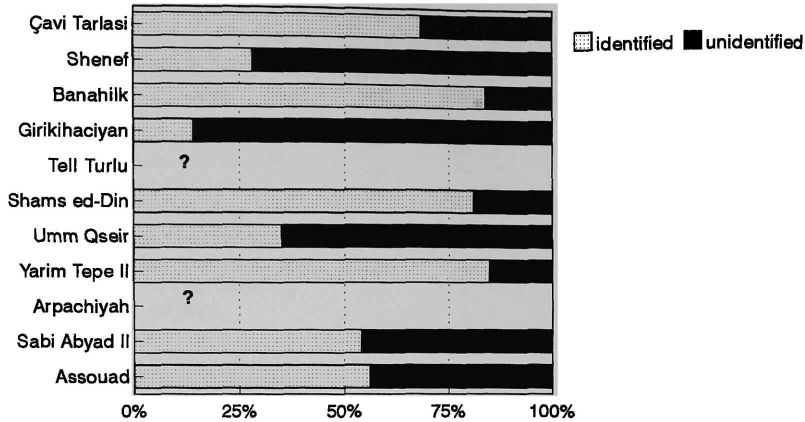

Figure 4.2 Percentages of identified versus unidentified remains

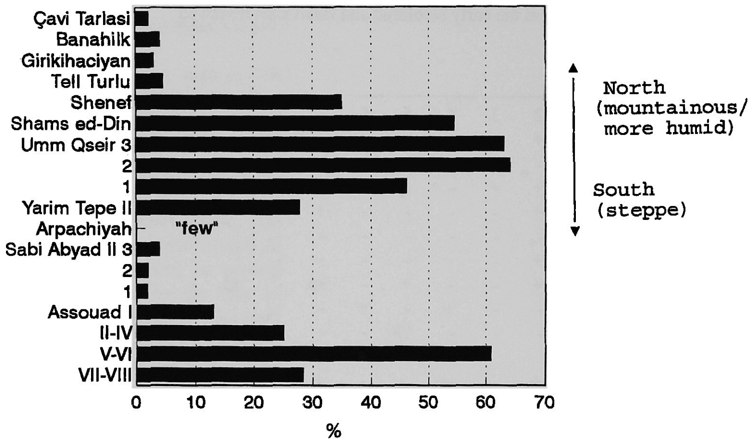

Figure 4.3 Percentages of wild animals

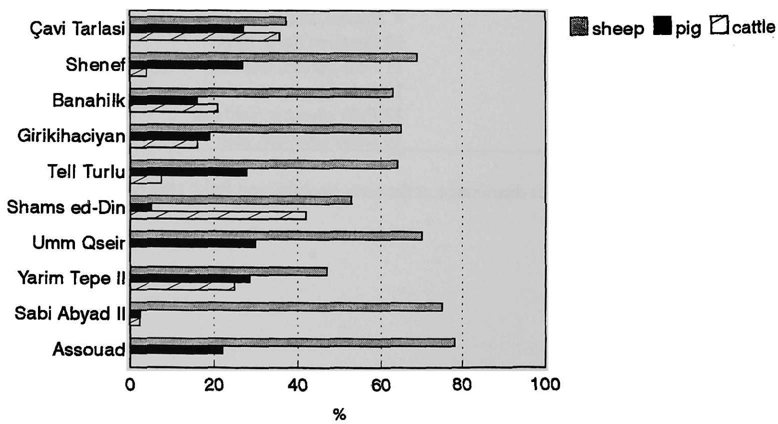

Figure 4.4 Percentages of the main domestic species

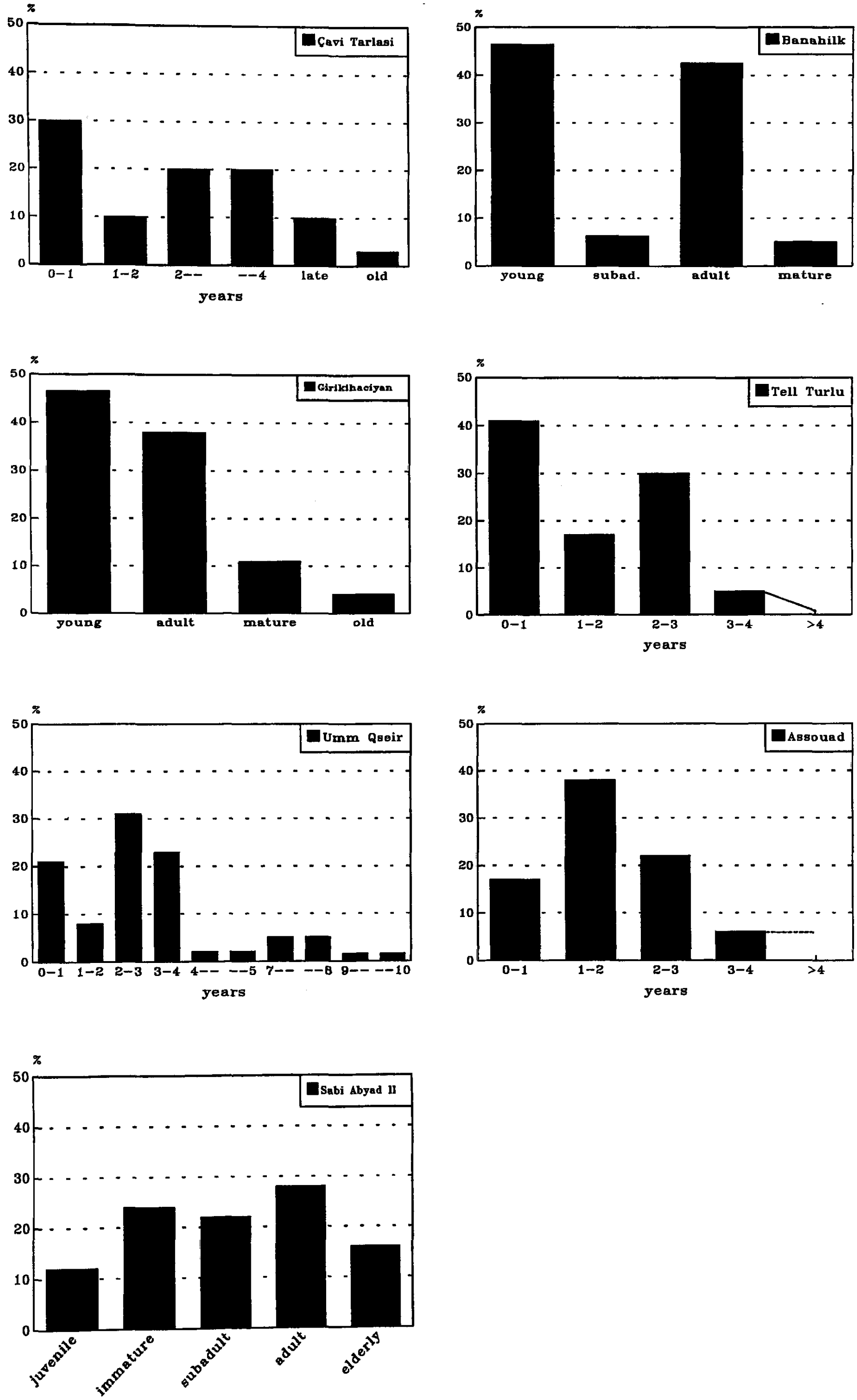

Figure 4.5 Comparison of ovicaprid mortality patterns

Chapter 5. Zooarchaeological analysis: methodology

5.1 Taphonomy

The interpretation of faunal remains is not complete without the analysis of taphonomical processes which affected the sample. Taphonomy is defined as the passage of organic material from the biosphere to the lithosphere (Efremov 1940: 85). In other words, after the death of the animals the osteological material undergoes a series of transformational processes which result in a death assemblage (thanatocoenosis) often very different from the original living assemblage (biocoenosis). These processes can be grouped into two categories, the pre-depositional processes, from the moment of death to the burial in the earth, and the post-depositional processes occurred in the earth (table 5.1) (Van Wijngaarden-Bakker 1986: 89).

	biotic forces	abiotic forces
pre-depositional processes:	human action	natural disarticulation
	animals	weathering
post-depositional processes:	microorganisms	chemical processes (type of soil, water, temperature, roots)
		physical processes (weight of upper layers, trampling)

Table 5.1 Taphonomic processes

5.1.1 Pre-depositional processes: bio-stratinomy

Within the pre-depositional processes particular attention has been paid to transformations due to human action. In particular the type and the localization of the butchering marks, as modification due to working processes, have been recorded. The analysis was done mainly visually; only in a few cases optical microscopy was used. Traces of fire were noted according to their intensity (burnt and calcinated) and to the degree they affected the bone.

Alteration due to animal action, either from rodents or carnivores, resulted in gnawing marks evident on the bone surface and in etched surfaces in the case of swallowed bones. Their presence on each fragment was recorded and their incidence of the whole assemblage has been taken into account.

5.1.2 Post-depositional processes: diagenesis

After being incorporated into the earth, bones are subjected to chemical processes which transform their organic content. Bones from arid zones of the Middle East are characterized by a low amount of organic content which makes them very fragile and their surface brittle. Deposition of carbonatic salt crystals is not uncommon either. Traces left on the bone surface by the acids of the roots are usually the most visible of the post-depositional factors.

Many bones from level 6 at Sabi Abyad were unintentionally affected long after the death of the animals by a fire which destroyed the village. Most likely the bones had already been partially incorporated in the earth at that time. No distinction between the two different (pre- and post-depositional) firing processes has been attempted, although the colour of the bones has been noted.

Soil corrosion, together with other post-depositional processes such as recovery and research methods, is probably the most important cause for the fragmentation of the bones from Sabi Abyad. To understand the degree of fragmentation of the material the state of preservation of the bone was marked on a scale of five categories (<25%, 25%, 50%, 75%, 100% of the original complete bone).

5.2 Recovery

The faunal remains from Sabi Abyad were hand-collected in the course of excavation without employing dry screening or wet sieving during the excavation. However, some samples were randomly sieved during the 1986 campaign (Buitenhuis, pers. comm.) to test the representativeness of the samples. Although the lack of sieving might hamper the representation of small species (Payne 1972, 1975), it seems that the representation of some categories such as fish remains, which were almost absent in the sieved samples, was not heavily biased (Buitenhuis, pers. comm.). In addition, according to van Wijngaarden-Bakker (1989) the lack of sieving did not alter the ratio between the large mammals enormously. Therefore, although an under-representation of smaller anatomical elements and smaller species cannot be completely excluded, this loss is presumably roughly similar throughout the periods of occupation of the site due to the same recovery methods.

5.3 Identification

The study of the faunal remains from Sabi Abyad was carried out at the University of Amsterdam. The material was identified according to species with the aid of the reference collection of the Zooarchaeological Department of the Institute for Pre- and Protohistory "Albert Egges van Giffen" (IPP) of the University of Amsterdam. A further identification of some doubtful gazelle remains was accomplished with the help of Dr. Hijlke Buitenhuis (BAI-University of Groningen). The identification to species level of equid remains was attained with the aid of Prof. Hans-Peter Uerpmann and the equid reference collection of the Institut für Ur- und Frühgeschichte of the University of Tübingen. The criteria used for the identification are described in detail in chapter 5.3.2 for the small herbivores and chapter 6.5.1 for the equids.

Specimens identifiable to element and to taxon were individually labelled with locus and lot code followed by a serial bone number. Each fragment was described and recorded according to the standard from used at the IPP. Besides species, anatomical element, side, part and quantity preserved, gnawing and butchering traces, pathological signs, and working or polishing were noted. The data were recorded in a zooarchaeological database using the specially designed program "ZAPINV" ("Zoö-Archeologisch Invoer Programma") created by Alfred Ankum of the R.A.A.P. foundation. The program, written in CLIPPER, creates dBase structured files. The further analysis of the faunal remains was also carried out with the help of other computer programs such as ZAP for the quantitative analysis, SPSS for the statistical analysis and HARVARD GRAPHICS for the graphic aspects.

The specimens not identifiable to taxon were grouped into the general categories of large mammals (LM), medium mammals (MM) and small mammals (SM). If this distinction was not possible either, they were classified as unidentified fragments (INDET). Vertebrae and costae were mainly included in these four categories. In case of doubtful identification the more general category was chosen.

5.3.1 General identification problems for the Middle East

The identification problems of faunal remains from Middle-Eastern sites consist in the occurrence of morphologically related forms associated with the poorly known ancient distribution of the major ungulate mammals. This concerns closely related forms of equids, of bovids, and especially of small herbivores. Within the first group onager and wild ass are the species for the period here concerned; for the second group Stampfli (1983: 433) remarks that some authors usually indicate the presence of "small cattle" which he thinks should be interpreted as red deer. This last aspect is almost completely excluded from this work because of the generally large size of the bovids from Sabi Abyad. Due to the importance and the large occurrence of the small herbivores faunal assemblages from the Middle East these animals will be discussed in more detail in the following section. As to the geographical distribution of ungulate mammals, the Middle East represents a position on the crossroads of the faunal region of the Old World. Northern Syria, and the Balikh valley, in particular, is located in a border zone of possible overlap of equid and gazelle species (cf. Uerpmann 1981, 1987, 1989).

5.3.2 Morphological distinction of small herbivores

The osteological identification of small herbivores from the Middle East involves the following aspects:

1) Identification of five morphologically similar species: sheep (*Ovis* sp.), goat (*Capra* sp.), gazelle (*Gazelle* sp.), roe deer (*Capreolus capreolus*) and fallow deer (*Dama* sp.).
2) Distinction between the genera *Ovis* and *Capra.*
3) Distinction between wild and domestic counterparts for the genera *Ovis* and *Capra*.

Besides the reference collections in Amsterdam, Tübingen and Groningen, a series of specific literature was used as reference (Stampfli 1983; Buitenhuis 1988; Boessneck 1969; Prummel and Frisch 1986). The identification of gazelle bones is particularly important since bones of these animals have been found in many late Neolithic, including Halafian, sites and they had a great economic importance in many early settlements of the Middle East. Particular attention therefore has been paid to the identification of bones of gazelle and their distinction from the other small herbivores. For the distinction between *Ovis* and *Capra* I have referred to the above-mentioned literature and therefore the criteria used for it are not extensively reported here.

Size can be a first and helpful criterium in the distinction of the five species, although it cannot be taken as an absolute criterium. A broad tentative division into three main groups can be made on the basis of the differences in size:
- the smallest-sized bones usually belong to gazelle and roe deer, but they can also be from small sheep or goat;
- the medium-sized bones are from sheep and goat;
- the largest-sized bone can belong to male sheep and goat or wild sheep and goat or to fallow deer (Buitenhuis 1988: 28).

5.3.2.1 Skeletal elements

In this section the criteria are reported that are used for the distinction of the gazelle bones from the ovicaprids bones from Sabi Abyad. The other small herbivores were hardly encountered in the sample and therefore they are scarcely described here. The values and the confidence given by the different authors to the different elements used for the separation of gazelle from the other small herbivores are reported in table 5.2.

Horncore. Horncores are rather easy to identify due to their clear differences both in shape and in size. Gazelle horncores are characterized by an internal compactness and no cavity (frontal sinus) is present as it is in ovicaprids. Gazelle horncores show external deep creases (particularly in the caudal part). The young gazelle horncores are often goatlike, but they always have deeper creases.

Dentes. The identification of isolated teeth of gazelle is not very difficult. They can be recognized by their smaller size and well-defined border between enamel (crown) and root. The general category of upper and lower molars mainly includes the first and the second molars. The third molar is easily recognizable. Attention must be paid to the upper forth

	Stampfli (1983)	Buitenhuis (1988)	Cavallo
Horn core	+	+	+
Atlas	...	...	-
Axis	...	...	-
Scapula	+	+	+
Humerus	+	+	+
Radius	+ p.	+ p.	+ p.
	- d.	+ d.	- d.
Ulna	± p.	+ p.	+ p.
Metacarpus/	± p.	+ p.	- p.
Metatarsus	+ d.	+ d.	± d.
Pelvis	-	...	-
Femur	+ p.	+ p.	+ p.
	+ d.	- d.	- d.
Patella	...	...	-
Tibia	-	-	-
Astragalus	-	-	-
Calcaneus	+	+	±
Phalanges	+ p.	-	±

p.= proximal; d.= distal; degree of confidence: - = few, ± = reasonable; + = good; ...= no information

Table 5.2 Relative values of the identifiable skeletal elements of small herbivores

deciduous premolars, which might be included in the same category of molars because of their similar shape. They are, however, usually smaller and more worn than the permanent upper molars.

Mandibula. The diastema is narrower and longer in cervids and gazelle than in *Ovis* and *Capra*. In *Cervus* the foramen mentale is larger and rounder; in *Dama* the foramen is longer and narrow. The processus angularis is pronounced outwards forming almost an angle in cervids while it is rounder in *Ovis* and *Capra*. In gazelle the body (ramus horizontalis) is laterally flatter than in the other species. In ovicaprids the body of the mandibula is higher.

Atlas. In general, the gazelle atlas resembles more the cervid atlas than that of the ovicaprids. The position of the foramen transversarium, however, is more caudal and the fossa alaris is less deep than in cervids.

Axis. The gazelle axis has sharp central and lateral cristae on the dorsal side as in cervids. There is no groove in the middle of the articular cranial surface in gazelle. The position and the inclination of the foramina is different from those of sheep and goat.

Scapula. The main diagnostic feature is the shape of the tuber scapulae. This is less developed in *Gazella* and *Capreolus* and does not protrude beyond the plane of the articular surface. The caudal part of the neck is often curved more deeply and has well-marked lateral edges in gazelle.

Humerus. The difference in the shape of the epicondylus medialis is the main character used for the differentiation between the caprines, gazelle and roe deer (Stampfli 1983; Buitenhuis 1988). The epicondylus medialis is shorter and does not reach the trochlea plane level in gazelle. The trochlea and the condylus lateralis have different proportions: the condyle is smaller and shorter, not reaching the coronoid fossa, in gazelle. The coronoid fossa is generally wider in *Ovis* and *Capra* and deeper and slightly triangular in section in gazelle.

Radius. The epicondylus lateralis of the proximal part of the radius is indicated in the literature as a good distinctive criterium of distinction and so is the shape of the distal part but I have not found many differences, especially in the distal part. The criteria indicated by Buitenhuis (1988) for the proximal part have been recognized. The medial part of the proximal articulation is more rounded in *Ovis* and *Capra*.

Ulna. If the complete proximal part is present the separation of the ulna of gazelle is not difficult because Capreolus is very different. The section of the olecranon of gazélle and roe deer ulnae varies considerably from those of ovicaprid, being almost triangular in gazelle and drop-like in roe deer (Buitenhuis 1988: 31, fig. 15).

Metacarpus. The diaphysis of the gazelle metacarpus is more triangular in shape. This 'section-criterium' is also valid for the roe deer. If only one condyle of the distal part is present the identification becomes more difficult, although some differences in the ratio between height and breadth are present: in gazelle the trochlea is relatively higher than in ovicaprids. These isolated parts have mainly been considered as Medium Mammals.

Pelvis. There are no indications for this element in Buitenhuis (1988) and few in Stampfli (1983). If only the acetabulum is present the differentiation is even more difficult because deer has an acetabulum similar to that of the gazelle. In the latter, however, the rim of the acetabulum presents a more pronounced protrusion in the caudal direction than in ovicaprids. In *Ovis* and *Capra* the shape of acetabulum is rounder, and irregular. In gazelle the os ileum is strikingly shorter in the medial part and the attachment to the collum ilei is more angular-shaped in wild animals. The ischium is straighter in ovicaprids than in the other species.

Femur. In the proximal part, the form of the caput femoris and the mode of attachment to the collum can be used as criteria for species discrimination. The fovea capitis is deeper in ovicaprids than in gazelle and roe deer. The distal part is more difficult to identify. Prummel and Frisch (1986) and Boessneck (1969) give no indication for the distinction of the distal part between *Ovis* and *Capra*. The trochlea patellaris is considered the best feature of distinction. The lateral and medial cristae are parallel in roe deer and the mediale is slightly thicker on the proximal part; in gazelle and fallow deer the medial crista continues proximally (see Stampfli 1983) with a more rounded shape; In *Ovis* and *Capra* the cristae are long, but the sulcus is deeper (Buitenhuis 1988: 34).

Tibia. The tibia has no useful characterizing features related to each species. The only difference I have noticed is in the shape of the crista tibiae, being more narrow in gazelle. The diaphysis of the gazelle tibia is more "twisted" than in ovicaprids. In the distal part, the processus malleolaris medialis is considered a good criterium (see Buitenhuis 1988).

Astragalus. It represents a difficult element to identify to species level. In gazelle the astragalus is relatively longer and narrower than in ovicaprids. The difference in length of the two proximal condyli is comparable to *Capra*, but the medial condylus has a sharper ridge.

Calcaneus. The main characteristic of the distinction between *Ovis* and *Capra* is "a pad" or "thickish piece" in the tuber calcanei. The tuber calcanei is narrower and longer in *Gazella*, *Dama*, *Cervus* and wider in *Ovis* and *Capra*. The sustentaculum is considerably smaller in gazelle and does not reach the plantar edge. The facies of the os centrotarsale is shorter and straighter in gazelle than in ovicaprids.

Metatarsus. In gazelle the distal part is more laterally-medially "pressed", the condyli are parallel; the distal part of the vascular groove has ridges in a way more similar to *Capra* than to *Ovis*.

Phalanges. The difficulty in the identification of phalanges is increased by the differences between the anterior and posterior as well as the axial and abaxial side. The phalanges (especially PH1) of gazelle are narrower. Cervids are slender and have a triangular section (see Stampfli 1983). This aspect is reflected in the proximal articulation which is narrower than in ovicaprids. The same characters are present in PH2. Complete bones are easy to identify. For the fragmented phalanges, the proximal part is easier to identify than the distal.

5.4 Quantification

In the last few decades a vast amount of literature has appeared on the different methods of quantification of archaeological faunal remains. These methods can be grouped basically into a method involving the number of identified specimens (NISP) or fragments count, the evaluation of minimal number of specimens (NMI) and the bones weight, on one side, and into more complicated mathematical and statistical formulae and elaborations on the other (cf. Daly 1969; Uerpmann 1973; Grayson 1979, 1984 and Gautier 1984 for a detailed discussion on the validity of and criticisms against the different methods; and cf. Krantz 1968; Poplin 1980; Ducos 1984, 1988; Casteel 1977, Turner 1982; Gilbert et al. 1981; Gilbert and Singer 1982; Horton 1984; Filler and Turner 1982 for the application and discussion of the various formulas). The major aim of these articles was the adoption of uniform methods of counting and estimating the abundance of individual animals from archaeological sites and a "more detailed examination of available methods and encouragement of development and testing of new approaches" (Casteel 1977: 133). Besides being far from a uniform method of quantification, the conclusions of almost all authors can be summarized in the following words: "the commonly used faunal quantification formulas do not universally provide accurate and precise reconstructions of the original species ratios even when applied to fully representative samples" (Gilbert et al. 1981: 92). The representativeness of the sample mainly depends on the taphonomic factors, cultural/human influence and recovery methods. In addition, significant differences in the quantification results derive from sampling procedures and different division of units of analysis (Grayson 1973; Gamble 1978).

Due to the bias inherent to the methods the faunal material from Sabi Abyad has been quantified by counting the number of fragments (NISP) and recording the percentages of each identified species. This is the most commonly used method of analysis, especially in faunal studies of Middle Eastern material, thus making comparison of sites from similar areas more effective. It has also been preferred to more elaborate methods or to the more subjective and more preservationally biased calculation of the MNI. The NISP seemed to the author to be the most objective method and the most functional one for other scholars.

The major biases concerning the method of the NISP are (1) the overrepresentation of large species due to different preservation; (2) the influence of slaughtering age; (3) the butchering methods; (4) the different number of skeletal elements for each species; (5) the presence of complete skeletons (Van Wijngaarden-Bakker 1986: 24). The fragmentation of the material is the major factor, which underlies all these biases influencing the relative representation of the species. Bones of large species are supposed to be prone to more fragmentation, as a result of butchery techniques and taphonomic processes, than those of small species. This seems only slightly to be the case for the Sabi Abyad material. Although the bovid remains seem to be more fragmented (see table 6.3), the lower percentage of ovicaprids and gazelle remains should probably be correlated to the specific problems of identification of small herbivores of the Middle East rather than to a lower degree of fragmentation of smaller species. The similar degree of fragmentation of the equids and the higher fragmentation of the suids (<25% category) justifies to consider the overrepresentation of larger species in the sample of Sabi Abyad to be not so strong. In addition, the soil condition seems to have affected thinner bones of smaller species more heavily, making them very brittle and thus more inclined to breakage than thicker bones of larger species (see how the degree of teeth fragmentation is much higher in the ovicaprid remains than in the bovids (table 6.4). The butchery methods with frequent use of small lithic implements and of few heavy tools would imply difficulties in breaking a strong thick bone of a large species. The possible underrepresentation of young individuals due to the influence of the slaughtering age has been taken into account in the course of the evaluation and interpretation. The occurrence of complete or partially complete skeletons is very limited in the sample of Sabi Abyad. Apart form those of rodents complete skeletons were absent. When articulated bones were recognized they were signalized and this problem has been taken into account during the interpretation, especially regarding the skeletal representation for each species. To overcome the problem of differential fragmentation and of different numbers of skeletal bones between species the selection of diagnostic bones or the division for the real number of bones present in each species is sometimes used (Davis 1987, Perkins 1964). For the Sabi Abyad sample this method has not been used. For the purpose of quantification all skeletal elements have been taken into account.

5.5 Ageing

The evaluation of the age at death of the animal was based on the eruption and wear stage of teeth and on the stage of epiphyseal fusion of long bones. Slightly different approaches have been used in the course of the research. In a first attempt at the faunal analysis (Cavallo 1996) a relative degree of wear stage was noted within the sample as it is described in the corresponding tables. Ages at death were mainly estimated in accordance with Silver (1969). However, these absolute ages reported in the tables must be seen as a suggestive age and not as an absolute age. The tooth eruption and wear are mostly affected by nutritional factors, diet, hardness of enamel, occlusion, mastication (Silver 1969). The last two of these factors have been taken into account in the selection of the recordable specimens, removing the pathological specimens.

In the final stage of the research, the ovicaprid mandibles and teeth were assigned to the wear and age stages of Payne (1973). For the gazelle the work of Legge and Rowley-Conwy (1987) on the correlation between the crown height and the age at death has been used. Their work concerns the goitred gazelle (*Gazella subgutturosa*) and applies to the gazelle remains of the site of Abu Hureyra on the middle Euphrates. Due to the location of this site in an area close and comparable to Sabi Abyad, the effects of the wear rate are presumed to have been similar.

The age classes based on the fusion stage of the post-cranial bones were calculated in the first attempt according to the method described by Chaplin (1971), whereas later the classification developed by O'Connor (1989) has been preferred. This method presents the advantages of calculating the different categories separately without influencing each others. The fusing groups are divided in relative categories - early, intermediate, late, final - and no absolute age is given. The last category - final - is related to the vertebrae. As these elements are usually not identifiable to species level, the "final" category was excluded in this study. The epiphyseal fusion method is biased by differential destruction of unfused versus fused elements. This problem has been taken into account in the interpretation of the data as well as the possible underrepresentation of unfused (juvenile) elements due to problems of identification.

5.6 Osteometry

The faunal remains from Sabi Abyad have been measured according to the measurements codified by von den Driesch (1976) and by means of the 'Knochenmessgerät' at the IPP (Dolling and Reichstein 1975; van Wijngaarden-Bakker 1979). Only bones with completely fused epiphyses have been measured. Additional measurements on equid remains have been taken according to Eisenmann and Beckouche (1986), Eisenmann et al. (1988) and Uerpmann (1991: 24).

Two main purposes were kept in mind during the metrical analysis. First, the metrical analysis was carried out to assess the size of the animal populations and to observe changes during the phases involved. Individual measurements are reported in Appendix while their elaboration into statistical values is inserted in the text. The statistical values consist of sample size, mean, standard deviation and coefficient of variation. Second, measurements were used to differentiate between species, in particular domestic sheep, goat, pigs and cattle from their wild counterparts. The overlapping between the domestic and wild forms associated with the lack of definitive ranges for the wild and the domestic groups limited the validity of this method and invites to caution in its use (see Cavallo 1996: 489).

The method of the "size-index" developed by Uerpmann (1979: Appendix 2, 1982: 18) has been used in specific cases. This method is based on the assumption that the proportions between the different anatomical elements of the archaeological specimens are similar to those of the element measurement/animal (archaeological or modern) used for comparison, or as "standard"[1]. The advantage of this method is that measurements of different elements can be combined together. This turned out to be particularly useful in the case of a small sample. In this dissertation it has been used in the evaluation of some *Ovis* and *Capra* bones. The size index of some Sabi Abyad specimens has been compared to the

[1] The size-index is calculated in the following way: SI= (x-m)/2s.50 (x= archaeological measurements; m= mean value; s= standard deviation)

extensive study on the size of sheep and goat that has been made by Uerpmann (1979).

The "difference of logarithms" was used to evaluate the size of the onager, in relation to the possible presence of the wild ass. According to this method the values or the means of the measurements of the animal used as standard and those of the archaeological specimens are converted to logarithm (base 10)[2]. The differences between the standard and the archaeological specimens are calculated and plotted on diagrams. The standard values correspond to the zero-line. Values larger than the standard (>0) are plotted above the standard line and values smaller (<0) are plotted below. Eisenmann et al. (1986) constructed a typical curve for the onager and the ass expressing the differences in size and the proportions of these animals in relation to the standard animal. This work has been used as a base of reference for the equid remains from Sabi Abyad.

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[2] DL= log (x)-log(s):
DL= difference of logarithm;
x= archaeological or modern reference specimen;
s= corresponding element of the standard animal.

Chapter 6. Sabi Abyad: the species

6.1 The material

The total amount of faunal material processed for this research comprises more than 35,000 fragments, coming from the squares P13, P14, P15, Q14, Q15, R13, excavated during the 1986, 1988 and 1991 campaigns (table 6.1). A large number of remains could not be ascribed to a specific level or even to a specific phase. Ca. 6900 bone fragments could be grouped into three chronological units based on the combination of stratigraphic considerations and artefactual associations. A comparable sample size of identified bone remains is the outcome for each phase (table 6.2). The list of species present in each phase is reported in tables 6.6, 6.7, 6.8 and the percentages of the main species for each level is reported in figure 6.1.

SQUARE	YEAR OF EXCAVATION
P13	1986
P14	1988
Q13	1988
Q14	1988
Q15	1988
R13	1988
P15	1988
P15	1991

Table 6.1. Sabi Abyad: faunal material analyzed

The colour of the bones is generally light yellowish-brown except for those from the oldest pre-Halaf level where the colour of the bones is dark brown. In these levels some bones were imbedded in a very compact earth which could be removed only with a weak acid. The colour of the burnt bones varies from black or white (calcinated bones) to different nuance if red, probably due to the effect of a kind of 'post-depositional' burning occurred when the bones were already imbedded/buried into the earth. The state of preservation of the faunal material from Sabi Abyad is in general poor. Most of the bones are heavily fragmented and have a very brittle surface.

Inevitably, the poor state of preservation of the material, and the high level of fragmentation, results in a high percentage of unidentifiable bones (ca. 75%). The calculation of the ratio of identifiable bones versus unidentifiable ones through time was based on the material from square Q15 and the trench P15. The percentage of identified bones varies from ca. 30% in the lowest levels to ca. 15% in the upper (Cavallo 1996). Almost half of the unidentifiable fragments could not even be ascribed to the categories of medium or large mammal (MM resp. LM).

The state of preservation of the material varies according to the levels. The bones retrieved from the oldest pre-Halaf levels are relatively better preserved than those from the youngest periods, the Transitional and the Early Halaf phases. The degree of fragmentation of the pre-Halaf bones shows in general a lower percentage of the most fragmented categories (<25% and 25% of the complete bones) (Cavallo 1995).

The relatively better preservation of the oldest material could be attributed to various factors such as (1) the depth of the layers and (2) the consequently the higher degree of moisture present in these layers or, in other words, the less evaporation which led to less loss of the organic component of the bone and (3) the location of the trench, probably at the border of the settlement, with consequently less pressure of the superimposed layers (and a quicker covering of the material by the upper levels) and (4) less trampling due to architectural features present in some of the pre-Halaf levels.

Tables 6.3 and 6.4 report the state of fragmentation of the bones and the teeth of the main species, calculated on the whole sample. The most fragmented bones are those of the small ruminants, ovicaprids and gazelle, with ca. 75% of the remains preserved for half or less than the original complete bone. They are followed by the suid bones, which show the highest degree of fragmentation within the 25% category. The 100% category, i.e. the complete preserved bones, is mainly represented by carpals, tarsals and phalanges.

The teeth show an opposite pattern regarding the degree of fragmentation (table 6.3 and 6.4). The high percentage (more than 60%)of complete or almost complete teeth could be attributed to differences in the chemical composition of bones and teeth, on one hand, and to diagenetic and post-depositional factors, on the other hand. Completely preserved teeth are particularly evident among the ovicaprids, as result of a breakage pattern of the mandibles due intense weathering. This pattern results in the fragmentation of the *processus articularis* and/or *processus coromoideus* on one side, and of the *symphysis* and *diastema* on the other side. The fragmentation of the *ramus horizontalis* has resulted in a high numbers of loose teeth. Quite often, however, the teeth could be used in a reconstruction of a tooth rwo of a single individual. Obvious recent breakage on the mandibulae, due to excavation, washing and transport, intensified this pattern.

The different degree of preservation for the various species and their overall high degree of fragmentation, can partly be explained by the taphonomic factors that have modified the material in relation to the setting of the site. There are, however, also specific biotic forces that have influenced on the assemblage, such as human activity (butchery and cooking) and animal activity (carnivore gnawing). The impact of these

phase:	Pre-Halaf		Transitional		Early Halaf		total	%
Sheep/Goat, *Ovis/Capra*	1358		1365		1602		4325	62.6
Sheep/Goat (?)	14		-		9		23	0.3
Sheep, *Ovis aries*	155	- 1567	189	-1584	90	-1740	434	6.3
Sheep (?)	8		-		-		8	0.1
Goat, *Capra hircus*	32		30		39		101	1.5
Cattle, *Bos taurus*	344		368		242		954	13.8
Cattle (?)	1		-		1		2	<0.1
Pig, *Sus domesticus*	92		164		380		636	9.2
Dog, *Canis familiaris*	11		6		6		23	0.3
Tot. domestic mammals	**2015(94.8%)**		**2122(92.5%)**		**2369(96.6%)**			
Wild sheep/goat	1		2		3		6	<0.1
Wild sheep *Ovis orientalis*	2		3		1		6	<0.1
Wild sheep (?)	2		-		-		2	<0.1
Wild? sheep	1		-		-		1	<0.1
Wild? sheep/goat	-		-		1		1	<0.1
Wild goat, *Capra aegagrus*	1		-		-		1	<0.1
Equids, *Equus sp.*	25		7		9		71	1.0
Onager, *Equus hemionus*	11		15		4		30	0.4
Onager (?)	1		2		-		3	<0.1
Wild ass, *Equus africanus*(?)	1		-		-		1	<0.1
Wild cattle, *Bos primigenius*	18		11		3		32	0.5
Wild cattle (?)	7		2		-		9	0.1
Gazelle, *Gazella subgutturosa*	28		54		40		122	1.8
Gazelle (?)	5		18		10		33	0.5
Persian fallow deer, *Dama mesopotamica*	2		3		-		5	<0.1
Red deer, *Cervus elaphus*	-		2		2		4	<0.1
Wild boar, *Sus scrofa*	3		2		1		6	<0.1
Striped hyaena, *Hyaena hyaena*	-		1		-		1	<0.1
Brown bear, *Ursus arctos*	-		1		-		1	<0.1
Red fox, *Vulpes vulpes*	1		11		4		16	0.2
Cape hare, *Lepus capensis*	1		9		6		16	0.2
Tot. wild mammals	**110 (5.2%)**		**173 (7.5%)**		**84 (3.4%)**			
Rodents	1		5		2		8	0.1
Tatera sp.	-		2		-		2	<0.1
Birds	-		3		4		7	0.1
Goose, *Anser sp.*	-		1		2		3	<0.1
Duck, *Anas sp.*	1		3		-		4	<0.1
Stork, *Ciconia cf. ciconia*	-		1		1		2	<0.1
Hooded crow, *Corvus corone*	-		2		-		2	<0.1
Tortoise, *Testudo graeca*	-		-		1		1	<0.1
Frog, *Rana* sp.	-		-		1		1	<0.1
Fish	-		-		1		1	<0.1
Molluscs	+		+		+		+	
Total	**2127**		**2312**		**2465**			

+ present

Table 6.2 Absolute and relative frequency of identified bones of domestic and wild species in each phase factors seems to have been low generally, but with a different pattern according to separate levels (Cavallo 1996: fig. 9.3). It should be born in mind that post-depositional processes may have partly obliterated the traces of the processes in question.

Tables 6.5 report the state of fragmentation and the incidence of butchering, burning and gnawing for the main species, respectively, calculated for the whole sample. The observed butchering marks consist almost entirely of short, fine, repeated cutmarks located in the articular zones of the bones. Chopmarks were observed in a few cases, and are mainly associated with horncores or large mammals bones. A slightly higher percentage (up to 5%) of butchering marks is present in the oldest levels (levels 8 to 6). The representation of bones with traces of carnivore gnawing per level is more variable.

The percentage is much more abundant in the lower levels 8 to 6 (ca. 8-20%) than in the upper levels 5-1 (ca. 1-3%) (Cavallo 1996: fig. 9.3). Level 6 shows the highest percentage of burnt animal remains (ca. 20%), which can be correlated with the signs of destruction by fire of the whole village (Akkermans and Le Mière 1992:5). In the other levels the proportion of burnt bones amounts to ca. 3%, except for levels 3A and 7 in which the percentage of burnt remains is less than 1% (ibid.).

The bones show only limited traces of cracking and flaking, so that it is assumed that they lay on the surface for a short time and were buried quickly. Indications of acid action of plant roots were occasionally noticed. On the surface of some bones precipitations of salt were present.

Part of the bone preserved	O/C	BOS	SUS	GAZE	EQUUS
<25%	30.4	41.6	37.4	16.2	30.8
25%	27.7	13.5	18.7	32.9	22.2
50%	17.7	9.3	15.7	26.2	8.5
75%	7.6	7.3	7.4	10.6	5.9
100%	16.5	28.2	20.7	13.9	32.4

Table 6.3 Degree of bone fragmentation (percentage)

Part of the tooth preserved	O/C	BOS	SUS
<25%	2.0	9.2	3.7
25%	5.0	14.2	21.0
50%	9.4	10.5	22.2
75%	12.9	28.9	39.5
100%	70.6	37.1	13.6

Table 6.4 Degree of tooth fragmentation (percentage)

	O/C	BOS	SUS	GAZE	EQUUS
cutmarks	107	97	13	5	9
chopmarks	7	2	3	1	2
butchery	114	6	16	6	11
burning	238	97	20	26	7
gnawing	168	65	42	2	23
total	4796	1101	703	192	129

Table 6.5 Incidence of butchery, burning and gnawing (number of fragments)

Pre-Halaf or Balikh IIA-C phase

The pre-Halaf phase is divided into 5 levels (levels 11-7). They represent the oldest levels and cover a period from ca. 5700 to ca. 5200 B.C. The faunal remains related to them and here described were recovered in the trench P15. These levels were not extensively excavated and in the small area investigated no particular architectural structures were found.

The faunal remains from the pre-Halaf phase amount in total to more than 2127 identified fragments. The most consistent sample is from level 8. A small variety of species is present. 13 mammal species were identified. They comprise, within the domestic species, sheep (*Ovis aries*), goat (*Capra hircus*), cattle (*Bos taurus*), pig (*Sus domesticus*) and dog (*Canis familiaris*). The wild species identified are the Asiatic mouflon (*Ovis orientalis*), onager (*Equus hemionus*), aurochs (*Bos primigenius*), gazelle (*Gazella subgutturosa*), wild boar (*Sus scrofa*), Persian fallow deer (*Dama mesopotamica*), and two smaller mammals, viz. fox (*Vulpes vulpes*) and hare (*Lepus capensis*). Only one species (*Anas platyrhynchos*) of bird, one fragment of rodent, and molluscs (*Melanopsis* sp., *Leguminaia* sp./ *Unio* sp. and *Polinices* sp.) were found.

Level:	11	10	9/10	9	8/9	8	7
Sheep/goat	17	79	4	17	306	884	51
Sheep/goat ?	-	1	-	-	5	8	-
Sheep	2	9	-	3	51	84	6
Sheep ?	-	2	-	-	6	-	-
Goat	3	3	-	1	9	14	2
Cattle	21	46	-	5	86	175	11
Cattle ?	-	-	-	-	-	1	-
Pig	12	10	1	1	16	32	20
Dog	1	2	-	-	1	6	1
Wild sheep/goat	-	-	-	-	-	1	-
Wild sheep	-	-	-	-	-	2	-
Wild sheep?	-	-	-	-	1	1	-
Wild goat	-	-	-	-	1	-	-
Wild? sheep	-	1	-	-	-	-	-
Equids	5	1	-	-	1	2	16
Onager	3	1	-	-	-	-	7
Onager ?	-	-	-	-	-	-	1
Wild ass ?	-	-	-	-	-	-	1
Wild cattle	-	5	-	-	6	7	-
wild? cattle	-	2	-	-	3	2	-
Gazelle	4	3	-	-	4	16	1
Gazelle ?	-	1	-	1	1	1	1
Wild boar	-	1	-	-	2	-	-
Fallow deer	-	-	-	-	1	1	-
Red fox	-	-	-	-	-	1	-
Cape Hare	-	-	-	-	1	-	-
Mallard	-	-	-	-	1	-	-
Rodents	-	-	-	-	1	-	-
Molluscs	+	+	+	+	+	+	+
Total	**68**	**167**	**5**	**28**	**503**	**1238**	**118**

Table 6.6 Pre-Halaf phase: absolute frequency of identified species in each level

Transitional or Balikh IIIA phase

Three levels were recognized in this phase: level 6, 5 and 4. These levels were more extensively excavated and are characterized by the presence of articulated rectangular and round (tholos) architectural structures. This phase is dated to ca. 5200-5100 B.C. The faunal remains related to this phase were found in squares P14, P15, Q14, Q15, R13 and dug up in the 1988 campaign.

The total amount of identified fragments consists of 2313 bones. The larger samples come from level 4 and 6. Both levels present the widest spectrum of species. In addition to the list of species identified for the pre-Halaf levels, striped hyaena (*Hyaena hyaena*), brown bear (*Ursus arctos*) and a larger number of birds (*Anser* sp., *Anas* sp., *Ciconia cf. ciconia* and *Corvus corone*), almost all from level 4, were identified. Rodents (*Tatera* sp.) and only molluscs (*Melanopsis* sp., *Leguminaia* sp./ *Unio* sp.) were found.

Level:	**6**	**5/6**	**5**	**4-6***	**4**
Sheep/goat	190	56	34	164	921
Sheep	24	2	7	38	118
Goat	5	-	-	6	19
Cattle	133	21	6	38	170
Pig	37	2	4	5	116
Dog	5	-	-	-	1
Wild sheep	3	-	-	-	-
Wild sheep/goat	-	1	-	-	1
Equids	20	1	-	4	12
Onager	6	-	1	1	7
Onager	1	-	-	-	1
Wild cattle	6	-	-	1	4
Wild? cattle	1	-	-	-	1
Gazelle	8	3	4	8	31
Gazelle ?	3	2	-	-	13
Wild boar	1	-	1	-	-
Fallow deer	1	-	-	1	1
Red deer	-	-	-	1	1
Brown bear	1	-	-	-	-
Striped hyaena	1	-	-	-	-
Red fox	2	6	-	1	2
Cape hare	1	-	3	2	3
Aves	-	-	1	1	1
Mallard	-	-	-	-	3
Goose	-	-	-	-	1
Stork	-	-	-	-	1
Crow	-	-	1	-	2
Molluscs	+	+	+	+	+
Total	**450**	**96**	**62**	**271**	**1433**

*grouped levels 4/6, 4/5/6, 4/5

Table 6.7 Transitional phase: absolute frequency of identified species in each level

Early Halaf or Balikh IIIB phase
The Early Halaf phase is divided into three main levels (levels 3-1). The earliest of these levels is further subdivided into three parts (level 3C, 3B, 3A), which represent, respectively, three occupational phases of the big rectangular building complex in the northern part of the area of the site excavated. The chronological dating of this phase is 5100-5000 B.C.

In total, 2465 identified fragments were attributed to this phase. The faunal sample related to this phase was retrieved in the following squares: P13 (1986), and P14, Q13, Q14, Q15 and R13 (1988). Except for *Dama*, the same number of large and medium-sized species is present as in the previous phase; the number of birds is smaller. *Testudo*, *Rana* and the only fragment of fish in the whole sample come from this phase. In addition to two landsnails (fam. Helicidae) and the freshwater molluscs found in the previous phase, two other species of freshwater molluscs (*Corbicula* sp. and *Ostrea* sp.) are present.

Level:	**3B**	**3A**	**3***	**1-3****	**2**	**1**
Sheep/goat	569	444	97	121	315	56
Sheep/goat ?	5	-	-	-	4	-
Sheep	35	35	2	6	8	4
Goat	19	9	-	4	6	1
Cattle	74	75	8	25	44	16
Cattle ?	-	1	-	-	-	-
Pig	73	147	30	17	103	10
Dog	-	1	4	-	1	-
Wild sheep	-	1	-	-	-	-
wild sheep/goat	3	-	-	-	-	-
Wild? sheep/goat	1	-	-	-	-	-
Equids	3	4	-	2	-	-
Onager	-	1	-	1	2	-
Wild cattle	3	-	-	-	-	-
Gazelle	8	20	3	1	8	-
Gazelle ?	1	3	-	-	6	-
Wild boar	-	-	-	-	1	-
Red deer	1	-	-	1	-	-
Red fox	2	-	-	-	2	-
Cape hare	6	-	-	-	-	-
Aves	-	1	1	2	-	-
Duck	1	1	-	-	-	-
Mallard,	-	-	-	-	-	-
Stork	-	1	-	-	-	-
Rodents	1	-	-	-	1#	-
Molluscs	+	+	+	+	+	+
Fish	1	-	-	-	-	-
Tortoise	-	1	-	-	-	-
Rana	-	1	-	-	-	-
Total	**806**	**746**	**145**	**180**	**501**	**87**

* grouped levels 3, 3A/3B, 3B/3A.
** includes 1/3A, 1/3B, 1/2, 1/2/3, 2/3A.
# most likely recent

Table 6.8 Early Halaf phase: absolute frequency of identified species in each level

6.2 Ovicaprids

6.2.1 Introduction

Ovicaprids form the largest group of animals found at Sabi Abyad They constitute up to 70% of the faunal material and their relative frequency remains constant throughout the whole period of habitation of the site (table 6.2). In this chapter the preliminary results, already published in Cavallo (1995, 1996) will be summarized in relation to the new data to understand which degree of domestication -or control- was attained by the inhabitants of Sabi Abyad concerning these two species.

6.2.2 Ratio Ovis : Capra

The ratio between sheep and goat (fig. 6.2.) remains the same in the first two phases while it is reduced in the last phase suggesting an increase of goats in the herds. These data based on the whole sample are confirmed when one takes into consideration only the most diagnostic elements (table 6.9).

Compared to sheep, goats are better milk producers especially in relation to their size whereas other products such as fat and wool, as well as their meat, are appreciated less (Zeuner 1963: 151; French 1970: 138). In addition, compared to sheep, which are mainly grazers, goats are browsers that might more easily feed on scrubs and thorny plants. They can also withstand aridity better and are therefore more adaptable to sparse pasture and a hotter and drier climate. Thus, the relative increase of the goats might also be seen as a response to environmental deterioration. An increase of goats might be the result of a change in herding economy towards more exploitation of milk, because goats produce an higher yields of milk than sheep.

		Ovis	Capra	Ratio O:C
Scap d.	E	9	2	4.5:1
Scap d.	T	31	4	7.7:1
Scap d.	P	12	-	12.0:1
Hum d.	E	20	3	6.7:1
Hum d.	T	31	4	13.7:1
Hum d.	P	41	9	4.5:1
Rad d.	E	17	7	2.7:1
Rad d.	T	24	4	6.0:1
Rad d.	P	42	9	4.6:1

Table 6.9 Ratio between *Ovis* and *Capra* based on selected elements

6.2.3 Metrical analysis

Through the metrical analysis it was possible to highlight the presence of wild individuals. Some specimens clearly fall outside the normal range of the ovicaprid measurements (fig. 6.3) and these have been labelled "wild individuals". These measurements have been compared with those of other wild sheep or goat identified at other sites from the Middle East, and their size index has been compared to the data of Uerpmann (1979) (see section 6.2.3.1). It is not excluded that some of the "wild" specimens are possibly larger domestic rams or that some smaller/female wild individuals were included in the domestic population (Cavallo, 1996: 489). Summing up the presence of wild animals in the separate phases, we see that they are evenly distributed (table 6.10).

	P	T	E
WILD	6	6	5
WILD?	-		1
WILD FEMALE/DOM. MALE	1	2	2

Table 6.10 Presence of wild *Ovis* and/or *Capra*

Comparison with the size of ovicaprids from the same general region shows that the ovicaprids from Sabi Abyad are clearly smaller than the local wild sheep population known from Mureybit. A few extreme values, however, overlap (see e.g. humerus and astragalus, figs. 6.4, 6.5). The highest values of the humerus and the astragalus are also comparable with Assouad. At this site dated around 6500 B.C. goats present an advanced state of domestication whereas the status of the sheep has not been defined (Helmer 1985b). The stratigraphy Assouad, however, is rather controversial. Compared to the domestic population from the Pre-pottery Neolithic site of Sabi Abyad II dated to 6700-6500 B.C., the ovicaprids from Sabi Abyad are smaller and less variable. The ovicaprids of Sabi Abyad are also smaller than those from Tell Bouqras on the Euphrates dated around the second half of the 7th millennium and the beginning of the 6th millennium, in which a mixed wild-domestic population is represented (Buitenhuis 1988; Uerpmann 1982).

The shoulder height of the sheep from Sabi Abyad varies from ca. 61 to 70 cm with a mean of 63 cm (table 6.11). The general size of the ovicaprid remains is comparable to that from the late Halafian site of Shams ed-Din and Tell Turlu (see figs. 6.4 and 6.5 for comparison of the humerus and astragalus measurements) located on the middle and upper Euphrates respectively. The range of the Sabi Abyad ovicaprid measurements is, however, larger and also smaller individuals are represented. The individuals from Çavi Tarlasi and Banahilk are slightly larger. This might be due to the more pronounced mountainous environment of these two sites.

			GL (mm)	SH (cm)
OVIS	RAD Q14 9.14/1	E	151.9	61.1
OVIS	MC Q15 17.73/1	T	118.6	57.7
OVIS	MC P15 18.43/6	T	126.4	61.8
OVIS	MC P15 9.24/13	T	130.0	63.6
OVIS	MC P15 13.26/18	T	136.2	65.5
OVIS	MT P15 40.119/104	P	142.3	61.3
OVIS	MT P15 40.120/28	P	139.7	63.4
OVIS	MT P15 54.162/162	P	135.0	64.2
OVIS	MT P15 40.121/27	P	141.4	64.2
OVIS	MC P15 54.166/24	P	143.3	70.1

Multiplying factors: RAD= 4.02; MC= 4.89; MT= 4.54 (from von den Driesch & Boessneck 1974).

Table 6.11 Shoulder height (SH) of ovicaprids

In the Appendix the ovicaprid measurements grouped in phases are reported while some statistical values of elements selected for their larger sample are presented in table 6.12. The ranges and the means remain constant suggesting that the size of the ovicaprids did not change throughout the three phases of habitation of the site. The same can be concluded if we look at the separate sheep measurements (table 6.13). Wide ranges and high coefficients of variation are clearly due to the presence of wild specimens. Excluding these cases, the coefficient of variation for post-cranial elements is on average 7.0 or less than 7.0 as expected in osteometric data of mixed herds of sheep and goat with a low degree of variation within the two species and a low sexual dimorphism (Brothwell 1993).

The impression of an unchanged population throughout the phases is, however, partly altered if we look at the size distribution of the distal breadth of the humerus of the sheep (fig. 6.6), and the size distribution of the goat forelimb bones (fig. 6.7). In the case of the sheep, the pre-Halaf phase shows a slightly bimodal curve with a concentration on the smaller-sized individuals, while in the Transitional phase larger sized individuals are represented. In the Early Halaf phase a bimodal distribution again appears, but now the higher peak concerns the larger-sized individuals. On the other hand, the goat measurements from two groups in the pre-Halaf phase shift to a representation of only smaller individuals in the Early Halaf period. These data suggest a selection of specific groups within the same population. Bimodality can be related to sexual dimorphism and may be the reflection of a change in use between the two species: more milking of sheep, besides goat milk, or the opposite. Killing them for milk instead of for meat means killing them at a younger age. This would have influenced the population growth rate, which is better visible on early fusing skeletal elements such as the humerus.

6.2.3.1 Metrical analysis in detail

Mandibula
Two higher values are present in LD and LM, but LM3 and BM3 fall within the normal range. The most likely interpretation is that they belong to a domestic ram or male goat.

Third lower molar
Normal distribution in both L and B. In L one high value (P15 P L=26.3 and B= 9.4; fig. 6.3/A) comparable with the wild sheep identified at Demircihüyük (L= 26.5-27.0 N=4; B=10.0-10.8 N=4) (Rauh 1981: 67). Large domestic sheep are present at the same site (L=26.0 and B: 11.0) (Rauh 1981: 58). In B a bimodal curve is slightly visible.

Scapula
Bimodal curve in SLC more likely due to sexual dimorphism than to the two different species, being *Ovis* and *Capra* evenly distributed. The size of the larger specimens is comparable with Mureybit (wild sheep) as well as with Shams ed-Din (domestic sheep and goat).

Humerus
One measurement is much higher than the normal range but it could not be identified as *Ovis* or *Capra* (fig. 6.3/B). The breadth of the trochlea (BT) is comparable to *Ovis orientalis* of Mureybit, Demircihüyük and Lidar Hüyük. SI=71.2-75.9 falls in the range of wild Ovis and Goat (Uerpmann 1979: 98,104).

Radius
Bimodal distribution in BP. High value (P15 T BP=41.5) of a fragment identified as sheep (fig. 6.3/C). It falls within the range of wild sheep (SI=81.1-85.2) (Uerpmann 1979: 98) and is comparable with wild sheep identified at other sites:
Tell Hesbân: BP=42.0 (Weiler 1981); Korucutepe: BP=45.5 (male); (43.0) (Capra) (Boessneck and von den Driesch 1975); Çayönü BP= 29.8 (Lawrence 1982); Demircihüyük BP= 37.0 (*Ovis*?) (Rauh 1981); Lidar Hüyük BP=41.5 (Kussinger 1988).

Ulna
Two larger fragments of *Ovis*. One has BPC=24.0 (SI=86.5) (fig. 6.3/D); the other has LO=51.4 (fig. 6.3/E) and SDO=27.0. They were considered wild.

Metacarpus
One specimen with BP=30.2 (SI=77.8) could be identified as wild sheep (fig. 6.3/F). Two other fragments one of *Ovis* (SD= 19.9 BD=28.0) and one of *Capra* (BD=28.9) with a SI of 57.9 - most probably have to be considered wild as well. A complete metacarpal of Ovis (GL=143.0 BP=24.8 SD=16.2) might come from a large male or a wild animal (see Cavallo 1995). The SI=50 points to the first hypothesis.

Pelvis
One specimen (LAR= 29.7 LA= 33.6) is slightly smaller than two female wild sheep identified at Demircihüyük (LA=34.0) (Rauh 1981) (fig. 6.3/G and 6.3/H).

Femur
One specimen (*Ovis*? BD=43.1) larger than the rest of the

sample and larger than *Ovis orientalis* of Jericho (BD= 39.5) (Clutton-Brock and Uerpmann 1974). Another specimen (*Ovis/Capra* DC=23.0; SI= 62.5) exceeds the rest of the material in size, and might belong to a wild animal (fig. 6.3/I).

Tibia
Only one fragment (BP=43.9) might come from a wild animal.

Astragalus
GLL shows a normal distribution of the measurements. One specimen with GLL=33.3 (SI=57.5) and BD=21.1 (SI=59.9) which falls outside the range of the rest of the material has been identified as *Ovis orientalis* (fig. 6.3/L).

Metatarsus
One fragment (SD= 14.2, BD= 26.5; SI >50.0, might come from a wild sheep (fig. 6.3/M).

Phalanges
PH1
Three larger specimens, one with GL=40.5 (fig. 6.3/N), one with BP=14.1 (fig. 6.3/O), and one with BD=14.2 (fig. 6.3/P) have been considered wild. The differences between front and hind limb might also have influenced the distribution.
No comparable measurements are available except for a similar specimen found at Korucutepe and identified there as wild *Ovis/Capra*.
PH2
Compared to PH1, PH2 do not present a normal distribution of the measurements, which are smaller than those of the *Ovis orientalis* from Mureybit.
PH3
Few measurements are available. There is one small specimen with DLS= 25.0 and one larger specimen with DLS=33.9, but there is no clear evidence that they are wild animals

Variable	Mean	Std Dev	Coef Var	Range	N
M3I E					
L	21.28	1.72	8.1	18.5 - 24.3	31
B	7.71	0.75	9.7	6.9 - 8.9	30
M3I T					
L	21.24	1.39	6.5	18.9 - 24.3	35
B	8.04	0.8	9.9	6.0 - 9.6	40
M3I P					
L	21.49	2.02	9.4	17.6 - 26.3 (24.0)*	29
B	8.01	0.73	9.1	6.6 - 9.4 (9.6)*	32
hum E					
BD	30.42	2.54	8.3	27.1 - 37.8 (34.0)*	26
BT	28.08	2.28	8.1	24.4 - 34.8 (31.1)*	27
hum T					
BD	30.03	1.81	6.1	25.3 - 34.2	29
BT	28.74	1.59	5.5	25.7 - 33.3	32
hum P					
BD	29.81	1.77	5.9	26.1 - 34.8	44
BT	28.27	1.75	6.2	24.7 - 32.6	48
astr E					
GLL	27.64	2.16	7.8	24.5 - 33.3 (30.9)*	20
BD	17.93	1.17	6.5	15.9 - 21.1 (19.3)*	21
astr T					
GLL	27.89	1.59	5.7	25.3 - 31.6	24
BD	18.17	1.10	6.1	16.4 - 20.7	26
astr P					
GLL	27.44	1.15	4.2	25.4 - 30.0	18
BD	17.92	1.02	5.7	16.7 - 20.0	17

* identified wild animals: within brackets the maximum values without the wild specimen is given.

Table 6.12 Statistic values of selected ovicaprid elements

Variable	Mean	Std Dev	Minimum	Maximum	N
scap E					
SLC	20.33	1.87	17.4	22.0	6
GLP	31.87	3.20	26.9	35.2	6
LG	24.02	2.11	20.5	26.4	6
BG	19.93	2.46	17.3	22.9	6
scap T					
SLC	20.60	1.20	18.9	22.2	5
scap P					
SLC	20.49	1.17	18.6	22.4	7
GLP	31.69	2.08	29.3	35.2	8
LG	24.35	1.17	22.9	26.2	10
BG	19.81	1.59	17.5	21.8	10
hum E					
BD	30.36	2.32	27.1	34.0	16
BT	27.98	2.12	25.5	31.1	16
hum T					
BD	29.93	1.69	25.3	32.8	26
BT	28.50	1.28	25.7	30.7	24
hum P					
BD	29.51	1.60	26.1	33.7	34
BT	27.96	1.53	24.7	32.6	34
rad E					
BP	30.25	2.31	26.7	34.0	13
rad T					
BP	31.64	3.81	27.4	41.5	10
BD	27.48	1.72	26.4	30.7	6
rad P					
BP	30.46	2.14	26.9	34.2	18
BD	27.77	1.67	25.7	30.7	9

Table 6.13 Statistic values of selected forelimb bones of sheep

6.2.4 Skeletal representation, fragmentation and butchery

The general pattern of skeletal representation of the ovicaprid is similar for all three phases (fig. 6.8; table 6.14). The dental and the mandibular elements are clearly the parts best represented. The increase of horncores in the Early Halaf phase is partly due to the increase of the goat horncores. Sheep horncores are represented less as the ewes were found to be mainly hornless. However, this phase in general shows a decrease in the incidence of cranial elements. A disproportion between forelimbs and hindlimbs exists only in the Transitional phase, while in the other phases they are represented in equal percentages (table 6.15). Consistent is the increase of carpal and tarsal bones throughout the phases, whereas the relative frequency of metapodials remains constant. This apparent contradiction might be explained by the fact that metapodials are the major elements used for making tools, and are therefore less represented in this sample.

A small percentage (2-3%) of ovicaprid remains shows traces of butchering increasing slightly in the Early Halaf phase (table 6.16). Evidence of skinning is present on the distal part of the metapodials and on the posterior (volar/plantar) side of one phalanx (fig. 6.9). This operation was probably also intended to separate the distal parts of the metapodials for artefact production. Heavy chopmarks were only observed at the basis of the horncore to separate the horn and horncore from the skull. The head of the animal was detached from the rest of the skeleton at the level of the first cervical vertebrae. Atlas and axis show traces of transversal cutmarks in the ventral part. Presumably the carcass was hanged and the head removed after the carcass had been ventrally cut up to the muscles of the neck.

Dismembering left traces of cutmarks mainly on the basis of the skull (fig. 6.9), on the ventral side of the pubis and on the medial side of the trochanter major of the femur. In this case

Element	P			T			E		
	O/C	O	C	O/C	O	C	O/C	O	C
cornu	1	2	7	1	2	8	1	2	21
cran	60	7		58	2	4	60	5	
max	32			6	3		24		
mand	171			132			135		
dentes	540			489			524		
hyoid				1			1		
atlas	11	1		18			8	6	2
axis	7	2		13	2		21	4	
cerv	6			2			6	3	
thor	1						5		
lumb	4						12		
caud							1		
vert							1		
sacr				3			4		
stern	2			1					
costa							1		
scap	49	12		22	31		47	9	2
hum	44	41	9	42	41	3	48	20	3
rad	32	42	9	52	24	4	56	19	7
ulna	20	8	3	10	16	3	30	5	
carp	21			24			30		
mc	46	11	2	44	20	2	43	2	1
pelv	70	4		110	6	1	64	4	2
fem	53	2		49	7	1	56		
patel	6			4			4		
tib	76	1		98			77		
fib							1		
astr	11	12	2	27	11		45	2	
calc	14	4		17	13	2	36	4	
tars	6	2		8	6		27	1	
mt	29	6		31	8	2	44	1	
mp	11			17			23	1	1
ph1	25	1	1	56			97	1	
ph2	8			17			38	1	
ph3	3			14			31	1	
sesam				1			5		
Total	1359	158	33	1367	192	30	1606	91	39

Table 6.14 Absolute frequency of ovicaprid skeletal elements

%	head	axial	forelimb	hindlimb	carp/tars	mp	ph	N
Early Halaf	46.6	3.7	12.3	12.3	8.6	6.9	10.4	1595
Transitional	51.9	1.4	9.5	19.4	5.7	6.9	6.6	1322
pre-Halaf	59.5	2.1	10.7	14.7	3.8	6.4	2.7	1351

head = mandibula, loose teeth, maxilla, skull fragments; axial = atlas, axis, vertebrae, sacrum; forelimb = scapula, humerus, radius, ulna
hindlimb = pelvis, femur, tibia

Table 6.15 Relative frequency of portions of ovicaprid remains the head of the femur was loosened up by cutting the ligaments and not by chopping. A similar method was used for the forelimb: cutmarks were observed on the neck of the scapula and less frequently on the proximal humerus.

Further partition of the limbs occurred at the elbow and the knee (fig. 6.9). Distal humeri, proximal radii and astragali present cutmarks indicating the cutting of the numerous and strong ligaments that envelope these areas. The effort put in this operation is perhaps meant to keep the distal part of the tibia intact, as this element was commonly used for tool production.

Cutmarks related to the removal of meat were observed along the spina and the ventral ridge of the scapula. Costae and vertebrae within the category of medium mammals also present cutmarks for the same purpose.

Traces related to the process of fabrication of tools were observed on the metapodials. They consist of rather long and parallel deep cutmarks made longitudinally on the diaphysis of the metapodials to divide these elements into two parts. They were subsequently modelled as awls.

phase	N	%
Early Halaf	47	3.0
Transitional	32	2.0
pre-Halaf	33	2.1

Table 6.16 Frequency of butchering marks observed on ovicaprid remains

6.2.5 Age at death

The results of the analysis of the dental eruption and wear are shown in figure 6.10. The pre-Halaf phase is represented by a relatively low percentage of very young individuals (<1 yr) with a peak of mortality between 3 and 4 years, followed by a gradual decline of older animals. In the Transitional phase an increase of animals killed at a younger age with a peak between 1-2 years can be observed. A second smaller mortality peak exists between 4-6 years followed by a sharp decrease of the last age classes, which are not represented in the mandibular wear stages. Clear selective culling of 0-2 years and 3-4 years classes is present in the Early Halaf phase.

A gradual, although small, increase of animals killed at a young age is present in the data on the epiphyseal fusion as well (tables 6.17, 6.18, 6.19 / fig. 6.11). The older epiphyseal age categories are characterized by a sharp decrease between the Middle I and Middle II age categories in the Early Halaf phase. This is also reflected in the mandibular wear stages between the high kill-off of the 3-4 years class in the pre-Halaf phase compared to lower kill-off in the older age classes.
From the above data a change in the exploitation of the ovicaprids in the course of time can be inferred. The data from the pre-Halaf phase may be interpreted as a pattern of meat exploitation in which the animals are mainly killed at the moment of maximum return in terms of meat weight and reproductivity. The ages between 2.5 and 4 years represent the moment when the rapid growth has ceased and the meat gain no longer increases relative to fodder input. This category presumably represents females which have lambed at least once or twice. The individuals killed at a juvenile age would then represent mostly males.

The increase of individuals killed as juveniles in the Transitional and Early Halaf phases could reflect a beginning emphasis on the exploitation of the ovicaprids for their secondary products such as milk. When milk exploitation is the main goal of ovicaprid husbandry the mortality pattern is usually characterized by a group of very young animals and by a group of mainly female adults (Payne 1973). Ewes have a reproductive life of 5-6 years with an average of 3 years starting from their second winter (Bates 1973: 147; Cribb 1991). The data suggest that in the Transitional phase sheep were kept until an older age than in the Early phase.

The mortality peak in the subadult category of 1-2 years instead of in the first year, however, cannot be explained by the pattern of milk exploitation. Redding (1981: 204) points out that the age of 6 months-2 years is the optimal age for slaughter when the security of the herd is more important than the maximization of its energy (i.e. exploitation mainly for its meat). Killing mainly males at this age would assure enough food and labour investment of the herders for the females responsible for the continuity of the herd.

The Early Halaf phase also shows a strong selective culling of two categories of animals. The first category (0-2 years) reflects the Transitional pattern, while the second category (3-4 years) reflects the pre-Halaf phase. In this phase therefore one gets the impression that the two previous patterns are fused together. This seems therefore a shift again towards a meat consumption pattern as in the pre-Halaf phase but this time more selective on specific classes.

However, it seems rather unlikely that a development in the exploitation of the ovicaprids for milk production was so soon abandoned. The increase in goat remains in the Early Halaf phase may have compensated for the possible shift towards more meat production, as goats are better milk producers than sheep. A reflection of the different use of the two species might be present here as well, as in the case of the size differences of the humerus (see above). Sheep continued to be used for meat (and wool?) while goats were used for milk and less for meat. An increase of goats milk may have changed the slaughtering pattern and kept the sheep (meat) kill off intact. According to the models developed by Redding (1984: 237), an increase of goats in herds may also have had the purpose to secure the herd when the herders became more involved in agriculture. It is also possible that milk production did not really decrease because part of the herd, which mainly consisted of the milk producers (older females) and lambs, was held at some distance from the site and is therefore not represented in the Sabi Abyad material. This material on the contrary might represent the animals from that herd consumed at the site together with those always maintained within or in the surroundings of the village.

The data do not provide clear evidence of exploitation of the ovicaprids for their wool: in this case one might expect an emphasis on or increase of older animals (Payne 1973). The development of a woolly fleece is considered one of the later changes resulting from domestication and it is not known when exactly it occurred (Ryder 1983). Although the first evidence of woolly sheep is dated to the end of the fourth millennium and consists of pictorial representations (Ryder 1983), one clay figurine of a sheep with long curly wool from Tepe Sarab dates the existence of this kind of sheep already in the 7th millennium (Bökönyi 1977: 25). It is not known if the sheep from Sabi Abyad were already in a stage in which woolly fleece was developed or if their aspect resembled more that of a wild sheep (hairy sheep). However, this does not exclude an occasional use of the wool by way of plucking it during the moult.

	UF	F	tot.	%F
scap (tuber)	8	18		
hum d.	3	84		
rad p.	4	50		
acetabulum	1	31		
tot. early	**17+7#**	**123**	**147**	**83.7**
ph1	3	17		
ph2		8		
mc d.	8	25		
tot. middle 1	**11**	**50**	**161**	**82.0**
tib d.	9	55		
mt d.	5	15		
ulna p.	5	6		
femur p.	10	18		
calc	4	8		
tot. middle 2	**33**	**102**	**135**	**75.5**
hum p.	-	3		
rad d.	8	18		
fem d.	6	15		
tib p.	5	2		
tot. late	**19**	**38**	**57**	**66.7**

neonatal or juvenile specimens from the other categories; neonatal: 2 tib d., fem p.; juvenile: 1 mc d., 1 tib d., 2 mt d.

Table 6.17 Ovicaprid epiphyseal fusion data - pre-Halaf

	UF	F	tot.	%F
scap (tuber)	4	21		
hum d.	8	66		
rad p.	5	41		
acetabulum	6	55		
tot. early	**23+3#**	**183**	**209**	**87.2**
ph1	3	45		
ph2	2	12		
mc d.	15	25		
tot. middle 1	**18**	**82**	**100**	**82.0**
tib d.	11	51		
mt d.	7	17		
ulna p.	4	5		
femur p.	10	26		
calc	8	16		
tot. middle 2	**40**	**115**	**155**	**74.2**
hum p.	3	1		
rad d.	10	11		
fem d.	6	7		
tib p.	10	11		
tot. late	**29**	**30**	**59**	**50.9**

juvenile specimens from the other categories: 2 mc d., 1 tib d., 1 mt d.

Table 6.18 Ovicaprid epiphyseal fusion data - Transitional

	UF	F	tot.	%F
scap (tuber)	4	23		
hum d.	2	54		
rad p.	1	47		
acetabulum	13	31		
tot. early	**20**	**155**	**175**	**88.6**
ph1	20	60		
ph2	5	29		
mc d.	11	9		
tot. middle 1	**36**	**98**	**122**	**70.5**
tib d.	12	32		
mt d	9	11		
ulna p.	4	6		
femur p.	14	14		
calc	22	8		
tot. middle 2	**41**	**71**	**112**	**63.4**
hum p.	2	4		
rad d.	14	9		
fem d.	12	3		
tib p.	8	3		
tot. late	**36**	**19**	**55**	**34.5**

Table 6.19 Ovicaprid epiphyseal fusion data - Early Halaf

6.2.6 Pathology
(fig. 6.12)

The majority of the pathological conditions observed on the ovicaprid remains concern mandibulae and dental elements. They consist mainly of malocclusion, anomalies in crown and tooth shape, tooth alignment and rotation. As already observed their incidence is higher in the pre-Halaf levels (Cavallo 1995) (table 6.20).

phase	Ovis/Capra	Ovis	Capra	tot.	%
Early Halaf	12		-	12	27.9
Transitional	9	2	-	11	25.6
pre-Halaf	18	-	2	20	46.5

				43	

Table 6.20 Frequency of ovicaprids remains with pathological alterations

Various oral pathologies were observed on the ovicaprid remains. A mandible (P15 40.120/17) presents an anomaly in the tooth alignment with a rotation of P3. The aetiology of developmental malformations is unknown (Baker and Brothwell 1980: 139-141). They can also originate from overcrowding or other desists or trauma, but none of these were observed on the mandible. Rotation may also be due to congenital defects (Levitan 1985: 46).

Abnormal crown shape was observed in a few lower first or second molars. In one case (P15 40.115/114) the abnormal crown shape is characterized by an enamel "depression" on one of the pillars. In another case (P15 40-115/253) the abnormal crown shape is characterized by a mesio-distal compression along one of the lobes. Hypoplasia may be one cause of these malformations.

Many teeth present abnormal roots characterized by an expansion of the root tips (fig. 6.12A). This dental pathology seems to be the result of a low-grade alveolar infection (Siegel 1976: 371, fig. 9c; Baker and Brothwell 1980: 150). In the Sabi Abyad material this condition was often observed in upper as well as lower molars from older individuals.

Infection on the tissues and the alveolar bone resulting in periodontal diseases and sometimes in abscesses was also present. The infection sometimes affected only the alveolar margins, sometimes to a larger extent the whole alveolar cavity and the mandibular bone, leading in a few cases to the loss of the tooth/teeth involved. One mandible (P15 40-120/32) shows an enlargement of the alveolar margins with the presence of pitting. The periodontal diseases of another mandible (R13 9-34/2) are due to the ante-mortem tooth loss of (probably) the third molar (M3) (fig. 6.12B). Yet another mandible (P15 17-39/6) presents a large alveolar bone destruction due to a long-standing abscess (6.12C). The infection affected more than one tooth root leading to the perforation through the mandibular bone for pus drainage (Baker and Brothwell 1980: 154). Another mandible (P15 50.144/1) shows traces of an infection characterized by swelling at the level of the P3 and P4 due probably to a cyst or an abscess.

Apart from oral pathologies on one mandible (Q13 29-56/3) the presence of an extra foramen close to the mental foramen was observed. The size of the major foramen is reduced. This anomaly could be due to an associated pathology such as an internal infection or to a congenital origin (Levitan 1985: 46). The latter is more probable as is probably the case for the Sabi Abyad specimens.

Fractures/trauma and ankylosis are the pathological alterations which mainly affected the postcranial skeletal elements. Healed fractures are observed especially on ribs. One pelvis (P14 35-160/1) also presents a healed fracture under the acetabulum. The abnormal shape of the processus coronoideus of a mandible is possibly due to a trauma. An example of ankylosis due to a trauma is represented by a radioulna (P13 18-5/3) characterized by considerable new bone formation on both elements around the point at which the two bones fused. The rest of the ulna is also rather deformed. Radii and ulnae are also the postcranial elements which mainly present irregular bone proliferation (infections?). In addition to these, a metacarpal affected by bone proliferation on the proximal articular surface was found.

In conclusion, while some pathological injuries described above might be explained as the result of congenital or developmental defects, others such as many of the oral and periodontal diseases, seem to be related more to the type of environment and forage/pasture. It is also interesting that their incidence is reduced in the later two phases, suggesting a better control and care of the herds.

6.2.6 Conclusion

The comprehensive analysis of the ovicaprid remains from Sabi Abyad strongly indicates that a process of transformation in the husbandry of the two species took place in the course of occupation of the site. The main components of this transformation can be summarized as follows:
1) increase of goats in the last (Early Halaf) phase as a possible response to environmental degradation.
2) although the osteometrical analysis does not show great changes in the general size of the ovicaprids, a possible internal shift towards different groups (female/males) seems to be present.
3) an important shift from a generalized pattern of meat exploitation towards a more selective culling as the result of the development of secondary products exploitation on one side and as a response to a critical situation such as possible environmental changes on the other side. This response may

have resulted in a possible development of seasonal pastoral movements or more mobile pastoralism.
4) the shift towards a more conscious control of the herds seems also to be reflected also in an improvement in the health conditions of the animals.

6.3 Bovids

6.3.1 Introduction

Nowadays cattle are the second most important economic animals in the Middle East after the ovicaprids. In the studied area two major races of cattle are bred: the shorthorned or polled humpless Oksh group and the cervical Damascus type (Felius 1985). The Oksh group is found in the northern inland parts of the Middle East (Caucasus, Turkey and Syria), whereas the Damascus group is common in the coastal areas of the Mediterranean from Turkey to Egypt. In Syria in particular the most common breeds of the latter group are the Joulan and the Chaissi type, both rather small, working breeds. In the Damascus region the largest and the best dairy cattle of the Middle East are found, the Shami cattle. To the Damascus type belongs also the South Anatolian Red, found in the region of Aleppo, in northern Syria.

These breeds are the results of a long process of domestication and selection which started about 8000 years ago. The aurochs, *Bos primigenius* the now extinct wild progenitor of the domestic cattle, was in the past widespread in the whole Middle East from the Levant to the Zagros-Mesopotamian region. The population was most likely divided into different zoogeographical subpopulations. Although it is a ubiquitous and very adaptable animal, the aurochs is essentially an animal of the open forest. For this reason it inhabited certain more favourable areas of the Middle East, such as regions with covered vegetation, marsh areas, lake surroundings and alluvial plains (Ducos 1991a: 162-163).

There is not yet complete agreement about the area in which the aurochs was first domesticated and about the period in which this happened. Until a few decades ago it was not clear whether cattle were first domesticated in Europe and then brought to Asia or viceversa or, alternatively, whether there were different nuclei of incipient domestication in both continents (Reed 1969: 373). For a long time the earliest evidence of domestic cattle came from Thessalia in Greece. The sites of Argissa Magula, dated about 6500 B.C., and Nea Nikomedeia, dated about 6100 B.C., both provided evidence of domestic cattle (ibid.) (table 6.21). In the Middle East the earliest evidence of domestic cattle appeared somewhat later. Hole et al. (1969: 303) found definitive evidence of domestic cattle in the Sabz phase (5500 B.C.) of the Deh Luran sequence in Khuzistan and he stated that domestic cattle appeared in this Zagros area certainly not before 6000-5800 B.C. and that they were introduced from another area. In northern and central Mesopotamia domesticated cattle were known from later (late Neolithic/Halafian) sites, such as Banahilk and Arpachiyah.

Nowadays more osteological data become available, but the debate is still open. Helmer (1989) sets the beginning of cattle domestication at the end of the late PPNB (end of the 7th - beginning 6th millennium) at sites such as Ras Shamra on the Syrian coast and Abou Gosh in Palestine. A possible presence of the domestic cattle at Bouqras[1], Hayaz, Tell es Sin, Suberde and the last levels of Mureybit would extend the possible area of first domestication to the Taurus (Helmer 1989; Clason 1980; Buitenhuis 1988 and pers. comm.; Lasota-Moskalewska 1994: 28). Ducos (1991a), however, does not agree with some of Helmer's interpretations and argues for more caution in the interpretation of the metrical data. He is more inclined to see a possible presence of a local population of *B. primigenius* at sites such as Abou Gosh and other Palestinian sites (Munhatta, Ain Mallaha) or a cultural selection of female wild cattle at Çatal Hüyük, and possibly Bouqras en Beisamoun (ibid.). The dimensions of the bovid remains from Tell Aray 2 in the El-Rouj basin in northwestern Syria points to the presence of domestic cattle in this area around the middle of the 6th millennium (Hongo, 1996). The much earlier (at the turn of the 8th-7th millennium) claim of the presence of domestic cattle at Nemrik on the Tigris in northern Iraq remains isolated in this area sofar (Lasota-Moskalewska 1994).

In the meantime more studies on faunal remains from late Neolithic/Halafian sites had become available: Shams ed-Din (Uerpmann 1982), Çavi Tarlasi (Schäffer and Boessneck 1988), Girikihaciyan (Mc Ardle 1990), and Tell Turlu (Ducos 1991b). At these sites, all dated to the first half of the 5th millennium, the presence of domestic cattle is widely attested. At each of these sites the majority of the bovid remains belong to domestic cattle and only a few remains may be attributed to the aurochs.

According to what is said above and due to the relatively early crucial date of Sabi Abyad, the bovid remains found at this site represent an important sample. In addition, Sabi Abyad is situated in a central position between the Levant, Anatolia, and the eastern Zagros.

This part of the study intends to present and evaluate the data on the bovid remains from Sabi Abyad in relation to their domestic status. The question is whether we see here a local process of domestication or a process of more control on the cattle herds by the inhabitants of the site from an initial stage of incipient domestication in the oldest levels of occupation to a fully domesticated population in the latest levels.

[1] The results on a new seclected sample of bovid remains from Bouqras would confirm the presence of domestic cattle at this site (Ketelaar 1996).

site	date (B.C.)	status	reference
Mureybit	8500-7000	wild	Ducos 1978
Çatal Hüyük	6000-5600(6400)	wild(dom)	Ducos 1988 (Perkins 1969)*
Jarmo	6750	wild	Stampfli 1983
Ali Kosh	6500-6000	wild	Flannery 1969
Bouqras	6000	wild/dom	Buitenhuis 1988
Hayaz Hüyük	6000	wild/dom	Buitenhuis 1988
Shams ed-Din	4500	dom+wild	Uerpmann 1982
Girikihaciyan	5000-4500	dom+wild	McArdle 1990
Çavi Tarlasi	4500	dom+wild	Schäffer-Boessneck 1988
Banahilk	4500	dom+wild	Laffer 1983
Tell Turlu	5000-4500	dom+wild	Ducos 1991

* Çatal Hüyük: levels I-VII (Ducos 1988), XII (Perkins 1969)

Table 6.21 Chronology of the sites with bovid samples used for comparison

The main criterion for the evaluation of the domestic status of the bovids will be the use of osteometrical data. Their importance and the caution needed for the use of the measurements has already been discussed elsewhere (Cavallo 1996). Unfortunately morphological data, such as the shape of the horncores, are lacking at Sabi Abyad because of the relatively poor state of preservation of bone at the site. The measurements of the Sabi Abyad bovid remains will be reported in the form of histograms of frequencies and plots. Because Sabi Abyad does not represent an isolated site, the question can be solved in relation to and with the help of the data from surrounding sites.

However, support for the osteometric identification may be obtained from other sources of evidence: the variation in the percentage of bovid remains within the whole sample as well as changes in the mortality pattern. Variation in skeletal representation, butchery methods, increase in pathological conditions can also support the domestic claim.

6.3.2 Metrical analysis

The purpose of the following section is to compare the Sabi Abyad cattle metrical sample with samples from other Neolithic, including the Halaf, sites and in particular to note the presence of wild individuals. The sites used for this comparison are indicated in table 6.21. The bovid remains found at Sabi Abyad belong to large-size animals (Appendix). A shoulder height of ca. 130 cm was calculated on one complete metacarpus (P15 14.35/1 T, GL= 200.2 mm) with the multiplication factor of 6.5 (von den Driesch & Boessneck 1974). The Neolithic domestic cattle was not much smaller than their wild counterparts (*B. primigenius*). The size of the *B. primigenius* of the Middle East was smaller than that of the European aurochs, which had a withers height of about 150-155 cm for cows and 170 cm for bulls (Bökönyi 1974: 101).

6.3.2.1 Metrical analysis in detail

M3I (figs. 6.13, 6.14, 6.15)
Most of the values of the length of the third molars lie between 33.7- 40.9 mm. One molar (L= 46.2) from the Transitional phase is definitely larger than the rest of the sample and its size falls well within the range of the aurochs of Europe and the Middle East (Laffer 1983: table 53). Its size corresponds to the highest values of Mureybit (41.2-46.8). The comparison with domestic cattle from Halafian sites shows closely corresponding ranges between them, although the Sabi Abyad range is wider.

The values of the breadth of the third lower molar show a much less uniform distribution. The range (11.2-15.6 mm) is definitely much smaller than that of Mureybit (17.0-19.0 mm). In the scatter-diagram of the length versus the breadth the data for the Sabi Abyad molars do not overlap those from Mureybit. The Transitional period shows the widest range. All the values from the pre-Halaf fall within the upper part of this range while the values from the Early Halaf phase fall within the lower part.

Humerus (figs. 6.16, 6.17, 6.18)
The histogram for the distal breadth of the humerus (BD) shows two rather separate groups. In the distribution of the breadth of the trochlea (BT) the values are more uniformly distributed. Two clusters are also clearly visible in the plot of the two measurements. The two larger specimens, both from the pre-Halaf phase, can be easily identified as wild animals. They fall within the range of variation for aurochs of the Middle East: Jarmo: BD= 90-108 mm; Deh Luran: BD= 88-102 mm. The other specimens from pre-Halaf levels fall well within the smaller-sized group of supposed domestic cattle.

The sample is comparable to that of Çatal Hüyük (see BD frequency distribution). Although only measurements of the humeri were available, Perkins (1969) attributed the bovids from the latest level (level VI) of Çatal Hüyük to domestic cattle, as well as those from the oldest ones (levels X-XII). The sample was also studied by Ducos (1988). Ducos' analysis relates to the levels VIII- II, possibly including in part specimens from Perkins' study. Ducos, however, concluded that the bovid remains from Çatal Hüyük belonged to wild animals. He explained their smaller size as due to the presence of mainly females. The sample of Çatal Hüyük, however, is hardly useful as it was not random but consists of selected material only (Buitenhuis, pers. comm.)

Radius
The values of the distal breadth (BD) of the radius are within the range of domestic cattle from the Middle East. No comparison is available for the proximal part (BP) but it does not seem to belong to an extraordinarily large animal.

Metacarpus (fig. 6.19)
Only one proximal metacarpus could be measured. Its proximal breadth is 80.8 mm. This value is comparable to those of the aurochs from Jarmo (69.5;74.0;85.2 mm) and from the Danish sites (63.0-90.0 mm). The bovid metacarpals from the later Halafian sites are all smaller (table 6.22). Two distal fragments can be attributed to the wild aurochs as their size falls within the range of variation of values for aurochs in the Middle East.

Sabi Abyad		80.8
Tell Turlu	(D)	65.4
Banahilk	(D)	64.1; 69.5
Çavi Tarlasi	(D)	(56); (59); (61); 63.0; 64.0
Shams ed-Din	(D)	59.0
Jarmo	(W)	69.5; 74.0; 85.2
D= domestic; W=wild		

Table 6.22 Comparison of the proximal breadth (BP) of the metacarpal

The other measurements form a group of a definitely smaller size and they most probably belong to domestic cattle. They are comparable to the domestic cattle of the Halafian sites of Çavi Tarlasi and Banahilk as well as to some values of the much earlier site of Bouqras. If we accept the hypothesis that an incipient domestication is present at Bouqras, this similarity should not surprise us. What is surprising, however, is that the value of a distal metacarpal from Mureybit falls within the lower range of 'domestic' cattle!

Tibia (fig. 6.20)
The sample mainly consists of fragments from the Transitional period and only one specimen from the Early Halaf phase. The measurements of the larger specimens are comparable to those from Mureybit and Jarmo. The lower values from Bouqras are intermediate. Although the tibiae from Banahilk were identified as domestic, one of them is within the range of the wild cattle.

Calcaneus
The size of two calcanei from the Transitional phase, albeit large, still falls within the range of the domestic cattle from Europe (Degerbøl and Fredskild 1970). A third specimen falls within the same range (Wijngaarden-Bakker 1989). The fragment belongs to somewhat later layers, confirming the general trend towards the reduction in size of the bovid.

The values from Sabi Abyad exceed those from Çavi Tarlasi (GL=140-127.0 mm n.=4; GB=45-48.0 mm n.=3). Comparisons from other sites are not available. A specimen from a still juvenile individual (UF) with an exceptionally large size from the pre-Halaf period should probably be attributed to the aurochs.

Astragalus (figs. 6.21, 6.22, 6.23)
The greatest lateral length (GLL) plotted against the distal breadth (BD) was compared to samples from Jarmo, Mureybit and Çatal Hüyük. The sample from Sabi Abyad partly overlaps the lower values for the aurochs from the two oldest sites (Jarmo and Mureybit). The size of the Sabi Abyad bovids is however comparable to that from Çatal Hüyük.

As the Halafian sites, a comparison is possible with the sites of Çavi Tarlasi. From Banahilk only the GLL can be compared. The GLL of this site falls within the lower range of the Sabi Abyad distribution.

The trend of reduction in size from the pre-Halaf period to the Early Halaf period is not so evident as in other elements. The values from pre-Halaf, however, are concentrated more within the upper part of the range whereas the only measurement from the Early Halaf phase belongs to the lower range.

Metatarsus (fig. 6.24)
The metatarsi that could be measured come mainly from the pre-Halaf period. The three highest measurements fall within the range of Mureybit and the European aurochs. The group of smaller specimens is comparable in size to those from the later Halafian sites of Banahilk, Çavi Tarlasi and Shams ed-Din.

PH1 (fig. 6.25)
The range of variation in the measurements of the first phalanges is wider compared to the other domestic cattle from the Halafian sites.

In figure 6.25 it is possible to observe that:
1. the pre-Halaf measurements have a range comparable to that of the Early Halaf phase but smaller than the Transitional's; all of them fall within the upper part of the range;
2. the range of variation of the Transitional phase is the widest; almost two separate groups are visible;
3. the values from the phalanges of the Early Halaf phase have

a range of variation as wide as that of the pre-Halaf phalanges but as a whole they are smaller.

The group of the highest values falls well within the range of the Pre-pottery Neolithic bovids of Jericho. These bovids are considered wild cattle and their smaller size compared to those from further north is considered a local adaptation to the environment (Clutton-Brock 1979; Uerpmann 1982: 32). According to this, the larger individuals from Sabi Abyad would represent wild cattle. A confirmation of this is the fact that the range of the values from Sabi Abyad overlaps the range of Mureybit in its upper part (only the measurement GL is much higher in Mureybit, but this depends on the different methods of taking these measurements). The lower values are similar to those from Shams ed-Din and other Halafian sites.

PH2 (figs. 6.26, 6.27, 6.28, 6.29)
Remarks similar to those of the first phalanges can be made about the second phalanges. One individual is exceptionally large. In the scatter diagrams it represents a very isolated element and does not follow the same pattern as the other phalanges. On the basis of some finds from Shams ed-Din Uerpmann (1982: 33-34) hypothesized on the existence of the wild water buffalo (*Bubalus*) in northern Mesopotamia in the late Neolithic. In particular he attributed a first phalanx to this species much larger, and much wider rather than longer, than the rest of the sample. If the specimen from Sabi Abyad belongs to an other species it might possibly be attributed to the buffalo. The distribution of *Bubalus* into western Mesopotamia has been discussed at great length for the period concerned. Meadow (communication at the last congress on Middle Eastern zooarchaeology), does not believe in such a far western distribution of this species and considers the specimen from Shams ed-Din to belong to a large animal. The morphological characteristics of the Sabi Abyad specimen are comparable to those of the other cattle phalanges from the same assemblage.

PH3 (fig. 6.30)
Three groups of measurements are visible in the histogram frequency of the length of third phalanges. The range of variation widely overlaps that of Mureybit.

6.3.2.2 Interpretation

From the analysis of the metrical data one may conclude that, as a whole, the range of most of the measurements from Sabi Abyad partly overlaps the smallest values of Mureybit, whereas it fits well that of Çatal Hüyük, being only slightly larger. Both the sample from Mureybit and from Çatal Hüyük were identified by Ducos (1978; 1988) as belonging to wild animals. He attributed the smaller size of Çatal Hüyük bovids to the fact that at this site female aurochs are mainly represented. Mureybit dates to the 9-8th millennium and there is no doubt about the identification of wild cattle. The site of Çatal Hüyük dates to the first half of the 6th millennium. It is interesting to note that on the basis of the size of the distal humerus Perkins (1969), attributed the bovids from the later levels from Çatal Hüyük to domestic cattle.

The bovids from the late Halafian sites are all comparable to the small bovids from Sabi Abyad and often they are even smaller. Their size corresponds to that of the Early Halaf phase of Sabi Abyad.

On the basis of the metrical analysis it is clear that some specimens from Sabi Abyad fall within the range of the *Bos primigenius* measurements of the Middle East. Mostly the metrical data are clearly separated from those of the rest of the sample. For these reasons they should be regarded with enough confidence as representative of the aurochs. A decrease in the proportion of wild to domestic cattle has been observed between the pre-Halaf (4.9%), Transitional (2.9%) and Early Halaf (1.2%) phase (table 6.23).

	P	T	E
M3I	2?	1	-
scap	-	1?	-
hum	2	-	-
mc	2	1	-
tib	-	3	-
tars#	1	-	1
mt	2	-	-
calc	1	-	-
astr	1?	1?	-
ph1	4	3	2
ph2	4+1?	1	-
ph3	2	2	-
total	18+4?*	11+2?	3

centrotarsale, not described in metrical analysis, see Appendix (measurements)
* in the Pre-Halaf phases three other specimens from juvenile individuals have been considered wild for their exceptional large size.

Table 6.23 Summary of the wild cattle identified from the metrical analysis

An interesting aspect of the bovid sample from Sabi Abyad is that it shows a reduction in size from the pre-Halaf to the Early Halaf period. The pre-Halaf values are, with very few exceptions, concentrated in the upper part of the range whereas those from the Early Halaf phase are in the lower part. Only two first phalanges are in the upper part but, at the same time, within the range of the wild aurochs and for this reason identified as *Bos primigenius*. The sample from the Transitional period constantly shows the widest range.

A serious constraint to the observations lies in the sexual dimorphism that is evident in bovids, especially in the wild ones and consequently a wide overlap between the wild females and the male domestic cattle would be present. This would mean that the so-called 'wild' specimens would represent the male aurochs whereas the 'middle size' specimens would be either domestic male or wild female. This in turn would signify that the wild population of aurochs became smaller in size in the course of time because none of the specimens reaches the dimensions of the larger individuals of Mureybit. Hunting of smaller females instead of huge male aurochs looks more probable.

Different interpretations are possible:

1) The pre-Halaf bovids represent a wild population. In this case at Sabi Abyad the *Bos primigenius* from the end of the 6th millennium would be smaller than those of two millennia before. This could be explained by a reduction in size of the wild population, either as a result of a local adaptation to the climate and to the environment or as a result of selective hunting of mainly females. The Transitional phase could represent the period of incipient domestication that would become stabilized in the Early Halaf period.

2) Alternatively, (incipient) domestication occurred in the pre-Halaf period and became stabilized in the later phases. Due to their large size it is difficult to consider all the pre-Halaf bovids as belonging only to domestic cattle. In this case the higher values would definitely come from wild animals while the lower ones from domestic animals.

6.3.3 Skeletal representation, fragmentation and butchery

Within the general pattern of skeletal representation, a few differences can be observed between the separate phases (table 6.24). In relation to the head, the histogram (fig. 6.31) shows an increase in the incidence of loose teeth from the pre-Halaf to the Early Halaf levels accompanied by an increase in the percentage of mandible fragments. To this lowest percentage of teeth in the pre-Halaf phase also corresponds the highest percentage of cranial elements. The pre-Halaf levels are characterized as well by a relatively high percentage of heavily fragmented horncore fragments.

Element	P	T	E
cornu	12	4	3
cran	16	17	6
max	2	1	2
mand	15	23	15
dentes	34	75	65**
hyoid	1	1	1
atlas	3	-	1
axis	3	3	-
cerv	3	-	-
thor	9	-	-
lumb	4	2	-
sacr	1	3	3
costa	15	-	3
scap	10*	8	2
hum	10	10	7
rad	3	18	7
ulna	4	3	8
carp	28	39	12
mc	12	17	8
pelv	6	10	6
fem	6	10	8
patel	1	3	2
tib	10	14	7
fib	2	8	1
astr	13	11	4
calc	14	6	7
tars	11	5	11
mt	18	7	9
mp	9	8	10
ph1	36	26	18
ph2	23	23	11
ph3	23	19	7
sesam	13	7	2
Total	370	381	246

* one scap (40.115/97) is BOS?; ** one dentes (13-40/2, pathological) is BOS? E?

Table 6.24 Absolute frequency of bovid skeletal elements

%	head	axial	forelimb	hindlimb	ph	sesam
Early Halaf	37.0	3.3	18.1	22.5	14.7	0.8
Transitional	31.8	2.1	24.9	19.4	17.8	1.8
pre-Halaf	21.6	10.3	18.1	21.9	22.1	3.5

mp were not included; head= mandibula, loose teeth, maxilla, skull fragments; axial= atlas, axis, vertebrae, sacrum; forelimb= scapula, humerus, radius, ulna, carpalia; hindlimb= pelvis, femur, patella, tibia, tarsalia

Table 6.25 Relative frequency of bovid skeletal portions

Elements of the forelimb are slightly less represented than the hindlimb in the Early and pre-Halaf phase whereas in the Transitional the ratio is inverted (table 6.25). The other most represented elements are the carpals and the phalanges, most of them discarded as a unit.

It is quite interesting that a marked increase through time in the relative frequency of head elements (from 21.6% to 37.0%) corresponds to a decrease in the frequency of phalanges (from 22.1% to 14.7%). This could be related to the major incidence of wild cattle observed in the pre-Halaf levels, suggesting that only part of the carcass of the killed animals was brought to the village.

The butchery marks (on about 3% of the bovid sample: 1.3% in pre-Halaf, 5.0% in Transitional, 3.7% in Early Halaf) were concentrated on the articulated parts of the limbs (fig. 6.32). The dismembering of the limbs occurred by cutting the head of the humerus and of the femur out of the glenoid cavity and of the acetabulum respectively. A scapula shows blade marks on the neck; for the hindlimb cutmarks are present at the end of the trochanter minor of the femur while no signs of butchering or breaking were observed on the pelvis. Disarticulation of the jaws is attested by the presence of a cutmark on the ramus horizontalis and frequent cutmarks or small chopmarks on the hyoid. The distal parts of the humeri frequently present cutmarks on the lateral side that result from the separation of the joint. The same butchering action has left cutmarks that have been observed on the olecranon of the ulna. Cutmarks on the ulna, close to the semilunar notch, are the result of the separation of this bone from the humerus. A concentration of butchery marks is present in the tarsal joint where both astragalus and calcaneum show a series of cutmarks on the medial and lateral side respectively. The disjointing of the lower part of the extremities occurred at the level of the metapodial-phalangeal joint. The metapodia carry signs of cutmarks on the dorsal side produced by the cutting of the tendons of the extensor muscles. The phalanges do not carry traces of butchery marks with the only exception of one first phalanx from the pre-Halaf period. In the middle of the diaphysis on the dorsal side there is a clear chopmark. Its round shape means that it was made with a rather pointed tool and if it were not for the lack of clear recent fractures it could easily be interpreted as a modern pick-mark. A similar feature is present on the diaphysis of a humerus (fig. 6.33) also from pre-Halaf levels.

6.3.4 Age at death

The tables 6.26, 6.27, 6.28 and figure 6.34 summarize the data on epiphyseal fusion of the bovid remains.

	UF	F	tot.	%F
scap (tuber)	-	2		
hum d.	2	4		
rad p.	-	2		
ph1	2	21		
ph2	1	20		
tot. early	**5**	**49**	**54**	**90.7**
mc d.	2	1		
mt d.	-	8		
mp d.	5	2		
tib d.	-	1		
calc	6	3		
tot. Middle	**13**	**17**	**30**	**56.7**
hum p.	-	1		
rad d.	1	-		
fem p.	3	-		
fem d.	1	-		
tib p.	-	3		
tot. late	**5**	**4**	**9**	**44.4**

Table 6.26 Bovid epiphyseal fusion data - pre-Halaf

	UF	F	tot.	%F
hum d.	7	-		
rad p.	1	7		
ph1	-	18		
ph2	-	19		
acetabulum	-	3		
tot. early	**8+2#**	**47**	**57**	**82.5**
mc d.	3	6		
mt d.	2	-		
mp d.	2	-		
tib d.	2	9		
calc	-	1		
tot. middle	**9**	**16**	**25**	**64.0**
hum p.	1	-		
rad d.	5	4		
ulna p.	1	1		
fem p.	1	1		
fem d.	-	4		
tib p.	1	-		
tot. late	**9**	**10**	**19**	**52.6**

juvenile specimens from the other categories: 1 mc, 1 mp.

Table 6.27 Bovid epiphyseal fusion data - Transitional

	UF	F	tot.	%F
scap (tuber)	-	2		
hum d.	1	4		
rad p.	-	6		
ph1	1	14		
ph2	-	9		
acetabulum	1	-		
tot. early	**3+1#**	**35**	**39**	**89.8**
mc d.	8	1		
mt d.	1	-		
mp d.	-	1		
tib d.	1	2		
calc	4	-		
tot. middle	**14**	**4**	**18**	**22.2**
rad d.	1	-		
ulna p.	2	2		
fem p.	4	-		
fem d.	1	-		
tib p.	1	1		
tot. late	**9**	**3**	**12**	**25.0**

juvenile specimen from the other categories: 1 mt.

Table 6.28 Bovid epiphyseal fusion data - Early Halaf

In the pre-Halaf phase less than 10% of the animals died in a juvenile stage and more than 50% survived the subadult and adult age. The presence of one fused and three unfused vertebrae suggests that killing at old age rarely occurred. The Transitional phase shows an increase of individuals killed at a young age combined with a decrease of individuals in the middle and late categories. The Early Halaf phase shows a percentage of young animals killed in the first category similar to that of the pre-Halaf phase but, in contrast, a clear increase of individuals killed in the Middle and Late categories. In none of the three periods very old animals are present. The scarce dental data that are available show absence of teeth with an advanced stage of attrition (table 6.29). This again shows the lack of old animals.

	P	T	E
M3I-/DP4+++/ P4 unerupted (subadult)	3	3	3
M3I+ (early adult)	1	2	1
M3I++ (adult)	1	8	5*
M3I+++ (senile)	-	-	-

* one specimen belongs to a wild animal
degree of wear: - unworn; + slightly worn, ++ worn; +++ heavily worn

Table 6.29 Bovid dental wear and eruption in each phase

The data on epiphyseal fusion show a clear process of transformation in cattle exploitation. First, the increase of young animals in the Transitional phase indicates that a larger component of domestic animals is present in this sample than in the pre-Halaf one. The low percentage of young animals of the pre-Halaf sample cannot be explained by differential destruction of unfused elements, as this sample is better preserved than the later ones. Secondly, in the Early Halaf phase most of the cattle were killed at a subadult or adult age. Presumably these animals were killed when they had reached their optimal age for slaughter, i.e. the moment in which they reached their optimal weight before their growth rate began to level off, and, in case of females, after they had calved once. This moment might correspond to an actual age of 2.5-3.5 years (Uerpmann 1973: 136).

A pattern of exploitation similar to that of the Early Halaf phase occurred at the late Halafian site of Çavi Tarlasi, where a predominance of cows was observed that had been killed around their third year (Schäffer and Boessneck 1988: 41). The cattle at Sabi Abyad were probably exploited mainly for their meat, even if this does not exclude the use of secondary products such as milk. If the main purpose was the milk production as supposed for Çavi Tarlasi (Schäffer and Boessneck 1988: 41), one would expect a major incidence of old animals: milk yield increases after each pregnancy with about 30% within the first three, and to a lesser degree until the fifth one (Hammond et al. 1971: 71). In addition, assuming that Neolithic cows had a breeding activity similar to wild species, with births mainly in spring, the production of milk would have been heavily affected by the low food intake of the dry months resulting in a steady decrease in its production (Hammond et al. 1971: 73-74).

6.3.5 Pathology

Anomalous tooth shapes were observed in three specimens. A lower tooth (P15 9.14/8, T), probably a molar, with an abnormal crown development resulted in a curious and irregular shape (fig. 6.35A). This anomaly is attributed to genetic and breeding factors (Baker and Brothwell 1980). One lower M1 or M2 (P14 32-157/3, T) presents a different degree of wear between the first and the second lobe due to malocclusion. A lower incisor (P14 28-121/1, phase unknown) shows a notch between the crown and the root (fig. 6.35B). These last phenomena are usually attributed to environmental and nutritional factors. The last anomaly, in particular, seems to occur more frequently with herbivores feeding on abrasive and coarse grass (Müller 1997).

Another element affected by pathological conditions is the phalanx. On two first phalanges a depression on the medial side at the point where the musculus interosseus medius goes through was observed. It is not known if this anomaly depends on deficiencies of pathological nature or on a strong development of the muscle. A second phalanx (P15 23-59/5 T) exhibits a slight bone proliferation (exostosis) at the proximal, posterior side. This should probably be regarded as considered a thickening of the area of attachment of the tendons rather than a form of pathology. A third phalanx (P15 23-58/41) is affected by osteoarthritis. It shows exostosis around the articular surface and the articular surface itself presents grooving and polishing (eburnation). Osteoarthritis is either a result of heavy use of the articulation or of old age. The second phalanges might reflect the same condition but to a lesser extent. Even if it is often correlated to their use as draught animals the real causes are not known, and it is possible that they are also the results of trauma (Baker and Brothwell 1980: 115). A radius (P15 26.60/54 T) shows a bone proliferation on the diaphysis, on which prints of blood vessels are visible. This condition probably has an infectious origin.

6.3.6 Conclusion

The data here presented show that the bovid remains from Sabi Abyad underwent a process of transformation during the three phases of habitation of the site. The evaluation of these data may help to answer the question whether the cattle were domesticated or not, and, if they were, since which phase.

Most likely the cattle represented a domestic breed since the first phase, the pre-Halaf phase. Their large size comparable to that of the wild aurochs might denote a first attempt at domestication. However, the wild component is certainly attested in this phase.

The Transitional phase probably represents the moment in which experimentation in the exploitation of cattle took place. In this phase both the largest and the smallest specimens are present: bulls and cows in terms of domestic breed. However, the wild component is still present and in a percentage only slightly smaller than the previous phase. The slaughtering curve also shows a pattern similar to the pre-Halaf phase, but with a higher percentage of young animals.

The Early Halaf phase presents a different pattern of exploitation, probably the result of the process of transformation already started in the preceding phases. The sample from this period is characterized by the presence of bovids of smaller size and by a killing-off pattern concentrated on subadult, adult but not old animals. This sample might have been represented mainly by females maintained until their first calf. The young bulls were probably killed before they reached an age in which their maintenance would have become difficult due to their character. Therefore the main purpose of the cattle exploitation seems to have been meat production, perhaps also accompanied by the utilization of their milk.

The lack of old animals suggests that the cattle were not used for ploughing or transport. However, in the absence of horses and/or donkeys one may wonder whether the wide distribution of Halafian ceramics should perhaps be linked to the use of cattle as beasts of burden.

6.4 Suids

6.4.1 Introduction

Suids, represented by 642 bones, constituted ablut 9% of the total faunal assemblage (table6.2). Most of the suid remains belong to the domestic pig (*Sus domesticus*). The importance of the pigs varies at considerable extent in the course of the time. Within the group of domestic animals the relative importance of pigs increases from 4.6% in the pre-Halaf phase to 7.7% in the Transitional phase and to16% in the Early Halaf phase. Apart from the metrical analysis, the description of the skeletal representation, butchering marks and pathological conditions, this chapter, in particular, gives an attempt at a separate analysis of the age at death for each phase.

6.4.2 Metrical analysis

The measurements are reported in Appendix. Comparison of the measurements showed the presence of two wild boars: a mandibula and a humerus from the Transitional (level 6) and pre-Halaf (level 8/9) phase respectively (Cavallo 1995, 1996). Due to their large size four other specimens must belong to wild animals even if, belonging to juveniles or partly broken, they could not be measured. They consist of a distal unfused radius (level 8/9), whose general size is comparable to the other wild humerus found in the same level; a proximal unfused ulna (level 10) with an articulation breadth (BPC) of at least 22.6 mm; a distal metapodial from level 5, and a female upper canine from level 2.

Summing up these data, it appears that the incidence of wild pigs decreases through time, from three in the pre-Halaf phase to two in the Transitional, and one in the Early Halaf phase. It is interesting to combine these data with the general representation of the suid remains in each phase, which clearly increases through time (table 6.30).

	N	%	tot. identified
Early Halaf	380	15.4	2470
Transitional	164	7.1	2312
pre-Halaf	92	4.3	2127

Table 6.30 Relative frequency of suid remains in each phase

6.4.3 Skeletal representation, fragmentation and butchery

Due to the high degree of fragmentation of the material the skull, in particular its cranial bones, is the best represented part (table 6.31, fig. 6.36). However, teeth are present in a lower frequency than in other species such as ovicaprids and bovids. A different pattern exists between cranial bones and teeth on one side and maxillae and mandibulae on the other side: there is an increase in the first group and a decrease of the second, indicating more fragmentation and worse preservation in the more recent - and upper - layers.

The forelimb is better represented than the hindlimb. Curiously the frequency of the forelimb bones - with the exception of the metacarpal - decreases through time while this happens for the hindlimb bones only for the pelvis: the tibia shows indeed an opposite trend while the relative frequency of the femur remains constant. All the distal parts of the limbs show a general increasing trend through time. Grouping together the different skeletal portions, it seems clear that the meat-bearing parts (upper fore- and hindlimbs, and skull) decrease at the expense of the less or none-meat- bearing parts (table 6.32).

Butchering marks were observed on few elements (table 6.33; fig. 6.37). On the skull, small repeated cutmarks on the zygomaticus and chopmarks on the ramus verticalis of the mandibula just under the processus coronoideus are related to the disarticulation of the lower jaw from the rest of the skull by cutting the masseter and the temporal muscle respectively. The relatively frequent and numerous traces of cutmarks on the lateral side of the ramus verticalis of the lower jaw are also associated with the removal of the thick masseter muscle. Other traces of cutmarks, which might be attributed to a process of disarticulation are those noted on the distal humerus, the proximal ulna, the proximal metapodials and on the condyli of the astragalus. Small chopmarks on the distal diaphysis of the femur might be the result of opening the diaphysis in order to extract the marrow.

Element	P	T	E
cran	12	28	63
max	6	10	9
mand	10	18	31
dentes	8	19	48
atlas	2	1	2
thor		5	1
cerv	1		
lumb			8
caud			1
sacr		2	
costa	13		
scap	8	12	19
hum	6	6	19
rad	6	3	12
ulna	4	9	15
carp		2	9
mc	2	7	19
pelv	5	5	9
fem	2	4	9
patel		3	
tib	2	8	17
fib	1	2	2
astr	2	5	11
calc	1	3	8
tars		3	7
mt		1	13
mp	2	4	4
ph1		5	23
ph2		2	9
ph3	2	2	10
total	82	166	381

Table 6.31 Absolute frequency of suid skeletal elements

%	head	axial	upper forelimb	lower forelimb	upper hindlimb	lower hindlimb	c/t/p	mp	ph
Early Halaf	39.6	3.2	10.0	7.0	4.8	5.0	9.2	9.4	11.0
Transitional	45.1	4.8	10.8	7.2	5.4	6.0	7.8	7.2	5.4
pre-Halaf	41.9	3.6	14.6	7.3	8.5	3.6	3.6	4.8	2.4

head= cranial bones, maxilla, mandibula, dental elements; axial= vertebrae; upper forelimb= scapula, humerus; lower forelimb= radius, ulna; upper hindlimb= pelvis, femur; lower hindlimb= tibia, fibula; c/t/p= carpalia, tarsalia, patella

Table 6.32 Relative frequency of suid skeletal portions

	cutmarks	chopmarks
cran	1	-
mand	2	1
hum	3	1
ulna	1	-
pelv	1	-
fem	-	1
mt	2	-
mp	1	-

Table 6.33 Frequency of butchering marks observed on suid remains

6.4.4 Age at death

Although the mandibulae and the loose teeth for which the age at death could be estimated are still few, they strongly indicate that suids were killed quite young in all phases (table 6.34). The specimens within the first category present an unerupted, erupting, or unworn M1; in all these specimens the M2 had not yet erupted. The age of eruption of these teeth for late maturing breeds or wild boar seems to occur at the age of about 6 months and 7-12 months respectively (Bull and Payne 1982: 56). The season of birth for wild boar in the Middle East is concentrated in April and May (Harrison 1968: 376, Bull and Payne 1982: 57). Assuming the same spring farrowing in the past, the data indicate a selective culling of most of the pigs in the autumn. The second category presents specimens with P4 only slightly worn and M3 erupted but unworn. This stage can be dated at around the end of the second year (eruption of M3 at about 18 months), indicating that these animals were killed at the beginning of their second winter. Specimens with an advanced stage of wear of M1 and with a slightly worn M3 represent the last category. This indicates that the animals had not reached their third year.

	P	T	E
juvenile (< 1 yr)	4	3	6
adult (ca. 2 yrs)	1	1	1
mature (>2 yrs)	1	2 (1W)	3

W= wild

Table 6.34 Suid mandibular tooth eruption

The epiphyseal fusion data are consistent with data obtained from the mandibular wear stages (tables 6.35, 6.36, 6.37). They also seem to indicate an increase through time of animals killed at a very young age. Perinatal bones, consisting of cranial and mandibular fragments, were found in each of the three phases. No fused bones are present in the last category, indicating that no animals reached their third year.

	UF	F	tot	%F
scap (tuber)	-	2		
hum d.	1	3		
rad p.	-	5		
acetabulum	1	1		
tot. early	**2**	**11**	**13**	**84%**
tib d.	-	-		
mc d.	-	1		
tot. intermediate I	**-**	**1**	**1**	**100%**
mt d.	1	1		
calc	-	-		
tot. intermediate II	**1**	**1**	**2**	**50%**
hum p.	-	-		
rad d.	1	-		
ulna p.	2	-		
fem p.	-	-		
fem d.	2	-		
tib p.	1	-		
tot. late	**6**	**-**	**6**	**-**
			---	
			tot.22	

Table 6.35 Suid epiphyseal fusion data - pre-Halaf

	UF	F	tot	%F
scap (tuber)	2	2		
hum d.	1	2		
rad p.	-	2		
acetabulum	1	3		
tot. early	**4+2***	**9**	**15**	**60%**
tib d.	1	1		
mc d.	2	3		
tot. intermediate I	**3**	**4**	**7**	**57%**
mt d.	1	-		
calc	1	1		
tot. intermediate II	**2**	**1**	**3**	**33%**
hum p.	1	-		
rad d.	1	-		
ulna p.	3	-		
fem p.	3	-		
fem d.	1	-		
tib p.	2	-		
tot. late	**11**	**-**	**11**	**-**
			---	
			tot. 36	

* 2 juvenile distal tibiae

Table 6.36 Suid epiphyseal fusion data – Transitional

	UF	F	tot	%F
scap (tuber)	5	3		
hum d.	3	7		
rad p.	2	5		
acetabulum	3	3		
tot. early	**13+1***	**18**	**34**	**53%**
tib d.	5	3		
mc d.	12	-		
tot. intermediate I	**17**	**3**	**20**	**15%**
mt d.	3	4		
calc	5	-		
tot. intermediate II	**8**	**4**	**12**	**33%**
hum p.	4	-		
rad d.	4	-		
ulna p.	3	-		
fem p.	3	-		
fem d.	5	-		
tib p.	1	-		
tot. late	**20**	**-**	**20**	**-**
			tot. 86	

* 1 juvenile distal tibia

Table 6.37 Suid epiphyseal fusion data- Early Halaf

6.4.5 Pathology

Pathological conditions on suid remains are few. They consist of an upper jaw (P15 56.173/20 LE: 11) affected by a periodontal disease which led to the *ante mortem* loss of the third molar as indicated by the reabsorption of the alveolus. The presence of an unworn M2 in the jaw indicates that this was not an old animal.

6.4.6 Summary

It has already suggested that Sabi Abyad might represent one of the first sites in this area in which the domestication of pigs occurred (Van Wijngaarden-Bakker 1989). The size of the suid remains with the presence of a few large or wild individuals combined with the slaughtering patterns concentrating on young animals since the pre-Halaf phase suggests that domestic pigs had been present since the first phases of occupation of Sabi Abyad. The new data confirm that their importance rose through time as they were increasingly incorporated in the husbandry economy of the site.

The increase in importance of pigs contrasts with the supposed environmental degradation which emerged from the analysis of the ovicaprids. The increase in pigs supposes that the environmental (humid) conditions for raising them were still available around the sites. On the other hand, pigs are omnivorous and can feed on an extremely large variety of food as well as on human food refuse. Their constraints are closer related to the water availability or humid climatic conditions. Their wider range of food resources associated to their high reproduction rate makes them suitable for a faster food return in terms of labour and food input than ovicaprids or even larger herbivores.

6.5 Equids

6.5.1 Morphological identification

Remains of *Equus* from prehistoric sites in Middle East are for the largest part attributed to the onager (*Equus hemionus*). However, since Ducos (1968) raised the question of the presence of the wild ass (*E. asinus*) in northwestern Syria, zooarcheologists have been taken into account the possible occurrence of this species in their bone assemblages. In order to distinguish between onager, *Equus hemionus*, and ass, *Equus africanus*, among the equid remains from Sabi Abyad, the identification of these remains was executed with the help of the reference collection of the Institut für Ur- und Frühgeschichte of the University of Tübingen and the help of Prof. H.-P. Uerpmann. The material used as reference was a recent skeleton of *E. hemionus kulan* and of *E. asinus*.

Identification to species level was not possible for all specimens. The following constraints were recognized:
Firstly, the degree of fragmentation of the material, and the consequent lack of diagnostic parts hampered the identification of many fragments. Secondly, some skeletal elements, such as the calcaneum, do not have any diagnostic features. Thirdly, the assemblage contained young specimens, unfused longbones and deciduous teeth in the assemblage. For those reasons the identification of many specimens (67.6%) remains uncertain and is entered in the tables (6.2, 6.6, 6.7, 6.8) as *Equus sp.*

6.5.1.1 Postcranial elements

Regarding the postcranial elements the following diagnostic characteristics were taken into account:

Scapula
The rather straight and flat shape of the spina points to the identification of the specimens from Sabi Abyad in which this part is preserved as onager. One specimen (Q15 13-22/11) raised some problems. Here the angle of the tuber scapulae with the glenoid cavity shows more resemblance with the curved shape of asses according to Uerpmann (pers. comm.). This characteristic combined with the overall shape of the bone indicates the presence of the domestic donkey. As domestic ass in Middle East has not been attested before the third millennium B.C. this fragment should most probably be considered an intrusion from the Bronze Age habitation levels.

Humerus
The humeri from Sabi Abyad consist mainly of distal parts and are generally heavily fragmented. Therefore the identification based on morphological criteria could not be carried out.

Radius
The degree of fragmentation of the Sabi Abyad radii does not allow the identification to species level. In addition, most radii belong to young individuals.

Ulna
In the Sabi Abyad sample only one proximal ulna is rather well preserved: the shape of the olecranon relatively longer than large in its volar view and generally more medially curved than in donkey, points to onager.

Femur
A useful criterion for the distinction between ass and onager is the shape of the trochanter minor in the proximal part: straighter in onager and curved in ass. This part is well preserved in only one specimen (P15 23-58/31), which has a shape typical of onager. For the distal ends the shape of the groove separating the two condyles when it reaches the trochlea could be used for distinction. In the Sabi Abyad sample, this part, when preserved, is more 'V' shaped such as in onager, and not curved as in ass.

Tibia
With regard to the distal tibia the most reliable distinguishing features of onager are: (1) the straighter contour-line of the medial malleolus; (2) the not very well developed groove which runs from this point on the medial side; and (3) the degree of curving of the articular surface for the astragalus at the tip of the malleolus (in onagers curving out medially less than in asses) (Uerpmann 1986: 259). These characteristics were observed in the specimens from Sabi Abyad, with the exception of one fragment (P15 10-76/13). This specimen shows a more notched contour line of the medial malleolus, but this could be attributed to its young age. The identification to species level of one complete tibia was also hampered by its juvenile age.

Astragalus
The criteria used for the identification at species level of this element were the shape of the distal tuberosity and the shape of the medial side of the trochlea. The specimens from Sabi Abyad are in this respect typical for onager (Uerpmann 1991, fig. 5).

Metapodia
In the Sabi Abyad sample there are no complete metapodials. The distal ends do not present diagnostic features. The volar edge of the only proximal metatarsal end is not as straight as in onager. This part, however, is not very diagnostic and it can be quite variable within the same species (Uerpmann, pers. comm.).

6.5.1.2 Dental elements
(fig. 6.38)

In relation to the differences between ass and onager teeth do not provide very reliable characteristics, especially the lower cheekteeth, and even less the deciduous ones (Eisenmann 1976). The upper cheekteeth provide more indication in the shape of the protocone. The Sabi Abyad sample contains mostly upper cheekteeth, one third of which is represented by deciduous teeth, and only one upper molar.

Lower cheekteeth:
Most of the lower molars/premolars (Q14 26-90/12 P3/4, Q15 8-14/3, Q14 26-108/1) show an enamel pattern with a rather open "V"-shaped vallis interna and a rather low vallis externa (not entering into the vallis interna). These aspects, as well as the overall form of the enamel pattern, are more similar to those observed on the onager used as comparison and much less to those of the ass.

One specimen (molar/premolar) (P15 30-81/3) has a slightly different fold morphology with a more 'U' horse -like shape of the vallis interna and a more intrusive vallis externa. The tooth belongs to a rather young animal for it still has a high crown. The wear was at its beginning and it is likely that the enamel wear pattern would have changed in time resulting in a more 'V' pronounced shape (Uerpmann pers. comm.). The shape of the 'vallis interna' is in any case not as deep as in horse and deeper `vallis externa' may also occur in onager. The shape and the size of the lobes also show more similarity to those of the onager.

The other lower cheekteeth belong to juvenile individuals and so they do not provide useful information. They consist of three loose milk premolars, one of which is badly preserved (P14 28-118/4). The other two (milk premolars 2 and 3) are still embedded in the jaw (P15 31-95/6).

Upper cheekteeth:
In the sample only one upper cheektooth (P15 28-71/5) is present. Based on the angle between the root and occlusal surface and on the generally squarer form of the occlusal surface it represents most probably a right first or second molar. The specimen is characterized by a relatively short asymmetrical protocone, elongated in its posterior part but not as much as in horse, with a rather flat lingual wall whereas in asses the shape of the protocone is more triangular. The protocone index (OL/LP[2]x 100) of 47.5 fits well in the middle of the range of modern and fossil onager (Eisenmann 1980, 1981; Payne 1991: fig. 5, table 11; Zeder 1986: fig. 11). The "pli caballin" is present, even if very poorly developed. The

[2] OL= occlusal length of the teeth; LP= occlusal length of the protocone. P15 28-71/5: OL= 11.4; LP= 24.

"pli caballin" can also appear in asses and half-asses (Bökönyi, 1986: 306) and was also observed in the sample from Mureybit (Ducos 1986: 237) as well as on the specimen in Tübingen (on premolars).

6.5.2 Metrical analysis

The identification based on morphological criteria was supported by a metrical analysis. In general, the equid remains from Sabi Abyad are comparable in size to those found at Mureybit (Ducos 1978, 1986) and Shams ed-Din (Uerpmann 1982, 1986, 1991). In these sites the bulk of the equid remains belongs to onager[3], *E. hemionus*. The size of the early Holocene onager is considerably larger than that of the "hemippus" (*E. hemionus hemippus*), the subspecies of onager that was present in Syria until the beginning of this century. The "hemippus" represents a 'remnant of a Mesopotamian population of hemiones, altered and dwarfed through isolation and deterioration of its habitat brought about by human settlement and agriculture during Holocene' (Uerpmann 1986: 250).

Humerus
In particular the index of the maximal trochlear height (medial) and the minimal trochlear height (in the middle) of the humerus was calculated, according to the measurements coded by Eisenmann et al. (1988, p.38, measurement n.9 and n.10). The results point to onager (fig. 6.38).

measurements	9	10	index (9x100/10)
SAB (P15:30-82/9)	35.2	26.8	131.3
Sh-Din	35.8	27.7	129.2
Sh-Din	38.9	28.9	134.2
Onager (1)	43.1	32.0	134.7
Donkey (2)	38.2	24.5	155.9
Donkey (3)	32.0	23.0	139.1

(1) *E. hemionus kulan* recent, Tübingen collection n.Eq48
(2) *E. asinus* recent, Tübingen collection n.Eq40
(3) *E. asinus* recent from Selenkahiye

Table 6.38 Comparison of the measurement of equid humeri

Metapodia
For the metapodials a log-analysis was executed, which was compared to the ratio-diagrams of modern and fossil asses presented by Eisenmann and Beckouche (1986, figs. 8 and 15). The metacarpal, of which only the distal part was preserved, shows a strong similarity to the onager taken as reference (fig. 6.39). For the metatarsal this correspondence is less clear, due in part to the small number of measurements that could be taken. A distal metatarsal shows a line similar to that of *E.africanus* (fig. 6.40, meas. n.11-14). However, its measurements are much smaller than those of the wild ass and closer to those of onager. The same is valid for the other single proximal measurement (fig. 6.40, meas. n.11), very close to the zero line of the onager taken as standard. Another distal metatarsus shows an opposite trend compared to the ass (fig. 6.40, meas. n.5-6,7-8).

Phalanges
Figure 6.41 shows the correlation between the greatest length and the smallest depth of the first phalanges of Sabi Abyad compared with the onager remains from Mureybit and Shams ed-Din, and with the ass specimens found in the Arabian Peninsula (Uerpmann 1991, fig. 3). Both the anterior and the posterior phalanges from Sabi Abyad are close to the regression line of the onager.

Phalanx II shows a situation similar to the first phalanx. In figure 6.41 the greatest length and the proximal breadth are compared with the measurements from other sites. The second phalanges from Sabi Abyad are similar to those of Shams ed-Din, except for an anterior one which is closer to the regression line of *Asinus*.

Concluding, we see that, when identification based on morphological criteria of the diagnostic specimens was possible, it points consistently to one species, the onager (*E. hemionus*), the most probable species occurring in this area at that time. Those features being similar either to ass or to both species, are usually very variable within the same species or their reliability is low. The only exception is a fragment of scapula from a domestic donkey, which has to be considered a possible intrusion.

Although caution must be taken due to the low numbers of measurements, the metrical analysis in general confirms the morphological identification with the exception of the phalanges. Within these elements there is an 'abnormal' specimen. It cannot be excluded that it belongs to wild ass. The same situation is present in Shams ed-Din (Uerpmann 1986) and in Mureybit (Uerpmann 1991 and pers. comm.). It is, therefore, possible to conclude that the equid bones from Sabi Abyad belong to one species, the onager, and that we cannot completely exclude the presence of the wild ass, whose range seems to have extended above the Euphrates into the Jezira (Uerpmann 1991: 29).

6.5.3 Skeletal representation, fragmentation and butchery

Except for a few loose teeth, fragments from the skull are scanty. Axial elements (vertebrae and costae), too, are underrepresented, due to the difficulties in the identification of these elements even at genus level. The best represented

[3] I consider Uerpmann's interpretation (1991 and pers. comm.) of the equid bones from Mureybet valid. Ducos (1986) attributes them to *E. africanus*.

elements are those from the limb bones, especially hind ones, and, in particularly, the distal parts (phalanges). These observations are valid for all phases (table 6.39, fig. 6.43).

Element	P	T	E
mand	1	1	-
dentes	1	7	2
atlas	-	2	-
axis	-	1	-
sacr	-	1	1
lumb	1	-	-
scap	1	7	-
hum	2	-	-
rad	1	4	1
ulna	2	2	-
carp	-	1	3
mc	1	-	1
pelv	3	1	-
fem	5	6	1
patel	1	2	-
tib	2	8	2
astr	3	1	-
calc	-	1	-
mt	4	-	1
ph1	6	2	-
ph2	2	2	1
ph3	2	2	-
sesam	-	1	-
Totaal	38	54	13

Table 6.39 Absolute frequency of equid skeletal elements

Remarkable is the decrease of the forelimb bones in the Early Halaf phase compared to a more gradual decrease of hindlimb bones, which are always better represented than the forelimbs (table 6.40). This can be related to the different preservation of the various types of bone according to the age at which the animal was killed. Epiphyseal fusion for all the hindlimb ends occurs at a later age than for the forelimb bones, where only the distal humerus and distal radius fuse at a later age (see tables 6.41, 6.42, 6.43). With the exception of one juvenile tibia, carpal/tarsal bones and phalanges, all skeletal elements are fragmented.

A small percentage of the equid remains presents butchery marks, especially cutmarks. These were observed on the following elements: pelvis, tibia, calcaneum, and especially phalanges (fig. 6.44). The frequent cutmarks on the first phalanx are clearly related to the careful removal of the skin, and in particular they can be ascribed to the cutting of the complex group of ligaments reaching this area (Cavallo 1996). Most of the other cutmarks can be attributed to a process of disarticulation. Disarticulation between the sacrum and the pelvis occurred at the basis of the tuber sacralis and on the neck of the ilium. The traces left at this point are related to the removal of the lateral sacro-iliac ligaments. The disarticulation of the femur from the pelvis is attested by the removal of the capsularis muscle, which connects this point to the superior ischiatic spine. Evidence of the separation of the distal part of the limb is present on the distal calcaneum, where traces of cutmarks are attributed to cutting ligaments connecting the calcaneum to the tibia (short ligament) and to the metatarsal (plantar ligament). The possible chopmark observed on the diaphysis of one phalanx (P15 88 30-81/11) might be attributed to the extraction of the marrow.

Due to the scarcity of the material itself and of the traces left on it, it is difficult to reconstruct a pattern of butchering of the hunted onagers. As noted, the majority of the traces can be attributed in their majority to the process of disarticulation, but it is difficult to decide whether this occurred at the tell or already at the kill site. The other type of process that can be demonstrated is the removal of the skin. Although distorted by the lack of identification of axial elements this pattern suggests that the animals were killed and partially butchered far from the site and partially brought to the site possibly using the skin, to which the toe bones remained attached, as container of the best parts. This technique, known as 'schlepp effect', results in a relatively higher abundance of toe bones. At Sabi Abyad the percentage of toe bones (60%) is only slightly higher than that of limb bones (40%) in the pre-Halaf and Early Halaf whereas this ratio is inverted in the Transitional phase (35.5% toe bones and 64.5% limb bones), only partially supporting the 'schlepp effect' model.

%	head	axial	forelimb	hindlimb	carp/tars	mp	ph	N
Early Halaf	15.4	7.7	6.7	33.1	23.1	15.4	7.7	13
Transitional	14.9	7.5	16.1	35.3	5.7	3.7	11.1	53*
pre-Halaf	5.2	2.6	15.8	39.0	7.9	13.1	26.4	38

head= mandibula, loose teeth, maxilla, skull fragments; axial= atlas, axis, vertebrae, sacrum; forelimb= scapula, humerus, radius, ulna; hindlimb= pelvis, femur, patella, tibia; * excluded sesamoids

Table 6.40 Relative frequency of equid skeletal portions

Binford (1978, 1981) points out that the transport of parts of the carcass is highly dependent on the edible values (meat, grease and marrow) associated with the bones. From this basis he elaborated a general utility index (GUI) for each bone, according to which scapula, humerus and and femur are highly valued parts. A pattern similar to Binford's model might be reflected only in the Transitional phase where the relative frequency of scapula (13.0%) and the femur (11.1%) is higher than that of the toe bones but, however, lower than the percentage of the tibia (14.8%), which is the best represented element of this phase (table 6.39).

Contrary to the results of the previous authors, O'Connell et al. (1988, 1990) observed that pelvis, vertebrae and the upper limb were the best represented bones within the assemblage of the Hadza. They concluded that an important role in the selection of the parts to be transported was played by the size of the animal and the distance between the kill area and the residential site (O'Connell at al. 1990: 302). It has also been demonstrated that certain bone assemblages are the results of preservational factors, depending on the density, size, age etc., more than on human transport (Lyman 1985).

6.5.4 Age at death

The age at death of the onager was evaluated according to the method developed by O'Connor (1989) combined with the information on the epiphyseal fusion given by Silver (1969). The data obtained are summarized in the tables 6.41, 6.42, 6.43. Although the samples are small, the results are similar for the three phases. Summing up the data (table 6.44), these indicate that at least 12% of the animals were killed in the first category, i.e. in their first year. Bearing in mind the possible underrepresentation of unfused bones it is most likely that this percentage was actually higher. A lower percentage of animals were killed in the second and in the third category, i.e. in their second and third year, indicating that hunting was concentrated on mature individuals.

	UF	F	tot.	%F
Scap (tuber)	1	-		
Acetabulum	-	1		
PH2 p.	-	8		
tot. early	**1**	**9**	**10**	**90%**
Hum d.	-	1		
Tib d.	-	1		
Mc d.	-	1		
Mt d.	-	1		
tot. middle	**-**	**4**	**4**	**100%**
Hum p.	-	-		
Rad d.	1	-		
Fem p.	1	-		
Fem d.	-	1		
tot. late	**2**	**1**	**3**	**67%**
Lumb.	-	1		

Table 6.41 Equid epiphyseal fusion data - pre-Halaf

	UF	F	tot.	%F
Acetabulum	1	1		
Phl p.	-	4		
tot. early	**1**	**5**	**6**	**83%**
Rad p.	1	-		
Tib d.	1	4		
tot. middle	**2**	**4**	**6**	**67%**
Rad d.	-	2		
Ulna p.	-	1		
Fem p.	1	3		
Fem d.	-	2		
Tib p.	-	1		
tot. late	**1**	**9**	**10**	**90%**

Table 6.42 Equid epiphyseal fusion data – Transitional

	UF	F	tot.	%
Ph2 p.	-	1		
tot. early	**-**	**1**	**1**	**100%**
Rad p.	-	1		
Mt d.	-	1		
Mc d.	-	1		
Tib d.	1	1		
tot. middle	**1**	**4**	**5**	**80%**
Fem p.	1	-		
tot. late	**1**	**-**	**1**	**-**

Table 6.43 Equid epiphyseal fusion data - Early Halaf

	UF	F	tot.	%F	killed in age range
Age class Early	2	15	17	88%	12%
Age class Middle	3	12	15	80%	8%
Age class Late	4	10	14	71%	9%
			---		71%
			46		

Table 6.44 Summary of the equid epiphyseal fusion data

From the teeth few data can be obtained, because it is difficult to distinguish the loose ones, especially between P3 and P4 and between M1 and M2. The sample from Sabi Abyad contains at least four adult lower cheekteeth (premolars and molars), one upper molar, and four lower milkteeth. Two of the latter are still embedded in their mandible and could therefore be identified as DP2 and DP3. If this mandible were from a horse it would be younger than ca. three years of age at which the permanent P2 replaces the decidous DP2 (Levine 1982: 247, Appendix I).

At this point it is interesting to interpret the information about the age at death in the light of the social behaviour of the onagers. They live in herds constituted by females and young animals (Groves 1974). The herds are held together by an old female while most of the adult males live apart for most of the year. They group together only during two times of the year, in winter due to pasture shortage and in summer during the rut period. The lactation may last until 1.5 years old and both sexes are not sexually mature before the age of two. It is therefore most likely that in the Sabi Abyad sample the adult animals are females.

Support for this interpretation also comes from the fierce temperament of the onagers. In fact, their hunting cannot have been an easy task onagers being quite swift and tireless runners which can run at up to over 50 kph for more than an hour. However, it was observed that " onagers (kulan) crowd together when they are frightened and flee in complete confusion " (Salensky 1907 in Bökönyi 1974: 53). It seems therefore likely that the easiest preys for the hunters were the younger, or the old and sick individuals from the larger herds rather than the isolated stallions.

Another characteristic of onager behaviour might provide information about the period of the year in which they were hunted. Onagers (like all wild equids) are migratory animals and follow regular migratory routes (Groves 1974: 103). Tristam (1889 in Clutton-Brock 1992) asserts that the Syrian wild ass moved as far north as Armenia during the summer, descending as far south as the Persian Gulf during the winter. It is therefore plausible that onagers were killed in late summer-beginning of winter during their moves north-south along their migration route. This is also the time of the year in which the vegetation is scanter. It is therefore most likely that hunters took advantage of concentrations of animals in areas with lusher grazing pasture and with more watering facilities such as along the Balikh and the wadis.

6.6 Gazelle

6.6.1 Introduction

Gazelle accounts for 2.3% of the overall faunal sample (table 6.1). It accounts to 155 bones, including 33 , which, on the basis of morphological characteristics, have an uncertain determination.. Some of these bones should perhaps be ascribed to roe deer (*Capreolus capreolus*) or fallow deer (*Dama sp.)*. However, the rare occurrence of fallow deer and the absence of roe deer within the Sabi Abyad faunal sample, make it likely that the 33 fragments in question belong to gazelle as well.

6.6.2 Metrical analysis

The question of which species of gazelle is present in the archaeological context has often been discussed. Three species may occur in northern Mesopotamia: the mountain gazelle (*G. gazella*), the Dorcas gazelle (*G. dorcas*) and the goitred or Persian gazelle (*G. subgutturosa*) (cf. Uerpmann 1982). The first species is nowadays found in the mountains and foothills along the periphery of the Arabian Peninsula and in the Levantine piedmont (Harrison 1968). The range of distribution of the lesse commonly found Dorcas gazelle covers partly the area of the mountain gazelle (ibid.). Both species are said to occur in northern Syria as well, in the area of Tell Abyad atr the Syro-Turkish border, but it requires confirmation (ibid.:353,358). The third species, the goitred gazelle, is widely distributed in Iraq and in Iran and on the Arabian Peninsula, (ibid.).

The size of the postcranial remains provides little information about the proper identification of the species of gazelle, which is one of the main problems with regard to the gazelle remains from archaeological sites (Hakker-Orion 1986; Uerpmann 1982: 27). From the shape of the horncores found at Sabi Abyad only the goitred gazelle (*Gazella subgutturosa*) could be identified (Cavallo 1996); it is therefore plausible that the postcranial remains belong to this species as well. In addition, the analysis of the faunal assemblage from archaeological sites along the Euphrates and the Balikh provided evidence, mainly based on horncores, of only one species, again the goitred gazelle, *G. subgutturosa* (Uerpmann 1982, 1987, Legge and Rowley-Conwy 1987; Buitenhuis 1988; von den Driesch 1993 and pers. comm.) *G. subgutturosa* is therefore the most probable species in this area.

The measurements of the Sabi Abyad gazelle perfectly match those of the small goitred gazelle from the late Halafian site of Shams ed-Din (Appendix 1; table 6.45). Its size is slightly smaller than that of the gazelle of Mureybit (Ducos 1978). Although identification to species level has not been given at the later site, on the basis of the homogeneity of the gazelle measurements Ducos suggests that at Mureybit only one species was present (Ducos 1978). Uerpmann points out that despite the smaller size the difference is not such as to postulate a different species at Shams ed-Din - and therefore at Sabi Abyad - from that of Mureybit. According to this the gazelle represented at Sabi Abyad is most likely a small-sized type of *G. subgutturosa*.

From the analysis of the morphology of the horncores it seems that only males are represented in the sample. In figure 6.45 the distribution of the size index of the scapula and humerus has been plotted. These elements were chosen because the forelimb usually shows a more pronounced sexual dimorphism than the other limb bones and they are, moreover, most common in the sample. The results show that mainly smaller individuals are present, which could be females. This apparent contradiction with the horncores can be explained by the observation that females of *G. subgutturosa* are either hornless or bear horns or that these are rudimentary horns (Harrison

1968: plate 123). In the latter case, it is very likely that if the females had horncores these might have been destroyed or discarded. Buitenhuis (pers. comm.) observed that at the modern village of Bouqras gazelle horncores were specifically used in weaving carpets and that they were by far the preferred tool. He suggests that finding only male horncores may therefore also represent a selection for "tool manufacture".

	Variable	Mean	Std Dev	Range	N
scap					
Sabi Abyad					
	SLC	16.6	1.6	14.8 - 19.1	16
	GLP	28.1	1.2	26.6 - 31.5	15
	LG	22.4	1.5	20.0 - 24.8	19
Shams ed-Din					
	SLC	15.0	1.2	13.0 - 16.5	12
	GLP	28.7	1.4	26.0 - 31.0	14
	LG	22.9	1.3	20.5 - 25.0	10
	BG	20.7	1.7	18.5 - 23.0	12
hum					
Sabi Abyad					
	BD	25.9	1.1	24.4 - 27.6	10
	BT	23.4	1.2	21.2 - 25.8	13
Shams ed-Din					
	BD	25.8	1.0	24.5 - 27.5	6
	BT	23.4	0.9	22.5 - 25.0	7

Table 6.45 Comparison of statistical values of scapula and humerus of gazelle from Sabi Abyad with those from Shams ed-Din.

6.6.3 Skeletal representation, fragmentation and butchery

The skeletal representation of the gazelle remains has already been discussed (Cavallo 1996). The new data indicate a higher representation of phalanges in the Early Halaf phase (table 6.46; fig. 6.46). Most of the phalanges belong to one individual and were found associated with a metatarsal from the same individual in the fill (R13 9.66) of rooms 4 and 5, building II, level 3A. Clearly a distal hindlimb was discarded here during butchering. Both the nature of the deposit and the kind of bone refuse indicate that at that time the building, or at least those rooms, were most probably not used for habitation.

The only evidence of human modification on the gazelle bones are cutmarks along the diaphysis of an unfinished tool. The cutmarks are longitudinally located along and inside the vascular groove in order to divide the bone into two pieces at this point (fig. 6.47). In the earlier levels of Çayönü many tools (awls, pins and needles) were made of cervid metapodials as these have a denser structure than those from ovicaprids (Buitenhuis, pers. comm.). The same may be true for the gazelle of Sabi Abyad.

	P	T	E
cornu	5	6	1
max		1	1?
mand	8	6	1?
dentes	1	2	4+2?
atlas		1	
axis			1+1?
scap	2+1?	11+4?	4+1?
hum	4	7+7?	2
rad	1	1?	4
ulna		3+1?	2+1?
mc	1?	1	1+1?
pelv	1	1+1?	1
fem	1+1?	4+4?	
tib	1?	4	1
astr		2	1?
calc		2	2+1?
tars	1	1	
mt	1+1?	1	3
ph1			4
ph2			2
ph3	1		4

Table 6.46 Absolute frequency of gazelle skeletal elements

6.6.4 Age at death

Due to the small amount of bones, the data of all three phases were taken together and not separately for each phase. Four groups were observed within the mandibular remains (table 4.7). The first group is characterized by a rather but not heavily worn DP4. M1 is only slightly worn. The DP4 is shed just after the first year (Legge and Rowley-Conwy 1987; Davis 1980). Their anatomical wear[4] is ca. 5.6, 6.1, and 7.4 mm, which corresponds with an age of ca.7/8-11 months according to the data on the *G. subgutturosa* presented by Legge and Rowley-Conwy (1987: 81). The data furnished by Davis on the *G. gazella* and *G. dorcas*, however, indicate an earlier (3-8 months) age (Davis 1980: 61, fig. 5). The second group presents a P4 almost completely erupted. DP4 is shed between 15 and 18 months (Legge and Rowley-Conwy 1987; Davis 1980) and by 20 months it is completely replaced by P4 (Davis 1980). This group would thus represent individuals of almost 1.5 year. The other specimens comprise adult individuals in which the M3 is worn on all three lobes. Based on the degree of wear they can be clustered into two groups: (a) all teeth rather worn but not heavily. M3 with a anatomical wear of (15.6), 17.9 (mixed layers), 18.5, and 18.5 mm. These individuals probably represent prime adults of more than 20 months old; (b) an older group with a more advanced stage of wear. The anatomical height of M3 is 12.1 (mixed layers), and 13.9 mm.

[4] Calculated according to Davis 1983: fig. 2.

group	N	N
1 (DP4++.M1-)	4	
2 (P4 erupt.)	2	
1/2		2
3 (M3+)	5 + 1 (from mixed layers)	
4 (M3++)	2 + 1 (from mixed layers)	
3/4		3
	--	--
tot.	13 + 2	5
degree of wear: - unworn; + slightly worn; ++ worn		

Table 6.47 Mandibular wear stages of gazelle

Although based on limited data, hunting seems to have been concentrated on adult or subadult individuals while neither old animals nor newly born individuals were killed. Although the underrepresentation of the young, most likely due to either taphonomic or identification bias, asks for caution, the epiphyseal data are consistent with this interpretation (table 6.48).

Two early Syrian sites provided evidence of seasonal hunting of goitred gazelle. At Abu Hureyra newly born animals, yearlings and adult animals were hunted through mass killing in late spring (Legge and Rowley-Conwy 1987). At Umm Qseir, too, hunting concentrated on yearlings killed in late spring (Zeder 1994). The degree of wear and state of dental eruption of the young individuals (first two groups) from Sabi Abyad, however, seems to indicate that gazelle were hunted here during the winter (fig. 6.48).

Winter represents the period of higher density of the population for gazelles. In this period the herds reach their maximum, males mixing with females (Heptner et al. 1966; Baharav 1974; Simmons and Ilany 1975-77). These larger groups start to separate when the females leave the herd to give birth in March-April. In spring and summer gazelles are more territorial animals characterized by small groups of females with their yearlings, small groups of young and adult bachelors and territorial males. Seasonal territorial behaviour is a characteristic for gazelles, which was certainly known to prehistoric people. Although most likely due to their small body size gazelles did not undertake long-distance migrations: they moved up and down the valley with a maximum range of 100 km. In October/November modern populations of goitred gazelles in Central Asia (Balchasch area) start to migrate to their winter pastures, which they leave at the end of February returning to their summer pastures (Heptner et al. 1966: 541).

A similar pattern of seasonal migration could be supposed for the Balikh valley: the gazelles probably concentrated in the valley after the spring, where they remained before spreading again into the steppe in autumn. Hatt (1959: 71) reports a note of Charles Reed, who observed that modern Kurdish populations from North Iraq (Chamchamal area) hunt gazelles (not females) only after rain with the help of dogs (and only from horseback). After rain, the hooves of the gazelles sink into the ground giving dogs a better chance to catch them whereas on hard ground gazelles would always outrun the dog.

It seems therefore that hunting at Sabi Abyad was concentrated on larger groups and on adult animals, which gives a better chance of success and more return in response to the effort. An adult female *G. subgutturosa* yields about 12-15 kg of meat, an adult male up to 18 kg (Heptner et al. 1966). Absence of newborn or very young gazelle might indicate that hunting of these herds took place on an individual basis as opposed to the mass killings postulated for Abu Hureyra. In addition to meat the gazelles were probably hunted for their skin as well, as happened until recent times (Heptner et al. 1966; Baharav 1974). The Sabi Abyad sample also provided evidence of utilization of the carcass of these animals for making tools but in how far this was occasional or intentional is difficult to say.

		UF	F	tot	%F	killed in age range
rad p.	ca.2m	-	3			
hum d.	ca.2m	-	18			
scap	3-6m	4	17			
tot.		**4**	**38**	**42**	**90%**	**10% (<1yr)**
tib d.	8-10m	1	5			
calc p.	10-16m	-	2			
mp d.	10-16m	3	4			
fem p.	10-16m	1	6			
fem d.	12-18m	1	2			
tib. p.	12-18m	-	6			
ulna p.	12-18m	1	6			
rad d.	12-18m	1	1			
tot.		**8**	**27**	**35**	**77%**	**67% (1-1.5yr)**

			77			**33% (>1.5yr)**

Table 6.48 Gazelle epiphyseal fusion data estimated in months (time of fusion from Davis 1980)

6.7 Other species

A large spectrum of minor species was identified at Sabi Abyad. Except for a fragment of frog, most of the species were already found in the sample used as a preliminary analysis of the material (Cavallo 1996). They consist of large herbivores (fallow deer and red deer), carnivores (dog, hyaena, brown beer and fox, and rodents (hare and jerbils). In addition, bird remains and molluscs were found. Measurements of these species are reported in appendix.

6.7.1 Fallow deer

Remains of fallow deer were found only in the Transitional and pre-Halaf levels. One almost complete scapula (level 6), one upper molars (level 4), one upper third molar (levels 4/5), one fragment (diaphysis) of tibia (level 8), and one proximal metatarsus (levels 8/9) were identified as Persian fallow deer (*Dama mesopotamica*). The metatarsus shows cutmarks on the dorsal side near the articulation.

Two species of fallow deer are found in the Near East: the European fallow deer (*Dama dama*) and the Persian fallow deer (*Dama mesopotamica*). The latter is sometimes regarded as a separate subspecies of *D. dama* (Chapman 1975:23). The Persian fallow deer is larger than the European one (Harrison 1968), but the distinction between the species is mainly based the shape of antlers: in contrast with the European fallow deer, the antlers of the Persian fallow deer are not palmate distally and are flattened in their basal part. In addition, the Persian fallow deer has a smaller brow tine. Unfortunately, no antlers were found in the late neolithic Sabi Abyad sample.

Remains of Persian fallow deer have been found at a series of sites in Syria and southeastern Turkey: Mureybit, Shams ed-Din, Tell Turlu and Çavi Tarlasi (Ducos 1978; Uerpmann 1982; Ducos 1991b; Schäffer and Boessneck 1988). At Tell Assouad on the Balikh, one calcaneum was found, but as its size is smaller than that of *Dama mesopotamica*, was identified as *Dama* spec. (Helmer 1985b). Comparisons of the measurements of the scapula found at Sabi Abyad with those from other archaeological sites in Syria and Turkey showed that the specimen from Sabi Abyad can be placed in either species (Cavallo 1996: tab. 23). Kussinger (1988:146) referring to data from Greece, Turkey, Israel and Syria, points out that there is an overlap between the measurements of male European fallow deer and female Persian fallow deer overlap.

It is suggested that the Sabi Abyad fallow deer belongs to the *D. mesopotamica*, on the basis of size of the skeletal remains and the geographical distribution of the species. Nowadays, the Persian fallow deer, threatened by extinction, mainly lives in limited areas in the plain of Khuzistan in southwestern Iran, although it has been reported in recent times as far north as Zakho in Iraq, close to the Turkish and Syrian border (Harrison 1968). Little is known about the status of the animal in Syria. Talbot (1960:284) mentions an unverified report of its existence in the Alawit region, north of Latakia, suggesting that it may have survived in the forested hills of northwestern Syria. In the past, fallow deer occurred just across the northern frontier of Syria, near Gaziantep in Asia Minor (Harrison 1968). It is unknown whether the distribution of the two subspecies in the past overlapped or was contiguous (Chapman 1975:23), but, on present evidence, it appears that the two species lived in separate regions without any overlap (Harrison 1968:368).

6.7.2 Red deer

Red deer (*Cervus elaphus*) is represented by one partial molar (level 4), one third phalanx (levels 1/3B) and two fragments of scapula (level 4/5). The identification of the two scapula fragments is not certain. They are fragments of the blade, in particular the *margo thoracicus* (*caudalis*). Their shape does not resemble an ovicaprid but rather a cervid. The section has a more triangular shape and it flattens towards the proximal end (*margo vertebralis*). The *fossa scapularis* is deeper than in the ovicaprids. Also the fragments do not resemble the scapula of *Dama*.

Only one measurement was available for comparison. The third phalanx from Sabi Abyad with a diagonal length of 49.8 mm is smaller than the one of a female *Cervus* reported from Demircihüyük (59.5 mm; Rauh 1981). At Hayaz Hüyük, Buitenhuis (1988: 122) identified a third phalanx of red deer, but no measurements are given.

6.7.3 Dog

The dog (*Canis familiaris*) is present in the separate phases of occupation of Sabi Abyad, although not in all levels. The complete list of canid skeletal elements is given in table 6.49. The large amount of material analyzed confirms the presence of dogs in the later early Halaf levels as well, previously only assumed on the basis of traces of carnivore gnawing on the bones from these levels (Cavallo 1996). However, their frequency in the later stages of occupation of the site seems to have been lower, especially considering the fact that the dental elements (one canine, one second and one third premolar and one first molar, all lower) found the floor in rooms 4 and 5 of building II (levels 3B/3A) most likely belong to one individual. The representation of canid remains is probably dependent on the part of the site excavated and the utilization of the area where the bones were found. Most of the dog remains come from the trench P15 (N=18) and from levels 8 and 6 (table 6.49). The preliminary study on the faunal sample from squares P14, Q14, Q15 and trench P15 showed that bones with traces of carnivore gnawing are much more abundant (ca. 8-20%) in the lower levels 8 to 6 than in the upper levels 5-1 (ca. 1-3%) (Cavallo 1996: fig. 9.3). Whereas the settlement of Sabi Abyad shifted more and more towards the centre of the mound in the course of the time, it seems that the slopes of the mound (including trench P15) were turned into open, outdoor areas (cf. chapter 2). The accumulation of household debris around the buildings of levels 8 to 6 would certainly have attracted scavenging dogs. It is not surprising that in these levels the highest percentage of carnivore gnawing is present and that the lowest layers contain a higher proportion of dog remains than the upper layers.

The dimensions of the canid remains, in particular of the mandibles, indicate animals of different size. The dog from Sabi Abyad must have been rather large, when compared with the dog remains from Çayönü (Lawrence 1980) and Tell Turlu (Ducos 1991b), although the smallest mandible is similar in size to that found at Shams ed-Din (cf. Cavallo 1996). One specimen (radius) shows traces of numerous small and repeated cutmarks, which are possibily due to the filletting of the sorrounding meat on the medial side of the diaphysis (Cavallo 1996: fig. 9.10).

Level	element	n.
(phase E)		
3A	axis	1
3B/3A	dentes	4
2	rad	1
(phase T)		
4	cran	1
6	hum	1
6	rad	1
6	ulna	1
6	tib	1
6	mc2	1
(phase P)		
7	mand	1
8	mand	2
10	mand	1
11	mand	1
8	dentes	2
8	rad	1
8	ulna	1
10	ulna	1
8/9	fem	1

Table 6.49 Frequency of canid skeletal element

6.7.4 Fox

In total 16 specimens of fox *(Vulpes vulpes)* were identified in the material. Most of them come from the same feature (Q13 25.69; in the fill of stone terrace of Level 5/6) and presumably belong to the same individual. The skeletal elements of fox are summarized in table 6.50. No cutmarks were observed.

Element	n.
mand	2
axis	1
lumb	1
caud	1
hum	2
ulna	1
fem	1
tib	1
mt	4
ph1	1
ph2	1

Table 6.50 Frequency of the skeletal elements of fox

6.7.5 Hyaena

A virtually complete mandible of striped hyaena (*Hyeana hyaena*) was found in the transitional level 6. The jaw belongs to an adult animal and shows a high degree of tooth wear. It was previously hypothesized that possibly a human modification was the cause of the tooth shape, in particular of the heavy wear of the canine, of the mandibula, as shown in fig. 6.49 (Cavallo 1993). The original height of the tooth is almost completely reduced. The wear is characterized by mesial-distal oriented long marks parallel to the occlusal plane. Mixed with these, and partly overlapping them, short perpendicular marks were noted in a microscopic observation. Comparison with a series of modern hyaena mandibles from the National Zoological Museum of Leiden was conducted. The series consisted of three African *Crocuta crocuta* and two *Hyaena hyaena*. In these specimens the feral tooth (M1) is the most worn cheektooth. Its wear is characterized by small sub-parallel marks perpendicularly oriented to the occlusal side and sloping on the buccal side. The premolars present a flatter and less extended wear. While these characteristics were also observed on the Sabi Abyad specimen, no comparable canines were found. The canines of modern species were characterized by a wear on the tip and on the distal side of the tooth, due to the occlusion with the upper incisors and the upper canine respectively. Due to the almost complete removal of the crown of the canine of the Sabi Abyad specimen, it is possible that these two different wear inclinations had disappeared.

Human intervention was also hypothesized because of the fact that wear comprises only half of the biting surface of the tooth while the other half seems to have been broken. It was imagined that part of the tooth had been removed by a kind of "sawing". In this case one would expect longer parallel marks combined with shorter diagonal marks in between. This pattern was not present on the archaeological specimen. On the contrary, most of the traces on the canine were parallel or sub-parallel with different depth and few short perpendicular marks were localized on the lingual border of the dentine and of the enamel. In addition, the other (broken) half of the tooth, was also partly worn. Based on these considerations and on the comparable wear pattern of the premolars and molars in other material, it is more plausible that the tooth broke for a natural reason and that the parallel longitudinal wear marks were generated by pulling off the meat out of their mouth which seems to be a common gesture with the hyaenas (Mary Stiner, pers. comm.).

The striped hyaena (*Hyeana hyaena*) is sole species of hyaena found in the Middle East is (Harrison 1968). This animal is known to come close to the villages, especially at night, and to feed on discarded food of the humans (Kruuk 1975:78)

6.7.6 Brown bear

The presence of the brown bear (*Ursus arctos*) is indicated by an almost complete third phalanx found in the Transitional level 6. The bear may have been brought to the site for its skin but no traces of cutmarks have been found on the fragment to confirm this assumption. Bear remains were also found at the Halafian sites of Çavi Tarlasi and Banahilk (Laffer 1983; Schäffer and Boessneck 1988:49). At the latter site and, further west, at Fikirtepe only limb bones are present. Also in the case of Fikirtepe, Boessneck and von den Driesch (1979) suggested that lower foot bones were brought to the site as part of the skin of the bear.

6.7.7 Hare

In total sixteen bone remains of hare (*Lepus capensis*) were found, most of them belonging to the Transitional period. Apart from two mandibles, one axis, one vertebrae caudale and one lumbale, the sample consists of limb bones of adult animals (one ulna, two humeri, one femur, one tibia, four metatarsi and two phalanges).The presence of hare is rather limited in the earliest levels (only one specimen) and it is most abundant in the Transitional period.

6.7.8 Rodents

Eight rodent remains were found. They represent isolated and fragmented specimens with a reddish yellow colour, similar to that of the other bones of the assemblage, although somewhat lighter. Because of the habit of this animals of digging deeply in the ground, specimens much lighter in colour (more white) such as the complete skeleton from the Early Halaf of square Q14 (8-24) were not included in the analysis, being almost certainly intrusive.

Rodent remains are present in each phase, but their incidence is higher in the Transitional phase (table 6.2). All the fragments that could be identified belong to the genus *Tatera*, most likely the Indian jerbil (*T.indica*), nowadays present in the studied area and identified at the more southern site of Mureybit (Harrison 1972, Helmer 1978). The major factor controlling the distribution of this species seems to have been food resources (Redding 1978). This species, which prefers relatively moist soil conditions feeds on stems, seeds, rhizomes, leaves of grasses, insects, and leguminous plants (Redding 1978:65). Supposing that the remains are related to the occupation of the village and that this species does not avoid human habitation (Hole et al. 1969: 320) it is likely that this animal was attracted by the presence of (storage) crop plants at the site.

6.7.9 Birds

Two fragments of the genus *Anser* were found: one distal ulna from level 3B, one proximal humerus from level 3A, and one tibiotarsus from level 4. Nowadays, three different species of goose are found as winter visitors in the regions south of the Taurus and Zagros mountains, particularly in the wetter areas of the valleys of Tigris and Euphrates (cf. Cramp and Simmons 1977): the graylag goose (*A.anser*), the white fronted goose (*A.albifrons*) and the lesser white fronted goose (*A.erythropus*). One of the *Anser* specimens (ulna) could be identified to a specific level as white fronted goose (*A. albifrons*).

Three species of duck (*Anas*) were identified at Sabi Abyad. Most of the duck bones were found in Transitional level 4: one radius of mallard (*A.platyrhynchos*), one ulna of wigeon (*A.penelope*), and one tibotarsal of gadwall (*A.strepera*). Another remain of mallard, viz. one almost complete scapula, comes from the pre-Halaf levels 8/9. These ducks are winter visitors in northern Syria today. They are found mainly at the confluence of the Balikh with the Euphrates, but the mallard occurs also further north, in the Balikh valley proper (cf. Cramp and Simmons 1977:507).

The presence of the white stork (*Ciconia cf. ciconia*) is indicated by two humeri (one from level 3 and one from level 4). The stork is present in northern Syria in summer; it has winter grounds in the lower Mesopotamia and eastern Africa. Remains of white stork have been found at Shams ed-Din, where it was identified tentatively as *C. cf. ciconia* and at El Qitar (Uerpmann 1982:13; Buitenhuis 1988). The habitat of the stork consists of open wetlands, savannah with scattered trees, steppes, floodlands, irrigated lands, moist meadows and pasture or arable fields, which offer easy food supply based exclusively on food of animal origin (Cramp and Simmons 1977).

The hooded crow (*Corvus corone*) is represented by two fragments found in level 4: one tibia and one femur (both right). They come from the fill in the antechamber of the large tholos in square Q15 and may belong to the same individual.

Most crow races in northern Syria are seasonal visitors coming from the Iranian central Plateau, but at least one race of hooded crow is a year-round resident in the region between the Persian Gulf to the upper Tigris, (Hole et al. 1969).

Seven other fragments of birds were found, but they could not be identified either to a level or genus. In general, the incidence of birds is rather low (N=1) in the pre-Halaf levels compared to both the Transitional (N=10) and early Halaf (N=7) levels.

6.7.10 Reptiles

Among the non-mammal remains a fragments of a carapax of a tortoise (*Testudo graeca*) was identified. The species was found at two other Halafian sites, viz. Gerikihaciyan and Çavi Tarlasi (Schäffer and Boessneck 1988; McArdle 1990).

6.7.11 Amphibians

One proximal tibiofibula of frog (*Rana sp.*) was found in room 3 of building II (level 3A).

6.7.12 Molluscs

Molluscs were found in all the separate phases (table 6.51). Their identification was made by Robert Moolenbeek of the 'Instituut voor Systematiek en Populatiebiologie (Zoölogisch Museum)' of the University of Amsterdam. Most of the molluscs (n.=22) belong to the 'Melanopsis complex' (*Melanopsis praemorsa* Linnaeus 1758, *M. praemorsa var. nodosa* Terrusa 1823, *M. praemorsa var. costata* Oliver 1804) (Glaubrecht 1993). A smaller number of bivalves (n.=16, plus a few fragments) belong to species either from the genus *Leguminaia* or *Unio*. Apart from these, two specimens of freshwater molluscs *Corbicula* sp. were found. Two marine molluscs were present as well. They consist of a fragment of *Ostrea* sp., whose origin could not be established, and an incomplete specimen of *Polinices* sp., coming from the Indian Ocean (either from the Persian Gulf or Red Sea or Oman). The latter presents a pierced hole (fig. 6.51) suggesting its use as an ornament. Finally, one landsnail (fam. *Helicidae*) was retrieved.

Given the rather small quantity of molluscs found, it is most likely that they constituted only a small protein supplement to the diet. One might even wonder if they were eaten at all, especially in the case of the *Melanopsis* group. These small freshwater molluscs could have been brought accidentally to the site, included in clay or more likely in reeds. In any case freshwater molluscs attest the exploitation of the Balikh river, whatever its purpose may have been.

The presence of the *Polinices* from the Indian Ocean attests to possible long-distance contacts with more southern populations, already in the pre-Halaf phase. As its utilization as ornament may suggest, it could have been some kind of special ware, exchanged throughout different communities.

6.7.13 Fishes

Only one fragment of fish was found within the whole sample of Sabi Abayd. It could not be identified even to genus level

Level	Melanopsis	Leguminaia/ Unio	Corbicula	Ostrea	Polinices	Helicidae
(phase E)						
1/2/3A		1				
1/3B		fr.				
2		4				2
3A	2	fr.	2			
3B	2	2		1		
3C/4		1				
(phase T)						
4	1	1				
6	12	1+fr.				
(phase P)						
7		3			1	
8	3	2				
8/9		fr.				
d.	2	1				

d.= disturbed levels; fr.= fragment

Table 6.51 Mollusc distribution in the separate levels

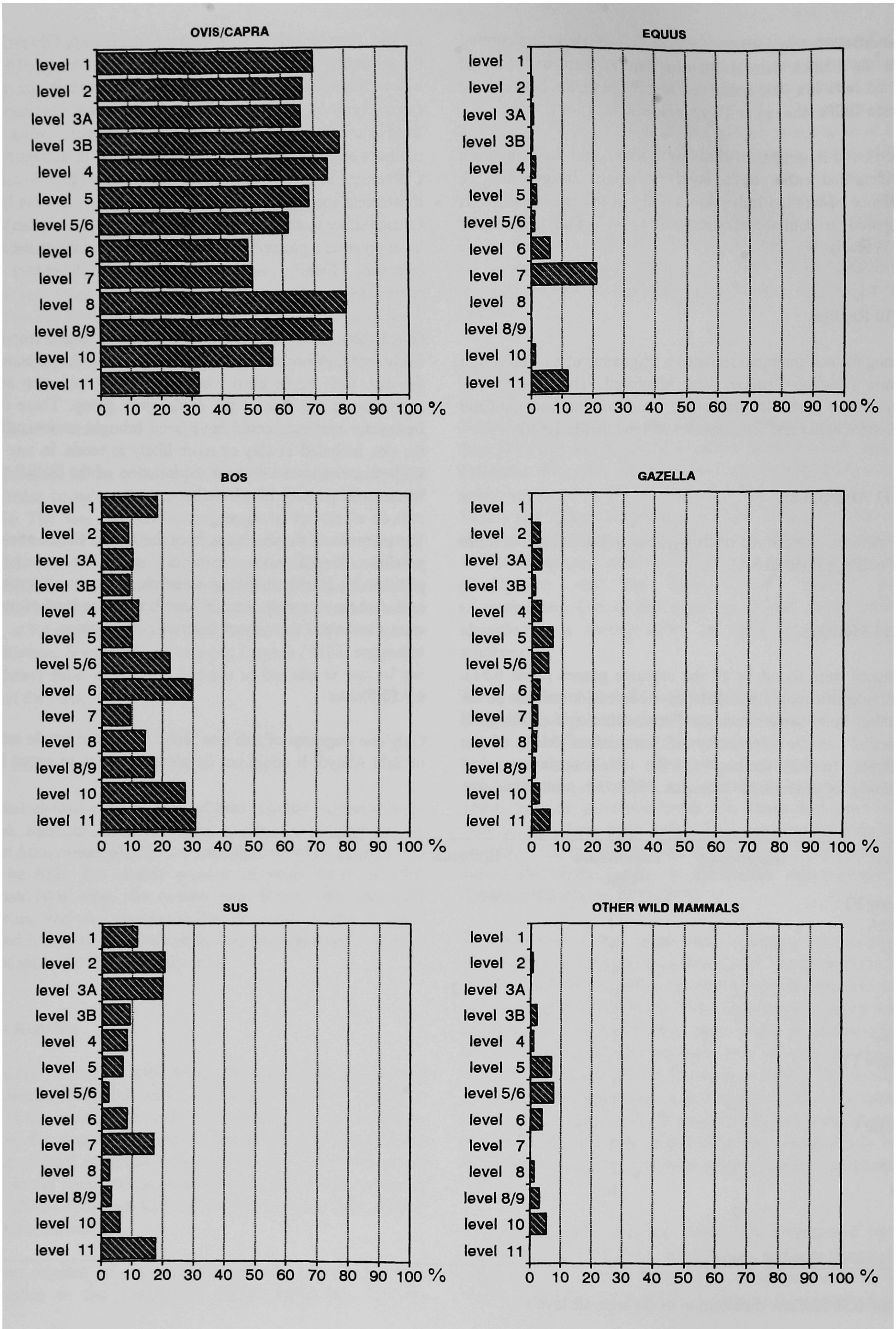


Figure 6.1 Relative frequencies of the main species per level

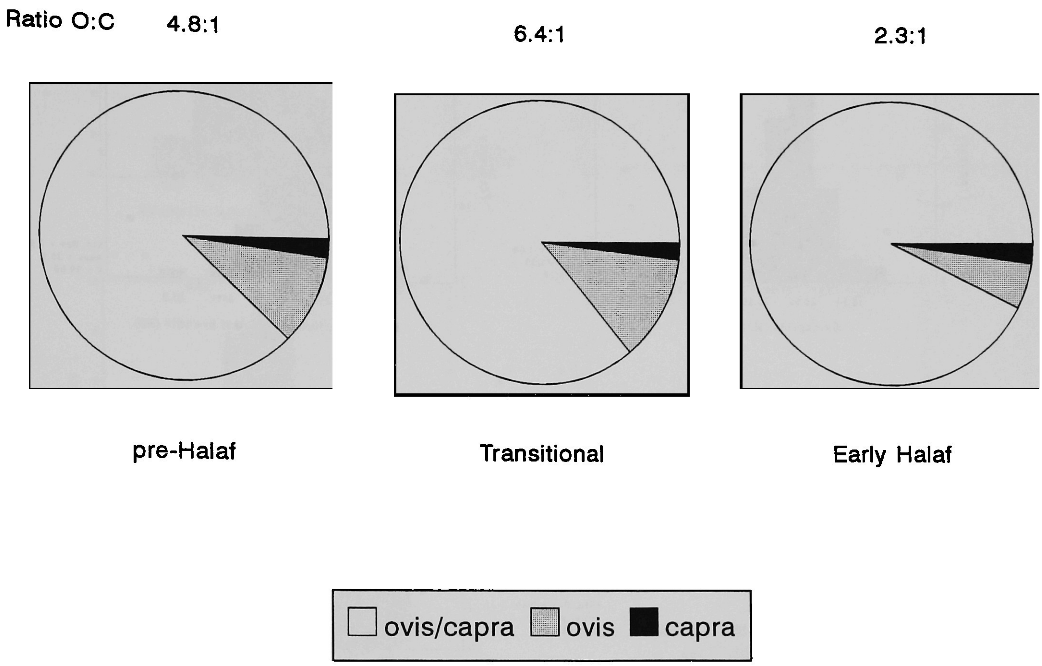


Figure 6.2 Number of specimens and ratio between *Ovis* and *Capra* based on the whole sample

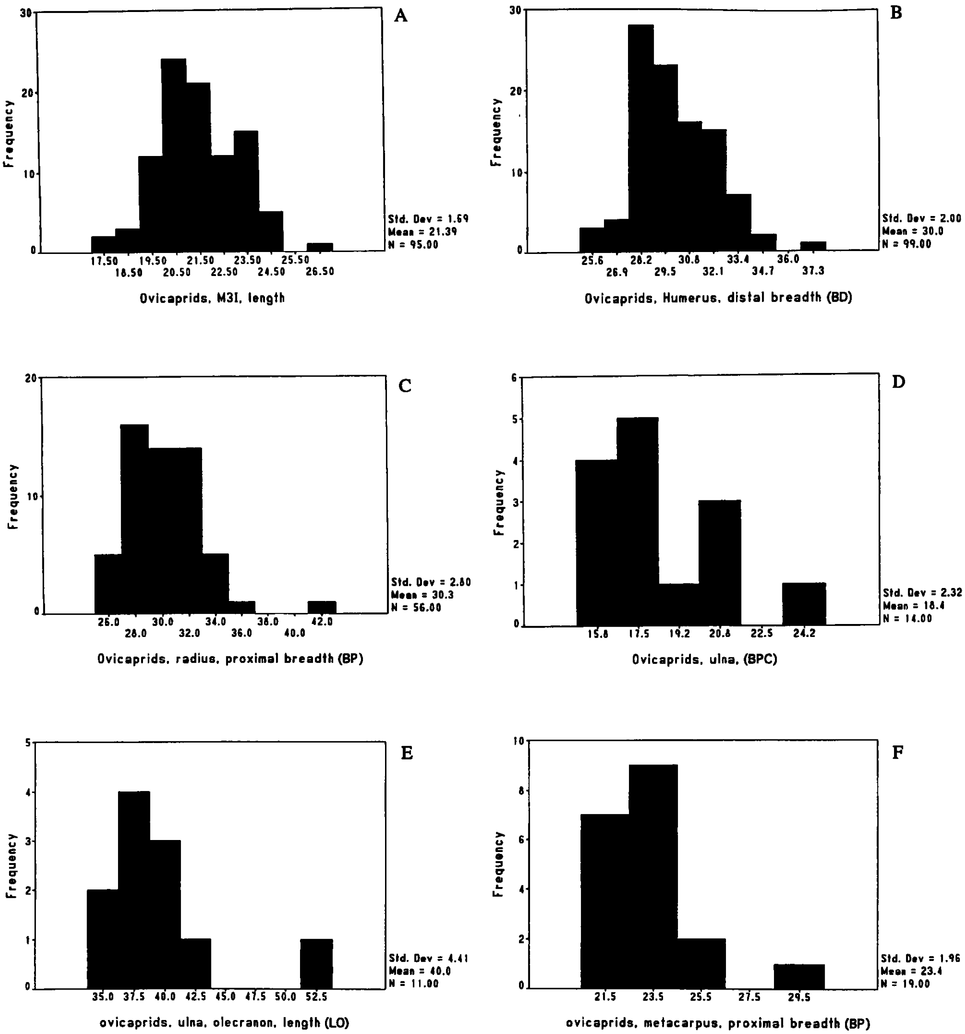


Figure 6.3 Size distribution of selected elements in which wild sheep and/or goat are present.

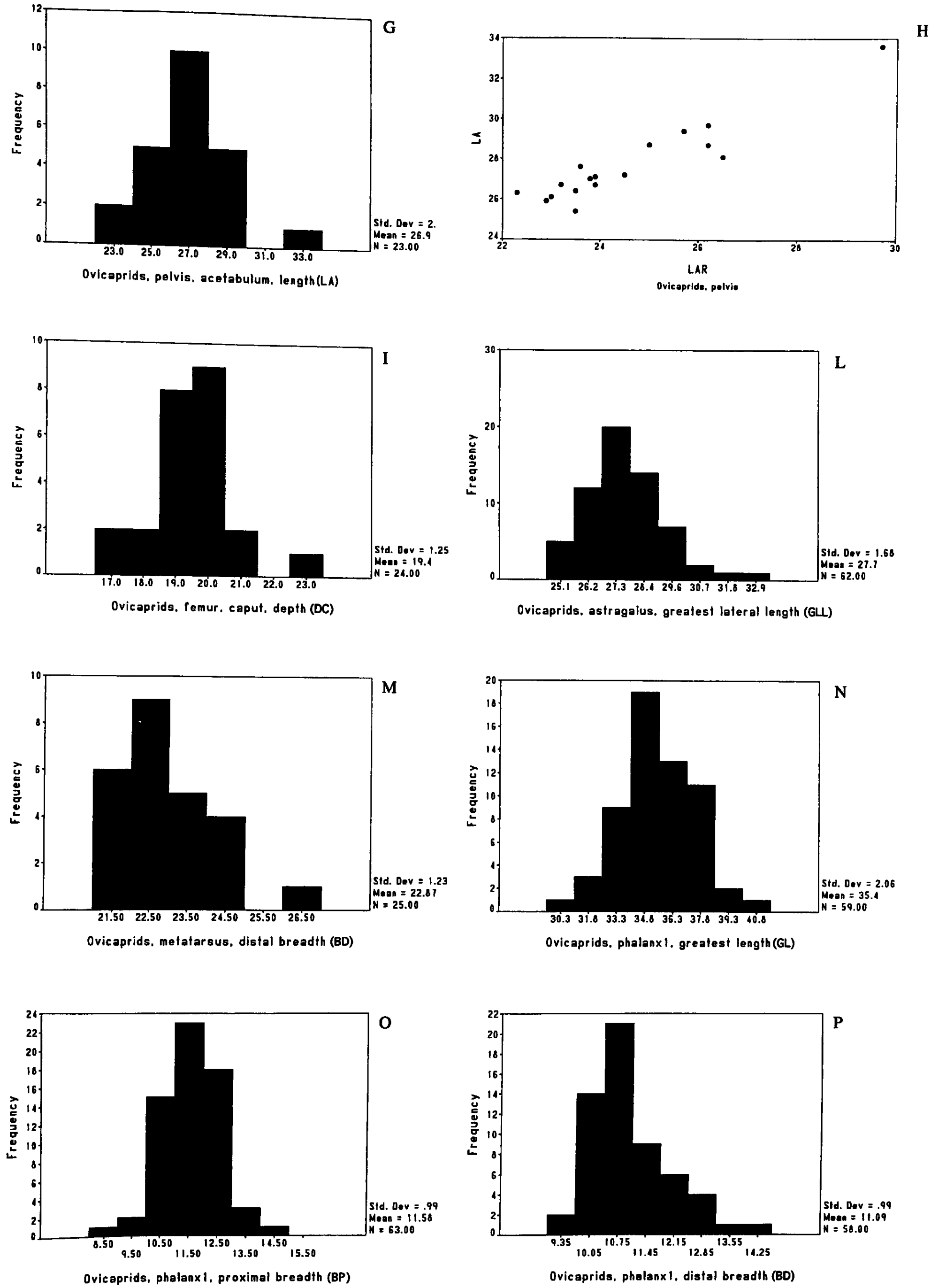
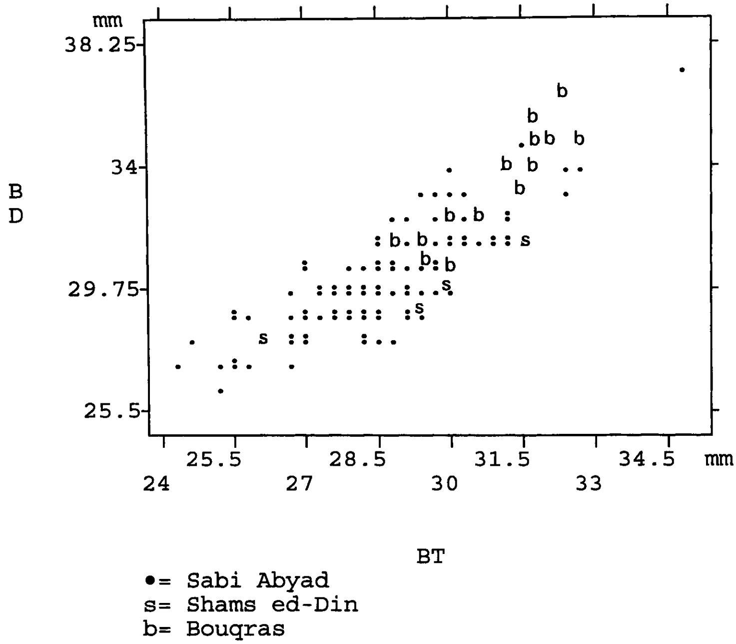


Figure 6.3 (continued) Size distribution of selected elements in which wild sheep and/or goat are present.



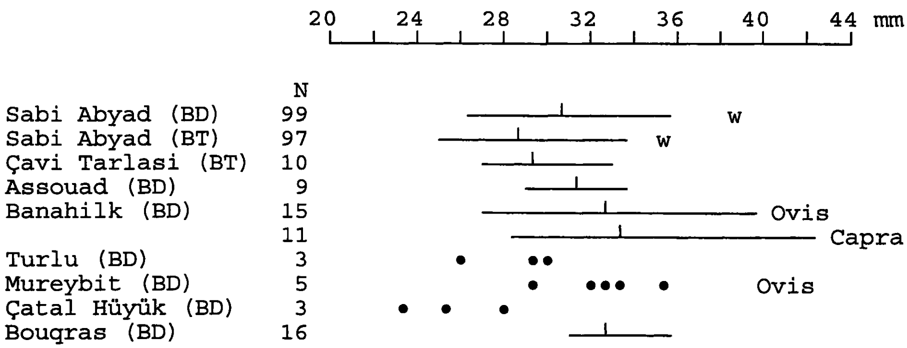
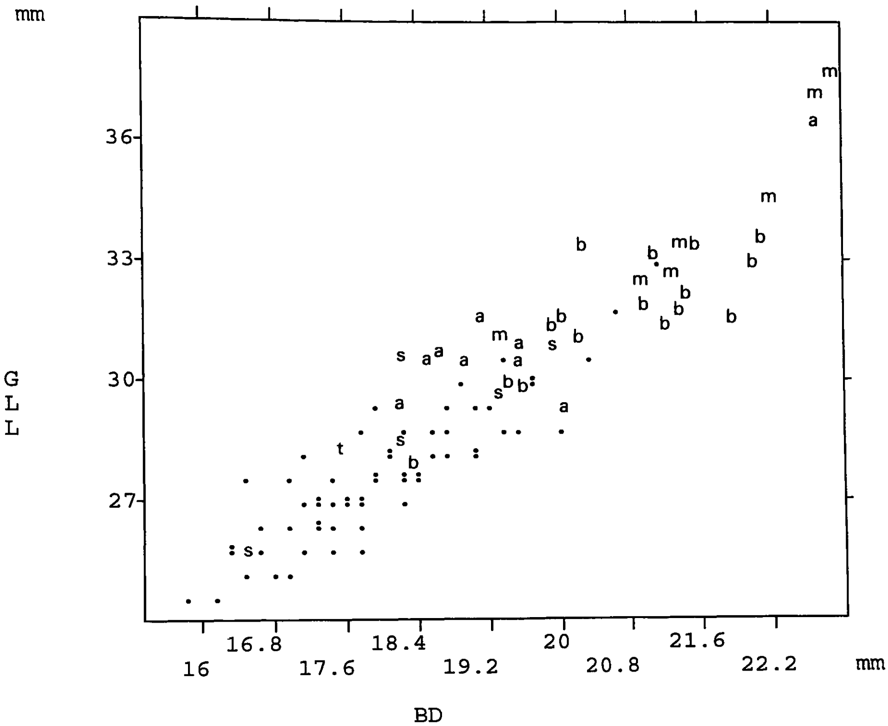


Figure 6.4 Comparison of the distal breadth (BD) and the greatest breadth of the trochlea (BT) of the ovicaprid humeri from Sabi Abyad with other sites



● = Sabi Abyad
a = Assouad
b = Bouqras
m = Mureybit
s = Shams ed-Din
t = Çavi Tarlasi

Figure 6.5 Comparison of the lateral greatest length (GLL) and the distal breadth (BD) of the ovicaprid astragali from Sabi Abyad with other sites

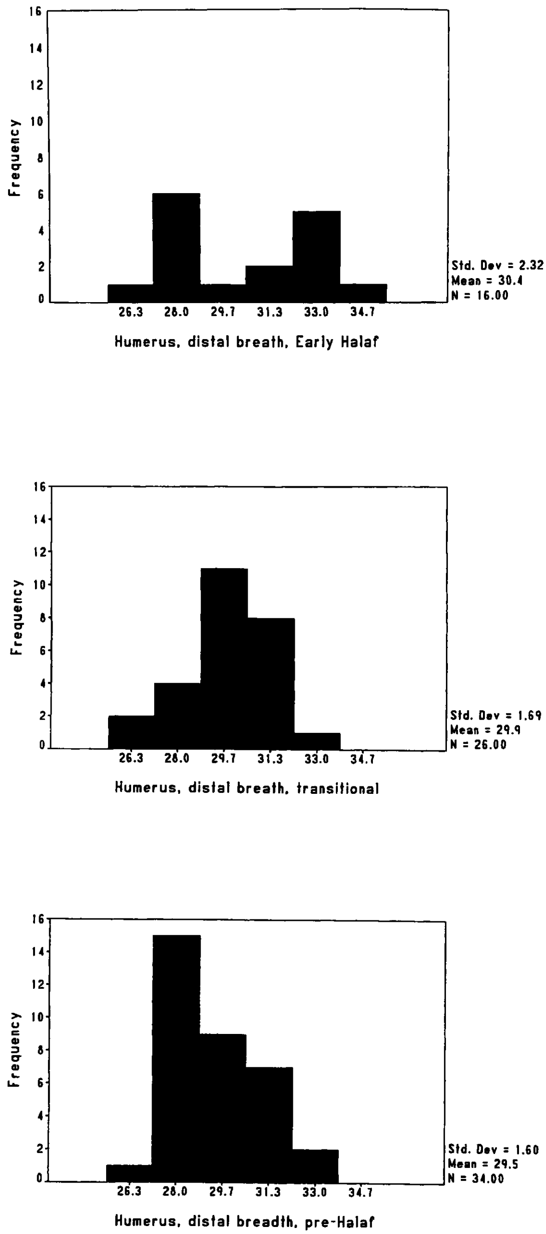


Figure 6.6 *Ovis*: size distribution of humerus distal breadth (BD)

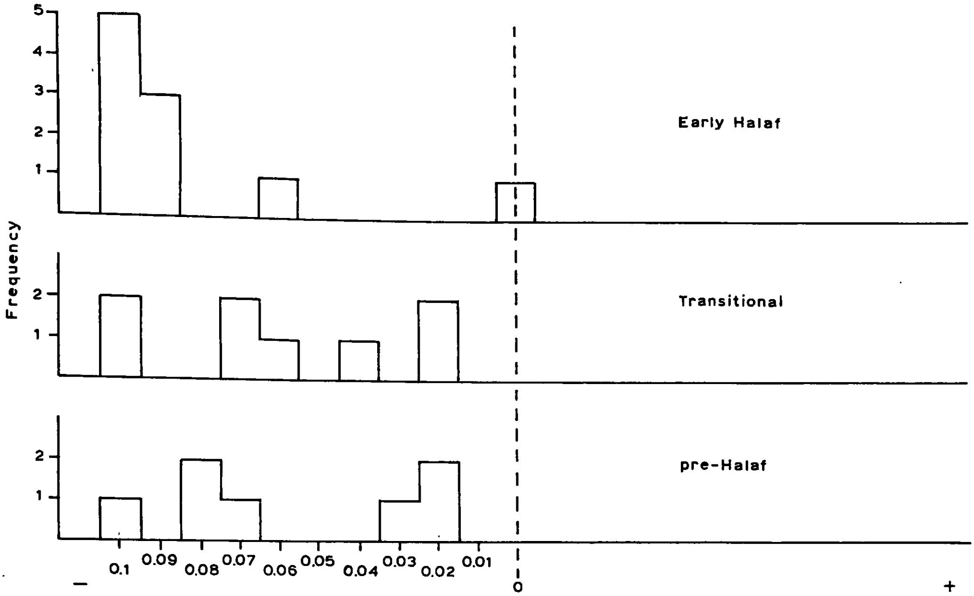


Figure 6.7 *Capra*: size index distribution of goat forelimb bones plotted against the "difference of logarithms" technique

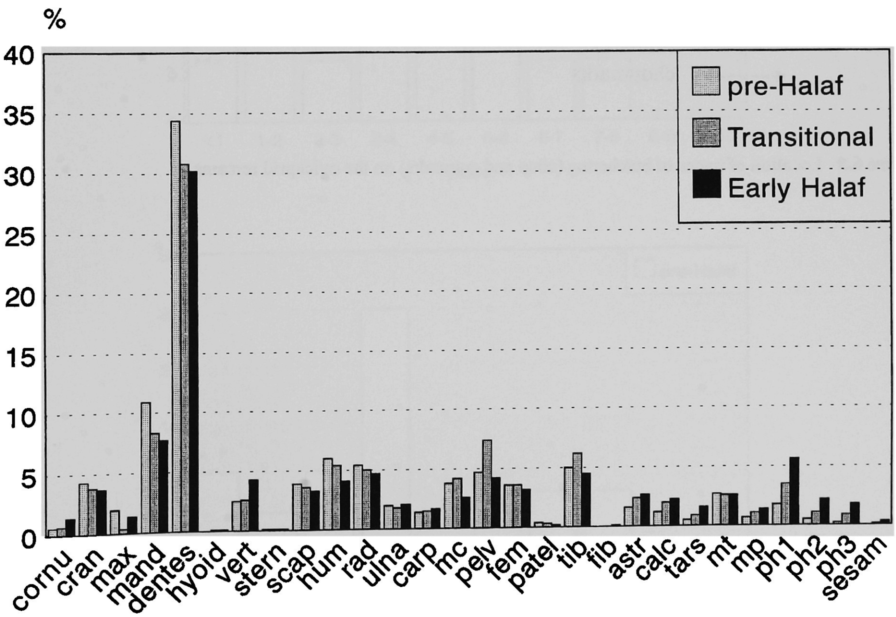


Figure 6.8 Relative frequency of ovicaprid skeletal elements within each phase

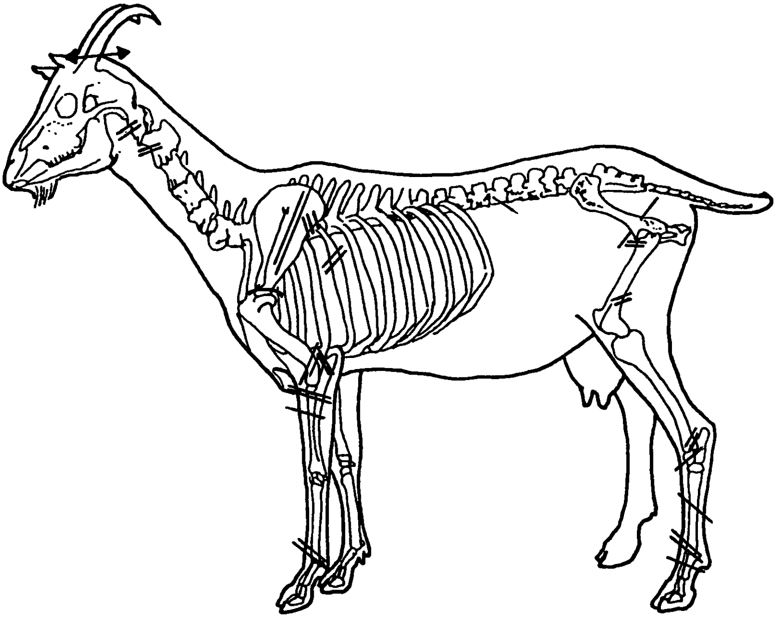


Figure 6.9 Location of traces of butchering (chop and cutmarks) on the ovicaprid remains

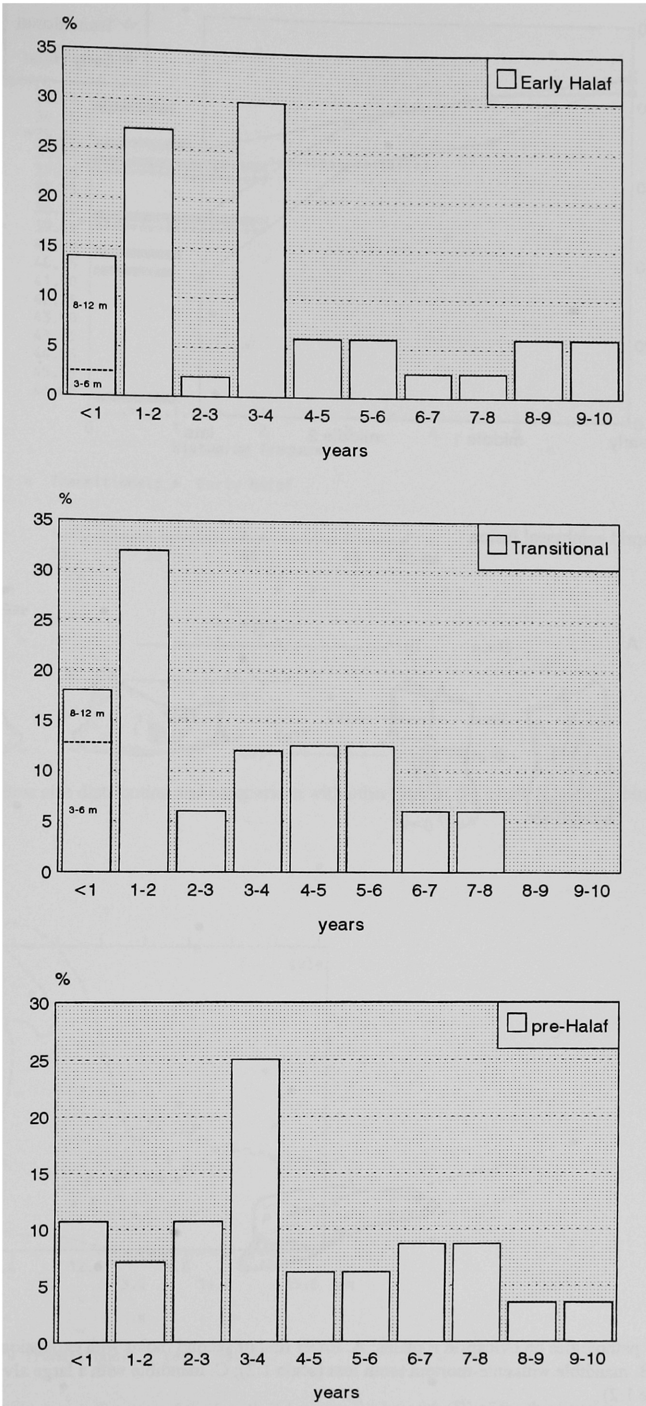


Figure 6.10 Ovicaprid mandibular wear (sample size: pre-Halaf = 56; Transitional = 31; Early Halaf = 42); suggested age according to Payne's wear stages (Payne 1973)

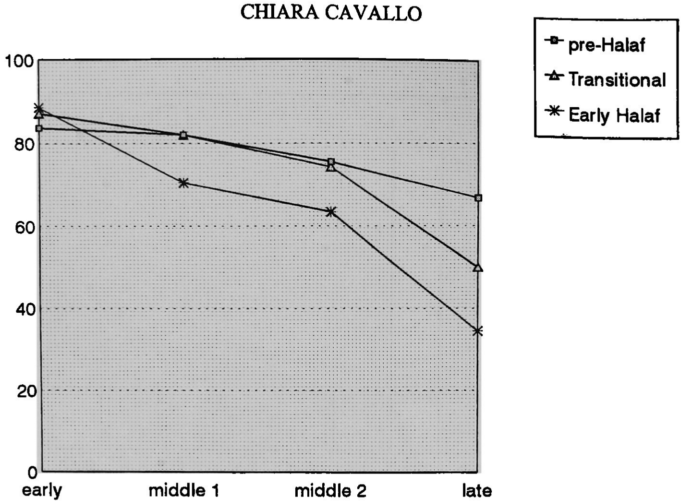


Figure 6.11 Ovicaprid epiphyseal fusion

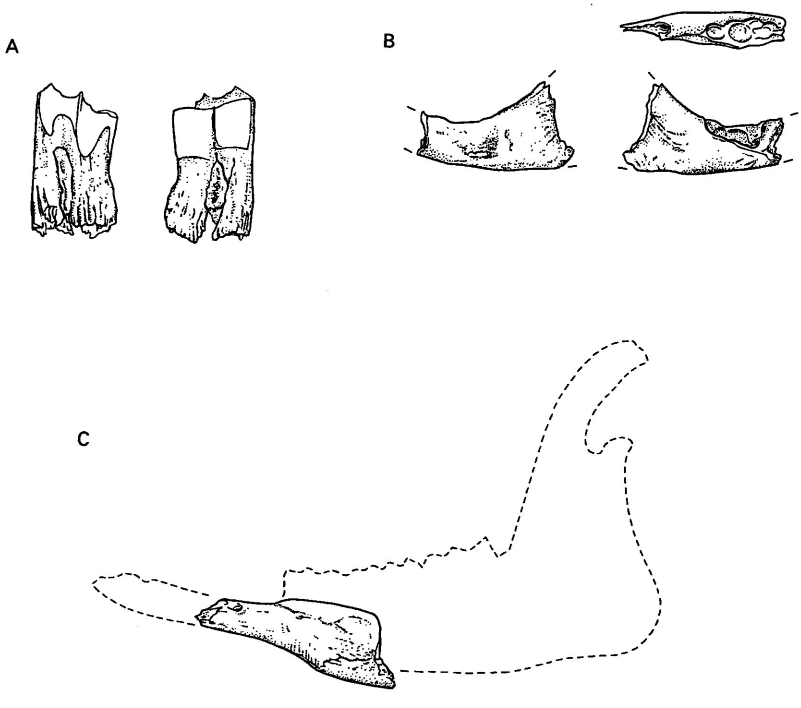


Figure 6.12 Oral pathologies on ovicaprid remains: A. lower first or second molar with expansion of the root tips (scale 1:1); B. mandible with ante-mortem tooth loss (scale 1:2); C. mandible with a large alveolar bone destruction (scale 1:2)

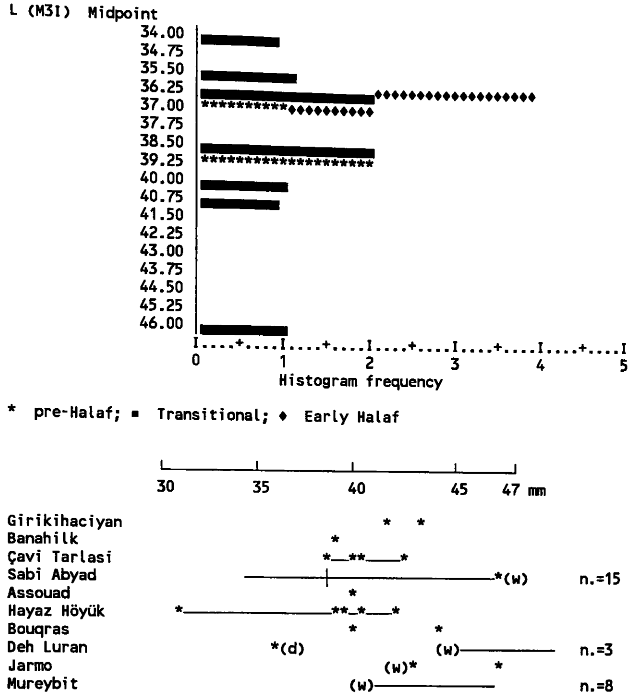


Figure 6.13 *Bos*: size distribution and comparison with other sites of the length (L) of the third lower molar (M3I)

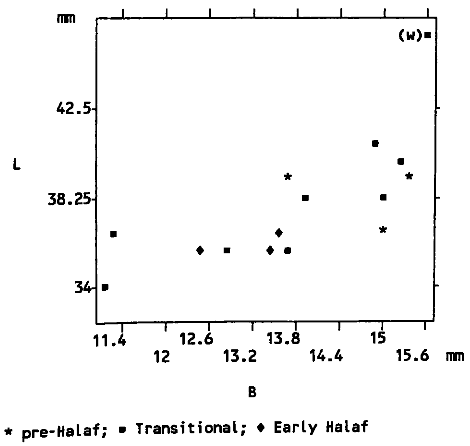


Figure 6.14 *Bos*: scatter-diagram of the length (L) versus the breadth (B) of the third molar

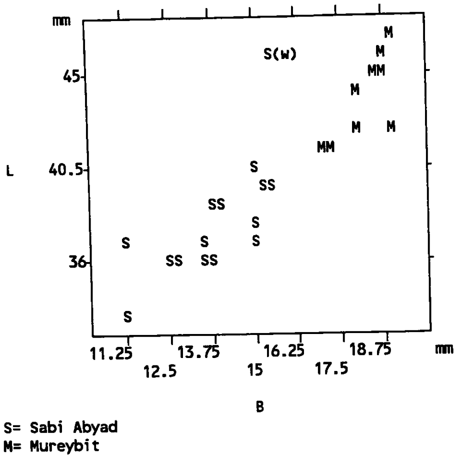


Figure 6.15 Scatter-diagram of the length (L) versus the breadth (B) of the bovid third molars from Sabi Abyad and from Mureybit

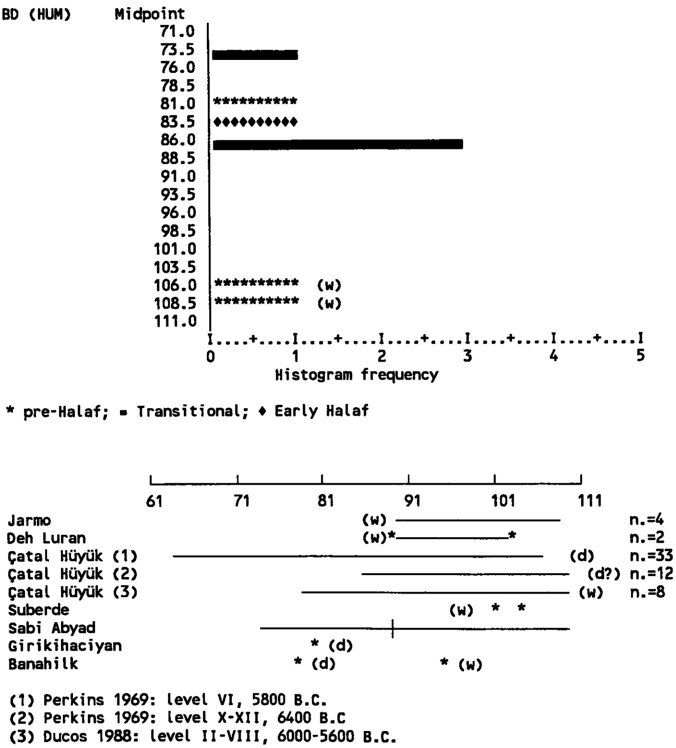


Figure 6.16 *Bos*: size distribution and comparison with other sites of the distal breadth (BD) of the humerus

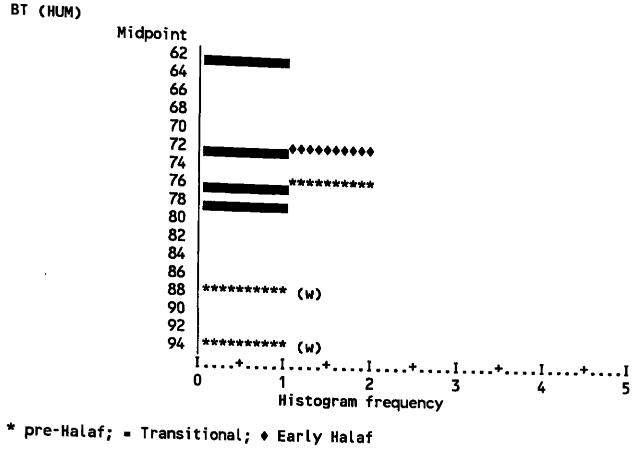


Figure 6.17 *Bos*: size distribution of the breadth of the trochlea (BT) of the humerus

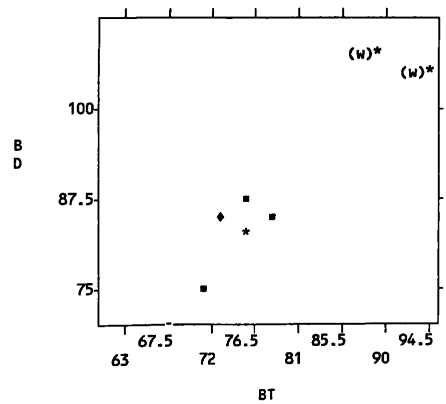


Figure 6.18 *Bos*: scatter-diagram of the distal breadth (BD) versus the breadth of the trochlea (BT) of the humerus

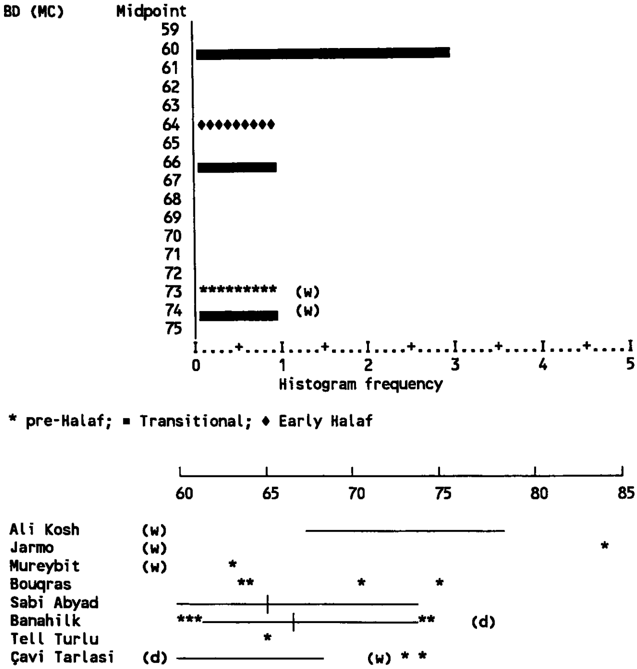


Figure 6.19 *Bos*: size distribution and comparison with other sites of the distal breadth (BD) of the metacarpus

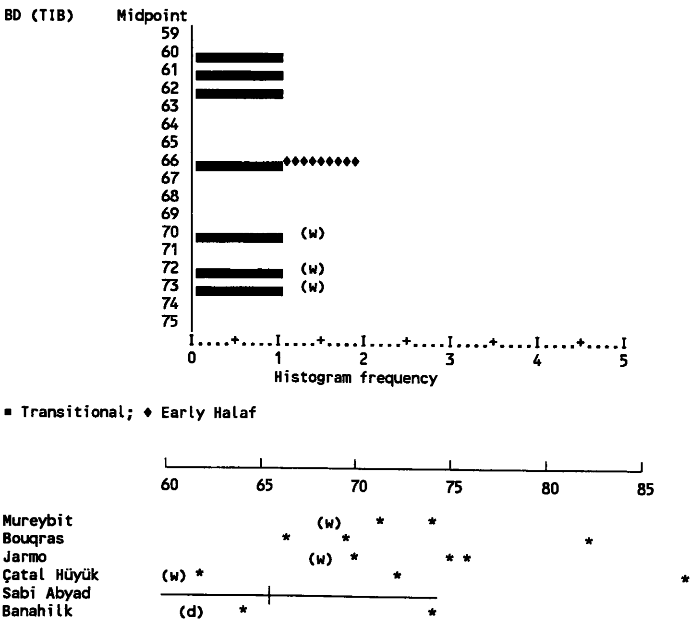
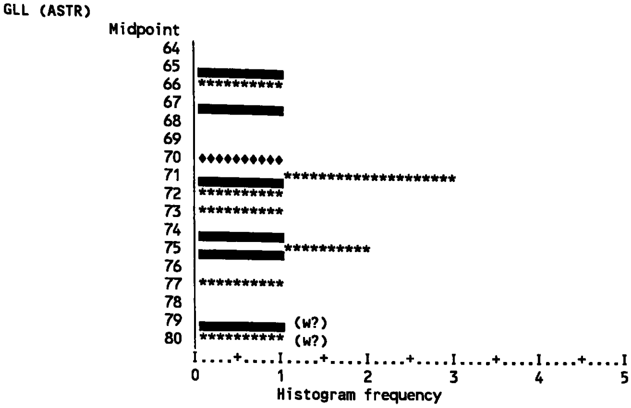


Figure 6.20 *Bos*: size distribution and comparison with other sites of the distal breadth (BD) of the tibia



* pre-Halaf; ▪ Transitional; ♦ Early Halaf

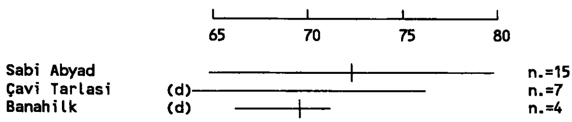
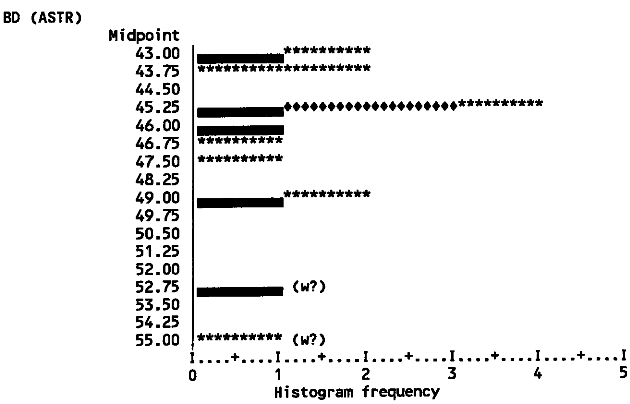


Figure 6.21 *Bos*: size distribution and comparison with other sites of the greatest length of the lateral half (GLL) of the astragalus



* pre-Halaf; ▪ Transitional; ♦ Early Halaf

Figure 6.22 *Bos*: size distribution of the distal breadth (BD) of the astragalus

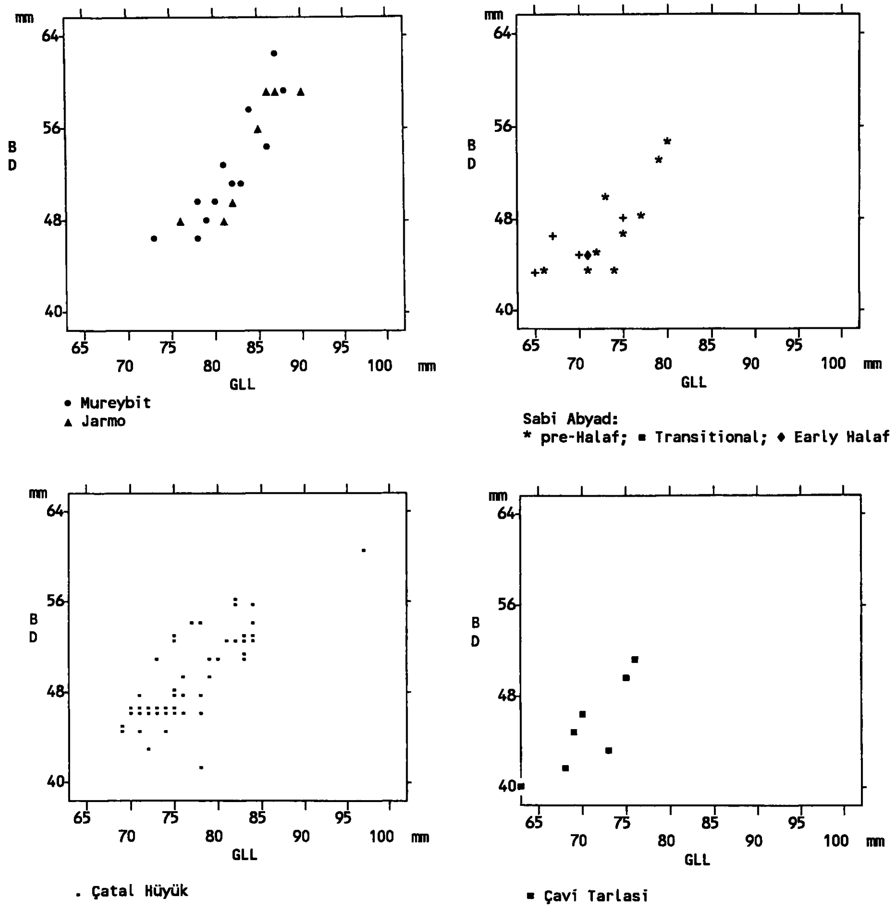


Figure 6.23 *Bos*: comparison of the scatter-diagram of the distal breadth (BD) versus the greatest length of the lateral half (GLL) of the astragali from Sabi Abyad with those from Mureybit, Jarmo, Çatal Hüyük, and Çavi Tarlasi

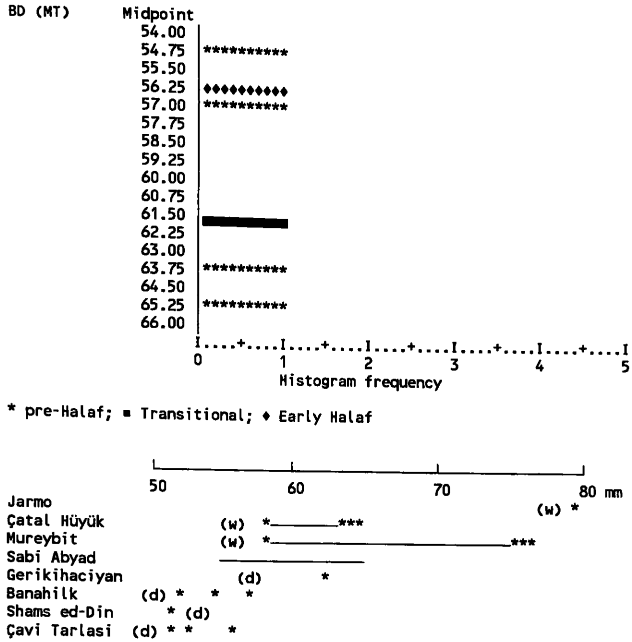


Figure 6.24 *Bos*: size distribution and comparison with other sites of the distal breadth (BD) of the metatarsus

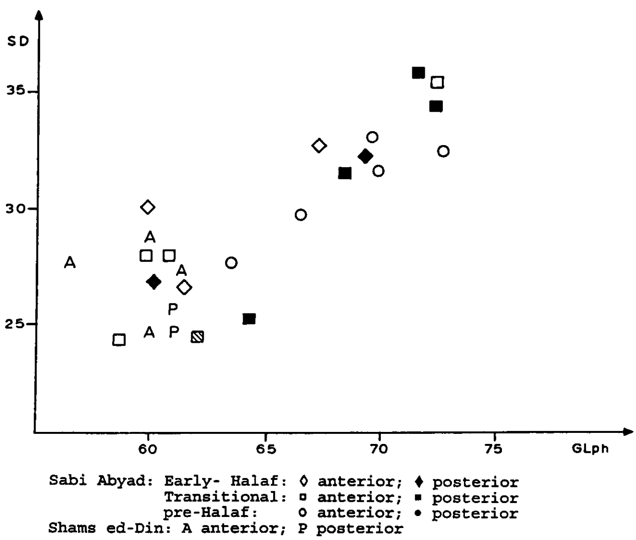


Figure 6.25 *Bos*: comparison of the measurements of greatest length of the peripheral half (GLpe) versus the smallest breadth of the diaphysis (SD) of the first phalanges from Sabi Abyad with those from Shams ed-Din.

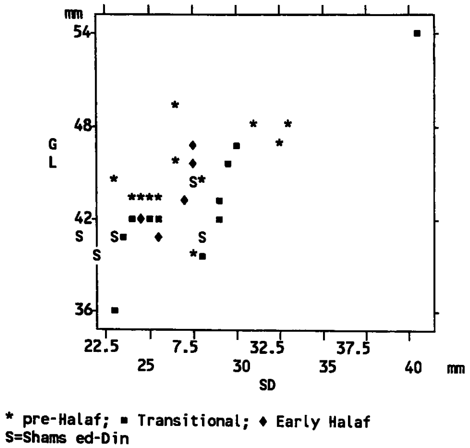


Figure 6.26 *Bos*: scatter-diagram of the greatest length (GL) versus the smallest breadth of the diaphysis (SD) of the second phalanx

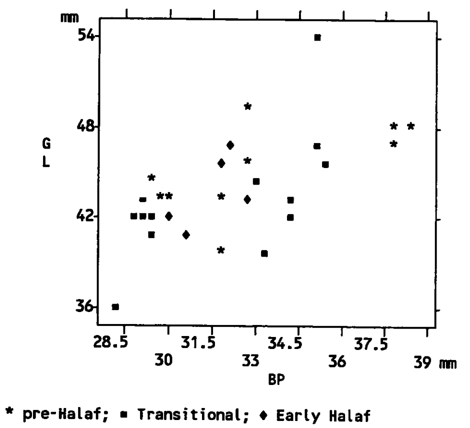


Figure 6.27 *Bos*: scatter-diagram of the greatest length (GL) versus the proximal breadth (BP) of the second phalanx

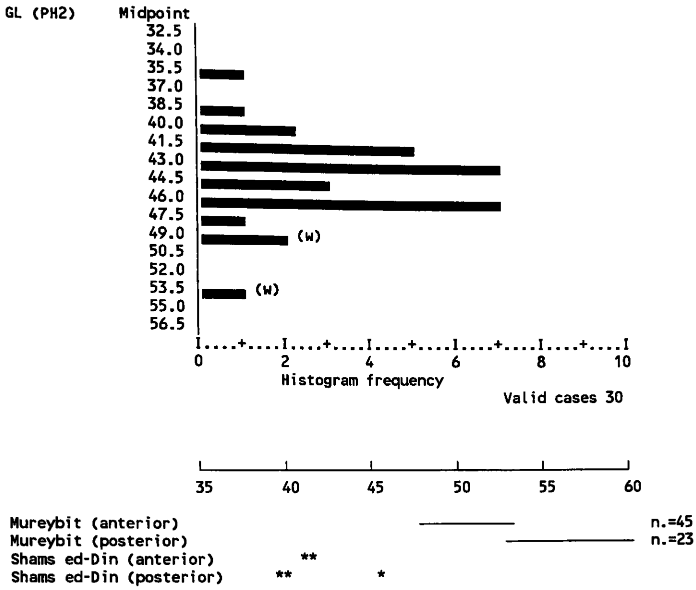


Figure 6.28 *Bos*: size distribution and comparison with other sites of the greatest length (GL) of the second phalanx

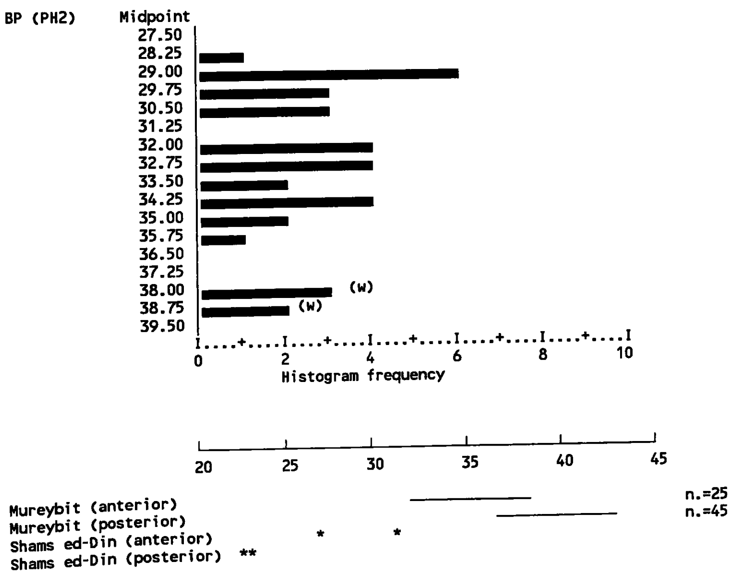


Figure 6.29 *Bos*: size distribution and comparison with other sites of the proximal breadth (BP) of the second phalanx

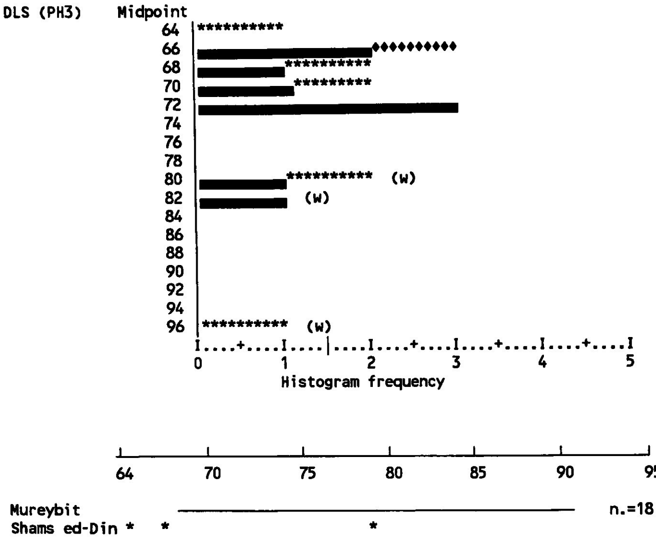


Figure 6.30 *Bos*: scatter-diagram and comparison with other sites of the diagonal length of the sole (DLS) of the third phalanx

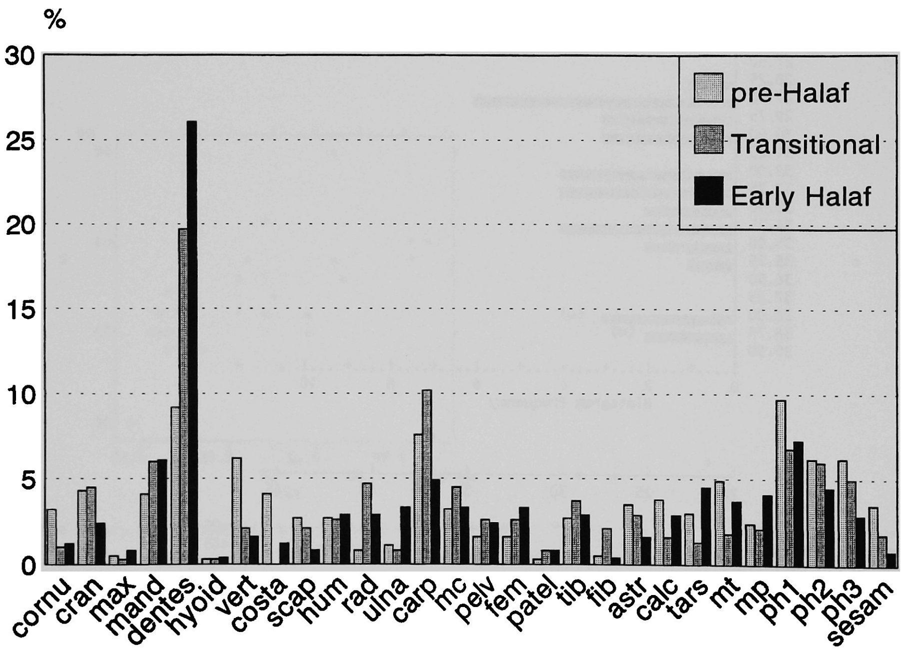


Figure 6.31 Relative frequency of bovid skeletal remains

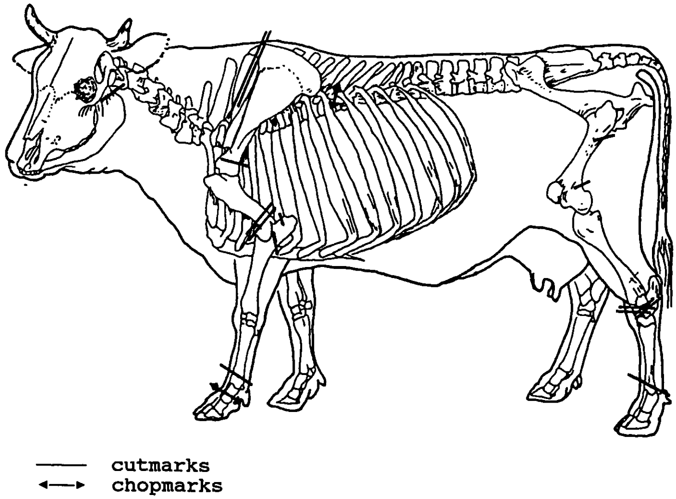


Figure 6.32 Location of traces of butchering on bovid remains

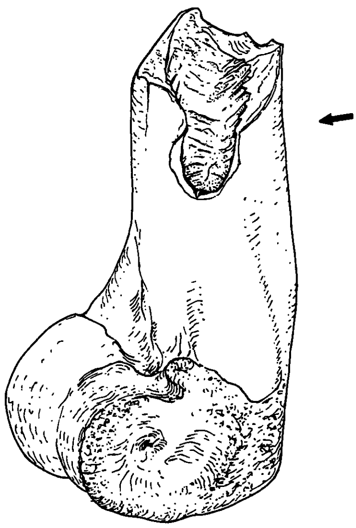


Figure 6.33 *Bos*: humerus with a chopmark on the diaphysis

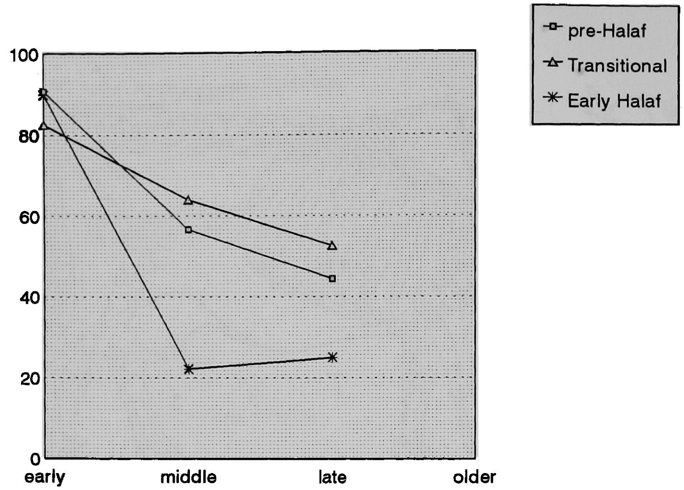


Figure 6.34 Bovid epiphyseal fusion

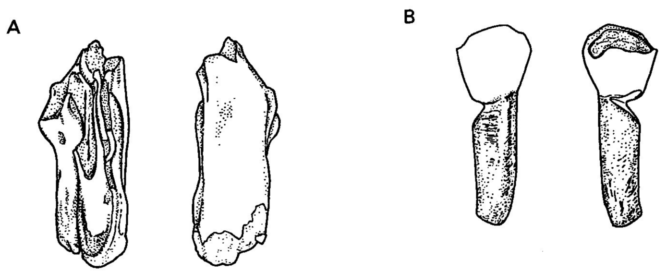


Figure 6.35 Abnormal tooth shape of bovid teeth: (A) lower molar, (B) incisive

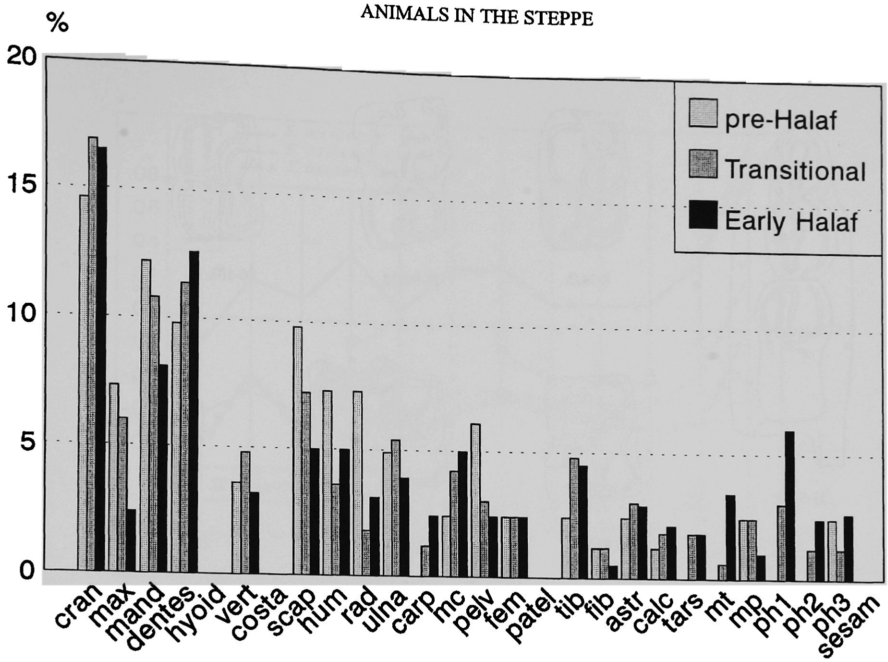


Figure 6.36 Relative frequency of suid skeletal elements in each phase (costae not included)

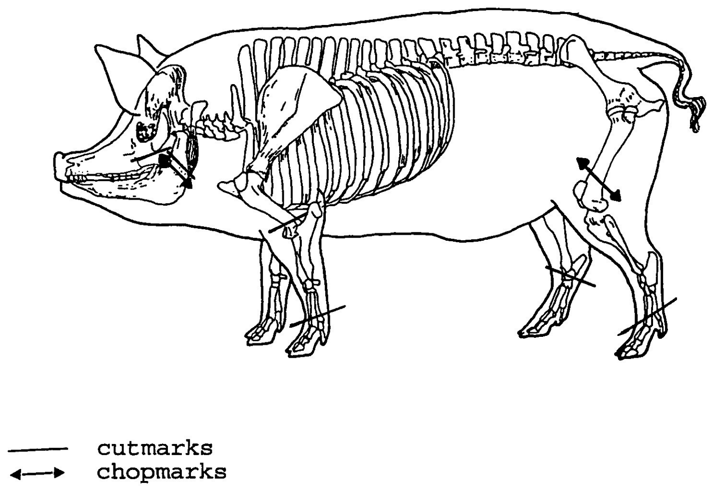


Figure 6.37 Location of traces of butchering on the suid remains

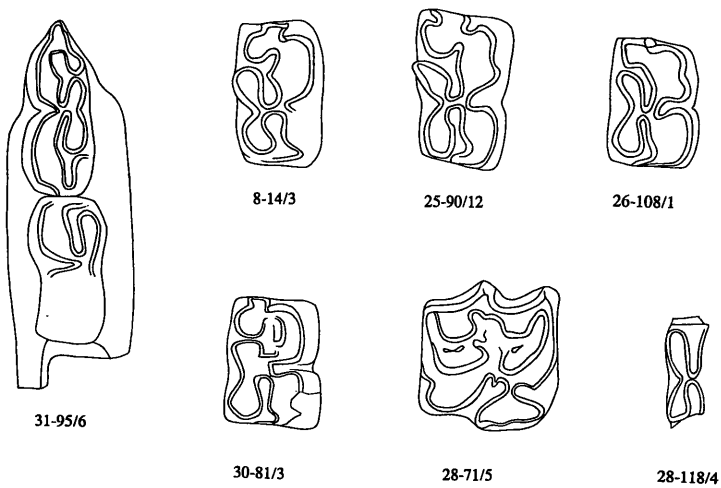


Figure 6.38 Enamel pattern of equid teeth

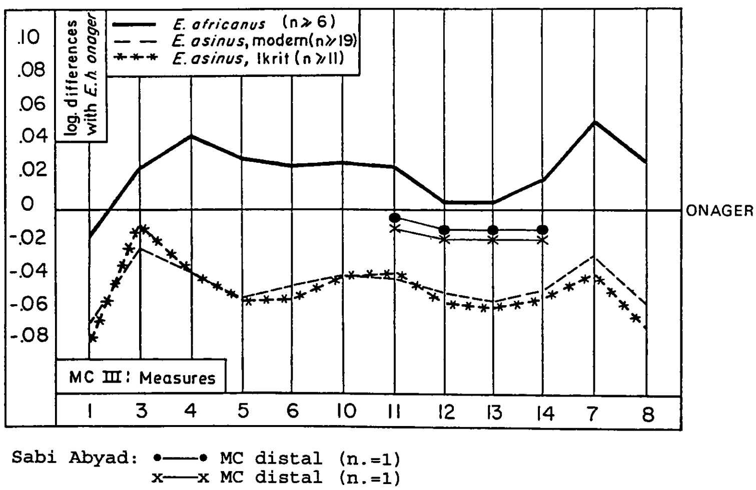


Figure 6.39 Ratio diagrams of the equid metacarpals from Sabi Abyad compared with the mean dimensions of metacarpals of various asses, modern and fossil; (after Eisenmann and Beckouche 1986, fig. 8)

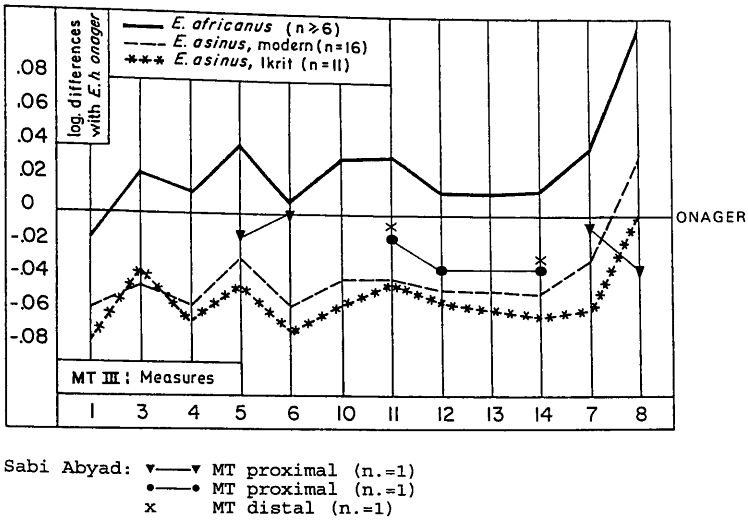


Figure 6.40 Ratio diagrams of the equid metatarsals from Sabi Abyad compared with the mean dimensions of metatarsals of various asses, modern and fossil; (after Eisenmann and Beckouche 1986, fig. 15)

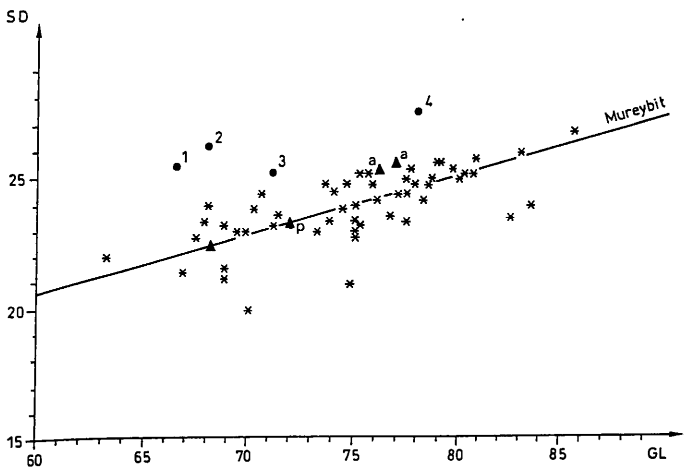


Figure 6.41 Scatter-diagram of the first phalanges (PH1) measurements of *Equus* from Sabi Abyad compared with other sites (after Uerpmann 1991, fig. 4)

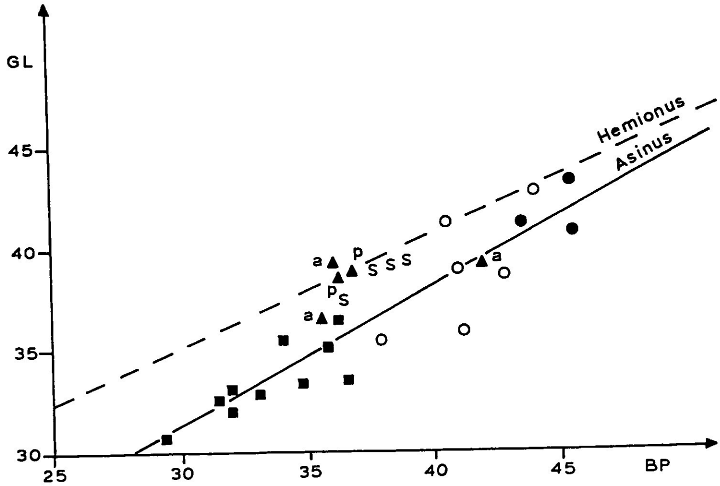


Figure 6.42 Scatter-diagram of the second phalanges (PH2) measurements of *Equus* from Sabi Abyad (▲) compared with the regression lines of *E. hemionus* and *E. asinus* (after Uerpmann 1991, fig. 3)
● = finds from arabian sites; ○ = recent *E.africanus*; ■ = recent donkeys; s = Shams ed-Din

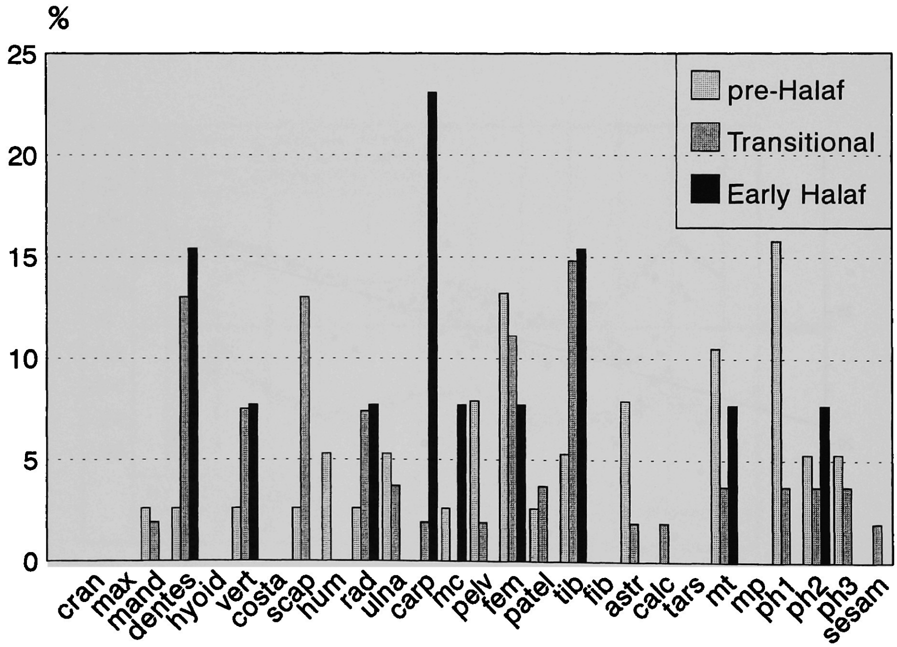


Figure 6.43 Relative frequency of equid skeletal elements

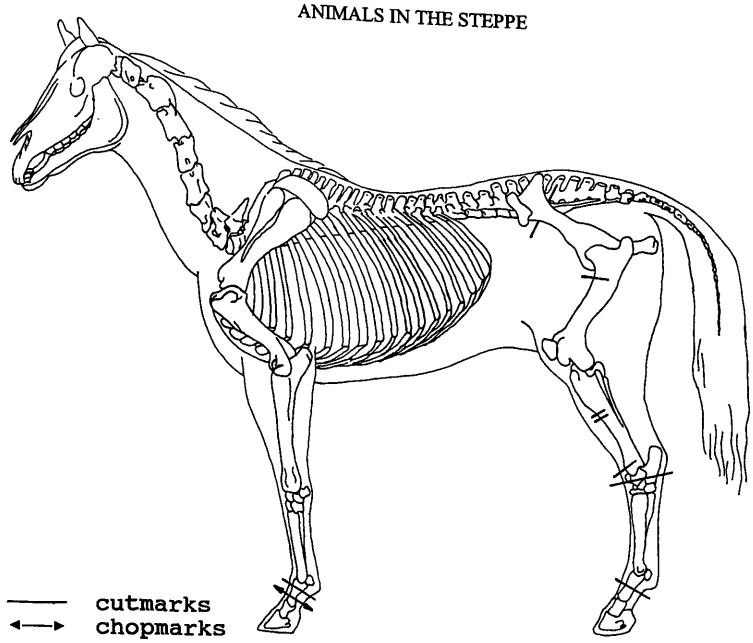


Figure 6.44 Location of traces of butchering on equid remains.

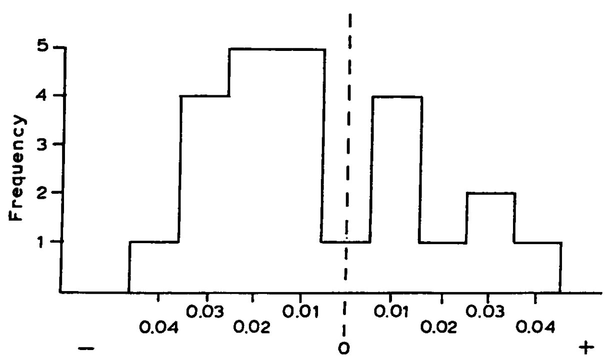


Figure 6.45 Size index distribution of the greatest length of the processus articularis (GLP) of the scapula and the distal breadth (BD) of the humerus of gazelle

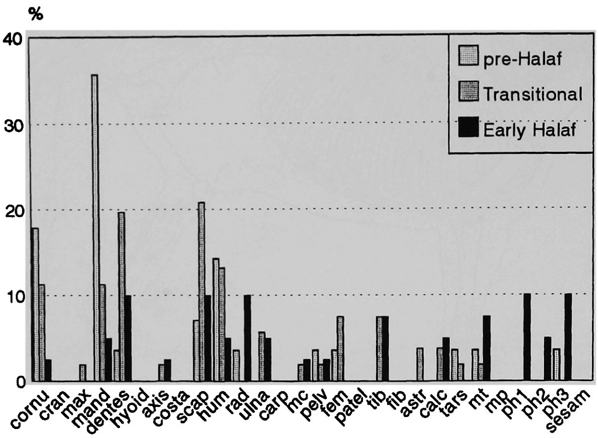


Figure 6.46 Relative frequency of gazelle skeletal elements

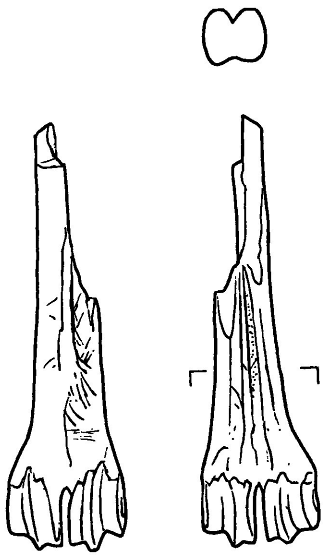


Figure 6.47 Distal metatarsus of gazelle with longitudinal cutmarks along the vascular groove (scale 1:1)

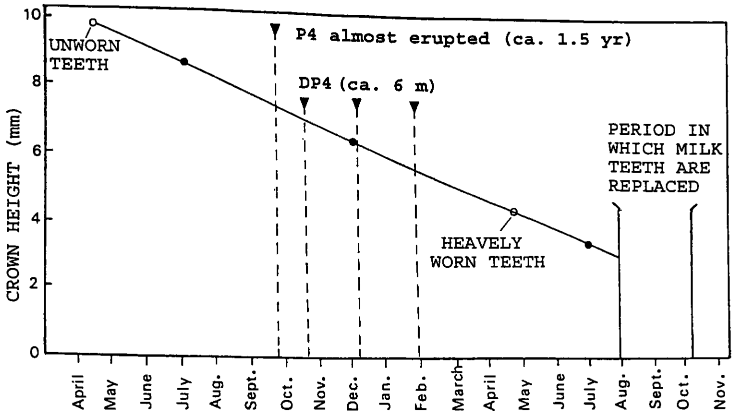


Figure 6.48 Degree of wear on the deciduous (DP) and permanent (P) fourth premolars of gazelle from Sabi Abyad (▼) related to the probable period of the year in which the animals were killed (after Legge and Rowley-Conwy 1987, p. 81)

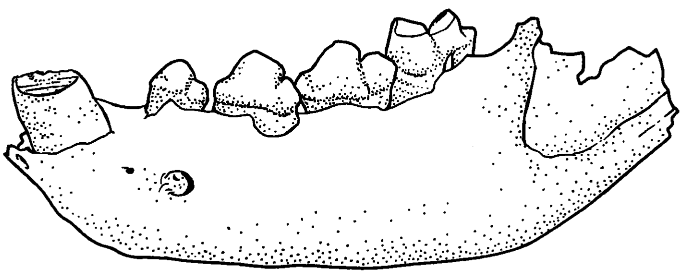


Figure 6.49 Mandibula of striped hyaena (*Hyaena hyaena*) with severe wear on the canine (scale 1:25)

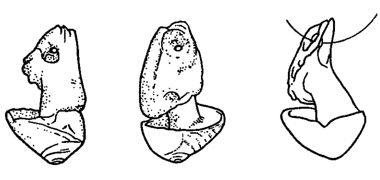


Figure 6.50 Indian Ocean shell (*Polinices* sp.) with a pierced hole (scale 1:1)

Chapter 7. Interpretation

7.1 Contextual approach

In order to interpret the analysis of the faunal remains from Sabi Abyad and to reconstruct the economical processes involved it is important to consider the context in which the bones were found and how representative the sample is. The composition of the samples may vary according to the contexts from which they have derived (Meadow 1975, 1978; Maltby 1979; Stallibrass 1985). The varying processes of food preparation and consumption result in different patterns of fragmentation and distribution of the remains within the different areas of the site.

In general primary, secondary and tertiary deposits may be distinguished (Schiffer 1972; 1976). Primary deposits are those which can be directly related to the process of food preparation and consumption. Secondary deposits are those not related to specific activity areas, consisting of refuse that has been discarded outside the area where it was generated. Tertiary depositions are those found in pits, wells, foundation trenches and by levelling of areas or buildings. All depositions are subject to natural factors of disposal modification due to erosion or scavengers. The faunal material from Sabi Abyad comes mainly from secondary and tertiary deposits. An exception is the material from level 6 which for a large part can be considered *in situ* owing to the sudden destruction of the village by fire (Akkermans and Verhoeven 1995). The majority of the bones from Sabi Abyad are, therefore, not directly related to the use of the structures in which they were found, but more to the abandonment of them.

	N	%
interior:		
room	1050	6.4
floor	94	0.6
inside	501	3.2
oven	26	0.2
tholos	1019	6.2
exterior:		
outside	1434	8.8
pit	4697	28.4
general	6720	41.6
wall	43	0.3
not assignable	806	4.9
tot. 16,330		

Table 7.1 Frequency of the material that could be ascribed to a context

More than half of the animal bones from Sabi Abyad could be associated with a certain type of context in which they were found (table 7.1). The following contexts were recognized: rooms, tholoi, ovens and pits. The faunal material comes from the refilling of these features. In the case of rooms, when a possible occupation floor was recognized it has been analyzed separately from the rest of the refilling of the same room. If it could not be specified from which part of a building the material came it has been considered as general interior material ("inside"). In contrast, part of the material was clearly found outside but in the vicinity of architectural structures ("outside"). Another large category consists of material that could not be clearly related to a feature ("general"), but which due to the position in the square and subsequent indications in the course of the excavation could be considered material coming from mainly large open areas. A few bones were found included in the house walls of level 6. The rest of the material could not be ascribed to a specific context. The representation of the contexts and the consequent distribution of the material in them varies considerably according to each level (table 7.2).

As noted, the activity of scavengers, in this case of dogs, contributes to the depositional pattern of the bones and they are presumed to have been more effective outside architectural structures or in other words in exterior areas. In this case one might expect a wider scattering of the material in exterior loci. At Sabi Abyad in general gnawed specimens show a slightly higher incidence in exterior contexts (2.0%) than in the interior ones (1.0%), while their percentage is identical (3.0%) on the identified remains. However, these figures vary widely according to the level, to whether they are associated with habitation or not and consequently to the different use of the same area (Cavallo 1996: 479; fig. 9.3). The lower levels present a significantly higher percentage (8-20%) of bones with traces of carnivore gnawing compared to the upper levels (1-3%). Due to a shift of the settlement northwards the area in which the squares of study are located turned into an open-outdoor area.

To find out if interior or exterior contexts led to a differentiation of deposition, the assemblage was first analyzed separately for interior and exterior areas (table 7.3). In the interior component the material from rooms, floors, ovens and tholoi has been included. The material from pits, from the vicinity of the habitations, and from large open areas has been the exterior component. In table 7.3 ovicaprids seem to be slightly better represented in exterior deposits against suids in the interior ones. *Bos*, *Gazella* and *Equus* have a similar representation in both categories of contexts. The percentages of the different species, however, vary remarkably when the levels are taken into consideration (table 7.4). Therefore there seems to be a better correlation with the presence/absence of a certain context in the levels and with the size of the sample than with a different depositional pattern.

	level	F	R	O	TH	INS	P	OUT	G
E	1	-	24	-	-	6	23	5	-
	2	-	-	4	-	31	-	-	46
	3	94	399	-	2#	27	295	585	279
T	4	-	6	16	949	203	2508	743	3326
	5	-	25	3	-	252	-	-	37
	6	-	579	3	-	11	-	-	978
P	7	-	10	-	-	-	-	-	380
	8	-	-	-	-	-	1688	-	555
	9	-	-	-	-	-	-	-	43
	10	-	-	-	-	-	-	-	205
	11	-	-	-	-	-	-	-	74

* Only the bones that could be related both to a level and to a context are reported in this table.
# Stratum 4A, locus 10.27= "finds from tholos I of stratum 4B"
Abbreviations: F= floor; R= room; O= oven; TH= tholos; INS= inside; P= pit; OUT= outside; G= general

Table 7.2 Distribution of the material according to contexts and levels*

	interior		exterior	
O/C	663	64.3	4043	72.4
SUS	154	16.9	379	6.8
BOS	157	15.2	843	15.1
CANIS	7	0.8	16	0.3
GAZE	25	2.5	131	2.3
EQUUS	12	1.3	90	1.6
OTHERS	13	1.4	85	1.5
tot.	1031		5587	

Table 7.3 Differential deposition of species within interior and exterior contexts

LEVEL:	6	4	3
interior			
O/C	41.8	68.6	66.6
SUS	7.0	14.2	20.8
BOS	42.6	14.7	8.7
GAZE	5.4	1.0	3.5
EQUUS	3.1	1.5	0.4
sample size:	129	204	404
exterior			
O/C	51.8	75.3	76.2
SUS	9.2	7.0	11.4
BOS	30.4	12.6	10.3
GAZE	18.5	3.7	1.6
EQUUS	66.7	1.4	0.5
sample size:	270	118	962

Table 7.4 Differential deposition of the five main species (percentages). Sample size >100

In order to see if the depositional patterns between interior and exterior contexts were affected by the size of the bones, the identified remains grouped into two categories were compared to the unidentified medium and large mammal remains of levels 6, 4, and 3 from squares Q15 and P15 (table 7.5). These squares were selected because they are the most representative for the type of contexts and for their sample size. The proportion of bones deposited in interior versus exterior contexts is 40 against 60 for level 6 and 20 against 80 for level 4 while no bones could be associated with interior contexts in level 3. The almost equal division between interior and exterior contexts of the material from level 6 is most likely due to a major concentration of architectural features in relation to the area of excavation. Level 4 constitutes a phase of occupation also characterized by architectural features, but these are less concentrated, while in level 3 the area of squares Q15 and P15 turns into a completely outdoor region. The area of level 4 is probably more equally divided between interior and exterior; therefore these values should probably be considered generally more representative. In this case the distribution of identified and unidentified material between interior and exterior contexts is quite similar. It may therefore be concluded that there is no large difference between internal and external contexts according to the size of the animals. Secondly, a more detailed analysis regarding the representation of skeletal elements of the main species has been carried out. The majority of the ovicaprid remains comes from exterior contexts, especially from pits and large open areas (table 7.6). In general cranial remains of the ovicaprids are better represented in the exterior contexts (fig. 7.1). They amount on average to ca. 10% (43.4% including loose teeth) for interior contexts and to ca. 11% (50% including teeth) for the exterior contexts. Vertebrae are better represented in interior contexts such as in rooms (5.4%) and floors (4.5%) against 0.7% - 2.7% of the exterior contexts. Of the postcranial elements, carpalia and metacarpals are better represented in rooms and floors and so are pelvis, femur and in general long bones. The dispersion of tibia, astragali and small tarsalia is slightly similar while the calcaneum shows an opposite trend similar to the phalanges, which are also more frequent outside.

	LEVEL 6		LEVEL 4		LEVEL 3
	n.	%	n.	%	n.
interior					
O/C+SUS+GAZE	67	51.9	191	86.4	-
BOS+EQUUS	62	48.1	30	13.6	-
MM	93	39.9	265	73.6	-
LM	140	60.1	95	26.4	-
	362		**581**		
exterior					
O/C+SUS+GAZE	134	58.8	886	86.3	4
BOS+EQUUS	94	41.2	141	13.7	6
MM	166	52.2	1224	75.1	25
LM	152	47.8	406	24.9	7
	456		**2657**		

Table 7.5 Differential deposition of species between internal and external contexts according to animal size; squares: P15 and Q15.

	o/c		sus		bos	
	n.	**%**	**n.**	**%**	**n.**	**%**
floor	66	1.4	20	3.7	3	0.3
room	332	7.1	98	18.5	89	9.1
inside	100	2.2	9	1.7	14	1.4
tholos	150	3.2	26	4.9	48	4.8
pit	1926	41.0	90	16.9	355	35.9
outside	577	12.3	82	15.5	96	9.7
general	1540	32.8	207	38.8	383	38.8
tot.	4691	100%	533	100%	988	100%

Table 7.6 Frequency of ovicaprid, suid and bovid remains according to the type of context

	interior				exterior		
	F	INS	R	TH	P	OUT	G
cornu		1	2	2	14	9	14
cran	1	1	22		90	17	62
max	1		7	1	32	4	9
mand	1	4	28	12	189	50	136
dentes	14	24	95	92	611	236	487
hyoid						1	1
atlas	2	1	8	1	22	6	9
axis	1	2	6		10	7	15
cerv			3		3	1	4
thor					1		
lumb					5		
caud					1		
sacr			1		4	2	2
stern					3		
scap	3	4	12	3	65	20	61
hum	1	7	15	6	97	24	100
rad	2	3	19	1	112	22	80
ulna		2	3	1	31	13	38
carp	9	5	10	2	29	2	16
mc	3	7	11	2	73	14	55
pelv	2	10	13	4	110	20	109
fem	9	6	10	2	65	25	54
patel	1	1		1	6	2	3
tib	5	5	22	6	94	23	90
fib		1					
astr	3	4	11	6	26	15	35
calc	1	1	4	4	28	13	31
tars	2	1	3	1	13	9	12
mt	1	1	9	1	52	17	38
mp	1	2	4		20	6	20
ph1	3	4	9	2	71	10	43
ph2		3	4		26	7	10
ph3				1	22	1	6
sesam					1	1	
Total	66	100	332	150	1926	577	1540

Table 7.7 Frequency of ovicaprid bones according to the type of context (Abbreviations: see table 7.2)

	interior					exterior		
	F	INS	R	TH	O	P	OUT	G
cornu						12	3	5
cran		1	2	1		14	1	18
max		1					1	2
mand		1	5	1		48	23	62
hyoid					1	1		2
atlas			1			3		
axis			2			2	1	1
cerv						2		1
thor						6		3
lumb				1		3		2
sacr			1	1		1		2
costa						12		3
scap			4			5	2	8
hum	1	1	3			6	3	15
rad			6	1		7	1	13
ulna			2			8	1	3
carp		1	5	3		28	10	34
mc			3			11	1	20
pelv		1	3			5	3	10
fem			3			6	5	5
patel			2					5
tib		1	5			12	2	10
fib	1		2			4		4
astr		2	3	1	1	11		10
calc		1	2	1		14	1	11
tars			1			10	3	10
mt	1		1			10	6	16
mp			1	1		11	1	9
ph1		1	5	2		32	11	30
ph2		4	1			22	7	23
ph3		4	2			23	1	18
sesam		1	1			13	3	4
Total	3	14	89	48	3	355	96	383

Table 7.8 Frequency of bovid bones according to the type of context (Abbreviations: see table 7.2)

	interior					exterior			
	F	INS	R	TH	O	P	OUT	GENERAL	
								n.	%
cran	5	1	17	3	1	16	16	39	18.8
max			6	4		2	2	12	5.8
mand	1		17			4	4	21	10.1
dentes		12	5			8	16	28	13.5
atlas	2					1		1	0.5
axis								1	0.5
cerv								1	0.5
thor							1	4	1.9
sacr		1						2	1.0
costa						10		3	1.4
scap		1	4	2		4	5	15	7.2
hum	1		7	2		4	5	7	3.4
rad			1			6	4	7	3.4
ulna	1		3	3		2	3	12	5.8
carp	1	1	1				2		
mc	3		3			1	1	11	5.3
pelv			3			5	3	5	2.4
fem			3			5	2	4	1.9
patel						1	2		
tib	1		4	4		4	2	6	2.9
fib			2	1		1		1	0.5
astr		2	5				3	8	3.9
calc			3			4	2	3	1.4
tars			1			3	1	1	0.5
mt			3			1	3	4	1.9
mp		3				2	2	3	1.4
ph1	2	1	3			2	2	7	3.4
ph2	1			1		1		1	0.5
ph3	2					3	1		
Total	20	9	98	26	1	90	82	207	

Table 7.9 Frequency of suid bones according to the type of context (Abbreviations: see table 7.2)

The relatively higher incidence of cranial elements in external contexts might be explained as the result of the butchering process occurring in large open areas on the one hand, and of trampling on the other, which resulted in a higher degree of fragmentation particularly evident in mandibles and cranial elements. The element representation within rooms and floors is not surprising either considering that despite the definitions it concerns re-depositional layers (filling) of the large multi-chambered building of level 3[1]. The architectural structures probably preserved the bones better and also prevented the dispersion of small bones such as carpalia and small tarsalia. That bones are more subject to destruction outside architectural features could also be the reason why the larger, stronger and more compact bones such as calcaneum and phalanges are better represented outside. That stronger bones have better chances of surviving in exterior areas is even more evident in *Bos* whose representation of phalanges is clearly higher than in the smaller species (O/C and *Sus*) (fig. 7.2).

The majority of the bovid bones comes from pits or large open areas (table 7.8). These two types of contexts show a similar element distribution in general (fig. 7.3). However, the cranial bones (cranium, maxilla and cornuus) are better represented in pits while the mandibulae and the teeth are absent or less represented. This might indicate a better preservation of the

[1] All the material found "on" the floor comes from level 3A; the material from the filling of the rooms comes in a great majority from level 3A (250 fragments), and from level 4 (1 fragment), level 5 (5 fragments), level 6 (54 fragments) and from level 7 (4 fragments).

cranial elements, in pits while in an open area they are subject to more fragmentation, with consequently a more difficult identification. While forelimb bones are found more in open areas, phalanges and distal hindlimb bones are slightly better represented in pits. This, together with the higher representation of cranial elements might indicate that the filling of pits consisted mainly of discarded refuse of butchering activities.

Compared to the previous two species the suid remains show a relatively better concentration in the fill of rooms within the internal contexts (table 7.6). In particular this concerns the rooms of the multi-chambered building of level 3[2], in which the incidence of suid remains is slightly higher than that from the vicinity of the structures ("outside") of the same level[3]. The distribution of the skeletal remains within each context is reported in table 7.9. Although the amount of bones is small there seem to be no important differences between the different contexts. The only differences might be represented by the lower frequency of teeth in pits indicating again less fragmentation or better preservation of suid bones in this kind of context as has already been observed for the other species.

From what is said above, it seems that there are no significant differences in the skeletal representation and in the size of the bones between internal and external contexts. Slightly better preservation seems, however, to be present in the material from the pits, which was probably discarded in one action and has been subjected less to scattering and trampling. The variation of species frequency observed between internal and external contexts within the various levels seems to be closer related to the representation of the kind of contexts within each level than to a differential preservation of the material. For this reason and for the problem of sample size it has been preferred to evaluate the faunal material according to phases and not to levels, in order to achieve a more reliable pattern and overcome the variations within the single levels.

7.2 Animal husbandry

The analysis of the faunal remains shows that animal exploitation at Sabi Abyad was based on four domestic animals - sheep, goat, cattle and pigs - since the beginning of the occupation of the site. These four species together are highly represented in the sample, amounting to more than 90% of the identified remains. The importance of domestic species increases slightly through time from 94.8% in the pre-Halaf phase to 96.6% in the Early Halaf phase, with a moderate reduction to 92.5% in the intermediate Transitional phase (table 6.2). Therefore, apart from these small fluctuations, the husbandry remains thus the basis of the animal economy at Sabi Abyad.

	pre-Halaf	Transitional	Early Halaf
number of fragments			
Ovis/Capra	1567	1584	1740
Bos	345	368	243
Sus	92	164	380
	----	----	----
	tot. 2004	2116	2363
%			
Ovis/Capra	78.2	74.8	73.7
Bos	17.2	17.4	10.2
Sus	4.6	7.8	16.1

Table 7.10. Relative frequency of the major domestic species

The emphasis of the animal husbandry is mostly on ovicaprid livestock whose remains account for more than 70% of the domestic species (table 7.10). Their importance, however, seems to have been somewhat reduced in the course of time especially after the pre-Halaf phase. The importance of cattle, the second main domestic animal, decreased as well, but not before the Early Halaf phase, while its importance remains essentially the same in the previous two phases. Pigs, in contrast, increase in importance constantly through all the separate phases with their remains outnumbering those of cattle in the Early Halaf phase.

The exploitation and the role of the main domestic species show important changes in the course of the occupation of the site. Various aspects of the zooarchaeological evidence indicate a process of transformation towards a more controlled and established husbandry for all four species.

Evidence has been presented that the husbandry of sheep and goat shifted from a generalized pattern of meat exploitation to the development of secondary product exploitation, together with an increase in goats and a development of possible pastoralism in the last phase of occupation. The mortality pattern of these animals in the pre-Halaf phase shows a concentration of individuals slaughtered in their first 3-4 years, followed by a gradual decline in the number of older animals, probably kept for reproduction purposes, indicating a pattern of exploitation of the ovicaprids mainly for their meat. This

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[2]From the fill of the rooms of the multi-chambered building of level 3A come 81 fragments; the rest was distributed between level 1 (4 fragments), level 4 (2 fragments), level 6 (9 fragments), either level 2 or 3A (2 fragments).

[3]Mainly from level 3B (21 fragments) and level 3A (26 fragments) while 9 fragments could be attributed either to levels 3A or 3B; the rest comes from outside the tholos of level 4 (12 fragments), from either levels 5 or 6 (2 fragments), and from either level 1 or 3A (2 fragments).

pattern changed in the subsequent Transitional phase, in which a clear increase of animals slaughtered at a young age between 1-2 years old -, combined with a concentration of old animals between 4 and 6 years, indicates a shift towards an exploitation of these animals (or at least part of them, namely goats) for their milk. Although the general size of the ovicaprids does not present noticeable changes in the course of time, the size distribution and the size index analysis of selected forelimb elements show variations towards a bimodal distribution of sheep specimens with a concentration on large-size individuals, and towards a representation of only smaller goat individuals. These variations might therefore also be a reflection of a change in use, such as more exploitation of milk (first sheep and then goat, or the opposite), which would have changed the growth rate. The milk exploitation would be concentrated on goats, while sheep remained the basis of the meat exploitation. This would be confirmed by the increase in the number of goats at the expense of sheep in the following Early Halaf phase, as shown from the variations of the ratio between the two species. In addition, the Early Halaf phase shows again a different pattern of mortality with a concentration of animals killed in few age classes, namely in the first and second year and then in their third to four year. This selective culling combined with an apparent return to a meat-oriented strategy would suggest that only part of the original herds, i.e. the part exploited and eaten at the site, is represented in the faunal assemblage of Sabi Abyad while the rest of the herds have been brought far from the direct surroundings of the site, at least for part of the year.

Cattle husbandry also shows changes towards a more selective breeding, concentrated on smaller and relatively young individuals. In the course of the occupation of Sabi Abyad there is an marked decrease of the bovid population size. The large size of the bovids from the pre-Halaf phase, partially, comparable to that of wild aurochs, might suggest a first attempt at domestication or a first stage in domestication. The process of domestication would have been further developed in the later Transitional phase, in which both large and small individuals are present, and finally in the definitely smaller animals in the Early Halaf phase. The mortality data are also consistent with this process of transformation. They show a constant increase of young animals combined with a decrease in adult animals throughout the separate phases. From these data, combined with the complete absence of old individuals, it could be concluded that cattle were mainly exploited for their meat. The reduction of the size of the bovid population could therefore have been the result of selection of relatively younger animals for meat purposes.

Pigs do not show any modifications such as size reduction or relevant changes in slaughtering patterns, as the previous species do. However, their importance constantly increases in the course of the occupation of the site. The percentage of pig remains is almost doubled in each phase (table 7.10). Pigs were killed quite young in all phases, but within this general pattern a constant increase of very young animals was present. Pigs form a significant part of the animal husbandry as an increasingly important source of meat.

Meat production seems to have been the major goal in the animal husbandry and common to all the main domestic species. However, their role and relative importance varies and changed through time. In terms of meat supply it seems that the exploitation of sheep, goat and cattle for this special purpose diminished in the course of time and was taken over by pigs in the Early Halaf phase. In order to establish the relative importance of the domestic species with regard to their meat supply, the ratio between the three species (table 7.11) was multiplied by the mean carcass weight of each species. A dressed carcass weight of 25 kg has been assumed for the ovicaprids (Dahl and Hjort, 1976: 200-203), 250 kg for cattle and 70 kg for pigs (Flannery 1969, table 2).

RATIO:	O/C	:	Bos	:	Sus
Early Halaf	4.6	:	0.6	:	1
Transitional	9.6	:	2.2	:	1
pre-Halaf	17.0	:	3.7	:	1

Table 7.11. Ratio between ovicaprids, bovids and suids, based on frequency of the previous table (table 7.10).

Figure 7.4 clearly shows the prominent position of cattle especially in the pre-Halaf and Transitional phase, in which they would have furnished almost two-thirds of the calorific needs. In addition the increasing importance of pigs as meat producers in the Early Halaf phase becomes evident. However, as pigs are usually killed rather young, the proportion of pig meat supply in relation to the other domestic species should probably be reduced. The number of young pigs killed at less than one year old also varies in the course of occupation of the site. Compared to the pre-Halaf phase (16%), their number doubles in the Transitional phase (40%), while it remains rather constant in the Early Halaf phase (37%). The mandible wear pattern indicates an autumnal killing when pigs reach the probable age of 6-9 months. This would presume a lower carcass weight than in a fully adult animal. In late-maturing breeds with a low plane of nutrition, the life weight of pigs would range between 45-70 kg with a dressing percentage of 70-75% (corresponding to ca. 33-51 kg) (Goodwin 1973: 39-41). Consequently the figure of ca. 42 kg (average dressing percentage) instead of 70 kg would be more appropriate for the Transitional and Early Halaf phase. However, the increase of the importance of pigs as a source of meat in the last phase remains evident.

The role of the ovicaprids seems to have been constant in the first two phases and increased in the last, at the expense of the bovids. The importance of the animals as a direct source of food procurement has already been pointed out by Akkermans (1993: 234-239). He suggested that cereal cultivation based on dry farming was not able to fulfil the food requirements of the Sabi Abyad population. Cereal cultivation would have provided about half to three quarters of the annual calorific demands of a small-scale settlement of not more than five households of 6-10 persons each. Akkermans calculated that the calorific contribution of ovicaprids would have satisfied only 13% of the necessary yield and that cattle and pigs would have been a better investment. The faunal data confirm this hypothesis. However, according to the zooarchaeological evidence the meat supply would have been furnished more consistently by cattle than by ovicaprids. Akkermans suggested that a meat-orientated animal husbandry alone would not have been enough and that a twofold strategy would have occurred, i.e. a meat-and-milk exploitation. The results of zooarchaeological analysis indicate that this occurred from the Transitional phase onwards for the ovicaprids. The mortality data of the ovicaprids, showing an increase of animals killed at a young age, reveal a shift towards milk production in the Transitional phase. A milk or meat-and-milk orientated strategy in case of cattle could not be attested. The reduction in size might point to a possible major representation of females but mortality data show that they were mainly kept not beyond their 3rd-4th years, which represents the optimal culling stage in terms of meat and fat return for late-breeding cattle (Van Wijngaarden-Bakker 1980). The reduction in the importance of cattle in the Halaf phase would therefore be better explained in terms of cost and labour than by a change in exploitation strategy, or possible competition with crop cultivation in terms of land demand. The important aspect of the last phase of occupation of Sabi Abyad is that the ovicaprid husbandry may for a large part have taken place away from the site and that within the Sabi Abyad faunal sample only the consumed part of the herd is represented. This view is supported by a general reduction in the number of ovicaprid remains (table 7.10) and by an apparent increase of their importance as meat producers (fig. 7.4). The concentration of Early Halaf ovicaprids killed in their 3rd-4th year age class, which represents the best moment to kill these animal for meat purposes, also support this interpretation.

In conclusion, animal husbandry represented an important complementary aspect of the subsistence economy of Sabi Abyad based on cereal production. Modification in the exploitation of the four species of livestock occurred in the course of time, indicating a prevalent transformation from a generalized to a more intensified and controlled animal husbandry, based on meat exploitation in the case of pig and cattle, and on meat-and-milk exploitation in the case of sheep and goat, or at least one of them. In contrast, there is no evidence for the exploitation of ovicaprids for wool or for the utilization of cattle for ploughing, neither in the form of direct osteological evidence such as modification of the metapodials, as shape or pathological alterations, nor in the form of mortality patterns indicating the presence of old animals. Moreover, the decrease in the importance of cattle contrasts with a possible utilization of these animals for ploughing. It is not excluded that the living animals could also have been important in other ways, providing other kinds of products such as dung, both for manure and for fuel. The scarce occurrence of seeds from palatable plants (grasses or shrubs) in the botanical samples from Sabi Abyad suggests that the practice of burning dung for heating must have been very limited, and that firewood collected from the riverine forest may have been the most common source of fuel (Van Zeist and Waterbolk-van Rooijen 1996: 540-541).

7.3 Hunting

Hunting always played a minor role in the animal economy of Sabi Abyad. The percentage of wild species is rather low, amounting to less than 10% of the identified species. The percentages for the separate species is slightly different from the previous preliminary account (Cavallo 1996). When a larger sample was analyzed, the steady decline of wild species, as previously reported (Cavallo 1996), could no longer be maintained. In addition the differences can be explained by the identification of more specimens attributed to wild species after a more defined metrical analysis. The last results indicate a slight increase of wild species in the Transitional phase, followed by a clear drop in the Early Halaf phase (fig. 7.5).

The wild species spectrum is dominated by gazelle and onager, but a wide range of other minor species is present (fig. 7.8, table 6.2). Interestingly, the highest percentage of wild species of the Transitional phase also shows the widest range of species. In this phase we also find the appearance of a large number of birds. It is interesting to correlate this result with the archaeological evidence. During the Transitional phase a new type of small and delicate arrowhead appears. Due to its smaller size it has been suggested that this kind of arrowhead was especially used for hunting birds, possibly in combination with the use of poison (Copeland 1996: 315).

A pattern in hunting season seems to be present. The zooarchaeological data associated with information taken from modern animal behaviourial patterns would suggest that hunting occurred in specific periods of the year, i.e. in autumn and/or in winter. The crown height and the wear patterns of the mandibular teeth of gazelle indicate a killing of these animals during October and February (fig. 6.48). The presence of mainly winter species of birds is also consistent with the interpretation that exploitation of wild game was concentrated in this part of the year. Onagers may also have been killed in this period during their moves along their migratory route. The fusing data indicate killing of young animals (probably under one year old) and adult animals, suggesting that hunting concentrated on herds of females and yearlings who live segregated from the males for most of the year. The presence of only male gazelle horncores might, on the other hand, suggest a preferred killing of only male gazelles. These data regarding the two species indicate that hunting parties would therefore seem to concentrate on herds and adults rather than on individual animals.

7.4 Processing of food and raw material

Apart from the exploitation of the animals from Sabi Abyad for food (meat, marrow and milk, and probably also fat and blood), there is evidence for the utilization of the animals for their hides and as source of raw material for bone manufacturing.

Within food processing four phases can be distinguished: killing, butchering, cooking and eating, to which conservation may be added. These separate phases of food processing leave different kinds of faunal refuse, that can sometimes be recognized within the faunal material. According to the species (domestic or wild) killing could have been carried out either at the site or away from it. As supported by the evidence of all the parts of the carcass present, the domestic species were killed at the site. The Early Halaf village of Sabi Abyad was characterized by few and scattered permanent structures, representing one or two extended house complexes per building phase, separated by open areas (Akkermans 1993: 164). In these open areas killing of domestic animals was presumably carried out. Killing of wild animals occurred away from the site. Depending on the distance of the place of killing, animal weight and number of people involved in the hunting party, the carcass could have been brought to the site completely or in part. According to this it seems likely that gazelle was brought in completely and onager only partially. However, there is no strong evidence for this difference and it is suggested that the all parts of the carcasses of these two animals were transported to the site. The less complete skeletal representation of the onager and gazelle remains compared to that of ovicaprids, cattle and pigs might be related more to the sample size and identification bias than to a selection of pieces brought to the site.

Butchering activities are well attested by the traces left on the bone surfaces. No differences in the butchering techniques were noted between the large-sized species and the small-sized mammals. Lithic tools such as knives, scrapers as well as unretouched flakes and blades could have been used for cutting and meat removing. The rare presence of heavy duty tools, such as choppers, axes, roughouts and hammerstones is consistent with the scarce occurrence of chopmarks. These are related to those skeletal parts whose removing or breakage would have required a heavy impact most exclusively. Chopmarks are thus present on horncores and on phalanges of bovids and equids. It is most likely that heavy duty tools were principally used for breaking the shaft of the long bones, but due to the recent fragmentation of the material this technique could not be widely investigated.

To the butchering phase belongs refuse of non or little meat-bearing skeletal portions, such as distal extremities and skulls. From the analysis of the single species it emerged that in the later levels a higher frequency of distal limbs, especially phalanges, of ovicaprids, gazelle, equids and suids was present as well as more skull elements of bovids and equids. This could be considered as evidence of butchering refuse. In this sense it is consistent with the archaeological evidence of a shifting of the village northwards and transformation of the zone, from which the faunal material has been analyzed, into a more open area. The correlation of a higher representation of cranial bones of bovids from pit contexts (cf. section 7.1) confirms the use of large open areas as butchering areas and of the pits as butchering refuse contexts after their primary use as sources of clay had come to an end (Verhoeven, pers. comm.).

Food preparation can be done in different ways: cooking in vessels or in ash, roasting, cooking in leather bags or in its own skin or surrounded by hot stones etc., but no conclusive evidence on the bones has been found as to the use of these techniques. The recent fragmentation of the bones hampered the reconstruction of the original fragmentation pattern. Most of the traces left on the bones are related to a process of disarticulation. The rather low occurrence of cutmarks in general and especially along the diaphyses suggests that meat was removed after the joint was cooked or boiled. Indication of possible roasting is presented by bones partially burnt at the joint level. Most of the traces of partial burning were found on small and medium mammal bones, a few on bovid ones and only one on a bird bone (table 7.12).

	Bos	Ovis/Capra	Sus	Gaze	LM	MM	Vulpes	Anas
astr	2							
calc		1	1					
costa						2		
fem		2						
hum		2		1	3		1	
mc	1	1						
mp		3					1	
mt	2	1					1	
ph1		4						
ph2	1	2						
rad		1						
scap	2	1						1
tib		3	1					
tibt							1	
ulna		1						

Table 7.12 Bones with traces of partial burning as possible evidence of roasting

Food preparation and eating are two closely related phases as far as bone refuse is concerned. They are both related to the parts of the carcass that yield the most meat. These parts are the upper limbs (scapula, humerus, femur and tibia) and the neck and thorax (vertebrae and ribs). The bones from these parts are rather frequent in the sample but no special concentration was observed. No evidence of meat conservation, either smoked, dried or salted could be ascertained from the faunal material.

There is clear evidence for the use of animals for other purposes than food processing. For example evidence of skinning in the form of cutmarks on the metapodials and on the phalanges of ovicaprids and equids. It is most likely that this practice was extended to the other animals and that the lack of evidence for these species must be attributed to the scarcity of the sample. Bones were also used for the production of various tools. The most common tool is the awl obtained from metapodials of both ovicaprids and gazelle. Semi-manufactured specimens allow the reconstruction of the process of fabrication (cf. section 6.6.3). Tibiae of small herbivores were fashioned in the form of gouges, after removing the proximal part. Ribs of large mammals such as bovids and equids were used as spatulas. They present a fairly worn and shiny surface on both sides, and one of the extremities (on the short side) is generally rounded.

7.5 Environmental exploitation

The faunal assemblage from Sabi Abyad is characterized by the presence of species well adapted to arid and semi-arid conditions as well as to the strong seasonality of the climate. Ovicaprids, which account for ca. 70% of the faunal remains from the site, are a good example of exploitation of animal species in relation to the local environment. Sheep and goats can well withstand extreme temperatures and drought and can easily exploit the feeding possibilities of the steppe and other areas of the valley. Sheep do not need to drink every day and can stay without water for up to five days as well as tolerate a high degree of salinity in the water (Schmidt and Nielsen 1964). The feeding habits of the two species form a good combination of selective grazing by sheep and indiscriminate browsing by goats. Studies on wild sheep showed that they can feed on a large variety of plant species (up to 180), such as *Poa* sp. and *Carex* sp. and on salty shrubs (*Anabasis*, *Salsola*); the diet of wild goats is restricted to a smaller number (40) of grass and herb species but they can also feed on a large variety of shrubs and leaves (Heptner et al. 1966).

The other main domestic species exploited are less suitable to dry environments. Owing to their physiological and metabolical conditions cattle cannot withstand drought and evaporation as easily (Schmidt and Nielsen 1964). They need to drink more frequently than sheep. For this reason they cannot move very far away from water sources and therefore they need moister grazing areas. Pigs are also less tolerant of heat and are extremely dependent on humidity.

The most plausible grazing grounds were those around the village in the flood plain. The original natural vegetation in the Balikh valley has been remarkably reduced and the prehistoric landscape features are almost completely unknown (see chapter 3). The modern situation, however, shows a selection in pasture areas in the flood plain (Bottema 1984) (fig. 7.7). The moister areas such as marshes and wet meadows on sediment-filled cut-off meanders are mainly grazed by cattle. Here *Rumex*, *Juncus* and *Cynodon dactylon* grow. Sheep and goats graze on higher elevated areas, such as slopes of tells where more erosion occurs, covered by dense shrubs of *Atriplex leucoclada* together with the less common *Peganum harmala*, *Alhagi* and *Cuscuta*.

Sheep and goat were also the most profitable users of the vast steppe on the higher plateaus bordering the valley, which were characterized by a richer covering of palatable grass and perennial shrubs than today (cf. chapter 3). The increase of goats in the last phase of occupation might reflect a wider exploitation of drier areas as a consequence of either possible degradation or environmental changes. This would mean exploitation of other environments besides those close to the village, i.e. not only the flood plain but also the steppe.

The exploitation of the steppe area is also represented by two typical steppe animals, the onager and the gazelle, which were the main hunted species (table 6.2). Today onagers like other wild equids live in open, flat and rather dry areas. They can withstand drought and high temperatures. The kulans in Iran can tolerate temperatures up to 58° in the daytime (Groves 1974). Although they usually drink daily, they can live without water for at least 2-3 days (Heptner et al. 1966). Their diet varies according to the season within 110 taxa, although they prefer feeding on juicy low-growing plants, such as *Carex* sp., *Poa* sp. and *Stipa* sp. (Heptner 1966: 849; Groves 1974: 102); in addition to these, they can also feed on salty herbaceous plants (*Anabasis* and *Salsola*) and shrubs such as *Artemisia* (ibid.). Gazelles have a similar habitat. Today the goitred gazelles live on gravel plains and limestone plateaus, like the onager with whose herds they have been observed to run (Groves 1974). They feed on 35-40 different species of grass and a large variety of shrubs, and tree-leaves such as pistachio leaves (Heptner et. al. 1966: 537-8); the dwarf scrub, *Rhanterium eppaposum*, is one of the most important food plants of this species in central Arabia (Harrison 1968: 364). They are also extremely drought and heat resistant and can last without water up to 3-7 days (Heptner et al. 1966: 538).

The analysis of the mortality patterns of the onager and of the gazelle indicates that the exploitation of the steppe environment as hunting ground was most probably concentrated on the winter which is one of the periods of denser herd population for these species (cf. section 6.5. and 6.6).

	pre-Halaf	Transitional	Early Halaf
dry environment/ steppe			
Ovis/Capra	7	5	5
Equus	38	54	13
Gazella	28 (33)	54 (72)	40 (50)
	tot. 73 (78)	113 (131)	58 (68)
moist environ./ river forest			
Bos	12 (25)	11 (13)	3
Sus	3	2	1
Ursus		1	
Cervus		2	2
Dama	2	3	-
	tot. 17 (24)	19 (21)	6
	----	----	----
	tot. 90 (102)	132 (152)	64 (74)
	%	%	%
steppe	**81.1 (76.5)**	**85.6 (86.2)**	**90.6 (92)**
river forest	**18.9 (23.5)**	**14.4 (13.8)**	**9.4 (8)**

()= doubtful identifications included

Table 7.13 Frequency of wild animals representative of dry and moist environments

Apart from these steppe species a large variety of other game species are indicators of exploitation of moister environments. Within these species we find red deer, fallow deer and brown bear as typical forest species, together with wild boar and aurochs. Today *Dama* lives in dense impenetrable jungles of white poplar and tamarisk bordering the rivers of southwestern Persia and of south Mesopotamia (Haltenorth 1959). They are browsers that feed on young shoots of poplar bushes (Harrison 1968: 368). Wild boar, whose omnivorous diet includes rhizomes of aquatic and marsh plants, today mainly lives in dense thickets and reed jungles (Harrison 1968: 375-376). Aurochs require a less restricted habitat and are more adaptable to various environments. However, they also demand moister environments compared to the ovicaprids, onager and gazelle, and a habitat with a dense continuous vegetation. These species could have found their typical habitat in the riverine forest along the Balikh valley which was dominated by poplar, tamarisk, willow shrubs and dense reed beds (cf. chapter 3.4). Exploitation of this moister environment is also documented by the presence of different species of aquatic birds such as *Anser* and *Anas* in the faunal assemblage of Sabi Abyad (cf. chapter 6 for the description of bird habitats).

The exploitation of other biotopes such as the river, the wadis or the temporary flooded areas around the site is attested by the presence of fish and molluscs in the faunal spectrum of the site. Their small amount, however, suggests that aquatic resources were scarcely exploited and this seems to be a general pattern in prehistoric sites of northern Syria (Buitenhuis and Zeder, pers. comm.).

It is not the aim of this work to investigate the exploitation of the various environments for purposes not directly related to the animals, as these have been widely discussed and evaluated elsewhere (Akkermans 1993). It may be worthwhile to mention that the exploitation of the flood valley for agricultural purposes was directly linked to the possibility for the domestic animals to graze on the stubble, as an integration within the agricultural system.

A general increase of the exploitation of animals from the steppe through time can be observed whereby the importance of the onager was reduced in the last phase while that of gazelle remained relatively constant (table 7.13). This difference cannot be attributed to an exploitation of different environments but must be the result of a different exploitation of the same environment. The first possibility is that this difference might be attributed to different hunting strategies and techniques. The lithic industry does not support this interpretation. Hunting was performed with the bow-and-arrow technique as indicated by the flint industry and documented by a pottery fragment representing two men with a bow (Akkermans 1993: fig. 3.21, p.77) as well as by the exceptional find of a bovid shoulderblade with an arrowhead still incorporated in the bone (fig. 7.6). This category of artefact (arrowheads) does not show significant modifications in shape and quantity through the separate phases of occupation, except for the introduction of a smaller type of arrowhead probably related to the hunting of wild fowl. However, the appearance and the increasing importance of sling missiles from level 6 onwards, which partly seem to have replaced the role of the arrowheads, becaming very rare, might suggest a change in the hunting techniques. A second possible explanation for the difference in onager and gazelle percentages may be searched in environmental changes, which may have brought a reduction or modification in the quantity of prey. Although direct evidence from palynology is lacking for the period concerned, the increase in goats shown in the latest Early Halaf phase, might also be explained by environmental degradation. The demand for arable lands and the impact of domestic animals under human influence might have contributed seriously to the degradation of the ecosystem by altering and restricting the original vegetation. Reduction of vegetation may effect the average rainfall and consequently the water availability, which could have had a rather great effect on the modification of the micro-climate of a small valley, such as that of the Balikh valley. In addition, gazelle is known to be slightly more resistant to heat and its more intermediate foraging strategies probably represented an advantage compared to that of the onager which dependents more on grazing.

In conclusion, although it is not possible to draw a definitive conclusion on the reasons for the variation of the hunting strategies, it seems however that within a general reduction of its importance through time, hunting at Sabi Abyad became increasingly concentrated on smaller preys such as gazelle instead of on larger herbivores such as aurochs and onager, and that the best exploited hunting grounds became the steppe.

It is interesting to observe that at the preceding Pre-pottery Neolithic site of Sabi Abyad II of the two species only gazelle was hunted while equid remains were completely absent. For that site it was suggested that hunting the gazelle did not imply venturing into the steppe, but that gazelles were probably hunted when they approached the river valley (Van Wijngaarden-Bakker and Maliepaard, in press). If we postulate for Sabi Abyad that hunting of both species is indicative of steppe exploitation, we can, therefore, observe on a wider chronological perspective that the area of the middle Balikh became more and more extensively exploited, as the percentage of gazelle and onager consistently increases at the late Halaf site of Khirbet esh-Shenef (table 7.14) (Hendrichs 1990).

	Sabi Abyad II (7th.mill.)	Sabi Abyad (6th mill.)	Shenef (5th mill.)
Gazelle	2.1%	1.7% (2.2%)	17%
Onager	-	1.6%	32%

()= doubtful identifications included

Table 7.14 Percentage (on the identified mammals) of gazelle and onager remains at the sites of Sabi Abyad II, Sabi Abyad and Khirbet esh-Shenef

7.6 Risk reduction

The location of Sabi Abyad in a marginal area, on the border of the dry farming zone, and generally characterized by a high degree of climatic fluctuations (cf. chapter 3) presents a high degree of risk in crop failures. After only a few consecutive dry years the isoyeth of 250 mm of rainfall, corresponding to the limit of dry farming, can retreat considerably northwards towards the upper border of the Balikh valley (Wirth 1969; see figs. 3.2, 3.3). Although drought is the most important factor, low temperatures or other natural hazards such as infections and diseases can also be a source of risk and disaster, sometimes causing the death of entire herds (Lewis 1988; cf. chapter 3). Besides these "natural" risks, cultural hazards such as changes in labor forces due to wars or changes in social relationships might also have played an important role (Halstead 1990). There are different ways to counteract the unpredictable variability in agricultural risks, according to the various levels of economy and technology. Halstead and O'Shea (1989) point out that there are four basic responses to food scarcity which derives from risk and uncertainty. They consist of 1) diversification, 2) mobility, 3) storage, and 4) exchange. With these aspects in mind it will be tried to understand the role of animals as one of the means to cope with and reduce the risk of shortage of food resources within the agricultural cycle of the community of Sabi Abyad.

Sabi Abyad was a settled village based on a subsistence economy. The agricultural production was carried out by dry-farming, as no definitive evidence of irrigation was found. The agriculture was based on cereal cultivation, especially on emmer wheat (*Triticum dicoccum*), followed by einkorn (*Triticum monococcum*) and, to a lesser extent, by barley (*Hordeum disticum*) (Van Zeist and Waterbolk-van Rooijen 1989, 1996). These are winter crops which are nowadays harvested in early spring, between April and May, while the fields are sown in autumn as soon as the rains start (Lewis 1988: 688; Akkermans 1993: 217).

As was described in a previous section, animal husbandry represented a complementary part to the cereal dry farming in terms of food supply. The harvest period, in spring, is a period of very intensive labor investment concentrated in a short time, probably within only two weeks (Akkermans 1993: 217). Spring is also the period in which young animals (lambs and calves) and dairy products are available for food requirements. Nowadays in the Middle East lambing takes place in late winter (between January and March) and spring and early summer constitute the period of the highest preparation of milk products as "lamb numbers are systematically reduced and the milk supply diverted to human use" (Cribb 1991: 29). The exploitation for dairy production seems to have been especially important from the Transitional phase onwards, in which the culling patterns of the ovicaprids show an increase of animals killed at a young age together with a reduction of old individuals, as a result of the exploitation of these animals for their milk. At the end of the summer probably the most critical period started as the supply of dairy products declined and vegetation impoverished. There is evidence that pigs at Sabi Abyad were killed at the end of the autumn and during the winter. This also corresponds to the period in which hunting mainly occurred. Stein (1989) suggests that at Gritille, a PPNB site on the northern Euphrates in Turkey, a similar pattern existed with hunting concentrated during winter. Winter is the period of major risks of diseases and relatively poor pasture for the livestock, but it is also the period in which the wild resources (caprines, aurochs, pigs), which migrated to lower altitudes because of snow in the surrounding Taurus mountains, would have been more accessible. Obviously men took advantage of seasonal animal movements, of the larger herd aggregation of wild animals during the cold months, and the ungulates' difficulties in moving on muddy grounds after the rains.

	Spring	Summer	Autumn	Winter
agriculture	harvest		sowning	
husbandry	dairy products		pigs/cattle	
hunting			---hunting---	

Table 7.15 Seasonal distribution of agriculture activities and resources during the year

7.6.1 Diversification

The role of diversification as a risk reduction strategy was limited in the case of crops. These were restricted to a few kinds of cereal crops while the role of pulses was not very important and the gathering of wild species was rare (Van Zeist and Waterbolk-van Rooijen 1996). As there is no indication of variation in farming during the three phases of occupation of Sabi Abyad, the zooarchaeological investigation shows that important transformations occurred in terms of animal management and resources such as changing and amplification of herding strategies (including milk production) and exploitation of wild animals. Interesting in this sense is the increase in number of species from the Transitional period onwards. In the same period a larger variety of hunted birds was also observed, which might be favored by a technological innovation such as the introduction of small transverse arrowheads which are supposed to have been especially utilized as poisoned projectiles useful in bringing down game birds and water fowl (Copeland 1996). Diversification in the form of a slight increase in hunting, a larger variety of species, and more milk exploitation in combination with meat exploitation, might be interpreted as responses to periods of crisis. The interpretation of the ovicaprid mortality pattern as possible herd security management in the Transitional period is consistent with the interpretation of a possible critical period in this phase.

A trend of diversification is also observable in a wider perspective. A continuous development in the subsistence strategies is present from the Pre-pottery Neolithic Sabi Abyad II to the lower levels (pre-Halaf levels) of Sabi Abyad (fig. 7.9). Sabi Abyad represents the transition from an (intensive) environment exploitation restricted to the flood valley (Sabi Abyad II and pre-Halaf phase of Sabi Abyad) to a wider environmental exploitation, including an extensive exploitation of the steppe. This wider environment exploitation is attested at Sabi Abyad by an enlargement of the number of species hunted and in an increase of the importance of the wild steppe species from the Transitional phase onwards, as well as, later in the 5th millennium, by the direct occupation of the southern part of the valley by the late Halaf society (see e.g. Khirbet esh-Shenef and Damishliyya) (Akkermans 1993). Looking at other regions, we see other late Halaf sites in which the hunting component is rather important and characterized by a wide spectrum of species. This is the case of Umm Qseir on the Khabur. Here the site was first interpreted as a pastoral camp on the basis of the short occupation and scarce architectural evidence. However, the faunal analysis showed an all-year-round occupation of the site (Zeder 1994), indicating a permanent exploitation of this area. The hunting component at this site is, however, rather high and increases in the course of occupation of the site, while other characteristics of the neolithic tradition, such as cattle husbandry, are missing or abandoned. Shams ed-Din on the Euphrates is also located in a strategic position on the borderline between the flood plain and the plateau so that a better exploitation of the steppe could have been possible (Uerpmann 1982), as attested by the relatively high percentage of hunted species, especially onager and, to a lesser extent, gazelle.

These characteristics are, however, typical of the southern Halafian sites located on the border zone of the steppe. The northern sites, such as Çavi Tarlasi, Banahilk, Girikihacyan and Tell Turlu rely mainly on husbandry while the wild component, though sometimes rather varied, is rather limited (cf. chapter 4, fig. 4.3). The north-south gradient seems to have been a rather important factor in the subsistence choices of the late Halaf community. The northern part could count on more stable and secure yields from crop cultivation, while the southern part was more subjected to the hazards of climatic fluctuations, which would have induced the inhabitants to exploit another and (at that time) abundant resources of the area, i.e. wild game. So in its last phases the settlements of the Halaf community appear to be more dispersed over a large territory, consisting of different biotopes. The Halaf culture at that time exhibits, therefore, a certain flexibility in its varied subsistence strategies, possibly as a conscious adaptation to the potential of the local environment.

7.6.2 Mobility

As the economy at Sabi Abyad relied heavily on agriculture and animal husbandry, the role of mobility as a buffer appears to have been limited. The relatively low frequency of wild animals combined with the fact that hunting was restricted in time to that part of the year when people are more released from farm work indicates that in general hunting played a minor role in the site's economy. The hunting component is a constant feature in the Neolithic settlements, and - its importance seems to be extremely variable (cf. chapter 3). As in the case of Gritille, for Sabi Abyad the winter season would also represent a period of crisis on the one hand and of possibly more prey on the other. Onager and gazelle herds are more dispersed in the summer in search of pasture while in winter they group for mating. For people winter is also the period in which there is more possibility to move from the site and thus when 'mobility' could have had more chance to develop.

The faunal analysis indicates that in the Early Halaf phase only part of the ovicaprid herds was kept at the site: differently from the previous phase, the mortality pattern of the Early Halaf phase shows a concentration on a few age categories with an apparent return to a meat-oriented strategy, after the development of the exploitation of these animals for their milk in the Transitional phase, suggests that only part of the original herds is represented in the Early Halaf assemblage (cf. chapter 6.2.5). The culling pattern of the ovicaprid sample of the Transitional phase could also be partly interpreted as the result of a herd-security strategy. In the same period there is a slight increase in hunting as well as in the number of species hunted. This combined to a later (Early Halaf) increase of goats might be a response to a crisis period in animal feeding resources which might have been resolved by moving part of the ovicaprid herds away from the site. The role of hunting a buffer in terms of mobility might have been, therefore, combined or even replaced by a more mobile or nomadic pastoralism in the last phase. Both hunting and pastoralism depend on seasonality. Pastoral nomadism is characterized by periodic changes in pastures, depending on the seasonal availability of grazing areas and water facilities (Khazanov 1984: 19). As the zooarchaeological evidence suggests, the Sabi Abyad population may have been increasingly involved in a more mobile pastoralism towards the last phase of occupation of the site. The possible development of secondary products such as milk, observed in the Transitional phase, could have facilitated this shift to a more mobile pastoral economy. Milk products are considered to be a pre-requisite for the development of a pastoral economy, which usually depends on these products (Bar-Yosef 1992: 16). It is not necessarily the whole population of Sabi Abyad that was involved in these more mobile pastoral activities, and not for the whole year. The permanent character of the village of Sabi Abyad remains as testified by the constant high percentage of domestic animals, by the increase in pigs and by a better controlled cattle husbandry. The sedentary character of the site is also attested by the continuing evidence of crop cultivation and the architectural remains. The presence of two components, sedentary agriculture and mobile pastoralism, is not in contradiction. As Khazanov (1984) points out there is a closely related and important relationship between agriculturalists and pastoralists. Pastoralists are extremely dependent on agriculturalists, in terms of agriculture products, or they are even, although to a different degree, involved in agricultural activities. Therefore, a form of semi-sedentary pastoralism might have developed at Sabi Abyad, where agriculture still played an important role and part of the population would have been involved in probably seasonal migrations. These people would return to the site for certain periods of the year. One of these periods was most likely the harvesting time in spring, when intense labour resources were required most. An extra combination would be the possibility of large herds grazing on stubble after harvesting.

Other archaeological evidence seems to suggest that already during the Transitional phase part of the Sabi Abyad population was not permanently present at the village. The numerous seals concentrated in a few rooms of a storage building of level 6 (Transitional phase) provide evidence of storage of goods and devices of property control (Akkermans, pers. comm.; Akkermans and Duistermaat, 1997). The size of the possible containers, number and type of impressions, and the concentration on a limited area of the village led the excavators to suppose that these goods did not belong to people living in the village, for whom this kind of control would not be necessary, but to people not permanently present at the village, these people being part of the nomadic population. This would presume the presence of two already developed specialized societies (agriculturalists and pastoralists) in the area. Khazanov (1984: 17) points out that pastoral nomadism is a rather specialized society: " pastoral nomadism represents a distinctive form of food producing economy in which extensive mobile pastoralism is the predominant activity and in which the majority of the population is drawn into periodic pastoral migration ".

This leads to the question when pastoralism developed in the area of study. Indications for the beginning of pastoralism are found in the early 6th millennium in the Jordan area (Köhler-Rollefson 1992) and during approximately the same period in southwestern and northwestern Iran (Hole et al. 1969; Voigt 1983).

For the Balikh valley, Sabi Abyad II at the end of the 7th millennium provides indications of a subsistence pattern based on an agrarian community, linked to its surrounding territory. In the possible chronological gap between Sabi Abyad II and Sabi Abyad a development or occupation of the area by a pastoral community could have occurred. However, in terms of subsistence patterns, the pre-Halaf levels of Sabi Abyad are consistent with Sabi Abyad II (fig. 7.9). The character of the subsistence of Sabi Abyad shows gradual changes towards an increasing involvement in wider exploitation of resources and environment and in a possibly more extensive and more mobile pastoralism, as an eventual adaptation to new circumstances. The development of a twofold economy which characterized the last phase of the Halaf society (in the first half of the 5th millennium) was distinguished by a larger site permanently occupied with a scattered number of small briefly occupied sites (Akkermans 1993; cf. chapter 3). This pattern might have been started in the last phases of occupation of Tell Sabi Abyad when part of the community left for the grazing grounds for part of the year and returned to the village at the moment of labour intensification, i.e. harvesting. The occupational pattern of the Balikh valley indicates that after a period of decline in population in the first half of the 6th millennium, an increase in the population took place towards the end of the same millennium and the early 5th millennium in correspondence with the appearance of Halaf traits (Akkermans 1993: 186ff). A proliferation of settlements during the Balikh IIIC period occurred, which is one of the " most densely occupied periods" of the valley (Akkermans 1993: 188). In the first half of the 5th millennium evidence of small, brief and repeated occupation is represented by the late Halafian site of Shenef, as two phases of occupation divided by a (modest) erosion layer. The Halaf settlement of the early 5th millennium of Damishliyya on the west bank of the Balikh was restricted to a very small area. The extremely restricted area on which pottery was found associated with the complete absence of architectural remains indicates that the site might have served as a seasonal camp site, repeatedly visited for a short time over a number of years (Akkermans 1993: 11). To these late Halaf sites, most of the pastoral component of the economy may have been transferred. The late Halafian sites in the steppe are also the sites with a higher percentage of hunted animals. Mobility characterized both hunting and pastoralism. Hunting, therefore, might have favoured the development of a more mobile pastoralism in the last phases of occupation of Sabi Abyad, just as more mobility might have favoured more hunting in the late Halaf sites. That most of these sites show a brief but still all-year-round occupation based on small-scale agriculture, might be due to the fact that from the purely pastoral camps probably no archaeological evidence is left, except in a few cases such as at Damishliyya (Akkermans 1993: 191).

7.6.3 Storage

Storage seems to have been one of the most adopted strategies to minimize the effects of variation in crop yields. Besides the direct evidence of burnt grain deposits, archaeological investigation provides evidence of many storage facilities, as indicated by the shape and dimensions of part of the building and by the numerous clay sealings (cf. Akkermans 1993 and the various contributions in Akkermans, ed., 1996). Livestock also represents an important form of 'indirect storage' or 'banking', which could have been fed with agricultural surplus in good years and eaten, or eventually exchanged, in lean years (Halstead 1990: 155; Flannery 1969: 87). In addition, increase in the size of the herds consists also in a form of surplus, and consequently a form of storage. This way of produce another type of surplus might have been provided a kind a 'status' in the community, or at least differentiate part of it.

7.6.4 Exchange

Regarding exchange, the archaeological investigations at Sabi Abyad may be taken as evidence for a possible centre within a more integrated system (Akkermans 1993, Akkermans and Le Mière, 1992). The evidence mainly consists of large storage facilities, in the appearance of numerous clay sealings from level 6 indicating a standardized administrative system, in the construction in the Early Halaf phase of certain architectural features such as an impressive stone wall supporting a terrace which might have functioned as a place for communal ceremonies. If we suppose that part of the community was becoming increasingly involved in more pastoral activities outside the village, a kind of short-distance exchange between the two parts of the community may be assumed to have had a rather great economical importance, in terms of pastoral products (meat and milk and/or milk products) on one side and agricultural products (cereals) on the other.

Besides, long-distance exchange is also attested, both by archaeological and faunal evidence. Stones and minerals, such as obsidian, copper ore and basalt, were obtained from Anatolia while cedar wood and Dark-Faced Burnished Ware came from the Levant (Akkermans 1993: 270ff; Van Zeist and Waterbolk-van Rooijen 1996: 540; Akkermans and Duistermaat, 1997). Contacts with north and central Iraq are attested for by the presence of Samarra- and Hassuna-like pottery. The furthest provenance is furnished by the presence of a shell from the Indian Ocean. The long-distance exchange, mainly related to goods of small dimensions or of a particular and rare value, does not seem to have played a decisive role in the subsistence patterns of the village of Sabi Abyad.

7.6.5 Summary

In all four basic risk reduction strategies that have been analyzed, animals were widely and variously involved. Therefore it can be concluded that animals played an important role in risk reduction as an answer to food scarcity, not only by broadening the range of food resources available for consumption but also by 'banking' them for lean periods. Diversification and storage seem to have been the most important strategies to counteract the irregular and unpredictable fluctuations of the Near East environment, with the possible addition of mobility in the last phase of occupation of Sabi Abyad, involving at least part of the population.

7.7 Conclusion

The zooarchaeological analysis of the faunal remains from Sabi Abyad has shown that the component of the economy based on the exploitation of animal resources went through important economic transformations in the course of the time of occupation of the site. A gradually increasing control in the animal husbandry is indicated by the transformation from a more generalized pattern of meat production to the development of the exploitation of secondary products (milk) in the case of ovicaprids, and by the better utilization of cattle and pigs as sources of meat. An expansion of environmental exploitation is indicated by the wild animal resources and by the possible development of a more mobile pastoralism. Sabi Abyad may therefore represent the moment of transformation from the more "site-related" economy of the early Neolithic community to the initial stage of the twofold economy which characterized the later stages of the late Halaf society with a site distribution of small short-term sites based on extensive husbandry and hunting, which were somehow dependent on permanently occupied and relatively larger sites nearby, based on intensive agriculture. It has been suggested that, without clear evidence for climatic changes, the reasons for the development of these different patterns of subsistence might be searched in an environmental deterioration due to overgrazing or reduction of grazing areas in the close surroundings of the site due to the use of land for agriculture, which may have been induced by population growth as indicated by the increase in size and number of sites in the Balikh in the late Neolithic/Halaf period.

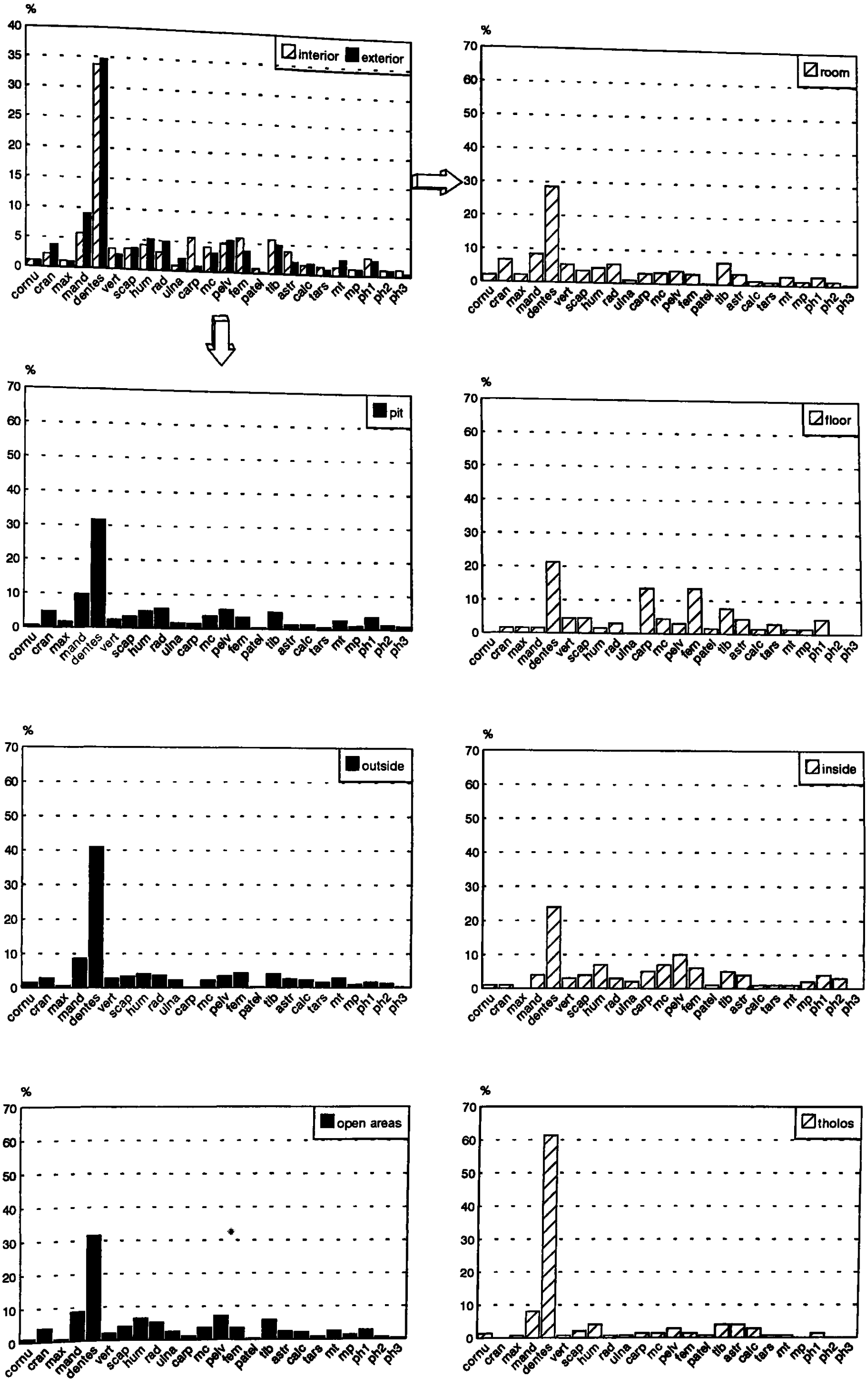

Figure 7.1 Element representation of ovicaprids remains found within different contexts

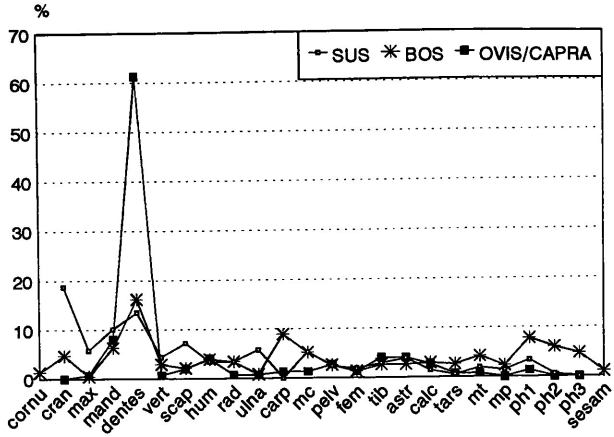

Figure 7.2 Element representation of suid, bovid and ovicaprid remains within the same type of context (large open areas= "general")

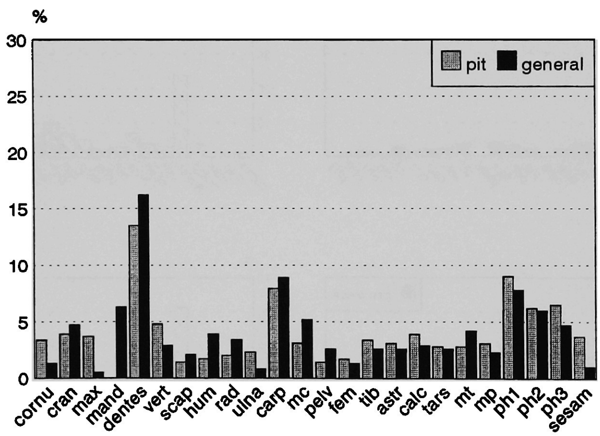

Figure 7.3 Element representation of bovid remains found in pits (p) and in large open areas ("general")

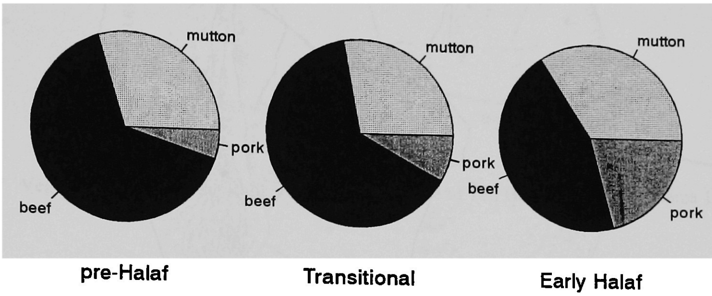

Figure 7.4 Ratio in meat yield of the domestic species

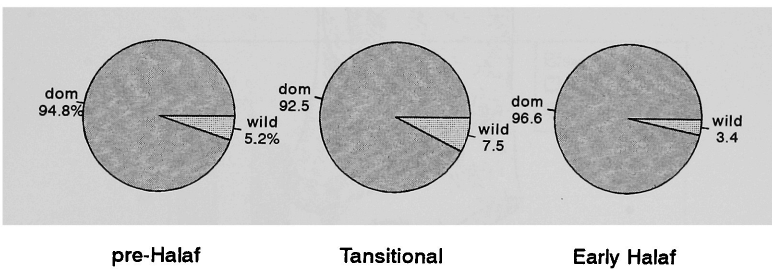

Figure 7.5 Relative frequency of domestic and wild species in each phase

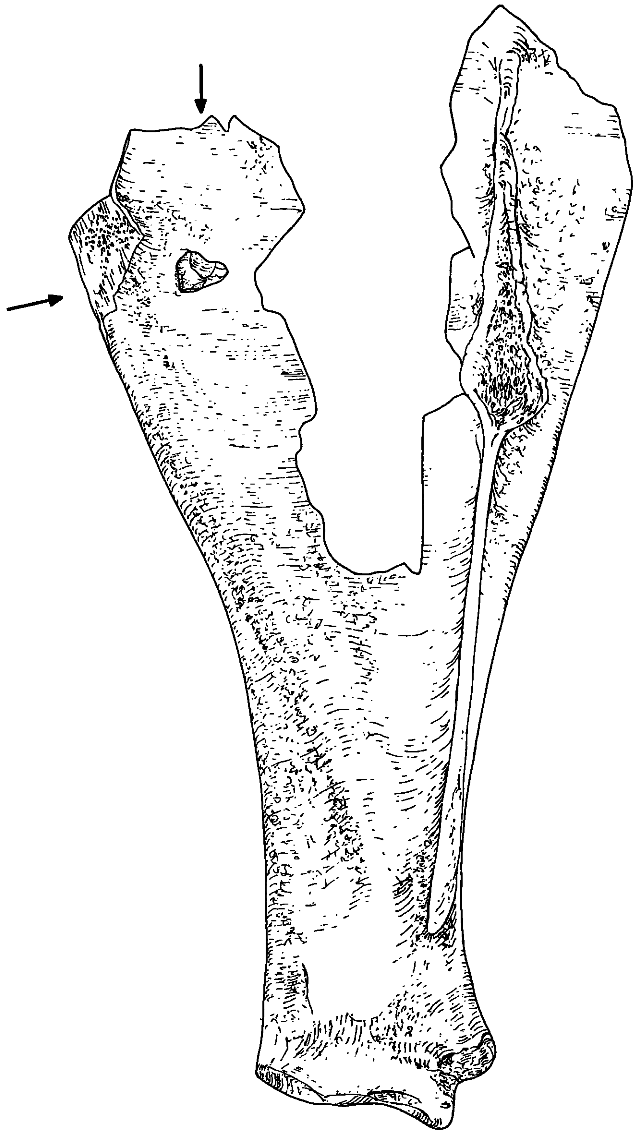

Figure 7.6 Bovid (aurochs) scapula with the remain of an arrowhead (scale 1:2)

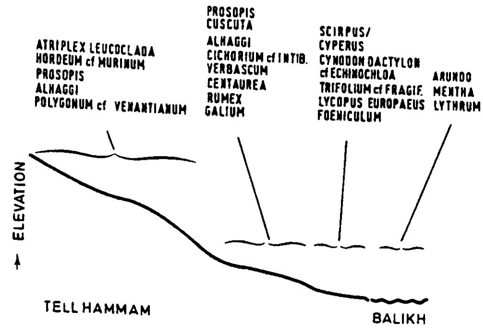

Figure 7.7 Vegetation scheme of the Balikh valley and the slope of Tell Hammam (from Bottema 1984, fig.2)

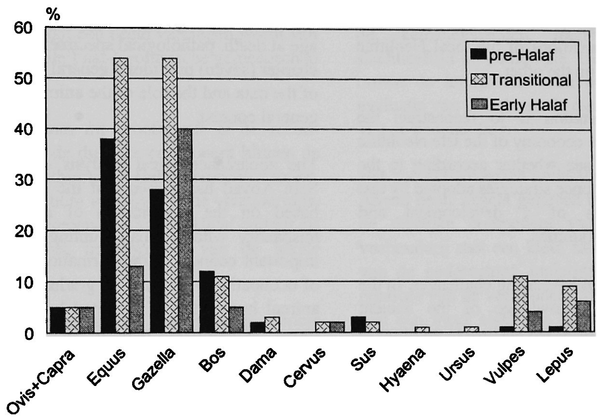

Figure 7.8 Relative frequency of wild species

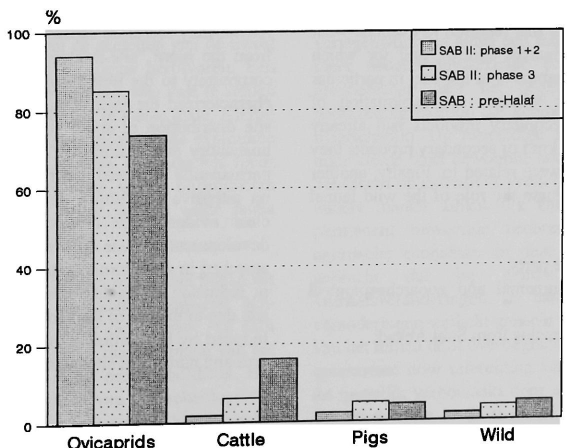

Figure 7.9 Strategies in animal exploitation of the early Neolithic communities in the Balikh valley

Summary

This research deals with the zooarchaeological analysis of the faunal remains found at the north-Syrian site of Tell Sabi Abyad. The research is part of a wider and ongoing regional research project of survey and excavations in the Balikh valley, which has the purpose to build a chronological and a cultural sequence of occupation of the valley.

This research has revealed that the site of Sabi Abyad, and the Balikh valley in general, occupied an important, even crucial chronological position in the prehistory of the region and, less specifically, of the Jezira - the region between the rivers Euphrates and Tigris - in northern Syria. The site is particularly important for the comprehension of the late Neolithic phase and the origin of the Halafian culture, in the second half of the 6th millennium B.C. The accurate archaeological investigation has unearthed a continuous sequence of late Neolithic occupation without any major hiatus, allowing the recognition of separate phases of occupation on the one hand, and elucidating the gradual transformations of the local Neolithic community to the Halaf society on the other.

The main aim of this dissertation is to reconstruct the importance of animals within the economy of the late Neolithic - Halafian community, and to see whether according to the archaeological results the subsistence strategies adopted by that community were the results of a development and transformation within local communities.

The research presented a series of interesting challenges. In the first place, due to the poor knowledge of the ancient geographical distribution of the different species in addition to their heavy reduction or even extinction in recent years, the identification of the species present in the sample is an important purpose in itself. This aspect is made particularly difficult by the morphological similarities of the skeleton of the most frequent species, namely the small herbivores. Secondly, it has been an important aim of this research to examine what degree of domestication, or human control, and for which species was attained by the inhabitants of the site. In particular it is important to recognize whether the exploitation of domestic animals for their secondary products had already developed, and if it had, what kind of secondary products they were and which species they were related to. Finally, another goal of the research is to evaluate the role of the wild faunal component.

The thesis is structured in three parts:
I. the archaeological, environmental and zooarchaeological backgrounds;
II. the analysis of the faunal remains from Sabi Abyad;
III. the interpretations.

The approach and the aims of the research, summarized above, are described in the first chapter. The second summarizes the archaeological context of Sabi Abyad, presenting the results of the archaeological investigations. The third chapter provides a reconstruction, based on pollen, botanical and faunal evidence, of the palaeoenvironmental setting. In the fourth chapter the state of the zooarchaeological research is reviewed and evaluated, in order to place the results of the analysis of the faunal remains from Sabi Abyad in a more general Neolithic context. In the fifth chapter the zooarchaeological methods used in this research is defined with emphasis on preservational aspects, on the specific Middle Eastern problems of identification of small herbivores as well as the more general zooarchaeological aspects of quantification, the criteria of ageing and of measuring. Chapter six consists of the body of the research: the direct analysis of the Sabi Abyad animal remains. This chapter presents the complete final analysis and the set of data (metrical information, skeletal representation, age at death, pathological specimens) for each species. The last chapter (seven) provides a general evaluation and interpretation of the data and the role of the animals at the sites within a more general context.

The zooarchaeological analysis of the faunal remains from Sabi Abyad has shown that the component of the economy based on the exploitation of animal resources (basically husbandry with a small hunting component) went through important economic transformations in the course of the time of occupation of the site. A gradually increasing control in the animal husbandry is indicated by the transformation from a more generalized pattern of meat production to the development of the exploitation of secondary products (milk) in the case of ovicaprids, and by the better utilization of cattle and pigs as sources of meat. An expansion of environmental exploitation is indicated by the wild animal resources and by the possible development of a more mobile pastoralism. Sabi Abyad may therefore represent the moment of transformation from the more "site-related" economy of the early Neolithic community to the initial stage of the twofold economy which characterized the later stages of the late Halaf society with a site distribution of small short-term sites based on extensive husbandry and hunting, which were somehow dependent on permanently occupied and relatively larger sites nearby, based on intensive agriculture. It has been suggested that, without clear evidence for climatic changes, the reasons for the development of these different patterns of subsistence might be searched in an environmental deterioration due to overgrazing or reduction of grazing areas in the close surroundings of the site due to the use of land for agriculture, which may have been induced by population growth as indicated by the increase in size and number of sites in the Balikh in the Halaf period.

Samenvatting

Dit onderzoek behandelt de zoöarcheologische analyse van de dierenresten afkomstig van de Noord-Syrische Tell Sabi Abyad. Het onderzoek maakt deel uit van een regionaal archeologisch project van verkenningen en opgravingen in het dal van de Balikh met als doel het opbouwen van een chronologische en culturele bewoningsgeschiedenis van de vallei.

Het onderzoek heeft aangetoond dat het Balikh-dal in het algemeen, en de vindplaats Sabi Abyad in het bijzonder, een belangrijke en zelfs cruciale plaats innemen in de chronologie van Noord-Syrie en met name van de Jezira, het gebied tussen Eufraat en Tigris. De vindplaats is vooral belangrijk voor het begrip van het Laat-Neolithicum, met name aan het begin van de Halaf-cultuur, tijdens de tweede helft van het zesde millennium voor Christus. De nauwgezette opgravingen hebben een stratigrafie opgeleverd met bewijs voor een continue bewoning, waarbij verschillende bewoningsfasen herkend konden worden, zodat een beeld verkregen wordt van de transformatie van de lokale Laat-Neolithische gemeenschap naar de Halaf-maatschappij.

Belangrijkste doelstelling van dit proefschrift is de reconstructie van het belang van de dierlijke component binnen de economie van de Laat-Neolithische en Halaf-gemeenschappen. Hierbij wordt gepoogd inzicht te verkrijgen in de veranderingsprocessen binnen de bestaanseconomie van de Halaf cultuur als gevolg van ontwikkeling en transformatie van de lokale gemeenschappen.

Het onderzoek wordt gekenmerkt door een aantal bijzondere uitdagingen. Zo was het aantonen van de aanwezigheid van de verschillende diersoorten een belangrijk onderdeel van het onderzoek vooral in het licht van de gebrekkige kennis van de prehistorische verspreiding van die soorten en hun recente sterk gedecimeerde en/of zelfs uitgestorven status. Determinatie van de verschillende soorten wordt bemoeilijkt door de sterke morfologische gelijkenis van de skeletten van de meest voorkomende soorten, met name de kleine herbivoren. Een tweede, belangrijk doel van het onderzoek was vast te stellen welke soorten gedomesticeerd waren en in welke mate. Hierbij werd aandacht besteed aan de vraag in hoeverre de exploitatie van de huisdieren ten behoeve van de bijproducten reeds ontwikkeld was en welke soort voor welke bijproducten gebruikt werd. Ten derde werd de rol van de wilde fauna geëvalueerd.

Het onderzoek bestaat uit drie delen. Het eerste deel behandelt de archeologische, ecologische en zoöarcheologische achtergrond, het tweede de analyse van de dierenresten van Sabi Abyad en het derde de interpretatie. De doelstellingen van het onderzoek worden geformuleerd in het eerste hoofdstuk. Het tweede hoofdstuk geeft een overzicht van de archeologische context van Sabi Abyad en van de resultaten van het archeologisch ondezoek. Het derde hoofdstuk geeft een reconstructie van de natuurlijke omgeving, gebaseerd op palynologische, paleobotanische en zoölogische gegevens. In het vierde hoofdstuk wordt de stand van zaken betreffende het zoöarcheologisch onderzoek besproken teneinde de resultaten van de analyse van de dierenresten van Sabi Abyad in een algemene neolithische context te kunnen plaatsen.

Het vijfde hoofdstuk is gewijd aan de zoöarcheologische onderzoeksmethoden met speciale aandacht voor zowel de specifieke problemen die spelen bij onderzoek in het Nabije Oosten zoals determinatie van de kleine herbivoren als meer algemene problemen zoals kwantificering, leeftijdsschatting en osteometrie.

Hoofdstuk zes bevat de kern van het onderzoek: de analyse van de faunaresten van Sabi Abyad. Dit hoofdstuk geeft voor de verschillende soorten de eindanalyse alsmede het complete gegevensbestand van osteometrische gegevens, verdeling van de skeletelelementen, fragmentatiegraad, slachtmethoden, slachtleeftijd en pathologie. Het zevende en laatste hoofdstuk omvat de interpretatie van de gegevens gevolgd door een evaluatie van de rol van de dieren binnen de algemene context van de nederzetting.

Het zoöarcheologisch onderzoek van de dierenresten van Sabi Abyad heeft inzicht gegeven in de transformatieprocessen, die de dierlijke component van de economie, gebaseerd op veehouderij met een klein aandeel jacht, tijdens de bewoning van de nederzetting onderging. Een geleidelijk toenemende controle van de veehouderij komt tot uiting in de transformatie van een meer algemeen patroon van vleesproductie naar de ontwikkeling van de exploitatie van bijproducten (melk) van ovicapriden en een verbeterd gebruik van runderen en varkens als vleesleveranciers. Zowel de samenstelling van de jachtbuit als de mogelijke ontwikkeling van een meer mobiel pastoralisme duiden op een uitbreiding van de exploitatie van de wijdere omgeving van de nederzetting. Sabi Abyad vertegenwoordigt aldus een fase van de transformatie van een meer nederzettingsgerichte economie van de neolithische gemeenschap naar het beginstadium van het tweeledige nederzettingspatroon dat kenmerkend is voor de latere Halaf-maatschappij. Dit tweeledige patroon wordt gekarakteriseerd door kleine, kort bewoonde nederzettingen met een economie gebaseerd op extensieve veehouderij en jacht, die op de een of andere manier afhankelijk zijn van nabij gelegen, grotere, permanent bewoonde nederzettingen met een intensieve agrarische economie. In deze dissertatie wordt naar voren gebracht dat bij gebrek aan aanwijzingen voor klimaatsveranderingen, de aanleiding voor bovengenoemde veranderingen wellicht gezocht moet worden in een degradatie van het milieu door overbegrazing ofwel in een afname van het graasareaal door uitbreiding van de gronden voor akkerbouw en mogelijk veroorzaakt door een bevolkingsgroei zoals deze tot uiting komt in de toename van aantal en grootte van de nederzettingen in de Balikh-vallei.

Riassunto

L'argomento principale di questo studio è costituito dall'analisi archeozoologica dei resti faunistici rinvenuti nel sito di Tell Sabi Abyad, situato nella Siria settentrionale. Questo studio fa parte di un piú ampio progetto di scavi e ricognizioni nella valle del Balikh, che hanno lo scopo di stabilire una sequenza cronologica e culturale dell'occupazione della valle. Queste ricerche hanno rivelato che il sito di Sabi Abyad e la valle del Balikh hanno occupato in passato una posizione importante nel corso dello sviluppo delle culture preistoriche nella valle e, più in generale, nella Gezira, ossia la regione tra i fiumi Eufrate e Tigri.

Il sito di Sabi Abyad si é rivelato particolarmente importante per la comprensione della fase tardoneolitica, in particolare dello sviluppo della cultura Halaf, nella seconda metà del VI millennio a.C. L'accurata indagine archeologica ha, infatti, messo in luce una continua e pressoché ininterrotta sequenza stratigrafica d'occupazione tardoneolitica che ha permesso di evidenziare il graduale e locale sviluppo delle comunità tardoneolitiche della regione.

Lo scopo principale di questa ricerca archeozoologica consiste nella ricostruzione del ruolo e nella comprensione dell'importanza che gli animali hanno rivestito nell'economia delle comunitá tardoneolitiche/Halaf.. Altro obiettivo è quello di verificare se, in conformità ai risultati archeologici, le strategie di sussistenza adottate dalla società Halaf sono anch'esse il risultato di uno sviluppo e di una trasformazione locale, o no.

Nel corso della ricerca sono stati affrontati diversi argomenti e sfide interessanti. Innanzi tutto, a causa della scarsa conoscenza dell'antica distribuzione geografica delle specie animali, amplificata dalla loro notevole e recente riduzione o estinzione, é stato importante determinare quali specie fossero presenti durante il periodo d'occupazione del sito e rappresentate nel campione. Quest'aspetto é stato reso inoltre più difficile dai problemi inerenti alla determinazione osteologica del materiale, soprattutto nel caso delle specie più comuni, ossia degli erbivori di media e piccola taglia, che presentano enormi sovrapposizioni e somiglianze morfologiche. In secondo luogo, un importante aspetto della ricerca é stato quello di capire quale stadio di domesticazione - o di controllo umano - fosse stato raggiunto dalla popolazione di Sabi Abyad, ed in particolare se lo sfruttamento degli animali domestici per i loro prodotti secondari fosse già stato svilluppato, e, se sí, in relazione a quali specie animali. Infine, si é cercato di capire il ruolo svolto dalla componente animale selvatica, ossia della caccia.

Il testo é suddiviso in tre parti: I. lo sfondo archeologico, ambientale e archeozoologico su cui si inserisce questa ricerca; II. l'analisi dei resti faunistici rinvenuti a Sabi Abyad; III. l'interpretazione dei risultati ottenuti.

Nel primo capitolo sono esposti gli scopi e le basi della ricerca, sopra sintetizzati. Il secondo capitolo presenta il sito di Sabi Abyad, riportando i risultati delle ricerche archeologiche. Il terzo capitolo sintetizza le conoscenze paleoambientali sulla regione in base ai dati geomorfologici, pollinici, botanici e faunistici. Il quarto capitolo riporta lo stadio delle conoscenze archeozoologiche dei siti inerenti al presente studio, ossia dei siti del Neolitico iniziale nella valle del Balikh e dei siti tardoneolitici/Halaf della valle stessa e di regioni adiacenti. Nel quinto capitolo sono stati definiti i metodi usati nella ricerca. Particolare attenzione é stata rivolta alle condizioni di conservazione del materiale, ai processi di trasformazione cui é stato sottoposto il materiale (tafonomia), ai problemi d'identificazione del materiale faunistico mediorientale, ai criteri di determinazione delle età di morte degli animali e di misurazione usati.

L'analisi dei resti faunistici di Sabi Abyad é descritta nel sesto capitolo. Qui sono riportati per ciascuna specie i dati e le analisi osteometriche, la rappresentazione scheletrica, lo stato di frammentazione, l'analisi delle tracce di macellazione, la determinazione dell'età di morte e le condizioni patologiche.

Nell'ultimo capitolo é riportata l'interpretazione e la valutazione dei risultati della ricerca. Dopo un approccio contestuale, viene proposta una valutazione del ruolo svolto dagli animali domestici e dalla caccia all'interno dell'economia degli abitanti di Sabi Abyad e, più in generale, delle comunitá neolitiche, soprattutto di quella Halaf, della regione. I risultati dell'analisi archeozoologica hanno evidenziato come l'economia animale del sito fosse basata sullo sfruttamento degli animali domestici ed, in minor misura, sulla caccia. Tuttavia nel corso dell'occupazione del sito si sono verificate importanti trasformazioni economiche relative allo sfruttamento degli animali. E' stato, infatti, possibile dimostrare un graduale e crescente controllo esercitato sugli animali domestici. In particolare, si é messa in luce la trasformazione da un'economia d'allevamento, indirizzato principalmente alla produzione di carne, ad uno sfruttamento degli animali domestici anche per i loro prodotti secondari (più precisamente latte nel caso degli ovicaprini) nonché ad un migliore sfruttamento di bovini e suini come fonte di rifornimento carneo.

Un allargamento delle aree ambientali sfruttate é indicato non solo dal tipo d'animali selvatici rinvenuti nel campione, ma anche dall'indicazione di un possibile sviluppo di un tipo di pastoralismo caratterizzato da un grado maggiore di mobilità. Sabi Abyad rappresenterebbe in questo senso il momento di trasformazione da un'economia legata al sito e ai suoi diretti dintorni delle prime comunità neolitiche della valle ad una duplice economia che caratterizza le successive comunità tardo-Halaf, rappresentate da un modello di insediamento con piccoli e temporanei siti basati sull'allevamento estensivo e

sulla caccia e legati ad un più grande insediamento, occupato permanentemente e basato su un'agricoltura intensiva. In questa tesi è ipotizzato che, in mancanza di una chiara testimonianza di un cambiamento climatico, le ragioni di questa trasformazione potrebbero essere ricercate in un deterioramento ambientale dovuto a pascolo eccessivo, ad una riduzione d'aree di pascolo nei dintorni più prossimi dell'insediamento a causa di un maggiore sfruttamento del terreno per la coltivazione, forse indotto da una crescita della popolazione come sembrerebbe indicato dall'aumento delle dimensioni e del numero dei siti nella valle del Balikh nel periodo Halaf.

References

Akkermans, P.M.M.G., 1989a. Tell Sabi Abyad: Stratigraphy & architecture. In *Excavations at Tell Sabi Abyad*, ed. P.M.M.G. Akkermans. Oxford: British Archaeological Reports International Series 468, pp. 17-75.

Akkermans, P.M.M.G., 1989b. The prehistoric pottery of Tell Sabi Abyad. In *Excavations at Tell Sabi Abyad*, ed. P.M.M.G. Akkermans. Oxford: British Archaeological Reports International Series 468, pp. 77-213.

Akkermans, P.M.M.G., 1991. New radiocarbon dates for the later Neolithic of Northern Syria. *Paléorient* 17(1), 121-125.

Akkermans, P.M.M.G., 1993. *Villages in the steppe - Later Neolithic settlement and subsistence in the Balikh valley, Northern Syria*. Ann Arbor: International Monographs in Prehistory (originally privately published: University of Amsterdam 1990).

Akkermans, P.M.M.G., 1996. Foreword. In *Tell Sabi Abyad The late Neolithic settlement*, ed. P.M.M.G. Akkermans. Istanbul: Nederlands Historisch-Archeologisch Instituut, pp. VII-XIII.

Akkermans, P.M.M.G & M. Le Mière, 1992. The 1988 excavations at Tell Sabi Abyad, a later Neolithic village in northern Syria. *American Journal of Archaeology* 96, 1-22.

Akkermans, P.M.M.G. & M. Verhoeven, 1995. An image of complexity: the Burnt Village at late Neolithic Sabi Abyad, Syria. *American Journal of Archaeology* 99(1), 5-32.

Akkermans, P.M.M.G. & K. Duistermaat, 1997. Of storage and nomads - The sealings from the late Neolithic Sabi Abyad, Syria. *Paléorient*, 22/2,17-44.

Baker, J. & D. Brothwell, 1980. *Animal diseases in archaeology*. London: Academic Press.

Baharav, D., 1974. Notes on the population structure & biomass of the mountain gazelle, *Gazella gazella gazella*. *Jsrael Journal of Zoology* 23, 39-44.

Bates, D.G., 1973. *Nomads and farmers: a study of the Yürük of Southeastern Turkey*. Ann Arbor: University of Michigan.

Bibikova, V.I., 1981. Husbandry in northern Mesopotamia in the 5th millennium B.C. (As based on the data from the Halaf settlement Yarim Tepe II). In *Earliest agricultural settlements of northern Mesopotamia*, eds. R.M. Munchaev & N.J. Merpert. Moscow: Nauka, pp. 299-307.

Binford, L.R., 1978. *Nunamiut ethnoarchaeology*. New York: Academic Press.

Binford, L.R., 1981. *Bones: ancient men and modern myths*. New York: Academic Press.

Boerma, J.A.K., 1988. Soils and environment of Tell Hamman et-Turkman. In *Hammam et-Turkman I* (Vol. 1), ed. M.N. van Loon. Istanbul: Nederlands Historisch-Archeologisch Instituut, pp. 1-11.

Boessneck, J., 1969. Osteological differences between sheep (*Ovis aries* L.) and goat (*Capra hircus* L.). In *Science in archaeology* (2nd ed.), eds. D.Brothwell & E.S. Higgs. London: Thames & Hudson, pp. 331-358.

Boessneck, J. & A. von den Driesch, 1975. Tierknochenfunde vom Korucutepe bei Elâzig in Ostanatolien. In *Korucutepe 1*, ed. M.N. van Loon. Amsterdam: North Holland/American Elsevier, pp. 1-220.

Boessneck, J. & A. von den Driesch, 1979. Die Tierknochenfunde aus der neolitischen Siedlung auf Fikirtepebij Kadiköy am Marmarameer, München: Universität München.

Bottema, S., 1984. The composition of modern charred seed assemblages. In *Plants and ancient man*, eds. W. van Zeist & W.A. Casparie. Rotterdam/Boston: Balkema, pp. 207-212.

Bottema, S., 1989. Notes on the prehistoric environment of the Syrian Djezireh. In *To the Euphrates and beyond*, eds. O.M.C. Haex, H.H. Curvers & P.M.M.G. Akkermans. Rotterdam: Bolkema, pp. 1-16.

Bottema, S. & van Zeist W., 1981. Palynological evidence for the climatic history of the Near East, 50,000-6,000 BP. In *Préhistoire du Levant*, eds. J. Cauvin & P. Sanlaville. Paris: Édition du CNRS, pp. 111-132.

Bottema, S. & Y. Barkoudah, 1979. Modern pollen precipitation in Syria and Lebanon. *Pollen and Spores* XXI(4), 427-480.

Bökönyi, S., 1977. *Animal remains from the Kermanshah valley, Iran*. Oxford: British Archaeological Reports Supplementary Series 34.

Bökönyi, S., 1982. The climatic interpretation of macrofaunal assemblages in the Near East. In *Palaeoclimates, palaeoenvironments and human communities in the Eastern Mediterranean region in later Prehistory*, eds. J.L. Bintliff & W. van Zeist. Oxford: British Archaeological Reports International Series 133(i), pp. 149-163.

Brothwell, D., 1993. On the problem of interpreting within sample variation. In *Skeletons in her cupboard: Festschrift for Juliet Clutton-Brock*, eds. A.T. Clason, S. Payne & H.-P. Uerpmann Oxford: Oxbow Book, pp. 19-31.

Buitenhuis, H., 1988. *Archeozöologisch onderzoek langs de Midden Eufraat*. Groningen: University of Groningen (Ph.D. thesis).

Buitenhuis, H., 1990. Archaeozoological aspects of late Holocene economy and environment in the Near East. In *Man's role in the shaping of the eastern Mediterranean landscape*, eds. S. Bottema, G. Entjes-Nieborg & W. van Zeist. Rotterdam: Balkema , pp. 195-205.

Bull, G. & S. Payne, 1982. Tooth eruption and epiphyseal fusion in pigs and wild boar. In *Ageing and sexing animal bones from archaeological sites*, eds. B. Wilson, C. Grigson & S. Payne. Oxford: British Archaeological Reports British Series 109, pp. 55-71.

Casteel, R.W., 1977. Characterization of faunal assemblages and the minimum number of individuals determened from paired elements: counting problems on archaeology. *Journal of Archaeological Science* 4, 125-134.

Cavallo, C., forthcoming. Faunal remains from Khirbet esh-Shenef.

Cavallo, C., 1995. Some observations on the animal remains from the pre-Halaf levels of the Sabi Abyad, northern Syria. In *Archaeozoology of the Near East II* eds. H. Buitenhuis & H.-P. Uerpmann. Leiden: Bakhuys, pp. 45-51.

Cavallo, C., 1996. The animal remains - A preliminary account. In *Tell Sabi Abyad The late Neolithic settlement*, ed. P.M.M.G. Akkermans. Istanbul: Nederlands Historisch-Archeologisch Instituut, pp. 475-520.

Cauvin, J., 1972. Sondage à Tell Assouad (Djézireh, Syrie). *Annales Archéologiques Arabes Syriennes* 22, 85-88.

Cauvin, J., 1974. Les debúts de la céramique sur le Moyen-Euphrate: nouveaux documents. *Paléorient* 2, 199-205.

Chaplin, R.E., 1971. *The study of animal bones from archaeological sites*. London: Seminar Press.

Chapman, D & N., 1975. *Fallow deer*. Lavenham: T. Dalton..

Clason, A.T., 1979/80. The animal remains from Tell es-Sinn compared with those from Bouqras. *Anatolica* 7, 35-53.

Clason, A. T., 1981. The faunal remains of four prehistoric and early historic sites in Syria as indicators of environmental conditions. In *Beiträge zur Umweltgeschichte des Vorderen Orients = Contribution to the environmental history of southwest Asia*, eds. W. Frey and H.-P. Uerpmann. Beihefte zum Tübinger Atlas des Vorderen Orients, Reihe A, Naturwissenschaften, nr.8. Wiesbaden: Dr. Ludwig Reichter Verlag, pp. 191-192.

Clason, A.T. & H. Buitenhuis, 1978. A preliminary report on the faunal remains of Nahr el Homr, Hadidi and Ta'as in the Tabqa Dam region in Syria. *Journal of Archaeological Science* 5, 75-83.

Clason, A.T. & J. Clutton-Brock, 1982. The impact of domestic animals on the vegetation during the first phases of animal husbandry in the Mediterranean and Near East. In *Palaeoclimates, palaeoenvironments and human communities in the eastern Mediterranean region in later Prehistory*, eds. J.L. Bintliff & W. van Zeist. Oxford: British Archaeological Reports International Series 133(i), pp. 145-148.

Clutton-Brock, J., 1979. The mammal remains from the Jericho Tell. *Proceedings of the Prehistoric Society* 45, 135-157.

Clutton-Brock, J., 1992. *Horse power - A history of the horse and the donkey in human society*. London: Natural History Museum.

Clutton-Brock, J. & H.-P. Uerpmann, 1974. The sheep of early Jericho. *Journal of Archaeological Science* 1, 261-274.

Copeland, L., 1996. The flint & obsidian industries. In *Tell Sabi Abyad The late Neolithic settlement*, ed. P.M.M.G. Akkermans. Istanbul: Nederlands Historisch-Archeologisch Instituut, pp. 285-338.

Collet, P., 1996. The figurines. In *Tell Sabi Abyad - The late Neolithic settlement*, ed. P.M.M.G. Akkermans. Istanbul: Nederlands Historisch-Archeologisch Instituut, pp. 403-414.

Cramp, S. & K. Simmons, 1977. *Handbook of birds of Europe, the Middle East and North Africa - vol 1: Ostrich to Ducks*. Oxford: Oxford University Press.

Cribb, R., 1991. *Nomads in archaeology*. Cambridge: Cambridge University Press.

Dahl, G. & A. Hjort, 1976. *Having herds: pastoral herd growth and household economy*. Stockholm: Stockholm studies in social anthropology 2.

Daly, P., 1969. Approaches to faunal analysis in archaeology. *American Antiquity* 34(2), 146-153.

Davidson, T.E., 1977. *Regional variation within the Halaf ceramic tradition*, Edinburgh: University of Edinburgh (Ph.D. thesis).

Davis, S.J.M., 1980. A note on the dental and skeletal ontogeny of *Gazella*. *Jsrael Journal of Zoology* 29, 129-134.

Davis, S.J.M., 1980. The age profiles of gazelles predated by ancient man in Israel: possible evidence for a shift from seasonality to sedentism in the Natufian. *Paléorient* 9(1), 55-62.

Davis, S.J.M., 1987. *The archaeology of animals*. London: Batsford..

Degerbøl, M. & B. Fredskild, 1970. *The Urus (Bos primigenius Bojanus) and neolithic domesticated cattle (Bos domesticus Linné) in Denmark*. København: Royal Danish Academy of Sciences and Letters.

Dive, J. & V. Eisenmann, 1991. Identification and discrimination of the first phalanges from pleistocene and modern *Equus*, wild and domestic. In *Equids in the ancient world II*, eds. R.H. Meadow & H.-P. Uerpmann. Beihefte zum Tübinger Atlas des Vorderen Orients A, 19/2. Wiesbaden: Dr. Ludwig Reichter Verlag, pp. 278-333.

Dolling, W. & H. Reichstein, 1975. Ein neues Gërat zum Vermessen zoologischer und archäologischer Objekte. In *Archaeozoological studies*, ed. A.T. Clason. Amsterdam: North Holland Publ. Comp., pp. 18-20.

Driesch, A. von den, 1976. *A guide to the measurement of animal bones from archaeological sites*. Harvard: Peabody Museum Bulletin 1.

Driesch A., von den & J. Boessneck, 1974. Kritische Anmerkungen zur Widerristhöhenberechnung aus Längenmaßen vor- und frühgeschichtlicher Tierknochen. *Säugetierkundliche Mitteilungen* 22, 325-348.

Ducos, P., 1978. *Tell Mureybet (Syrie IX-VII millénaires) - Étude archéozoologique et problèmes d'écologie humaine*. Paris: Édition du CNRS.

Ducos, P., 1984. La contribution de l'archéozoologie à l'estimation des quantités de nourriture: évaluation du nombre initial d'individus. In *Animals and Archaeology 3: early herders & their flocks*, eds. C. Grigson & J. Clutton-Brock, Oxford: British Archaeological Reports International Series 202, pp. 13-24.

Ducos, P., 1986. The Equid of Tell Muraibit, Syria. In *Equids in the ancient world I*, eds. R.H. Meadow & H.-P. Uerpmann. Beihefte zum Tübinger Atlas des Vorderen Orients A, 19/1. Wiesbaden: Dr. Ludwig Reichter Verlag, pp. 237-245.

Ducos, P., 1988. *Archéozoologie quantitative - Les valeurs numériques immédiates à Çatal Hüyük*. Bordeaux: Cahiers du Quaternaire 12.

Ducos, P., 1991a. *Bos*, *Ovis* et *Capra* dans les sites Néolithiques du Proche Orient - A propos de la comunication de D. Helmer au colloque préhistoire du Levant 2. *Paléorient* 17(1), 161-168.

Ducos, P., 1991b. La faune de Tell Turlu (Turquie) et les animaux domestiques dans la culture de Halaf. *Akkadica* 72, 1-19.

Duistermaat, K., 1996. The seals and sealings. In *Tell Sabi Abyad - The late Neolithic settlement*, ed. P.M.M.G. Akkermans. Istanbul: Nederlands Historisch-Archeologisch Instituut, pp. 339-402.

Efremov, J.A., 1940. Taphonomy: new branch of paleontology. *Pan-American Geologist* 74, 81-93.

Eisenmann, V., 1980. *Les Chevaux (Equus sensu lato) fossiles et actuels: crâne et dents jugales supérieures*. Paris: Cahiers de Paléontologie.

Eisenmann, V., 1981. Étude des dents jugales inférieures des *Equus* (Mammalia, Périssodactyla) actuels et fossiles. *Palaeovertebrata* 10(3-4), 127-226

Eisenmann, V., 1986. Comparative osteology of modern & fossil horses, half-asses, & asses. In *Equids in the ancient world I*, eds. R.H. Meadow & H.-P. Uerpmann. Beihefte zum Tübinger Atlas des Vorderen Orients A, 19/1. Wiesbaden: Dr. Ludwig Reichter Verlag, pp. 67-116.

Eisenmann, V. & S. Beckouche, 1986. Identification and discrimination of metapodials from pleistocene and modern *Equus*, wild and domestic. In *Equids in the ancient world I* , eds. R.H. Meadow & H.-P. Uerpmann. Beihefte zum Tübinger Atlas des Vorderen Orients A, 19/1. Wiesbaden: Dr. Ludwig Reichter Verlag, pp. 117-163.

Eisenmann, V., M.T. Alberti, C. de Giuli & U. Staesche, 1988. The methodology. In *Studing fossil horses* (Vol.I), eds. M. Woodbourne & P. Sondaar. Leiden: Brill pp. 1-70.

Epstein, H., 1970. *Fettschwanz- und Fettsteissschafe*. Wittenberg Lutherstadt: A. Ziemsen Verlag.

Felius, M., 1985. *Genus Bos: cattle breeds of the world*. Rahway, N.J: MSD Agvet.

Fieller, N.R. & A. Turner, 1982. Number estimation in vertebrate samples, *Journal of Archaeological Science* 9, 49-62.

Flannery, K.V., 1969. Origins and ecological effects of early domestication in Iran and the Near East. In *The domestication and exploitation of plants and animals*, eds. J. Ucko & G.W. Dimbleby. London: Duckworth, pp. 73-100.

French, M.H., 1970. *Observations on the goat*. Rome: FAO agricultural Studies 80.

Gamble, C., 1978. Optimising information from studies of faunal remains. In *Sampling in contemporary British archaeology*, eds. J.F. Cherry, C. Gamble, S. Shennan. Oxford: British Archaeological Reports British Series 50, pp. 321-353.

Gautier, A., 1984. How do I count you, let me count the ways? Problems of archaeozoological quantification. In *Animals and archaeology 4: husbandry in Europe*, eds. C. Grigson & J. Clutton-Brock. Oxford: British Archaeological Reports International Series 227, pp. 237-251.

Gilbert, A.S., B.H. Singer & D. Perkins, 1981. Quantification experiments on computer-simulated faunal collections. *Ossa* 8, 79-94.

Gilbert, A.S. & B.H. Singer,1982. Reassessing zooarchaeological quantification. *World Archaeology* 14, 21-40.

Glaubrecht, M., 1993. Mapping the diversity: geographycal distribution of the freshwater snail *Melanopsis* (Gastropoda: ?Cerithioidea: Melanopsidae) with focus on its systematics in the Mediterranean Basin. *Mitteilungen aus hamburgischen zoologischen Museum und Institut* 90, 41-97.

Goodwin, D.H., 1973. *Pig management and production: a practical guide for farmers and students*. London: Hutchinson.

Grayson, D.K., 1973. On the methodology of faunal analysis. *American Antiquity* 39(4), 432-439.

Grayson, D.K., 1979. On the quantification of vertebrate archeofaunas. In *Advances in Archaeological Method and Theory* 2, ed. M.B. Shiffer, pp. 199-237.

Grayson, D.K., 1984. *Quantitative zooarchaeology*. Orlando: Academic Press.

Gremmen, W.H.E. & Bottema S., 1991. Palynological investigations in the Syrian Gazira. In *Die rezente Umwelt von Tall Seh Hamad und Daten zur Umweltrekonstruktion der Assyrischen Stadt Dur-katlimmu*, ed. H. Kühne. Berlin: Reimer, pp. 105-116.

Groves, C.P., 1974. *Horses, asses and zebras in the wild*. Hollywood, Fla: Ralph Curtis.

Guest, E., 1966. *Flora of Iraq*. Baghdad: Ministery of Agriculture and Agrarian Reform.

Hammond, J., I.L. Mason & Robinson T.J., 1971. *Hammond's farm animals*. London: Edward Arnold.

Hakker-Orion, D., 1986. The determination of sex & species in gazelles with the use of stepwise discriminant analysis. In *Database managment and zooarchaeology*, ed. L.H. van Wijngaarden-Bakker. Strasbourg: Conseil de l'Europe (PACT 14).

Haltenorth, T., 1959. Beitrag zur Kenntnis des Mesopotamischen Damhirsches-*Cervus (Dama) mesopotamicus* Brooke, 1875- und zur Stammes- und Verbreitungsgeschichte der Damhirsche allgemein. *Säugetierkundliche Mitteilungen* 7, 1-89.

Halstead, P., 1990. Waste not, want not: traditional responses to crop failure in Greece. *Rural History* 1(2), 147-164.

Halstead, P. & J. O'Shea, 1989. Introduction. In *Bad years economics: responses to risc and uncertainty*, eds. P. Halstead & J. O'Shea, pp. 1-7. Cambridge: Cambridge University Press.

Harrison, D.L., 1968. *The mammals of Arabia (Vol. II): Carnivora - Artiodactyla Hyracoidea*. London: Ernest Benn Limited.

Harrison, D.L., 1972. *The mammals of Arabia (vol. III): Lagomorpha Rodentia*. London: Ernest Benn Limited.

Hatt, R.T., 1959. *Mammals of Iraq*. Miscellaneous publications Museum of Zoology n.106. Ann Arbor: University of Michigan.

Helmer, D., 1978. Les rongeurs de Tell Mureybet. Étude Préliminaire. In *Tell-Mureybet (Syrie IX-VII millénaires) Étude archéozoologique et problèmes d'écologie humaine*, Ducos P. Paris: Édition du CNRS.

Helmer, D., 1985a. Etude préliminaire de la faune de Çafer Höyük (Malatya, Turquie). *Cahiers de l'Euphrate* 4, 117-120.

Helmer, D., 1985b. Étude de la faune de Tell Assouad (Djézireh, Syrie) sondage J. Cauvin. *Cahiers de l'Euphrate* 4, 275-285.

Helmer, D., 1989. Le développement de la domestication au Proche-Orient de 9500 à 7500 BP: les nouvelles données d'El Kowm et de Ras Shamra. *Paléorient* 15(1), 111-121.

Helmer, D., 1991. Les changements des stratégies de chasse dans le Néolithique précéramique de Cafer Höyük est (Turquie). *Cahiers de l'Euphrate* 5-6, 131-138.

Hendrichs, U., 1990. *De dierresten van Khirbet esh-Shenef, een Laat-Halaf vindplaats in Noord-Syrië*, scriptie IPP. Amsterdam: University of Amsterdam.

Heptner, V.G., A.A. Nasimovic & A.G. Bannicov, 1966. *Die Säugetiere der Sowjetunion*, B and I?, Paarhufer und Unpaarhufer. Jena: Fischer.

Hijara, I.H., 1980. Arpachiyah 1976. *Iraq* 42, 131-154.

Hole, F., K.V. Flannery & J.A. Neely, 1969. *Prehistory and human ecology of the Deh Luran Plain*. Ann Arbor: Memoirs of the Museum of Anthropology (University of Michigan 1).

Hole, F. & G.A. Johnson, 1986-87. Umm Qseir on the Khabur; preliminary report on the 1986 excavation. *Annales Archéologiques Arabes Syriennes* 36/37, 172-220.

Hongo, H., 1996. Faunal remains from Tell Aray 2, northwestern Syria, *Palèorient* 22/1, 125-145.

Horton, D.R., 1984. Minimum numbers: a consideration. *Journal of Archaeological Science* 11, 255-271.

Hötzl, H. & J.G. Zötl, 1978. Climatic changes during the quaternary period. In *Quaternary in Saudi Arabia*, eds. S.S. Al-Sayari & J.G. Zötl. Wien: Austrian Academy of Science, pp. 301-310.

Ketelaar, D., 1996. *Domesticatie van het rund in Bouqras*, scriptie IPL. Groningen: University of Groningen.

Khazanov, A.M., 1984. *Nomads and the outside world*, Cambridge: Cambridge University Press.

Köhler-Rollefson, I., 1992. A model for the development of nomadic pastoralism on the Transjordanian Plateau. In *Pastoralism in the Levant*, eds. Bar-Yosef O. & A.M. Khazanov. Monographs in World Archaeology 10. Madison, Wis.: Prehistory Press, pp. 11-18.

Krantz, G.S., 1968. A new method of counting mammal bones. *American Journal of Archaeology* 72, 286-288.

Krupp, F. & W. Schneider, 1991. Bestandserfassung der rezenten Fauna im Bereich des Nahr al-Habur. In *Die rezente Umwelt von Tall Seh Hamad und Daten zur Umweltrekonstruktion der Assyrischen Stadt Dur-katlimmu*, ed. H. Kühne. Berlin: Reimer, pp. 69-85.

Kussinger, S., 1988. *Tierknochenfunde vom Lidar Hüyük in Südostanatolien (Grabungen 1979-86)*. München: Universität München (Ph.D. thesis).

Laffer, J.P.,1983. The faunal remains from Banahilk.In *Prehistoric archaeology along the Zagros flanks*, eds. L.S. Braidwood, R.J. Braidwood, B. Howe, C.A. Reedand, P.J. Watson. Oriental Institute Publications n.105. Chicago: University of Chicago pp. 629-647.

Lasota-Moskalewska, A., 1994. Animal remains from Nemrik, a pre-pottery Neolithic site in Iraq. In *Nemrik 9* (Vol.4), ed. S.K. Kozlowski. Varsavia: University of Varsavia.

Lawrence, B., 1980. Evidences of animal domestication at Çayönu. In *The joint Istanbul-Chicago Universities' prehistoric research in Southeastern Anatolia*, eds. H. Çambel & R.J. Braidwood. Istanbul: Edebiyat Fakultesi Basimevi, pp. 257-308.

Lawrence, B., 1982. Principal food animals at Çayönu. In *Prehistoric village archaeology in South-Eastern Turkey: the 8th millennium site of Çayönü*, eds. L.S. Braidwood & R.J. Braidwood. Oxford: British Archaeological Reports International Series 138 , pp. 175-199.

Legge, A.J., 1975. The fauna of Tell Abu Hureyra: a preliminary analysis. *Proceedings of the Prehistoric Society* 41, 74-77.

Legge, A.J. & P.A. Rowley-Conwy, 1987. Gazelle killing in stone age in Syria. *Scientific American* 257(2), 76-83.

Le Mière, M. & O. Nieuwenhuyse, 1996. The prehistoric pottery. In *Tell Sabi Abyad The late Neolithic settlement*, ed. P.M.M.G. Akkermans. Istanbul: Nederlands Historisch-Archeologisch Instituut, pp. 119-284.

Levine, M.A., 1982. The use of crown height measurements and eruptions-wear sequences to age horse teeth. In *Ageing and sexing animal bones from archaeological sites*, eds. B. Wilson, C. Grigson & S. Payne. Oxford: British Archaeological Reports British Series 109, pp. 223-250.

Levitan, B., 1985. A methodology for recording the pathology & other anomalies of ungulate mandibles from archaeological sites. In: *Palaeobiological Investigations*, eds. N.R.J. Fieller, D.D. Gilberson & N.G.A Ralph. Oxford: British Archaeological Reports International Series 266, pp. 41-54.

Lewis, N., 1988. The Balikh valley and its people. In *Hammam et-Turkman I* (*Vol. 2*), ed. M.N. van Loon. Istanbul: Nederlands Historisch-Archeologisch Instituut, pp. 683-695.

Loon, M.N. van, 1988. *Hammam et-Turkman I*. Istanbul: Nederlands Historisch-Archeologisch Instituut.

Lyman, R.L., 1985. Bone frequencies: differential transport in situ destruction and the MGUI. *Journal of Archaeological Science* 12, 221-236.

Mallowan, M.E.L., 1946. Excavations in the Balikh valley - 1938. *Iraq* 8, 111-159.

Maltby, M., 1979. *Faunal studies on urban sites: the animal bones from Exeter 1971-1975*. Exeter Archaeological Reports 2. Sheffield: University of Sheffield University.

McArdle, J., 1990. Halafian fauna at Girikihaciyan. In *Girikihaciyan - A Halafian site in southeastern Turkey*, eds. P.J. Watson & S.A. LeBlanc. Institute of Archaeology Monograph 33. Los Angeles: University of California, pp. 109-120.

Meadow, R.H., 1975. Mammal remains from Hajji Firuz: a study in methodology. In *Archaeozoological studies*, ed. A.T. Clason, Amsterdam: North Holland Publ. Comp, pp. 265-283.

Meadow, R.H., 1978. Effects of context on the interpretation of faunal remains: a case of study. In *Approaches to faunal analysis in the Middle East*, eds. R.H. Meadow & M.A. Zeder. Peabody Museum Bullettin 2. Cambridge, Mass.: Harvard University, pp. 15-21.

Mulders, M.A., 1969. *The arid soils of the Balikh basin (Syria)*. Utrecht: University of Utrecht (Ph.D. thesis).

Munchaev, R. & N. Merpert, 1981. *Earliest agricultural settlement of northern Mesopotamia*. Moskow: Nauka.

Müller, H.-H., 1997. Notches in animal teeth - Artificial or Natural/Pathological?. *Anthropozoologica* 25/26, pp.149-152.

O'Connell, J.F. & K. Hawkes, 1988. Hadza hunting, butchering, & bone transport & their archaeological implications. *Journal of Anthropological Research* 44(2), 113-161.

O'Connell, J.F., K. Hawkes & N.B. Jones, 1990. Reanalysis of large mammal body part transport among the Hadza. *Journal of Archaeological Science* 17, 301-316.

O'Connor, T.P., 1989. *Bones from Anglo-Scandinavian levels at 16-22 Coppergate*. The Archaeology of York, vol.15/3. London: Council for British Archaeology for the York Archaeological Trust.

Payne, S., 1972. On the interpretation of bone samples from archaeological sites. In *Papers in economic prehistory*, ed. E.S. Higgs. Cambridge: University Press,pp. 65-81.

Payne, S., 1973. Kill-off patterns in sheep and goats: the mandibles from Aşvan Kale. *Anatolian Studies* 23, 281-303.

Payne, S., 1975. Partial recovery and sample bias. In *Archaezoological studies*, ed. A.T. Clason. Amsterdam: North Holland Publ.Comp., pp. 7-17.

Payne, S., 1991. Early Holocene Equids from Tall-i-Mushki (Iran) and Can Hasan III (Turkey). In *Equids in the ancient world II*, eds. R.H. Meadow & H.-P. Uerpmann. Beihefte zum Tübinger Atlas des Vorderen Orients A, 19/2. Wiesbaden: Dr. Ludwig Reichter Verlag, pp. 133-177.

Perkins, D., 1964. Prehistoric fauna from Shanidar, Iraq. *Science* 144, 1565-1566.

Perkins, D., 1969. Fauna from Çatal Hüyük: evidence for early cattle domestication in Anatolia. *Science* 164, 177-179.

Perkins, D. & P. Daly, 1968. A hunters' village in Neolithic Turkey. *Scientific American* 219(5), 96-106.

Poplin, F., 1980. Un problème d'ostéologie quantitative: calcul d'effectif initial d'aprè appariements. Généralisation aux autres types de remontages e à d'autres matériels archéologiques. *Revue Archéométrique* 5, 159-165.

Prummel, W. & H.-J. Frisch, 1986. A guide to the distinction of species, sex and body in bones of sheep and goat. *Journal of Archaeological Science* 13, 567-577.

Rauh, H., 1981. *Knochenfunde von Säugetieren aus dem Demircihüyük (Nordwestanatolien)*. München: Universität München (Ph.D. thesis).

Redding, R.W., 1978. Rodents and the archaeological paleoenvironment: considerations, problems, and the future. In *Approaches to faunal analysis in the Middle East*, eds. R.H. Meadow & M.A. Zeder. Peabody Museum Bullettin 2. Cambgridge, Mass.: Harvard University, pp.63-69.

Redding, R.W., 1981. *Decision making in subsistence herding of sheep and goats in the Middle East*. Michigan: University of Michigan (Ph.D. thesis).

Redding, R.W., 1984. Theoretical determinations of a herder's decisions: modeling variation in the sheep/goat ratio. In J *Animals and archaeology 3: early herders and their flocks*, eds. Clutton-Brock & C. Grigson. Oxford: British Archaeological Reports International Series 202, pp. 223-241.

Reed, C.A., 1969. The pattern of animal domestication in the prehistoric Near East. In *The domestication and exploitaton of plants and animals*, eds. P.J. Ucko & G.W. Dimbleby. London: Duckworth, pp. 361-380.

Rösner, U. & F. Schäbitz, 1991. Palynological and sedimentological evidence for the historic environment of Khatouniye, eastern Syrian Djezire.

Paléorient 17(1): 77-87.

Ryder, M.L., 1983. *Sheep & Man*, London: Duckworth.

Schäffer, J. & J. Boessneck, 1988. Bericht über die Tierreste aus der halafzeitlichen Siedlung Çavi Tarlasi (Nibisin/Osttürkei). *Istanbuler Mitteilungen* 38, 37-64.

Shiffer, M.B., 1972. Archeological context & systemic context. *American Antiquity* 37, 156-165.

Shiffer, M.B., 1976. *Behavioral archeology*. New York: Academic Press.

Schmidt-Nielsen, K., 1964. *Desert animals: physiological problems of heat and water*. Oxford: Clarendon.

Siegel, J., 1976. Animal palaeopathology: possibilities & problems. *Journal of Archaeological Science* 11, 467-475.

Silver, I.A., 1969. The ageing of domestic animals. In *Science in archaeology* (2nd ed.), eds. D.R. Brothwell & E. Higgs. London: Thames and Hudson, pp. 283-302.

Simmons, A.H. & G. Ilany, 1975-77. What mean these bones? Behavioural implications of gazelles' remains from archaeological sites. *Paléorient* 3, 269-274.

Spoor, R.H. & Collet P., 1996. The other small finds. In *Tell Sabi Abyad - The late Neolithic settlement*, P.M.M.G. Akkermans. Istanbul: Nederlands Historisch-Archeologisch Instituut, pp. 439-473.

Stampfli, H.R., 1983. The fauna of Jarmo, with notes on animal bones from Matarrah, the `Amuq, & Karim Shahir. In *Prehistoric archaeology along the Zagros flanks*, eds. L.S. Braidwood, R.J. Braidwood, B. Howe, C.A. Reedand, & P.J. Watson. Oriental Institute Publications n.105. Chicago: University of Chicago, pp. 431-483.

Stein, G., 1989. Strategies of risc reduction in herding and hunting systems of Neolithic Southeast Anatolia. In P.J. *Early animal domestication and its cultural context*, eds. P.J. Cratbree, D. Campana & K. Ryan. MASCA research papers in science and archaeology 6, supplement. Philadelphia, P.A.: MASCA, pp. 87-97.

Stallibrass, S.M., 1985. Some effects of preservational bias on interpretations of animal bones. In *Palaeobiological investigations*, eds N.R.J. Fieller, D.D. Gilbertson & N.G.A. Ralph. Oxford: British Archaeological Reports International Series 266, pp. 65-72.

Talbot, L.M., 1960. A look at threatened species. *Oryx* 5, 153-293.

Thalen, D.C.P., 1979. *Ecology and utilization of desert scrubs rangeland in Iraq*. The Hague: Dr.W.Junk.

Tristam, H.B., 1889. *The natural history of the Bible*. London: Society for promoting Christian Knowledge.

Turner, A., 1982. Minimum number estimation offer minimal insight in faunal analysis. *Ossa* 7, 199-201.

Uerpmann, H.-P., 1973. Animal bone finds & economic archaeology: a critical study of 'osteo-archaeological' method. *World Archaeology* 4(3), 307-322.

Uerpmann, H.-P., 1979. *Probleme der Neolithisierung des Mittelmeerraums*. Beihefte zum Tübinger Atlas des Vorderen Orients B/28. Wiesbaden: Dr. Ludwig Reichter Verlag.

Uerpmann, H.P., 1982. Faunal remains from Shams ed-Din Tannira, a Halafian site in northern Syria. *Berytus* 30, 3-52.

Uerpmann, H.-P., 1986. Halafian equid remains from Shams ed-Din Tannira in northern Syria. In *Equids in the ancient world I*, eds. R.H. Meadow & H.-P. Uerpmann. Beihefte zum Tübinger Atlas des Vorderen Orients A, 19/1 Wiesbaden: Dr. Ludwig Reichter Verlag, pp. 246-265.

Uerpmann, H.-P., 1987. *The ancient distribution of ungulate mammals in the Middle East*. Beihefte zum Tübinger Atlas des Vorderen Orients A, 27. Wiesbaden: Dr. Ludwig Reichter Verlag.

Uerpmann, H.-P., 1989. *Tübinger Atlas von Vorderen Orients* (Tübinger Atlas des Vorderen Orients): A VI 16 (1-8). Wiesbaden: Dr. Ludwig Reichter Verlag.

Uerpmann, H.-P., 1991. Equus africanus in Arabia. In *Equids in the ancient world II*, eds. R.H. Meadow & H.-P. Uerpmann. Beihefte zum Tübinger Atlas des Vorderen Orients A, 19/2. Wiesbaden: Dr. Ludwig Reichter Verlag, pp. 12-33.

Verhoeven, M., 1994. Excavation at Tell Sabi Abyad, a later Pre-Pottery Neolithic B village in the Balikh valley, northern Syria. *Orient Express* 1, 9-12.

Verhoeven, M. & P. Kranendonk, 1996. The excavations: stratigraphy & architecture. In *Tell Sabi Abyad - The late Neolithic settlement*, ed. P.M.M.G. Akkermans. Istanbul: Nederlands Historisch-Archeologisch Instituut, pp. 25-118.

Voigt, M., 1983. *Haij Firuz Tepe, Iran The Neolithic settlement*. University Museums Monograph 50. Philadelphia: University of Pennsylvania.

Watson, J.P., 1980. The vertebrate fauna of Arpachiyah. *Iraq* 42, 152-153.

Watson, J.P. & S.A. LeBlanc, 1990. *Girikihaciyan A Halafian site in southeastern Turkey*. Institute of Archaeology Monograph 33. Los Amgeles: University of California.

Wilkinson, T.J., 1996. Sabi Abyad: the geoarchaeology of a complex landscape. In *Tell Sabi Abyad - The late Neolithic settlement*, ed. P.M.M.G. Akkermans. Istanbul: Nederlands Historisch-Archeologisch Instituut, pp. 1-24.

Wirth, E., 1971. *Syrien: eine geographische Landeskunde*. Darmstadt: Wissenschaftliche Buchgesellschaft.

Wijngaardern-Bakker, L.H. van, 1979. Elektronische meetapparatuur voor (archeo)zoölogisch gebruik. *Lutra* 20, 8-9.

Wijngaarden-Bakker, L.H. van, 1980. An *archaeozoological study of the Beaker settlement at Newgrange, Ireland*. Amsterdam: University of Amsterdam (Ph.D. thesis).

Wijngaarden-Bakker, L.H. van, 1986. The animal remains from the Beaker settlement at Newgrange, Co. Meath: final report. *Proceedings of the Royal Irish Academy* 86,C,(2), Dublin: Royal Irish Academy, pp. 2-111.

Wijngaarden-Bakker, L.H. van, 1989. The animal remains from Tell Sabi Abyad - square P14. In *Excavations at Tell Sabi Abyad Prehistoric investigations in the Balikh Valley, northern Syria*, ed. P.M.M.G. Akkermans. Oxford: British Archaeological Reports International Series 468, pp. 301-323.

Wijngaarden-Bakker, L.H. van & C.H. Maliepaard, in press. Zooarchaeological study of the Prepottery Neolithic levels of Sabi Abyad II.

Weiler, D., 1981. *Saügetierknochenfunde vom Tell Hesbân in Jordanien*. München: Universität München (Ph.D. thesis).

Zeder, M.A., 1986. The Equid Remains from Tal-e Malyan, Southern Iran. In *Equids in the ancient world I*, eds. R.H. Meadow & H.-P. Uerpmann. Beihefte zum Tübinger Atlas des Vorderen Orients A, 19/1. Wiesbaden: Dr. Ludwig Reichter Verlag, pp. 366-412.

Zeder, M.A., 1994. After the revolution: post-Neolithic subsistence in northern Mesopotamia. *American Anthropologist* 96(1), 97-126.

Zeder, M., in press. Regional patterns of animal exploitation in the Khabur Basin, 7000 to 1500 B.C. In Festschrift for Sandor Bökönyi, eds. L. Bartosiewicz, E. Jerem & W. Meideds. Budapest: Archaeolingua.

Zeist, W. van, R. W. Timmers & S. Bottema, 1968(1970). Studies of modern and Holocene pollen precipitation in Southeastern Turkey. *Palaeohistoria* 14, 19-39.

Zeist, W. van & H. Woldring, 1978. A postglacial pollen diagram from Lake Van in east Anatolia. *Review of Paleobotany and Palynology* 26, 249-276.

Zeist, W. van & H. Woldring, 1980. Holocene vegetation and climate of northwestern Syria. *Palaeohistoria* 22, 111-125.

Zeist, W. van & W. Waterbolk-van Rooijen, 1985. The palaeoebotany of Bouqras, eastern Syria. *Paléorient* 11, 131-147.

Zeist, W. van, W. Waterbolk-van Rooijen & S. Bottema, 1988. Some notes on the plant husbandry of Tell Hammam et-Turkman. In *Hammam et-Turkman I*, ed. M.N. van Loon. Istanbul: Nederlands Historisch-Archeologisch Instituut, Appendix 2, pp. 705-715.

Zeist, W. van & W. Waterbolk-van Rooijen, 1989. Plant remains from Tell Sabi Abyad. In *Excavations at Tell Sabi Abyad - Prehistoric investigations in the Balikh Valley, northern Syria*, ed. P.M.M.G. Akkermans. Oxford: British Archaeological Reports International Series 468, pp. 325-335.

Zeist, W. van & S. Bottema, 1991. *Late quaternary vegetation of the Near East*. Beihefte zum Tübinger Atlas des Vorderen Orients A/18. Wiesbaden: Dr. Ludwig Reichter Verlag.

Zeist, W. van & W. Waterbolk-van Rooijen, 1996. The cultivated & wild plants. In *Tell Sabi Abyad - The late Neolithic settlement*, ed. P.M.M.G. Akkermans. Istanbul: Nederlands Historisch-Archeologisch Instituut, pp. 521-550.

Zeuner, F.E., 1963. *A history of domesticated animals*. New York: Harper & Row Publishers.

Appendix : Measurements

Measurements (in mm) taken after Von den Driesch (1976)

List of abbreviations

B	Breadth of molar
BCH	Basal circumference of the horncore
BD	Breadth of the distal end
BF	Breadth of the Facies articularis
BFcd	Breadth of the cranial articular surface
BFd	Breadth of the Facies articularis distalis
BFcr	Breadth of the caudal articular surface
BFa	Breadth of of the distal articular surface[1]
BG	Breadth of the glenoid cavity
BM1	Breadth of M1
BM3	Breadth of M3
BP	Breadth of the proximal end
BPC	Breadth across the coronoid process
BT	Breadth of the trochlea
DC	Depth of the caput femoris
DD	Depth of the distal end
DFa	Depth of the distal articular surface[2]
DHA	Diagonal height
DLS	Diagonal length of the sole
DPA	Depth across the processus anconaeus
GB	Greatest breadth
GDH	Greatest diameter of the horncore base
GH	Greatest height
GL	Greatest length
GLL	Greatest length of the lateral half
GLM	Greatest length of the medial half
GLP	Greatest length of the processus articularis
GLpe	Greatest length of the peripheral half
H	Height
Hs	Height along the spine
L	Length of molar
LA	Length of the acetabulum including the lip
LAR	Length of the acetabulum on the rim
LCDe	Lenght of the corpus including the dens
LCR	Length of cheecktooth row
LD	Length of the dorsal surface
LG	Length of glenoid cavity
LL	Lateral lenght
LM	Length of the molar row
LM1	Length of M1
LM1a	Alveolar length of M1
LM1c	Length of M1 at the cingulum
LM3	Length of M3
LO	Length of olecranon
LP	Length of the premolar row
LS	Length of the symphysis
SB	Smallest breadth of the shaft of the ilium
SD	Smallest breadth of the diaphysis
SDO	Smallest depth of the olecranon
SH	Smallest height of the shaft of the ilium
SLC	Smallest length of he collum scapulae
a	anterior
p	posterior
W	wild
	unworn

[1]measured for the astragalus, after Uerpmann (1991: 24)

[2]measured for the astragalus, after Uerpmann (1991: 24)

OVIS/ CAPRA: measurements

SPECIES	ELEM	SQ	NUM	SUB	FA	LP	LM
O/C	CRAN	P15	32 87	1	P	27.9	
O/C	CRAN	P15	31.100	1	P		38.0

SPECIES	ELEM	SQ	NUM	SUB	FA	GL	GB	BFCD	BFCR
OVIS	ATLAS	R13	9 88	2	E			45 9	
OVIS	ATLAS	Q13	10 50	1	E				45.0
CAPRA	ATLAS	Q13	54 139	10	E		71.4		
O/C	ATLAS	P15	13 26	20	T	55 2	73 9		
OVIS	ATLAS	P15	40.115	309	P			45 5	

SPECIES	ELEM	SQ	NUM	SUB	FA	LCDE	H	BFCR
OVIS	AXIS	R13	9 82	44	E	55 7		44 1
OVIS	AXIS	Q13	33.105	1	E	62 4	58 5	47 1
O/C	AXIS	P15	40 115	73	P	59.8		47 0
O/C	AXIS	P15	30 81	12	P	63 3	67 5	49 0
O/C	AXIS	P15	11 33	45	T	52 3		37.7
O/C	AXIS	P15	13.26	21	T			47.7
Mean								**45.4**
Std Dev								**4.11**
Min.								**37.7**
Max.								**49.0**
N								**6**

SPECIES	ELEM	SQ	NUM	SUB	FA	LCR	LP	LM	LM3	BM3
O/C	MAND	R13	33.113	4	E		21.7			
O/C	MAND	Q14	17 75	33	E		26 4			
O/C	MAND	P14	8 128	5	E		25 7			
O/C	MAND	R13	16 93	1	E		20 7			
O/C	MAND	Q13	30 94	1	E		22.9			
O/C	MAND	Q13	59 210	1	E				18 9	8.2
O/C	MAND	Q13	75 221	12	E				19 3	8.2
O/C	MAND	R13	14 32	12	E			48.7	20 1	7 3
O/C	MAND	Q14	12 59	1	E			51.5	21.0	8 1
O/C	MAND	Q13	25 55	2	E				23 4	8.4
O/C	MAND	R13	9.34	6	E	72,0	24 1	48 1	23 9	8 8
O/C	MAND	P15	17.41	18	T		22 0			
O/C	MAND	P15	13 28	74	T		27 2			
O/C	MAND	P15	13.27	78	T		29 2			
O/C	MAND	P15	17 41	13	T		20.6			
O/C	MAND	P15	22 45	4	T		19 8			
O/C	MAND	P15	26.64	2	T		24 4			
O/C	MAND	P15	11.29	3	T			48 3	21 2	7 3
O/C	MAND	P15	24 50	2	T	72.7	22 4	48 8	22.4	8.9
O/C	MAND	P15	9 21	57	T				23.0	8 5
O/C	MAND	P15	17.39	5	T				23.1	7 9
O/C	MAND	P15	42.129	12	P	71 8	21 5	50.5		
O/C	MAND	P15	42 129	8	P				18 3	6 9
O/C	MAND	P15	42 129	11	P	71 7	24 2	47 2	19 5	8.0
O/C	MAND	P15	40 115	534	P		23 8		20 9	7.8
O/C	MAND	P15	55 165	1	P		26 2		21 2	7 5
O/C	MAND	P15	40 115	570	P		23 1		22 1	8 4
O/C	MAND	P15	40.115	569	P	71 6	21 8	48.6	23 4	8 4
O/C	MAND	P15	40 116	104	P				23 5	8 2
O/C	MAND	P15	42 129	20	P	76.8	22.9	54 5	23 7	9 1
O/C	MAND	P15	42 129	70	P	73 3	20.8	38.9	24 0	9 4
O/C	MAND	P15	40 115	542	P		21.0		25.5	9.0
Mean							**23.3**		**21.9**	**8.2**
Std Dev							**2.44**		**1.98**	**0.65**
Min.							**19.8**		**18.3**	**6.9**
Max.							**29.2**		**25.5**	**9.4**
N							**22**		**20**	**20**

SPECIES	ELEM	SQ	NUM	SUB	FA	L	B	
O/C	M3I	Q14	20 58	1	E	18 5	6.9	
O/C	M3I	R13	9.14	14	E	19 1	6 9	
O/C	M3I-	R13	14 32	26	E	19 1	7.1	
O/C	M3I	Q13	54 216	5	E	19 3	7 3	
O/C	M3I-	R13	14 32	56	E	19 6	6 0	
O/C	M3I-	R13	14 32	25	E	19 6	6.4	
O/C	M3I	R13	9 14	14	E	19 7	7.4	
O/C	M3I	Q14	47 124	12	E	20,0	6 9	
O/C	M3I	Q14	47 124	13	E	20 1	6.8	
O/C	M3I	Q13	62.166	19	E	20 1	7.1	
O/C	M3I	Q14	17.47	14	E	20 1	8.0	
O/C	M3I	Q14	19.56	4	E	20.2	7.3	
O/C	M3I	Q14	5.7	2	E	20 5	7.7	
O/C	M3I	Q13	30 62	9	E	20.8	7 7	
O/C	M3I	Q14	17.87	8	E	20 9	8.6	
O/C	M3I	Q14	17 50	18	E	21.1	7 5	
O/C	M3I	R13	9 19	4	E	21.1	8 5	
O/C	M3I	Q13	74 223	5	E	21.2	8 0	
O/C	M3I	Q13	74 223	8	E	21.3	8 0	
O/C	M3I	Q14	17.102	1	E	21.5	7 8	
O/C	M3I	Q14	22.60	3	E	21 8	7.6	
O/C	M3I	Q14	17.107	7	E	22 1	8.9	
O/C	M3I	R13	9 53	19	E	22 4	8.8	
O/C	M3I	R13	13 48	2	E	23 0	8 6	
O/C	M3I	Q13	47.183	3	E	23 4		
O/C	M3I	R13	14 41	6	E	23.5	8.5	
O/C	M3I	Q13	63 174	8	E	23.5	8.9	
O/C	M3I	Q13	62 163	41	E	23 8	8 0	
O/C	M3I	Q14	5 26	5	E	23.9	7.7	
O/C	M3I	Q13	62.163	39	E	24.3	8 2	
O/C	M3I	Q14	4 6	3	E	24.3	8 3	
O/C	M3I	P15	23 58	13	T		7 3	
O/C	M3I	Q15	18 34		T		7 6	
O/C	M3I	Q15	18 37	5	T		8.9	
O/C	M3I	P15	23 49	4	T		9 0	
O/C	M3I	Q15	17.56	2	T		9 0	
O/C	M3I	P15	13.26	2	T		9 2	
O/C	M3I-	Q15	17 79	1	T	18.9	6 4	
O/C	M3I-	Q15	18.82		T	19.3	7.3	
O/C	M3I	Q14	26 108	8	T	19.6	6 0	
O/C	M3I	Q14	22.73	6	T	19.6	7 7	
O/C	M3I	P15	11 30	17	T	19 8	8.2	
O/C	M3I	P15	26 60	2	T	20 0	7.3	
O/C	M3I	P15	9.18	40	T	20 0	7.6	
O/C	M3I	Q14	26.108	7	T	20 2	7 3	
O/C	M3I	P15	11 30	24	T	20 2	8 0	
O/C	M3I-	Q15	27.88		T	20.2	7 3	
O/C	M3I-	Q15	31 116	4	T	20.3	7 0	
O/C	M3I-	P15	4.4	1	T	20.7	8 0	
O/C	M3I	P15	11.30	23	T	20 7	8.1	
O/C	M3I	P15	4 4	5	T	20.9	8.7	
O/C	M3I	Q14	11 85	7	T	21.0	7 6	
O/C	M3I	P15	11 33	7	T	21.3	8 7	
O/C	M3I	Q15	17.24	8	T	21.5	7 3	
O/C	M3I	Q15	17 28	3	T	21 5	7.5	
O/C	M3I-	P15	14 35	56	T	21 5	7 8	
O/C	M3I	P15	9 14	9	T	21.6	8 8	
O/C	M3I	P15	11 25	56	T	21.7	8 6	
O/C	M3I	Q15	22 76	2	T	21.7		
O/C	M3I	Q15	19.103		T	21 8	7.5	
O/C	M3I	P15	27.75	3	T	22,0	8.4	
O/C	M3I	Q14	27 84	8	T	22,0	8 2	
O/C	M3I	P15	26.60	43	T	22.2	8 6	
O/C	M3I	Q14	30.93	4	T	22.5	8.0	
O/C	M3I	Q15	24 71	4	T	22.7	7.2	
O/C	M3I	P15	13.27	7	T	22 9	8 5	
O/C	M3I	P15	10.15	5	T	22 9	8 5	
O/C	M3I	P15	27 65	24	T	22 9	9.2	
O/C	M3I	Q15	18.34		T	23.5	8 4	
O/C	M3I	P15	28.72	5	T	23.5	8.8	
O/C	M3I	Q15	19 114	5	T	24,0	9.6	
O/C	M3I	P15	28.69	1	T	24 3	8.7	
O/C	M3I	P15	35 106	5	P		7 0	
O/C	M3I	P15	40 114	25	P		8 8	
O/C	M3I	P15	40.120	32	P		9 1	
O/C	M3I-	P15	40.115	602	P	17 6	7.2	
O/C	M3I	P15	35.106	3	P	17 9	7 8	
O/C	M3I	P15	40 116	50	P	18.4	7 7	
O/C	M3I	P15	40.116	56	P	19,0	6 6	
O/C	M3I	P15	40 116	47	P	19 9	7.2	
O/C	M3I	P15	40.115	543	P	20 0	6 7	
O/C	M3I	P15	40 115	621	P	20.1	8 1	
O/C	M3I	P15	36 108	5	P	20 2	7 6	
O/C	M3I	P15	40 115	589	P	20.2	8 0	
O/C	M3I	P15	40.115	598	P	20 4	7.7	
O/C	M3I	P15	40 115	572	P	20.9	7.3	
O/C	M3I	P15	40 115	571	P	20.9	7.7	
O/C	M3I	P15	40 115	554	P	21.0	7 7	
O/C	M3I	P15	35.105	28	P	21 1	7 2	
O/C	M3I	P15	17 41	10	P	21.3	8 8	
O/C	M3I	P15	40.115	523	P	21 3	8.5	
O/C	M3I	P15	40 115	553	P	21.8	8 0	
O/C	M3I	P15	40 115	561	P	21 9	8.7	
O/C	M3I	P15	40.116	54	P	22 0	7.5	
O/C	M3I	P15	40 117	5	P	22.8	7 9	
O/C	M3I	P15	35 102	1	P	23 1	8.8	
O/C	M3I	P15	56 174	6	P	23.3	8 6	
O/C	M3I	P15	54 166	42	P	23 3	8 5	
O/C	M3I	P15	42 129	73	P	23.5	8 9	
O/C	M3I	P15	40 114	89	P	23.5	8.5	
O/C	M3I	P15	40 115	601	P	23.6	8.0	
O/C	M3I	P15	40 115	599	P	23.8	9 0	
O/C	M3I	P15	40 116	44	P	24,0	7 8	
O/C	M3I	P15	40 115	583	P	26.3	9 4	W
Mean						**21.4**	**7.6**	
Std Dev						**1.69**	**0.76**	
Min.						**17.6**	**6.0**	
Max.						**26.3**	**9.6**	
N						**95**	**102**	

SPECIES	ELEM	SQ	NUM	SUB	FA	SLC	GLP	LG	BG
OVIS	SCAP	Q13	64.226	7	E	17 4	26 9	20.5	17.3
O/C	SCAP	R13	22.100	6	E	18.8	29 3	22.1	19.4
O/C	SCAP	R13	33 108	1	E	18 8	29.0	21 7	16 9
OVIS	SCAP	Q13	75 221	4	E	18.9	29.3	23.1	17.4
CAPRA	SCAP	Q14	6 12	24	E	19.3	29.2	20 8	19 5
O/C	SCAP	R13	9.18	6	E	19.4	30 6	23,0	18 8
OVIS	SCAP	Q13	29 41	1	E	20.2	32.1	24 4	18 6
CAPRA	SCAP	Q13	54 216	1	E	20.5		20 5	20 1
O/C	SCAP	R13	9 81	1	E	21 5	32.3	22 5	22.0
OVIS	SCAP	Q14	7 44	35	E	21 6	35 2	26 4	22 9
OVIS	SCAP	Q14	18.43	3	E	21.9	33 2	25 8	21 5
OVIS	SCAP	Q13	62 163	1	E	22 0	34 5	23.9	21 9
O/C	SCAP	P15	9 18	30	T	15 6		23.5	20.0
O/C	SCAP	P15	9 21	21	T	15.7	31 6	24.7	19 2
O/C	SCAP	P15	13.26	5	T	17.8			17.5
O/C	SCAP	P15	13 27	51	T	17 9	30 3	22 5	19.0
O/C	SCAP	P15	11.35	15	T	18 2	29.1	28 5	17 9
O/C	SCAP	P15	10.15	18	T	18.2			
O/C	SCAP	P15	11 35	22	T	18 2	33 8	22.1	
CAPRA	SCAP	P15	23 53	2	T	18 3	27 9		18 6
O/C	SCAP	P15	9 21	21	T	18 7	30 0	23.0	18 6
O/C	SCAP	P15	12 23	5	T	18.8	31 3	24 7	19 5
OVIS	SCAP	P15	15 37	13	T	18 9			20 3
O/C	SCAP	P15	10 13	10	T	19,0	30 7	24 7	19.3
O/C	SCAP	P15	13.28	51	T	19.1	31.8	20 2	19 7
OVIS	SCAP	Q15	19.99	11	T	20 2	31 0	23 9	20 7
OVIS	SCAP	Q15	17.56	4	T	20 7			
OVIS	SCAP	Q15	24 71	8	T	21,0			
O/C	SCAP	P15	13 28	56	T	21.2	34,0	26 5	21.0
O/C	SCAP	P15	13 27	50	T	21 2	33.2	26 0	20 6
CAPRA	SCAP	P15	28.63	6	T	21 3			21 0
O/C	SCAP	P15	26 60	10	T	21.8			
OVIS	SCAP	Q15	19 103	14	T	22 2			21 2
O/C	SCAP	P15	13 28	53	T		30.1	24 4	17 5
O/C	SCAP	P15	35 103	10	P	17.1		22.5	18.0
O/C	SCAP	P15	42 123	11	P	18.6	28 9	23 1	19 2
OVIS	SCAP	P15	40 115	365	P	18 6		23.4	17 7
OVIS	SCAP	P15	42 123	13	P	19 8	30.7	23.0	18 8
OVIS	SCAP	P15	40 119	105	P	20 1	31 3	24.6	18 9
OVIS	SCAP	P15	40 119	106	P	20 8	29 9	23.2	20 7
OVIS	SCAP	P15	40.118	21	P	20 8		25.7	21 6
OVIS	SCAP	P15	56 173	6	P	20 9	33 1	24.8	20 6
O/C	SCAP	P15	35 102	7	P	20 9			
O/C	SCAP	P15	36.107	1	P	21.8	32.2	25 7	20 6
OVIS	SCAP	P15	40 118	2	P	22.4	35.2	26.2	21 3
OVIS	SCAP	P15	40 115	366	P		30.3	24 6	19 2
OVIS	SCAP	P15	53.169	2	P		29 3	22.9	17.5
OVIS	SCAP	P15	42 123	18	P		33 7	25 1	21 8
Mean						**19.7**	**31.2**	**23.8**	**19.6**
Std Dev						**1.70**	**2.09**	**1.86**	**1.53**
Min.						**15.6**	**26.9**	**20.2**	**16.9**
Max.						**22.4**	**35.2**	**28.5**	**22.9**
N						**44**	**34**	**38**	**42**

SPECIES	ELEM	SQ	NUM	SUB	FA	BP	SD	BD	BT	
O/C	HUM	Q13	30 53	1	E				26.9	
O/C	HUM	Q13	74 219	9	E				26 6	
OVIS	HUM	Q13	54 133	10	E			27.1	25 6	
O/C	HUM	R13	9 82	35	E			27 3	24.4	
OVIS	HUM	Q13	57.152	4	E			27 5	25.6	
OVIS	HUM	Q13	31.98	1	E			27 6	25 6	
OVIS	HUM	Q14	22 67	6	E			28.1	28 1	
OVIS	HUM	Q15	19 103	1	E			28.4	26 6	
O/C	HUM	Q14	5 32	20	E			28 6	27 5	
OVIS	HUM	Q13	64 226	8	E			28 7	25.5	
OVIS	HUM	Q13	27 38	3	E			28 8	25 5	
O/C	HUM	Q14	22 60	2	E			28 8	27 7	
CAPRA	HUM	Q14	46 129	6	E			29 2	27 8	
CAPRA	HUM	Q14	17 106	3	E			29 7	27 8	
O/C	HUM	R13	9 19	2	E			29 7		
O/C	HUM	Q14	17 47	3	E			29 8	28 1	
OVIS	HUM	Q14	22 64	12	E			30 1	27 6	
OVIS	HUM	Q15	17 24	25	E			30.9	27 1	
O/C	HUM	R13	9 19	1	E			31 5	28 9	
OVIS	HUM	Q14	17 40	1	E			31 6	30 5	
OVIS	HUM	Q14	3 30	7	E			32 3	31 1	
OVIS	HUM	Q15	16.27	1	E			32 5	31 1	
OVIS	HUM	Q13	43 120	1	E			32 5	28 7	
OVIS	HUM	Q13	30 62	2	E			32 8	29 4	
O/C	HUM	R13	14 32	3	E			32 8	30 1	
OVIS	HUM	Q14	18 43	1	E			32 9	29 7	
OVIS	HUM	P14	8 72	27	E			34 0	29.9	
O/C	HUM	Q14	17.50	6	E			37 8	34 8	W
OVIS	HUM	P15	23 46	4	T				25 7	
O/C	HUM	Q14	22 73	1	T				28 2	
O/C	HUM	P15	26 60	28	T				28 7	
O/C	HUM	P15	9 21	17	T				29 2	
O/C	HUM	P15	28.62	1	T				29 2	
O/C	HUM	P15	14 35	38	T				33 3	
OVIS	HUM	P15	13 28	32	T			25 3		
OVIS	HUM	P15	10 15	1	T			26 2		
O/C	HUM	P15	11 30	32	T			28 5	26 7	
OVIS	HUM	P15	9 24	8	T			28.5	27.2	
OVIS	HUM	P15	13.26	16	T		12.6	28 6	27 0	
OVIS	HUM	P15	11 25	2	T			28.6	27 2	
OVIS	HUM	P15	14 35	36	T			28 6	26.7	
OVIS	HUM	Q15	1.4	4	T			29.1	28.4	
OVIS	HUM	P14	31 139	15	T			29.4	27.4	
OVIS	HUM	P15	9 18	15	T			29 6	26.7	
OVIS	HUM	P15	13 27	33	T			29 8	28 9	
OVIS	HUM	P15	9 24	7	T			29 8	28 2	
OVIS	HUM	Q15	19 38	1	T			29 9	28.9	
O/C	HUM	P15	13 28	31	T			30 0	28.1	
OVIS	HUM	P15	25.54	1	T			30 1	28 1	
OVIS	HUM	P15	12 20	6	T			30 1	29.0	
OVIS	HUM	Q15	19.99	6	T		15.1	30.2	28.7	
OVIS	HUM	P15	26.64	28	T			30 3		
OVIS	HUM	P15	13 28	29	T			30 3	29.4	
OVIS	HUM	P15	9.18	14	T			30 5	29 6	
OVIS	HUM	P15	16 38	14	T			30.6	29.6	
OVIS	HUM	Q15	17 24	26	T			31 2	29.6	
OVIS	HUM	P15	23 57	7	T			31 6	29 4	
OVIS	HUM	P15	11 31	3	T			31 7	28.4	
OVIS	HUM	Q15	18 45	4	T			31.7	29 7	
OVIS	HUM	P15	13 27	32	T		15.5	31 8	30.7	
OVIS	HUM	Q15	18.93	2	T			32,0	29.1	
OVIS	HUM	P15	13 27	34	T			32.8	30 4	
CAPRA	HUM	P14	21 102	1	T			34 2	32.4	
O/C	HUM	P15	40.115	72	P				26.6	
OVIS	HUM	P15	40 115	87	P	32 9				
O/C	HUM	P15	35.105	25	P				26 5	
O/C	HUM	P15	35 106	31	P				31.4	
O/C	HUM	P15	40 115	179	P				27.2	
OVIS	HUM	P15	42.129	4	P			26.1	25 1	
OVIS	HUM	P15	40.116	9	P			27.2	26 3	
OVIS	HUM	P15	35.106	8	P			27.8	26 6	
OVIS	HUM	P15	35.105	24	P			28.1	26.7	
O/C	HUM	P15	40.115	71	P			28.1	26 6	
OVIS	HUM	P15	49.163	31	P			28 2	27 8	
OVIS	HUM	P15	40.117	19	P			28 3	24.7	
OVIS	HUM	P15	54.166	4	P			28.4	28.5	
OVIS	HUM	P15	49 163	28	P			28.4	27 9	
OVIS	HUM	P15	40 117	53	P			28.5	27 2	
OVIS	HUM	P15	40.118	63	P			28 5	26.5	
OVIS	HUM	P15	40.115	348	P			28 6	26.9	
CAPRA	HUM	P15	42.129	2	P			28.7	27.2	
OVIS	HUM	P15	42.129	43	P			28.7	27 3	
OVIS	HUM	P15	40 115	68	P			28 8	27 7	
OVIS	HUM	P15	40.115	344	P			28 8	27.7	
OVIS	HUM	P15	40.118	8	P			28 8	28 0	
OVIS	HUM	P15	40.115	345	P			28 8	27.5	
OVIS	HUM	P15	40 115	353	P			28 9	26.8	
OVIS	HUM	P15	40.117	17	P			28.9	28 6	
OVIS	HUM	P15	40 115	168	P			29.3	28.5	
OVIS	HUM	P15	40 119	23	P			29 4	27.4	
CAPRA	HUM	P15	40 118	13	P			29 5	28 5	
OVIS	HUM	P15	40 115	354	P			29.5	28 0	
CAPRA	HUM	P15	40.119	24	P			29 5	29.0	
OVIS	HUM	P15	40 115	308	P			29 8	27.5	
OVIS	HUM	P15	40 115	167	P			30 0	28 7	
OVIS	HUM	P15	40 117	57	P			30.2	26 9	
OVIS	HUM	P15	40 115	352	P			30.2	28.1	
OVIS	HUM	P15	40.117	77	P			30 6	28.7	
OVIS	HUM	P15	49 163	27	P			30 7	28 0	
O/C	HUM	P15	40.114	44	P			30 8	29 1	
CAPRA	HUM	P15	40 119	101	P			31,0	28 6	
O/C	HUM	P15	40.115	70	P			31 1	30.9	
OVIS	HUM	P15	40.130	2	P			31 2	28.6	
OVIS	HUM	P15	40 115	303	P			31 3	30 0	
OVIS	HUM	P15	40.115	69	P			31 6	30 3	
OVIS	HUM	P15	40.118	47	P			31 7	29 6	
O/C	HUM	P15	40 115	169	P			31.7	30 9	
OVIS	HUM	P15	42 129	3	P			32,0	29 6	
OVIS	HUM	P15	40.120	43	P			32.2	30 3	
CAPRA	HUM	P15	42 134	13	P			33.1	32 3	
OVIS	HUM	P15	40 116	16	P			33.7	32.6	
CAPRA	HUM	P15	42 129	1	P			34 8	31.6	
Mean								**30.1**	**28.3**	
Std Dev								**2.00**	**2.3**	
Min.								**25.3**	**24.4**	
Max.								**37.8**	**34.8**	
N								**99**	**107**	

SPECIES	ELEM	SQ	NUM	SUB	FA	GL	BP	SD	BD	
O/C	RAD	R13	9 14	1	E			13 9	25 3	
OVIS	RAD	Q14	6 12	20	E				27 5	
OVIS	RAD	Q14	11 55	8	E				28.4	
CAPRA	RAD	Q14	6 10	2	E				28 8	
OVIS	RAD	Q13	62.168	23	E		26 7			
CAPRA	RAD	14	17 47	5	E		26 7			
O/C	RAD	R13	13 76	1	E		27 0			
CAPRA	RAD	Q14	17 100	5	E		27 5			
O/C	RAD	R13	9 19	7	E		27 6			
CAPRA	RAD	Q13	44.132	1	E		27 7			
CAPRA	RAD	Q13	74 223	19	E		27 8			
OVIS	RAD	Q13	27 38	2	E		27.9			
OVIS	RAD	Q13	43 128	6	E		28.0			
OVIS	RAD	Q13	54 133	11	E		28.3			
O/C	RAD	R13	22 100	7	E		28 5			
OVIS	RAD	Q14	7 44	45	E		28 6			
O/C	RAD	R13	14.24	1	E		28.7			
OVIS	RAD	Q13	62.168	7	E		29 6			
OVIS	RAD	Q14	17.41	9	E		29 7			
OVIS	RAD	Q14	9 14	11	E	151.9	31 2	17 0	28 4	
OVIS	RAD	Q14	11 55	5	E		31 3			
OVIS	RAD	Q13	54.139	2	E		32 2			
OVIS	RAD	Q13	49 160	15	E		32 8			
OVIS	RAD	Q13	49.160	5	E		32 9			
OVIS	RAD	Q14	12 45	4	E		34.0			
CAPRA	RAD	Q13	49.146	2	E		35 0			
OVIS	RAD	P15	28 62	3	T				26 4	
OVIS	RAD	P15	11 22	6	T				26 4	
OVIS	RAD	P15	11 33	19	T				26 6	
OVIS	RAD	P15	13 27	36	T				26 6	
CAPRA	RAD	Q15	17 84	18	T				27.9	
OVIS	RAD	P14	32 149	2	T				28 2	
CAPRA	RAD	Q15	22 101	4	T				29 0	
OVIS	RAD	Q15	34 119	2	T				30 7	
O/C	RAD	P15	11 33	17	T		26 0			
CAPRA	RAD	P14	31 145	1	T		26.5			
OVIS	RAD	P15	14 35	19	T		27 4			
OVIS	RAD	P15	23 53	24	T		28.8	14 3		
O/C	RAD	P15	16.38	19	T		29 6			
OVIS	RAD	P15	11 33	46	T		30.0			
OVIS	RAD	P15	7 9	8	T		30 3			
OVIS	RAD	P14	32 157	8	T		30 9			
OVIS	RAD	P15	23 57	1	T		31 1	14 5		
OVIS	RAD	Q15	19 103	2	T		31.4			
OVIS	RAD	P14	31 154	6	T		32.2			
CAPRA	RAD	P15	11 25	14	T		32 3			
OVIS	RAD	P15	18.43	7	T		32 8			
CAPRA	RAD	P14	32 157	12	T		33 9			
OVIS	RAD	P15	28 71	10	T		41 5			W
OVIS	RAD	P15	40 119	100	P				25 7	
OVIS	RAD	P15	40 115	340	P				25 7	
OVIS	RAD	P15	40 116	7	P				26 6	
OVIS	RAD	P15	40 115	136	P				27 2	
OVIS	RAD	P15	40.115	398	P				27 6	
OVIS	RAD	P15	54 166	8	P				28 5	
OVIS	RAD	P15	46.142	6	P				28 8	
OVIS	RAD	P15	35 105	26	P				29 1	
OVIS	RAD	P15	40.115	27	P				30 7	
OVIS	RAD	P15	42 129	2	P		26 9			
OVIS	RAD	P15	40 114	80	P		27.6			
OVIS	RAD	P15	49 163	4	P		28.3			
OVIS	RAD	P15	40 115	386	P		28 6			
OVIS	RAD	P15	40 115	405	P		29 0	15 2		
OVIS	RAD	P15	40 118	37	P		29 2			
OVIS	RAD	P15	42 129	44	P		29 4			
OVIS	RAD	P15	56 174	4	P		29 6			
OVIS	RAD	P15	40 117	22	P		30.3			
OVIS	RAD	P15	40 115	503	P		30 3			
OVIS	RAD	P15	40 115	388	P		30 4			
OVIS	RAD	P15	45 132	1	P		30 4			
OVIS	RAD	P15	42 133	7	P		32 2			
OVIS	RAD	P15	32 93	1	P		32 6	17 3		
OVIS	RAD	P15	40 120	35	P		32 7			
OVIS	RAD	P15	49 163	29	P		32 7	17 8		
CAPRA	RAD	P15	52 155	1	P		33 6			
OVIS	RAD	P15	35 105	3	P		33 9			
OVIS	RAD	P15	40 117	21	P		34 2			
Mean							30.3		27.7	
Std Dev							2.80		1.50	
Min.							36.0		25.3	
Max.							41.5		30.7	
N							56		22	

SPECIES	ELEM	SQ	NUM	SUB	FA	LO	DPA	SDO	BPC	
O/C	ULNA	R13	10.15	3	E		21.7	19.7		
OVIS	ULNA	Q14	17.50	4	E	38.1	24 5	20 8	17.5	
OVIS	ULNA	Q14	17 107	5	E	38 7	25.3	20 6	20.0	
CAPRA	ULNA	P15	11 29	2	T				21.0	
OVIS	ULNA	P15	11.30	52	T			23.4	18.0	
OVIS	ULNA	P15	28 71	12	T				24 0	W
O/C	ULNA	P15	18 43	1	T				16.6	
O/C	ULNA	P15	18 43	2	T		24.2			
OVIS	ULNA	P15	26 60	14	T		26.5			
OVIS	ULNA	P15	28 71	21	T		26.6	24 2	20.6	
OVIS	ULNA	P15	9.21	22	T		27.0	24.3	19 6	
OVIS	ULNA	P15	9.24	40	T	34 7		19.7	15 5	
OVIS	ULNA	Q15	17.33	5	T	36.2		20.2	17 4	
OVIS	ULNA	Q15	10.16	1	T	37.8	22 9	20.3	16 3	
O/C	ULNA	Q15	31.116	10	T	38 4	23.7	22.0	17 4	
CAPRA	ULNA	P14	32.157	6	T	40 3	25.6	22.6		
CAPRA	ULNA	Q15	18 97	13	T	41.1		20 0		
OVIS	ULNA	P15	53 169	3	P		25.1	21.7	16.4	
OVIS	ULNA	P15	35 106	12	P	40.8	22 6	16 0		
OVIS	ULNA	P15	45.126	5	P	42 7	27.7	24 0	17.9	
OVIS	ULNA	P15	40.115	128	P	51 4		27.0		W
Mean						40.0	24.9	21.7	18.4	
Std Dev						4.41	1.83	26.6	2.32	
Min.						34.7	21.7	16.0	15.5	
Max.						51.4	26.6	24.3	24	
N						11	13	16	14	

SPECIES	ELEM	SQ	NUM	SUB	FA	GL	BP	SD	BD	
OVIS	MC	Q13	46 127	1	E				25 7	
OVIS	MC	P15	9 24	13	T	130.0	22 2	15.4		
OVIS	MC	P15	13.26	18	T	136 2	24 4	15.4		
OVIS	MC	P15	9.24	12	T		22 2	12.8		
O/C	MC	P15	9 24	18	T		24 6			
OVIS	MC	P15	23.58	8	T		21.5	12.7		
OVIS	MC	P15	17.41	24	T		24 4			
O/C	MC	P15	26.60	58	T		23 2			
O/C	MC	P15	11 25	4	T		23.4			
O/C	MC	P15	14 35	20	T		22.4			
OVIS	MC	P15	28 71	13	T		30.2			W
O/C	MC	P15	23.53	20	T		23 5			
OVIS	MC	P15	10 15	22	T				22 1	
OVIS	MC	Q15	17 73	1	T	118 6	21 0	12.2	22.4	
CAPRA	MC	P15	15 37	10	T				23 1	
OVIS	MC	P15	11 30	34	T				23.5	
OVIS	MC	P15	18 43	6	T	126.4		13 0	24.4	
OVIS	MC	P15	13.27	28	T				25 0	
OVIS	MC	Q15	19 99	3	T				25 2	
OVIS	MC	Q15	24.59	1	T				25.8	
OVIS	MC	P15	9 24	14	T			14 7	25.9	
OVIS	MC	P15	26 73	5	T				26.3	
O/C	MC	P15	23 56	9	T				26.5	
O/C	MC	P15	13 27	35	T				26.7	
O/C	MC	R13	29 99	1	T				26 9	
O/C	MC	P15	42.129	40	P		22.0			
OVIS	MC	P15	31 85	2	P			12.6		
O/C	MC	P15	53.169	4	P		22 8			
OVIS	MC	P15	54.166	24	P	143 3	24.8	16 2		W
O/C	MC	P15	42.123	5	P		23 9			
O/C	MC	P15	42 123	4	P		22.3			
O/C	MC	P15	42 134	21	P		23.3			
O/C	MC	P15	43.134	24	P		22 8			
O/C	MC	P15	40 120	36	P				22 7	
OVIS	MC	P15	40 119	52	P			13.2	23 7	
OVIS	MC	P15	40 115	198	P				24.8	
OVIS	MC	P15	40 117	14	P			17 6	25 3	
OVIS	MC	P15	40 115	162	P				25 5	
OVIS	MC	P15	40.115	415	P			16,0	25.6	
CAPRA	MC	P15	40.116	14	P				27.0	
OVIS	MC	P15	40 115	507	P			19.9	28 0	W
CAPRA	MC	P15	40 116	6	P				28 9	W
Mean							23.4	14.7	25.6	
Std Dev							1.96	2.30	1.76	
Min.							21,0	12.2	22.1	
Max.							30.2	19.9	28.9	
N							19	13	22	

SPECIES	ELEM	SQ	NUM	SUB	FA	LA	LAR	
O/C	PELV	R13	14 41	3	E	23 6		
O/C	PELV	R13	9.82	53	E	24 1		
OVIS	PELV	Q13	33 72	3	E	25 1		
O/C	PELV	Q14	46 129	3	E	25 4	23 5	
O/C	PELV	Q13	74 223	21	E	26 9		
O/C	PELV	Q14	5 21	4	E	27 1	23 9	
O/C	PELV	R13	27 121	3	E	27 6		
O/C	PELV	Q14	8 31	1	E	28 7	26.2	
O/C	PELV	Q13	62 179	1	T	22 9		
O/C	PELV	R13	25 64	5	T	24 9		
O/C	PELV	P15	11 30	81	T	25 9	22 9	
O/C	PELV	P15	26 60	34	T	26 1	23.0	
O/C	PELV	Q14	23 65	11	T	26 3	22.3	
O/C	PELV	Q15	24.71	13	T	26.4	23 5	
OVIS	PELV	P15	22 45	3	T	26 7	23.9	
O/C	PELV	Q15	22.105	8	T	27 0	23 8	
O/C	PELV	P15	14 35	41	T	27.2	24.5	
O/C	PELV	P15	12.23	4	T	27 6	23 6	
O/C	PELV	P15	13 28	65	T	28.1	26 5	
OVIS	PELV	P15	13.26	35	T	28 7	25 0	
O/C	PELV	P15	16.38	31	T	29 4	25 7	
O/C	PELV	P14	8 140	1	T	29.7	26 2	
OVIS	PELV	P15	28.71	20	T	33 6	29.7	W
O/C	PELV	P15	40 115	152	P		25 4	
O/C	PELV	P15	55 168	2	P		25 4	
O/C	PELV	P15	42 134	33	P		25 7	
O/C	PELV	P15	42 134	32	P		25 8	
OVIS	PELV	P15	49 119	39	P		27 1	
OVIS	PELV	P15	40 120	1	P		27 4	
O/C	PELV	P15	49 157	3	P		27 4	
OVIS	PELV	P15	40 115	416	P		27 8	
O/C	PELV	P15	36 109	1	P		28 2	
O/C	PELV	P15	42 123	1	P		29 1	
OVIS	PELV	P15	42 129	53	P		29.3	
O/C	PELV	P15	42.129	57	P		29.3	
Mean						**26.9**	**25.7**	
Std Dev						**2.28**	**2.15**	
Min.						**22.9**	**25.4**	
Max.						**33.6**	**29.7**	
N						**23**	**12**	

SPECIES	ELEM	SQ	NUM	SUB	FA	BP	DC	SD	BD	
O/C	FEM	Q13	28 71	4	E		18 6			
O/C	FEM	Q13	75 228	1	E		19.5			
O/C	FEM	Q13	64 226	6	E		23.0			W
O/C	FEM	Q13	74 223	16	E				35 9	
OVIS?	FEM	P15	13.28	13	T				36 6	
OVIS?	FEM	P15	23 58	5	T				33 8	
O/C	FEM	P15	9.21	26	T				31 1	
O/C	FEM	P15	9 24	1	T	38 4	17 2			
O/C	FEM	Q14	27 127	1	T		17 4	21 4		
OVIS	FEM	P15	9 18	17	T		17 5			
O/C	FEM	P15	11 30	43	T		18 1			
O/C	FEM	P15	28 63	5	T		18 6		34 1	
OVIS	FEM	P15	26 73	4	T	41 8	18.7			
CAPRA	FEM	P15	9 24	4	T	37 6	18 8			
O/C	FEM	P15	13 28	11	T		19 4			
OVIS	FEM	P15	13 26	9	T	45 1	19 6			W?
OVIS	FEM	P15	35 106	30	T	43.2	19.7			
OVIS	FEM	P15	9 24	3	T	41.3	19 8			
OVIS	FEM	P15	13 27	65	T	41 2	19 8			
OVIS	FEM	P15	9 24	5	T		20.3			
O/C	FEM	P15	11.35	32	T		20 5			
OVIS	FEM	P15	9 24	2	T	42.7	21 0			
O/C	FEM	P15	40 115	17	P				33 9	
O/C	FEM	P15	40 121	16	P				34 6	
O/C	FEM	P15	36 109	5	P				34 9	
O/C	FEM	P15	40 116	8	P				36 2	
OVIS?	FEM	P15	35.106	15	P				36.5	
OVIS?	FEM	P15	35 106	14	P				43.1	W
O/C	FEM	P15	40 115	95	P		19 1			
O/C	FEM	P15	40 119	102	P		19 3			
O/C	FEM	P15	42 129	15	P		19 4			
O/C	FEM	P15	40 115	338	P		19 8			
O/C	FEM	P15	40 115	310	P		20.0			
O/C	FEM	P15	42 129	14	P		20 3			
Mean						**41.4**	**19.4**		**35.5**	
Std Dev						**2.46**	**1.25**		**2.98**	
Min.						**37.6**	**17.2**		**31.1**	
Max.						**45.1**	**23.0**		**43.1**	
N						**8**	**24**		**11**	

SPECIES	ELEM	SQ	NUM	SUB	FA	BP	SD	BD	DD	
O/C	TIB	Q13	49 160	12	E	36 4				
O/C	TIB	Q13	25 169	13	E			21.9	18 1	
O/C	TIB	P14	8 128	13	E			22.5		
O/C	TIB	Q14	11 55	11	E			23.3		
O/C	TIB	R13	2 88	12	E			23 4		
O/C	TIB	Q13	28 83	1	E			23 4	17.1	
O/C	TIB	Q13	43 128	8	E			24 1	18.8	
O/C	TIB	Q14	25 68	4	E			24 1		
O/C	TIB	Q14	6 17	1	E			24.3		
O/C	TIB	Q14	18 43	7	E			24.5		
O/C	TIB	Q13	54.139	6	E			24 7	19 6	
O/C	TIB	Q13	74 219	10	E			24 7		
O/C	TIB	Q14	5.32	18	E			24 8		
O/C	TIB	Q13	62 166	3	E			25.0	19 8	
O/C	TIB	Q14	17 53	2	E			25.5		
O/C	TIB	Q13	62.168	24	E			25 6	20 4	
O/C	TIB	Q14	1 8	5	E			26 1		
O/C	TIB	Q14	1 8	8	E			26.5		
O/C	TIB	Q13	45.134	1	E	43.9				w
O/C	TIB	Q14	30.101	9	T				21.4	
O/C	TIB	Q15	33.118	2	T	38 3				
O/C	TIB	P15	14.35	11	T	35 8				
O/C	TIB	P15	16 38	20	T			21.3	18 1	
O/C	TIB	Q15	17.24	17	T			23.0		
O/C	TIB	P15	17 42	7	T			23 5	18.1	
O/C	TIB	Q14	24.117	4	T			23.6		
O/C	TIB	P15	4 4	7	T			23 7	18 1	
O/C	TIB	P15	23.53	10	T		14,0	23 9	18.7	
O/C	TIB	P15	11 30	41	T		13 7	24 0	18.6	
O/C	TIB	P15	23.53	25	T		14.5	24 2	19.8	
O/C	TIB	P15	12.17	1	T		15,0	24 2	18.8	
O/C	TIB	P15	23.53	9	T			24.3	19 0	
O/C	TIB	P15	27 61	1	T			24.5	19 0	
O/C	TIB	P15	13.28	2	T			24.5	18 9	
O/C	TIB	P15	14.35	14	T		14.8	24 7	20.3	
O/C	TIB	Q15	22.105	12	T			24.9		
O/C	TIB	P15	28 70	6	T			25.0	19.8	
O/C	TIB	P15	28 66	4	T			25.3	19.9	
O/C	TIB	Q13	25.175	15	T		14 6	25 4	19 6	
O/C	TIB	P15	15.36	2	T			25.4	19 8	
O/C	TIB	P15	11 30	33	T			25 4	20.3	
O/C	TIB	P15	26 60	47	T			25.5	19 7	
O/C	TIB	P15	13 27	25	T			25.5	20.1	
O/C	TIB	P15	9 24	54	T			25 8	20.1	
O/C	TIB	Q15	17 24	19	T			26,0		
O/C	TIB	P15	23.59	18	T			26.1	20 5	
O/C	TIB	P15	13.26	7	T			26.2		
O/C	TIB	Q15	13 22	4	T			26.3		
O/C	TIB	P15	13 27	24	T			26 7	19 8	
O/C	TIB	P15	26 60	48	T			26.9	20 7	
O/C	TIB	P15	23.49	3	T			27,0	20 3	
O/C	TIB	Q15	22.88	4	T			27 1		
O/C	TIB	Q14	35.103	3	T			27.1		
O/C	TIB	P15	26 60	46	T		14 3	27 3	21.5	
O/C	TIB	Q15	17 84	11	T			27 4		
O/C	TIB	P15	9.24	22	T			27.6	21 1	
O/C	TIB	P15	24 50	3	T		15 6	27.7	21 9	
O/C	TIB	P15	35 106	29	P			24 9	20.5	
O/C	TIB	P15	35 103	12	P			26 1	19.6	
Mean								**25.0**	**19.7**	
Std Dev								**1.44**	**1.08**	
Min.								**21.3**	**17.1**	
Max.								**27.7**	**21.9**	
N								**54**	**34**	

SPECIES	ELEM	SQ	NUM	SUB	FA	GLL	BD	
O/C	ASTR	R13	21 46	1	E	24 5	15 9	
O/C	ASTR	Q14	4 6	1	E	24 5	16.2	
O/C	ASTR	R13	9.34	9	E	25.3	16 8	
O/C	ASTR	Q13	62 173	12	E	25 8	17 1	
O/C	ASTR	Q14	17.107	1	E	26.1	17 7	
O/C	ASTR	Q13	62.173	6	E	26 2	17.3	
O/C	ASTR	Q13	30 62	3	E	26 4	17 2	
O/C	ASTR	R13	9.82	11	E	26.8	17 3	
O/C	ASTR	Q13	75 221	7	E	26.9	17 7	
O/C	ASTR	Q13	12 18	3	E	27 4	18 4	
O/C	ASTR	R13	9 82	12	E	27 6	17 0	
O/C	ASTR	R13	9.82	3	E	28,0	18 1	
OVIS	ASTR	Q13	11 49	2	E	28,0	18 1	
O/C	ASTR	R13	9 34	5	E	28 7	17 8	
O/C	ASTR	R13	9 34	10	E		18 2	
O/C	ASTR	Q14	5.21	2	E	28.8	18 5	
O/C	ASTR	Q13	43.197	3	E	28.9	18 7	
O/C	ASTR	Q13	75 221	10	E	29 3	19 2	
O/C	ASTR	R13	9 22	3	E	29.4	19 0	
O/C	ASTR	Q14	17 107	3	E	30 9	19 3	
OVIS	ASTR	Q13	30 85	8	E	33 3	21.1	W
O/C	ASTR	Q15	18 90	7	T		18 0	
O/C	ASTR	Q15	20.42	1	T		17 5	
OVIS	ASTR	P15	9 21	9	T		19 4	
OVIS	ASTR	P15	11.30	25	T	25.3	16 5	
OVIS	ASTR	P15	13.27	14	T	25.7	16 4	
O/C	ASTR	P15	9 18	5	T	25.9	16 4	
O/C	ASTR	Q13	25 175	18	T	26.0	17 5	
O/C	ASTR	Q14	35 103	2	T	26.6	17 0	
OVIS	ASTR	P15	13 27	15	T	26 6	17 8	
OVIS	ASTR	P15	16 38	2	T	26 8	17 8	
OVIS	ASTR	P15	13 28	42	T	27,0	17 5	
O/C	ASTR	Q15	17 87	1	T	27 2	18.3	
O/C	ASTR	Q15	17.24	21	T	27 4	17.9	
O/C	ASTR	P14	28.117	5	T	27.6	18 3	
O/C	ASTR	P14	32.149	3	T	27.7	18 2	
OVIS	ASTR	P15	11.30	26	T	27.8	18 0	
OVIS	ASTR	P15	11 25	32	T	27 8	17.5	
O/C	ASTR	Q15	22.52	1	T	28.3	18 5	

O/C	ASTR	Q15	18 34	6	T	28 3	18.7
O/C	ASTR	P15	11 30	39	T	28 6	19.5
O/C	ASTR	Q15	7 13	4	T	28 7	18.3
OVIS	ASTR	P15	9.24	64	T	29.1	
O/C	ASTR	Q15	31 115	8	T	29.3	18 7
OVIS	ASTR	P15	11 22	11	T	29.3	18 0
O/C	ASTR	P14	18 95	2	T	29.9	19.7
O/C	ASTR	P14	31 136	4	T	30 8	20 4
O/C	ASTR	Q15	31 115	7	T	31 6	20 7
O/C	ASTR	P15	43 130	6	P	25 4	17.0
O/C	ASTR	P15	40 120	46	P	25 8	16.7
O/C	ASTR	P15	35 106	7	P	26.2	17 4
OVIS	ASTR	P15	40 118	57	P	26 5	16 7
OVIS	ASTR	P15	40 115	510	P	26.8	17 6
CAPRA	ASTR	P15	40 114	157	P	26.9	17.1
O/C	ASTR	P15	35 106	9	P	27 0	
O/C	ASTR	P15	40.114	30	P	27 1	17.6
OVIS	ASTR	P15	40.115	464	P	27 3	17.2
CAPRA	ASTR	P15	40.114	90	P	27 3	17.3
OVIS	ASTR	P15	40 115	509	P	27 7	18 2
OVIS	ASTR	P15	40.115	466	P	27.8	18 4
OVIS	ASTR	P15	49 163	25	P	28,0	17 1
OVIS	ASTR	P15	40 116	13	P	28 1	19 0
OVIS	ASTR	P15	40 115	463	P	28.5	19.0
OVIS	ASTR	P15	40.114	137	P	28.7	20.0
OVIS	ASTR	P15	40 115	462	P	28.8	19.4
OVIS	ASTR	P15	40.115	508	P	30.0	18.9
Mean						27.7	18.0
Std Dev						1.68	1.09
Min.						24.5	15.9
Max.						33.3	21.1
N						62	64

SPECIES	ELEM	SQ	NUM	SUB	FA	GL	GB
O/C	CALC	R13	14 41	2	E		22 1
O/C	CALC	Q14	17.107	6	E	52 8	18.4
OVIS	CALC	Q13	62 173	2	E	55 8	20 4
O/C	CALC	Q15	17 84	15	T		20 0
OVIS	CALC	P15	15.37	19	T	50 9	17.7
OVIS	CALC	P15	13 27	20	T	51 4	18 9
OVIS	CALC	P15	13 26	10	T	52.1	17.4
OVIS	CALC	P15	13 28	36	T	53 7	18 2
OVIS	CALC	P15	16 38	5	T	54.0	18 7
OVIS	CALC	P15	13 27	19	T	54 1	18.7
OVIS	CALC	Q13	25 175	23	T	54.5	
O/C	CALC	Q14	36.104	1	T	54 9	17 8
OVIS	CALC	P15	13 27	22	T	56 5	18 5
OVIS	CALC	P15	11 30	29	T	56 6	18 8
OVIS	CALC	P15	13.27	21	T	57 6	19.0
OVIS	CALC	P15	9.24	82	T	58 8	21 5
O/C	CALC	P14	32 147	2	T	59 2	20 5
OVIS	CALC	P15	11.30	30	T	59 8	23.6
OVIS	CALC	P15	28 71	18	T	63 4	22 1
OVIS	CALC	P15	40 115	173	P		19 9
OVIS	CALC	P15	40 115	465	P	55 6	17.8
OVIS	CALC	P15	35 102	10	P	56 2	20 3
OVIS	CALC	P15	31 92	7	P	57 1	19.9
OVIS	CALC	P15	40 116	24	P	59 6	20 9
Mean						55.9	19.6
Std Dev						3.11	1.63
Min.						50.9	17.4
Max.						63.4	23.6
N						21	23

SPECIES	ELEM	SQ	NUM	SUB	FA	GL	BP	SD	BD	
O/C	MT	Q13	10.16	1	E		18.9		22 4	
O/C	MT	P15	13 27	30	T		18 2			
O/C	MT	P15	13 28	45	T		18 8			
O/C	MT	P15	14 35	26	T		19 2			
O/C	MT	P15	11 25	11	T		19 6	10 6		
O/C	MT	P15	11 25	8	T		19 7			
O/C	MT	P15	14 35	27	T		20.2	11 0		
O/C	MT	P15	26.73	6	T		20 2			
O/C	MT	P15	23 58	54	T		20 7	10.8		
O/C	MT	P15	11 33	18	T		21 3			
O/C	MT	P15	9 21	8	T		22,0			
O/C	MT	P15	9 24	16	T		22.2			
OVIS	MT	P15	13 28	47	T				21.5	
OVIS	MT	P15	9 24	11	T				21 5	
O/C	MT	P15	11 31	2	T				21.5	
OVIS	MT	P15	13 27	29	T				21 6	
OVIS	MT	P15	13.27	26	T				21 6	
OVIS	MT	P15	14.35	23	T				21 7	
O/C	MT	Q13	65 182	2	T				22.3	
OVIS	MT	P15	9 24	19	T				22 6	
O/C	MT	Q13	25 175	19	T				22 9	
OVIS	MT	Q15	22 52	2	T				23.5	
CAPRA	MT	P15	13.27	27	T				23.5	
CAPRA	MT	P15	23.58	6	T				24.4	
OVIS	MT	Q15	13 25	5	T				24.5	
O/C	MT	P15	40.115	10	P		20.8			
OVIS	MT	P15	40.120	28	P	139.7	20.0	10 5	22.0	
OVIS	MT	P15	54 162	162	P	135,0	19 6	11 1	22 1	
OVIS?	MT	P15	40 115	428	P				22 1	
OVIS	MT	P15	40 120	30	P				22.2	
OVIS	MT	P15	40 121	27	P	141.4	19.8	11.8	22 8	
OVIS	MT	P15	40 119	104	P	142 3	20 0	10.3	23.2	
OVIS	MT	P15	40.116	4	P				23.3	
OVIS?	MT	P15	40.116	2	P			11 0	23 4	
OVIS?	MT	P15	54.162	4	P				24.4	
OVIS	MT	P15	40 115	417	P				24 5	
OVIS?	MT	P15	40 116	3	P			14 2	26.3	W
Mean							20.1	11.2	22.9	
Std Dev							1.07	1.18	1.23	
Min.							18.2	10.5	22.0	
Max.							22.2	14.2	26.3	
N							17	9	25	

SPECIES	ELEM	SQ	NUM	SUB	FA	GL	BP	SD	BD	
O/C	PH1	Q13	54.198	4	E		10.4	9.0	10 1	
O/C	PH1	Q13	76.222	3	E		10.9	9 1	10 8	
O/C	PH1	P14	8.72	5	E		12.2	9.4		
O/C	PH1	Q14	1.8	14	E	32 9	10.4	8.9	10.8	
O/C	PH1	P14	8 72	10	E	33.2	10.8	8.6	10.5	
O/C	PH1	R13	13 48	1	E	33.2	11 0	9.6	11 1	
O/C	PH1	Q13	57.152	2	E	33 5	11 2	8.4	10.0	
O/C	PH1	P14	8 116	1	E	34.4	11 8	8.8	11 0	
O/C	PH1	P14	8.140	7	E	34 6	11 2	8.7	10.8	
O/C	PH1	Q13	64 227	2	E	34.9	13 1	11.6	12 7	
O/C	PH1	P14	8 128	1	E	35 2	10.7	7 9	10.1	
O/C	PH1	P14	15.39	15	E	35.5	10 1	8.1	9.5	
O/C	PH1	Q13	47 193	1	E	35.6	10 6	8.3	9 9	
O/C	PH1	P14	8.72	8	E	35 8	12 4	10 2	12.4	
O/C	PH1	P14	8.72	3	E	35.9	11 9	9.7	11 9	
O/C	PH1	P14	8 140	14	E	36,0	10.6	8 0	10.3	
O/C	PH1	P14	8 72	2	E	36.1	11 7	10.1	12.0	
O/C	PH1	Q13	47 111	1	E	36 5	11 4	9 9		
O/C	PH1	P14	8 128	4	E	36.6	13 3	11,0	14 2	W
O/C	PH1	P14	13.87	8	E	36 7	11 5	8.9	11 0	
O/C	PH1	Q14	1 8	10	E	37 2	12.2	9 2	11 6	
O/C	PH1	Q14	23.77	4	E	37 2	11.4	8 8	11.1	
O/C	PH1	P14	8.128	2	E	37 3	12.4	9 1	11.2	
O/C	PH1	P14	8.128	8	E	38 3	11.9	8.8	10.4	
O/C	PH1	P15	9 21	28	T		12 6	10 5		
O/C	PH1	P15	9 21	30	T		12 3			
O/C	PH1	P15	13 28	40	T	29.9	11 2	9 0	11.0	
O/C	PH1	P15	13 27	17	T	31 6	11.4	9 5	10.5	
O/C	PH1	Q15	7.13	2	T	32 2	9 7	11 8	11 1	
O/C	PH1	P15	9.24	73	T	32 7	9.9	7 8	9 8	
O/C	PH1	P15	13 27	9	T	33 1	10.6	8.7	10.5	
O/C	PH1	Q15	22.52	3	T	33.4	10 9	7.7	10 5	
O/C	PH1	Q13	25.175	14	T	33.5	10 7	8.6	9 5	
O/C	PH1	P15	23.53	29	T	33 5	11 0	8.6	11 0	
O/C	PH1	P15	11 30	27	T	34,0	11 3	7.9	10.2	
O/C	PH1	Q15	19 103	9	T	34.1	8 8	10.6	10 4	
O/C	PH1	P15	9 21	33	T	34 2	10.6	8,0	9.8	
O/C	PH1	P15	9 18	6	T	34 4	10 7	8 8	10 1	
O/C	PH1	Q15	19 43	9	T	34 5	11 4	9 2	11 1	
O/C	PH1	P15	11 25	36	T	34.6	11 8	9.6	10 9	
O/C	PH1	P15	11 25	35	T	34 6	11 9	9.4	11.1	
O/C	PH1	P15	15 37	20	T	34 7	10.4	8 2	10.4	
O/C	PH1	P15	9 24	70	T	34.8	12.0	9.2	10 5	
O/C	PH1	P15	14.35	33	T	34.9	12.5	9.2	11 9	
O/C	PH1	P15	13.26	15	T	34.9	12 0	10.6	12 1	
O/C	PH1	P15	9.24	71	T	35,0	11 1	8.9	10.2	
O/C	PH1	P15	9.18	3	T	35.1	13 2	11,0	12 7	
O/C	PH1	P15	11 25	37	T	36.2		11.7		
O/C	PH1	P15	10.15	19	T	36.2	11.9	8 6	11 6	
O/C	PH1	P14	32.157	16	T	36.8	12 9	9.2	11 6	
O/C	PH1	P15	11 25	34	T	37 2	12.1	9 2	11.1	
O/C	PH1	Q15	27 110	8	T	37.7	14 1	11.9	13 4	W
O/C	PH1	P15	23.59	6	T	38,0	12.5	11.3		
O/C	PH1	Q15	28 100	3	T	38 2	12 5	9.7	12 4	
O/C	PH1	P15	9.24	65	T	38 4	12 9	9 5	11 6	
O/C	PH1	Q15	22.105	4	T	38.4		9 3	11 4	
O/C	PH1	P14	28 118	28	E	40.5	12 7	10 5	11.5	W
O/C	PH1	P15	35 105	29	P		11 4	9.6		
O/C	PH1	P15	40.115	104	P	32.4	12 2	9 3	10 5	
CAPRA	PH1	P15	40 118	64	P	34 2	12 9	11 1	13 1	
OVIS	PH1	P15	40 119	103	P	34.8	11 8	9.0	11 1	
O/C	PH1	P15	40 114	33	P	36 6	10 6	8 7	10 0	
O/C	PH1	P15	42.129	22	P	38 2	11 6	9.2	11 2	
OVIS	PH1	P15	40.119	30	P	38.6	12 8	10 9	12 6	
OVIS	PH1	P15	40 119	110	P	38 7	11 6	9 4	11 5	
Mean						35.4	1.6	9.4	11.1	
Std Dev						2.06	0.99	1.05	0.99	
Min.						29.9	8.8	8.1	9.5	
Max.						40.5	13.3	11.9	14.2	
N						59	63	64	58	

SPECIES	ELEM	SQ	NUM	SUB	FA	GL	BP	SD	BD
O/C	PH2	Q13	30 62	8	E		10 5	8 0	
OVIS	PH2	Q13	55 199	3	E	20 9	12.7	10 2	10 1
O/C	PH2	Q13	33 76	2	E	21 1		9 0	
O/C	PH2	Q13	30 62	15	E	21 6	13.1	10 1	10 0
O/C	PH2	Q13	64 227	3	E	22 1	12.8	9.7	10 6
O/C	PH2	Q13	62.173	3	E	22 8	10 8	8.0	9 0
O/C	PH2	Q15	11 23	8	T	18 7	11 0	7 9	8 4
O/C	PH2	Q13	62 179	3	T	20.6	10 7	8 2	
O/C	PH2	Q15	27 110	7	T	20 6	11 4	9 1	9 2
O/C	PH2	Q15	22.105	3	T	21 5	10 7	8 0	8 8
O/C	PH2	P15	9 24	72	T	21 7	9.8	6 9	8.2
O/C	PH2	P15	13.27	10	T	22 3	10 5	8 1	9 3
O/C	PH2	P15	9 24	69	T	23 8	10.6	7.4	8 8
O/C	PH2	P15	9 24	66	T	24.4	12 0	8.9	9 5
O/C	PH2	P15	9 24	76	T		11 5	8 1	
O/C	PH2	P15	40 119	31	P	21 0	11 7	8.8	9 6
O/C	PH2	P15	35.105	30	P	21 3	10 8	7 7	8 7
O/C	PH2	P15	40 115	405	P	22 1	10 7	7 3	8 5
O/C	PH2	P15	40 115	113	P	24 0	13.3	10 1	10.9
O/C	PH2	P15	40.114	103	P	24 5	10.6	8 7	9 7
O/C	PH2	P15	40 115	165	P	24 7	13 6	10 1	10 0
Mean						22.1	11.4	8.6	9.4
Std Dev						1.60	1.11	1.00	0.77
Min.						18.7	9.8	7.3	8.2
Max.						24.7	13.6	10.2	10.9
N						19	20	21	17

SPECIES	ELEM	SQ	NUM	SUB	FA	GB	DLS
O/C	PH3	P15	9 24	77	T		25 3
O/C	PH3	P15	9 24	74	T		27.9
O/C	PH3	P15	11 25	41	T		27 9
O/C	PH3	P15	11 25	42	T		28 6
O/C	PH3	P15	9 24	75	T		28.9
O/C	PH3	P15	9.24	67	T		29 9
O/C	PH3	P15	9 24	68	T		31,0
O/C	PH3	P15	15 37	21	T		32.3
O/C	PH3	P15	9 21	32	T		33 9
OVIS?	PH3	P15	40 116	134	P	9 6	29 5
Mean							29.5
Std Dev							2.44
Min.							25.3
Max.							33.9
N							10

BOS: measurements

SPECIES	ELEM	SQ	NUM	SUB	FA	L	B	
BOS	M3I	R13	22.100	3	E	35 9	13 4	
BOS	M3I-	Q13	49 160	2	E	35 9	12.5	
BOS	M3I-	R13	10 15	6	E	36 9	13 6	
BOS	M3I	P15	26.64	3	T	33.7	11 2	
BOS	M3I-	Q14	6 10	1	T	35 7	13.7	
BOS	M3I	P14	32 147	9	T	35.9	12 8	
BOS	M3I-	Q15	20.41	1	T	36 6	11 3	
BOS	M3I	Q15	18.90	4	T	38 2	15 0	
BOS	M3I	Q15	17 48	2	T	38 4	13 9	
BOS	M3I	P15	10 13	6	T	39.9	15 2	
BOS	M3I	Q15	21.46	1	T	40.9	14.9	
BOS	M3I	Q14	5.19	2	T	46 2	15 6	W
BOS	M3I	P15	40 116	107	P	36.9	15 0	
BOS	M3I	P15	40 115	278	P	39.0	13.7	
BOS	M3I	P15	54 166	49	P	39 4	15 4	
Mean						30.0	13.8	
Std Dev						2.97	1.41	
Min.						33.7	11.2	
Max.						46.2	15.6	
N						20	15	

SPECIES	ELEM	SQ	NUM	SUB	FA	LCDE	BFCR
BOS	AXIS	P15	46 137	1	P		94 4

SPECIES	ELEM	SQ	NUM	SUB	FA	HS	SLC	GLP	LG	
BOS	SCAP	P15	23 58	22	T		55 9	71.4	61 1	
BOS	SCAP	R13	28.103	1	T		69 1	82 8	70 4	W?

SPECIES	ELEM	SQ	NUM	SUB	FA	BD	BT	
BOS	HUM	R13	9 82	23	E	84 2	72.7	
BOS	HUM	Q14	11 76	1	T		61 1	
BOS	HUM	P15	28.63	1	T	73.9	71 0	
BOS	HUM	Q13	25 175	21	T	86 4	75 9	
BOS	HUM	P15	23 59	1	T	85.0	78.0	
BOS	HUM	P15	43 130	13	P	82 0	75.8	
BOS	HUM	P15	54 166	18	P	108.0	88 7	W
BOS	HUM	P15	42 129	24	P	106 1	94 4	W
Mean						89.4	77.2	
Std Dev						12.75	10.35	
Min.						73.9	61.1	
Max.						108	94.4	
N						7	8	

SPECIES	ELEM	SQ	NUM	SUB	FA	BP	BD
BOS	RAD	P15	23.58	17	T		73 2
BOS	RAD	P15	13.32	3	T		73.2
BOS	RAD	P15	26 60	54	T		74 2
BOS	RAD	P15	40 119	84	P	98 5	

SPECIES	ELEM	SQ	NUM	SUB	FA	LO	SDO
BOS	ULNA	Q15	27 110	2	T	93 0	54 9

SPECIES	ELEM	SQ	NUM	SUB	FA	GL	BP	SD	BD	
BOS	MC	Q14	17 100	6	E				64 0	
BOS	MC	P15	14 35	1	T	200.2	59 2	33,0	59.7	
BOS	MC	P15	13 28	7	T				59 9	
BOS	MC	P15	23 56	9	T				60 2	
BOS	MC	Q14	26 95	2	T				66 2	
BOS	MC	P15	23 58	16	T				73 7	W
BOS	MC	P15	40 116	32	P			44.3	73 2	W
BOS	MC	P15	49.163	10	P		80 8			W
Mean									65.3	
Std Dev									6.08	
Min.									59.7	
Max.									73.7	
N									7	

SPECIES	ELEM	SQ	NUM	SUB	FA	LA	LAR
BOS	PELV	P15	13.28	22	T	69 4	53 7

SPECIES	ELEM	SQ	NUM	SUB	FA	DC
BOS	FEM	P15	26.60	15	T	53 5
BOS	FEM	P15	19 11	6		47.4

SPECIES	ELEM	SQ	NUM	SUB	FA	BD	
BOS	TIB	Q14	17.87	14	E	65.5	
BOS	TIB	P15	13 27	57	T	60 3	
BOS	TIB	P15	26 64	4	T	60 8	
BOS	TIB	P15	27.65	3	T	61.9	
BOS	TIB	P15	9 24	20	T	65.9	
BOS	TIB	P15	17 42	13	T	69 8	W
BOS	TIB	P15	16 38	22	T	71 5	W
BOS	TIB	P15	14.35	2	T	73.3	W
Mean						66.1	
Std Dev						4.99	
Min.						60.3	
Max.						73.3	
N						8	

SPECIES	ELEM	SQ	NUM	SUB	FA	GLL	BD	
BOS	ASTR	Q14	1.1	2	E	70.8	45.5	
BOS	ASTR	Q13	44.107	1	E		45.4	
BOS	ASTR	P15	13.27	56	T	65 2	42.8	
BOS	ASTR	Q15	21.46	2	T	67 3	45.9	
BOS	ASTR	P15	26.60	50	T	69 8	45.3	
BOS	ASTR	P15	26 73	12	T	70 9		
BOS	ASTR	Q15	18.90	1	T	74 8	48.7	
BOS	ASTR	P15	14.35	8	T	78 8	52.9	W?
BOS	ASTR	P15	31 92	12	P	66.2	43 9	
BOS	ASTR	P15	33.96	3	P	70.8	43 1	
BOS	ASTR	P15	40.115	99	P	71.6	45 1	
BOS	ASTR	P15	46.149	2	P	72 6	49.2	
BOS	ASTR	P15	40 115	100	P	73 9	43 8	
BOS	ASTR	P15	40 115	280	P	75 1	46.7	
BOS	ASTR	P15	54.166	14	P	76 7	47.6	
BOS	ASTR	P15	40 121	28	P	79.6	55 0	W?
Mean						72.3	46.8	
Std Dev						4.29	3.5	
Min.						65.2	42.8	
Max.						79.6	55	
N						15	15	

SPECIES	ELEM	SQ	NUM	SUB	FA	GL	GB
BOS	CALC	P15	9 24	24	T	152.1	54 6
BOS	CALC	Q15	22.76	5	T	151.4	53 4

SPECIES	ELEM	SQ	NUM	SUB	FA	GL	
BOS	CENTRO	Q14	17 50	7	E	64 4	
BOS	CENTRO	Q14	17 41	16	E	71 7	
BOS	CENTRO	P15	23.58	46	T	58 6	
BOS	CENTRO	Q14	30 8	8	T	60.8	
BOS	CENTRO	P15	36 108	9	P	54 3	
BOS	CENTRO	P15	40.117	58	P	71.2	W
Mean						63.5	
Std Dev						6.97	
Min.						58.6	
Max.						71.7	
N						6	

SPECIES	ELEM	SQ	NUM	SUB	FA	BP	SD	BD	
BOS	MT	Q14	6 10	4	E			56.4	
BOS	MT	P15	8 11	6	T			61 3	W?
BOS	MT	P15	49 163	55	P			54 9	
BOS	MT	P15	31 95	7	P			56 7	
BOS	MT	P15	40 119	68	P			64 1	W
BOS	MT	P15	40 116	33	P		39 0	64 9	W
BOS	MT	P15	37 110	1	P	46 6			
BOS	MT	P15	49 163	66	P	48.3			
Mean								59.7	
Std Dev								4.29	
Min.								56.4	
Max.								64.9	
N								6	

SPECIES	ELEM	SQ	NUM	SUB	FA	GL	BP	SD	BD	
BOS	PH1	Q13	5 7	2	E			23 7	26 5	
BOS	PH1	Q13	59 212	3	E		28 3			
BOS	PH1	Q14	1 1	1	E	61 7	32.6	26 9	30 2	
BOS	PH1	R13	22 100	5	E	61 1	32 7	26 8	28 8	
BOS	PH1	Q14	22 61	3	E	63 3	33 0		30.8	
BOS	PH1	R13	16.59	2	E	60.0	33 4	30 2	34 3	
BOS	PH1	Q14	17 75	15	E	67.5	37.9	33 9		W
BOS	PH1	Q14	17 41	6	E	69 2	38 1	32 1	36 6	W
BOS	PH1	P15	26 60	20	T	62 3	27 3	24 6	28.6	
BOS	PH1	P15	14 35	3	T	58 8	28 1	24 0	27 5	
BOS	PH1	Q15	18.30	5	T		29 2	26.2		
BOS	PH1	P15	13.20	8	T		31 2			
BOS	PH1	P15	23 58	48	T	61.0	32.2	27 8		
BOS	PH1	Q14	30 98	1	T	60 0	32 9	27 9	31 5	
BOS	PH1	P15	27 65	5	T		34.6	28 3	30.1	
BOS	PH1	P15	23.46	5	T		35 2			
BOS	PH1	P15	26.60	52	T	68.5	35 9	31 4	35 9	
BOS	PH1	P15	9 21	34	T	73 9	40 6	35 6	40.2	W
BOS	PH1	Q14	30 93	12	T	64 3		25.1	25 8	
BOS	PH1	P15	9.24	25	T	73.0		35 8	38 7	W
BOS	PH1	P15	23 58	45	T			26 8	28.2	
BOS	PH1	P15	26 64	8	T			26 2	29.3	
BOS	PH1	P15	40 115	194	P		25.3			
BOS	PH1	P15	40.117	29	P		30.4			
BOS	PH1	P15	40 115	191	P		30.6			
BOS	PH1	P15	40 119	67	P		30 7			
BOS	PH1	P15	49 163	57	P	63 8	31 4	27 4	30 2	
BOS	PH1	P15	40 120	15	P		32.4			
BOS	PH1	P15	40 115	16	P		32 8			
BOS	PH1	P15	40.115	291	P	70 1	35.7	31 5	34 5	W
BOS	PH1	P15	31 95	5	P	66 7	36 3	29.9	33 6	
BOS	PH1	P15	49 163	2	P		36 9			W
BOS	PH1	P15	53.169	7	P	69 8	37 8	33 4		W
BOS	PH1	P15	53 169	5	P	73 1	39 5	32.9	38 7	W
BOS	PH1	P15	40 115	105	P				29 6	
BOS	PH1	P15	30 81	10	P				29 8	
BOS	PH1	P15	42 134	16	P			26.6	31 8	
BOS	PH1	P15	40.117	45	P			28.9	32 1	
Mean						65.7	33.2	30.0	31.8	
Std Dev						4.89	3.77	3.54	3.96	
Min.						60.0	28.1	24.0	25.8	
Max.						73.9	40.6	35.6	40.2	
N						19	29	25	24	

SPECIES	ELEM	SQ	NUM	SUB	FA	GL	BP	SD	BD	
BOS	PH2	P14	8 72	28	E	40.7	30 7	25 5	26 5	
BOS	PH2	Q14	7 44	38	E	41 6	29 2	23 6	24 0	
BOS	PH2	Q14	17 75	14	E	43 2	32 7	27 2	28 0	
BOS	PH2	Q15	32 113	3	E	44 5				
BOS	PH2	Q13	33 76	1	E	45 6	31 8	27.7	27 1	
BOS	PH2	Q14	17 41	7	E	46 0			31 6	
BOS	PH2	Q14	17 100	12	E	46 2	32 2	27 4	29 1	
BOS	PH2	Q14	25 68	5	E		34 1	30.3		
BOS	PH2	P15	23 59	6	T	35 9	28 2	23 0		
BOS	PH2	P15	26 60	19	T		30 8	24 8		
BOS	PH2	R13	25 64	3	T	41 8	29 0	23 9	24 9	
BOS	PH2	P14	32 149	14	T	40.8	29.3	23 7	25.2	
BOS	PH2	P15	11 35	1	T	43 1	29 1	24 5	25.5	
BOS	PH2	P15	23 56	11	T	41.9	29 9	24 2	25 7	
BOS	PH2	R13	25 64	2	T	42.5	28 7	25 1	25 9	
BOS	PH2	Q15	18.53	2	T		30 6	26 0	28 0	
BOS	PH2	P15	9.24	26	T	41 7	34 2	28.3	29.2	
BOS	PH2	P15	14 35	4	T	39 2	33.4	27.8	29.9	
BOS	PH2	P15	26.64	9	T	46.0	35.5	29 5	29 9	
BOS	PH2	P15	26.64	9	T	46 4	35.2	30.0	30 2	
BOS	PH2	P15	11.33	42	T		33 4	28 3	30.3	
BOS	PH2	P15	27.65	6	T	43.1	34 1	29.2	30.9	
BOS	PH2	P15	23 59	5	T		38.2	31 1	31 8	
BOS	PH2	P15	11 25	19	T			30 3	32.2	
BOS	PH2	P15	9 21	36	T	53 4	35.2	40 5	38.3	W
BOS	PH2	P15	35 103	9	P	44 5	29.3	23 2	23.9	
BOS	PH2	P15	40.115	106	P	43 0	29 7	24.3	25 0	
BOS	PH2	P15	31 92	13	P	43 0	30.1	25 0	24.7	
BOS	PH2	P15	40.114	134	P	43.7	31 8	25.1	25.2	
BOS	PH2	P15	40 120	14	P	40.0	31 9	27.3		
BOS	PH2	P15	40 114	132	P	48.7	32.6	26 7	26.7	
BOS	PH2	P15	49 163	56	P	45.4	32.8	26 3	26.6	
BOS	PH2	P15	35.106	16	P	44.7	32 9	28.4	28 4	
BOS	PH2	P15	56 173	14	P		34 0	28.2		
BOS	PH2	P15	40 115	207	P				32.2	W?
BOS	PH2	P15	40 115	40	P	48.3	37.7	31 2	32 3	W
BOS	PH2	P15	40 117	34	P	46.6	37 9	32 6	36.5	W
BOS	PH2	P15	49 163	60	P	47 4	38.5	32 9	36.9	W
BOS	PH2	P15	54 162	14	P		38 8			W
Mean						44.0	32.7	27.5	28.8	
Std Dev						3.34	3.06	3.54	3.79	
Min.						35.9	28.2	23,0	23.9	
Max.						53.4	38.8	40.5	38.3	
N						30	35	35	32	

SPECIES	ELEM	SQ	NUM	SUB	FA	DLS	
BOS	PH3	Q14	12 35	2	E	66.4	
BOS	PH3	P15	26 60	21	T	65.4	
BOS	PH3	P15	23 53	7	T	66 1	
BOS	PH3	P15	24 48	6	T	68.3	
BOS	PH3	P15	13.26	8	T	70.5	
BOS	PH3	P15	14 35	6	T	71 8	
BOS	PH3	P15	15 37	16	T	72 3	
BOS	PH3	P15	9 24	30	T	72 8	
BOS	PH3	P15	23 58	47	T	80 5	W
BOS	PH3	P15	26.60	55	T	82.1	W
BOS	PH3	P15	40.121	41	P	63.2	
BOS	PH3	P15	40 121	21	P	68 6	
BOS	PH3	P15	40 115	195	P	69.0	
BOS	PH3	P15	31 100	4	P	80.1	W
BOS	PH3	P15	35.104	2	P	96.8	W
Mean						72.9	
Std Dev						8.73	
Min.						63.2	
Max.						96.8	
N						15	

SUS: measurements

SPECIES	ELEM	SQ	NUM	SUB	FA	LM3	BM3	
SUS	MAND	P15	18 43	10	T	39.3	16 3	W

SPECIES	ELEM	SQ	NUM	SUB	FA	L	B
SUS	M3S	Q14	16.46	1	E	30 1	17.0
SUS	M3S-	Q13	55 199	10	E	31 6	18 2
SUS	M3S-	Q15	18 82	11	T		18 6
SUS	M3S-	Q15	18.93	5	T	28 3	18.1
SUS	M3S	Q13	48 176	3	T	34.8	21 3

SPECIES	ELEM	SQ	NUM	SUB	FA	SLC	GLP	LG	BG
SUS	SCAP	R13	9.14	38	E	24 1	32 0	26.6	21 0
SUS	SCAP	P15	28.62	2	T	23 1	35.7	29.5	23.4
SUS	SCAP	Q15	7 13	1	T	22 5	35.2	28 2	24.8
SUS	SCAP	P15	30.80	16	P	24 1	34 5		

SPECIES	ELEM	SQ	NUM	SUB	FA	BD	BT	
SUS	HUM	Q14	17 75	12	E	39.7		
SUS	HUM	P15	31 95	8	P	37.8		
SUS	HUM	P15	40 118	80	P	56 4	46.9	W

SPECIES	ELEM	SQ	NUM	SUB	FA	BP
SUS	RAD	Q13	30.62	4	E	27.5
SUS	RAD	Q14	17.47	10	E	28.2
SUS	RAD	P15	23.53	48	T	31.9
SUS	RAD	P15	35 102	8	P	28.0

SPECIES	ELEM	SQ	NUM	SUB	FA	GL	BP	SD	BD
SUS	MC4	P15	28 70	5	T	72 2	16 1	13.1	16 6

SPECIES	ELEM	SQ	NUM	SUB	FA	LA	LAR	SH	SB
SUS	PELV	Q13	64.177	2	E	29.5	26 1		
SUS	PELV	P15	14 35	40	T	36 5	32 2	20.9	11 5

SPECIES	ELEM	SQ	NUM	SUB	FA	BD
SUS	TIB	Q15	13 22	9	T	30.4
SUS	TIB	P15	56 173	7	P	29 8

SPECIES	ELEM	SQ	NUM	SUB	FA	GH	GLL	BD
SUS	ASTR	R13	14 41	1	E	36.6	41 0	22 3
SUS	ASTR	R13	5 10	2	E		39 0	
SUS	ASTR	Q13	75 221	6	E	39 1	42 5	25.3
SUS	ASTR	P15	23 57	5	T	37 7	42 5	24.3
SUS	ASTR	P15	26 74	2	T	36 1		24 7

SPECIES	ELEM	SQ	NUM	SUB	FA	GL	BP	SD	BD
SUS	PH1	Q14	16 39	1	E	36 5	17.2	13 7	16.2
SUS	PH1	R13	9 34	11	E	21 0	14 1	12.1	13 0
SUS	PH1	P15	14 35	30	T	38 4	18.3	14.5	16 9
SUS	PH1	Q14	30 98	12	T	35.5		13 3	14.9

SPECIES	ELEM	SQ	NUM	SUB	FA	GL	BP	SD	BD
SUS	PH2	Q15	18 34	14	T	23 6	16 5	13 6	15 2
SUS	PH2	P14	8 122	13	E	23 7	17 4	15.4	16 7

SPECIES	ELEM	SQ	NUM	SUB	FA	GL	GB	DLS
SUS	PH3	Q14	17 75	32	E			29.7
SUS	PH3	P15	11 33	30	T	32 5	14.0	30 3
SUS	PH3	P15	40 118	133	P			30 3
SUS	PH3	P15	40 119	94	P		15 4	32.7

EQUUS: measurement

SPECIES	ELEM	SQ	NUM	SUB	FA	LG	BG
EQUUS	SCAP	Q15	13 22	11	E	46.6	35 7
EQUUS	SCAP	P15	23.58	33	T	41 0	35.0

SPECIES	ELEM	SQ	NUM	SUB	FA	BD	BFD
EQUUS	RAD	P15	27.65	13	T	62 5	54 5

SPECIES	ELEM	SQ	NUM	SUB	FA	SDO
EQUUS	ULNA	Q15	27 110	1	T	40 6

SPECIES	ELEM	SQ	NUM	SUB	FA	BD
EQUUS	MC	P15	26 64	3	T	37 9

SPECIES	ELEM	SQ	NUM	SUB	FA	BP	DC
EQUUS	FEM	P15	29 78	2	T	91 2	43 6

SPECIES	ELEM	SQ	NUM	SUB	FA	BD	DD
EQUUS	TIB	Q14	22 64	15	E	56 4	
EQUUS	TIB	Q15	13 25	3	T	55 0	
EQUUS	TIB	P15	23 58	32	T	57 0	41 5
EQUUS	TIB	P15	23 58	27	T	57 6	38 2
EQUUS	TIB	P15	29 78	5	T	58 8	43 3

SPECIES	ELEM	SQ	NUM	SUB	FA	GH	GLL	BD	BFD
EQUUS	ASTR	P15	23 58	42	T	47 3			40 9
EQUUS	ASTR	P15	31 83	3	P	48 5			42 4
EQUUS	ASTR	P15	55 168	18	P	44.9	45 4		40 2
EQUUS	ASTR	P15	56 173	10	P	50 8	47 5		41 9

SPECIES	ELEM	SQ	NUM	SUB	FA	GB
EQUUS	CALC	P15	23 58	43	T	39 9

SPECIES	ELEM	SQ	NUM	SUB	FA	BD
EQUUS	MT	P15	30 82	7	P	35 1
EQUUS	MT	Q13	46 114	2	E	36 5

SPECIES	ELEM	SQ	NUM	SUB	FA	GL	BP	SD	BD
EQUUS	PH1	P15	17 39	7	T		42.6		
EQUUS	PH1	P15	17.47	4	T	68 5	41 1	22.5	32 9
EQUUS	PH1	P15	30 81	7	P	73 6	41 9	23 4	34 2
EQUUS	PH1	P15	30 82	5	P	76.2	43 4	25.0	35 9
EQUUS	PH1	P15	30 80	10	P		40.7	23 0	32 2
EQUUS	PH1	P15	30 82	6	P	77 1	42 2	25 2	

SPECIES	ELEM	SQ	NUM	SUB	FA	GL	BP	SD	BD
EQUUS	PH2	P15	17 47	5	T		37 4	30.9	
EQUUS	PH2	P15	17.39	8	T	38 6	36 6	31 9	33.7
EQUUS	PH2	P15	30 81	9	P	38 8	41 9	37 7	38 3
EQUUS	PH2	P15	30.81	8	P	38 9	37 0	31 5	32.0

SPECIES	ELEM	SQ	NUM	SUB	FA	GL	GB	BF	LD
EQUUS	PH3	P15	23 56	14	T	39 3	46 2	35.5	34 8

GAZELLA: measurements

SPECIES	ELEM	SQ	NUM	SUB	FA	B	D
GAZE	CORNU	P15	11 35	69	T	21 8	31 8

SPECIES	ELEM	SQ	NUM	SUB	FA	LD	LP	LM	LM3	BM3
GAZE	MAND	P15	17 41	17	T	62 7	19 4	40.4	19 0	6 9
GAZE	MAND	P15	22 45	4	T		19.9			
GAZE	MAND	P15	16.38	12	T		23 8			
GAZE	MAND	P15	54 162	7	P		20 8			

SPECIES	ELEM	SQ	NUM	SUB	FA	BFCR
GAZE	AXIS	R13	9 66	1	E	35.6

SPECIES	ELEM	SQ	NUM	SUB	FA	SLC	GLP	LG	BG
GAZE	SCAP	Q14	17.126	1	E	15 5	28.7	22 8	19.3
GAZE	SCAP	Q14	3 30	6	E	16 6	27 9	22.2	19.3
GAZE	SCAP	Q14	5 26	4	E	15 3	27 7	21.4	19.6
GAZE	SCAP	P15	11 30	48	T		26.6	21 8	17 9
GAZE	SCAP	P14	24 113	2	T	16 5	27 8	21 3	18.7
GAZE	SCAP	P15	13.32	9	T				19.0
GAZE	SCAP	P15	23 49	1	T	15 0	28 6	24 4	19 3
GAZE?	SCAP	P15	11 30	44	T		27 9	21 8	19.4
GAZE	SCAP	P15	11.29	6	T	15.4	27 3	21 9	19.4
GAZE	SCAP	P15	15.37	14	T	14 8			20 0
GAZE	SCAP	P15	16 38	28	T	16 9	27 0	23.5	20 9
GAZE?	SCAP	Q15	24 71	9	T	18.3		20.5	21 4
GAZE	SCAP	P15	13.28	5	T	14.8	29.4	24.8	21 5
GAZE	SCAP	P14	32 157	50	T	18.8	29 1	20.9	21 6
GAZE	SCAP	Q15	21 46	5	T	19.1		24.6	22.3
GAZE	SCAP	Q15	22.52	5	T	18 3	27.8	22 6	22.5
GAZE	SCAP	Q15	19.103	15	T	19 0	31.5	24 3	24 4
	Mean					16.7	28.2	22.6	20.4
	Std Dev					1.66	1.26	1.41	1.68
	Min.					14.8	26.0	20.5	17.9
	Max.					19.1	31.5	24.8	24.4
	N					14	13	15	17

SPECIES	ELEM	SQ	NUM	SUB	FA	BD	BT
GAZE	HUM	Q13	64 226	9	E		22 5
GAZE	HUM	Q13	52 158	3	E	24.4	22 6
GAZE	HUM	R13	9 66	11	E		24 0
GAZE	HUM	R13	9.34	3	E	27.0	25.8
GAZE?	HUM	P15	11 25	7	T	25.7	22 9
GAZE	HUM	P15	23.58	3	T	25 9	23 0
GAZE?	HUM	P15	26 73	10	T	25.7	23 1
GAZE?	HUM	P15	14.35	37	T	27.0	23.7
GAZE?	HUM	P14	32.157	10	T	26 9	24 1
GAZE?	HUM	Q15	18 34	5	T	27 6	24 2
GAZE?	HUM	P15	26.60	49	T		24 6
GAZE	HUM	P15	40.119	47	P	24.9	22 6
	Mean					26.1	23.6
	Std Dev					1.07	0.99
	Min.					24.4	22.5
	Max.					27.6	25.8
	N					10	12

SPECIES	ELEM	SQ	NUM	SUB	FA	BP	BD
GAZE	RAD	Q14	47.124	23	E	25.7	
GAZE	RAD	Q13	30.85	2	E	24 1	22 3

SPECIES	ELEM	SQ	NUM	SUB	FA	LO	DPA	SDO	BPC
GAZE	ULNA	Q13	20 32	5	E	35 7	21.1		13.8
GAZE	ULNA	P15	9 14	19	T	37 6	22 7	18 1	13 8
GAZE	ULNA	P15	13 28	20	T	36 6	22 2	17.9	13 5
GAZE	ULNA	Q15	25 60	6	T	31 8	19.0	16 8	13.3

SPECIES	ELEM	SQ	NUM	SUB	FA	BD
GAZE	MC	R13	22 58	6	E	19 6

SPECIES	ELEM	SQ	NUM	SUB	FA	LA	LAR
GAZE?	PELV	Q15	17.28	8	T	24 8	20 7

SPECIES	ELEM	SQ	NUM	SUB	FA	BP	DC	SD	BD
GAZE	FEM	R13	9.88	14	E				32.0
GAZE	FEM	P15	16.38	17	T		17 4		
GAZE	FEM	P15	13 27	64	T	41 6	17.0		
GAZE	FEM	Q15	33.118	3	T		17 2		
GAZE?	FEM	P14	33 152	1	T		17.7		
GAZE?	FEM	P14	21.102	5	T		17 7		
GAZE	FEM	P14	32.147	3	T				30 5

SPECIES	ELEM	SQ	NUM	SUB	FA	BP	BD
GAZE	TIB	P15	9 24	9	T	33 9	
GAZE	TIB	P15	26 64	5	T		22 9
GAZE	TIB	P14	26.133	6	M		21 1

SPECIES	ELEM	SQ	NUM	SUB	FA	GLL	BD
GAZE	ASTR	Q13	43 120	7	E	24 9	15 6

SPECIES	ELEM	SQ	NUM	SUB	FA	GB
GAZE	CALC	R13	9.88	17	E	16.4

SPECIES	ELEM	SQ	NUM	SUB	FA	BD
GAZE	MT	P15	10.15	24	T	21 7
GAZE	MT	Q13	47 111	3	E	20.1

SPECIES	ELEM	SQ	NUM	SUB	FA	GL	BP	SD	BD
GAZE	PH1	R13	9 66	13	E	37 0	9.4	7.5	8.4
GAZE	PH1	R13	9 66	12	E	36 9	9 3	7 1	8 3
GAZE	PH1	Q13	30.62	6	E		8 7	6 7	7 8

SPECIES	ELEM	SQ	NUM	SUB	FA	GL	BP	SD	BD
GAZE	PH2	R13	9.66	14	E	20.8	8 3	6.3	6.7
GAZE	PH2	R13	9 66	15	E	20 6	8.2	6 7	7 3

SPECIES	ELEM	SQ	NUM	SUB	FA	DLS
GAZE	PH3	R13	9.66	17	E	24 7
GAZE	PH3	R13	9 66	16	E	25 4
GAZE	PH3	R13	13.23	4	E	25.7

DAMA: measurements

SPECIES	ELEM	SQ	NUM	SUB	FA	BP
DAMA	MT	P15	40 116	97	P	26 4

VULPES: measurements

SPECIES	ELEM	SQ	NUM	SUB	FA	LM1	BM1
VULPES	MAND	Q13	49.124	3	E	14 3	5 3

SPECIES	ELEM	SQ	NUM	SUB	FA	SD	BD	BT
VULPES	HUM	P15	42 129	45	P	7.2	15 4	12.3

SPECIES	ELEM	SQ	NUM	SUB	FA	BP
VULPES	TIB	Q13	25 55	1	E	19 2

SPECIES	ELEM	SQ	NUM	SUB	FA	GL	BP	SD	BD
VULPES	PH1	Q13	25 69	4	E	16 3	5.1	3 0	4 1
VULPES	PH2	Q13	25 69	5	E	10.3	4 4	3.2	3 7

LEPUS: measurements

SPECIES	ELEM	SQ	NUM	SUB	FA	SD	BD	BT
LEPUS	HUM	P15	42 129	45	P	7 2	15 4	12 3

SPECIES	ELEM	SQ	NUM	SUB	FA	BP
LEPUS	RAD	Q13	62 168	5	E	7 8