THE DEVELOPMENT OF GOAT AND SHEEP HERDING DURING THE LEVANTINE NEOLITHIC

Volume 1

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ABSTRACT

This thesis examines the development of goat and sheep herding in the Levant during the Neolithic period, and focuses particularly on the emergence of caprines as major early domesticates and the development of specialised pastoral economies. It is divided into two sections. The first consists of a critical review of published palaeoclimatic, archaeological, archaeobotanical and zooarchaeological data, which are integrated to provide baseline interpretations of caprine domestication and the development of specialised pastoral economies. The second section presents the results of a zooarchaeological analysis of the faunal assemblage from the Neolithic site of 'Ain Ghazal, located in the Jordanian Highlands, which are evaluated in the context of the two baseline interpretations presented in the first section. The relative merits of the different methods by which archaeological caprine remains can be identified to species are also discussed. It is argued that goats were probably first domesticated in or immediately adjacent to the Lebanon and Anti-Lebanon Mountains during the 10th millennium b.p., and that mouflon were probably first domesticated in the piedmont zones of the Taurus and Zagros Mountains during the first half of the 9th millennium b.p.. The independent domestication of goats in the Zagros Mountains during the first half of the 9th millennium b.p. is regarded as a strong possibility. It is concluded that the concepts of there have been a temporal gap between the appearance of the earliest permanent agricultural villages and the earliest domestic caprines, and that significant periods of loose-herding preceded the full domestication of these species, may need to be reconsidered. Pastoral economies during the Levantine Neolithic seem to have been based on sedentary animal husbandry aimed at subsistence-orientated meat production. There is however some evidence that simple forms of distant pastures husbandry, still focused on subsistence-orientated meat production, may have developed during the Neolithic period.

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CHAPTER 1: INTRODUCTION

"In the 'Old Stone Age' men relied for a living entirely on hunting, fishing and gathering wild berries, roots, slugs and shell-fish. Their numbers were restricted by the provision of food made for them by Nature ... In the 'New Stone Age' men control their own food supply by cultivating plants and breeding animals. Given favourable circumstances, a community can now produce more food than it needs to consume, and can increase its production to meet the requirements of an expanding population" (Childe 1936, p.35).

1.1: INTRODUCTION:

This study examines the development of goat and sheep herding during the Levantine Neolithic. It focuses primarily on the emergence of caprines as major early domesticates and on the development of specialised pastoral economies in the Levant, and is based on a critical review of published data and on a zooarchaeological analysis of the faunal assemblage from the important Neolithic site of 'Ain Ghazal, located in the Jordanian Highlands.

The development of goat and sheep herding during the Levantine Neolithic was an important factor in wider patterns of cultural change associated with the emergence of early food-producing economies. The domestication of plants and animals and consequent abandonment of hunting and gathering in favour of crop cultivation and animal husbandry has long been considered one of the most significant steps in human evolution. The ecological and environmental consequences of this transition were associated with the development of settled life and were a significant factor in the subsequent emergence of complex urban societies (Harris 1996, p.1).

Archaeological investigation of the domestication process began in the early part of the twentieth century with the pioneering work of Childe (1928), who formulated the concept of the 'Neolithic Revolution', and Vavilov (1926) who introduced the concept of 'centres of origin'. However, it was not until after the Second World War that archaeological fieldwork focused specifically on this issue began. The work of Braidwood in 'Iraq (Braidwood and Braidwood 1950) was followed in the 1950s by a number of other multidisciplinary projects involving the excavation of Neolithic agricultural settlements such as Hacilar (Melaart 1958), Çatal Höyük (Mellaart 1962), × Jericho (Kenyon 1960) and Beidha (Kirkbride 1966). The results of such projects suggested that south-west Asia was the earliest centre of plant and animal domestication in the world.

With the 'New Archaeology' of the 1960s, typified by the writings of Binford (1968) and Flannery (1968), the debate surrounding the origins of agriculture shifted away from identification of domestic forms of plants and animals of ever increasing antiquity and focused instead on the processes by which agriculture had developed in the first place. Systems theory and general ecological and economic concepts were thus brought into the debate and were quickly adopted by British archaeologists such as Higgs and Jarman (1969) and Harris (1969). Investigation of archaeological data in terms of ecological principles gathered momentum during the 1970s with the work of Higgs and the 'palaeoeconomy' school at Cambridge (eg: Higgs 1975). This emphasised "the continuities that connected, rather than the differences that separated, hunter-gatherer and agricultural modes of plant and animal exploitation" (Harris 1990, p.9) and challenged the traditional dichotomy between wild and domestic. Attention was focused instead on identifying the range of human-plant/animal relationships which had existed during the post-Glacial period (eg: Higgs and Jarman 1972, Jarman and Wilkinson 1972, Harris 1977).

Continued research over the past two decades (eg: Rindos 1984, Grigson and Clutton-Brock 1984, Clutton-Brock 1989, Harris and Hillman 1989, Gebauer and Price 1992, Smith 1995, Harris 1996) has demonstrated the great complexity and diversity of human-plant/animal interactions and the importance of precise definition and use of general terms such as domestication, cultivation, husbandry, agriculture and pastoralism (Harris 1990, p.11). Today the debate on the origins of agriculture has shifted away from universal, unilineal explanations of the processes involved and is focusing instead on attempts to describe and explain regional variation in transitions to cultivation and husbandry in different areas of the world.

Despite almost five decades of archaeological research, the nature of this transition in south-west Asia continues to attract scholarly attention for two main reasons. Firstly, the region is regarded as the world's earliest centre of extensive plant and animal domestication. Secondly, the agricultural systems which developed there were a important factor in the emergence of the world's first complex urban societies, which began to emerge in Egypt and Mesopotamia during the 6th millennium b.p..

1.2: THE EMERGENCE OF FOOD-PRODUCING ECONOMIES IN THE LEVANT:

Over the past four or five decades a generally accepted view of the emergence of food producing economies in the Levant has developed. This view is briefly summarised below, as it forms the starting point for this study.

The world's first food-producing economies are thought to have emerged in the Fertile Crescent of south-west Asia over approximately 1,500 years during the early Neolithic period of the 10th and 9th millennia b.p.. The transition from hunting and gathering to food production was based on the development of two complementary economic activities: cultivation of cereals and legumes and husbandry of goats and sheep. These developments were preceded by an intensification in the use of wild plant and animal resources and increased levels of sedentism during the late Epipalaeolithic period of the late 12th and 11th millennia b.p.. The domestication and cultivation of cereals and legumes is thought to have begun during the mid 10th millennium b.p. in the southern Levant between Jericho and the Damascus basin and subsequently diffused into the northern Levant and Taurus/Zagros arc. The package of early plant domesticates included emmer wheat, barley, einkorn wheat, lentil, pea, flax, bitter vetch and chick pea (eg: Zohary and Hopf 1988, Bar-Yosef and Kislev 1989, Zohary 1989 and 1996, Hillman 1996).

The establishment of the first agricultural economies is generally thought to have preceded the domestication of goats and sheep by up to a millennium. Although archaeologists still differ in their interpretation of the data, the domestication of goats and sheep is generally thought to have occurred during the first half of the 9th millennium b.p. (eg: Helmer 1989, Bar-Yosef and Meadow 1995, Legge 1996, Garrard et al. 1996, Hole 1996). Whilst there is evidence to suggest that goats were domesticated at a number of independent centres throughout the Fertile Crescent (Legge 1996), sheep seem to have been domesticated within a relatively restricted area of the Taurus/Zagros arc and were introduced to the Levant during the latter half of the 9th millennium BP

(Legge 1996, Ducos 1993a). By the beginning of the 8th millennium b.p. goats and sheep were being herded together throughout the Levant and the latter rapidly became the dominant species in the herds (Garrard et al.1996, p.210). Cattle and pigs are thought to have been domesticated slightly later than goats and sheep, but domestic forms of these two species seem to have become widespread over much of Southwest Asia by the end of the 9th millennium b.p. (Grigson 1989, Helmer 1992, Kusatman 1991). The remaining components of the modern Mediterranean economy, namely olives, fruit trees, donkeys and possibly vines, seem to have been added to the early Neolithic package of plant and animal domesticates by the Chalcolithic period of the 6th millennium b.p. (Zohary and Spiegel-Roy 1975, Davis 1980, Kislev 1987).

The extent to which the development of more specialised pastoral economies, whether wholly or partially disarticulated from sedentary agriculture, may have featured in the sequence of events described above has been the subject of widely differing interpretations. Some researchers have argued that such economies may have emerged during the Neolithic period in association with the development of mobile systems of animal husbandry (e.g.: Perrot 1993a, Ducos 1993a, Rollefson and Köhler-Rollefson 1993a), whilst others have argued that they are more likely to have emerged with the secondary products revolution of the Chalcolithic period (e.g.: Levy 1983). Despite these differences of opinion most researchers agree that extremely specialised forms of pastoralism known from the recent past could not have developed until the widespread adoption of horses and possibly camels as riding animals in the late 4th and early 3rd millennia b.p. (e.g.: Bar-Yosef and Kha~~s~~zanov 1992). x

1.3: THE RATIONALE FOR THIS STUDY:

Although the scenario described in 1.2 above has been widely accepted, the archaeological and zooarchaeological data on which it is based has until recently been deficient in two critical areas.

Firstly, although hunter-gatherer, agricultural and pastoral groups of the late Epipalaeolithic, Neolithic and Chalcolithic Levant clearly exploited semi-arid as well as more fertile regions, until relatively recently archaeological investigation of the period has focused on the modern moist-steppe and woodland zones known as the 'Levantine Corridor' (Bar-Yosef and Belfer-Cohen 1989a, Bar-Yosef 1991). The results of excavations in these areas have demonstrated that "information drawn from sites in the 'sown land' is insufficient to clarify the Near Eastern origins of animal husbandry and incipient pastoralism. The lack of evidence from the Syro-Arabian desert and Sinai has distorted our understanding of socioeconomic regional developments" (Bar-Yosef and Khazanov 1992, p.1).

Secondly, in order to reconstruct prehistoric strategies of animal husbandry it is necessary to correctly identify and analyse the remains of prehistoric animals, especially goats and sheep. Unfortunately, the bones of goats and sheep are extremely similar. Even after a major attempt by Boessneck, Müller and Teichert (1964) to describe and standardise the differences in the post-cranial skeleton between the two species, correct identification of frequently heavily fragmented prehistoric material remained problematic. For many years it has been common practice for zooarchaeologists to categorise this material simply as goat/sheep and as a result the species composition of Neolithic herds has remained unknown.

However, in more recent years these deficiencies have begun to be corrected. In the southern Levant an important body of field research focusing at least partially on the Neolithic has been carried in the present zones of dry steppe and sub-desert (eg: Bar-Yosef 1981c, Rosen 1984, Betts 1993, Goring-Morris 1993, Garrard et al. 1996) In addition, zooarchaeologists have developed more sophisticated methods of separating goat and sheep bones (eg: Kratochvil 1969, Payne 1969 and 1985b, Prummel and Frisch 1986, Buitenhuis 1995) with the result that it is now possible to correctly identify a greater proportion of fragmented prehistoric goat and sheep remains than has previously been the case.

This study therefore draws on these recent developments in Levantine prehistoric archaeology and zooarchaeology and, in conjunction with a fresh archaeozoological analysis of a large Levantine Neolithic faunal assemblage which focuses specifically on caprine remains, examines whether 'traditional' views of the emergence of caprines as major early domesticates and the development of more specialised pastoral economies can be updated in light of recent data.

CHAPTER 2: METHODOLOGY

2.1: INTRODUCTION:

This chapter describes the methods by which the development of goat and sheep herding during the Levantine Neolithic was examined in this study. The primary objective of these methods was that they should yield data relating to two key issues: the emergence of caprines as major early domesticates, and the development of more specialised pastoral economies in the Levant. A two-stage approach was felt to be the most effective way by which these issues could be examined.

The first stage consists of a critical review of published palaeoclimatic, archaeological, archaeobotanical and zooarchaeological data. Once evaluated separately, these disparate published data are then integrated to generate up to date baseline interpretations of the emergence of caprines as early domesticates and the development of specialised pastoral economies in the Levant.

The second stage consists of a zooarchaeological analysis of the faunal assemblage from one of the region's largest, longest inhabited and most extensively excavated Neolithic sites: 'Ain Ghazal. The results of this analysis are then evaluated in light of the two baseline interpretations produced in the first stage in an attempt to assess how 'Ain Ghazal fitted into the processes by which caprines emerged as major early domesticates and more specialised pastoral economies developed in the Levant.

2.2 FIRST STAGE (CHAPTERS 3, 4, 5 AND 6):

The critical review of palaeoclimatic, archaeological, archaeobotanical and zooarchaeological data is presented in Chapters 3, 4, 5 and 6. Chapters 3, 4 and 5 are primarily descriptive, whilst Chapter 6 is primarily interpretative. The archaeological context for the emergence of caprines as early domesticates and the development of more specialised pastoral economies in the Levant is generally thought to extend from the late Epipalaeolithic, through the Neolithic and into the Chalcolithic period (Bar-Yosef and Khazanov 1992), or from c.12,500b.p. to c.5,200b.p.. The first stage therefore focuses primarily on this timespan.

The environmental setting of the Levant is described in detail in Chapter 3. This discusses the geography, geology, geomorphology, modern climate and modern vegetation of the region, and palaeo-climatic and palaeo-environmental reconstructions.

Late Epipalaeolithic, Neolithic and Chalcolithic archaeological data from the Levant are described detail in Chapter 4, which is structured around commonly used Levantine archaeological periods, defined primarily on the basis of material culture. General issues of terminology are discussed, and the archaeological data specific to each period described. These data relate primarily to the means by which the period is defined, settlement size and location, chipped stone assemblages, chronology, phases and facies, and key aspects of material culture.

Data relating to late Epipalaeolithic, Neolithic and Chalcolithic subsistence strategies are described in detail in Chapter 5. The geographical scope of this chapter is extended from the Levant to south-west Asia. This is done to take into account the fact that a number of researchers have argued that caprine domestication may have been earliest in south-west Iran. With such a large and culturally diverse area under consideration, it was decided to structure Chapter 5 around periods defined primarily on radiocarbon chronologies, rather than around the Levantine archaeological periods used in Chapter 4. The discussion of each of these periods includes a brief summary of relevant palaeo-climatic and archaeological data, drawn from Chapters 3 and 4 in the case of the Levant but including additional data relating to other areas of south-west Asia, a brief description of archaeobotanical data and a detailed description of zooarchaeological data. The southern Levant, northern Levant and Iraq/Iran are discussed separately in an attempt to highlight chronological and regional variation in subsistence strategies. It should be noted that the primary aim of Chapter 5 is to describe rather than interpret published data relating to the late Epipalaeolithic, Neolithic and Chalcolithic subsistence strategies of south-west Asia.

In contrast, Chapter 6 critically reviews the relevant environmental, archaeological and subsistence data described in Chapters 3 to 5, and by integrating them attempts to generate two up to date baseline interpretations, one focused on the emergence of caprines as major early domesticates, and the other on the development of more specialised pastoral economies in the Levant.

Thus, in Chapter 6 explanations of animal domestication in general and models of caprine domestication in south-west Asia in particular are reviewed to clarify the processes by which caprines may have emerged as major early domesticates. In addition, published data relating to late Pleistocene and early Holocene caprine zoogeography from south-west Asia is critically re-examined in an attempt to identify potential early centres of domestication. Published caprine zooarchaeological data from south-west Asia is then systematically tested against criteria generally used to identify domestic caprines in archaeological faunal assemblages. Finally, these results are integrated with archaeological and environmental data to generate an integrated baseline interpretation of caprine domestication in the Levant, in which light the zooarchaeological data from ‘Ain Ghazal is examined in Chapter 11.

In addition, Chapter 6 describes the various types of pastoral economy known from modern and historical data, and discusses long-standing problems of terminology. It draws on this modern and historical data in an attempt to anticipate the types of pastoral economy which might be expected during the Levantine Neolithic, and critically reviews previous work on some of the faunal assemblages described in Chapter 5 in which researchers have examined the processes by which more specialised pastoral economies may have developed in the Levant. Finally, it draws on all of these data in an attempt to generate an integrated baseline interpretation of the development of more specialised pastoral economies in the Levant, focusing particularly on the types of pastoral economy which available evidence suggests may have emerged during the Neolithic.

2.3: SECOND STAGE (CHAPTERS 7, 8, 9, 10 AND 11):

The zooarchaeological analysis of the ‘Ain Ghazal faunal assemblage is discussed in Chapters 7, 8, 9, 10, 11. Chapter 7 briefly introduces the site of ‘Ain Ghazal, its archaeology, and previous work on the faunal assemblage. Chapter 8 presents the results of attempts made during the course of this study to identify the ‘Ain Ghazal caprine remains to species. Chapter 9 describes the representation of taxa at ‘Ain Ghazal in the results of this study. Chapter 10 focuses on the ‘Ain Ghazal caprine remains examined in this study, and attempts firstly to establish their wild or domestic status, and secondly the likelihood of these animals having been managed within the context of a more specialised pastoral economy.

Finally, in Chapter 11 the results of this zooarchaeological analysis of the 'Ain Ghazal faunal assemblage, as described in Chapters 8, 9 and 10, are examined in light of the two baseline interpretations of the emergence of caprines as early domesticates, and the development of specialised pastoral economies presented in Chapter 6.

Primary zooarchaeological data obtained during this study is presented in three appendices, Appendix A lists the morphological criteria score counts of 'Ain Ghazal caprine POSACs subjected to principal components analysis. Appendix B lists the measurements taken on 'Ain Ghazal caprine specimens which were identified to species (burnt specimens are excluded). Appendix C provides NISP and adjusted NISP bone counts by species and skeletal element for each phase.

2.3.1: Zooarchaeological Methodology:

A detailed review of the relative merits of the numerous and diverse methodological approaches to zooarchaeological analysis is beyond the scope of this study. Such reviews have already been provided by, amongst others, Grayson (1979), Hesse and Wapnish (1985), Davis (1987), Martin (1994), Lyman (1994) and Reitz and Wing (1999). Instead, this section therefore aims to simply and succinctly describe the methodological procedures used on the material from 'Ain Ghazal which was selected for analysis.

2.3.1.1: Aims and Objectives:

As the principal aims of this zooarchaeological analysis were to establish whether the 'Ain Ghazal caprines were wild or domestic, and whether they were managed within the context of a more specialised pastoral economy the methodological procedures were ideally required to generate zooarchaeological data relevant to the following areas of × interest.

1) Taphonomic factors affecting the faunal assemblage, to allow the factors involved in its deposition and modification to be defined, and to enable potential taphonomic bias to be taken into account in its analysis.

2) Representation of the main medium and large herbivore taxa, to establish the relative economic importance of each of the main food taxa, to shed light on subsistence

strategies at ‘Ain Ghazal, to establish the ratio of goats to sheep in order to aid interpretation of herd management, and to shed further light on the early Holocene distribution of wild goats and mouflon in south-west Asia.

3) Measurements of caprine remains, to aid identification of caprine remains to species, to assist in generation of sex ratios, and to help establish whether the ‘Ain Ghazal caprines were wild or domestic.

4) Age profiles of caprine remains, to help establish whether the ‘Ain Ghazal caprines were wild or domestic, to aid interpretation of herd management, and to shed light on times of year at which caprines may have been present at ‘Ain Ghazal.

5) Sex ratios of caprine remains, to help establish whether the ‘Ain Ghazal caprines were wild or domestic, and to aid interpretation of herd management.

6) Morphology of caprine remains, to aid identification of caprine remains to species, and to help establish whether the ‘Ain Ghazal caprines were wild or domestic.

2.3.1.2: Material Available for Analysis:

Thanks to the generosity of the excavators of ‘Ain Ghazal, Dr. Gary Rollefson and Dr. Zeidan Kafafi, almost the entire faunal assemblage from ‘Ain Ghazal was made available for analysis, with the following minor exceptions: all bird remains, the small mammal remains excavated between 1993 and 1995, and the entire faunal assemblage excavated during 1996. The bird remains excavated between 1982 and 1989 are currently undergoing analysis by Dr. William Gillespie at the Department of Geosciences of the University of Arizona (see Gillespie 1984 and 1986). The bird remains and small mammal remains excavated between 1993 and 1995, and the entire faunal assemblage excavated during 1996 are currently undergoing analysis by Prof. Dr. Angela von den Driesch at the Institut für Paläoanatomie, Domestikationsforschung und Geschichte der Tiermedizin at Munich (see von den Driesch and Wodtke 1997).

2.3.1.3: Sampling of the Material Available for Analysis:

With such a large body of material available for analysis, it was apparent from the outset of this study that some material would have to be excluded if the study were to be completed within the time available. As the material available for analysis did not include bird remains and some of the small mammal remains, it was an easy decision to decide to restrict this analysis to the major medium and large herbivores represented in the faunal assemblage, i.e.: caprines, gazelle, pigs, cattle and equids (see Köhler-Rollefson, Gillespie and Metzger 1988 and Köhler-Rollefson, Quintero and Rollefson 1993).

However, as these taxa make up the by far the greater part of the 'Ain Ghazal faunal assemblage it was still necessary to further reduce this material. Therefore, it was also decided to exclude all material excavated from the East Field (see Chapter 7, Figure 7.2). Two reasons lay behind this decision. Firstly, the earliest and latest phases of occupation at 'Ain Ghazal, i.e.: the MPPNB and Yarmoukian (see Chapter 7), do not appear to be represented in this area of the site. Secondly, no radiocarbon dates were available from the East Field at the outset of this study, as large scale excavations in this area of the site only commenced during 1995.

This process of exclusion therefore left the medium and large herbivore remains excavated from the west bank of the Wadi Zarqa, i.e.: the Central Field, South Field, North Field and a number of outlying excavation squares (see Chapter 7, Figure 7.3). All of this material was analysed during the course of this study, with the following minor exceptions.

1) All material from mixed contexts.
2) All material excavated during 1982, excluded because it was predominantly excavated from the side of the road-cut (see Chapter 7, Figure 7.3).
3) All material excavated from AG84 Square 4048, AG88 Square 4459, AG89 Square 7876 and AG89 7704 (see Chapter 7, Figure 7.3), excluded because no stratigraphic information was available for these excavation squares, all of which in any case lay outside the main areas of excavation.
4) All material from AG93 Square 3477 (see Chapter 7, Figure 7.3), excluded because it was not possible to relocate this material during the course of this study.

The material on which this zooarchaeological analysis of the 'Ain Ghazal faunal assemblage is based therefore consists of the medium and large herbivore remains from secure contexts in the excavation squares listed in Table 2.1 below (see Chapter 7, Figure 7.3 for their location).

AG83		AG84		AG85		AG88		AG89		AG93		AG94		AG95	
Square	Phase	Square	Phase	Square	Phase	Square	Phase	Square	Phase	Square	Phase	Square	Phase	Square	Phase
3073	m	3073	m	3282	m,l,c,y	3275	l,c,y	3279	m/l	3279	c,y	3675	c,y	5516	l,l/c,c
3074	m	3080	m	3482	m,l,c,y	3276	c,y	3300	l,l/c,c	3478	y	3676	c,y	5716	l/c,c
3075	m	3081	m			3277	c,y	3475	c	3479	y	3873	y	5718	c
3076	m	3082	m			3475	c,y	3483	y	3480	y	3874	y	5719	l,l/c
3077	m	3273	m			3476	c,y	3675	c,y	3679	y	3875	y	5916	l/c,c
3078	m	3283	m			3477	c,y	3676	c,y	3680	c,y	3876	y	5917	l,l/c,c
3079	m	4452	c,y			3481	c,y	3677	c,y	3875	y	3878	y	5918	m,l,l/c,c
3080	m	4453	c,y			3482	y	3678	c,y	3876	y	3879	y	5919	l,l/c,c
3081	m	4454	c,y			3675	c,y	3679	c,y	3883	l,c	4073	y		
3082	m					3676	c,y	3680	c,y	5317	l,l/c,c	4074	y		
3083	m					3681	c,y	3681	c	5517	l,l/c,c	4075	y		
3273	m					3682	c,y	4453	c,y	5518	l,l/c,c	4076	y		
3283	m					3683	c,y	4454	c			5516	c		
						4453	c	4455	c,y			5717	l/c,c		
						4454	c,y	4654	c,y			5718	l,l/c,c		
						4455	c,y	4655	c,y			5918	l,l/c,c		
						4654	c,y	5493	l/c,c,y						
						4655	c,y	5518	l,c						
								6260	c,y						
								6891	l,c,y						

Phase Codes: m=MPPNB, l=LPPNB, l/c=LPPNB/PPNC, c=PPNC, y=Yamoukian

Table 2.1: The Excavation Squares and Phases from which the Medium and Large Herbivore Remains Examined during this Study of the 'Ain Ghazal Faunal Assemblage Originated

2.1.3.4: Retrieval and Preparation:

All excavated sediments from 'Ain Ghazal were dry-sieved through a 5mm mesh to aid retrieval. Most faunal remains were washed in the field soon after excavation. Those which remained unwashed at the time of this study were dry-brushed where necessary. In most instances no further cleaning of the faunal remains was necessary, but occasionally a dilute solution of acetic acid was used to remove the thick calcrete deposits which affected a significant proportion of material from Yarmoukian contexts situated close to the modern ground surface. Although some of the washed faunal remains had already been marked with the year of excavation, context number and bag number and could therefore be 'strewn', it was decided to examine the material selected for analysis 'bag by bag' to avoid the time-consuming task of marking the substantial number of specimens that remained unmarked.

2.1.3.5: General Methodological Considerations:

In general terms, the body of material selected for analysis was both substantial and highly fragmented. These two considerations largely dictated the choice of methodological procedure. The desire to undertake as detailed an analysis of the selected material as possible had to be balanced against the twin facts that detailed analyses of large, highly fragmented faunal assemblages are extremely time-consuming and that the time available for this study was relatively limited. As a result, the methodological procedures eventually applied to the selected material were largely based on a minimalist approach developed by Davis (1992) which aims to "produce a maximum amount of useful information with minimum effort and avoid recording low grade and redundant information" (Davis 1992, p.1).

2.1.3.6: Parts of the Skeleton which were Counted:

All medium and large herbivore bones and teeth were examined, but following Davis only "certain regions of some of these bones are recorded as a matter of course. These regions are similar to Watson's (1979) 'diagnostic zones' and are here referred to as the Parts Of Skeleton Always Counted or POSAC for short" (Davis 1992, p.1). POSACs are the primary unit of analysis in this study, and the POSACs recorded are primarily those described by Davis (1992).

A few minor adjustments were however made to Davis' methodology to take the particular needs of this study into account. The most significant of these alterations was the use in this study of epiphyses as the POSAC for unfused long bones, rather than the diaphyses used by Davis. This was done because caprine epiphyses are more easily identifiable to species than diaphyses. As such, it was felt that use of epiphyses as unfused long bone POSACs would aid construction of separate age profiles for goats and sheep. Isolated mandibular teeth were not included as POSACs owing to the difficulty in identifying caprine teeth to species. Radials and carpals 2 and 3 were excluded for the same reason. However, despite these minor adjustments to Davis' methodology the term POSAC has been retained throughout this study for convenience.

The POSACs recorded in this study are listed below in Table 2.2, drawing heavily on Davis' (1992) descriptions where appropriate. These form the basic unit of analysis for this study, and are used to calculate taxonomic representation and proportions of adult and juvenile individuals.

POSAC	**Description**
Mandible	If more than half the tooth row/tooth sockets are present
Scapula	If more than half the glenoid articulation is present
Distal Humerus (fused/fusing)	Medial half of the trochlea
Distal Humerus (unfused)	Medial half of the epiphysis
Distal Radius (fused)	Medial half of the articular surface
Distal Radius (unfused)	Medial half of the epiphysis
Distal Metacarpal (fused/fusing)	Condyles (in pigs only Mc 3 and 4, in equids only Mc 3)
Distal Metacarpal (unfused)	Condyles (in pigs only Mc 3 and 4, in equids only Mc 3)
Ischium	The part of the acetabulum rim formed by the ischium, if more than half is present
Distal Femur (fused/fusing)	Lateral condyle, if more than half is present
Distal Femur (unfused)	Lateral part of the epiphysis, if more than half is present
Distal Tibia (fused/fusing)	Medial part of the articulation, if more than half is present
Distal Tibia (unfused)	Medial part of the epiphysis, if more than half is present
Astragalus	Lateral surface, if more than half is present
Calcaneum	All of the sustenaculum plus half or more of the adjacent surface which articulates with the astragalus
Distal Metatarsal (fused/fusing)	Condyles (in pigs only Mt 3 and 4, in equids only Mt 3)
Distal Metatarsal (unfused)	Condyles (in pigs only Mt 3 and 4, in equids only Mt 3)
Proximal First Phalanx (fused/fusing)	Articular surface, if more than half is present (in pigs only PI 3 and 4)
Proximal First Phalanx (unfused)	Epiphysis, if more than half is present (in pigs only PI 3 and 4)
Third Phalanx	Articular surface, if more than half is present (in pigs only PIII 3 and 4)

Table 2.2: Descriptions of POSACs Recorded in this Study

Wherever possible, the following information was recorded for each of the POSACs described above: year of excavation, excavation square number, context number, bag number, species/taxon (goat/sheep/caprine/gazelle/small ruminant/cattle/pig/equid), sex, POSAC, state of fusion (fused/fusing/unfused), side of body, state of preservation (good/fair/poor), level of calcretion (high/medium/low), butchery marks, whether burnt, presence of gnawing (rodent/carnivore), and measurements (see 2.1.3.11 below).

In addition, the following non POSAC parts of the skeleton were recorded separately and were not included in POSAC counts: mandibular teeth, whether isolated or in mandibles (if more than half present), and horncores (lower two-thirds only). Mandibular teeth were assigned to the wear stages of Payne (1973) (see 2.3.1.9 below), and caprine horncore cross-sections were drawn (if more than 75% preserved).

With the exception of the caprine horncore cross-section drawings, all recorded information was entered into a specially designed Microsoft Access database for ease of recording and processing. It should be noted that although taphonomic information relating to state of preservation, level of calcretion, butchery, and gnawing was recorded, it was felt that its description and interpretation could not be satisfactorily achieved within the limitations of time and space inherent in this study and is therefore not discussed further.

2.1.3.7: Identification:

All of the analysed medium and large herbivore remains were identified, to species where possible, through comparison with published and unpublished morphological criteria (e.g.: Halstead n.d., Martin n.d.a and n.d.b, Boessneck 1969, Kratochvil 1969, Schmid 1972, Pales and Garcia 1981, Payne 1985b, Prummel and Frisch 1986, Hillson 1992, Helmer and Rocheteau 1994) and through comparison with modern reference material held in the collections of the Institute of Archaeology, University College London and the British Institute at Amman for Archaeology and History. In an attempt to ensure that the identifications of caprine remains to species were as reliable as possible, some of the caprine identifications thus obtained were independently checked on the basis of metrical separations of all distal metacarpals (Payne 1969, see also Chapter 8), and principal components analysis of approximately one third of distal scapulae, distal humeri, distal radii, distal tibiae, distal metapodia, first phalanges, third phalanges, astragalae and calcanea (Buitenhuis 1995, see also Chapter 8).

The methodology for the principal components analysis followed that of Buitenhuis' (1995) principal components analysis of caprine scapulae exactly. However, this was expanded in this study to include all of the POSACs described above. For each of these POSACs, a series of characteristics drawn from the published and unpublished morphological criteria listed above were drawn up and scored from one to four on each examined specimen. These were "scored not so much in terms of sheep-like or goat-like, but more in their own terms, like strongly curved or straight (Buitenhuis 1995, p.141). The scores thus obtained were then subjected to a principal components analysis (extracting two factors, and replacing missing data by means), for each POSAC separately, using the computer program Statistica (version 5). The resulting factor loadings for each characteristic were then examined in an attempt to determine which were the most reliable characteristics on each POSAC by which a reliable identification to species could be made, i.e.: which characteristics had the highest proportion of one and four scores, rather than intermediate two or three scores. Finally, the factor scores for each specimen were plotted, with specimens categorised as goat, sheep or goat/sheep on the basis of the initial identifications obtained through comparison with published/unpublished morphological criteria and modern reference material (see above). The resulting plots were then examined in an attempt to determine whether principle components analysis has the potential to identify a higher proportion of caprine specimens to species than traditional methods (see Chapter 8).

2.3.1.8: Quantification:

NISP (Number of Identified Specimens) counts of all POSACs were recorded, but were subsequently modified into 'adjusted NISP' counts to take anatomical frequency and the effects of fragmentation into account. NISP counts of equid metapodia and phalanges were therefore doubled, whilst those of single bovid metapodial condyles were halved. Taxonomic representation and proportions of adults and juveniles were calculated on the basis of these 'adjusted NISP' counts of POSACs.

As mandibular teeth and caprine horncores (both non-POSACs) were not included in calculations of taxonomic representation and proportions of adults and juveniles, only NISP counts were recorded for these skeletal elements.

It should be stressed that this study is focused specifically on the caprine remains from 'Ain Ghazal. Consequently, the non-caprine medium and large herbivore remains encountered in the faunal assemblage were not analysed further once identified and quantified (see also Chapter 9).

2.3.1.9: Ageing:

Ageing of caprine remains was undertaken on the basis of mandibular tooth eruption and wear, and on the basis of epiphyseal fusion.

Mandibular teeth were assigned to the eruption and wear stages of Payne (1973). Owing to the high levels of fragmentation characteristic of the 'Ain Ghazal faunal assemblage, most teeth were encountered individually rather than in mandibles. Each individual tooth, including the those found in mandibles, was therefore aged and counted separately. Less well preserved specimens which could only be attributed to a range of age classes were apportioned between the individual age classes according to the method described by Payne (1973).

Ageing of caprine remains on the basis of epiphyseal fusion was done by calculating proportions (adjusted NISP) of fused and fusing/unfused specimens for four POSACs known to fuse at different ages. The four POSACs selected were scapulae, distal tibiae, distal metapodials, and distal radii. The approximate age at fusion for each POSAC was taken from Noddle (1974) for both goats and sheep.

2.3.1.10: Sexing:

Attempts were made to sex the 'Ain Ghazal caprine remains on the basis of morphological differences between males and females on the ischium POSAC (see Table 2.1), of morphological and metrical differences between male and female horncores (see Chapters 9 and 10) and by analysing POSAC measurements to see if sexual dimorphism was reflected in the resulting plots. None of these attempts was particularly successful. The proportion of ischium POSACs identified as male or female was too low to warrant further discussion. The problems encountered in the sexing of the caprine horncores are fully discussed in Chapter 10, whilst those encountered in sexing the caprine remains on the basis of metrical information are fully discussed in Chapter 11.

2.3.1.11: Measurements:

Wherever possible, the measurements listed in Table 2.3 and 2.4 were taken on all 'Ain Ghazal caprine specimens examined during the course of this study, whether fused or fusing/unfused. Although burnt and unburned specimens were measured at the time of data collection, measurements taken on burnt specimens were excluded from all subsequent analyses. All measurements were taken in accordance with the methods described by von den Driesch (1976a), from which the abbreviations of measurements used throughout this study are also derived (with the sole exception of metapodial trochlea width and condyle width measurements, which were taken and abbreviated in accordance with Payne (1969)).

POSAC	Measurements
Mandible	No measurements taken
Scapula	SLC, BG, LG, GLP
Distal Humerus	Bd
Distal Radius	Bd, BFd
Distal Metacarpal	Bd, w troch, w cond.
Ischium	No measurements taken
Distal Femur	Bd
Distal Tibia	Bd
Astragalus	GLl, GLm, Dl, Bd
Calcaneum	GL, GB
Distal Metatarsal	Bd, w troch, w cond.
Proximal First Phalanx	Glpe, Bp, SD, Bd
Third Phalanx	DLS, Ld, MBS

Table 2.3: List of Measurements Taken on 'Ain Ghazal Caprine POSACs

Non-POSAC	Measurements
Mandibular tooth	No measurements taken
Caprine horncore	Max BD, Min BD

Table 2.4: List of Measurements Taken on 'Ain Ghazal Caprine Non-POSACs

CHAPTER 3: THE ENVIRONMENTAL SETTING OF THE LEVANT

3.1: INTRODUCTION:

This chapter aims to describe the environmental setting of the Levant. It discusses the geology, geomorphology, climate and vegetation of the region today and palaeoclimatic and vegetational reconstructions relevant to the late Epipalaeolithic, Neolithic and Chalcolithic periods. These environmental conditions formed the backdrop against which the development of goat and sheep herding during the Levantine Neolithic took place. As both wild and domestic animals are specifically adapted to varying combinations of geology, geomorphology, climate and vegetation, these conditions strongly influenced the subsistence strategies practised before, during and after the period in question. As such they are of immediate relevance to the processes by which caprines emerged as major early domesticates and more specialised pastoral economies developed in the Levant.

3.2: THE LEVANT:

The term Levant is generally applied to the region bounding the eastern littoral of the Mediterranean. The location of this region connecting the continents of Africa, Asia and Europe has ensured its significance throughout human history. Topographic contrasts and a wide range of temperature and rainfall levels have combined to create highly diverse combinations of landscape and environment throughout the region. Exploitable plant and animal resources reflect the region's physical diversity and are mirrored in a rich variety of human subsistence strategies practised during the period under consideration.

3.3: THE GEOLOGY OF THE LEVANT:

Geologically the Levant is bounded in the north by the young Anatolian and Iranian fold mountains and in the south by the stable Nubo-Arabian shield, once part of the ancient Gondwana continent. Between this and the mountains is the geosynclinal basin of the Tethys Sea which once joined what is now the Mediterranean Sea and the Indian Ocean. Huge quantities of fossil marine material were deposited in this basin giving rise to the limestones which make up most of the Levant today (Helms 1981, p.18). The region is commonly divided into five main geological zones (see Figure 3.1), which are highlighted in bold type below. These five zones were formed in three main stages, each of which was characterised by a distinct tectonic regime (Garfunkel 1988, p.7).

The Late Pre-Cambrian Pan African orogenic stage dates to more than 570 m.y.a. (Garfunkel 1988, p.14). During this stage the **Nubo-Arabian shield**, a huge plutonic and metamorphic basement surrounding the Red Sea, was formed. Today it is exposed only in the extreme south of the region and slopes down to the north-east, where it disappears beneath thick layers of sedimentary rocks deposited in and around the basin of the Tethys Sea.

The Early Cambrian to Mid-Cenozoic platformal stage is dated to between 570 and 25 m.y.a. (Garfunkel 1988, p.14). This stage saw the deposition of the sedimentary rocks which make up the greater part of the Levant today whilst the region was part of a relatively stable Arabo-African continent. These sedimentary rocks were deposited in three main zones which differ from each other in the extent to which a marine depositional environment predominated. On the foreland of the Nubo-Arabian shield is the **stable shelf of the Tethys Sea** (Bender 1974, p.16). This represents a largely continental depositional environment dominated by layers of Palaeozoic sandstones. To the north of the stable shelf is the **unstable shelf of the Tethys Sea** (Bender 1974, p.16) which represents the transition from the predominantly continental depositional environment of the stable shelf to the marine geosynclinal environment of the Mesopotamian foredeeps further to the north. The unstable shelf is dominated by successions of Mezozoic limestones. The **Mesopotamian foredeeps** comprise a series of deep troughs in which thick successions of Mesozoic and Cenozoic marine sediments were deposited. This zone is represented in the Levant only by a thin seam along the southern edge of the Anatolian and Iranian fold mountains.

The Mid-Cenozoic to Recent stage of rifting and continental breakup, which started around 25 m.y.a. and came to an end less than 1 m.y.a. (Garfunkel 1988, p.14), was the most recent major stage in the geological formation of the Levant. During this stage the region was affected by extensive faulting and vertical motion associated with the break-up of the Arabo-African continent. The separation of the Arabian peninsular from Africa led to the formation of the Dead Sea rift, the Red Sea, the Gulfs of Suez and Aqaba and the **Iranian and Anatolian fold mountains**. The massive lava flows, basalt boulders, tuffs and alluvial basalt plains of north-eastern Israel, south-western Syria and the north-eastern desert of Jordan were the result of the volcanic activity that accompanied these events.

The youngest rocks in the Levant are found in depressions such as the Dead Sea rift and Azraq basin and were formed within the last million years. These rocks are predominantly soft siltstones and mudstones deposited in the large lakes which occupied these areas until a few thousand years ago (Andrews 1995, p.14).

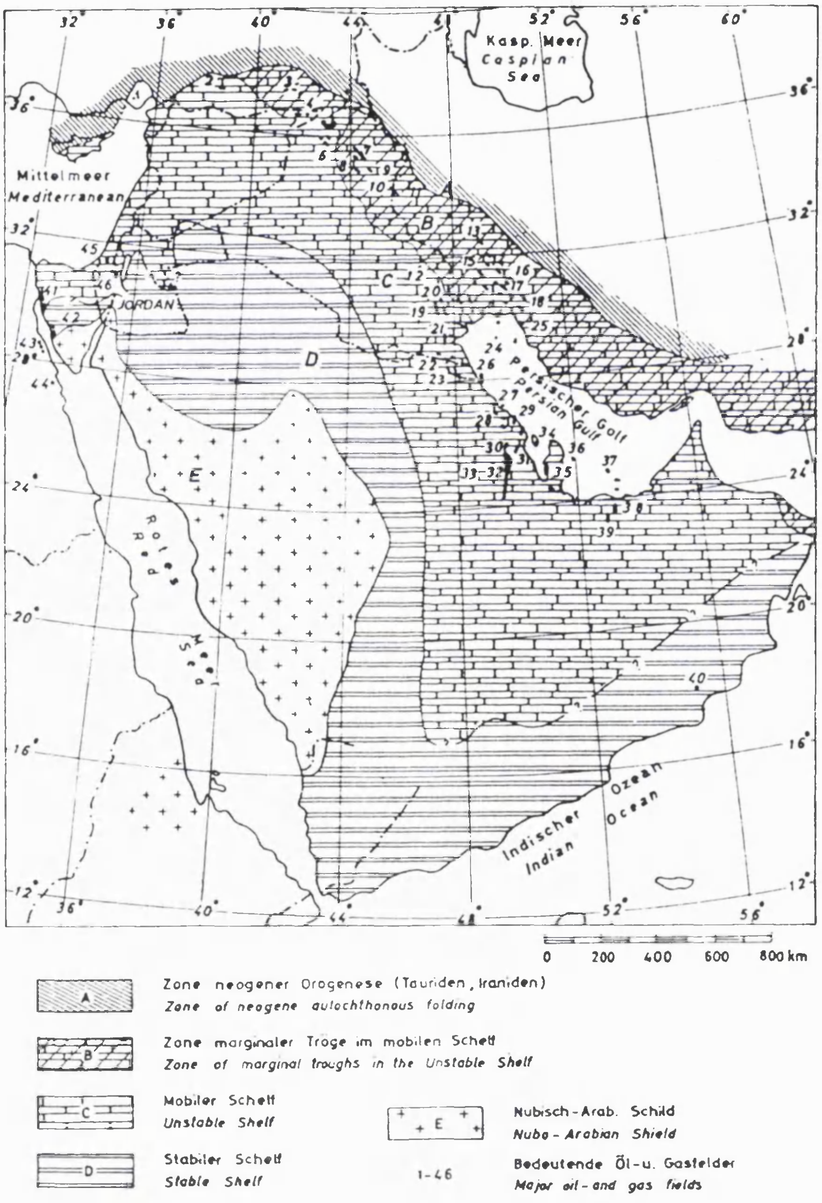


Figure 3.1: Geological Map of South-West Asia

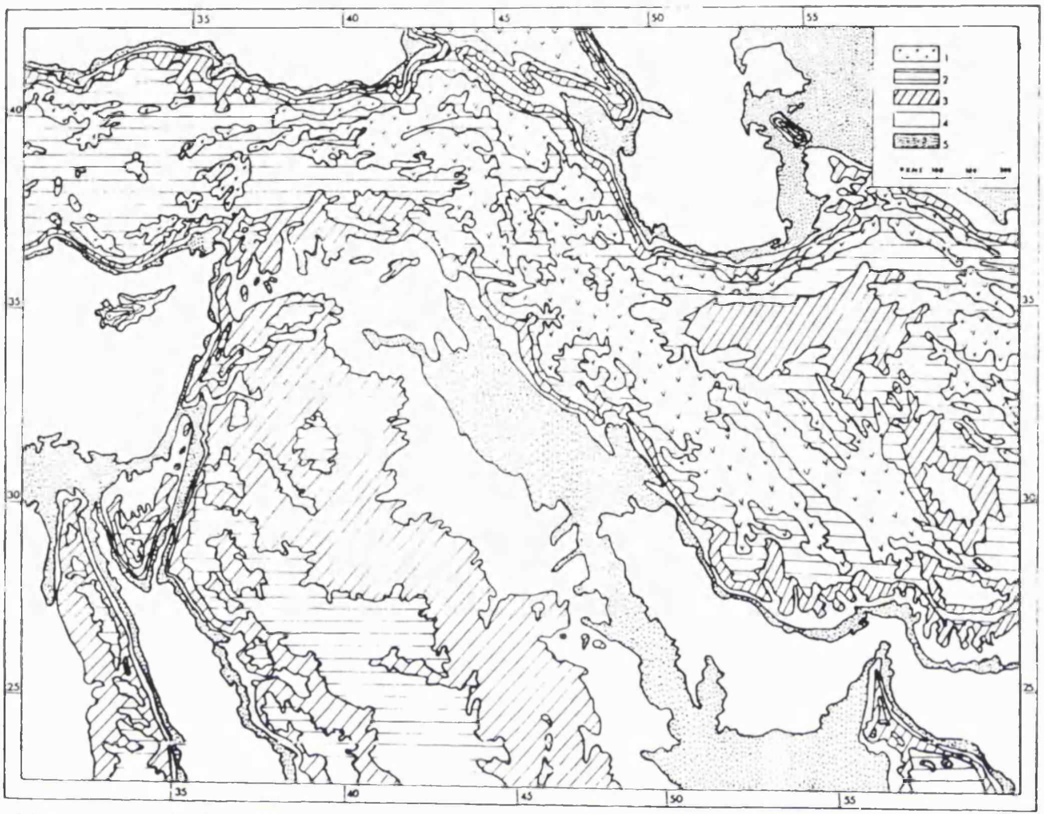
(Bender 1974, p.17 Figure 22a)

3.4: GEOMORPHOLOGY OF THE LEVANT:

The main topographical features of the Levant lie in four parallel belts which follow the north-south orientation of the coast (Zohary 1973, pp.8-10, van Zeist and Bottema 1991, pp.17-19). These four belts (see Figure 3.2), highlighted in bold type below, are more clearly defined in the south than in the north of the region.

A series of predominantly **limestone mountain ranges**, which are interrupted by broad transversal valleys, form the backbone of the Levant. From north to south these ranges are the Ansariye Mountains of western Syria at more than 1300m. a.s.l., the Lebanon Mountains at more than 3000m a.s.l., and the lesser ranges of Galilee, central Palestine, and the Negev Highlands, all generally less than 1000m. a.s.l.. In western Syria and Lebanon the mountains approach close to the sea, but in Israel there is a **broad coastal plain**, narrow in the north and wider in the south. To the east of this mountainous backbone is a **rift valley** formed from north to south by the Orontes valley, the Beqa'a valley, the Jordan valley, the Dead Sea basin (situated at more than 400m b.s.l.), and the Wadi Araba. The rift valley is flanked to the east by a **further series of mountain ranges and highlands**. These are, from north to south, the Anti-Lebanon Mountains at more than 2500m. a.s.l. and from which series of low mountain ridges branch out north-eastwards across the Syrian desert almost as far as the Euphrates, Mount Hermon at 2814m. a.s.l., the Golan Heights and, finally, the Jordanian Highlands which are generally in excess of 1000m. a.s.l.. This series of mountain ranges and highlands slope gently down to the east, where they merge into the dry steppes and sub-deserts of Syria, Iraq and Jordan.

In the extreme south-west of the Levant is the Sinai Peninsular. This comprises a limestone plateau which slopes up southwards from the Mediterranean towards a high range of plutonic and metamorphic mountains, which include Gebel Katherina at 2637m. a.s.l..

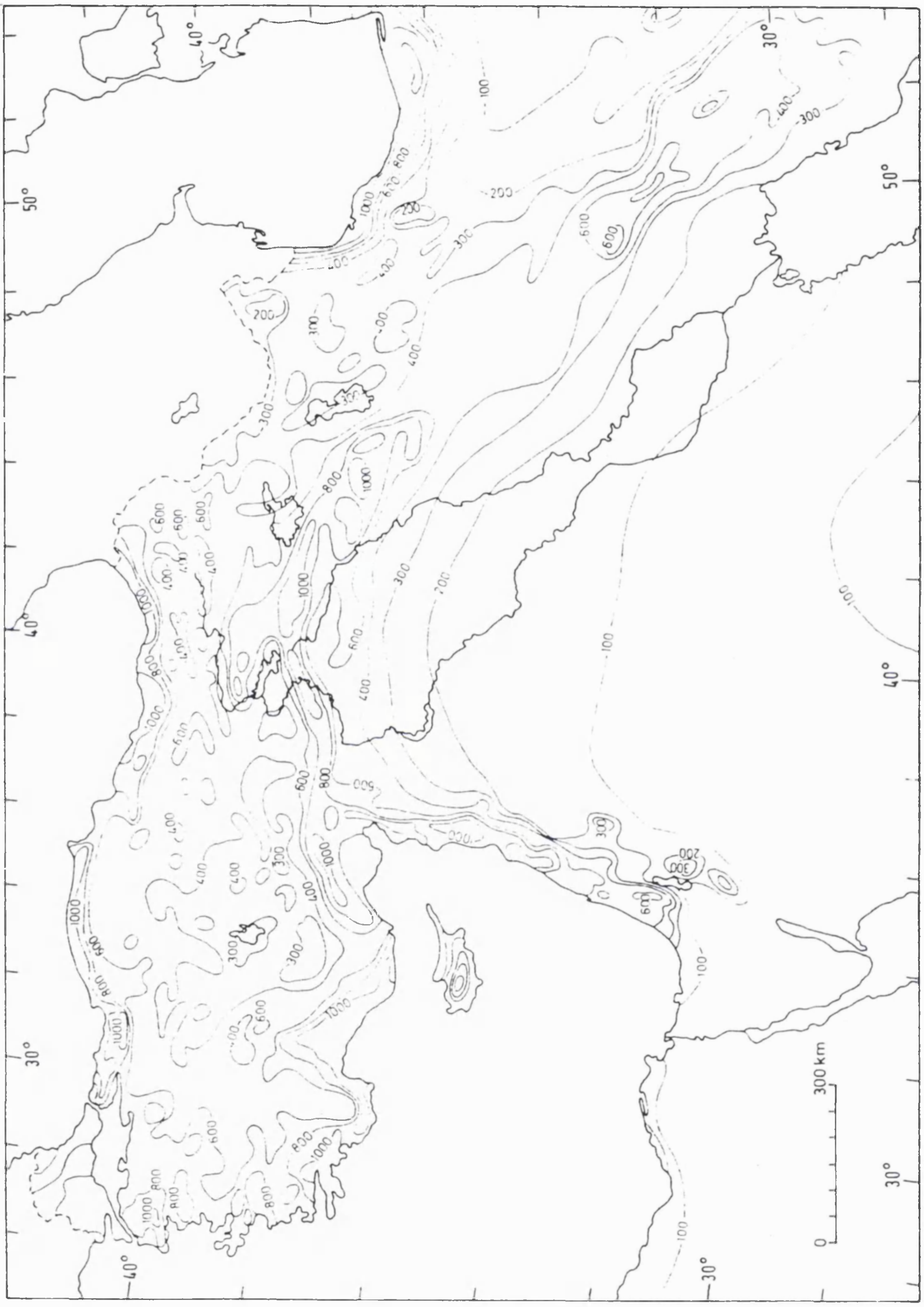


Map 3: Altitudinal sketch map of the area: 1–2,000–5,000 m; 2–1,000–2,000 m; 3–500–1,000 m; 4–200–500 m; 5–0–200 m.

Figure 3.2: Geomorphological Map of South-West Asia
(Zohary 1973, p.6 Map 3)

3.5: CURRENT CLIMATE OF THE LEVANT:

The climate of the Levant is affected by global, regional and local geographical factors, which include altitude, geomorphology and distance from the sea (van Zeist and Bottema 1991, p.19). The climate is relatively diverse and therefore reflects the region's varied topography. However there are some general trends: the Levant experiences a seasonal climate with winter rainfall predominating. Across the region, annual precipitation tends to decrease from north to south and from west to east (see Figure 3.3). Also, the lower the average level of annual precipitation, the greater the level of inter-annual variation.



Mean annual precipitation in the Near East. Isohyets of 100, 200, 300, 400, 600, 800 and 1000 mm

Figure 3.3: Modern Rainfall Distribution Map of South-West Asia

(van Zeist and Bottema 1991, p.21 Fig.3)

3.6: CURRENT VEGETATION OF THE LEVANT:

As the ability of plants to exist at all is limited by moisture, the distribution of plant species tends to be affected by temperature, air humidity, soil quality and annual level of precipitation. The location of phyto-geographical zones, which comprise areas of similar species composition and, in particular, which have the same dominant species (Zohary 1973, p.78), is a reflection of climatic variation.

Since Zohary's (1973) oft-quoted descriptions of the Mediterranean, Irano-Turanian, Saharo-Arabian and Sudanian regions, which comprise the four main phyto-geographical zones of the Levant, a number of further vegetation studies have been carried out in the region (e.g.: Al-Eisawi 1985, Kürschner 1986, van Zeist and Bottema 1991). These have led to refinement of Zohary's original descriptions and consequent adjustments to nomenclature to accommodate increasing levels of detail. Although Zohary's (1973) descriptions of the Mediterranean, Irano-Turanian, Saharo-Arabian and Sudanian regions form the basis of the following discussion, the results of more recent work by van Zeist and Bottema (1991) have been incorporated into the following descriptions of the Mediterranean and Irano-Turanian regions.

It should also be stressed that human interference has severely affected the modern range of vegetation found in the Levant. Arboreal species are especially reduced. Reliance on modern plant distribution data can therefore lead to certain inaccuracies regarding the species composition of the various phyto-geographical zones and the location of the boundaries between them. In some areas, for example, steppic Irano-Turanian vegetation is known to have filled the niche left by the clearance of the Mediterranean forests (Zohary 1973, p.101). For this reason, the phyto-geographical zones as described below refer to the estimated potential natural plant cover under current climatic conditions.

3.6.1: Mediterranean Region:

The Mediterranean region is characterised by short, mild, rainy winters and long, relatively hot, dry summers. Annual precipitation ranges from 300 to 1000mm. p.a.. Mediterranean vegetation in the Levant experiences year-round growth and typically consists of maquis or evergreen forest. However, as neither maquis or evergreen forest can develop in areas with less than 400mm. precipitation p.a., in such areas mixed dwarf-shrub and herbaceous vegetation develops instead. Two zones of maquis can be distinguished in areas with more than 400mm. precipitation p.a.. The lower zone, which extends from sea-level to 300m. a.s.l., consists of xeromorphic shrub dominated by carob (*Ceratonia siliqua*) and terebinth (*Pistacia* spp.) communities. The upper zone, which extends from 200 to 1200m. a.s.l. in Israel but up to 1650m. a.s.l. in drier areas such as the southern Jordanian highlands, consists of evergreen broad-leaved forest which is dominated by evergreen Palestinian oak (*Quercus calliprinos*), often in shrub form.

In areas of higher precipitation lying above 1100m. a.s.l., such as the Lebanon and Anti-Lebanon Mountains and Mount Hermon, the evergreen broad-leaved forest begins to give way to cold-deciduous forest dominated by deciduous Turkey oak (*Quercus cerris*) and deciduous Lebanese oak (*Quercus libani*), which in turn give way above 1600m. a.s.l. to coniferous forest dominated by Cedar of Lebanon (*Cedrus libani*), Cilician fir (*Abies cilicica*) and Greek juniper (*Juniperus excelsa*).

Two additional types of woodland were also once found in the Mediterranean regions of the Levant, although these have now been largely destroyed. Cold-deciduous broad-leaved lowland woodland dominated by deciduous Tabor oak (*Quercus ithaburensis*) would have covered large areas of northern Israel up to elevations of 500m. a.s.l., whilst mixed evergreen forests dominated by Aleppo pine (*Pinus halapensis*) would have have extended from sea level up to 1000m. a.s.l. in the Mount Carmel area.

3.6.2: Irano-Turanian Region:

The climate of the steppic Irano-Turanian region is more extreme than that of the Mediterranean region. As a result of its continentality it experiences great annual and diurnal ranges of temperature; compared to the Mediterranean region summers are longer and hotter, winters are colder, and rainfall, which ranges from 150 to 350mm. p.a., is lower. Growth of vegetation is suspended bi-annually owing to the extreme temperatures at the height of summer and winter. Typically, Irano-Turanian vegetation in the Levant is dominated by sagebush (*Artemesia herba-alba*) and consists of mixed formations of xeromorphic dwarf-shrublands and grasslands.

Between the Mediterranean and Irano-Turanian regions is a region containing elements of both plant communities, within which two zones can be distinguished. The first, forest-steppe dominated by Atlantic terebinth (*Pistacia atlantica*), almond (*Amygdalus korschinskii*) and hawthorn (*Crataegus aronia*) is found on the eastern slopes of the Palestinian mountains and also in the highlands of northern Jordan. The second, forest steppe dominated by Christ's thorn (*Ziziphus spina-christi*), is found in the south-eastern part of the Palestinian coastal plain and adjacent foothills.

3.6.3: Saharo-Arabian Region:

Where annual precipitation falls below 150mm. steppic Irano-Turanian vegetation gives way to desert-steppic Saharo-Arabian vegetation and eventually to largely unvegetated desert. In this zone the climate is seasonal, but winters are short and mild, and summers long, hot and extremely dry. Precipitation, which can range from 0 to 100mm. p.a., is torrential and sporadic with most areas in this region receiving between 25 and 50mm. p.a.. These climatic conditions combine to make the Saharo-Arabian environment a marginal one regarding plant life, particularly on exposed hammadas where vegetation is sparse and of low diversity. However, in wadi beds and depressions where run-off water accumulates vegetation is denser and more diverse. Here low shrubs such as bean caper (*Zygophyllum damosi*) and glasswort (*Anabasis articulata*), or desert adapted trees such as acacia (*Acacia* spp.), predominate. Many species of annuals are also found in the Saharo-Arabian region, however these are extremely unstable and only appear in years when sufficient moisture is present.

3.6.4: Sudanian Region:

In contrast to the seasonal regions described above, the Sudanian region is tropical in character with warm winters and very hot summers. Annual precipitation ranges from 0 to 100mm.. It is therefore these high temperatures, rather than annual levels of precipitation, which differentiate the Sudanian from the Saharo-Arabian regions. Sudanian vegetation is divided into two variants, the Eritreo-Arabian which comprises the forest and savannah highlands of north-east Africa and south-west Arabia, and the Nubo-Sindian which comprises those areas where temperatures are high enough to support a tropical vegetation but where annual precipitation is inadequate to support it.

It is Nubo-Sindian Sudanian vegetation which is found in the Levant, primarily in southern parts of the rift valley and coastal plain at elevations between 400m. b.s.l. and sea-level. In general the Sudanian region consists of hot, barren deserts. As in the Saharo-Arabian region, vegetation tends to be confined to wadi beds and depressions where run-off water accumulates; acacias (*Acacia* spp.), rimth (*Hammada salicornica*) and Christ's thorn (*Zizyphus spina-christi*) predominate.

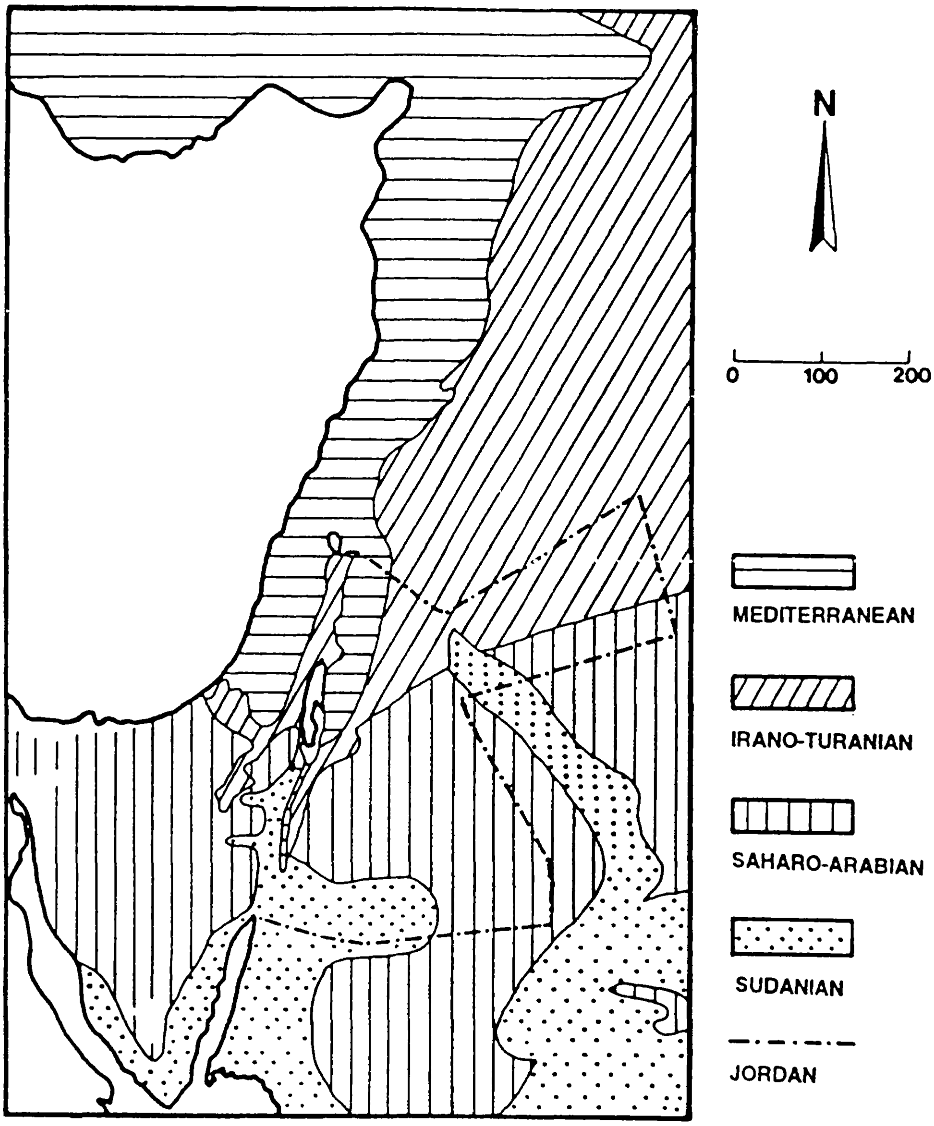


Figure 3.4: Location of Modern Phyto-Geographical Zones in the Levant (Martin 1994, p.14 Figure 1.2, adapted from Zohary 1973)

3.7: LATE PLEISTOCENE AND EARLY HOLOCENE CLIMATE AND VEGETATION OF THE LEVANT:

Many types of data, including wetland pollen cores, marine cores, archaeological flora and fauna, fluvial deposits, aeolian deposits and the sedimentology of the Lisan formation have been used to reconstruct the late Pleistocene and early Holocene climate and vegetation of the Levant. This mass of data has recently been summarised by Sanlaville (1996) who has demonstrated that the major climatic events of the Würm glacial chronology, which affected the northern hemisphere during the late Pleistocene and early Holocene, can be seen to a greater or lesser extent in most data types from the Levant.

Unfortunately, long-term sequences of reliable palaeo-environmental data are relatively rare and are effectively restricted to pollen cores from the Hula basin in northern Israel and the Ghab valley in north-western Syria, and to sedimentological studies of the Lisan formation of the Dead Sea and rift valley area. These offer glimpses of more localised, shorter-term climatic and vegetational changes in the Levant during the late Pleistocene and early Holocene than are apparent in most other data types, which tend only to reflect the major events of the Würm glacial chronology, and consequently form the basis of the following discussion.

3.7.1: Würm Glacial Chronology:

The major climatic events of the Würm glacial chronology which affected the northern hemisphere during the late Pleistocene and early Holocene are summarised below in chronological order (Baruch 1994 and Sanlaville 1996) and are highlighted in bold type.

25,000 to 15,000b.p.: the **Pleniglacial**, during which the cold and especially the aridity of the last glacial period reached its maximum extent.

15,000 to 10,000b.p.: the **Late Glacial**, which was characterised by major climatic oscillations associated with the rapid glacial retreat which eventually brought about the end of the last Ice Age. The glacial regime deteriorated rapidly through a series of fluctuations, the most important of which were the **Allerød** warm oscillation of 12,000 to 11,000b.p. and the **Younger Dryas** cold oscillation of 11,000 to 10,400b.p..

10,000 b.p. to present: the **Holocene**, the beginning of which brought an important climatic amelioration with a climatic optimum being reached in the **Atlantic period** of 8,000 to 5,000b.p..

3.7.2: Wetland Pollen Cores:

Pollen-rich lacustrine deposits are extremely scarce in the Levant. Consequently wetland pollen cores relating to the region during the late Pleistocene and early Holocene have been extracted from only two sites which are separated by a distance of more than 300km., namely: the Hula basin in northern Israel and the Ghab valley in north-western Syria. Unfortunately comparisons between the two sets of data have been hindered by problems in dating the Ghab cores, which are only now being gradually resolved.

3.7.2.1: Wetland Pollen Cores from the Hula Basin:

Over the years pollen diagrams have been prepared from various cores extracted from the Hula basin. These have formed the basis of most reconstructions of the climatic and vegetational history of the southern Levant during the late Pleistocene and early Holocene. The pollen diagram prepared by Weinstein-Evron (1983 and 1987) from the L-07 core covers the period from c.130,0000 to c.45,000b.p. and can be disregarded as it relates to a period earlier than that under consideration in this study. Furthermore, its proposed chronology is unsupported by radiocarbon dates and must therefore be considered speculative. The pollen diagram prepared by Horowitz from the K-Jam core (Horowitz 1971), covers the late Pleistocene and early Holocene period but is of limited use on account of discontinuities in the core and the fact that it is supported by only one radiocarbon date. The pollen diagram prepared by Tsukada from a further core (van Zeist and Bottema 1982, p.305) covers the late Pleistocene and early Holocene and is well supported by eleven radiocarbon dates, but unfortunately does not distinguish between the pollen of deciduous oaks (e.g.: *Quercus ithaburensis*, *Quercus cerris* and *Quercus libani*) and of evergreen oaks (e.g.: *Quercus calliprinos*) which are more tolerant of drier conditions.

These pollen diagrams have now been largely superceded by a diagram prepared by Baruch and Bottema (Baruch and Bottema 1991, Baruch n.d., Baruch 1994, Goring-Morris and Belfer-Cohen 1997) from yet another core. This covers the late Pleistocene, early Holocene and mid Holocene, is well supported by ten radiocarbon dates and distinguishes between the pollen of deciduous and evergreen oaks. It is consequently considered to be the most reliable and useful of the various pollen diagrams from the Hula Basin and is therefore described in more detail below.

17,000 to 15,000b.p.: the continued survival of predominantly evergreen oak woodland in the area during the cold, dry conditions of the Late Glacial.

15,000 to 11,500b.p.: a steady increase in arboreal pollen, predominantly deciduous oak, from c.15,000b.p., representing late Pleistocene woodland expansion which probably occurred in response to increased levels of annual precipitation. This process seems to have accelerated from c.13,000b.p. and reached a climax at c.11,500b.p.. The level of terebinth (*Pistacia* spp.) pollen was relatively high during the entire period, which is probably a reflection of mild winters and warm, moist summers.

11,500 to 10,500b.p.: a sharp decline in arboreal pollen and return to more steppic conditions, which probably occurred in response to decreased levels of annual precipitation of progressively increasing severity and, in the latter half of the period, to falling temperatures associated with the Younger Dryas. "Just before the beginning of the Holocene, climatic conditions in the southern Levant seem to have become almost as harsh as in the Pleniglacial maximum" (Baruch 1994, p.110).

10,500 to 7,000b.p.: a general increase in arboreal pollen from c.10,500b.p. provides evidence for some woodland re-expansion in response to the onset of moister and warmer conditions at the beginning of the Holocene. However, the deciduous oak forest does not seem to have re-expanded into the entire area it covered during the first half of the Late Glacial between 15,000 and 11,500b.p.. The fact that from c.10,500b.p. the level of evergreen oak pollen increased more than that of deciduous oak suggests that conditions for tree growth were slightly less favourable.

7,000 to 3,000b.p.: a sharp increase in arboreal pollen, which at times re-attained Late Glacial levels and included both deciduous and evergreen oak, is suggestive of continued and intensive woodland re-expansion during the climatic optimum of the Atlantic period. The level of terebinth (*Pistacia* spp.) pollen was also relatively high during the entire period, which is probably a reflection of mild winters and warm, moist summers. At the end of this period the arboreal pollen seems to have reverted back to early Holocene levels, which hints at the beginning of a process of woodland contraction that seems to have continued until the present day.

3.7.2.2: Wetland Pollen Cores from the Ghab Valley:

Our current knowledge of the palynological history of the northern Levant during this period is based entirely on the upper section of the Ghab I core (Niklewski and van Zeist 1970). This is rather unfortunate as this part of the Ghab sequence is rather inadequately dated, being supported by only one radiocarbon date. It is therefore unsurprising that the Ghab I pollen diagram, as originally published, revealed patterns of woodland expansion and contraction which not only directly contradict Baruch and Bottema's (1991) well-dated pollen diagram from Hula (see 3.7.2.1 above), but also pollen diagrams from almost all other cores in the wider region, e.g.: Tenaghi-Phillipon, Karamik-Batakligi and Zeribar (Hillman 1996, p169).

It is now generally accepted (Cappers et al. In Press) that the most likely reason for these discrepancies is that the single Ghab I radiocarbon date is several centuries too early, having been obtained from mollusc shells which could potentially have incorporated fossil carbon during their growth. Following exhaustive research, Hillman (1996) has therefore proposed that the Ghab I pollen diagram be re-dated to give the following palynological sequence:

15,000 to 11,500b.p.: a major episode of woodland expansion starting at c.15,000b.p., which continued, albeit with fluctuations, until c.11,500b.p..

11,500 to 10,100b.p.: a major episode of woodland contraction during which the proportion of herb pollen was high, reflecting a predominantly steppic environment.

10,100 to 8,000b.p.: a dramatic woodland expansion, which included increases in levels of oak (*Quercus* spp.), terebinth (*Pistacia* spp.), hornbeam (*Carpinus* spp.), European hop-hornbeam (*Ostrya carpinifolia*) and olive (*Olea* spp.).

8,000 to 7,600b.p.: a slight woodland contraction, which was especially severe between c.8,000 and c.7,600b.p. (Sanlaville 1996, p.23). This suggests that humidity reached its highest level at the beginning of the Holocene, before decreasing slightly after c.8,000b.p.. During this period terebinth (*Pistacia* spp.) disappeared altogether, which is suggestive of relatively dry conditions with colder winters.

If it is accepted, Hillman's (1996) proposed re-dating of the Ghab I pollen diagram reveals a similar sequence of events to Baruch and Bottema's (1991) pollen diagram from the Hula Basin which suggests that the northern Levant may have been affected by the same global and local climatic events as the southern Levant during the late Pleistocene and early Holocene.

3.7.3: Sedimentology of the Lisan Formation:

The large amount of research carried out on the lacustrine sediments of the Lisan formation, which were deposited in the late Pleistocene Lisan lake, has recently been summarised by Goldberg (1994) and Sanlaville (1996). The Lisan lake extended from south of the modern Dead Sea to the Sea of Galilee from at least 60,000b.p. until the onset of the Younger Dryas at c.11,000b.p.. This research, which includes studies of lithology, mineralogy and geochemistry, has formed the basis of varied reconstructions of the expansion and contraction of the Lisan lake and associated sequences of climatic change.

3.7.3.1: Expansion and Contraction of the Lisan Lake and Dead Sea:

By combining the sometimes contradictory results of the various lines of research it has been possible to build up an approximate curve of variation in the level of the Lisan lake and its successor, the Dead Sea. The chronology of this curve is based predominantly on radiocarbon dating of algal stromatolites, which have been shown to contain abundant fossil carbon (Goldberg 1994, p.99) and should therefore be treated with caution. Nevertheless, after detailed consideration of a vast array of data Sanlaville (1996, p.17) has proposed the following sequence of events:

17,000 to 11,300b.p.: from a level of approximately 370m. b.s.l. at c.17,000b.p., the level of the Lisan lake may have risen to 180m. b.s.l. by c.14,600b.p., and perhaps as high as 150m. b.s.l. between 13,000 and 12,000b.p. (Bowman and Gross 1992), before beginning to retreat again.

11,300 to 10,000b.p.: lake levels seem to have retreated extremely rapidly from c.11,300b.p. onwards during a phase of massive evaporation which corresponded with the latter part of the Allerød and the whole of the Younger Dryas. This marked the end of the Lisan lake and the beginnings of the Dead Sea. Cores taken from the delta of Wadi Zeelim, on the eastern shore of the north basin of the Dead Sea, have revealed deposits of rock-salt between 425 and 418m. b.s.l. (Yechieli et al. 1993) which indicate that lake levels were lower during the Younger Dryas than today.

10,000 to 7,000b.p.: the level of the lake seems to have risen to approximately its present level, possibly by 10,000b.p., but certainly by 8,200b.p. (Yechieli et al. 1993) and to have risen again at c.7,000b.p. to at least 300m. b.s.l.. This strongly suggests that the onset of the Holocene was accompanied by a return to moister conditions.

7,000b.p. to present: the lake seems to have contracted again, reaching present its level by c.6,000b.p..

3.7.3.2: Supporting Archaeological Data:

Archaeological research in the area once occupied by the Lisan lake has provided some additional data which support the results of the sedimentological studies summarised by Goldberg (1994) and Sanlaville (1996) Epipalaeolithic sites containing Kebaran and Geometric Kebaran industries are rarely found at elevations below 180m. b.s.l., which suggests that the Lisan lake was at its maximum elevation until at least the end of the Geometric Kebaran period at c.13,000b.p.. Lake levels had clearly fallen by the establishment at c.11,000b.p. of the Natufian settlement at Jericho, located at 200m. b.s.l. (Sanlaville 1996).

Studies of the sediments overlying Epipalaeolithic and PPNA sites in the lower Jordan Valley (Bar-Yosef et al. 1974, Hovers and Bar-Yosef 1987) suggest that conditions were relatively moist until c.11,000b.p., i.e.: during the Kebaran, Geometric Kebaran and early Natufian, that there was a more arid episode between c.11,000 and 10,300b.p., i.e.: during the late Natufian, but that moister conditions returned from 10,300b.p. onwards, i.e.: during the PPNA.

The abundance of rich PPNA sites in the Jordan valley has been taken as evidence of an 'Early Neolithic Pluvial' (Bar-Yosef et al. 1991). However, the extent to which the existence of a thriving PPNA culture in the Jordan Valley could have been a reflection of moister climatic conditions across the Levant at this time remains unclear. Sites of this period remain scarce in the dry steppe and sub-desert areas of southern and eastern Jordan where a slight increase in rainfall might be expected to have resulted in increased settlement density (Garrard pers.comm).

3.7.4: Summary of Late Pleistocene and Early Holocene Climate and Vegetation of the Levant:

During the late Pleistocene and early/mid Holocene the Levant seems to have come under the influence of the same major climatic events as the rest of the northern hemisphere. These events, the Pleniglacial, Late Glacial (including the Allerød and Younger Dryas oscillations) and Holocene, are clearly reflected in most of the data used to reconstruct the climate and vegetation of the region during this period.

The long sequences of data from the Hula pollen cores and the sediments of the Lisan formation are sufficiently detailed to permit tentative reconstruction of more regional climatic events during the same period. In particular, the southern Levant seems to have been affected by a cold and dry episode at c.12,000b.p. and another such episode between 8,000 and 7,600b.p.. Although the Ghab I pollen diagram and various data from Abu Hureyra suggest that the northern Levant was affected by the same climatic events as the southern Levant, this data is currently insufficiently well dated to permit detailed comparisons between the two areas. A summary of the climatic and vegetational changes thought to have affected the southern Levant during the late Pleistocene and early/mid Holocene is presented below.

3.7.4.1: Late Glacial Climatic Amelioration (15,000 to 11,000b.p.):

A prolonged phase of climatic amelioration following the extreme cold and aridity of the Pleniglacial is reflected in the Late Glacial woodland expansion. This is apparent from increases in arboreal pollen in Baruch and Bottema's (1991) pollen diagram from the Hula Basin and in the Ghab I pollen diagram as re-dated by Hillman (1996).The rising of the Lisan lake to its highest ever level of at least 180m. b.s.l by 14,600b.p. has been interpreted as reflecting increased temperatures and precipitation.

Supporting data (Sanlaville 1996, p.22) include the appearance of lakes at this time in the Negev, the location of Kebaran sites in the Negev and Sinai within alluvial and colluvial deposits, the dating of the most recent episode of soil formation in the Negev to between 15,000 and 11,000b.p., and various analyses of archaeological flora and fauna from the southern Levant which suggest that climatic conditions were especially favourable during this period.

This general pattern of climatic amelioration seems to have been briefly interrupted at about 12,000b.p. by a short period of increased cold and aridity which is reflected in a decline in arboreal pollen in Baruch and Bottema's (1991) pollen diagram from the Hula Basin, the Ghab I pollen diagram as re-dated by Hillman (1996), and in analyses of pollen from archaeological sites in the southern Levant (Sanlaville 1996, p.23).

3.7.4.2: Return of Cold and Arid Conditions During the Younger Dryas (11,000 to 10,000b.p.):

The return of cold and arid conditions in the Levant during the Younger Dryas is apparent from a major decrease in arboreal pollen and corresponding increases in the pollen of steppic species in Baruch and Bottema's (1991) pollen diagram from the Hula Basin and the Ghab I pollen diagram as re-dated by Hillman (1996). This increased aridity seems to have led to higher rates of evaporation, which caused the Lisan lake to drop to below 420m. b.s.l..

Supporting data (Sanlaville 1996, p.23) include large scale erosion of the Lisan marls, the formation of sabkhas and the appearance of gypsum crusts in the area once occupied by the Lisan lake, and analyses of archaeological fauna and flora from the southern Levant which are suggestive of a general increase in aridity at this time.

3.7.4.3: Early/Mid Holocene Climatic Amelioration (10,000 to 6,000b.p.):

The return of warmer and moister conditions at the beginning of the Holocene, after a brief transitional phase, is clearly seen in significant increases in arboreal pollen in

Baruch and Bottema's (1991) pollen diagram from the Hula Basin and in the Ghab I pollen diagram as re-dated by Hillman (1996), however these were slightly lower than during the Late Glacial. The remnants of the Lisan lake rose rapidly during the early Holocene, reaching 300m. b.s.l. by c.7,000b.p.. The early Holocene climatic amelioration seems to have intensified during the mid Holocene, between 7,000 and 3,000b.p., when arboreal pollen re-attained Late Glacial levels in Baruch and Bottema's (1991) pollen diagram from the Hula Basin.

The early/mid Holocene climatic amelioration may have been interrupted between 8,000 and 7,600b.p. by a brief period of increased cold and aridity (Sanlaville 1996, p.23). During this period the level of terebinth (*Pistacia* spp.) pollen, which is characteristic of mild winters and moist, warm summers, appears to have been much reduced in the Ghab I pollen diagram as re-dated by Hillman (1996).

CHAPTER 4:THE ARCHAEOLOGY OF THE LEVANT 12,500 TO 5,200B.P.

4.1: INTRODUCTION:

This chapter aims to describe in outline the archaeology of the Levant between 12,500 and 5,200b.p., which comprises the late Epipalaeolithic, Neolithic and Chalcolithic periods. These periods are generally accepted as forming the archaeological and cultural context within which caprines emerged as major early domesticates and more specialised pastoral economies developed in the Levant (Bar-Yosef and Khazanov 1992, p.1). Thus, general issues of archaeological terminology relevant to the entire period 12,500 to 5,200b.p. are discussed, and archaeological data specific to each phase of the Levantine late Epipalaeolithic, Neolithic and Chalcolithic periods described. These data include, for each phase, the means by which the phase is defined in the archaeological record, settlement size and location, chipped stone assemblages, chronology, phases and facies, and key aspects of material culture. Subsistence strategies are discussed separately in Chapter 5. Heavy use has been made of the following reviews: Bar-Yosef (1981a, 1981b, 1991, 1995), Bar-Yosef and Belfer-Cohen (1989a and 1989b), Fellner (1995), Gilead (1988), Gopher (1994 and 1995), Gopher and Gophna (1993), Henry (1989), Kafafi (1998), Martin (1994), Rollefson (1989, 1998a), Rollefson and Köhler-Rollefson (1993a), Sellars (1998) and Valla (1995).

4.2: ARCHAEOLOGICAL TERMINOLOGY:

The geological, geomorphological, climatic and vegetational diversity of the Levant, and the climatic and vegetational changes that occurred during the period under consideration (see Chapter 3), have resulted in considerable chronological and geographical variation in the late Epipalaeolithic, Neolithic and Chalcolithic archaeology of the region. Given such cultural complexity it is therefore essential that the chrono-cultural terminology used in the study of these periods enables the various components of material culture to be defined and classified in a consistent and precise manner. "Without the ability to classify, define and attribute the components of the system to social units of appropriate size, it will be very difficult to reconstruct what has occurred" (Gopher 1994, p.16).

Traditionally, chrono-cultural terminology for prehistoric periods was defined through typological analysis of architecture and chipped stone assemblages. However, the advent of radiocarbon dating and, more recently, the ability to calibrate radiocarbon years with calendar years has enabled the traditional terminologies to be more precisely defined. Today one has the option of either "categorising sites as belonging to a certain time transect or...defining cultural entities in space and time" (Bar-Yosef 1995, p.190).

Despite the radiocarbon revolution analyses of chipped stone continue to be an important tool in the definition of prehistoric terminologies as it is an almost universal category of artefact. A hierachical system in which assemblages, industries and cultures are defined is generally utilised in such analyses. These units can then be sub-divided, either temporally into phases or geographically into facies, and the results correlated with radiocarbon data where available.

Various terminologies have been used in studies of Levantine prehistory (Kenyon 1957, de Vaux 1970, Moore 1973 and 1978, Braidwood 1975, Crowfoot-Payne 1976, Aurenche et al. 1981, Bar-Yosef 1981a, Hours et al. 1994). These have recently been reviewed by Gopher (1994), and form the basis of the terminology used in his seriation analysis of Levantine Neolithic arrowheads (Gopher 1994). This is the most up to date description of large-scale chrono-cultural terminology relating to the period under consideration in this study, and is therefore described in detail below.

4.2.1: Chrono-Cultural Terminology used by Gopher (1994):

The chrono-stratigraphic units originally identified by Kenyon (1957) on the basis of the presence or absence of pottery in the stratigraphic sequence at Jericho (Pre-Pottery Neolithic A (PPNA), Pre-Pottery Neolithic B (PPNB), Pottery Neolithic A (PNA) and Pottery Neolithic B (PNB)), were retained by Gopher as the princip~~le~~al chronological units of cultural change for the Levantine Neolithic. Within these chronological units he followed Crowfoot-Payne (1976) and attempted to define temporally and geographically distinct smaller units distinguished by differences in material culture, particularly chipped stone assemblages, which are identified by local names. In practice Gopher sought to define these smaller units by seriation of arrowhead assemblages.

This is essentially a refined version of an approach first advocated by Bar-Yosef (1981a) in his attempt to define and classify data from the Jordan Valley, Sinai and Negev which could not be adequately reconciled with existing chrono-cultural terminologies defined on the Israeli coastal plain or in the mountains of central Palestine. Like Gopher, Bar-Yosef (1981a) utilised Kenyon's PPNA and PPNB as regional chronological units, within which he attempted to identify different lithic industries on the basis of a simplified typology of arrowheads.

Despite its apparent simplicity this approach is not without its difficulties. Principal amongst these is that radiocarbon dating has demonstrated that the regional chronological units are of different lengths in different areas, owing to the direction and rate of diffusion processes (Gopher 1994, p.20). Thus, the northern Levantine PPNA seems to have been far shorter than its southern counterpart. Furthermore, in many areas it has not always been possible to define smaller local units owing to the fragmentary nature of the data. However, despite its problems this approach seems to offer the best means of defining and classifying the various aspects of Levantine material culture under discussion here in a consistent and precise manner. It therefore forms the basis of the chrono-cultural terminology used in this chapter.

4.2.2: Chrono-Cultural Terminology used in this Chapter:

In this chapter the period 12,500 to 5,200b.p. is divided into the following commonly used regional chronological units: Natufian, Pre-Pottery Neolithic A, Pre-Pottery Neolithic B, Pottery Neolithic and Chalcolithic. However, where they have been defined, the archaeological data is discussed in the context of temporally and geographically distinct smaller units.

4.2.3: The Levantine Corridor:

The importance of the Levant in the emergence of the world's earliest sedentary food-producing economies has long been known. However, within the Levant the area known as the Levantine Corridor seems to have played a role of especial significance (Bar-Yosef and Belfer-Cohen 1989a). "In its most simplistic form the 'Levantine Corridor' stretches from the southern part of the Jordan Valley and the western flanks of the Trans-Jordanian plateau into the Damascus basin, and north into the Euphrates Valley. The Neolithic sites within this 'corridor' seem to represent the earliest agricultural manifestations of what later characterised Neolithic economies over the entire Fertile Crescent. While semi-sedentary and sedentary villages were established in the 'Levantine Corridor', people continued to hunt while practising cultivation of cereals and/or legumes that were supplemented by gathered wild seeds and fruits. In contrast, it is believed that neighbouring groups continued to practice economic systems which relied on hunting and gathering of food items that were available in local areas. It should be stressed that in all these Early Neolithic sites hunting lasted as a foraging activity until the introduction of domesticated goats and sheep which first occurred along the 'Levantine Corridor' during the PPNB" (Bar-Yosef 1991, pp.1-2).

4.3: THE LEVANTINE LATE EPIPALAEOLITHIC (12,500 TO 10,300B.P.):

Of the various periods of the Levantine Epipalaeolithic, which lasted from c.20,000 to c.10,300b.p. only the late Epipalaeolithic Natufian, its most recent period, is of relevance to the emergence of caprines as major early domesticates and the development of more specialised pastoral economies in the region.

4.3.1: The Natufian:

The simple, mobile hunter-gatherer cultures of the Levantine Epipalaeolithic became increasingly complex during the late Epipalaeolithic Natufian period, which lasted from c.12,500 to c.10,300b.p. and saw the emergence of large semi-sedentary communities with a rich material culture and wide range of socio-economic strategies. Although Natufian culture displays much continuity with that of preceding periods, a key innovation was the "tendency to prolong as much as possible those periods when families grouped together, at the expense of periods of dispersal" (Valla 1995, p.183). As such the Natufian can be said to have laid the foundations for the subsequent emergence of sedentary agricultural villages during the Neolithic. Unfortunately, the cultural diversity of the Natufian makes the period extremely difficult to define.

4.3.1.1: Definition:

Natufian chipped stone assemblages were historically identified on the basis of the presence of lunates in a microlithic assemblage (Garrod 1932). However, by the early 1970s it was clear that this definition would have to be refined as it included geographically and chronologically disparate sites of varying size and type.

Henry (1973) therefore attempted to define the Natufian more closely on the basis of the technological and typological characteristics of its chipped stone assemblages. Bar-Yosef (1970) took a different approach and proposed that the term be limited to 'base camp' sites, namely those with architecture, burials and diverse material culture, located in the Judean desert, Jordan Valley and Carmel and Galilee Mountains.

The issue of what constitutes the Natufian has never been satisfactorily resolved (e.g.: Byrd 1987, Perles and Philips 1991): "the definition of the Natufian and exactly what this complex encompasses continue to be a topic of debate among Near Eastern prehistorians" (Sellars 1998, p.83). Notwithstanding these problems of definition some generally recognised characteristics of the Natufian can be described.

4.3.1.2: Settlement Size and Location:

Natufian sites, located both in the open and in caves and rock-shelters, are found throughout the Levant in a wide variety of environmental settings. Although most known sites are located in the Mediterranean region, recent identification of Natufian sites in the more marginal dry steppe and sub-desert zones has demonstrated the full range of variation in Natufian settlement patterns. Indeed, "the core (Mediterranean vegetation zone) - periphery (everywhere else) dichotomy discussed for the Natufian may most accurately reflect the varying degree of research done in these regions" (Byrd and Colledge 1991, p.274). Sites vary enormously in size, from 15m.^{2} to more than 1000m.^{2}; Bar-Yosef (1981b, p.401) has suggested that the largest represent sedentary 'base camps' and the smaller ones more temporary 'seasonal camps'.

4.3.1.3: Chipped Stone:

In Henry's (1973) definition, which was largely based on data from Israel, Natufian chipped stone assemblages were characterised as consisting of microliths made on broad blades from multiple platform cores using a microburin technique. Tools were dominated by lunates, with backed bladelets, burins, scrapers and notches/denticulates present in lesser, though roughly equal, numbers. More recent work on Natufian assemblages (Byrd 1987; Sellars 1989) has generally reinforced Henry's definition, although a clear preference for single platform cores east of the Rift Valley has been identified (Sellars 1998, p.91).

4.3.1.4: Chronology, Phases and Facies:

Seriation of Natufian chipped stone assemblages has resulted in the identification of an Early Natufian phase, dated from c.12,500 to 11,000b.p., and a Late Natufian phase, dated from 11,000 to c.10,300b.p.. Early Natufian assemblages are dominated by bifacial (Helwan) retouch whereas Late Natufian assemblages are dominated by normal abrupt and bipolar retouch (Sellars 1998, p.93). In general, the relatively high level of variability seen in Early Natufian assemblages declines through time (Bar-Yosef 1981b).

A distinct local industry, the Harifian, has been identified within the terminal Late Natufian in the Negev and Sinai peninsula. The Harifian has been dated to between c.10,500 and c.10,000b.p. (Fellner 1995, p.29) and is defined by the presence of the Harif point and a decrease in the proportion of microliths (Bar-Yosef 1981b). It is thought that increasing aridity during the Late Natufian (see Chapter 3) may have reduced the food resources available in the Mediterranean region, thus forcing some populations into more marginal areas further to the south (Bar-Yosef and Belfer-Cohen 1989a, p.475).

4.3.1.5: Key Aspects of Material Culture:

Natufian material culture differed from that of its predecessors in five main areas: ground stone, worked bone, architecture, burial and artistic expression.

The quantity and variety of ground stone artefacts increased enormously during the Natufian. This has been interpreted as reflecting increased levels of cereal processing and sedentism during the period (Henry 1989, p.195), although some researchers argue that larger group sizes may also have been a contributing factor (Wright 1991, p.35).

Worked bone also became increasingly common during the Natufian. Artefacts, which were often elaborately decorated, include awls, points, barbed points, borers and sickle hafts. These may have been "indirectly tied to ranking and prestige, which, in turn, fuelled intensified foraging and the development of surpluses" (Henry 1989, p.197).

Although isolated structures are known from earlier Epipalaeolithic periods, during the Natufian carefully planned structures containing a wide variety of installations were constructed in small clusters, or 'villages', for the first time (Valla 1995, p.172). These structures were generally semi-subterranean, curvilinear and constructed of unmodified stone. Pits, which may have served as silos, are also a common feature on Natufian sites.

Natufian burials tended to be within or adjacent to structures; the Early Natufian was characterised by a wide range of group burials and the Late Natufian by individual burials from which the skull was often removed. Much discussion on Natufian social organisation has been generated by the wealth and variety of skeletons, grave types and grave goods (e.g.: Henry 1989, Byrd and Monahan 1995).

During the Natufian artistic expression became increasingly sophisticated. Pendants, beads, necklaces, statuettes and figurines made from a variety of materials, including bone, tooth, soft stone and marine shell, are all fairly common. The presence of marine shells on Natufian sites has been interpreted as evidence for the existence of a long distance trade network: "several of the Jordanian sites from which marine shells have been recovered in quantity are situated in excess of 200km. from the nearest marine source" (Sellars 1998, p.94).

4.4: THE LEVANTINE NEOLITHIC (10,300 TO 6,000B.P.):

For the purposes of this chapter the Levantine Neolithic is divided into PPNA, PPNB and PN periods. Archaeological data relating to these periods are described in chronological order below.

4.4.1: Pre-Pottery Neolithic A:

The PPNA period, which in the Levant is generally considered to date from 10,500/10,300 to 9,300b.p., saw the establishment of large sedentary villages and the transition from foraging to cereal production. As such it represents a "crucial threshold in human prehistory...that embodies profound changes in sedentism, social organisation, and technology" (Kuijt 1994, p.166).

4.4.1.1: Definition:

The PPNA was first identified by Kenyon (1957) at Jericho where the term was used to designate the earlier period of aceramic Neolithic occupation. It was distinguished from later phase of aceramic Neolithic occupation, or PPNB, on the basis of architectural typology characterised by oval or circular stone structures with mud floors (Kenyon

1957). Crowfoot-Payne's (1983) analysis of the chipped stone assemblage demonstrated that the PPNA assemblage from Jericho differed significantly from assemblages of roughly the same date from sites situated in the mountains of central Palestine to the west. She therefore proposed that the PPNA industry at Jericho be named Sultanian to distinguish it from this different industry, for which she adopted Echegaray's (1966) term Khiamian. Today the term PPNA is generally utilised to identify the period 10,500/10,300 to c.9,300b.p.. In the Levant very different site-types, located in many of the region's environmental zones, have been dated to the PPNA. Most, however, are characterised by curvilinear architecture and either Sultanian or Khiamian chipped stone industries.

4.4.1.2: Settlement Size and Location:

The great majority of known PPNA sites in the region are located in the Levantine Corridor, in the Jordan Valley or adjacent mountains (Kuijt 1994, p.166). Although cave sites were still occupied during the PPNA, though perhaps only on a seasonal basis, the majority of known sites are located in the open. Site size varied widely, ranging from 100 to 150m.^{2} upwards; the size of the largest sites increased enormously during this period, reaching a maximum of 2.5 hectares at Jericho. The few PPNA sites which have been discovered outside the Levantine Corridor fall into the smallest size category and seem to represent the seasonal activities of small groups of mobile hunter-gatherers (but see Kuijt 1994 for a detailed discussion of the under-representation of the PPNA outside the Levantine Corridor). Within the Levantine Corridor, the smallest sites have been interpreted as temporary campsites of hunting or gathering task groups from the larger sites, which are generally regarded as hamlets or villages (Bar-Yosef 1995, p.192).

4.4.1.3: Chipped Stone:

A few common features characterise PPNA chipped stone assemblages from southern Sinai to northern Iraq regardless of which industry they belong to. Foremost amongst these is the presence of varying proportions of Khiam points.

PPNA Khiamian assemblages are characterised by microliths, though in lower frequencies than during the Natufian, Khiam points and sickle blades, but no bifacial tools. In contrast, PPNA Sultanian assemblages are characterised by blade production and bifacial flaking, with lower proportions of microliths and Khiam points, but numerous large sickle blades, burins, perforators, picks, and tranchet adzes and axes (Bar-Yosef 1991, p.13).

Most researchers interpret the Khiamian as an independent archaeological entity that represents a short transitional period between Late Natufian hunting and gathering economies and the establishment of PPNA agricultural villages, represented by the Sultanian. Others regard the Khiamian as a geographical facies of the Sultanian although the "actual meaning in terms of human behaviour of such a definition is rather ambiguous" (Bar-Yosef 1991, p.13).

4.4.1.4: Chronology, Phases and Facies:

In the southern Levant the PPNA is generally considered to date from 10,500/10,300 to c.9,300b.p., although the period may have started a little earlier in the Damascus basin (Bar-Yosef 1995, p.195). Few radiocarbon dates and high standard deviations combine to make the beginning of the period poorly defined; the end of the period is represented by the most recent radiocarbon dates from Jericho (Bar-Yosef 1995, p.190). It should be noted that a number of researchers (e.g.: Baird 1993) tend to refer to the period 9,600 to 9,300b.p. as Early PPNB, although this is by no means universally accepted, especially in the southern Levant.

The Khiamian seems to have emerged right at the beginning of the PPNA but probably lasted for no more than a few hundred years. It seems to have been confined to the Mediterranean region of the central Palestinian mountains. The Khiamian is generally found overlying late Natufian occupations, from which it is thought to have developed, and is broadly contemporary with the Harifian (see 4.3.1.4 above). The Sultanian dominated the latter part of the PPNA and is thought to date from 10,300/10,100 to c.9,300b.p.. It is best known from sites in and adjacent to the Jordan Valley.

4.4.1.5: Key Aspects of Material Culture:

The material culture of the PPNA provides evidence for the first appearance of a regional site hierarchy in the southern Levant. This is most clearly seen in architecture and in the distribution of imported materials and other rare items such figurines (Kuijt 1994, pp.181-182). Other important aspects of PPNA culture include burials and the treatment of skulls.

To date few Khiamian structures have been discovered. Architecture in the larger Sultanian villages generally took the form of circular or oval semi-subterranean houses, similar to those of the Natufian period but with the added refinement of a mud-brick superstructure. These houses varied in size and in the amount of open space between them. This variation has been interpreted as reflecting varying degrees of kinship relationship between households (Bar-Yosef 1995, p.192). Non-residential, communal structures appeared in the Levant for the first time during the PPNA, again at the larger Sultanian agricultural villages. The most significant of these have been found at Jericho: a tower with an internal stairway standing eight metres high, which probably served some ritual or social function, and a series of huge walls originally thought by Kenyon (1979) to have been defensive but re-interpreted by Bar-Yosef (1986) as an attempt to protect the settlement from flood water.

Anatolian obsidian made its first appearance in the southern Levant during the PPNA, having travelled a distance of more than 1000km from its source. This obsidian may have been distributed within the region from the larger villages (Bar-Yosef 1995, p.198).

Compared to the Natufian, few examples of artistic expression are known from the PPNA. Virtually all known examples came from the larger Sultanian villages, and often take the form of seated female figurines. The "definitely female figures mark a clear departure from the Natufian world where animals dominate the inventory of known objects" (Bar-Yosef 1995, p.197).

PPNA burials are well known and show a high degree of continuity from Late Natufian practice; most consist of individual interments without grave goods. The practice of removing the skull from adult burials which had begun during the Late Natufian became commonplace during the PPNA. In contrast, skeletons of children are generally found intact (Bar-Yosef 1995, p.197).

4.4.2: Pre-Pottery Neolithic B:

The PPNB period in the southern Levant is generally thought to have lasted from c.9,300 to 8,000b.p., although some researchers (e.g.: Baird 1993) argue that it may have started as early as c.9,600b.p., and is characterised by an expanding population and increasing degrees of complexity in all spheres. These included architecture, burial practices, ritual, long-distance contacts, and exchange and subsistence activities. The archaeology of the PPNB is much better known than that of preceding and succeeding periods and numerous sophisticated socio-economic interpretations of the data have been presented. The overview of the PPNB presented below is therefore extremely simplified owing to the wealth of data available.

4.4.2.1: Definition:

Like the PPNA, the PPNB was first defined by Kenyon (1957) at Jericho where the term was used to designate the later phase of aceramic Neolithic occupation at the site. The presence within the chipped stone assemblage of Byblos points and bipolar cores and a shift from curvilinear to rectilinear architecture was originally used to distinguish the PPNB from the preceding PPNA (Kenyon 1957). Many of the cultural traits characterising the PPNB at Jericho were subsequently found at broadly contemporary sites of varying size and type throughout the entire Levant. However, pronounced regional trends have also been identified.

It is now clear that variability in PPNB material culture is both chronologically and geographically based. Consequently, the period is typically divided into Early, Middle, Late and Final phases and further sub-divided into four main geographical facies: southern Levant, central Levant, northern Levant and Taurus mountains (Cauvin 1987). However, "rigid...divisions are perhaps misleading, for the temporal and geographical boundaries are to some extent tenuous and occasionally arbitrary. The geographic divisions probably fluctuated during the sequence, especially in cases where sites were near the juncture of two facies areas" (Rollefson 1989, p.168).

Owing to the sheer variability and quantity of data available definitions of the PPNB have necessarily remained extremely broad-based. Even today chipped stone assemblages are assigned to the PPNB on the basis of the presence of a few 'type-fossils', predominantly bipolar naviform cores and Helwan, Jericho, Byblos and Amuq points. PPNB-type chipped stone assemblages have been found from the piedmont zone of the Taurus mountains to the Sinai peninsular.

In an attempt to reconcile the uniformity of some aspects of PPNB material culture across this huge area with the pronounced regionalism evident in others, Bar-Yosef and Belfer-Cohen (1989b) suggested that the concept of a homogenous PPNB culture area be abandoned. In its place they introduced the concept of a PPNB 'Interaction Sphere' composed of distinctive sedentary agricultural communities centred on the Levantine Corridor, linked with each other and with hunter-gatherer groups to the east and west through inter-societal exchange systems.

The Final PPNB phase, dated to the first half of the 8th millennium b.p., has been the subject of much discussion. Whilst it is clear that the Final PPNB is not very different from the Late PPNB in the northern Levant, Rollefson has suggested, largely on the basis of excavations at 'Ain Ghazal, that the southern Levant "underwent a major upheaval in terms of settlement pattern, inferred social organisation, economic exploitation practices, lithic production, ritual treatment of the dead and general lifestyle" (Rollefson and Köhler-Rollefson 1993a, p.41) sufficient to warrant the term PPNC, instead of Final PPNB. This view is gradually gaining support amongst researchers (eg: Gopher and Gophna 1993, Garfinkel 1994, Gopher 1994, Kuijt 1997). As much of this study is focused on 'Ain Ghazal, Rollefson's terminology has been adopted. In this chapter PPNB therefore refers only to the Early, Middle and Late phases. The Final PPNB/PPNC is discussed separately in 4.4.3 below.

4.4.2.2: Settlement Size and Location:

PPNB sites are well known from all environmental zones of the Levant. The general trend of increasing settlement size and expanding population which characterised the PPNA continued into the PPNB, although this trend was by no means temporally or geographically uniform.

Early PPNB data from the southern Levant is rare (see Kuijt 1997 and Rollefson 1998 for two different views concerning the transition from the PPNA to PPNB in the southern Levant), but by the Middle PPNB some sites in the Levantine Corridor were considerably larger than the largest PPNA sites. 'Ain Ghazal, for example, is thought to have covered an area of 4 to 5 hectares at this time (Rollefson 1998a, p.110).

During the Late PPNB there was great disturbance of settlement patterns throughout the Levantine Corridor. Many sites located predominantly, though not exclusively, in the Jordan Valley were abandoned. These included established settlements such as Jericho, Munhatta and Beidha. In contrast, settlement density in the Jordanian Highlands seems to have increased significantly during this period. Existing sites such as 'Ain Ghazal continued to be occupied and numerous new sites, including Basta, Wadi Shu'eib and 'Ain Jammam, were established in previously unoccupied locations. During the Late PPNB many of these settlements experienced phenomenal expansion, with many eventually exceeding 10 hectares (Rollefson 1989, p.169). Two explanations have been put forward to explain the abandonment of settlements in the Jordan Valley during Late PPNB. The first (de Contenson 1982) argues that increasing aridity destroyed their × agricultural base, whilst the second (Köhler-Rollefson 1988, Rollefson and Köhler-Rollefson 1989) suggests that population increase, sedentism, over-grazing and an increased dependence on agriculture "slowly but steadily throttled smaller and ecologically sensitive MPPNB settlements, forcing a relocation of the affected populations, in part at least, to farming villages in more tractable environmental circumstances" (Rollefson 1998a, p.114).

Areas outside the Levantine Corridor were also occupied during the PPNB although here settlements were much smaller, especially in the more arid dry steppe and sub-desert zones of the south and east of the region (Bar-Yosef 1995, p.195 Table 1). Many such sites seem to reflect seasonal occupation by groups of hunter-gatherers.

4.4.2.3: Chipped Stone:

PPNB chipped stone assemblages exhibit some aspects of uniformity across the PPNB Interaction Sphere as well as pronounced regional characteristics. Arrowhead typology and the widespread use of the naviform core and blade technique are amongst the most uniform characteristics of PPNB chipped stone assemblages. These can therefore be used to distinguish them from those of the PPNA and PPNC. In contrast, axes and adzes display a great deal of regional variation, possibly as a result of "constraints imposed by local traditional and hafting techniques" (Bar-Yosef and Belfer-Cohen 1989b, p.64).

Arrowhead typology has been shown to be closely linked to chronology during the Pre-Pottery Neolithic (Bar-Yosef 1981a, Gopher 1994). There seems to have been a gradual shift from the Khiam points of the PPNA to Helwan points, then Jericho and Byblos points and finally to Amuq points during the course of the PPNB. However, considerable chronological overlap between these types is also apparent.

Early PPNB chipped stone assemblages are rare in the Levant, but where they exist they are characterised by prismatic and bipolar, especially naviform, cores, Helwan points, long sickle blades and tranchet axes (Bar-Yosef 1981a, p.564). Middle PPNB assemblages from the region are much better known. These are dominated by naviform cores and "long, inversely retouched sickle blades, the high frequency of Jericho and Byblos points and their variants, a few Amuq points and the partial replacement of tranchet axes by the amygdaloid and oval types" (Bar-Yosef 1981, p.564). Late PPNB assemblages tend to be technologically similar to those of the Middle PPNB, but display increased typological variation (Rollefson 1998, p.111). This was particularly pronounced in arrowheads, of which Byblos and Amuq points were the most frequent types.

4.4.2.4: Chronology, Phases and Facies:

The PPNB (Early, Middle and Late phases only) in the southern Levant is generally thought to date to between c.9,300 and 8,000b.p.. In the northern Levant it seems to have started slightly earlier, perhaps by c.9,900b.p. (Bar-Yosef and Belfer-Cohen 1989b, p.59, Gopher 1994, p.260). The phases of the PPNB in the southern Levant are relatively difficult to define and may well overlap slightly. Nevertheless, within the region the Early PPNB is generally thought to date from c.9,600 to c.9,300b.p., the Middle PPNB from c.9,300 to c.8,500b.p. and the Late PPNB from c.8,500 to c.8,000b.p..

The status of the Early PPNB in the southern Levant remains problematic. Some researchers (e.g.: Kuijt 1997) argue that this phase was confined to the northern Levant, whilst others (e.g.: Gopher 1994, Rollefson 1998a) have attributed a number of southern Levantine sites, located predominantly in Galilee and the Golan Heights (Gopher 1994, p.260), to this phase.

Gopher (1994) has also proposed that the Middle and Late PPNB in the southern Levant be divided into northern and southern facies: the "southern unit existed in the Sinai, Negev, and the eastern and western fringes of the Araba from the late eighth millennium to 6,000 B.C.. The northern units include the fringes of the Judean desert, the Jordan Rift Valley, the central hills as far as Hebron, and the Coastal Plain. It may be called 'Tahunian', although the term is problematic. This unit functioned between c.7,300/7,200 and 6,000 B.C." (Gopher 1994, p.260).

4.4.2.5: Key Aspects of Material Culture:

The PPNB saw significant development in architecture, burial, artistic expression and in patterns of trade and exchange, especially within the Levantine Corridor.

The most important architectural development during the PPNB was a gradual shift from circular or oval structures to rectangular buildings at larger sites within the Levantine Corridor. Many of these rectangular buildings were characterised by solid plaster floors. Within the region there was great variety in the size of structures, their subdivisions, installations and number of rooms (Banning and Byrd 1984). There is also evidence for the existence of two storey houses at Beidha, Basta and 'Ain Ghazal. At sites in dry steppe and sub-desert zones of the region architecture continued to be dominated by curvilinear structures throughout the PPNB (Bar-Yosef 1995, p.193).

Although the great majority of known PPNB burials come from settlements, the "number of MPPNB burials simply does not conform to population estimates of the settlements and ... an off-site cemetery or other form of post-mortem disposal was the norm" (Kirkbride 1968, quoted in Rollefson 1998a, p.108). PPNB burials exhibit great variety: adults were often buried beneath floors or courtyards and many had their skulls removed, thus displaying continuity from Natufian and PPNA practice. During the PPNB, however, these skulls were often elaborately modelled in plaster or bitumen. This has been interpreted as evidence for the existence of an ancestor cult (Bar-Yosef 1995, p.197).

Artistic expression seems to have undergone a revival during the PPNB and many art objects seem to have served some ritual purpose. These include numerous small animal and human, predominantly female, figurines. The female figurines are commonly thought to represent a 'mother goddess' (Bar-Yosef 1995, p.197-198). Caches of plaster human statues and busts have been excavated at 'Ain Ghazal; their context "hints at the presence of an organised religion with distinguished members of the community who served the cult" (Bar-Yosef 1995, p.198).

Many aspects of PPNB material culture suggest that a long distance network of trade and exchange operated during the period. This seems to have encompassed both agricultural and hunter-gatherer communities and was probably the mechanism that gave rise to the PPNB Interaction Sphere. The homogeneity seen in arrowhead typology throughout the region suggests that exchange of objects and information between groups of hunters was an important aspect of inter-communal interaction. Objects traded over long distances during the PPNB include Anatolian obsidian, high quality flint, rare minerals for bead production and marine shells.

4.4.3: Final Pre-Pottery Neolithic B/Pre-Pottery Neolithic C/Early Late Neolithic:

Whilst it has long been clear that the first half of the 8th millennium b.p. in the northern Levant saw the continuation of PPNB culture in the form of the Final PPNB (Rollefson 1989, p.169), the situation in the southern Levant remains poorly understood in comparison. The abandonment of many established settlements in the Jordan Valley during the Late PPNB led Kenyon (1979, p.46) to suggest that the entire region was abandoned for up to a thousand years, a concept which became known as the Palestinian Hiatus. More recent research, especially at 'Ain Ghazal (e.g.: Rollefson, Simmons and Kafafi 1992), has shown that the sequence of events in the Jordan Valley was not representative of the region as a whole. It is now known that the southern Levant was continuously occupied throughout the Late PPNB, though with severe disruption to established settlement patterns and significant cultural changes in all spheres, especially within the Levantine Corridor. This has prompted Rollefson to suggest that the period be termed the PPNC (Rollefson and Simmons 1986, p.161). However, in the dry steppe and sub-desert zones of the region the period is generally referred to as the early Late Neolithic, especially in eastern Jordan (e.g.: Garrard, Baird and Byrd 1994).

4.4.3.1: Definition:

In the northern Levant the Final PPNB essentially represents the continuation of PPNB cultural practices into the 8th millennium b.p., with the important addition of pottery to the cultural inventory (Rollefson 1989, p.171). The PPNC of the southern Levantine Corridor was first defined at 'Ain Ghazal in 1984, where continuous occupation from the Late PPNB until the Pottery Neolithic Yarmoukian culture of the latter half of the 8th millennium BP was documented for the first time. The PPNC at 'Ain Ghazal was distinguished from the PPNB on the basis of significant differences in lithic typology and technology, architecture and burial, which have subsequently been recognised at a number of other sites the southern Levant (Rollefson 1998a, p.115). However, in comparison with the 9th millennium b.p. this period remains relatively poorly documented with conspicuous regional variation within it.

4.4.3.2: Settlement Size and Location:

Owing to the fact that settlements dating to the first half of the 8th millenium b.p. were unknown in the southern Levant prior to 1984, the number of sites remains small. To date the great majority of identified PPNC sites are located in the Jordanian Highlands and include 'Ain Ghazal, Wadi Shu'eib, es-Seyyeh and possibly Basta, Beidha, es-Sifiya, Ghweir and 'Ain Jammam (Rollefson 1998a, p.118). In addition, PPNC material culture has also been recognised in Israel at Khirbet Sheikh 'Ali (Garfinkel 1994) and Atlit Yam (Gopher and Gophna 1993). The dry steppe and sub-desert zones of the region were also occupied during this period. Early Late Neolithic occupation has been widely documented in eastern Jordan (Garrard, Baird and Byrd 1994), although it is unclear if these sites belong to the PPNC cultural tradition (see Rollefson 1998a, p.118 for a brief discussion of the problems of identifying a PPNC presence in this region). The quantity of data is too small to make generalisations about site size, but at 'Ain Ghazal the LPPNB expansion of the site continued into the PPNC, when it covered between 12 and 13 hectares (Rollefson, Simmons and Kafafi 1992).

4.4.3.3: Chipped Stone:

So far few analyses of PPNC chipped stone assemblages have been published. 'Ain Ghazal provides much of the data for this phase, and the extent to which this assemblage is representative of developments across the region remains unclear.

At 'Ain Ghazal the naviform core and blade technique characteristic of the PPNB was largely abandoned during the PPNC as flake production increased. In addition, the frequency of transverse burins decreased, side-scrapers gave way to transverse-scrapers and the frequency of tabular and bifacially retouched knives increased (Rollefson 1998a, p.115). Arrowhead typology also changed significantly during the PPNC, with the long, heavy points of the PPNB giving way to shorter, lighter points (Rollefson and Köhler-Rollefson 1993a).

4.4.3.4: Chronology, Phases and Facies:

The Final PPNB, PPNC and early Late Neolithic are all considered to date from c.8,000 to c.7,500b.p.. During this period the northern Levant saw a continuation of PPNB cultural practices in the form of the Final PPNB. In contrast, available data suggests that the southern Levant may have followed a very different sequence of cultural development in the form of the PPNC and early Late Neolithic. To date there is insufficient data to identify phases and facies during the first half of the 8th millennium b.p. in the southern Levant. However, it seems increasingly likely that the PPNC phenomenon as identified at 'Ain Ghazal was centred on the Levantine Corridor and that the sequence of cultural development in adajacent regions followed a different pattern, as suggested by the early Late Neolithic of eastern Jordan.

4.4.3.5: Key Aspects of Material Culture:

The amount of data from the Levant which dates to the first half of the 8th millennium b.p. is relatively small. The material available, which comes predominantly from 'Ain Ghazal, does however suggest that there may have been significant changes in architecture and burial.

At 'Ain Ghazal, the large, rectilinear, multi-roomed, plaster-floored houses of the PPNB gave way to two very different types of structure, also rectilinear, during the PPNC, namely: simple, single-roomed houses with mud-plaster floors and more complex multi-roomed corridor-buildings. The latter structures seem to represent semi-subterranean storage bunkers, whose walls may have supported a platform on which temporary structures could potentially have been erected (Rollefson 1998a). Similar corridor buildings have been excavated at Beidha. Kirkbride (1966, p.72) assigned these to the Middle PPNB on the basis of radiocarbon dating, but Rollefson (1998a, p.116) has noted that these dates may represent 'old wood' and could therefore be too early. Curvilinear architecture continued to predominate in the dry steppe and sub-desert zones of the Levant throughout the period.

Burials are known from a number of sites dating to the first half of the 8th millennium b.p. and represent a clear departure from PPNB practice. Most significantly, skulls were no longer removed from the skeletons, suggesting that the PPNB ancestor cult had changed or had even been abandoned altogether (Rollefson, Simmons and Kafafi 1992, p.464). Multiple burials were relatively frequent and, at 'Ain Ghazal at least, grave offerings in the form of pig bones were a common feature in burial pits (Rollefson 1998a, p.117). Secondary burials also increased in frequency, at both agricultural and hunter-gatherer sites; at sites in the Sinai peninsula it seems that "the dead were first buried at the location of death and were later removed to the central site" (Bar-Yosef 1995, p.197).

4.4.4: Pottery Neolithic:

It has long been clear that large scale socio-political structures began to emerge in the north-eastern Levant and Mesopotamia during the 8th and 7th millennia b.p.. Consequently, the Pottery Neolithic cultures of this region, such as the Hassuna, Samarra, Halaf and Ubaid, have been intensively investigated during the course of research into the development of the urbanised civilisations of Mesopotamia (Gopher 1995, p.205). However, as research in the Levant has focused primarily on the emergence of the earliest food producing economies during the Natufian and Pre-Pottery Neolithic periods the succeeding Pottery Neolithic of the 8th and 7th millennia b.p. remains poorly understood.

Although it is clear that very different socio-economic systems appeared in the Levant following the collapse of the PPNB Interaction Sphere at the end of the 9th millennium b.p., their analysis remains difficult owing to "inadequate publication, poor techniques of excavation and analysis, and the scarcity of organic remains and radiometric dates" (Gopher and Gophna 1993, p.301). However, most researchers agree that development of new socio-economic systems during the Pottery Neolithic laid the foundations for the subsequent emergence of complex urban societies in the Levant during the Chalcolithic period and especially the Early Bronze Age.

The most significant of these changes was a reduction in the scale of Pottery Neolithic cultural units compared to the vast PPNB Interaction Sphere, which is generally attributed to a decline in the importance of hunting (Gopher 1995, p.214). This suggests that the widespread network of trade and exchange which functioned during the PPNB had completely broken down. Additionally, although occasional use of pottery during the PPNB has been documented in the southern Levant, its widespread adoption during the Pottery Neolithic was not merely a "utilitarian functional innovation, but... (for the first time) an assemblage operating also on the social and symbolic levels" (Gopher 1995, p.216).

4.4.4.1: Definition:

The term Pottery Neolithic was first used by Kenyon to describe the phase of occupation at Jericho which succeeded the Pre-Pottery Neolithic. Two phases were originally identified, the Pottery Neolithic A and Pottery Neolithic B. These were rapidly adopted by researchers investigating the 8th and 7th millennia b.p. in the southern Levant. However, in the same decade the Yarmoukian was identified as a distinct cultural entity following excavations at Shaar Hagolan (Stekelis 1951), as was the Wadi Raba culture, following excavations at Tel Aviv, Wadi Raba and Teluliot Batashi (Kaplan 1958). It therefore soon became apparent that the 8th and 7th millennia b.p. in the southern Levant were characterised by pronounced chronological and regional variation and that Kenyon's PNA and PNB as identified at Jericho were too site specific to be applied to the region as a whole.

In the southern Levant today the term Pottery Neolithic is generally used to describe the period between c.7,500 and c.6,000b.p., within which smaller geographical or temporal units, described by local names, are identified. The most significant of these smaller units are the Yarmoukian, Lodian (which includes the PNA) and Wadi Raba (which includes the PNB) cultures (Gopher and Gophna 1993 and Gopher 1995).

4.4.4.2: Settlement Size and Location:

During the PN the Levantine Corridor seems to have lost its previous importance. During this period site distribution was therefore probably influenced by new factors, but unfortunately these are poorly understood.

The Yarmoukian seems to have been centred on a belt running east-west across central Israel and Jordan, from the coastal plain to the Jordanian plateau. As such it encompassed a wide variety of environmental zones. In addition, isolated occurrences have also been recorded in the Judean desert and western Galilee (Gopher 1995, p.214).

The Lodian, in contrast, seems to have had a more restricted distribution, with sites being restricted to low-lying and hilly areas along the coastal plain, central Jordan valley and to the east of the Dead Sea (Gopher 1995, p.214).

The situation during the Wadi Raba culture was more complex as this culture included a wider range of sub-units than its predecessors (Gopher 1995, p.214). The normative Wadi Raba culture, as defined by Kaplan (1958), seems to have been confined to low-lying areas in northern and central Israel, specifically the northern Jordan valley, Jezreel valley and coastal plain. However, the normative Wadi Raba culture seems to have been surrounded by local variants (Gopher and Gophna 1993, pp.336-337). The most significant of these variants were Kenyon's PNB, centred on Jericho, and the Qatifian, which was centred on the Negev and Dead Sea region.

It is difficult to make generalisations about site size during the PN as most occurrences represent unexcavated find spots. However, although Yarmoukian 'Ain Ghazal may well have extended over most of 12 or 13 hectares it covered during the PPNC (Rollefson, Simmons and Kafafi 1992), the majority of PN sites in the Levant seem to have been small in comparison to those of the PPNB (Gopher 1995, p.214).

4.4.4.3: Chipped Stone:

There are a number of key differences between the chipped stone assemblages of the PN and PPNB. Some of these were already apparent by the PPNC, which in many respects represents a transitional phase between the two.

Most significantly, the frequency of arrowheads decreased throughout the PN to virtual absence in Wadi Raba assemblages. This has been interpreted as reflecting a continued decline in the importance of hunting. Furthermore, the arrowheads of the Pottery Neolithic were significantly smaller and of different typology than those of the PPNB, which most probably reflects changes in hunting techniques or bow technology (Gopher 1995, p.217). There was also a pronounced change in sickle blades from the long, finely denticulated blades of the PPNB to shorter, more coarsely denticulated blades during the

Pottery Neolithic, which may be a reflection of changes in harvesting techniques (Gopher 1995, p.217).

There are also a number of differences between the chipped stone assemblages of the main cultural units of the PN. Yarmoukian assemblages were dominated by flake production although bipolar blade cores continued to be present in small numbers. Characteristic tools include new sub-types of Byblos and Amuq points, small Haparsa and Herzliya points, coarsely denticulated sickle blades, bifacial knives and prototabular scrapers (Gopher and Gophna 1993, pp.308-311). There is little quantitative data on Lodian chipped stone assemblages, but bipolar blade cores seem to have died out completely in favour of flake production. Characteristics of the Lodian include Haparsa, Herzliya and Nizzanim points, lower frequencies of the Yarmoukian sub-types of Byblos and Amuq points, some transverse arrowheads, coarsely denticulated sickle blades and tabular long knives and scrapers (Gopher and Gophna 1993, pp.318-319). Wadi Raba chipped stone assemblages are also dominated by flake production. Arrowheads tend to be almost completely absent; characteristic tools include rectangular, backed and double truncated sickle blades and bifacial awls, borers, endscrapers and trucations (Gopher and Gophna 1993, p.327).

4.4.4.4: Pottery:

Prior to the discovery of the PPNC at 'Ain Ghazal in 1984 it was generally believed that the southern Levant was re-colonised at the end of the Palestinian Hiatus by Yarmoukian pottery making groups originating from further to the north (Rollefson 1993). The discovery of the PPNC at 'Ain Ghazal not only showed the concept of the Palestinian Hiatus to be untenable but also demonstrated, through the discovery of small quantities of fired sherds in PPNC strata at 'Ain Ghazal (Rollefson 1993), that the development of ceramic technology in the southern Levant was in all probability a local, rather than imported, phenomenon. There "is no clear evidence to connect these early pottery producers to any foreign populations ... It was not until the 5th millennium BC that any signs of northern influence appear in the material culture of southern Levantine entities" (Gopher 1995, pp.207-208).

In general, published Pottery Neolithic ceramic assemblages emphasise decorated vessels to the virtual exclusion of the undecorated vessels which make up the bulk of any assemblage of this period. With this in mind, a brief description of the pottery of the main cultural units of the Pottery Neolithic is presented below. Clay spindle whorls were common throughout the whole period.

Yarmoukian pottery is characterised by hand-made short pedestalled bowls, chalices, platter-basins, necked jars and hole-mouth jars. Typical decoration includes "plain reverse bands incised with 'herringbone' motifs arranged in diagonal and horizontal configurations on red slipped backgrounds" (Gopher 1995, p.210). Lodian pottery assemblages include two elements: coarse undecorated bowls, jars and flat trays and finer wide, open bowls, small jars and cups decorated with painted burnished motifs (Gopher and Gophna 1993, p.319 and Gopher 1995, p.211). Wadi Raba pottery assemblages are characterised by a "small, thin, highly fired, carinated bowl of grit free fabric, usually slipped and burnished in deep glossy black or red" (Gopher and Gophner 1993, p.328) generally referred to as Dark Faced Burnished Ware. In addition bowrim jars, perhaps with wheel made rims, and pedestal bowls are common, and characteristic decoration includes "slip, burnish, incision, pointilée impressions, combing and applied plastic" (Gopher 1995, p.212) and some painted motifs.

4.4.4.5: Chronology, Phases and Facies:

Owing to the limited quantity and variable quality of data available it is difficult to describe chronological and geographical variation in PN material culture in any detail. As a whole, the period seems to have lasted from c.7,600 to c.6,000b.p.. Seriation of chipped stone and pottery assemblages, supported by radiocarbon dating, has resulted in the identification of the three main cultural entities: the Yarmoukian, Lodian and Wadi Raba cultures. These can be regarded both as phases and facies of the PN, as they are chronologically and, to a certain extent, geographically distinct, albeit with a degree of overlap between them.

The earliest cultural unit of the Pottery Neolithic was the Yarmoukian, which lasted from c.7600 to c.7,100b.p.. This was followed by the Lodian, which has been dated from c.7,000 to c.6,500b.p.. The most recent unit was the Wadi Raba. The normative Wadi Raba culture and most of its variants seem to have lasted from c.6,750 to c.6,250 b.p., whilst the Qatifian appears to have been slightly later and dates to the latter half of the 7th millennium b.p. (Gopher and Gophna 1993, p.342).

4.4.4.6: Key Aspects of Material Culture:

A brief overview of the architecture, burials and art objects for the main cultural units of the PN is presented below. Unfortunately, any such synthesis is hampered by the relatively small number of excavated PN sites in the Levant. Most of the available information comes from only a few sites and cannot therefore be assumed to reflect the potential range of variation over the region as a whole.

Architecture at the few excavated Yarmoukian sites exhibits great variety: rectangular, curvilinear and apsidal structures are all known, often from the same site. In general, Yarmoukian structures had "stone foundations, plaster was used occasionally, but it is not yet clear whether mudbrick was used. Sites also contain pits of various sizes" (Gopher and Gophna 1993, pp.311-312). Virtually nothing is known of Lodian architecture, but pits, shallow depressions and hearths appear on most excavated Lodian sites, along with isolated stretches of stone walling (Gopher 1995, p.210). Wadi Raba architecture is much better known and is characterised by rectangular, single or multiple room houses built on stone foundations with earth floors; no curvilinear architecture is known. Pits, sometimes plaster lined, are also a common feature on Wadi Raba sites (Gopher and Gophna 1993, p.332).

Only a handful of burials are known from the Pottery Neolithic which suggests that a fundamental change in burial practice had occurred by the beginning of the period. Unfortunately the reason for this scarcity of burials remains enigmatic as there is no evidence for the use of off-site graveyards during this period. All known Pottery Neolithic burials are on site and individual, and in all cases the skull was present. This confirms that the PPNB-type ancestor cult had been abandoned. By the time of the Wadi Raba culture foetuses and infants were being buried in pottery jars, which hints at a change in their place in society (Gopher 1995, pp.219-220).

In contrast to the virtual absence of art objects during the PPNC and Pottery Neolithic Lodian and Wadi Raba cultures, a wealth of clay and stone figurines are known from the Yarmoukian. This suggests that they served a function specific to the Yarmoukian culture, but as there is no clear evidence linking them to religious activities or fertility rituals, this function remains unclear. These figurines consist of a "large group of incised stone figurines and a group of anthropomorphic figurines shaped in clay" (Gopher 1995, p.218).

4.5: THE LEVANTINE CHALCOLITHIC (6,400 TO 5,200B.P.):

Recovery from the breakdown of the PPNB Interaction Sphere at the end of the 9th millennium b.p., was a lengthy process which is difficult to reconstruct in detail. It seems that during the PPNC population groups evolved a wide variety of small scale socio-economic systems in response to these events. By the mid 8th millennium b.~~c~~p. a × degree of stability was apparently regained in the form of the relatively homogenous Yarmoukian culture. This in turn eventually developed into the larger, more sophisticated, village based Wadi Raba culture (Gopher and Gophna 1993, pp.345-346). The true impact of these developments was however not seen until the Chalcolithic period of c.6,400 to c.5,200b.p., (Gilead 1988, pp.399-405), during which a variety of sophisticated regional cultures flourished in the southern Levant.

A detailed discussion of the Chalcolithic period is beyond the scope of this work. Consequently, only a brief description is presented below, in the form of the abstract of Gilead's (1988) review of the period. "The Levant of the fourth millennium B.C. was scattered with numerous small farming communities. The agricultural activities were based on growing barley, wheat, lentils, and fruit trees. This was accompanied by raising sheep-goats, pigs and cattle and occasionally using marine resources. The architecture and the thick accumulation of debris loaded with pottery refuse indicate that the sites were sedentary and occupied for long periods. The social organisation of these communities does not appear to have been very complex. The evidence argues against the existence of hierarchies and high-status social units that had the power to dominate and permanently regulate production and distribution. The evidence of religious activities also indicates that a priesthood, if it existed, was not dominant in the regulation of social and economic activities. The rapid cultural changes in the Levant during the late fourth and early third millennium were probably caused by the impact of events in Egypt and Mesopotamia. The local modifications were readjustments to the large scale changes in the Near East which influenced the rural and provincial Levantine Chalcolithic societies" (Gilead 1988, p.397).

CHAPTER 5: SUBSISTENCE IN SOUTH-WEST ASIA 12,500 TO 5,200 B.P.

5.1: INTRODUCTION:

This chapter aims to describe published data relating to subsistence strategies in south-west Asia between 12,500b.p. and 5,200b.p.. The geographical scope of this chapter has been extended from the Levant, which forms the basis of Chapters 3 and 4, to include the entire area of south-west Asia. This was done to take into account the fact that a number of researchers (e.g.: Hesse 1978, Smith 1995, Hole 1996) have argued that caprine domestication may have been earliest in south-western Iran. With such a large and culturally diverse area under consideration, it was decided to structure this chapter around periods defined primarily on radiocarbon chronologies, rather than around the Levantine archaeological periods used in Chapter 4. The periods which form the basis of this chapter are, with the following minor alterations, those of Hours et al. (1994). The boundary between their Periods 0 and 1 has been lowered from 12,000b.p. to 12,500b.p., so that the Early Natufian and Late Natufian can both be incorporated into Period 1, and the end of their Period 9 has been raised from 5,700b.p. to 5,200b.p. so that the whole of the south Levantine Chalcolithic can be included within it (see Table 5.1).

Period	Date (b.p.)	Equivalent Archaeological Periods (see Chapter 4)
0	14,000-12,500	Late Zarzian (Iraq/Iran only)
1	12,500-10,300	Natufian
2	10,300-9,600	PPNA
3	9,600-8,600	Middle PPNB
4	8,600-8,000	Late PPNB
5	8,000-7,600	Final PPNB or PPNC or Early Late Neolithic
6	7,600-7,000	Yarmoukian
7	7,000-6,500	Lodian
8	6,500-6,100	Wadi Raba and Early Ghassulian
9	6,100-5,200	Mid to Late Ghassulian

Table 5.1: Description of Periods used in this Chapter

The aim of this chapter is to describe subsistence activities in south-west Asia during each period. The sections on each period include a brief summary of relevant palaeo-climatic and archaeological data, a brief description of archaeobotanical data and a detailed description of zooarchaeological data from the southern Levant, northern Levant and Iraq/Iran. These areas are examined separately to highlight chronological and regional variation in subsistence strategies. Identification of potential domesticates as wild, proto-domestic or domestic is based on the published conclusions of the relevant researchers. The evid~~i~~ence on which these published conclusions are based are described where necessary for cattle, pigs and donkeys in this chapter. In the case of caprines, this evidence is not described here, but is discussed in detail in Chapter 6.

The section on each period includes two tables in which the published faunal assemblages from the southern Levant, northern Levant and Iraq/Iran are summarised. The first table includes all taxa of hedgehog size and above and is designed to illustrate the range of taxa in each faunal assemblage. In the first table caprine remains in each assemblage are broken down into proportions of undifferentiated *Capra* spp./*Ovis* spp., identified *Capra* spp. and identified *Ovis* spp. The second table is restricted to major medium and large herbivores and is designed to illustrate the relative proportions of domesticates and/or potential domesticates (see Garrard 1984). In the second table the overall proportions of *Capra* spp. and *Ovis* spp. have been calculated on the basis of the proportions of identified *Capra* spp. and *Ovis* spp. in the first table. The proportion of caprine remains identified to species and the resulting goat to sheep ratios are also listed. Each section also includes a map giving the location of each site featured in the tables.

It is immediately clear from the tables that there is considerable variation in the range of zooarchaeological data available. Many samples are extremely small and whilst some reports deal with all taxa and provide quantitative data, others deal only with a handful of taxa on presence or absence basis. Even if quantitative data is provided, methods of quantification can be inconsistent: numbers of identified mandibles, numbers of identified specimens and minimum numbers of individuals have all been employed by different researchers. Even more variation is evident in the proportions of caprine remains identified to species; some researchers classify all caprine remains as undifferentiated goat/sheep, whereas others identify a substantial proportion to species. This is significant because the lower the proportion of caprine remains identified to species, the less reliable the calculated proportions of goats and sheep become (see Chapter 8). These inconsistencies in the data can combine to make detailed comparisons between faunal assemblages an unrewarding exercise.

This chapter therefore takes a 'broad-brush' approach, accepting that inconsistencies within and between individual faunal assemblages exist. An attempt is made to identify general chronological and geographical trends in subsistence strategies in south-west Asia between 12,500b.p. and 5,200b.p. The aim is to present the backdrop against which two of the most important aspects of caprine zooarchaeology, namely: the emergence of caprines as major early domesticates and the development of more specialised pastoral economies in the Levant, can be examined in more detail in Chapter 6.

5.2: PERIOD 1: 12,500 TO 10,300B.P. (TABLES 5.2 AND 5.3, FIGURE 5.1):

During Period 1 south-west Asia was inhabited by a diverse range of small hunter-gatherer societies whose subsistence depended on the exploitation of varying combinations of locally available wild plants and animals. These combinations were determined largely by the nature of the environment in the immediate vicinity of the site. Useful summaries of the edible wild plant and animal resources available to hunter-gatherers in south-west Asia during the late Pleistocene and early Holocene have been provided by Garrard (1984), Byrd (1989) and Hillman (1996). Although all taxa from Period 1 faunal and botanical assemblages are thought to have been wild, with the possible exception of dog (Davis and Valla 1978, Davis 1981 and 1987) and rye (Hillman 1996), there is good evidence to suggest that the period saw an intensification of subsistence activities subsequently associated with the domestication process. Sites of Period 1 are best known from the southern Levant. Only a handful of sites have been excavated in the northern Levant, whilst in Iraq-Iran the Zagros uplands, where research into the late Epipalaeolithic of this region has been concentrated, seem to have been abandoned between c.12,500b.p. and c.11,000b.p., perhaps in response to the changing environmental conditions of the Bölling-Allerød interstadial (Hole 1987 and 1996). As a result there are hardly any faunal assemblages dating to Period 1 from Iraq/Iran to compare with those from the northern and southern Levant. The few published late Epipalaeolithic faunal assemblages from Iraq-Iran date to the late Zarzian period of c.14,000b.p. to c.12,500b.p. and although they thus predate the Period 1 faunal assemblages of the northern and southern Levant by up to two millennia they have been included in this review as a window into the late Epipalaeolithic of this large and environmentally complex region. It should also be noted that the latter part of Period 1 saw the return of cold, dry conditions to all areas of south-west Asia during the Younger Dryas stadial of c.11,000 to c.10,000b.p..

During Period 1 complex hunter-gatherer societies of the Natufian cultural entity extended across the northern and southern Levant. As described in Chapter 4 these societies seem to have been more sedentary than their predecessors and occupied much larger settlements than had previously been the case. Only four Natufian sites have yielded botanical assemblages, three from the southern Levant and the exceptionally large and diverse assemblage from Abu Hureyra (Hillman et al. 1989) from the northern Levant. It is clear from Garrard's recent summary of these assemblages (Garrard 1999) that Natufian societies exploited an extremely wide variety of wild cereals, pulses, nuts and fruits, and that they focused more on the large-scale processing and storage of these resources than had their predecessors, especially during the late Natufian (11,000b.p.-10,300b.p). Although there is no evidence for extensive cereal cultivation during this period (Hillman et al. 1989, Garrard 1999) a small number of morphologically domestic rye grains, representing the earliest evidence for plant domestication from south-west Asia, have been identified at Abu Hureyra (Hillman 1996). Explanations for this apparent intensification of plant-food economies have tended to focus on the increased availability of these resources during the late Glacial woodland expansion of ca.15,000b.p.-11,000b.p. (e.g. Wright 1977, Henry 1989, McCorriston and Hole 1991, Hillman 1996) and link the growing preoccupation with storage and possible early attempts at cultivation during the late Natufian to resource stress associated with the retreat of the woodland and its plant-food resources during the cold and dry Younger Dryas stadial of ca.11,000b.p.-10,000b.p. (e.g. Bar-Yosef and Meadow 1995, Hillman 1996).

With regard to Natufian faunal assemblages, although there is little temporal differentiation between them (Byrd 1989, Martin 1994, Fellner 1995) clear differences can be seen between the different environmental zones. At sites in the woodland and moist steppe zones of the southern Levant (i.e. Abu Usba, Nahal Oren, El Wad B, Kebara, Rakefet, Hayonim Cave, Hatoula, Hayonim Terrace, Shukbah, Fazael VI, Mallaha II-IV and I, Wadi Hammeh 27, Salibiya I, Ain Rahub) gazelle were the predominant taxon, followed by varying proportions of fallow deer, wild cattle and wild boar. At higher, more mountainous locations in the woodland zone (i.e. Saaïde II) gazelle gave way to wild goat and red deer; similar locations in the dry steppe and sub-desert zones (i.e. Rosh Horesha, Rosh Zin, Khallat Anaza, Beidha, Wadi Judayid 2) saw higher proportions of ibex and/or wild goat, accompanied by gazelle, equids and occasionally wild sheep. Around the wetlands of the Azraq Basin (i.e. Azraq 18) wild cattle were the predominant taxon, whilst in the undulating steppic terrain overlooking the Euphrates Valley in the northern Levant (i.e. Abu Hureyra, Mureybet) gazelle predominated and were accompanied by equids and a few wild sheep.

As described above hardly any archaeological data are available from Period 1 in Iraq/Iran, even with the inclusion of the preceding late Zarzian. What little information exists comes primarily from caves and rock-shelters located at elevations in excess of 800m. in the Zagros uplands and suggests periodic occupation by small groups of mobile hunter-gatherers practising vertical movement. Reconstruction of the subsistence activities of these groups is hindered by the fact that none of these sites have yielded botanical assemblages and that the faunal assemblages have in general been rather inadequately published. In his review of late Pleistocene and early Holocene subsistence strategies in the Zagros, Hesse (1978) has suggested that during the late Epipalaeolithic at least two faunal specialisations, focusing on equids (i.e. Palegawra, Warwasi, Ghar i Khar) and wild goats (i.e. Zarzi, Shanidar Cave B2 and perhaps Pa Sangar in the Khorramabad Valley) respectively, can be identified and tentatively suggests that this may be a reflection of the habitat preferences of these taxa (Hesse 1978, pp.41-42).

The fact that the composition of faunal assemblages throughout south-west Asia during Period 1 appears to have been so strongly and consistently influenced by the nature of the environment in the immediate vicinity of sites suggests that they are primarily a reflection of the habitat preferences of the various taxa. The obvious conclusion to be drawn from this observation is that during Period 1 faunal assemblages at least partially reflected the relative abundance of taxa to be found within site territories. However, it is equally clear that although "humans, like most carnivores, may exhibit opportunistic hunting behaviour...the actual strategy is non-random and directed, as to species, as well as categories within the species (as defined by health status, age and sex)" (Horwitz 1989, p.154). This raises the possibility that the composition of faunal assemblages may also have been influenced by cultural preferences for one taxon over another. The predominance of gazelle at Natufian sites in the woodland and moist steppe zones in the southern Levant and the high frequencies of male and/or juvenile gazelle observed in some of these assemblages has therefore led a number of researchers to suggest that

Natufian hunter-gatherers may have developed more complex hunting strategies which specifically targeted gazelle and involved high levels of selection, herd management or even 'proto-domestication' (e.g.: Legge 1972, Saxon 1974, Henry 1975, Garrard 1980, Cope 1991). These suggestions have recently been challenged on two counts. Firstly, as the focus of research has shifted away from the traditional Natufian core-area of coastal and central Palestine in recent years it has become apparent that the predominance of gazelle in Natufian faunal assemblages is actually restricted to the woodland and moist steppe. This suggests that Natufian hunting strategies were less focused on gazelle than previously envisaged. Secondly, studies of gazelle behavioural ecology (e.g.: Baharav 1974, Davis 1983, Henry and Garrard 1988, Martin 1994) have demonstrated the extent to which the variation in sex ratios and the proportion of juveniles observed in Natufian faunal assemblages could be a reflection of the natural seasonal variation in the age and sex composition of gazelle herds in the wild.

The evidence for the development of more complex relationships between humans and animals during Period 1 is more convincing in the case of the dog. The provenance of the Palegawra dog, identified by Turnbull and Reed (1974) as domestic on the basis of its small size and originally dated to ca.12,000b.p., has been cast into doubt by by Uerpmann (1982) who noted that the layer from which it originated was contaminated by much later deposits containing domestic caprines. However, Davis has argued for the presence of domestic dog at a number of Natufian sites in Israel. This argument (Davis and Valla 1978, Davis 1981 and 1987) is based on the presence of small canid carnassial teeth at Hayonim Terrace and Mallaha, the discovery at Mallaha of a human burial containing an articulated puppy skeleton, and the presence in Natufian layers at Hatoula of numerous corroded small bones interpreted as having been partially digested by carnivores. However, Quintero and Köhler-Rollefson (1997) have recently criticised Davis' interpretation of this evidence on the grounds that it may reflect no more than the taming of a small wolf subspecies and in a detailed argument suggest that dog domestication is more likely to have been a Neolithic phenomenon. "While some Natufians may have tamed and kept wolf pups even to maturity, it is unlikely that the Natufians would have genetically controlled only one animal species, kept it isolated, selectively bred it, maintained it and cared for its population" (Quintero and Köhler-Rollefson 1997, p.572).

Site	Period	Area	n	Equ	Bos	Sus	Gaz	Alc	C+O	(C/O)	(Cpr)	(Ovi)	Cer	Dam	Cap	Lep	Can	Vul	Fel	Mus	Eri	Source
Palegawra	0	ZU	2459	45.6	0.8	2.8	3.9		25.3	15.9	3.9	5.4	18.5			0.4	0.5	1.3	0.2	0.3	0.4	Turnbull and Reed 1974
Warwasi	0	ZU	15	53.3		6.7			40.0	26.7	13.3											Turnbull 1975
Zarzi	0	ZU	12				x		X		X							x				Garrod 1930
Ghar i Khar	1	ZU	?	X																		Perkins pers.comm. cited in Hesse 1978
Shanidar Cave (B2)	1	ZP	?			x			X		X	x	x	x	x		x	x		x		Perkins 1964
Tel Abu Hureyra	1	EV	154	15.2			65.3		10.8			10.8				8.7						Legge 1975 and 1996
Mureybet (Ia)	1	EV	1559	23.5	2.8	0.3	49.7		2.4			2.4		0.6		10.8	0.2	7.6	1.3	0.8		Helmer 1991a
Saaïde II	1	BV	284		2.5		4.2		34.9		34.9		20.8		3.5	28.2	1.1	2.1	1.1	1.4	0.4	Churcher 1994
Abu Usba	1	PC	?	x	x	x	X		x		x			x	x	x	x	x	x	x	x	Stekelis and Haas 1952
Nahal Oren	1	PC	1846		9.2	3.9	83.3		0.2		0.2		0.1	2.6	0.7							Noy et al. 1973
El Wad (B)	1	MC	1474	0.1		0.9	88.4	0.1	0.2		0.2		0.2	3.3	0.1	2.6		2.6	0.8	0.7		Garrard 1980
Kebara	1	MC	327	1.2	20.8	4.3	33.0	6.1					1.2	3.4	0.6	7.3	0.6	11.0	4.6	5.8		Saxon 1974
Rakefet	1	MC	1002		0.7	4.1	80.5		0.9		0.9		2.6	6.2	0.5	0.6	0.3	1.8	1.7	0.2		Garrard 1980
Hayonim Cave	1	CP	?	1.0	5.0	2.9	58.4	1.0	6.0		6.0		25.7			x		x		x	x	Bar-Yosef and Tchernov 1966 and Cope 1991
Hatoula	1	CP	89		x	1.1	75.3	x	x			x				7.9		7.9	1.1	4.5	2.2	Davis 1985 and Davis et al. 1994
Hayonim Terrace	1	CP	4572		0.1	0.9	82.4	0.02	0.5		0.5		0.02	14.0	1.0	0.6	0.02	0.3	0.1	0.1		Henry et al. 1981
Shukbah	1	CP	368		10.9	x	82.3	0.5						3.3	0.3	0.3	0.8		1.4	0.3		Garrod and Bate 1942
Fazael VI	1	JV	120		0.8	4.2	52.5		2.5		2.5			8.3		24.2		5.0			2.5	Tchernov 1993
Mallaha (II-IV)	1	JV	687		4.9	6.4	63.5		6.1		6.1		4.2	6.6	8.3	x	x	x	x	x	x	Bouchud 1987
Wadi Hammeh 27	1	JV	212	0.9	0.5	4.7	75.5		7.1		7.1		0.5	0.5	0.9	4.7	0.9	3.3	0.5			Edwards et al. 1988
Mallaha (I)	1	JV	905		5.3	14.8	47.2		4.0		4.0		9.4	8.8	10.5	x	x	x	x	x	x	Bouchud 1987
Salibiya I	1	JV	370		0.8	5.1	77.3		1.4		1.4			1.9		4.9	0.3	7.3	0.8	0.3		Crabtree et al. 1991
Rosh Horesha	1	NG	990	1.8	0.1		59.9		36.9		36.9	x				1.0		0.2		0.1		Butler et al. 1977 and Davis et al. 1982
Rosh Zin	1	NG	15	6.7			40.0		46.7		46.7			6.7								Tchernov 1976
Ain Rahub	1	NJ	240	7.9	19.2		60.4		11.3		11.3						1.3					Shiyab 1997
Azraq 18	1	EJ	290	26.9	53.1		19.0									0.3	0.3	0.3				Martin 1994
Khallat Anaza	1	EJ	34	8.8			26.5		53.0	47.1	5.9					8.8	2.9					Martin 1994
Beidha	1	SJ	139	2.2	5.8		25.9		64.7		64.7					0.7	0.7					Hecker 1989
Wadi Judayid 2	1	SJ	193	9.8	6.2		20.7		62.1	35.2	12.4	14.5				0.5			0.5			Henry and Turnbull 1985

Iran-Iraq Area Codes: ZU=Zagros Uplands, ZP=Zagros Piedmont
N.Levant-Euphrates Area Codes: EV=Euphrates Valley
S.Levant Area Codes: BV=Beqa'a Valley, PC=Palestine Coast, MC=Mount Carmel, CP=Central Palestine, JV=Jordan Valley, NG=Negev, NJ=Northern Jordan, EJ=Eastern Jordan, SJ=Southern Jordan
Taxa Codes: Equ=*Equus* spp., Bos=*Bos* spp., Sus=*Sus* spp., Gaz=*Gazella* spp., Alc=*Alelaphus buselaphus*, C+O=total Subfamily Caprinae i.e. C/O+Cpr+Ovi, (C/O)=*Capra* spp. or *Ovis* spp., (Cpr)=*Capra* spp., (Ovi)=*Ovis* spp., Cer=*Cervus elaphus*, Dam=*Dama mesopotamica*, Cap=*Capreolus capreolus*, Lep=*Lepus capensis*, Can=*Canis* spp., Vul=*Vulpes* spp., Fel=Family Felidae, Mus=Family Mustelidae, Eri=Family Erinaceidae
Quantitative Data: all % NISP except: x=taxon present (excluded from n and % NISP calculations), X=most abundant of present taxa (excluded from n and % NISP calculations)

Table 5.2: Proportions of Taxa in Faunal Assemblages from Period 1 (12,500 to 10,300b.p.) and (Iraq-Iran only) Period 0 (14,000 to 12,500b.p.)

Site	Period	Area	n	Hrb	Equ	Bos	Sus	Gaz	C+O	(Cpr)	(Ovi)	(C:O)	(id)	Cer	Dam	Cap	Source
Palegawra	0	ZU	2459	96.9	47.1	0.8	2.9	4.0	26.1	10.9	15.2	1:1.4	36.8	19.1			Turnbull and Reed 1974
Warwasi	0	ZU	15	100.0	53.3		6.7		40.0	40.0		1:0	33.3				Turnbull 1975
Zarzi	0	ZU	12	?				x	X	X		1:0	?				Garrod 1930
Ghar i Khar	1	ZU	?	?	X												Perkins pers.comm. cited in Hesse 1978
Shanidar Cave B2	1	ZP	?	?			x		X	X	x	X:x	?	x	x	x	Perkins 1964
Abu Hureyra	1	EV	154	91.3	16.6			71.5	11.8		11.8	0:1	?				Legge 1975 and 1996
Mureybet Ia	1	EV	1559	79.3	29.6	3.5	0.4	62.7	3.0		3.0	0:1	?		0.8		Helmer 1991a
Saaide II	1	BV	284	65.9		3.8		6.4	53.0	53.0		1:0	?	31.6		5.3	Churcher 1994
Abu Usba	1	PC	?	?	x	x	x	X	x	x		1:0	?		x	x	Stekelis and Haas 1952
Nahal Oren	1	PC	1846	100.0		9.2	3.9	83.3	0.2	0.2		1:0	?	0.1	2.6	0.7	Noy et al. 1973
El Wad B	1	MC	1474	93.2	0.1		1.0	94.8	0.2	0.2		1:0	?	0.2	3.5	0.1	Garrard 1980
Kebara	1	MC	327	64.5	1.9	32.2	6.7	51.2						1.9	5.3	0.9	Saxon 1974
Rakefet	1	MC	1002	95.5		0.7	4.3	84.3	0.9	0.9		1:0	?	2.7	6.5	0.5	Garrard 1980
Hayonim Cave	1	CP	?	99.0	1.0	5.1	2.9	59.0	6.1	6.1		1:0	?	26.0			Bar-Yosef and Tchernov 1966 and Cope 1991
Hatoula	1	CP	89	76.4		x	1.4	98.6	x		x	0:1	?				Davis 1985 and Davis et al. 1994
Hayonim Terrace	1	CP	4572	98.9		0.1	0.9	83.3	0.5	0.5		1:0	?	0.02	14.2	1.0	Henry et al. 1981
Shukbah	1	CP	368	96.8		11.3	x	85.0							3.4	0.3	Garrod and Bate 1942
Fazael VI	1	JV	120	68.3		1.2	6.1	76.9	3.7	3.7		1:0	?		12.2		Tchernov 1993
Mallaha II-IV	1	JV	687	100.0		4.9	6.4	63.5	6.1	6.1		1:0	?	4.2	6.6	8.3	Bouchud 1987
Wadi Hammeh 27	1	JV	212	90.6	1.0	0.6	5.2	83.3	7.8	7.8		1:0	?	0.6	0.6	1.0	Edwards et al. 1988
Mallaha I	1	JV	905	100.0		5.3	14.8	47.2	4.0	4.0		1:0	?	9.4	8.8	10.5	Bouchud 1987
Salibiya I	1	JV	370	86.5		0.9	5.9	89.4	1.6	1.6		1:0	?		2.2		Crabtree et al. 1991
Rosh Horesha	1	NG	990	98.7	1.8	0.1		60.7	37.4	37.4	x	X:x	?				Butler et al. 1977 and Davis et al. 1982
Rosh Zin	1	NG	15	100.0	6.7			40.0	46.7	46.7		1:0	?		6.7		Tchernov 1976
Ain Rahub	1	NJ	240	98.8	8.0	19.4		61.1	11.4	11.4		1:0	?				Shiyab 1997
Azraq 18	1	EJ	290	99.0	27.2	53.6		19.2									Martin 1994
Khallat Anaza	1	EJ	34	88.3	10.0			30.0	60.0	60.0		1:0	11.1				Martin 1994
Beidha	1	SJ	139	98.6	2.2	5.9		26.3	65.6	65.6		1:0	?				Hecker 1989
Wadi Judayid 2	1	SJ	193	98.8	9.9	6.3		21.0	62.9	29.0	33.9	1:1.2	43.3				Henry and Turnbull 1985

Iran-Iraq Area Codes: ZU=Zagros Uplands, ZP=Zagros Piedmont
N.Levant-Euphrates Area Codes: EV=Euphrates Valley
S.Levant Area Codes: BV=Beqa'a Valley, PC=Palestine Coast, MC=Mount Carmel, CP=Central Palestine, JV=Jordan Valley, NG=Negev, NJ=Northern Jordan, EJ=Eastern Jordan, SJ=Southern Jordan
Taxa Codes: Hrb=% of major medium and large herbivores in n, Equ=*Equus* spp., Bos=*Bos* spp., Sus=*Sus* spp., Gaz=*Gazella* spp., C+O=total Subfamily Caprinae, (Cpr)=*Capra* spp., (Ovi)=*Ovis* spp., (C:O)=ratio *Capra* spp.:*Ovis* spp., (id)=% of total Subfamily Caprinae identified to genus, Cer=*Cervus elaphus*, Dam=*Dama mesopotamica*, Cap=*Capreolus capreolus*
Quantitative Data: all % NISP except: x=taxon present (excluded from n and % NISP calculations), X=most abundant of present taxa (excluded from n and % NISP calculations)

Table 5.3: Proportions of Major Medium and Large Herbivores in Faunal Assemblages from Period 1 (12,500 to 10,300b.p.) and (Iraq-Iran only) Period 0 (14,000 to 12,500b.p.)

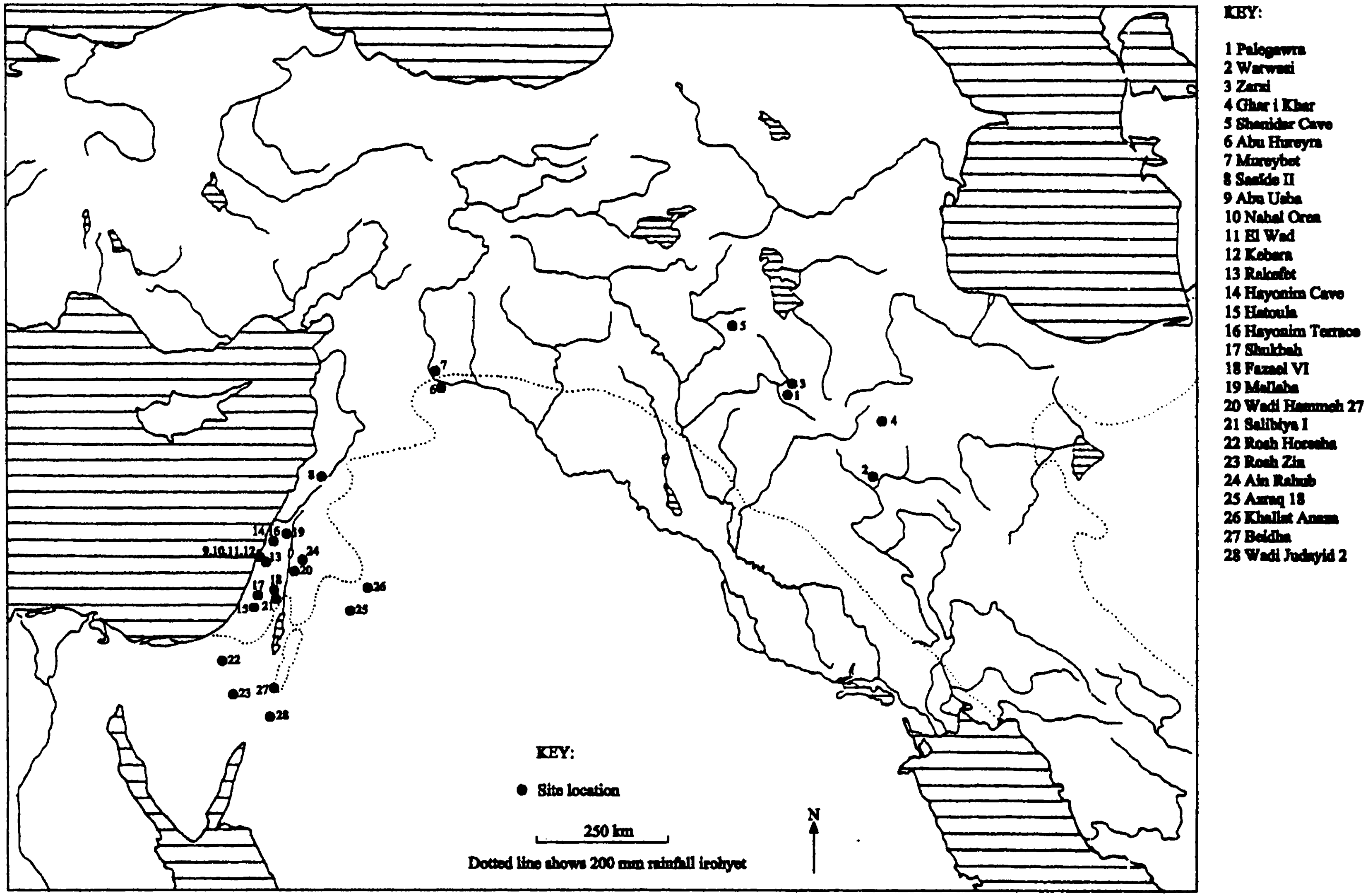


Figure 5.1: Location of Period 1 (12,500b.p.-10,300b.p.) and Period 0 (14,000b.p.-12,500b.p. Iraq-Iran only) Sites with Faunal Assemblages

5.3: PERIOD 2: 10,300B.P. TO 9,600B.P. (TABLES 5.4 AND 5.5, FIGURE 5.2):

The increasing levels of sedentism, expansion of site size and intensification of plant-food economies characterising Period 1 accelerated across the Pleistocene-Holocene boundary into Period 2 in all areas of south-west Asia, coinciding with the early Holocene climatic amelioration. At a number of locations in the southern Levantine Corridor this process culminated in the appearance of permanent agricultural villages, which have yielded the earliest evidence for the intensive cultivation of morphologically domestic cereals. Elsewhere in south-west Asia increasingly sedentary complex hunter-gatherer societies were the norm. There seems to have been a good deal of continuity in faunal economies between Periods 1 and 2 as both agricultural and hunter-gatherer groups continued to exploit combinations of taxa determined largely by local environmental conditions. All fauna in Period 2 assemblages is generally thought to have been wild, with the exception of some claims for the presence of domestic goat at Tell Aswad (Legge 1996) and, more tentatively, domestic pig at Hallan Çemi (Rosenberg et al. 1998) respectively. Sites of Period 2 are well represented in the southern Levant, with the exception of the dry steppe and sub-desert zones of Jordan, but are less well known in the northern Levant. Available information suggests that small villages/hamlets of the PPNA cultural entity extended across most of the southern and at least some of the northern Levant. In Iraq/Iran the gap in the archaeological record, which followed the abandonment of late Zarzian caves and rock-shelters in the Zagros uplands (see above), seems to have lasted until establishment of a series of Proto-Neolithic villages/hamlets at or just before the beginning of Period 2 (Hole 1987 and 1996). These were located in the piedmont zone of the Taurus/Zagros arc at elevations of less than 800m. and were of a different cultural tradition to the PPNA villages to the west (e.g.: Kozlowski 1994, Watkins 1995, Hole 1996, Rosenberg et al. 1998).

Garrard (1999) has recently summarised the Period 2 botanical data from south-west Asia. Although nine sites have yielded botanical assemblages, these are unevenly distributed throughout the Fertile Crescent and no information at all is available from the south-eastern end of the Taurus/Zagros arc. From the information available it seems that throughout the greater part of south-west Asia a similar range of wild cereals, pulses, nuts and fruits were exploited during Period 2 as during Period 1. There is some evidence to suggest that wild cereals and pulses may have been more intensively exploited and perhaps even cultivated throughout the Levantine Corridor during Period 2 (Hillman 1996, Garrard 1999), but morphological evidence for plant domestication is restricted to emmer wheat, einkorn wheat and two-row barley from a few PPNA sites in the southern Levantine Corridor (i.e. Tell Aswad, Jericho, Iraq ed-Dubb), typically located near lakes or springs. Most attempts to explain cereal domestication (e.g. Hillman 1996) have argued that it occurred in response to a combination of resource stress and population growth which was triggered by increased levels of sedentism and the intensification of plant-food economies during the preceding Natufian.

In contrast, strategies of faunal exploitation throughout south-west Asia seem to have been relatively stable across the Pleistocene-Holocene boundary. Throughout the region both hunter-gatherer and agricultural groups, except perhaps at Tell Aswad, continued to hunt combinations of wild taxa apparently determined more by availability than any cultural preferences, much as their predecessors had done in Period 1. In the southern Levant gazelle were still predominant at sites in the woodland and moist steppe zones (i.e. Nahal Oren, Hatoula 4/5, Gesher, Gilgal I, Netiv Hagdud, Jericho), whereas the dry steppe and sub-desert zones continued to see higher proportions of ibex and/or wild goat (i.e. el-Khiam, Abu Salem, Ramat Harif). Although gazelle were still predominant in the woodland and moist steppe zones, there was a small but significant decline in their representation and a corresponding rise in the proportion of small mammals. This may have been linked to the so-called broad-spectrum revolution (Flannery 1969), although the view that a broadening of the resource base was a necessary pre-condition for domestication has been increasingly challenged in recent years (e.g.: Edwards 1989 and 1991, Martin 1994). A more likely explanation (Tchernov 1993, Davis et al. 1994) is that the population growth already linked to cereal domestication may also have led to gazelle coming under increasing hunting pressure and that small mammals were increasingly exploited to compensate.

A notable exception to these observations can be seen in PPNA layers at Tell Aswad, situated within the moist steppe zone of the Levantine Corridor close to the shoreline of the former Lake Aateibé in the Damascus Basin. Here goats, rather than gazelle as elsewhere in this environmental zone during Period 2, were the most common taxon from the beginning of the site's occupation at ca.9,800 b.p.. Ducos (1993a and 1993b) has argued, on the basis of age/sex ratios, that these goats were subject to a form of loose-herding or proto-domestication. Legge (1996, pp.252-253), noting the relatively small size of these animals, has gone further and argues that there is no reason why the PPNA goat population from Tell Aswad should not be interpreted as fully domesticated. Whether fully domesticated or not, the predominance of goats at Tell Aswad during Period 2 may well be an early indication of the more general shift from gazelle to goats documented throughout the southern Levantine Corridor during Period 3. Significantly, Tell Aswad has also yielded some of the earliest evidence in south-west Asia for the intensive cultivation of morphologically domestic cereals (Garrard 1999).

In the northern Levant a similar range of taxa were exploited during Period 2 (i.e. Nahr el-Homr, Mureybet II/III) as had been during Period 1, although the focus seems to have shifted somewhat from gazelle to equids. In Iraq/Iran the occupational shift from the Zagros uplands to the piedmont zone is clearly reflected in the faunal assemblages. The goats and equids which dominated late Epipalaeolithic assemblages were replaced in Period 2 by combinations of sheep and gazelle, with some red deer, wild boar and wild cattle, which were determined largely by altitude and the habitat preferences of these taxa. Thus at elevations above 400m. (i.e. Karim Shahir, Shanidar Cave B1, Zawi Chemi Shanidar, Hallan Çemi) sheep tended to outnumber gazelle, whereas at lower elevations (i.e. M'lefaat, Qermez Dere) gazelle were predominant. Redding has recently suggested that evidence for pig domestication can be seen during Period 2 at Hallan Çemi, citing the presence of small pig molars, an extremely high proportion of juveniles and a bias towards males in support of his argument (Rosenberg et al. 1998). However, this claim has been countered by von den Driesch who notes that "wild pigs live in herds and multiple couples...because often double births are produced in a single year...the proportion of juveniles thus is naturally large (von den Driesch and Wodtke 1997, pp.525-528).

Site	Period	Area	n	Equ	Bos	Sus	Gaz	Alc	C+O	(C/O)	(Cpr)	(Ovi)	Cer	Dam	Cap	Lep	Can	Vul	Fel	Mus	Eri	Source
M'lefaat	2	ZP	142		1.4	4.9	51.4		35.2			35.2				2.8	x	4.2	x			Turnbull 1983
Karim Shahir	2	ZP	193		4.7	9.8	5.7		64.2	48.2	1.6	14.5	9.8			1.0		4.7				Stampfli 1983
Shanidar Cave (B1)	2	ZP	63		x	x			100.0		57.1	42.9	x	x	x		x	x		x		Perkins 1964
Zawi Chemi Shanidar	2	ZP	1221			x			51.0		7.1	43.9	49.0	x	x		x	x		x		Perkins 1964
Hallan Çemi	2	TP	?			19.8			48.8		2.6	46.2	25.0	x		2.0	x	x	x	x	x	Rosenberg 1998
Qermez Dere	2	UMP	3916	0.03	0.8		52.3		12.7	12.7						7.2		26.6	0.2	0.2		Watkins 1995
Nahr el Homr	2	EV	227	85.0			14.5						0.4									Clason and Buitenhuis 1975
Mureybet (II)	2	EV	?	62.0	8.9	1.8	24.5		0.7			0.7	3.1									Ducos 1978b
Mureybet (III)	2	EV	?	45.7	5.1	3.4	38.7		5.8			5.8	2.3									Ducos 1978b
Tel Aswad I-II	2+3	DB	2815	6.2	14.5	12.9	21.8		44.64		44.6	0.04										Ducos 1993a
Nahal Oren	2	PC	516		1.6	3.5	87.9		3.1		3.1		0.2	2.9	0.8							Noy, Legge and Higgs 1973
Hatoula (Khiamian)	2	CP	82		1.2	1.2	20.7	x	x			x		x		34.1	1.2	14.6	6.1	18.3	2.4	Davis 1985 and Davis et al. 1994
El Khiam	2	CP	134			0.8	6.3		93.0		93.0											Ducos 1997
Hatoula (Sultanian)	2	CP	72	x	x	x	37.5	x?	x			x		x		27.8		22.2	5.6	2.8	4.2	Davis 1985 and Davis et al. 1994
Gesher	2	JV	65			3.1	90.8									3.1		3.1				Horwitz and Garfinkel 1991
Gilgal I	2	JV	21		4.8	4.8	38.1							14.3		4.8	4.8	9.5			19.0	Noy, Sculdenrein and Tchernov 1980
Netiv Hagdud	2	JV	420			1.9	28.8	0.2	0.5		0.5			0.2		20.0	0.7	36.2	3.8		7.6	Tchernov 1994
Jericho	2	JV	548	0.2	6.2	9.9	53.6		3.6	1.3	1.8	0.5		0.2	0.4		1.5	23.4	1.1			Clutton-Brock 1979
Abu Salem	2	NG	1155	1.1			52.6		45.3		45.3	x				0.8		0.3				Butler et al. 1977 and Davis et al. 1982
Ramat Harif	2	NG	632	x			52.1		47.9		47.9	x				x						Goring-Morris 1987
Iraq ed Dubb	2	JH	?		x	x	X		x	x												Kuijt et al. 1991

Iran-Iraq Area Codes: ZP=Zagros Piedmont, TP=Taurus Piedmont, UMP=Upper Mesopotamian Plain
N.Levant-Euphrates Area Codes: EV=Euphrates Valley
S.Levant Area Codes: DB=Damascus Basin, PC=Palestine Coast, CP=Central Palestine, JV=Jordan Valley, NG=Negev, JH=Jordan Highlands
Taxa Codes: Equ=*Equus* spp., Bos=*Bos* spp., Sus=*Sus* spp., Gaz=*Gazella* spp., Alc=*Alelaphus buselaphus*, C+O=total Subfamily Caprinae i.e. C/O+Cpr+Ovi, (C/O)=*Capra* spp. or *Ovis* spp., (Cpr)=*Capra* spp., (Ovi)=*Ovis* spp., Cer=*Cervus elaphus*, Dam=*Dama mesopotamica*, Cap=*Capreolus capreolus*, Lep=*Lepus capensis*, Can=*Canis* spp., Vul=*Vulpes* spp., Fel=Family Felidae, Mus=Family Mustelidae, Eri=Family Erinaceidae
Quantitative Data: all % NISP except: x=taxon present (excluded from n and % NISP calculations), X=most abundant of present taxa (excluded from n and % NISP calculations)

Table 5.4: Proportions of Taxa in Faunal Assemblages from Period 2 (10,300 to 9,600b.p.)

Site	Period	Area	n	Hrb	Equ	Bos	Sus	Gaz	C+O	(Cpr)	(Ovi)	(C:O)	(id)	Cer	Dam	Cap	Source
M'lefaat	2	ZP	142	92.9		1.5	5.3	55.3	37.9		37.9	0:1	?				Turnbull 1983
Karim Shahir	2	ZP	193	94.2		5.0	10.4	6.1	68.2	6.8	61.4	1:9.1	25.1	10.4			Stampfli 1983
Shanidar Cave B1	2	ZP	63	100.0		x	x		100.0	57.1	42.9	1:0.8	?	x	x	x	Perkins 1964
Zawi Chemi Shanidar	2	ZP	1221	100.0			x		51.0	7.1	43.9	1:6.2	?	49.0	x	x	Perkins 1964
Hallan Çemi	2	TP	?	93.6			21.2		52.1	2.8	49.4	1:17.8	?	26.7	x		Rosenberg 1998
Qermez Dere	2	UMP	3916	65.8	0.05	1.2		79.4	19.3			?	0.0				Watkins 1995
Nahr el Homr	2	EV	227	99.9	85.1			14.5						0.4			Clason and Buitenhuis 1975
Mureybet II	2	EV	?	100.0	62.0	8.9	1.8	24.5	0.7		0.7	0:1	?	3.1			Ducos 1978b
Mureybet III	2	EV	?	100.0	45.7	5.1	3.4	38.7	5.8		5.8	0:1	?	2.3			Ducos 1978b
Tell Aswad I-II	2+3	DB	2815	100.0	6.2	14.5	12.9	21.8	44.6	44.6	0.04	1:0	?				Ducos 1993a
Nahal Oren	2	PC	516	100.0		1.6	3.5	87.9	3.1	3.1		1:0	?	0.2	2.9	0.8	Noy, Legge and Higgs 1973
Hatoula	2	CP	82	23.1		5.2	5.2	89.6	x		x	0:1	?		x		Davis 1985 and Davis et al. 1994
El Khiam	2	CP	134	100.0			0.8	6.3	93.0	93.0		1:0	?				Ducos 1997
Hatoula	2	CP	72	37.5	x	x	x	100.0	x		x	0:1	?		x		Davis 1985 and Davis et al. 1994
Gesher	2	JV	65	93.9			3.3	96.7									Horwitz and Garfinkel 1991
Gilgal I	2	JV	21	62.0		7.7	7.7	61.5							23.1		Noy, Sculdenrein and Tchernov 1980
Netiv Hagdud	2	JV	420	31.4			6.1	91.7	1.6	1.6		1:0	?		0.6		Tchernov 1994
Jericho	2	JV	548	74.1	0.3	8.4	13.4	72.3	4.9	3.8	1.1	1:0.3	63.9		0.3	0.5	Clutton-Brock 1979
Abu Salem	2	NG	1155	99.0	1.1			53.1	45.8	45.8	x	1:x	?				Butler et al. 1977 and Davis et al. 1982
Ramat Harif	2	NG	632	100.0	x			52.1	47.9	47.9	x	1:x	?				Goring-Morris 1987
Iraq ed Dubb	2	NJ	?	?		x	x	X	x			?	0.0				Kuijt et al. 1991

Iran-Iraq Area Codes: ZP=Zagros Piedmont, TP=Taurus Piedmont, UMP=Upper Mesopotamian Plain

N.Levant-Euphrates Area Codes: EV=Euphrates Valley

S.Levant Area Codes: DB=Damascus Basin, PC=Palestine Coast, CP=Central Palestine, JV=Jordan Valley, NG=Negev, NJ=Northern Jordan

Taxa Codes: Hrb=% of major medium and large herbivores in n, Equ=*Equus* spp., Bos=*Bos* spp., Sus=*Sus* spp., Gaz=*Gazella* spp., C+O=total Subfamily Caprinae, (Cpr)=*Capra* spp., (Ovi)=*Ovis* spp., (C:O)=ratio *Capra* spp.:*Ovis* spp., (id)=% of total Subfamily Caprinae identified to genus, Cer=*Cervus elaphus*, Dam=*Dama mesopotamica*, Cap=*Capreolus capreolus*

Quantitative Data: all % NISP except: x=taxon present (excluded from n and % NISP calculations), X=most abundant of present taxa (excluded from n and % NISP calculations)

Table 5.5: Proportions of Major Medium and Large Herbivores in Faunal Assemblages from Period 2 (10,300 to 9,600b.p.)

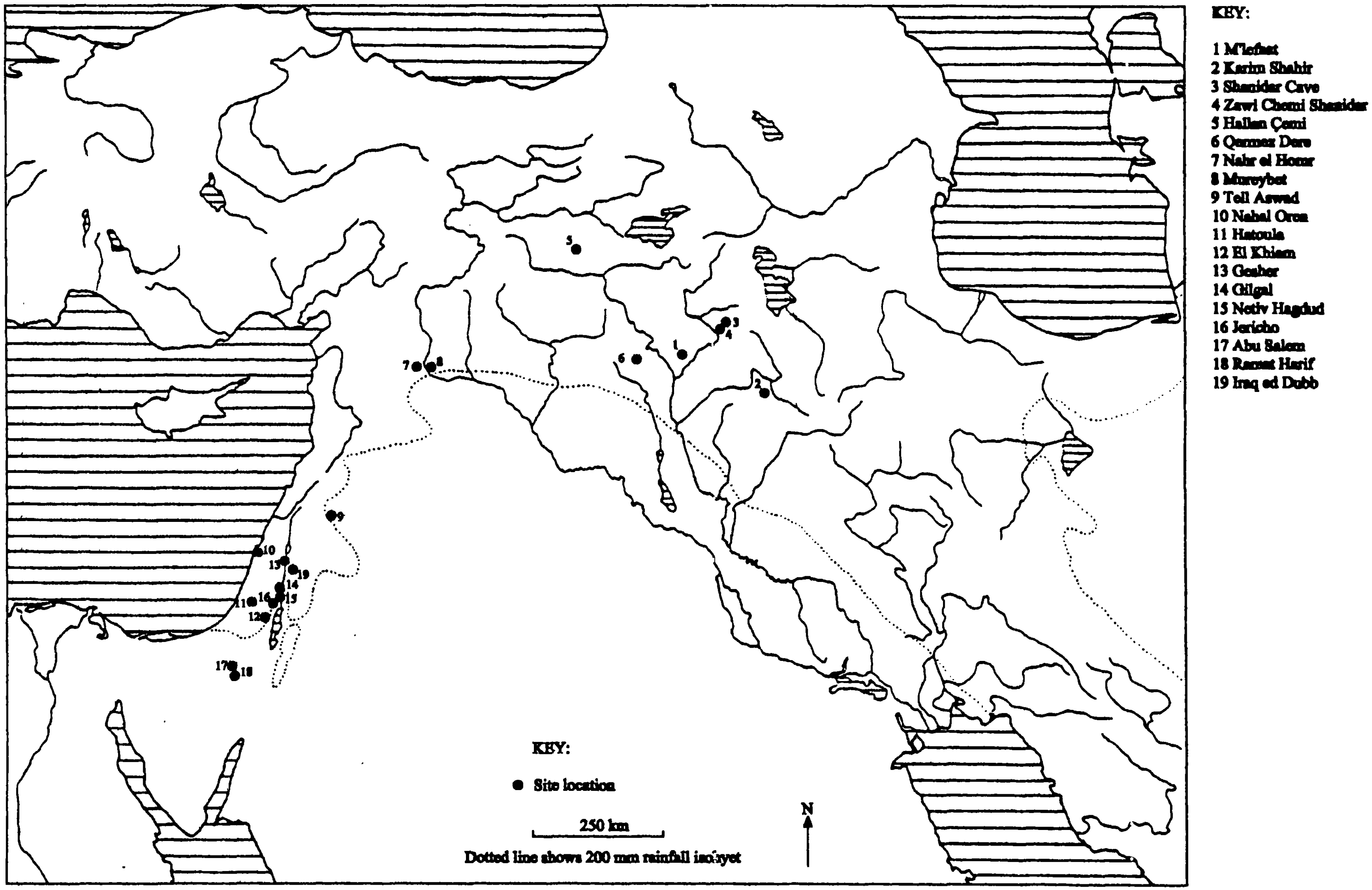


Figure 5.2: Location of Period 2 (10,300-9,600b.p.) Sites with Faunal Assemblages

5.4: PERIOD 3: 9,600B.P. TO 8,600B.P. (TABLES 5.6 AND 5.7, FIGURE 5.3):

Period 3 is characterised by the spread of permanent agricultural villages from the southern Levantine Corridor, where they first emerged during Period 2, into all areas of the Fertile Crescent. A number of these agricultural villages are commonly regarded as having yielded the earliest definite indications of caprine domestication. Sites of Period 3 are well known from a wide variety of environmental zones in the northern and southern Levant. Here the wide-ranging cultural developments, described in Chapter 4, which were associated with the rise of the PPNB Interaction Sphere (Bar-Yosef and Belfer-Cohen 1989b) gradually replaced the PPNA cultural entity. In contrast, the quantity of archaeological data from Iraq/Iran for Period 3 is still extremely limited, which is especially unfortunate as some of the earliest indications of goat domestication come from this region (e.g.: Hesse 1978, Hole, Flannery and Neely 1969). Nevertheless, it is clear that with the onset of the early Holocene climatic optimum, settlement in the region began to expand out of the piedmont zone of the Taurus/Zagros arc, to which it had apparently been confined during since the beginning of Period 1, as a series of Early Neolithic agricultural villages were established in the Zagros uplands during Period 3 (Hole 1996).

The Period 3 botanical assemblages from south-west Asia have recently been summarised by Garrard (1999). These provide clear evidence for the diversification of agricultural economies and their expansion out of the southern Levantine Corridor. Domestic cereals, which by Period 3 also included naked six-row barley and free-threshing wheat, have been found throughout the Fertile Crescent and, in the southern Levant at Jilat 7 (Colledge 1994), in the dry steppe zone beyond. There is also evidence for the widespread cultivation of pulses, including the presence at a number of locations of morphologically domestic forms of pea, broad bean and chickpea. In all areas cultivated cereals and pulses continued to be augmented by a wide variety of nuts and fruits.

During Period 3 faunal economies of the type first noted at Tell Aswad during Period 2, i.e. focused on exploitation of proto-domestic/domestic caprines, began to emerge at a number of other permanent agricultural villages in a few specific locations of south-west Asia, namely: the southern Levantine Corridor, upper Euphrates valley and Zagros uplands. However, outside these areas both agricultural and hunter-gatherer groups continued to rely on various combinations of available wild taxa.

In the southern Levant the shift towards proto-domestic/domestic goats seems to have spread during Period 3 from the Damascus Basin, where it was first noted during Period 2 at Tell Aswad (Ducos 1993a), throughout the agricultural villages of the southern Levantine Corridor (i.e. Ghoraife I, Munhatta, Jericho, Beidha), at this stage augmenting rather than replacing earlier hunting strategies. There is also good evidence that fully domestic sheep were introduced to the Damascus Basin (i.e. Tell Aswad II, Ghoraife I) from the northern Levant during Period 3 (Ducos 1993a), which hints at a southward diffusion of domestic sheep through the Levantine Corridor. In contrast, both agricultural and hunter-gatherer groups to the east and west of the southern Levantine Corridor maintained their reliance on hunted wild taxa throughout Period 3. Thus, in the woodland and moist steppe zones to the west (i.e. Nahal Oren, Rakefet, Yiftahel, Kfar Hahoresh) gazelle continued to predominate, followed by varying proportions of wild cattle, wild boar, wild goat and a few fallow deer. Similarly, in the dry steppe zone to the east (i.e. Wadi Jilat 7, Wadi Jilat 26, Wadi Jilat 32) gazelle were also the most common taxon, but were here accompanied by hare and fox.

A similar shift towards proto-domestic/domestic caprines has also been documented in the northern Levant during Period 3. However, the shift was at this stage apparently confined to the upper Euphrates Valley (i.e. Çayönü, Cafer Höyük) and seems to have been focused on sheep, rather than goats. Thus, in the earliest layers at Çayönü (c.9,500 to c.9,000b.p.) wild boar were the most common taxon, followed by red deer, wild goat, wild cattle and wild sheep. However, in the upper layers at Çayönü (c.9,000 to c.8,500b.p.) these wild taxa had been largely replaced by domestic or semi-domestic sheep and, to a lesser extent, goats. Despite the presence of small numbers of domestic or semi-domestic sheep and, less frequently, goats at Period 3 sites in the northern Levantine Corridor (i.e. Abu Hureyra 2A, Mureybet IVb), it is clear that in this particular region hunted gazelle, equids and wild cattle continued to form the mainstay of the faunal economy. The focus on equids noted here during Period 2 seems to have been a temporary phenomenon, as gazelle reverted to their earlier predominance during Period 3.

Insufficient information is available from Iraq/Iran with which to identify regional trends in faunal exploitation during Period 3. Although the agricultural village of Ganj Dareh (9,000b.p. to 8,400b.p.), located high in the Zagros uplands, has yielded the earliest clear indications of goat domestication and intensive goat husbandry in south-west Asia (Hesse 1978), it is also clear that at similar agricultural villages elsewhere in the region earlier hunting strategies were maintained throughout Period 3. These continued to be influenced by local environmental conditions, especially altitude. Thus, at Tepe Asiab in the Zagros uplands red deer and wild goat were predominant, whilst at Ali Kosh BM, located further to the south on the Deh Luran plain, wild goat, perhaps subject to a form of herd management or proto-domestication (Hole, Flanney and Neely 1969), and gazelle were the most common taxa.

Site	Period	Area	n	Equ	Bos	Sus	Gaz	Alc	C+O	(C/O)	(Cpr)	(Ovi)	Cer	Dam	Cap	Lep	Can	Vul	Fel	Mus	Eri	Source
Ganj Dareh	3	ZU	29381		0.6	1.0	0.02		91.9	74.0	16.0	1.9	0.2			4.3	0.02	2.0	0.1	0.02	0.02	Hesse 1984
Tepe Asiab	3	ZU	1104	0.4	4.4	12.7	0.1		24.2		16.8	7.3	26.0	0.3		3.4	2.7	13.9	0.6	10.2	1.1	Bökönyi 1977
Ali Kosh (BM)	3	ZP	1858	2.7	1.3	0.2	23.6		71.8	65.6	6.3							0.4				Hole, Flannery and Neely 1969
Çayönü (earlier)	3	TP	?		14.8	44.7			23.4		15.1	8.3	17.0									Lawrence 1982
Çayönü (upper)	3	TP	?		2.2	15.2			81.3		26.0	55.3	1.3									Lawrence 1982
Tel Abu Hureyra (2A)	3	EV	1500	6.0	3.5	0.8	81.8		6.2	6.2	x	x		0.7		0.5	0.1	0.3				Legge 1975
Mureybet (IVB)	3	EV	?	2.7	27.0	2.7	52.4		8.0			8.0		7.1								Ducos 1978b
Cafer Höyük	3	EV	1628		7.4	16.6			57.9	39.7	10.6	7.6	1.4	0.7	1.0	13.6	0.4	1.0	0.1			Helmer 1991b
Ghoraife (I)	3	DB	321	1.9	6.8	9.9	30.0		51.5		38.9	12.6										Ducos 1993a
Nahal Oren	3	PC	570		2.4	4.6	76.4		13.9		13.9			1.0	1.7							Noy, Legge and Higgs 1973
Rakefet	3	MC	718		1.2	5.0	82.7		0.4		0.4		0.7	5.4	0.3	0.9		2.9	0.1	0.4		Garrard 1980
Yiftahel	3	CP	?		x	x	x		15.0		15.0			x	x			x		x		Horwitz 1987a
Kfar Hahoresh	3	CP	420		8.1	4.3	57.4		22.9		22.9			1.2		6.0		8.3				Goring-Morris et al. 1996
Munhatta	3	JV	566		12.7	22.6	27.3		33.0	33.0	x				3.5			1.0	0.4			Ducos 1968
Jericho	3	JV	795	0.5	11.4	14.7	13.7		48.8	3.8	43.1	1.9		0.4	0.4		0.9	8.1	1.1			Clutton-Brock 1979
Nahal Divshon	3	NG	?		x		x		x		x			x								Tchernov 1976
Wadi Jilat 7 (1)	3	EJ	317				42.9									49.8		7.3				Martin 1994
Wadi Jilat 7 (2-4)	3	EJ	1080		0.1		57.4									33.5	0.2	8.4	0.2		0.2	Martin 1994
Wadi Jilat 26	3	EJ	12				33.3									58.3		8.3				Martin 1994
Wadi Jilat 7 (5)	3+4	EJ	89				46.1									44.9	2.2	6.7				Martin 1994
Wadi Jilat 32	3+4	EJ	156				2.6									89.1		7.1			1.3	Martin 1994
Beidha (II-V)	3	SJ	5141	0.9	2.9	0.5	6.6		87.5		87.5					0.1	0.1	1.2	0.3	0.04		Hecker 1975

Iran-Iraq Area Codes: ZU=Zagros Uplands, ZP=Zagros Piedmont
N.Levant-Euphrates Area Codes: TP=Taurus Piedmont, EV=Euphrates Valley
S.Levant Area Codes: DB=Damascus Basin, PC=Palestine Coast, MC=Mount Carmel, CP=Central Palestine, JV=Jordan Valley, NG=Negev, EJ=Eastern Jordan, SJ=Southern Jordan
Taxa Codes: Equ=*Equus* spp., Bos=*Bos* spp., Sus=*Sus* spp., Gaz=*Gazella* spp., Alc=*Alelaphus buselaphus*, C+O=total Subfamily Caprinae i.e. C/O+Cpr+Ovi, (C/O)=*Capra* spp. or *Ovis* spp., (Cpr)=*Capra* spp., (Ovi)=*Ovis* spp., Cer=*Cervus elaphus*, Dam=*Dama mesopotamica*, Cap=*Capreolus capreolus*, Lep=*Lepus capensis*, Can=*Canis* spp., Vul=*Vulpes* spp., Fel=Family Felidae, Mus=Family Mustelidae, Eri=Family Erinaceidae
Quantitative Data: all % NISP except: x=taxon present (excluded from n and % NISP calculations), X=most abundant of present taxa (excluded from n and % NISP calculations)

Table 5.6: Proportions of Taxa in Faunal Assemblages from Period 3 (9,600 to 8,600b.p.)

Site	Period	Area	n	Hrb	Equ	Bos	Sus	Gaz	C+O	(Cpr)	(Ovi)	(C:O)	(id)	Cer	Dam	Cap	Source
Ganj Dareh	3	ZU	29381	93.7		0.6	1.1	0.02	98.1	87.6	10.4	1:0.1	19.5	0.2			Hesse 1984
Tepe Asiab	3	ZU	1104	68.1	0.6	6.5	18.6	0.1	35.5	24.8	10.8	1:0.4	99.6	38.2	0.4		Bökönyi 1977
Ali Kosh (BM)	3	ZP	1858	99.6	2.7	1.3	0.2	23.7	72.1	72.1		1:0	8.8				Hole, Flannery and Neely 1969
Çayönü (Earlier)	3	TP	?	99.9		14.8	44.7		23.4	15.1	8.3	1:0.5	?	17.0			Lawrence 1982
Çayönü (Upper)	3	TP	?	100.0		2.2	15.2		81.3	26.0	55.3	1:2.1	?	1.3			Lawrence 1982
Abu Hureyra (2A)	3	EV	1500	99.0	6.1	3.5	0.8	82.6	6.3	x	X	?	?		0.7		Legge 1975
Mureybet (IVb)	3	EV	?	99.9	2.7	27.0	2.7	52.5	8.0		8.0	1:0	?		7.1		Ducos 1978b
Cafer Hoyuk	3	EV	1628	85.0		8.7	19.5		68.1	39.7	28.4	1:0.7	31.4	1.6	0.8	1.2	Helmer 1991b
Ghoraife (I)	3	DB	321	100.0	1.9	6.8	9.9	30.0	51.5	38.9	12.6	1:0.3	?				Ducos 1993a
Nahal Oren	3	PC	570	100.0		2.4	4.6	76.4	13.9	13.9		1:0	?		1.0	1.7	Noy, Legge and Higgs 1973
Rakefet	3	MC	718	95.7		1.3	5.2	86.4	0.4	0.4		1:0	?	0.7	5.6	0.3	Garrard 1980
Yiftahel	3	CP	?	15.0		x	x	x	100.0	100.0		1:0	?		x	x	Horwitz 1987a
Kfar Hahoresh	3	CP	420	93.9		8.6	4.6	61.1	24.4	24.4		1:0	?		1.3		Goring-Morris et al. 1996
Munhatta	3	JV	566	99.1		12.8	22.8	27.5	33.3	x		1:0	?			3.5	Ducos 1968
Jericho	3	JV	795	89.9	0.6	12.7	16.4	15.2	54.3	52.0	2.3	1:0.04	92.2		0.4	0.4	Clutton-Brock 1979
Nahal Divshon	3	NG	?	?		x		x	x	x		1:0	?		x		Tchernov 1976
Wadi Jilat 7 (1)	3	EJ	317	42.9				100.0									Martin 1994
Wadi Jilat 7 (2-4)	3	EJ	1080	57.5		0.2		99.8									Martin 1994
Wadi Jilat 26	3	EJ	12	33.3				100.0									Martin 1994
Wadi Jilat 7 (5)	3+4	EJ	89	46.1				100.0									Martin 1994
Wadi Jilat 32	3+4	EJ	156	2.6				100.0									Martin 1994
Beidha (II-V)	3	SJ	5141	98.4	0.9	2.9	0.5	6.7	88.9	88.9		1:0	?				Hecker 1975

Iran-Iraq Area Codes: ZU=Zagros Uplands, ZP=Zagros Piedmont
N.Levant-Euphrates Area Codes: TP=Taurus Piedmont, EV=Euphrates Valley
S.Levant Area Codes: DB=Damascus Basin, PC=Palestine Coast, MC=Mount Carmel, CP=Central Palestine, JV=Jordan Valley, NG=Negev, EJ=Eastern Jordan, SJ=Southern Jordan
Taxa Codes: Hrb=% of major medium and large herbivores in n, Equ=*Equus* spp., Bos=*Bos* spp., Sus=*Sus* spp., Gaz=*Gazella* spp., C+O=total Subfamily Caprinae, (Cpr)=*Capra* spp., (Ovi)=*Ovis* spp., (C:O)=ratio *Capra* spp.:*Ovis* spp., (id)=% of total Subfamily Caprinae identified to genus, Cer=*Cervus elaphus*, Dam=*Dama mesopotamica*, Cap=*Capreolus capreolus*
Quantitative Data: all % NISP except: x=taxon present (excluded from n and % NISP calculations), X=most abundant of present taxa (excluded from n and % NISP calculations)

Table 5.7: Proportions of Major Medium and Large Herbivores in Faunal Assemblages from Period 3 (9,600 to 8,600b.p.)

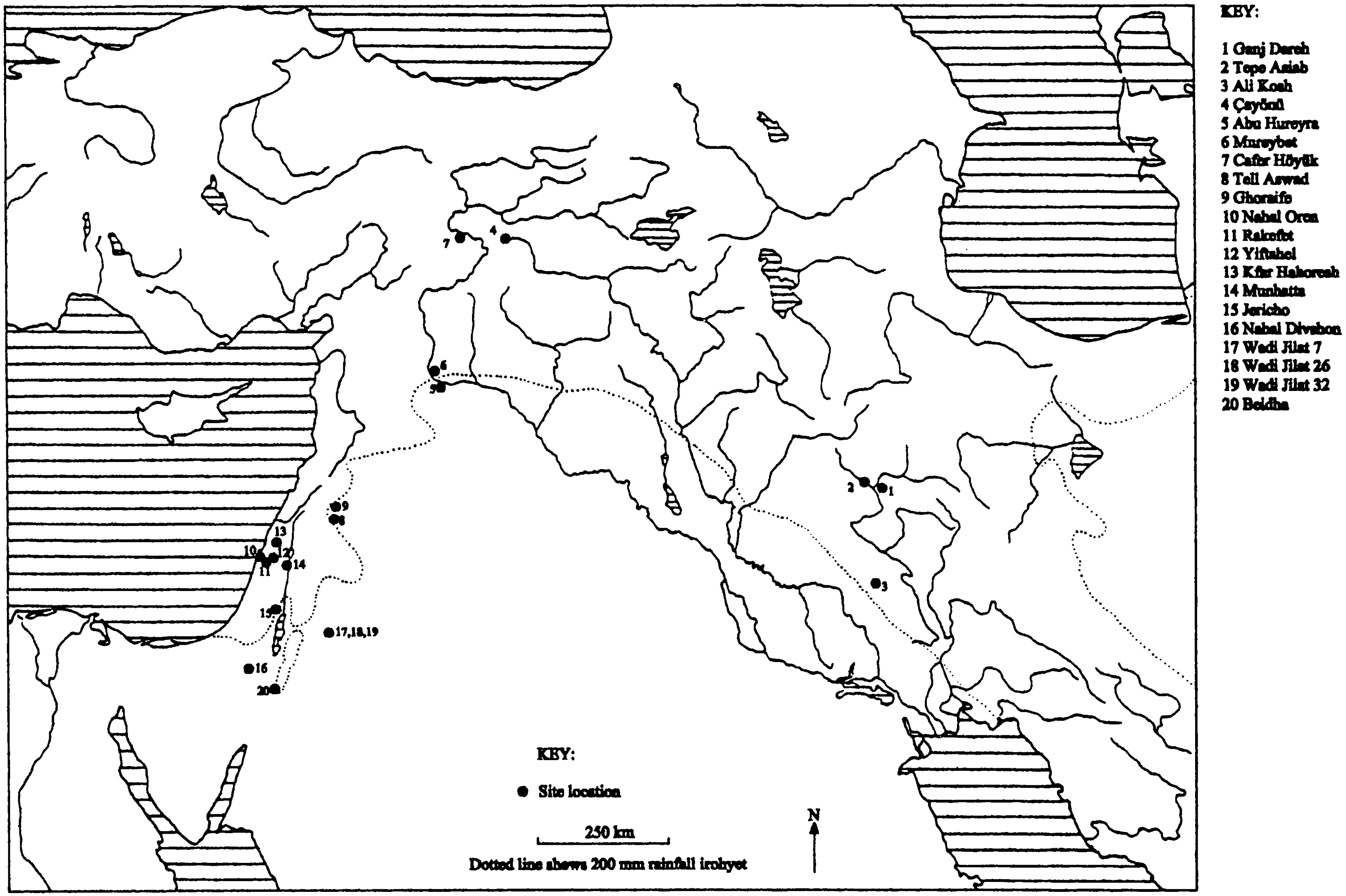


Figure 5.3: Location of Period 3 (9,600b.p.-8,600b.p.) Sites with Faunal Assemblages

5.5: PERIOD 4: 8,600 TO 8,000B.P. (TABLES 5.8 AND 5.9, FIGURE 5.4):

Period 4 saw the spread of faunal economies based on intensive exploitation of domestic caprines across all areas of south-west Asia except the dry steppe and sub-desert zones of the southern Levant (i.e. eastern Jordan and Sinai). In most areas of the Fertile Crescent mixed herds of domestic goats and sheep were integrated with agricultural economies to form an apparently stable system of mixed farming. There is also evidence for the diversification of such economies at a number of Period 4 sites in the upper Euphrates Valley, which have yielded the earliest clear indications of pig domestication in south-west Asia. However, in the more arid areas of south-west Asia which were less suited to cultivation, such as eastern Jordan or south-western Iran plant and animal domesticates augmented rather than replaced the earlier hunting and gathering traditions. Sites of Period 4 are well represented in the northern and southern Levant, which saw the consolidation of the PPNB Interaction Sphere during the Late PPNB, but are again less well known from Iraq/Iran.

It is clear from Garrard's (1999) summary of Period 4 and 5 botanical assemblages from south-west Asia that, with regard to plant-economies, the main developments of the Neolithic Revolution were in place throughout the region by the beginning of Period 4. Thus, domestic emmer wheat, einkorn wheat, free-threshing wheat, two-row barley, naked six-row barley and rye were present in varying combinations across the Fertile Crescent and in the dry-steppe zone beyond. These were supplemented by similarly varied combinations of cultivated, if not always morphologically domestic, legumes and pulses which included lentil, pea and occasionally chickpea and bitter vetch. A wide variety of wild nuts and fruits were also exploited, most commonly pistachio and fig. In the dry steppe zones of south-west Asia cultivated domestic cereals were almost always augmented by gathered wild cereals, especially einkorn wheat and two-row barley, perhaps to guard against the increased likelihood of crop failure in these regions (Garrard et al. 1996). Little evidence is available from the sub-desert zones of the region, but the complete absence of domesticates in the botanical assemblage from Dhuweila (Colledge 1994) suggests that here the prospect of crop failure outweighed the potential benefits of cultivation. Throughout south-west Asia subsequent periods seem to have been characterised by the consolidation of this package of early Neolithic cultivars rather than any new innovations, at least until the addition in the southern

Levant by the beginning of Period 9 of cultivated olive, fig, pomegranate and possibly vine (Zohary and Spiegel-Roy 1975, Davis 1980, Kislev 1987, Grigson 1995a).

In contrast to the relative stability evident in plant-food economies across south-west Asia by Period 4, faunal economies continued to evolve. In the southern Levant, the shift towards proto-domestic/domestic goats first noted in the Damascus Basin during Period 2 and in the southern Levantine Corridor during Period 3 continued to spread, reaching the agricultural villages of the woodland zone to the west (i.e. Abou Gosh, Atlit-Yam) by the end of Period 4. At the same time domestic sheep increased in number at sites in the Damascus Basin (i.e. Ghoraife II, Ramad I), where they seem to have entered the southern Levant during Period 3 (i.e. Tell Aswad II, Ghoraife I), and expanded into the southern Levantine Corridor (i.e. es-Siffiyeh, Basta, Wadi Fidan A). The emergence of mixed herds of domestic goats and sheep in this region seems to have been marked by intensified caprine exploitation at the expense of wild taxa, especially gazelle. The dry steppe and sub-desert zones of the southern Levant were apparently unaffected by these developments. Here, faunal assemblages clearly indicate the continuation of earlier hunting strategies exploiting locally available wild taxa. Thus, at sites in the high mountains of southern Sinai (i.e. Wadi Tbeik, Ujrat el-Mehed) ibex and hare were the most common taxa, whereas in the more gently undulating basalt desert of eastern Jordan (i.e. Ibn el-Ghazzi, Dhuweila 1) gazelle and hare predominated. Around the Azraq wetlands (i.e. Azraq 31) gazelle also appear to have been predominant, but were here accompanied by high proportions of equids and wild cattle, reflecting the habitat preferences of these taxa.

In the northern Levant, the intensive exploitation of domestic sheep which emerged in the upper Euphrates Valley during Period 3 seems to have continued into Period 4 (i.e. Gritille, Hayaz Höyük). These Period 4 sites in the upper Euphrates Valley, where wild boar was especially well represented during earlier periods, have also yielded the earliest clear indications of pig domestication in south-west Asia (Kusatman 1991). The introduction of pig to the early Neolithic package of plant and animal domesticates gave economies in this region the advantage of diversity. This provided the "potential for explosive growth and expansion into a wide range of environmental settings. Farming societies now had a rich variety of strategies to chose from as they set about to combine available wild species with cultivated crop plants and domestic animals in ways that would be most advantageous to them in their particular environmental and cultural landscape" (Smith 1995, p.89). It should however be stressed that the dry steppe and sub-desert zones of south-west Asia were as unsuited to domestic pigs as wild boar, owing to the water requirements of this taxon. As a result swine herding in this and subsequent periods was only a viable option in the woodland and moist steppe zones of the region. In the northern Levantine Corridor and adjacent dry steppe zone (i.e. Tell Molla Assad, Tell Assouad I-VI, Abu Hureyra 2B, Tell es-Sinn, Bouqras) the shift towards domestic caprines occurred slightly later than in the upper Euphrates valley. Nevertheless, this shift was well established by the beginning of Period 4 and was likewise focused on sheep, rather than goats. It is particularly apparent at Abu Hureyra, where domestic sheep replaced gazelle as the predominant taxon between phases 2A and 2B. Significantly, the proportion of domestic caprines in this region was highest at newly-established sites located the dry steppe zone (i.e. Tell es-Sinn, Bouqras).

Unfortunately as little data is available from Iraq/Iran for Period 4 as for preceding periods: only three faunal assemblages have been published in any detail (i.e. Tepe Guran, Ali Kosh AK, Jarmo). Identification of the shift from hunting to caprine husbandry in Iraq/Iran is also hindered by the fact that, in contrast to the situation over most of the northern and southern Levant, wild caprines were extensively exploited in earlier hunting economies. Nevertheless, it has been argued on the basis of age/sex ratios and horncore morphology that at least some of the goats and sheep in these Period 4 faunal assemblages from Iraq/Iran were fully domestic (e.g. Hole, Flannery and Neely 1969). It also seems that domestic goats were more common in these herds than domestic sheep (Hesse 1978). Unfortunately the limited data available makes it difficult to describe the expansion of domestic caprines across the various regions of Iraq/Iran in any detail. It would appear that during Period 4 goat husbandry expanded out of the Zagros uplands, where it was first documented at Ganj Dareh during Period 3, into the piedmont zone of the Taurus-Zagros arc (i.e. Jarmo, Ali Kosh AK). It also seems that during this period domestic sheep were introduced to both the Zagros uplands (Tepe Guran) and more arid parts of the piedmont zone (Ali Kosh AK) from elsewhere. Neither area has yielded any evidence for the presence of sheep, wild or domestic, in earlier periods. In addition, data from Ali Kosh AK, which yielded significant proportions of gazelle and equids in addition to domestic caprines, tentatively suggests that in more arid areas, such as the Deh Luran plain, earlier hunting traditions were less readily abandoned than in areas more suited to agriculture.

Site	Period	Area	n	Equ	Bos	Sus	Gaz	Alc	C+O	(C/O)	(Cpr)	(Ovi)	Cer	Dam	Cap	Lep	Can	Vul	Fel	Mus	Eri	Source
Tepe Guran	4+5	ZU	2420		x	x	x		X		X	x	x			x	x	x	x	x		Flannery 1967 cited in Hesse 1978
Ali Kosh (AK)	4	ZP	4430	6.4	4.0	0.4	28.5		60.2	56.0	4.1	0.1					0.1	0.4	0.1		0.1	Hole, Flannery and Neely 1969
Jarmo	4+5	ZP	6642	1.3	3.9	5.1	4.0		81.6	69.1	8.3	4.2	2.1		0.1	0.1	0.7	0.6	0.2	0.4		Stampfli 1983
Gritille	4	EV	1394		3.4	17.9	1.1		76.1	68.3	2.0	5.8	0.4	0.3	0.1	0.4	0.2	0.1			0.1	Stein 1989
Tel Molla Assad	4	EV	59	13.6	44.1		1.7		28.8	8.5	15.3	5.1		8.5			1.7	1.7				Clutton-Brock 1985
Tel Assouad (I-VI)	4	EV	616	1.0	12.2	10.2	20.7		55.1		32.2	22.9		0.2			0.5			0.3		Helmer 1985a
Tel Abu Hureyra (2B)	4	EV	504	0.7	7.6	0.5	18.6		70.5	70.5	x	x				0.9		0.7	0.5			Legge 1975
Tel es-Sinn	4	EV	590	1.0	5.3		1.4		92.0	79.3	4.4	8.3					0.2	0.2			0.3	Clason 1980
Hayaz Höyük	4	EV	2215		12.0	21.1	0.05		64.0	59.1	2.4	2.5	1.4		0.5	0.5	0.1	0.4				Buitenhuis 1988
Bouqras	4	EV	5015	0.1	9.3	0.1	1.4		88.6	78.5	4.3	5.8		0.4		0.1	0.04	0.1				Buitenhuis 1988
Ghoraife (II)	4	DB	721	0.7	17.5	9.7	8.2		63.5		15.1	48.4										Ducos 1993a
Ramad (I)	4	DB	3043	0.5	10.0	10.8	2.9		75.8		18.7	57.1										Ducos 1993a
Atlit-Yam	4+5	PC	322		42.5	9.0	3.0		45.0		45.0			0.3								Galili et al. 1993
Abou Ghosh	4	CP	3612		17.5	13.0	13.3		55.9		55.9			0.2								Ducos 1978a
Beisamoun	4	JV	78	2.6	1.3	26.9	14.1		52.6		52.6								2.6			Davis 1978
Nahal Issaron	4	NG	?	x			x		X		X					x						Goring-Morris and Gopher 1983
Wadi Tbeik	4	SI	937	1.8	0.2		8.5		24.4		24.4					64.6		0.2	0.2			Tchernov and Bar-Yosef 1982
Ujrat el-Mehed	4	SI	2479	0.04	0.04		1.5		91.6		91.6					6.3		0.5	0.04			Dayan et al. 1986
Es-Sifiyeh	4	JH	?			x	x		70.0		45.0	25.0		x		x		x				Mahasneh 1997
Azraq 31	4	EJ	56	25.0	21.4		39.3		3.6	3.6						10.7						Martin pers.comm.
Ibn el-Ghazzi	4	EJ	18				88.9									11.1						Martin 1994
Dhuweila (1)	4	EJ	2693	1.1			96.6		0.14	0.1		0.04				1.4	0.1	0.5			0.1	Martin 1994
Wadi Fidan A	4	SJ	757	0.3	6.3		2.4		90.0	54.3	24.8	10.8		0.1			0.3	0.3	0.4			Richardson 1997
Basta	4	SJ	35192	0.3	4.0		10.8		84.5		50.7	33.8		0.1			0.2	x	x	x		Becker 1991

Iran-Iraq Area Codes: ZU=Zagros Uplands, ZP=Zagros Piedmont
N.Levant-Euphrates Area Codes: EV=Euphrates Valley
S.Levant Area Codes: DB=Damascus Basin, PC=Palestine Coast, CP=Central Palestine, JV=Jordan Valley, NG=Negev, SI=Sinai, JH=Jordanian Highlands, EJ=Eastern Jordan, SJ=Southern Jordan
Taxa Codes: Equ=*Equus* spp., Bos=*Bos* spp., Sus=*Sus* spp., Gaz=*Gazella* spp., Alc=*Alelaphus buselaphus*, C+O=total Subfamily Caprinae i.e. C/O+Cpr+Ovi, (C/O)=*Capra* spp. or *Ovis* spp., (Cpr)=*Capra* spp., (Ovi)=*Ovis* spp., Cer=*Cervus elaphus*, Dam=*Dama mesopotamica*, Cap=*Capreolus capreolus*, Lep=*Lepus capensis*, Can=*Canis* spp., Vul=*Vulpes* spp., Fel=Family Felidae, Mus=Family Mustelidae, Eri=Family Erinaceidae
Quantitative Data: all % NISP except: x=taxon present (excluded from n and % NISP calculations), X=most abundant of present taxa (excluded from n and % NISP calculations)

Table 5.8: Proportions of Taxa in Faunal Assemblages from Period 4 (8,600 to 8,000b.p.)

Site	Period	Area	n	Hrb	Equ	Bos	Sus	Gaz	C+O	(Cpr)	(Ovi)	(C:O)	(id)	Cer	Dam	Cap	Source
Tepe Guran	4+5	ZU	2420	?		x	x	x	X	X	x	X:x	?	x			Flannery 1967 cited in Hesse 1978
Ali Kosh (AK)	4	ZP	4430	99.5	6.4	4.0	0.4	28.6	60.5	59.1	1.4	1:0	7.0				Hole, Flannery and Neely 1969
Jarmo	4+5	ZP	6642	98.1	1.3	4.0	5.2	4.1	83.2	55.2	27.9	1:0.5	15.3	2.1		0.1	Stampfli 1983
Gritille	4	EV	1394	99.3		3.4	18.0	1.1	76.6	19.7	57.0	1:2.9	10.2	0.4	0.3	0.1	Stein 1989
Tel Molla Assad	4	EV	59	96.7	14.1	45.6		1.8	29.8	22.3	7.4	1:0.3	70.8		8.8		Clutton-Brock 1985
Tell Assouad I-VI	4	EV	616	99.4	1.0	12.3	10.3	20.8	55.4	32.4	23.0	1:0.7	?		0.2		Helmer 1985a
Abu Hureyra 2B	4	EV	504	97.9	0.7	7.8	0.5	19.0	72.0	x	X	?	?				Legge 1975
Tell es-Sinn	4	EV	590	99.7	1.0	5.3		1.4	92.3	32.0	60.3	1:1.9	13.8				Clason 1980
Hayaz Hoyuk	4	EV	2215	99.1		12.1	21.3	0.1	64.6	31.6	33.0	1:1	7.7	1.4		0.5	Buitenhuis 1988
Bouqras	4	EV	5015	99.9	0.1	9.3	0.1	1.4	88.7	37.8	50.9	1:1.3	11.4		0.4		Buitenhuis 1988
Ghoraife II	4	DB	721	99.6	0.7	17.6	9.7	8.2	63.8	15.2	48.6	1:3.2	?				Ducos 1993a
Ramad I	4	DB	3043	100.0	0.5	10.0	10.8	2.9	75.8	18.7	57.1	1:3.2	?				Ducos 1993a
Atlit-Yam	4+5	PC	322	99.8		42.6	9.0	3.0	45.1	45.1		1:0	?		0.3		Galili et al. 1993
Abou Gosh	4	CP	3612	99.9		17.5	13.0	13.3	56.0	56.0		1:0	?		0.2		Ducos 1978a
Beisamoun	4	JV	78	97.5	2.7	1.3	27.6	14.5	53.9	53.9		1:0	?				Davis 1978
Nahal Issaron	4	NG	?	?	x			x	X	X		1:0	?				Goring-Morris and Gopher 1983
Wadi Tbeik	4	SI	937	34.9	5.2	0.6		24.4	69.9	69.9		1:0	?				Tchernov and Bar-Yosef 1982
Ujrat el-Mehed	4	SI	2479	93.2		0.04		1.6	98.3	98.3		1:0	?				Dayan et al. 1986
Es-Sifiyeh	4	JH	?	70.0			x	x	100.0	64.3	35.7	1:0.6	?		x		Mahasneh 1997
Azraq 31	4	EJ	56	89.3	28.0	24.0		44.0	4.0			?	0.0				Martin pers.comm.
Ibn el-Ghazzi	4	EJ	18	88.9				100.0									Martin 1994
Dhuweila 1	4	EJ	2693	97.8	1.1			98.7	0.1		0.1	0:1	28.6				Martin 1994
Wadi Fidan A	4	SJ	757	99.1	0.3	6.4		2.4	90.8	63.3	27.6	1:0.4	39.6		0.1		Richardson 1997
Basta	4	SJ	35192	99.7	0.3	4.0		10.8	84.8	50.9	33.9	1:0.7	?		0.1		Becker 1991

Iran-Iraq Area Codes: ZU=Zagros Uplands, ZP=Zagros Piedmont

N.Levant-Euphrates Area Codes: EV=Euphrates Valley

S.Levant Area Codes: DB=Damascus Basin, PC=Palestine Coast, CP=Central Palestine, JV=Jordan Valley, NG=Negev, SI=Sinai, JH=Jordan Highlands, EJ=Eastern Jordan, SJ=Southern Jordan

Taxa Codes: Hrb=% of major medium and large herbivores in n, Equ=*Equus* spp., Bos=*Bos* spp., Sus=*Sus* spp., Gaz=*Gazella* spp., C+O=total Subfamily Caprinae, (Cpr)=*Capra* spp., (Ovi)=*Ovis* spp., (C:O)=ratio *Capra* spp.:*Ovis* spp., (id)=% of total Subfamily Caprinae identified to genus, Cer=*Cervus elaphus*, Dam=*Dama mesopotamica*, Cap=*Capreolus capreolus*

Quantitative Data: all % NISP except: x=taxon present (excluded from n and % NISP calculations), X=most abundant of present taxa (excluded from n and % NISP calculations)

Table 5.9: Proportions of Major Medium and Large Herbivores in Faunal Assemblages from Period 4 (8,600 to 8,000b.p.)

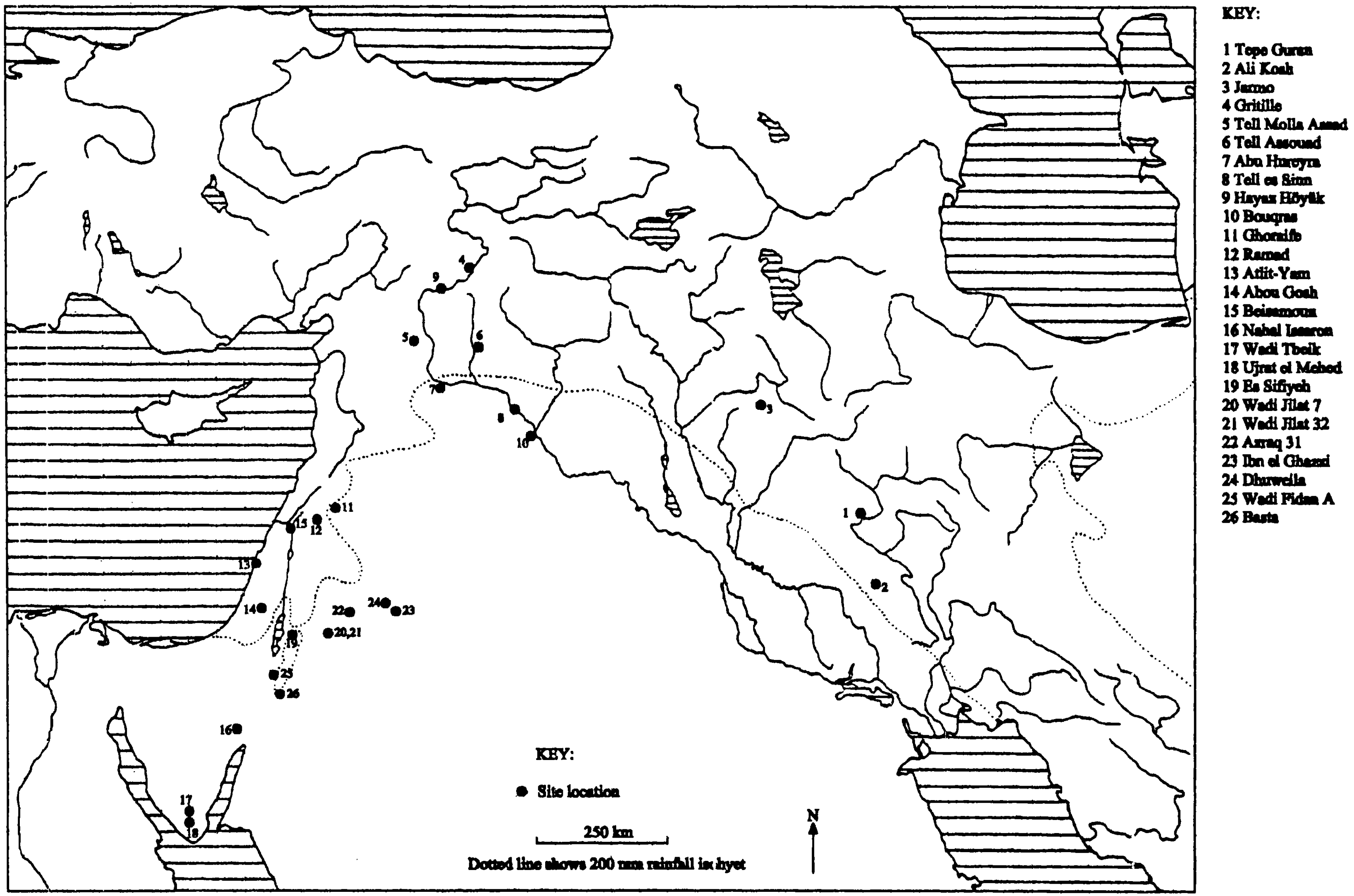


Figure 5.4: Location of Period 4 (8,600b.p.-8,000b.p.) Sites with Faunal Assemblages

5.6: PERIOD 5: 8,000 TO 7,500B.P. (TABLES 5.10 AND 5.11, FIGURE 5.5):

A brief period of increased cold and aridity seems to have interrupted the early Holocene climatic optimum throughout south-west Asia during Period 5 (Sanlaville 1996 and 1997). There are some signs that the effects of this temporary climatic severity were most keenly felt at agricultural villages in the more marginal south-eastern and south-western limbs of the Fertile Crescent (i.e. Wadi Fidan C, Ali Kosh MJ). Here there seems to have been a temporary resurgence in the exploitation of wild cereals and animals, which adds credence to the view that earlier hunting and gathering traditions were maintained in such areas as a risk buffer even after the introduction of domesticates. These climatic conditions do not however appear to have halted the apparently inexorable spread of mixed herds of domestic goats and sheep, as they appeared for the first time during Period 5 in the few areas of south-west Asia which had continued to rely on earlier hunting traditions throughout Periods 3 and 4, namely: the dry steppe and sub-desert zones of the southern Levant. With the spread by the end of Period 5 of mixed herds of domestic goats and sheep into all of the varied environmental zones of south-west Asia significant differences emerged in the ratios of goats to sheep. Thus, in more mountainous and/or arid regions (e.g. Ali Kosh MJ, Tepe Tula'i, Wadi Fidan C) goats tended to outnumber sheep, whereas in more undulating, steppic terrain (e.g. Umm Dabaghiyeh, Umm el-Tlel 2, Qdeir I, El Kowm II Caracol, Wadi Jilat 25, Wadi Jilat 13) sheep were generally favoured over goats. These differences are unsurprising, given the physiological and ethological differences between the species (e.g. Lancaster and Lancaster 1991). The diversification of mixed farming economies also continued throughout Period 5; the earliest clear indications of cattle domestication have been found at a few sites of this period in the northern and southern Levant, though not at this stage in Iraq/Iran (Grigson 1989, Helmer 1992). The geography and chronology of cattle domestication unfortunately remains poorly understood, owing in part to the high levels of fragmentation and small sample sizes associated with most south-west Asian cattle bone assemblages. As described in Chapter 4, during Period 5 the PPNB 'interaction sphere' of the northern and southern Levant began to break down. This was replaced by increasingly divergent, more localised cultural traditions which included the Final PPNB in the northern Levant, the PPNC in the southern Levant and early Late Neolithic in the dry steppe and sub-desert zones (e.g. Rollefson 1989, Kozlowski and Gebel 1994, Garrard et al. 1996). In Iraq/Iran the Early Neolithic of Period 4 was succeeded during Period 5 by the Early

Ceramic Neolithic (Hole 1987). Unfortunately sites of Period 5 are poorly represented in all regions of south-west Asia and even fewer have yielded published faunal assemblages.

As described above, there are tentative hints that sedentary agriculture in the extreme southern margins of the Fertile Crescent may have come under some strain during the temporary climatic severity of Period 5. These are based on the botanical assemblages of Period 4 and 5 from Wadi Fidan A/C, situated in the Wadi Araba of southern Jordan (Colledge 1994) and Ali Kosh AK/MJ, located on the Deh Luran plain of south-western Iran (Helbaek 1969, van Zeist et al. 1984). Thus, the Period 4 botanical assemblage from Wadi Fidan A yielded wild and domestic two-row barley, domestic emmer wheat and domestic einkorn wheat. These were supplemented during Period 5 at Wadi Fidan C by domestic free-threshing wheat and, more unusually, wild einkorn wheat. Similarly, whereas the Period 4 botanical assemblage from Ali Kosh AK yielded wild and domestic two-row barley, naked six-row barley, wild and domestic einkorn wheat and domestic emmer wheat, that of Period 5 Ali Kosh MJ was restricted to wild and domestic two-row barley and domestic emmer wheat. In contrast, plant-food economies in less marginal areas of the Fertile Crescent seem to have experienced little change during this period (Garrard 1999).

As it is only relatively recently that sites of Period 5 have been excavated in the southern Levant, the number of published faunal assemblages from this region is extremely limited. It is however clear that mixed herds of domestic sheep and goats, in which sheep were predominant, had been introduced to the dry steppe and sub-desert zones of eastern Jordan by the beginning of Period 5 (i.e. Wadi Jilat 13 1-3, Wadi Jilat 25, Azraq 31). However, the introduction of domestic caprines to this region, which lay beyond the theoretical boundaries for reliable rainfall agriculture, did not lead the abandonment of earlier hunting strategies as the traditional range of wild taxa (i.e. gazelle, hare, fox) continued to be well represented. Hardly any faunal data is available from other parts of the southern Levant, but at both Labweh and Wadi Fidan C domestic caprines were predominant. It should however be noted that at Wadi Fidan C the proportion of wild taxa, especially gazelle, increased significantly over their Period 4 representation at Wadi Fidan A.

A similarly restricted set of data is available from the northern Levant for Period 5 and, as in the southern Levant, the dry steppe zone is best represented. In the el-Kowm Basin (i.e. Umm el-Tlel 2, Qdeir I, El Kowm II Caracol) domestic sheep were the predominant taxon and were accompanied by a few domestic goats. Gazelle were also well represented, suggesting that hunting continued to play a significant role in these economies, however the relatively high proportions of hare and, to a lesser extent fox, noted in assemblages from the dry steppe zone of eastern Jordan appear to have been absent. Abu Hureyra has yielded a virtually identical Period 5 faunal assemblage to those of the el-Kowm Basin, although the proportion of cattle is slightly higher.

In contrast, the few Period 5 faunal assemblages from Iraq/Iran (i.e. Tepe Sarab, Ali Kosh AK, Tepe Tula'i, Umm Dabaghiyeh) display considerable variation, reflecting both the environmental diversity of the region and differences in site function. Thus, at Tepe Sarab domestic caprines predominated and, for the first time in the Zagros uplands, sheep outnumbered goats. However, at Ali Kosh MJ although the proportion of sheep increased slightly during Period 5, the overall proportion of domestic caprines declined as exploitation of wild taxa, especially gazelle and equids, intensified. In addition to the agricultural villages discussed above, two further sites in Iraq/Iran provide evidence of rather more specialised economic activities. At Tepe Tula'i, interpreted as a seasonally occupied pastoral campsite (Hole 1974), domestic goat completely dominated the faunal assemblage; unusually, the next most common taxon was dog. In contrast, equids were the predominant taxon at Umm Dabaghiyeh, followed by gazelle and a few domestic caprines, and thus serve as an important reminder that in some areas of south-west Asia at least hunting continued to make a significant contribution to the economy, despite the apparent ubiquity of domestic caprines. Period 5 has also yielded the earliest clear evidence for the presence of domestic pig in Iraq/Iran, in the form of significant size reduction in pig molars from early Ceramic Neolithic layers at Jarmo.

Site	Period	Area	n	Equ	Bos	Sus	Gaz	Alc	C+O	(C/O)	(Cpr)	(Ovi)	Cer	Dam	Cap	Lep	Can	Vul	Fel	Mus	Eri	Source
Tepe Sarab	5	ZU	7093	0.1	1.5	0.4	12.0		82.4		23.7	58.7	1.1		0.01	0.1	1.8	0.4	0.1	0.1	0.1	Bökönyi 1977
Ali Kosh (MJ)	5	ZP	1342	10.7	2.4	0.4	31.4		52.4	49.9	1.9	0.6					0.7	1.4	0.6		0.1	Hole, Flannery and Neely 1969
Tepe Tula'i	5	ZP	2576	0.5	0.2	0.3	1.0		96.2	92.7	3.5						1.9					Hole 1974
Umm Dabaghiyeh	5	JZ	6431	68.9	3.9	1.2	16.0		8.7		3.0	5.7				0.05	1.0	0.1		0.03		Bökönyi 1973 and 1978
Tel Abu Hureyra	5	EV	341	0.3	6.3	1.5	21.6		68.7		x	x		0.3	0.3	1.0						Legge 1975
Umm el Tlel 2	5	KB	267		0.4	0.4	22.8		74.1	44.9	2.6	26.6				1.1	0.4	0.7				Helmer and Saña 1993
Qdeir I (early)	5	KB	?	x			x		62.0		x	X				x		x				Stordeur 1993
El Kowm II Caracol	5	KB	?	x			x		X		x	X						x				Stordeur 1989
Labweh	5	BV	940	1.4	10.5	7.7	5.3		74.6		36.6	38.1	x	x			0.4	x				Bökönyi 1978
Wadi Jilat 25 (early-late)	5	EJ	149				6.0		67.8	47.7	1.3	18.8				23.5		2.0			0.7	Martin 1994
Wadi Jilat 13 (1-3)	5	EJ	2933	0.1	0.2		25.0		27.4	14.2	3.8	9.4				33.7	0.7	5.1	3.3	0.9	3.5	Martin 1994
Azraq 31	5	EJ	1151	2.3	0.3		32.1		24.4	12.6	2.5	9.3				31.0	1.9	4.4	3.0		0.4	Martin pers.comm.
Wadi Fidan C	5	SJ	468	0.2	2.1		33.8		60.0	30.3	23.3	6.4		0.2		3.4					0.2	Richardson 1997

Iran-Iraq Area Codes: ZU=Zagros Uplands, ZP=Zagros Piedmont, JZ=Jezira
N.Levant-Euphrates Area Codes: EV=Euphrates Valley, KB=El Kowm Basin
S.Levant Area Codes: BV=Beqa'a Valley, EJ=Eastern Jordan, SJ=Southern Jordan
Taxa Codes: Equ=*Equus* spp., Bos=*Bos* spp., Sus=*Sus* spp., Gaz=*Gazella* spp., Alc=*Alelaphus buselaphus*, C+O=total Subfamily Caprinae i.e. C/O+Cpr+Ovi, (C/O)=*Capra* spp. or *Ovis* spp., (Cpr)=*Capra* spp., (Ovi)=*Ovis* spp., Cer=*Cervus elaphus*, Dam=*Dama mesopotamica*, Cap=*Capreolus capreolus*, Lep=*Lepus capensis*, Can=*Canis* spp., Vul=*Vulpes* spp., Fel=Family Felidae, Mus=Family Mustelidae, Eri=Family Erinaceidae
Quantitative Data: all % NISP except: x=taxon present (excluded from n and % NISP calculations), X=most abundant of present taxa (excluded from n and % NISP calculations)

Table 5.10: Proportions of Taxa in Faunal Assemblages from Period 5 (8,000 to 7,600b.p.)

Site	Period	Area	n	Hrb	Equ	Bos	Sus	Gaz	C+O	(Cpr)	(Ovi)	(C:O)	(id)	Cer	Dam	Cap	Source
Tepe Sarab	5	ZU	7093	97.5	0.1	1.5	0.4	12.3	84.5	24.3	60.2	1:2.5	?	1.1		0.01	Bökönyi 1977
Ali Kosh MJ	5	ZP	1342	97.3	11.0	2.5	0.4	32.3	53.9	40.9	12.9	1:0.3	4.8				Hole, Flannery and Neely 1969
Tepe Tula'i	5	ZP	2576	98.2	0.5	0.2	0.3	1.0	98.0	98.0		1:0	3.6				Hole 1974
Umm Dabaghiyeh	5	JZ	6431	98.7	69.8	4.0	1.2	16.2	8.8	3.0	5.8	1:1.9	?				Bökönyi 1973 and 1978
Abu Hureyra PN	5	EV	341	99.0	0.3	6.4	1.5	21.8	69.4	x	X	?	?		0.3	0.3	Legge 1975
Umm el Tlel 2	5	KB	267	97.7		0.4	0.4	23.3	75.8	6.8	69.1	1:10.2	39.4				Helmer and Saña 1993
Qdeir I early	5	KB	?	62.0	x			x	100.0	x	X	x:X	?				Stordeur 1993
El Kowm II Caracol	5	KB	?	?	x			x	X	x	X	x:X	?				Stordeur 1989
Labweh	5	BV	940	99.5	1.4	10.6	7.7	5.3	75.0	36.7	38.2	1:1	?	x	x		Bökönyi 1978
Wadi Jilat 25 early-late	5	EJ	149	73.8				8.1	91.9	5.9	85.9	1:14.5	29.6				Martin 1994
Wadi Jilat 13 1-3	5	EJ	2933	52.7	0.2	0.4		47.4	52.0	15.0	37.0	1:2.5	48.2				Martin 1994
Azraq 31	5	EJ	1151	59.1	3.9	0.5		54.3	41.3	8.7	32.5	1:3.7	48.4				Martin pers.comm.
Wadi Fidan C	5	SJ	468	96.3	0.2	2.2		35.1	62.3	48.9	13.4	1:0.3	49.5		0.2		Richardson 1997

Iran-Iraq Area Codes: ZU=Zagros Uplands, ZP=Zagros Piedmont, JZ=Jezira

N.Levant-Euphrates Area Codes: EV=Euphrates Valley, KB=El Kowm Basin

S.Levant Area Codes: BV=Beqa'a Valley, EJ=Eastern Jordan, SJ=Southern Jordan

Taxa Codes: Hrb=% of major medium and large herbivores in n, Equ=*Equus* spp., Bos=*Bos* spp., Sus=*Sus* spp., Gaz=*Gazella* spp., C+O=total Subfamily Caprinae, (Cpr)=*Capra* spp., (Ovi)=*Ovis* spp., (C:O)=ratio *Capra* spp.:*Ovis* spp., (id)=% of total Subfamily Caprinae identified to genus, Cer=*Cervus elaphus*, Dam=*Dama mesopotamica*, Cap=*Capreolus capreolus*

Quantitative Data: all % NISP except: x=taxon present (excluded from n and % NISP calculations), X=most abundant of present taxa (excluded from n and % NISP calculations)

Table 5.11: Proportions of Major Medium and Large Herbivores in Faunal Assemblages from Period 5 (8,000 to 7,600b.p.)

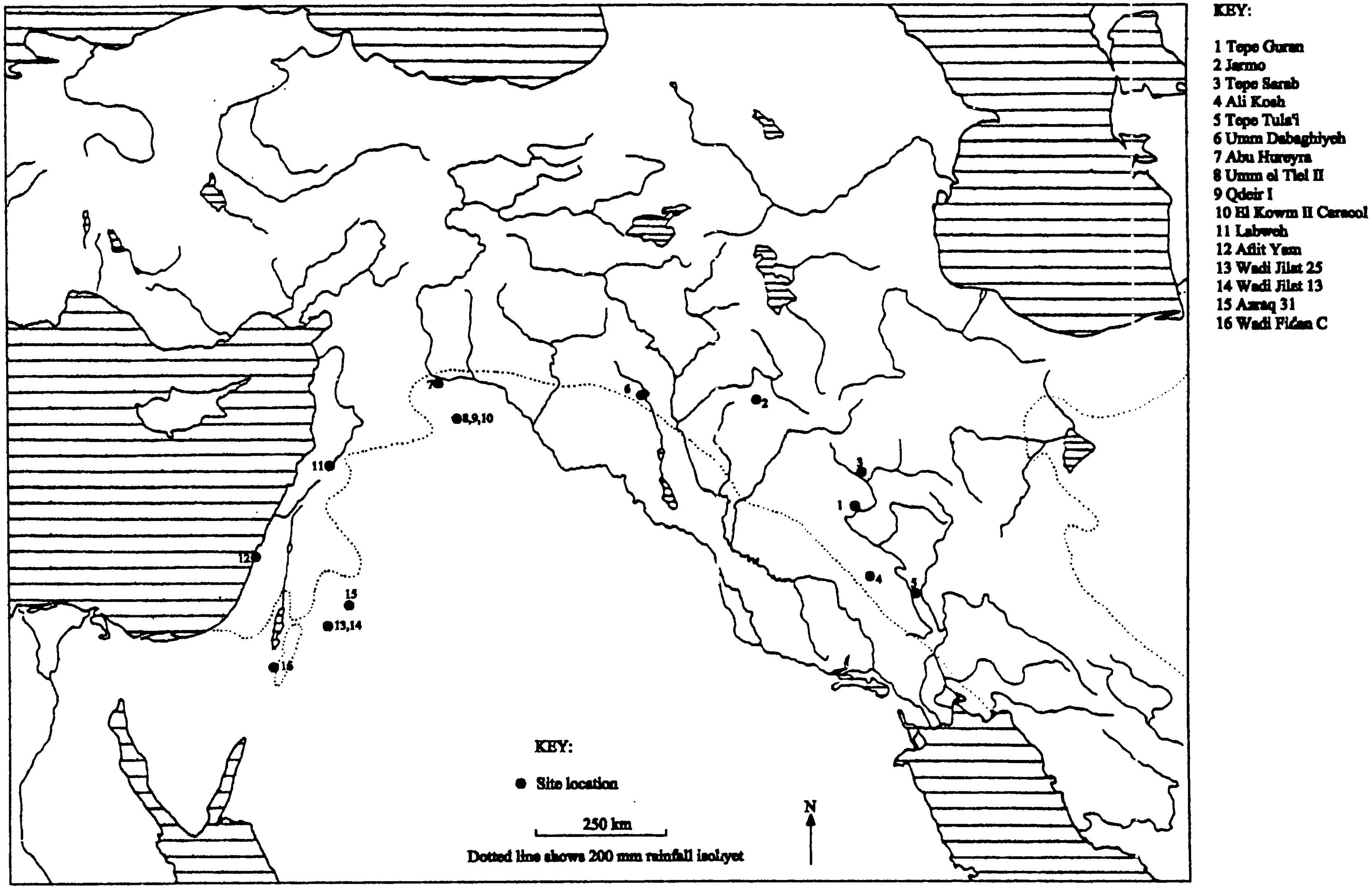


Figure 5.5: Location of Period 5 (8,000b.p.-7,600b.p.) Sites with Faunal Assemblages

5.7: PERIOD 6: 7,600 TO 7,000B.P. (TABLES 5.12 AND 5.13, FIGURE 5.6):

The decline of the Pre-Pottery Neolithic cultural entity of the northern and southern Levant at the end of Period 5 is marked by a corresponding decline in the density of the published archaeological record across all regions of south-west Asia, although this is more likely to be a reflection of the relative lack of research directed at the diverse ceramic Neolithic traditions of Periods 6 to 8 than a genuine absence of material. Although the situation is gradually being rectified (e.g. Kafafi 1987, 1992 and 1998, Rollefson, Simmons and Kafafi 1992, Gopher and Gophna 1993, Gopher 1995, Akkermans et al. 1996), so far few Period 6 sites have been excavated and even fewer have yielded published faunal assemblages. In the southern Levant the Yarmoukian Pottery Neolithic seems to have succeeded the PPNC across much of the woodland and moist steppe zones. In contrast, there was little cultural change in adjacent dry steppe and sub-desert zones where the early Late Neolithic tradition of Period 5 was maintained into Period 6. A similarly complex situation prevailed in the northern Levant as local ceramic Neolithic cultural entities, largely derived from the Final PPNB, emerged at the beginning of Period 6 only to be displaced, especially in north-eastern Syria, by the intrusive Chalcolithic early Halaf culture towards the end of the period (Gilead 1988). Available data from Iraq/Iran suggests that the Early Ceramic Neolithic of Period 5 was succeeded during Period 6 by the Developed Ceramic Neolithic, which included the Hassuna and Sammara traditions (Hole 1987). Climatically, all regions of south-west Asia are thought to have experienced the return of the early Holocene climatic optimum, following its brief interruption during Period 5 (Sanlaville 1996).

Insufficient data are available with which to identify regional patterns in faunal economies in Period 6, although it is clear that mixed herds of domestic goats and sheep predominated at most sites. These seem to have been accompanied in the woodland and moist steppe zones by significant numbers of domestic pigs and, in the northern and southern Levant, domestic cattle; there is no evidence that domestic cattle were exploited during Period 6 in Iraq/Iran (Grigson 1989). In addition, there are a few further observations that deserve comment. In the dry steppe and sub-desert zones of the southern Levant it is clear that during Period 6 earlier hunting traditions continued to be practised alongside caprine husbandry. Gazelle, hare and equids, in addition to domestic sheep and goats, were well represented at Jebel Naja and Burqu 27 2, whilst at Dhuweila, gazelle completely dominated the faunal assemblage, as had been the case during Period 4. Faunal data from the northern Levant during Period 6 is restricted to the assemblage from Tell Sabi Abyad. Equids were the most common hunted taxon during the earliest, ceramic Neolithic phase of occupation at this site, however their representation declined sharply over the course of Period 6 as the Halaf culture became established. Finally, goat to sheep ratios across south-west Asia during Period 6 still appear to have been a reflection of physiological and ethological differences between the species, as was the case during Period 5. Thus, goats still predominated in more mountainous and/or arid terrain (i.e. Hajji Firuz, Choga Mami, Tell es-Sawwan) and sheep in more steppic and/or less arid localities (i.e. Arpachiyah, Tell Sabi Abyad, Munhatta 2, Dhuweila 2, Jebel Naja, Burqu 27 2).

Site	Period	Area	n	Equ	Bos	Sus	Gaz	Alc	C+O	(C/O)	(Cpr)	(Ovi)	Cer	Dam	Cap	Lep	Can	Vul	Fel	Mus	Eri	Source
Hajji Firuz	6	ZU	325		1.5	31.7			63.1	43.1	11.7	8.3	0.6			0.9	1.5	0.3		0.3		Meadow 1983
Choga Mami	6	ZP	638	1.6	1.3	7.8	8.0		78.6		69.2	9.4		x			2.7		x			Bökönyi 1978
Arpachiyah	6+7	UMP	248	x	x	x	x		X		x	X					x					Watson 1980
Tel es-Sawwan	6+7	MP	2972	2.5	0.1	0.1	4.1		91.8		60.6	31.2		x		x	1.4	x				Bökönyi 1978
Tel Sabi Abyad (N)	6	EV	269	9.7	11.5	10.8	2.6		63.2	55.4	1.1	6.7		0.4			1.9					Cavallo 1996
Tel Sabi Abyad (T)	6	EV	2245	2.4	17.1	7.2	3.2		69.0	59.0	1.4	8.6	0.1	0.1		0.4	0.3	0.2				Cavallo 1996
Tel Sabi Abyad (H)	6	EV	868	0.7	11.5	13.2	1.4		72.5	65.9	2.3	4.3	0.2			0.3		0.1				Cavallo 1996
Munhatta (2)	6+7+8	JV	117		20.6	23.1	25.9		23.6		3.4	20.2			6.9		x	x				Ducos 1968
Abu Thawwab	6	JH	125	2.4	12.8	0.8	15.2		68.0	68.0							0.8					Kafafi 1988
Dhuweila (2)	6	EJ	8185	0.7			96.8		0.44	0.3	0.04	0.1				1.7	0.2	0.1		0.04	0.1	Martin 1994
Jebel Naja	6	EJ	9				33.3		44.4	11.1	11.1	22.2				22.2						Martin 1994
Burqu 27 (2)	6	EJ	143	12.6			11.9		51.1	44.1	0.7	6.3				20.3	2.8	0.7			0.7	Martin 1994

Iran-Iraq Area Codes: ZU=Zagros Uplands, ZP=Zagros Piedmont, UMP=Upper Mesopotamian Plain, MP=Mesopotamian Plain

N.Levant-Euphrates Area Codes: EV=Euphrates Valley

S.Levant Area Codes: JV=Jordan Valley, JH=Jordanian Highlands, EJ=Eastern Jordan

Taxa Codes: Equ=*Equus* spp., Bos=*Bos* spp., Sus=*Sus* spp., Gaz=*Gazella* spp., Alc=*Alelaphus buselaphus*, C+O=total Subfamily Caprinae i.e. C/O+Cpr+Ovi, (C/O)=*Capra* spp. or *Ovis* spp., (Cpr)=*Capra* spp., (Ovi)=*Ovis* spp., Cer=*Cervus elaphus*, Dam=*Dama mesopotamica*, Cap=*Capreolus capreolus*, Lep=*Lepus capensis*, Can=*Canis* spp., Vul=*Vulpes* spp., Fel=Family Felidae, Mus=Family Mustelidae, Eri=Family Erinaceidae

Quantitative Data: all % NISP except: x=taxon present (excluded from n and % NISP calculations), X=most abundant of present taxa (excluded from n and % NISP calculations)

Table 5.12: Proportions of Taxa in Faunal Assemblages from Period 6 (7,600 to 7,000b.p.)

Site	Period	Area	n	Hrb	Equ	Bos	Sus	Gaz	C+O	(Cpr)	(Ovi)	(C:O)	(id)	Cer	Dam	Cap	Source
Hajji Firuz	6	ZU	325	96.9		1.5	32.7		65.1	38.1	27.0	1:0.7	31.7	0.6			Meadow 1983
Choga Mami	6	ZP	638	97.3	1.6	1.3	8.0	8.2	80.8	71.1	9.7	1:0.1	?		x		Bökönyi 1978
Arpachiyah	6+7	UMP	248	?	x	x	x	x	X	x	X	x:X	?				Watson 1980
Tel es Sawwan	6+7	MP	2972	98.6	2.5	0.1	0.1	4.2	93.1	61.5	31.6	1:0.5	?		x		Bökönyi 1978
Tel Sabi Abyad N	6	EV	269	98.2	9.9	11.7	11.0	2.6	64.4	9.1	55.3	1:6.1	12.3		0.4		Cavallo 1996
Tel Sabi Abyad T	6	EV	2245	99.1	2.4	17.3	7.3	3.2	69.6	9.7	59.9	1:6.1	14.5	0.1	0.1		Cavallo 1996
Tel Sabi Abyad H	6	EV	868	99.5	0.7	11.6	13.3	1.4	72.9	25.4	47.5	1:1.9	9.1	0.2			Cavallo 1996
Munhatta 2	6+7+8	JV	117	100.0		20.6	23.1	25.9	23.6	3.4	20.2	1:5.9	?			6.9	Ducos 1968
Abu Thawwab	6	JH	125	99.2	2.4	12.9	0.8	15.3	68.5			?	0.0				Kafafi 1988
Dhuweila 2	6	EJ	8185	97.9	0.7			98.8	0.4	0.1	0.3	1:2.5	31.8				Martin 1994
Jebel Naja	6	EJ	9	77.7				42.9	57.1	19.0	38.1	1:2	75.0				Martin 1994
Burqu 27 2	6	EJ	143	75.6	16.7			15.7	67.6	6.8	60.8	1:9	13.7				Martin 1994

Iran-Iraq Area Codes: ZU=Zagros Uplands, ZP=Zagros Piedmont, UMP=Upper Mesopotamian Plain, MP=Mesopotamian Plain
N.Levant-Euphrates Area Codes: EV=Euphrates Valley
S.Levant Area Codes: JV=Jordan Valley, JH=Jordan Highlands, EJ=Eastern Jordan
Taxa Codes: Hrb=% of major medium and large herbivores in n, Equ=*Equus* spp., Bos=*Bos* spp., Sus=*Sus* spp., Gaz=*Gazella* spp., C+O=total Subfamily Caprinae, (Cpr)=*Capra* spp., (Ovi)=*Ovis* spp., (C:O)=ratio *Capra* spp.:*Ovis* spp., (id)=% of total Subfamily Caprinae identified to genus, Cer=*Cervus elaphus*, Dam=*Dama mesopotamica*, Cap=*Capreolus capreolus*
Quantitative Data: all % NISP except: x=taxon present (excluded from n and % NISP calculations), X=most abundant of present taxa (excluded from n and % NISP calculations)

Table 5.13: Proportions of Major Medium and Large Herbivores in Faunal Assemblages from Period 6 (7,600 to 7,000b.p.)

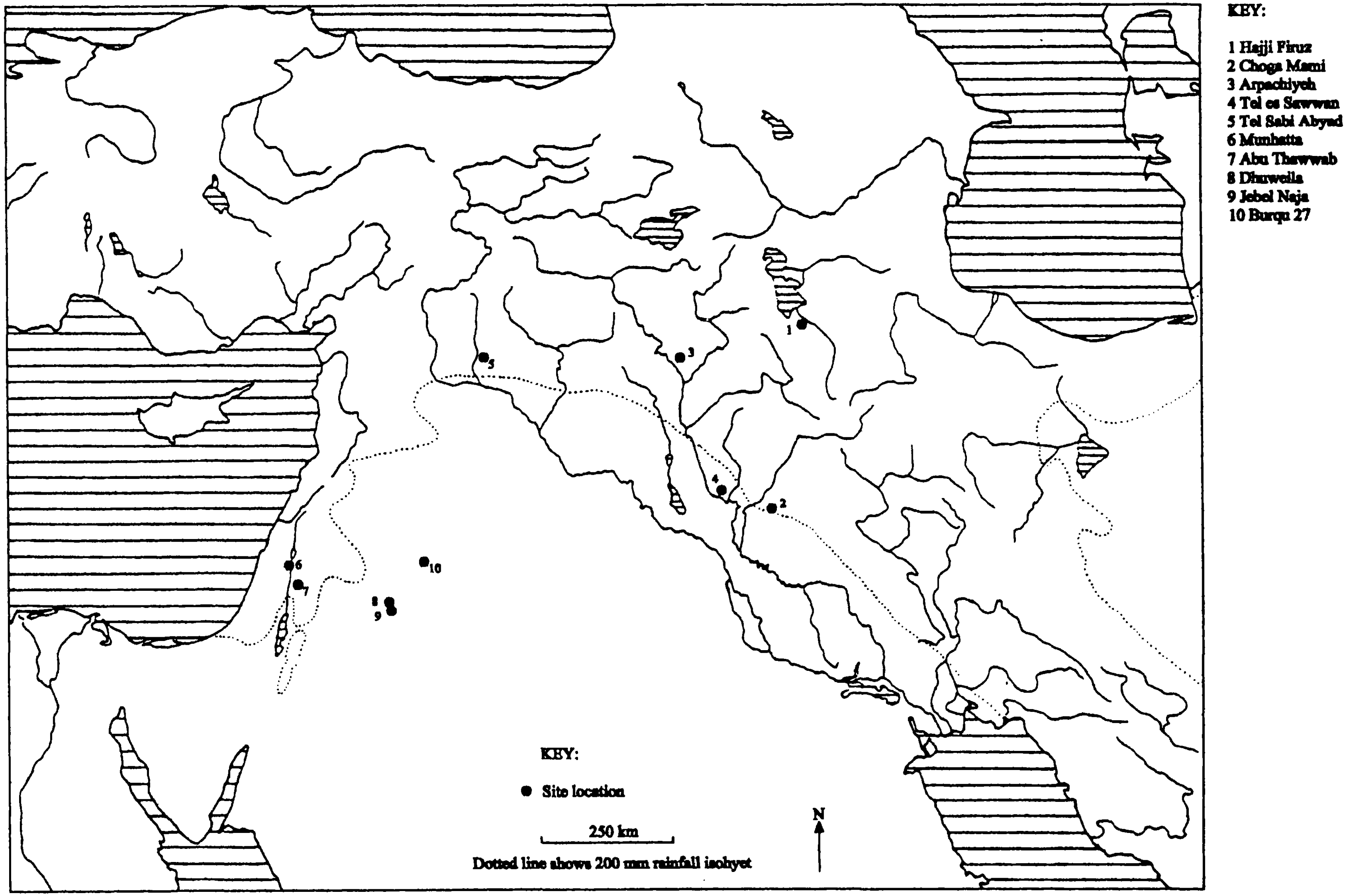


Figure 5.6: Location of Period 6 (7,600b.p.-7,000b.p.) Sites with Faunal Assemblages

5.8: PERIOD 7: 7,000 to 6,500b.p. (Tables 5.14 and 5.15, Figure 5.7):

Even less information is available from Period 7 than Period 6; published faunal assemblages are especially lacking. Culturally the Lodian entity extended across most of the woodland and moist steppe zones of the southern Levant during Period 7 (Gopher and Gophna 1993), whereas adjacent dry steppe and sub-desert zones were characterised by the late Late Neolithic. By Period 7 the Halaf culture had spread across much of the northern Levant (Gilead 1988), during which time a number of local Chalcolithic cultural entities also emerged in Iraq/Iran (Hole 1987).

The extremely limited faunal data suggests that on the whole the economies of Period 7 closely resembled those of Period 6, the main development apparently being the introduction of domestic cattle to Iraq/Iran (Grigson 1989). It would therefore appear that by Period 7 domestic caprines, accompanied by varying proportions of domestic pigs and cattle, formed the basis of faunal economies in all areas of south-west Asia. The two latter taxa seem to have been especially well represented along the Taurus/Zagros arc (i.e. Girikihaciyan, Banahilk, Çavi Tarlasi, Tel Turlu). It should however be stressed that earlier hunting strategies were by no means totally superceded, especially in the dry steppe and sub-desert zones of the region. In the steppe of northern Syria and northern Iraq the tradition of equid hunting, previously noted during Period 2 at Nahr el-Homr and Mureybet II/III, during Period 5 at Umm Dabaghiyeh and, to a lesser extent, at Tell Sabi Abyad at the beginning of Period 6, continued into Period 7 at Shams ed-Din, where equids dominated the faunal assemblage. Evidence for the continuation of hunting and trapping alongside caprine husbandry during Period 7 has also been obtained from Burqu 27 3, where hare and equids were still well represented.

Site	Period	Area	n	Equ	Bos	Sus	Gaz	Alc	C+O	(C/O)	(Cpr)	(Ovi)	Cer	Dam	Cap	Lep	Can	Vul	Fel	Mus	Eri	Source
Girikihaciyan	7	TU	2020	0.1	15.5	17.9			63.2		21.1	42.1	0.8			0.1	1.3	1.0				McArdle 1990
Banahilk	7	ZP	777	x	21.0	15.7			63.3	42.3	9.3	11.7	x		x		x	x	x		x	Laffer 1983
Ras al Amiyah	7	MP	98	3.1	46.9	4.1	2.0		38.8	38.8							5.1					Flannery and Cornwall 1969
Çavi Tarlasi	7	EV	3388	0.5	35.2	26.7	0.4		36.2	30.3	3.5	2.4	0.2	0.1		0.1	0.4	0.1	0.03			Schäffer and Boessneck 1988
Tel Turlu	7	EV	122		9.8	24.6	2.5		61.4	55.7	4.1	1.6		0.8			0.8					Ducos 1991
Shams ed-Din	7	EV	1337	44.0	7.6	1.4	7.7		36.3	27.5	2.2	6.6	0.1	0.1			0.6	2.2	0.1			Uerpmann 1982
Arjoune	7	OV	1414	0.6	18.5	21.8	0.6		57.4	49.0	5.1	3.3	0.1			0.2	0.8		0.1			Grigson 1996
Jericho	7+8	JV	66	1.5	6.1	1.5	4.5		77.3	33.3	39.4	4.5					7.6		1.5			Clutton-Brock 1979
Burqu 27 (3)	7	EJ	37	5.4					32.4	21.6		10.8				59.5	2.7					Martin 1994

Iran-Iraq Area Codes: TU=Taurus Uplands, ZP=Zagros Piedmont, MP=Mesopotamian Plain
N.Levant-Euphrates Area Codes: EV=Euphrates Valley, OV=Orontes Valley
S.Levant Area Codes: JV=Jordan Valley, EJ=Eastern Jordan
Taxa Codes: Equ=*Equus* spp., Bos=*Bos* spp., Sus=*Sus* spp., Gaz=*Gazella* spp., Alc=*Alelaphus buselaphus*, C+O=total Subfamily Caprinae i.e. C/O+Cpr+Ovi, (C/O)=*Capra* spp. or *Ovis* spp., (Cpr)=*Capra* spp., (Ovi)=*Ovis* spp., Cer=*Cervus elaphus*, Dam=*Dama mesopotamica*, Cap=*Capreolus capreolus*, Lep=*Lepus capensis*, Can=*Canis* spp., Vul=*Vulpes* spp., Fel=Family Felidae, Mus=Family Mustelidae, Eri=Family Erinaceidae
Quantitative Data: all % NISP except: x=taxon present (excluded from n and % NISP calculations), X=most abundant of present taxa (excluded from n and % NISP calculations)

Table 5.14: Proportions of Taxa in Faunal Assemblages from Period 7 (7,000 to 6,500b.p.)

Site	Period	Area	n	Hrb	Equ	Bos	Sus	Gaz	C+O	(Cpr)	(Ovi)	(C:O)	(id)	Cer	Dam	Cap	Source
Girikihaciyan	7	TU	2020	97.5	0.1	15.9	18.4		64.8	21.6	43.2	1:2	?	0.8			McArdle 1990
Banahilk	7	ZP	777	100.0	x	21.0	15.7		63.3	28.0	35.3	1:1.3	33.2	x		x	Laffer 1983
Ras al Amiyah	7	MP	98	94.9	3.3	49.4	4.3	2.1	40.9			?	0.0				Flannery and Cornwall 1969
Çavi Tarlasi	7	EV	3388	99.3	0.5	35.4	26.9	0.4	36.5	21.6	14.8	1:0.7	16.3	0.2	0.1		Schäffer and Boessneck 1988
Tel Turlu	7	EV	122	99.1		9.9	24.8	2.5	62.0	44.6	17.4	1:0.4	9.3		0.8		Ducos 1991
Shams ed Din	7	EV	1337	97.2	45.3	7.8	1.4	7.9	37.3	9.3	28.0	1:3	24.2	0.1	0.1		Uerpmann 1982
Arjoune	7	OV	1414	99.0	0.6	18.7	22.0	0.6	58.0	35.2	22.8	1:0.6	14.6	0.1			Grigson 1996
Jericho	7+8	JV	66	90.9	1.7	6.7	1.7	5.0	85.0	76.3	8.7	1:0.1	56.8				Clutton-Brock 1979
Burqu 27 3	7	EJ	37	37.8	14.3				85.7		85.7	0:1	33.3				Martin 1994

Iran-Iraq Area Codes: TU=Taurus Uplands, ZP=Zagros Piedmont, MP=Mesopotamian Plain
N.Levant-Euphrates Area Codes: EV=Euphrates Valley, OV=Orontes Valley
S.Levant Area Codes: JV=Jordan Valley, EJ=Eastern Jordan
Taxa Codes: Hrb=% of major medium and large herbivores in n, Equ=*Equus* spp., Bos=*Bos* spp., Sus=*Sus* spp., Gaz=*Gazella* spp., C+O=total Subfamily Caprinae, (Cpr)=*Capra* spp., (Ovi)=*Ovis* spp., (C:O)=ratio *Capra* spp.:*Ovis* spp., (id)=% of total Subfamily Caprinae identified to genus, Cer=*Cervus elaphus*, Dam=*Dama mesopotamica*, Cap=*Capreolus capreolus*
Quantitative Data: all % NISP except: x=taxon present (excluded from n and % NISP calculations), X=most abundant of present taxa (excluded from n and % NISP calculations)

Table 5.15: Proportions of Major Medium and Large Herbivores in Faunal Assemblages from Period 7 (7,000 to 6,500b.p.)

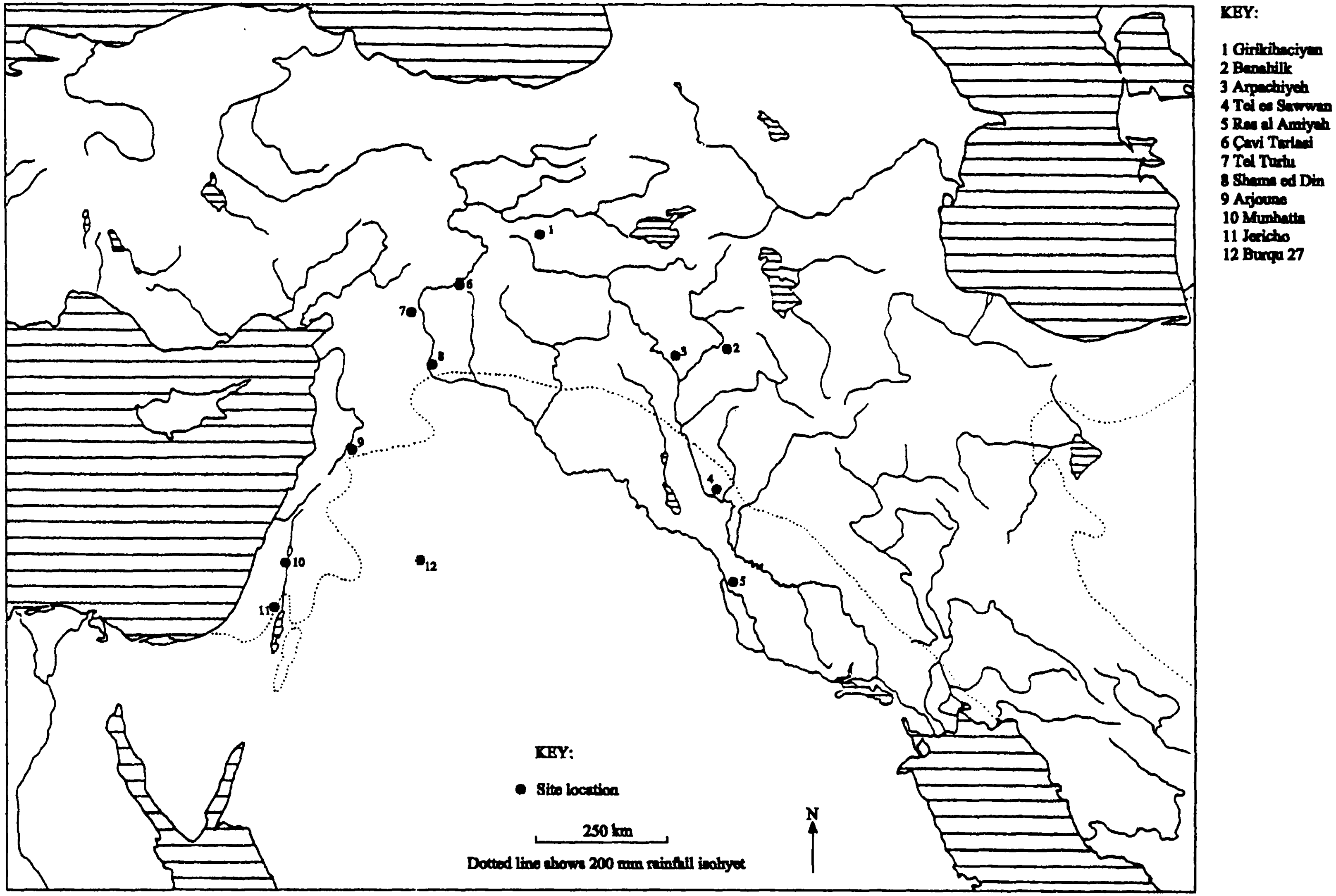


Figure 5.7: Location of Period 7 (7,000b.p.-6,500b.p.) Sites with Faunal Assemblages

5.9: PERIOD 8: 6,500 to 6,100b.p. (Tables 5.16 and 5.17, Figure 5.8):

Although the archaeological record of south-west Asia during Period 8 is better known than that of its immediate predecessors, few faunal assemblages have been published, especially from the northern Levant and Iraq/Iran. The dry steppe and sub-desert zones of the region are also under-represented in the archaeological record. Generally speaking Period 8 appears to have been characterised by the development of more complex chiefdom societies as Chalcolithic cultural entities were established and/or consolidated across the region. Considerable regional variation is evident in the archaeological record of the southern Levant, but it is clear that various Wadi Raba traditions succeeded those of the Lodian towards the end of Period 7 (Gopher and Gophna 1993). These were themselves replaced during the latter half of Period 8 with the establishment of a series of settlements belonging to the Chalcolithic early Ghassulian cultural entity. The picture in the northern Levant during Period 8 is even more confused, owing to the relative lack of research and the disturbed stratigraphy at a number of key sites, but there is evidence for the replacement of Pottery Neolithic and late Halaf cultural entities by a number of local Chalcolithic traditions during this period (Gilead 1988). The archaeological record in Iraq/Iran is even less well known but here too regional Chalcolithic traditions seem to have developed during Period 8, some of which were influenced by the Ubaid culture of southern Mesopotamia (Hole 1987). Although researchers differ in their interpretation of the often contradictory palaeoenvironmental data, there is some evidence to suggest that Period 8 saw the beginnings of a shift towards moister conditions and woodland expansion, especially in the southern Levant (Goring-Morris and Belfer-Cohen 1997), the effects of which seem to have become more pronounced during Period 9 (Besançon 1981, Bottema and Van Zeist 1981, Goldberg and Rosen 1987).

Hardly any faunal data from Period 8 are available from the northern Levant and Iraq/Iran, but the little that exists (i.e. Tepe Sabz S/K/M, Körtepe, Arjoune) suggests that domestic caprines, accompanied by domestic pigs and domestic cattle, continued to form the basis of faunal economies. Fortunately, significantly more data are available from the southern Levant and this demonstrates that during Period 8 there was a marked increase in the representation of domestic cattle and, to a lesser extent, domestic pigs at the expense of domestic caprines at both Pottery Neolithic (i.e. Neve Yam, Abu Zureiq, Tel Dan, Hagoshrim) and early Chalcolithic (i.e. Tel Tsaf, Wadi Ghazze) sites, situated in a variety of environmental zones across the region. Notwithstanding evidence for intensive exploitation of wild olives on the coastal plain of Palestine at the end of Period 6 (Galili et al. 1989), the earliest clear indications of olive cultivation date to Period 8 and have been obtained from a small number of early Chalcolithic sites in the Jordan Valley (i.e. Tel Tsaf, Tuleilat Ghassul) (Grigson 1995a). The intensification of cattle and pig husbandry and the early indications of horticulture documented in the southern Levant during Period 8 may well have been linked to the onset of moister climatic conditions. However, Khazanov (1984) has also argued that increases in the number of cattle and pigs in the desert and steppe regions of Eurasia have generally been associated with increasing dependence on sedentary agriculture.

Site	Period	Area	n	Equ	Bos	Sus	Gaz	Alc	C+O	(C/O)	(Cpr)	(Ovi)	Cer	Dam	Cap	Lep	Can	Vul	Fel	Mus	Eri	Source
Tepe Sabz (S/K/M)	8	ZP	328	1.8	7.3	2.7	10.4		57.3	51.8	3.7	1.8					17.4	0.9	0.3	1.5	0.3	Hole, Flannery and Neely 1969
Körtepe	8	EV	165		20.6	16.4			61.2	51.5	2.4	7.3	1.8									von den Driesch 1976b
Arjoune	8	OV	1776	2.0	19.8	22.3	0.5		54.8	47.2	4.2	3.4	0.3			0.2	0.1		0.1			Grigson 1996
Neve Yam	8	PC	89		29.2	22.5	15.7	1.1	31.5	31.5												Horwitz 1988
Abu Zureiq	8	CP	77		45.5	19.5			35.0		35.0											Ducos 1968
Tel Dan	8	JV	63	1.6	50.8	14.3			31.7	22.2	4.8	4.8					1.6					Horwitz 1987b
Hagoshrim	8	JV	196	0.5	63.8	5.6	12.0		14.3			14.3		3.0	0.8							Ducos 1968
Tel Tsaf	8	JV	118	0.8	33.9	16.9	3.4		44.9	44.9												Hellwing 1989
Tuleilat Ghassul (early)	8	JV	423		11.2	7.1	6.1		75.6	75.6												Bourke 1997
Tuleilat Ghassul (mid)	8	JV	594	x	8.2	10.2	2.0		79.6	79.6												Bourke 1997
Wadi Ghazzé	8	NG	65	1.6	36.9	33.8	2.0		22.6		22.6						3.1					Ducos 1968

Iran-Iraq Area Codes: ZP=Zagros Piedmont

N.Levant-Euphrates Area Codes: EV=Euphrates Valley, OV=Orontes Valley

S.Levant Area Codes: PC=Palestine Coast, CP=Central Palestine, JV=Jordan Valley, NG=Negev

Taxa Codes: Equ=*Equus* spp., Bos=*Bos* spp., Sus=*Sus* spp., Gaz=*Gazella* spp., Alc=*Alelaphus buselaphus*, C+O=total Subfamily Caprinae i.e. C/O+Cpr+Ovi, (C/O)=*Capra* spp. or *Ovis* spp., (Cpr)=*Capra* spp., (Ovi)=*Ovis* spp., Cer=*Cervus elaphus*, Dam=*Dama mesopotamica*, Cap=*Capreolus capreolus*, Lep=*Lepus capensis*, Can=*Canis* spp., Vul=*Vulpes* spp., Fel=Family Felidae, Mus=Family Mustelidae, Eri=Family Erinaceidae

Quantitative Data: all % NISP except: x=taxon present (excluded from n and % NISP calculations), X=most abundant of present taxa (excluded from n and % NISP calculations)

Table 5.16: Proportion of Taxa in Faunal Assemblages from Period 8 (6,500 to 6,100b.p.)

Site	Period	Area	n	Hrb	Equ	Bos	Sus	Gaz	C+O	(Cpr)	(Ovi)	(C:O)	(id)	Cer	Dam	Cap	Source
Tepe Sabz S/K/M	8	ZP	328	79.5	2.3	9.2	3.4	13.1	72.1	48.5	23.6	1:0.5	9.6				Hole, Flannery and Neely 1969
Körtepe	8	EV	165	100.0		20.6	16.4		61.2	15.1	46.1	1:3	15.8	1.8			von den Driesch 1976b
Arjoune	8	OV	1776	99.7	2.0	19.9	22.4	0.5	55.0	30.4	24.6	1:0.8	13.9	0.3			Grigson 1996
Neve Yam	8	PC	89	98.9		29.5	22.8	15.9	31.9			?	0.0				Horwitz 1988
Abu Zureiq	8	CP	77	100.0		45.5	19.5		35.0	35.0		1:0	?				Ducos 1968
Tel Dan	8	JV	63	98.4	1.6	51.6	14.5		32.2	16.1	16.1	1:1	30.3				Horwitz 1987b
Hagoshrim	8	JV	196	100.0	0.5	63.8	5.6	12.0	14.3		14.3	0:1	?		3.0	0.8	Ducos 1968
Tel Tsaf	8	JV	118	99.9	0.8	33.9	16.9	3.4	44.9			?	0.0				Hellwing 1989
Tuleilat Ghassul Early	8	JV	423	100.0		11.2	7.1	6.1	75.6			?	0.0				Bourke 1997
Tuleilat Ghassul Mid	8	JV	594	100.0	x	8.2	10.2	2.0	79.6			?	0.0				Bourke 1997
Wadi Ghazze	8	NG	65	96.9	1.7	38.1	34.9	2.1	23.3	23.3		1:0	?				Ducos 1968

Iran-Iraq Area Codes: ZP=Zagros Piedmont

N.Levant-Euphrates Area Codes: EV=Euphrates Valley, OV=Orontes Valley

S.Levant Area Codes: PC=Palestine Coast, CP=Central Palestine, JV=Jordan Valley, NG=Negev

Taxa Codes: Hrb=% of major medium and large herbivores in n, Equ=*Equus* spp., Bos=*Bos* spp., Sus=*Sus* spp., Gaz=*Gazella* spp., C+O=total Subfamily Caprinae, (Cpr)=*Capra* spp., (Ovi)=*Ovis* spp., (C:O)=ratio *Capra* spp.:*Ovis* spp., (id)=% of total Subfamily Caprinae identified to genus, Cer=*Cervus elaphus*, Dam=*Dama mesopotamica*, Cap=*Capreolus capreolus*

Quantitative Data: all % NISP except: x=taxon present (excluded from n and % NISP calculations), X=most abundant of present taxa (excluded from n and % NISP calculations)

Table 5.17: Proportions of Major Medium and Large Herbivores in Faunal Assemblages from Period 8 (6,500 to 6,100b.p.)

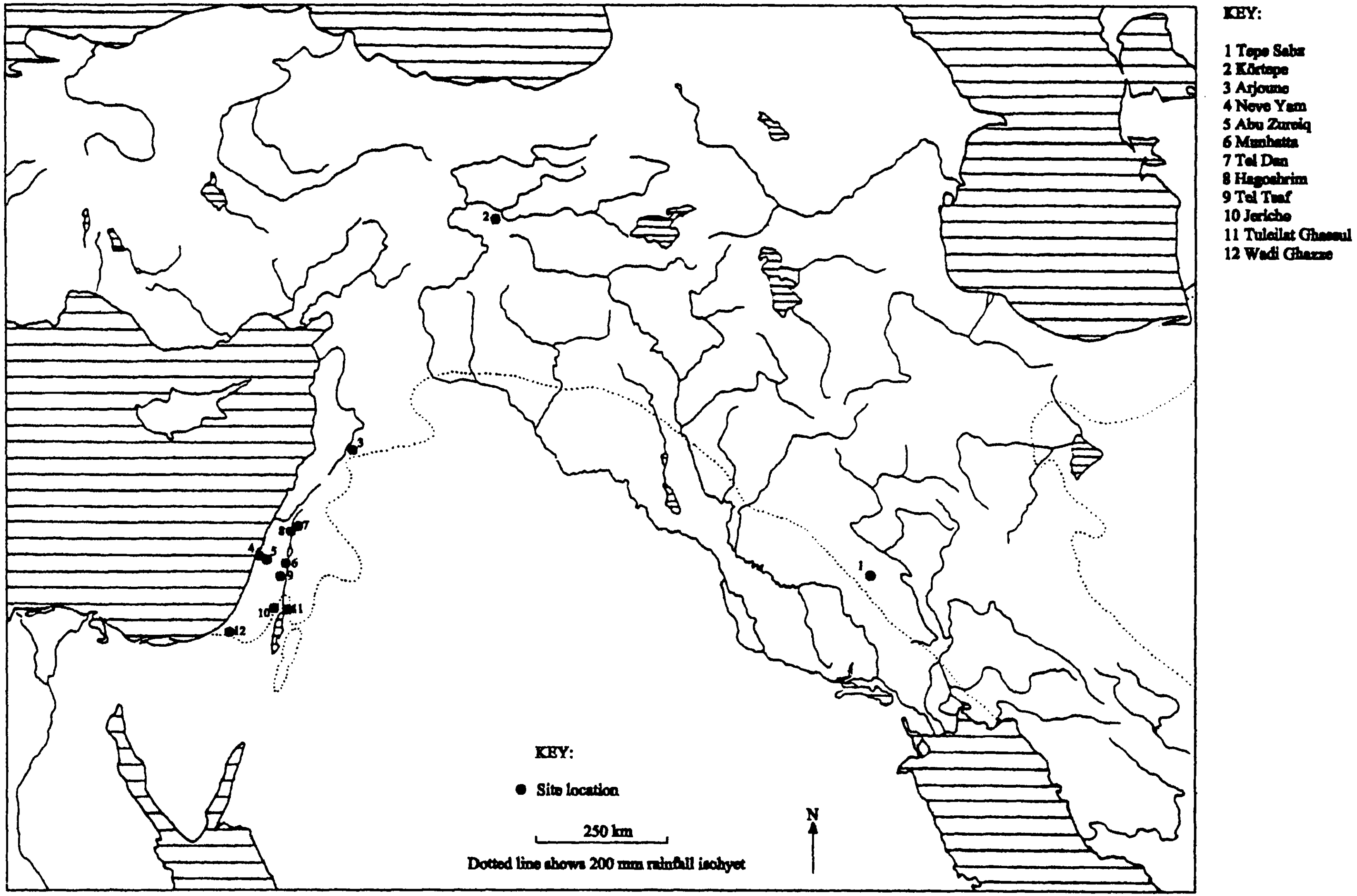


Figure 5.8: Location of Period 8 (6,500b.p.-6,100b.p.) Sites with Faunal Assemblages

5.10: PERIOD 9: 6,100 to 5,200b.p. (Tables 5.18 and 5.19, Figure 5.9):

Period 9 is generally regarded as seeing the florescence of Chalcolithic chiefdom societies across south-west Asia and as such has been the subject of a great deal of research, especially in the southern Levant. A detailed discussion of the Chalcolithic cultural entities of the region is beyond the scope of this work, as research has tended to focus on their role in the process of state formation. Most, however, were characterised by population expansion, the development of complex site hierarchies and the emergence of social ranking, craft specialisation and metallurgy. These important developments have to some extent overshadowed subsistence as a topic for research, despite the fact that it was during this period that the secondary products of animals e.g. milk, wool and energy are thought to have been exploited for the first time (Sherratt 1981, Davis 1984, Grigson 1987a, Horwitz and Smith 1991). Period 9 also saw some marked changes in settlement patterns, most notably in the southern Levant where there was a significant increase in settlement density throughout the dry steppe zone of the Negev (Gilead 1988). As described above, there is good evidence that Period 9 was characterised by relatively moist conditions and woodland expansion, especially in the southern Levant.

Chalcolithic botanical assemblages, summarised by Kislev (1987), indicate that the package of early Neolithic cultivars continued to form the basis of plant-food economies throughout south-west Asia, including the dry steppe zones (i.e. Horvat Beter, Tell Abu Matar, Shiqmim (Kislev 1987, p.272)), during Period 9. However, it seems that in the woodland and moist steppe zones of the southern Levant cereals and pulses were increasingly augmented during this period by cultivated fruit trees, especially olive, but also date, fig, pomegranate and possibly vine (Kislev 1987, Grigson 1995a).

The fact that the Chalcolithic has been the subject of significantly more research than the Pottery Neolithic is reflected in the increased amount of faunal data available from Period 9. The southern Levant is especially well represented and here the extra data available enables the generally increased representation of domestic cattle and domestic pigs documented in the region during Period 8 to be more precisely delineated. It is apparent that domestic cattle and domestic pigs were most intensively exploited in the woodland and moist steppe zones of the southern Levant , especially on the coastal plain (i.e. Tel Aviv Jabotinsky Road, Metzer, Gat Govrin) where they tended to outnumber domestic caprines. In contrast, at sites in the dry steppe and sub-desert zones of the region (i.e.Tuleilat Ghassul, Horvat Beter, Horvat Hor, Bir Abu Matar, Shiqmim, Grar, Bir es-Safadi, Jawa) domestic caprines predominated, accompanied by much lower proportions of domestic cattle and, in all but the most arid locations, domestic pigs. There seems to have been a strong correlation between the distribution of pigs and the reconstructed Period 9 300mm. p.a. isohyet (Grigson 1995a). Unfortunately less faunal data is available from the northern Levant for Period 9, however the assemblages from Kurban Höyük and Hassek Höyük, both located in the upper Euphrates Valley, suggest that here economies were dominated by domestic pigs, accompanied by lesser proportions of domestic cattle and domestic caprines. Faunal data from Iraq/Iran suggests that mixed herds of domestic caprines, in which sheep now tended to greatly outnumber goats, continued to form the basis of faunal economies, and that domestic cattle were the next most common taxon. However, it should be noted that our knowledge of this period is based primarily on data from the Kermanshah Valley (i.e. Tepe Siahbid, Choga Maran, Tepe Dehsavar). On the Deh Luran plain (i.e. Tepe Sabz B) gazelle and equids continued to be hunted in significant numbers, as they had been at Ali Kosh and Tepe Sabz S/K/M in previous periods, suggesting that earlier hunting strategies continued to be a useful risk-buffer in this marginal environment even as late as Period 9. Finally, the earliest clear evidence for the presence of morphologically domestic donkey in south-west Asia has been obtained from Tell Rubeidheh in Iraq, which dates to the latter half of Period 9 (Payne 1988). Artistic representations of donkeys carrying loads have also been found at a number of contemporary sites in the southern Levant (Grigson 1995a). These complementary lines of evidence suggest that domestic donkeys may have been present across much of south-west Asia during Period 9; the "fact that the bones of equids are so few in archaeological assemblages and that sometimes articulated limbs are found suggest that they did not form part of the normal diet. The obvious interpretation is that they were used for transport" (Grigson 1995a, p.258).

Site	Period	Area	n	Equ	Bos	Sus	Gaz	Alc	C+O	(C/O)	(Cpr)	(Ovi)	Cer	Dam	Cap	Lep	Can	Vul	Fel	Mus	Eri	Source
Tepe Siahbid	9	ZU	532	0.2	30.1	6.0	2.4		60.3		7.1	53.2	0.4				0.4	0.2				Bökönyi 1977
Choga Maran (mid)	9	ZU	147	x	17.4	1.4			81.2		63.8	17.4					x					Davis 1984
Tepe Dehsavar	9	ZU	618	0.8	13.1	0.5	3.4		80.3		5.7	74.6	0.2					1.8				Bökönyi 1977
Tepe Sabz (B)	9	ZP	212	6.1	9.0	1.9	19.3		50.9	49.1	0.5	1.4					8.5	4.2				Hole, Flannery and Neely 1969
Tel Rubeidheh	9	ZP	681	11.5	4.4		2.6		80.7	73.7	0.7	6.3					0.6	x?			0.1	Payne 1988
Kurban Höyük	9	EV	76		21.1	50.0	1.3		27.6	26.3	1.3											Wattenmaker and Stein 1986
Hassek Höyük	9	EV	3262		15.2	61.9			22.5	14.9	5.0	2.6	0.1			0.2	0.2			0.03		Boessneck and von den Driesch 1981
Tel Aviv Jabotinsky St	9	PC	599		61.4	10.7	3.4		24.5		11.9	12.6										Ducos 1968
Metzer	9	PC	394	0.5	20.6	44.2	2.6		22.6		4.2	18.4		6.6			3.2					Ducos 1968
Gat Govrin	9	PC	210	3.8	36.2	18.1	8.9		33.0		29.8	3.2										Ducos 1968
Sataf	9	CP	27	3.7	7.4	14.8			74.1	55.6	18.5											Grigson 1991
Tuleilat Ghassul (late)	9	JV	1420	x	9.3	8.2	2.1		80.4	80.4												Bourke 1997
Munhatta (1)	9	JV	358	0.3	31.2	25.5	11.7		30.7		18.0	12.7					0.6					Ducos 1968
Abu Hamid	9	JV	449	0.5	12.0	25.1	0.7		60.1		60.1						1.6					Dollfuss et al. 1988
Horvat Beter	9	NG	206	0.5	8.3		15.5		75.7	75.7												Angress 1959
Horvat Hor	9	NG	123		26.0				74.0		24.4	49.6										Horwitz 1990
Bir Abu Matar	9	NG	257	1.6	10.5				84.8		12.5	72.4					3.1					Josien 1955
Shiqmim	9	NG	533		10.7		0.9		85.9	78.6	3.0	4.3					1.3		1.1			Grigson 1987a
Grar	9	NG	1165	1.2	21.8	16.2	1.6	0.1	57.4	49.8	5.0	3.1				0.1	1.1	0.3	0.2			Grigson 1995b
Bir es-Safadi	9	NG	2023		9.1		x		90.9		46.0	44.9					x					Grigson 1995a and Ducos 1968
Jawa	9	EJ	2541	2.1	8.5		2.4		86.9		17.4	69.5				0.2	0.04					Köhler 1981

Iran-Iraq Area Codes: ZU=Zagros Uplands, ZP=Zagros Piedmont

N.Levant-Euphrates Area Codes: EV=Euphrates Valley

S.Levant Area Codes: PC=Palestine Coast, CP=Central Palestine, JV=Jordan Valley, NG=Negev, EJ=Eastern Jordan

Taxa Codes: Equ=*Equus* spp., Bos=*Bos* spp., Sus=*Sus* spp., Gaz=*Gazella* spp., Alc=*Alelaphus buselaphus*, C+O=total Subfamily Caprinae i.e. C/O+Cpr+Ovi, (C/O)=*Capra* spp. or *Ovis* spp., (Cpr)=*Capra* spp., (Ovi)=*Ovis* spp., Cer=*Cervus elaphus*, Dam=*Dama mesopotamica*, Cap=*Capreolus capreolus*, Lep=*Lepus capensis*, Can=*Canis* spp., Vul=*Vulpes* spp., Fel=Family Felidae, Mus=Family Mustelidae, Eri=Family Erinaceidae

Quantitative Data: all % NISP except: x=taxon present (excluded from n and % NISP calculations), X=most abundant of present taxa (excluded from n and % NISP calculations)

Table 5.18: Proportions of Taxa in Faunal Assemblages from Period 9 (6,100 to 5,200b.p.)

Site	Period	Area	n	Hrb	Equ	Bos	Sus	Gaz	C+O	(Cpr)	(Ovi)	(C:O)	(id)	Cer	Dam	Cap	Source
Tepe Siahbid	9	ZU	532	99.4	0.2	30.3	6.0	2.4	60.7	7.1	53.5	1:7.5	?	0.4			Bökönyi 1977
Choga Maran (mid chal)	9	ZU	147	100.0	x	17.4	1.4		81.2	63.8	17.4	1:0.3	?				Davis 1984
Tepe Dehsavar	9	ZU	618	98.3	0.8	13.3	0.5	3.5	81.7	5.8	75.9	1:13.1	?	0.2			Bökönyi 1977
Tepe Sabz Bayat	9	ZP	212	87.2	7.0	10.3	2.2	22.1	58.4	15.4	43.0	1:2.8	3.7				Hole, Flannery and Neely 1969
Tel Rubeidheh	9	ZP	681	99.2	11.6	4.4		2.6	81.4	8.1	73.2	1:9	8.7				Payne 1988
Kurban Höyük	9	EV	76	100.0		21.1	50.0	1.3	27.6	27.6		1:0	4.7				Wattenmaker and Stein 1986
Hassek Höyük	9	EV	3262	99.7		15.2	62.1		22.6	14.8	7.7	1:0.5	33.8	0.1			Boessneck and von den Driesch 1981
Tel Aviv Jabotinsky Rd	9	PC	599	100.0		61.4	10.7	3.4	24.5	11.9	12.6	1:1.1	?				Ducos 1968
Metzer	9	PC	394	97.1	0.5	21.2	45.5	2.7	23.3	4.3	18.9	1:4.4	?		6.8		Ducos 1968
Gat Govrin	9	PC	210	100.0	3.8	36.2	18.1	8.9	33.0	29.8	3.2	1:0.1	?				Ducos 1968
Sataf	9	CP	27	100.0	3.7	7.4	14.8		74.1	74.1		1:0	25.0				Grigson 1991
Tuleilat Ghassul Late	9	JV	1420	100.0	x	9.3	8.2	2.1	80.4			?	0.0				Bourke 1997
Munhatta 1	9	JV	358	99.4	0.3	31.4	25.7	11.8	30.9	18.1	12.8	1:0.7	?				Ducos 1968
Abu Hamid	9	JV	449	98.4	0.5	12.2	25.5	0.7	61.1	61.1		1:0	?				Dollfuss et al. 1988
Horvat Beter	9	NG	206	100.0	0.5	8.3		15.5	75.7			?	0.0				Angress 1959
Horvat Hor	9	NG	123	100.0		26.0			74.0	24.4	49.6	1:2	?				Horwitz 1990
Bir Abu Matar	9	NG	257	96.9	1.7	10.8			87.5	12.9	74.6	1:5.8	?				Josien 1955
Shiqmim	9	NG	533	97.5		11.0		0.9	88.1	36.2	51.9	1:1.4	8.5				Grigson 1987a
Grar	9	NG	1165	98.2	1.2	22.2	16.5	1.6	58.5	36.1	22.4	1:0.6	14.1				Grigson 1995b
Bir es Safadi	9	NG	2023	100.0		9.1		x	90.9	46.0	44.9	1:1	?				Grigson 1995a and Ducos 1968
Jawa	9	EJ	2541	99.9	2.1	8.5		2.4	87.0	17.4	69.6	1:4	?				Köhler 1981

Iran-Iraq Area Codes: ZU=Zagros Uplands, ZP=Zagros Piedmont

N.Levant-Euphrates Area Codes: EV=Euphrates Valley

S.Levant Area Codes: PC=Palestine Coast, CP=Coastal Palestine, JV=Jordan Valley, NG=Negev, EJ=Eastern Jordan

Taxa Codes: Hrb=% of major medium and large herbivores in n, Equ=*Equus* spp., Bos=*Bos* spp., Sus=*Sus* spp., Gaz=*Gazella* spp., C+O=total Subfamily Caprinae, (Cpr)=*Capra* spp., (Ovi)=*Ovis* spp., (C:O)=ratio *Capra* spp.:*Ovis* spp., (id)=% of total Subfamily Caprinae identified to genus, Cer=*Cervus elaphus*, Dam=*Dama mesopotamica*, Cap=*Capreolus capreolus*

Quantitative Data: all % NISP except: x=taxon present (excluded from n and % NISP calculations), X=most abundant of present taxa (excluded from n and % NISP calculations)

Table 5.19: Proportions of Major Medium and Large Herbivores in Faunal Assemblages from Period 9 (6,100 to 5,200b.p.)

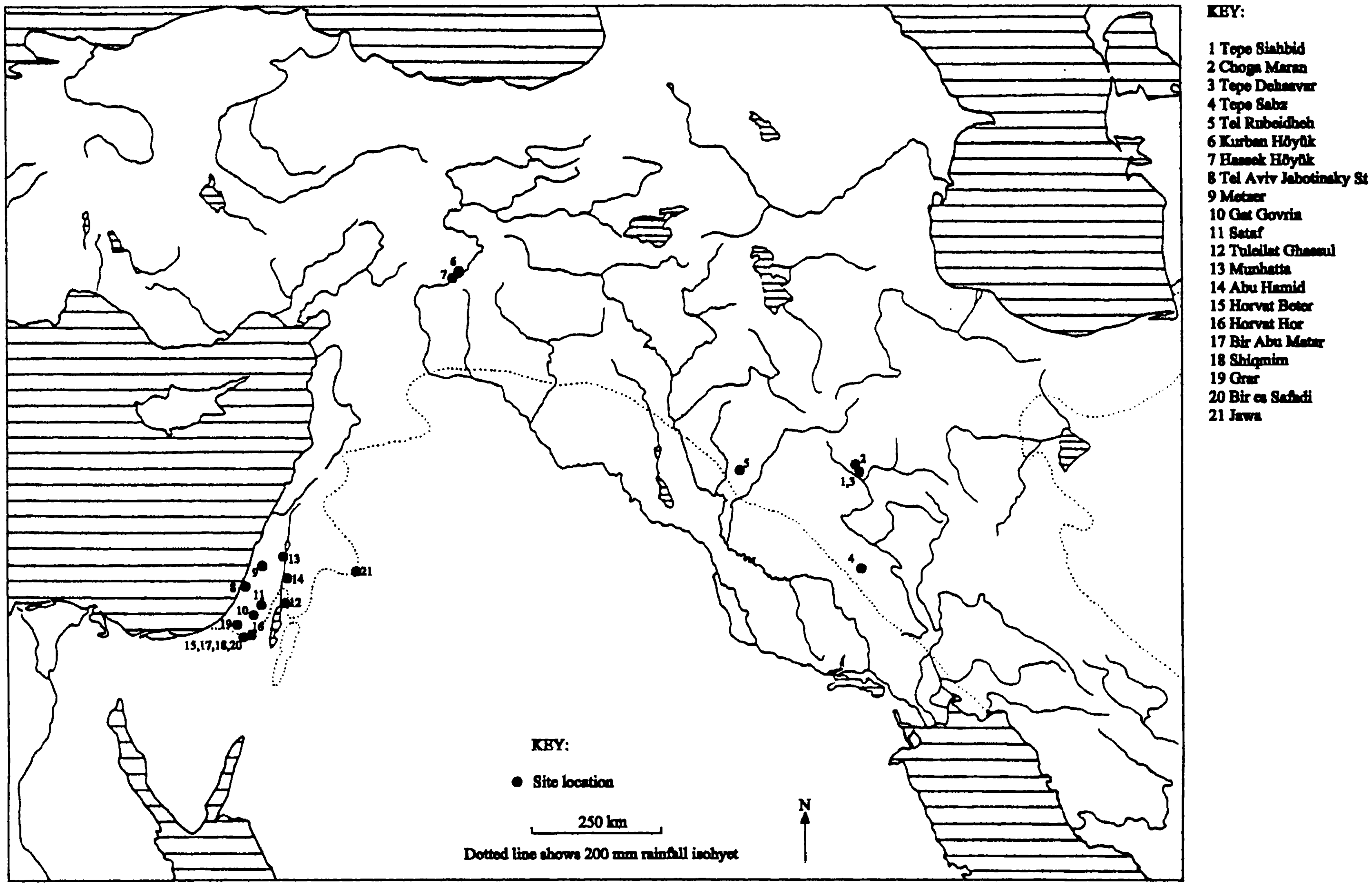


Figure 5.9: Location of Period 9 (6,100b.p.-5,200b.p.) Sites with Faunal Assemblages

5.11: CONCLUSIONS:

This chapter describes the main regional and chronological trends in subsistence strategies in south-west Asia between 12,500 and 5,200b.p.. As such it introduces much of the data and many of the themes in interpretation which are relied on in later discussions. However, it should be read in the context of the descriptions of the environmental setting of the Levant and of Levantine late Epipalaeolithic, Neolithic and Chalcolithic archaeological data presented in Chapters 3 and 4 respectively, as one of the aims of this study is to present as integrated an examination of the development of goat and sheep herding during the Levantine Neolithic as possible.

Chapter 6 adopts a critical and interpretative approach to the environmental, archaeological and subsistence data described in Chapters 3, 4 and 5, in an attempt to generate up to date, integrated baseline interpretations of the emergence of caprines as early domesticates and the development of more specialised pastoral economies in the Levant. It is against these baseline interpretations that the results of the zooarchaeological analysis of the faunal assemblage from 'Ain Ghazal described in Chapters 8, 9 and 10 are examined in Chapter 11.

CHAPTER 6: KEY ISSUES IN THE ZOOARCHAEOLOGY OF CAPRINES IN SOUTH-WEST ASIA 12,500 TO 5,200B.P.

6.1: INTRODUCTION:

The zooarchaeology of caprines in south-west Asia between 12,500b.p. and 5,200b.p. has been dominated by two key themes: firstly, the initial emergence of caprines as major early domesticates and secondly, the subsequent role of domestic caprines in the development of more specialised pastoral economies. This chapter discusses these themes in more detail in the context of the environmental, archaeological and subsistence data described in Chapter 3, 4 and 5. The aim is critically review these disparate strands of information in order to generate integrated, up to date interpretations of the emergence of caprines as early domesticates and the development of more specialised pastoral economies in the Levant, against which the results from 'Ain Ghazal can be examined.

6.2: THE EMERGENCE OF CAPRINES AS MAJOR EARLY DOMESTICATES IN SOUTH-WEST ASIA:

6.2.1: Explanations of Animal Domestication:

A detailed discussion of the many and varied explanations for the beginnings of animal domestication is beyond the scope of this study. This section therefore summarises the main themes involved and briefly discusses some of the ways in which researchers have tried to explain the beginnings of caprine domestication in south-west Asia. Despite their apparent diversity, most explanations for the beginnings of animal domestication return to three main themes.

1) **Sedentism and associated resource stress,** whether in the context of demographic pressure (Binford 1968, Davis et al. 1994), depletion of game around permanent agricultural settlements (Cohen 1977, Legge and Rowley-Conwy 1987), attempts to guard against the possibility of crop failure (Flannery 1969, Garrard et al. 1996) or restriction of animal migration patterns by early Holocene forest expansion (Hesse 1978, Hole 1996).

2) **Increasing social complexity**, such as competition and reciprocation between groups (Hayden 1990, Bender 1978), advertisement of social change in other spheres

(Cauvin 1994) or the symbolic importance of controlling the natural environment (Hodder 1990).

3) **Accidental convergence**; Uerpmann (1996) has suggested that animal domestication may have been a natural biological process, to which humans merely responded, which was caused by the unique convergence of a series of specific ecological and cultural circumstances in the restricted geographical area of south-west Asia during the relatively short time period of the early Holocene.

Explanations for the beginnings of caprine domestication in south-west Asia have drawn on all of the factors listed above, but have varied considerably in the importance attached to the role of sedentism in that process. A distinction can be drawn between attempts to explain the beginnings of caprine domestication in the Levant, where increasing levels of sedentism, intensified plant food exploitation and/or agriculture are known to have preceded animal domestication, and attempts to explain the beginnings of caprine domestication in the Zagros region, where the link between sedentism, intensified plant food exploitation and/or agriculture on the one hand and the appearance of domestic animals on the other is more tenuous.

Researchers attempting to explain the beginnings of caprine domestication in the Levant (e.g.: Cohen 1977, Legge and Rowley-Conwy 1987, Garrard et al. 1996) have tended to focus on arguments that it developed during the PPNB (Periods 3 and 4) following the appearance of the first agricultural villages during the PPNA (Period 2) as a means of ensuring the continued or enhanced availability of protein in response to resource stress caused by a combination of population expansion, over-hunting of game around agricultural settlements and attempts to guard against the possibility of crop failure. These factors have all been linked to long term increases in levels of sedentism and intensification of plant food economies from the Natufian (Period 1) onwards.

In contrast, researchers attempting to explain the beginnings of caprine domestication in the Zagros region (e.g.: Hesse 1978, Hole 1996, Smith 1995), where the evidence for sedentism and the appearance of agriculture prior to the first appearance of domestic caprines during the Early Neolithic (Period 3) is more tenuous, have tended to focus on arguments that it developed in response to resource stress caused by the particular environmental conditions that developed in the area during the climatic amelioration that followed the end of the Younger Dryas at c.10,000b.p.. In particular, it has been suggested (Hesse 1978, Hole 1989 and 1996) that although wild caprines would soon have moved into the vast areas of upland pasture opened up by the retreat of snow-lines during the climatic amelioration, subsequent woodland expansion would have made it "more difficult for herds to escape the heavier snows in winter through transhumance. These conditions may have had a deleterious effect upon the overall caprine biomass and must have led periodically to the extinction of local populations" (Hole 1996, p.276). It has therefore been argued that hunter-gatherer groups in the area, who are known to have extensively exploited seasonally mobile caprine herds during the late Zarzian (Period 0), may therefore have begun to domesticate caprines in order to ensure the continued availability of protein under these conditions of resource stress (Hole 1996).

6.2.2: The Definition and Recognition of Animal Domestication in the Archaeological Record:

The definition and recognition of animal domestication have formed the topic of a vast amount of research over the years and continue to attract controversy. For many years a domesticated animal was regarded simply as "one whose breeding is largely controlled by humans" (Davis 1987, p.126). However, use of the word 'domesticate' to refer to both the process of domestication and the domesticated animal itself has led to some confusion. "The latter implies documenting changes over time...while the former involves identifying the end results of a process, and includes an implicit contrast between 'wild' and 'domestic'." (Meadow 1989a, p.81). Consequently a number of researchers, such as Higgs and Jarman (1972) and Jarman and Wilkinson (1972), argued against the use of the word 'domesticate' at all, preferring to concentrate instead on the "whole range of relationships (that) exist between humans and animals which do not necessarily correlate with animals being morphologically domestic or wild" (Martin 1994, p.66). In more recent years researchers have adopted a more moderate stance on the use of the word 'domesticate', tending instead to distinguish between cultural definitions of domestication, which focus on the role of human behaviour in the process, and zoological definitions of domestication which focus on the end product of that process, the domesticated animal itself (Crabtree 1993).

In 1969 Bökönyi published what is now regarded as the classic definition of cultural domestication, including within it the entire process of "capture and taming by man of a species with particular behavioural characteristics, their removal from their natural living areas and breeding community, and their maintenance under controlled breeding conditions for profit" (Bökönyi 1969, p.219). In order to emphasis still further the role of human behavioural adaptations in the exploitation of morphologically wild animals Hecker introduced the term 'cultural control'. This was defined as "that array of human behaviours that has a profound effect on some aspect of the exploited animal population's natural behaviour and dramatically interferes with its movements, breeding schedule or population structure in such a way as to make the animals more accessible to humans" (Hecker 1982, p.219). Similar approaches have been adopted by Ducos, who used the term 'proto-élevage' to refer to "une exploitation contrôllée et raprochée d'un animal maintenu dans son biotope et ethologie naturels" (Ducos 1993a, p.164), and Horwitz, who used the term 'incipient domestication' to refer to the existence of a "long term relationship with a specific species, involving increasing levels/degrees of contact and control between humans and animals" (Horwitz 1989, p.155). However, as Martin has succinctly noted, the fact that "many of these new terms imply that they occurred before domestication suggests that there is still a search for a state of true domesticates, and that the term 'domestication' still has some currency as defining a fixed relationship between humans and animals" (Martin 1994, p.66).

In contrast, researchers are in broad agreement as to how zoological domestication can be defined. Six criteria are generally accepted as reflecting the "degree of population isolation and transformation indicative of human control" (Legge 1996, p.240) by which the bones of a domestic animal can be distinguished from those of its wild progenitors. These are the presence of a foreign species, species frequency change, size change, changes in population structure, morphological change and pathology (Davis 1987, Horwitz 1989, Meadow 1989a, Crabtree 1993, Legge 1996).

Following Legge's (1996) lead, a narrow view is taken of animal domestication in this study. "Given the problems associated with the recognition of early domestication, it is improbable that the material available for study can yet be used to determine...finer gradations of the process, even supposing they correspond to reality" (Legge 1996, p.240). In this study a domestic animal is therefore defined as one "with which people have already established extremely close physical contact, which people breed from, and do not hunt, which they probably herd or keep penned for most of the time, and which they manage in some way" (Martin 1994, p.66) and which can be considered zoologically domestic on the basis of the six criteria listed above.

Unfortunately the identification of zoologically domestic animals is not a straightforward matter. A population may be considered wild on the basis of one criterion and domestic on the basis of another. The stage of the domestication process at which the six criteria commonly used to identify zoologically domestic animals become detectable in the faunal record is imperfectly understood and seems to vary considerably. Each is therefore critically discussed below; heavy use has been made of detailed reviews by Davis (1987), Meadow (1989) and Martin (1994).

1) **Presence of a foreign species:** The presence of a potentially domestic animal outside the natural geographical range of its wild progenitors is considered one of the most reliable criteria by the presence of a domesticate can be demonstrated. Use of this criterion requires detailed knowledge of past animal distributions (Meadow 1989a) and an appropriate cultural setting (Legge 1996). In addition, natural explanations for the presence of an apparently foreign species, such as "fluctuating distributions or sudden irruptions of animals into new areas" (Martin 1994, p.67) need to be discounted.

2) **Species frequency change:** A significant increase in the frequency of a species known to have been domesticated is also considered to be a reliable criterion by which the presence of a domesticate can be demonstrated. It rests on the assumption that the frequency of species in faunal assemblages from the periods immediately preceding domestication reflects the relative abundance of species in the area rather than cultural preferences for one species over another on the part of hunters (Davis 1987). Natural explanations for changes in the frequency of a species, such as changing environmental conditions (Martin 1994), need to be discounted and the possibility that domestic animals were present in small numbers in faunal assemblages otherwise dominated by wild taxa should be kept in mind.

3) **Size change:** Many animals are known to have decreased in body size during the domestication process. Observed size reduction in the faunal remains of animals known to have been domesticated has therefore been widely used to support claims for their presence as domesticates. Various explanations for this phenomenon have been put forward, ranging from intentional selection on the part of humans for smaller animals (Martin 1994) to natural selection associated with the potentially lower levels of nutrition available to early domesticates whose mobility was restricted (Meadow 1989a). The stage of the domestication process at which size reduction occurred is poorly understood; early domesticates may well have been the same size as their wild progenitors. There are a number of further problems associated with assessment of size change, including: the scarcity of samples of wild animals from the same areas as early domesticates against which to measure size reduction (Legge 1996), the fact that the observed size of a sample is significantly affected by its population structure, specifically age and sex ratios (Legge 1996), and fact that the large samples of measurements required are all too rarely available (Martin 1994). Size-index (Uerpmann 1979, Ducos and Horwitz 1997) and log ratio (Meadow 1983) methods by which small samples can be combined for comparison with a 'standard animal' suffer from the general problem that one skeletal element may be larger than the standard whilst another may be smaller (Legge 1996). Finally, other potential causes of size reduction, such as climatic change (Davis 1981, Ducos and Horwitz 1997) or regional variation (Uerpmann 1979) need to be discounted.

4) **Changes in population structure:** The observation of age and sex ratios in a population of potential domesticates which differ from those believed to characterise populations of their wild progenitors has been widely used to support claims for the presence of domestic animals. A key problem with this approach is that it is almost impossible to define a normal population structure for wild populations as age and sex ratios are known to vary considerably "between populations and within populations at different times of year, and under changing conditions" (Martin 1994, p.67); such variation is especially pronounced in caprines (Harrison and Bates 1991). Furthermore, the fact that both wild and domestic populations can be selectively culled means that it is extremely difficult to use age and sex ratios to conclusively demonstrate that a population was being hunted, whether opportunistically or selectively, rather than herded and vice versa (Meadow 1989a).

5) **Morphological Change:** Although there are known to be significant morphological differences between many domestic species and their wild progenitors, the use of observed morphological change to support claims for the presence of domesticates can be problematic, especially in early populations, as "many of these changes...may not have occurred until the later stages of animal husbandry and are associated with the development of highly selected breeds" (Davis 1987, p.135). The reasons for the development of morphological change are poorly understood, be they intentional selection on the part of humans or the relaxation of natural selective pressures (Martin 1994). The potential range of morphological variation within and between wild populations is equally unclear.

6) **Pathology:** The appearance of higher than normal frequencies of pathological conditions associated with the confinement of animals and/or the protection by humans of animals thus disadvantaged from natural predators has occasionally been used to support claims for the presence of domesticates. However, the frequency of pathological conditions in wild populations is poorly understood and even in domestic populations tends to be rare. In addition, there is an "immense problem in determining the exact aetiology of a pathology as several diseases may leave similar marks" (Horwitz 1989, p.163).

To summarise, there are problems with each of the six criteria generally used to identify zoological domestication. The appearance of a species in an area lying outside its natural range or a significant increase in the frequency of a species within a particular area are probably the most reliable criteria by which domestication can be demonstrated. Size reduction and morphological change can potentially provide evidence for the presence of domesticates, but may be of limited use in identifying the earliest stages of the process. Changes in population structure and the presence of high frequencies of pathologies can both be extremely difficult to interpret.

"Arguments for animal domestication based on faunal remains from archaeological sites are likely to be more convincing if they employ multiple lines of evidence than if they are based on any one feature alone...Where possible, all of these features are best examined together and trends documented and evaluated on the basis of large faunal collections from single sites covering significant spans of time, or from multiple sites within a limited region. In addition, interpretations are best made within the archaeological context of the site and region being examined, because only then can features of community and settlement patterning, site structure, and material culture be evaluated and related to the faunal remains" (Meadow 1989a, p.87). With these comments in mind, the data relating to caprine domestication in south-west Asia are examined in detail below.

6.2.3: Caprine Zoogeography in South-West Asia during the Late Pleistocene and Early Holocene:

The importance of being able to reconstruct the ancient geographical range of the wild progenitors of domestic caprines has long been accepted, since "the distribution of the wild ancestor should define the area where the species was first domesticated" (Smith 1995, p.53). Recognition of this fact has resulted in the publication of a considerable body of literature dealing with the ancient and modern distribution of wild caprines in south-west Asia (e.g. Isaac 1970, Nadler et al. 1973, Uerpmann 1987, Harrison and Bates 1991). The overall geographical ranges of wild caprines in south-west Asia during the late Pleistocene and early Holocene is therefore fairly well defined, although it should be noted that a degree of uncertainty continues to surround the extent to which wild sheep penetrated the southern Levant during this period. However, the relative lack of quantitative zooarchaeological data from the region at the time that many of these studies were compiled has meant that their results are generally based on non-quantitative distribution maps which combine zoological data showing the distribution of wild caprines today with archaeological data showing the location of sites which have yielded wild caprine bone. As a result potential variation in the abundance of wild caprines within their extensive overall geographical ranges has remained poorly explored. This factor is of crucial importance to zooarchaeologists attempting to identify early centres of domestication as wild caprines are much more likely to have been first domesticated in those areas of their overall geographical ranges in which they were most abundant and had consequently played an important role as prey species in the periods immediately preceding domestication. Fortunately the amount of published quantitative late Pleistocene and early Holocene zooarchaeological data from south-west Asia has increased dramatically over the last decade and a half. As a result it is now more feasible to attempt to explore variation in the abundance of wild caprines within their areas of distribution during this period.

This section therefore summarises the results of previous work on the overall geographical ranges of wild caprines in south-west Asia during the late Pleistocene and early Holocene and attempts to delineate their probable areas of distribution. The relative proportion of caprines in selected faunal assemblages is then analysed to assess potential variation in caprine abundance within these areas. To minimise the chance of early domestic caprines being included on account of their morphological similarity to wild forms it was decided to restrict this analysis to faunal assemblages known to predate the beginning of Period 3 i.e. 9,600b.p., in deference to the "widely held belief that domesticates do not exist in these periods" (Martin 1994, p.69). It should be noted that this analysis is based on the assumption that the relative abundance of taxa in these faunal assemblages is more a reflection of relative taxonomic abundance in the immediate vicinity of sites (see Chapter 5) than any cultural preferences for one taxon over another on the part of the inhabitants.

6.2.3.1: *Capra* spp.:

Any attempt to reconstruct the overall geographical range of the ancestor of the domestic goat *Capra hircus* is complicated by the fact that two post-cranially indistinguishable species of the genus *Capra* are known to have inhabited south-west Asia during the late Pleistocene and early Holocene: the bezoar or wild goat *Capra aegagrus* and the Nubian ibex *Capra nubiana*. The wild goat is known to be the progenitor of the domestic goat (Davis 1987, p.132) whereas the Nubian ibex has never been domesticated. Both species survive in limited numbers in the region today.

The wild goat is restricted to the higher parts of the Taurus and Zagros mountains today (Harrison and Bates 1991), but find-spots of archaeological bone confirm that its range during the late Pleistocene and early Holocene was more extensive (Uerpmann 1987, p.117 Figure 53). The "most conspicuous extension of its former range reached south along the Levantine shore of the Mediterranean well into Palestine and the Transjordanian highlands" (Uerpmann 1987, p.114). Data on the habitat preferences of wild goat today have been summarised by Harrison and Bates (1991, p.185): "The old males inhabit the higher mountains in summer, often on or above the snow line; females and young are found on the lower ridges. In winter all are found together in the rocks, scattered pines and bushy ground at about 615 to 925 metres elevation. However, they may descend, even in fine weather, almost to sea level...Their food consists mainly of mountain grasses, shoots of small species of oak and cedar and various berries." These data strongly suggest that the overall geographical range of the wild goat during the late Pleistocene and early Holocene included all areas of the Fertile Crescent in which craggy, broken hill-country or mountainous terrain coincided with woodland or forest vegetation.

The Nubian ibex has a more southerly distribution than the wild goat. Today it is restricted to the mountains of the Judean desert, the Negev plateau and the Sinai peninsular. In addition it is thought to have inhabited parts of the central and southern Syrian deserts until relatively recently (Harrison and Bates 1991, pp.182-183). Although it is virtually impossible to distinguish the post-cranial bones of Nubian ibex from those of wild goat, there are clear morphological differences in the cross-section of the male horncores (e.g.: Davis 1987, p.132). Early Holocene Nubian ibex horncores have been identified at El Khiam (Ducos 1997), Wadi Fidan C (Richardson 1997), Ramat Harif (Goring-Morris 1987), Beidha (Hecker 1975 and 1989) and Ujrat el Mehed (Dayan et al. 1986). Analysis of ancient DNA has also recently confirmed the presence of Nubian ibex at Abou Gosh (Horwitz pers.comm.). The distribution of these sites (see Figure 6.1) suggests that the geographical range of the Nubian ibex during the late Pleistocene and early Holocene was probably more or less the same as it is today, with the notable addition of the eastern rift margins of the Wadi Arabah. Its presence in the deserts of central and southern Syria during this period remains uncertain (Tchernov and Bar-Yosef 1982, p.23) but the paucity of faunal assemblages from the area means that this possibility cannot as yet be discounted. The Nubian ibex thus seems to have occupied a rather different environmental niche to the wild goat during the late Pleistocene and early Holocene, namely craggy, broken hill-country or mountainous terrain which coincided with an arid or semi-arid climatic regime.

The boundary between wild goat and Nubian ibex thus seems to have followed the major zoological dividing line between Palaearctic and Ethiopian, or African, faunas (see Uerpmann 1987, p.133 Figure 61) in south-west Asia. This line closely follows the northern limit of the Arabian desert and effectively separates "desert species from those which do not tolerate the lack of surface water, the temperature extremes, and the sparse vegetation" (Uerpmann 1987, pp.136-137). Although climatic fluctuations may have caused the boundary between wild goat and Nubian ibex to have shifted slightly over time, it should be stressed that there is no biogeographical or ecological evidence to suggest that wild goat and Nubian ibex have ever been sympatric in south-west Asia. It is much more likely that the "distribution pattern of both species (has been) parapatric throughout time. Sympatry would have caused, by means of character displacement, some morphological differences between the two species" (Tchernov and Bar-Yosef 1982, p.23). Significantly the only site to have yielded identifiable horncores of both wild goat and Nubian ibex, i.e. Beidha, is located in mountainous terrain, right on the boundary between the environmental niches represented by the respective habitat preferences of the two species.

The previous work described above has therefore demonstrated that the overall geographical range of the wild goat in south-west Asia during the late Pleistocene and early Holocene was extensive, probably comprising all areas of the Fertile Crescent where craggy, broken hill-country or mountainous terrain coincided with woodland or forest vegetation. These environmental conditions are broadly delineated by the 400mm. p.a. isohyet, below which woodland or forest vegetation cannot develop (Zohary 1973, van Zeist and Bottema 1991), and would have included the upland and piedmont zones of the Taurus and Zagros mountains, the Ansaryie Mountains, the Lebanon and Anti-Lebanon mountains, the Jordan Highlands and most of northern and central Palestine. Having thus established the area within which the domestication of wild goat could have occurred, i.e.: the overall geographical range of the species, variation in its abundance within this area is explored below in an attempt to identify the locations in which wild goat domestication is most likely to have occurred, i.e.: where it was especially abundant and had played an important role as prey species prior to domestication.

Table 6.1 therefore shows the proportions of wild goat in south-west Asian faunal assemblages which predate Period 3 (major medium and large herbivores only; data taken from Tables 5.3 and 5.5). Faunal assemblages containing a significant proportion (arbitrarily defined as >25%) of wild goat are highlighted in bold type. To avoid confusion between wild goat and Nubian ibex, sites lying within or immediately adjacent to the probable late Pleistocene and early Holocene range of Nubian ibex (i.e.: Rosh Horesha, Rosh Zin, Khallat Anaza, Wadi Judayid 2, El Khiam, Netiv Hagdud, Jericho, Abu Salem, Ramat Harif) are excluded as the two species are not generally thought to have been sympatric. In the unique case of Beidha, where both species have been identified, the proportion of wild goat in the post-cranial material identified only as *Capra* spp. (65.6%; see Table 5.3) has been calculated using the ratio of identifiable wild goat to Nubian ibex horncores, i.e.: 1:3 (Hecker 1975, p.385).

Site	Period	Area	Alt	n	Hrb	Cpr	Source
Zarzi	0	ZU	1000	12	?	**X**	Garrod 1930
Shanidar Cave B2	1	ZP	822	?	?	**X**	Perkins 1964
Shanidar Cave B1	2	ZP	822	63	100.0	**57.1**	Perkins 1964
Saaide II	1	BV	1035	284	65.9	**53.0**	Churcher 1994
Warwasi	0	ZU	1000	15	100.0	**40.0**	Turnbull 1975
Beidha	1	SJ	1300	139	98.6	16.4	Hecker 1989
'Ain Rahub	1	NJ	410	240	98.8	11.4	Shiyab 1997
Palegawra	0	ZU	990	2459	96.9	10.9	Turnbull and Reed 1974
Wadi Hammeh 27	1	JV	-50	212	90.6	7.8	Edwards et al. 1988
Zawi Chemi Shanidar	2	ZP	425	1221	100.0	7.1	Perkins 1964
Karim Shahir	2	ZP	500	193	94.2	6.8	Stampfli 1983
Mallaha II-IV	1	JV	100	687	100.0	6.1	Bouchud 1987
Hayonim Cave	1	CP	250	?	99.0	6.1	Bar-Yosef and Tchernov 1966
Mallaha I	1	JV	100	905	100.0	4.0	Bouchud 1987
Fazael VI	1	JV	-200	120	68.3	3.7	Tchernov 1993
Nahal Oren	2	PC	50	516	100.0	3.1	Noy, Legge and Higgs 1973
Hallan Çemi	2	TP	640	?	93.6	2.8	Rosenberg 1998
Salibiya I	1	JV	-200	370	86.5	1.6	Crabtree et al. 1991
Rakefet	1	MC	300	1002	95.5	0.9	Garrard 1980
Hayonim Terrace	1	CP	250	4572	98.9	0.5	Henry et al. 1981
El Wad B	1	MC	30	1474	93.2	0.2	Garrard 1980
Nahal Oren	1	PC	50	1846	100.0	0.2	Noy, Legge and Higgs 1973
Abu Usba	1	PC	140	?	?	x	Stekelis and Haas 1952
Abu Hureyra	1	EV	250	154	91.3	absent	Legge 1975 and 1996
Mureybet Ia	1	EV	300	1559	79.3	absent	Helmer 1991a
Kebara	1	MC	50	327	64.5	absent	Saxon 1974
Hatoula	1	CP	250	89	76.4	absent	Davis 1985, Davis et al.1994
Shukbah	1	CP	100	368	96.8	absent	Garrod and Bate 1942
Azraq 18	1	EJ	550	290	99.0	absent	Martin 1994
M'lefaat	2	ZP	400	142	92.9	absent	Turnbull 1983
Nahr el Homr	2	EV	450	227	99.9	absent	Clason and Buitenhuis 1975
Mureybet II	2	EV	300	?	100.0	absent	Ducos 1978b
Mureybet III	2	EV	300	?	100.0	absent	Ducos 1978b
Hatoula	2	CP	250	82	23.1	absent	Davis 1985, Davis et al.1994
Hatoula	2	CP	250	72	37.5	absent	Davis 1985, Davis et al.1994
Gesher	2	JV		65	93.9	absent	Horwitz and Garfinkel 1991
Gilgal I	2	JV	-200	21	62.0	absent	Noy et al. 1980

Table 6.1: Percentage of *Capra aegagrus* in Period 0, 1 and 2 Faunal Assemblages from South-West Asia (>25% in bold)

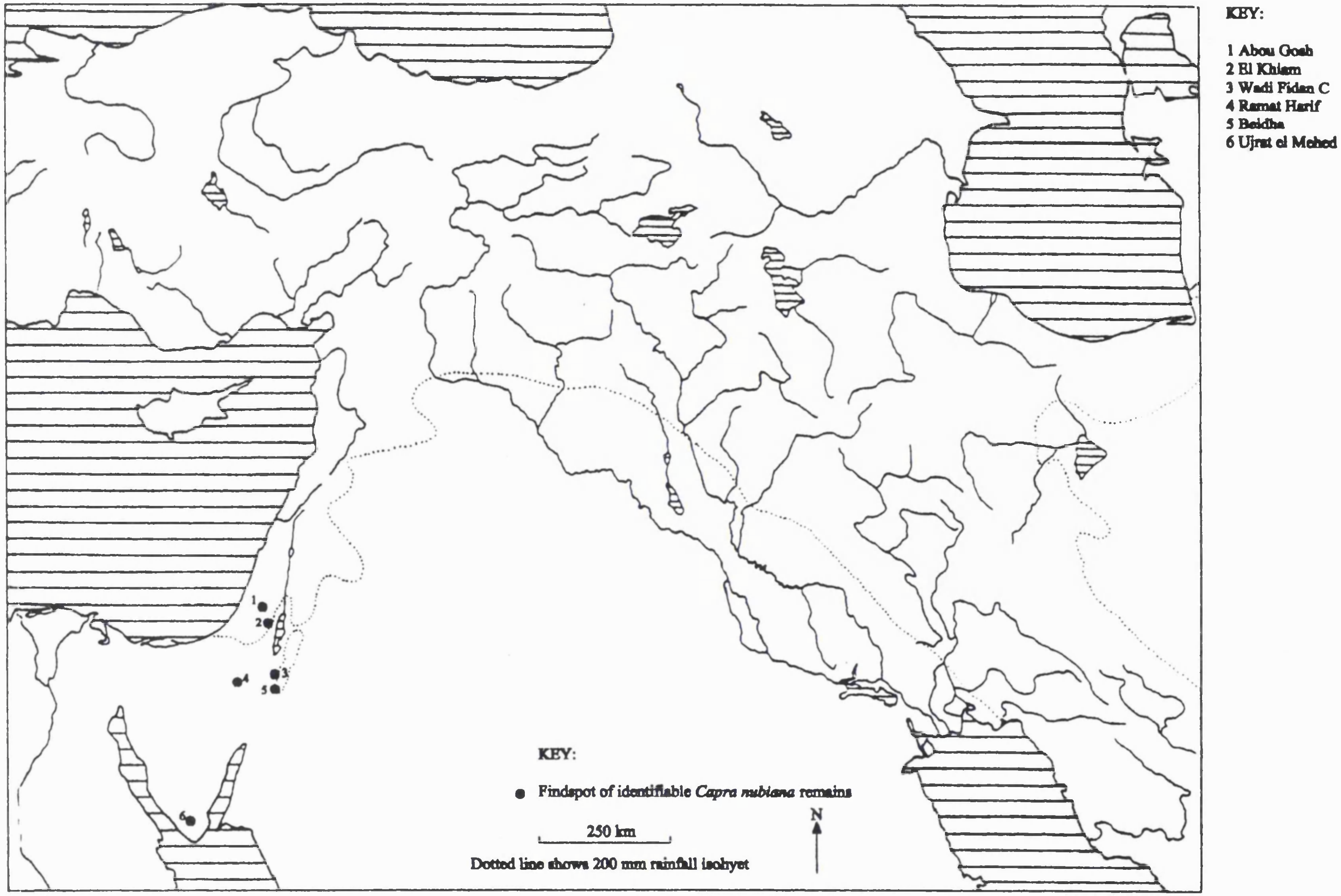
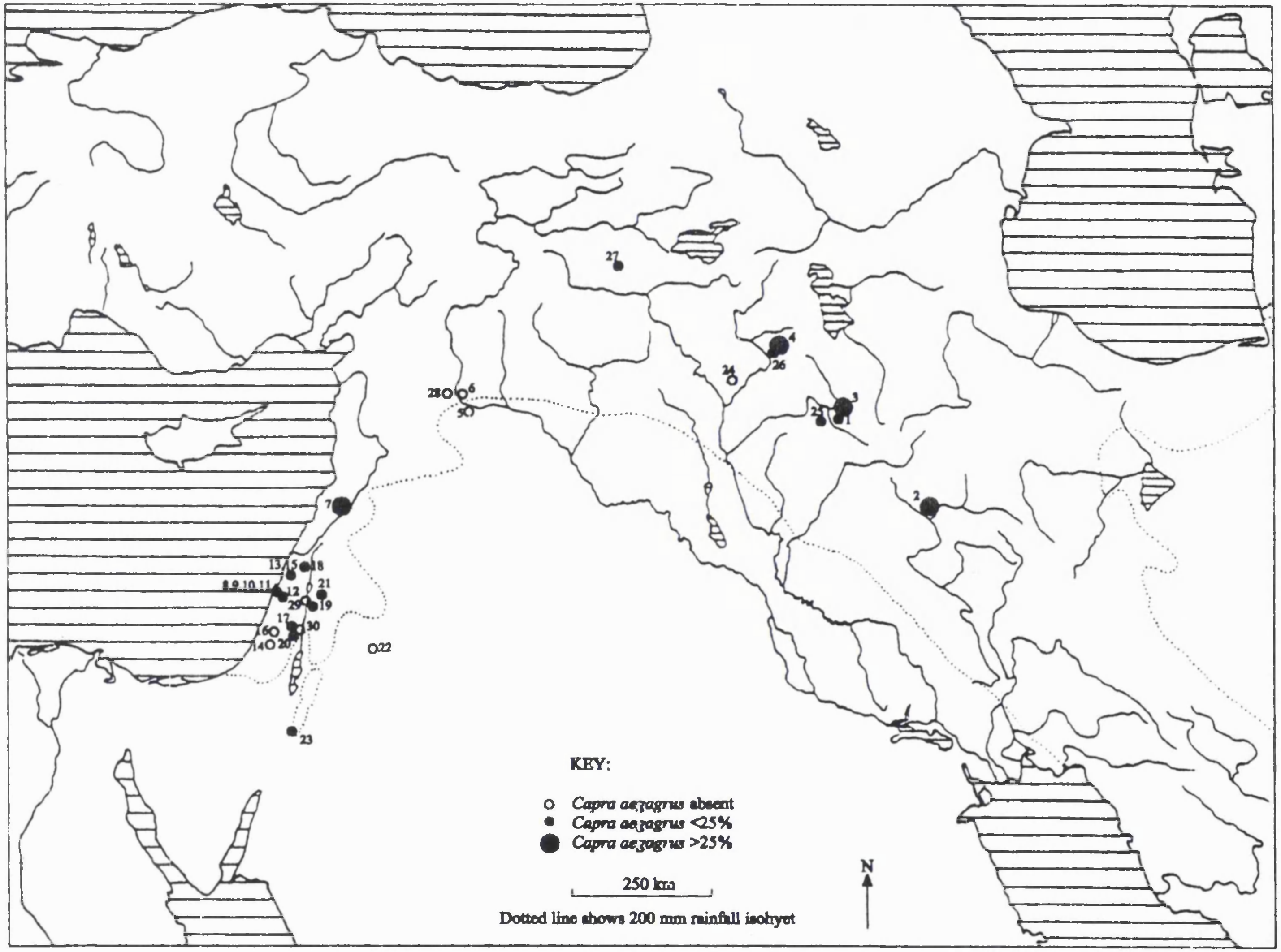


Figure 6.1: Location of Late Pleistocene and Early Holocene Sites with Identifiable Remains of *C.nubiana*



KEY:

1 Palegawra
2 Warwasi
3 Zarzi
4 Shanidar Cave (B1 and B2)
5 Abu Hureyra
6 Mureybet (Ia, II and III)
7 Saaide II
8 Abu Usba
9 Nahal Oren (Periods 1 and 2)
10 El Wad B
11 Kebara
12 Rakefet
13 Hayonim Cave
14 Hatoula (Period 1, Kh and Su)
15 Hayonim Terrace
16 Shukbah
17 Fazael VI
18 Mallaha
19 Wadi Hammeh 27
20 Salibiya I
21 'Ain Rahub
22 Azraq 18
23 Beidha
24 M'lefaat
25 Karim Shahir
26 Zawi Chemi Shanidar
27 Hallan Çemi
28 Nahr el Homr
29 Gesher
30 Gilgal I

Figure 6.2: Distribution and Abundance of *C.aegagrus* in South-West Asia During Periods 0, 1 and 2

Although some of the sample sizes are uncomfortably small, the data in Table 6.1 strongly suggest that wild goat was by no means evenly distributed throughout its overall geographical range during the late Pleistocene and early Holocene. It is also apparent that this variation was related not to chronology, but to geographical area and local environmental conditions. In particular, the proportion of wild goat in these faunal assemblages seems to have varied considerably with altitude, which is unsurprising given the extent to which altitude is linked to the environmental variables of topography and vegetation in south-west Asia. The faunal assemblages in Table 6.1 can be divided into three broad groups on the basis of the proportions of wild goat (see also Figure 6.2): those containing significant proportions of wild goat (>25%), those in which wild goat was present but rare (<25%) and those in which wild goat was absent altogether.

Five faunal assemblages from four sites contained significant proportions of wild goat. All of these sites (Zarzi, Shanidar Cave, Saaïde II, Warwasi) are situated at elevations in excess of 800m. a.s.l. within or immediately adjacent to cool, high mountainous terrain i.e.: the Anti-Lebanon and Zagros Mountains, which would have supported cold-deciduous forest vegetation during the late Pleistocene and early Holocene (Zohary 1973, van Zeist and Bottema 1991). Wild goat was present but rare in a further 18 faunal assemblages from 16 sites. Although the environmental conditions around these sites varies considerably, it is significant that none are located in the type of mountainous terrain described above. Typically these sites are located at elevations well below 800m. a.s.l. in or immediately adjacent to broken hill-country (e.g.: Hayonim Cave, Nahal Oren, Rakefet, Hayonim Terrace, El Wad B, Nahal Oren, Abu Usba), rift valley margins (e.g.: Beidha, Wadi Hammeh 27, Mallaha, Fazael VI, Salibiya I) or the piedmont zones of greater mountain ranges (e.g.: Zawi Chemi Shanidar, Karim Shahir, Hallan Çemi), which would have supported woodland or forest vegetation of one type or another during the late Pleistocene and early Holocene (Zohary 1973, van Zeist and Bottema 1991). Wild goat appears to have been absent altogether in a total of 14 faunal assemblages from 10 sites. These are typically located beyond the 400mm. p.a. isohyet, below which woodland or forest vegetation cannot develop, at elevations of less than 500m. a.s.l. in flat or undulating terrain including the Euphrates Valley (e.g.: Abu Hureyra, Mureybet, Nahr el Homr), the floor of the Jordan Valley (e.g.: Gesher, Gilgal I) and southern parts of the Shefela (e.g.: Hatoula, Shukbah).

The data in Table 6.1 and Figure 6.2 therefore strongly suggests that although the overall geographical range of the wild goat during the late Pleistocene and early Holocene would have included all areas of the Fertile Crescent where craggy, broken hill-country or mountainous terrain coincided with woodland or forest vegetation, it was only present in significant numbers in cool, high mountainous terrain supporting cold deciduous forest vegetation. During the late Pleistocene and early Holocene these environmental conditions would probably have been restricted to four locations in south-west Asia: the Lebanon, Anti-Lebanon, Taurus and Zagros Mountains. These should therefore be regarded as the locations within or immediately adjacent to which wild goat domestication was most likely to have first occurred. All evidence suggests that elsewhere within its range, e.g.: the piedmont zones of the Taurus and Zagros mountains or the woodland zones of Israel and Jordan, wild goat was relatively uncommon and/or only present on a seasonal basis.

6.2.3.2: *Ovis* spp.:

Reconstruction of the overall geographical range of the ancestor of the domestic sheep *Ovis aries* is complicated by the fact that different researchers have recognised anywhere between one and 17 species of Old World *Ovis* spp. (Meadow 1989b, p.29). To minimise the potential for confusion the minimalist approach adopted by Uerpmann (1987, p.126) has been followed here. This divides the wild sheep of western Asia into two species: the mouflon *Ovis orientalis* and the urial *Ovis vignei,* on the basis of the number of chromosomes in the karyotype: the mouflon has 54 whereas the urial has 58 (Nadler et al. 1973). As the domestic sheep has 54 chromosomes it is generally considered to be descended from the mouflon (Davis 1987, pp.130-131). Both species survive in limited numbers in the wild today.

The modern distribution of the urial includes Turkmenistan, Afghanistan, Baluchistan and the deserts of central Iran as far west as the Caspian Sea. The limited zooarchaeological data from this area suggests that its range during the late Pleistocene and early Holocene may have been more restricted (Uerpmann 1987, pp.127-132). There is no evidence to suggest that the urial has ever inhabited south-west Asia and it can therefore assumed that all wild sheep remains from this area represent mouflon.

Within south-west Asia the mouflon is today restricted to isolated parts of the Taurus and Zagros Mountains (Harrison and Bates 1991). Although find-spots of archaeological bone confirm that its range was more extensive during the late Pleistocene and early Holocene (Uerpmann 1987, p.128 Figure 58) its exact distribution is not entirely clear. The remains of mouflon have been identified at numerous sites in the northern Fertile Crescent, predominantly in the piedmont zones of the Taurus and Zagros Mountains but also in the Zagros Mountains proper and in the central Euphrates Valley. Further to the south "despite extensive excavations of terminal-Pleistocene and early-Holocene sites in northern Israel, central and northern Jordan and southern Syria, no remains of wild sheep have been found which date to before 6,500 b.c." (Garrard et al. 1996, p.209). However, the remains of mouflon have been identified at a number of Period 1 and 2 sites located in the southernmost Levant, specifically the Hisma Basin, Negev plateau and southern Shefela. It is therefore appears that during the late Pleistocene and early Holocene, south-west Asia supported a small and potentially isolated population of mouflon in the southernmost Levant in addition to the more extensive populations of the northern Fertile Crescent. Data on the modern habitat preferences of Armenian mouflon is provided by Harrison and Bates (1991, p.188): "It lives in mountain steppe areas in summer, favouring meadows and grassy places on bare mountains. It migrates seasonally and spends the winter in the lower foothills".

The previous work described above suggests that during the late Pleistocene and early Holocene the mouflon would have occupied a rather different, albeit potentially overlapping, environmental niche to the wild goat, comprising those areas of the Fertile Crescent where rolling hill-country or steppic terrain coincided with open woodland, dwarf shrubland or grassland vegetation. As such vegetation tends to develop between the 350 and 150mm. p.a. isohyets (Zohary 1973) it is highly probable that the mouflon was more drought-tolerant than the wild goat. During the late Pleistocene and early Holocene these environmental conditions would have dominated the piedmont zones of the Taurus and Zagros mountains, the upper/central Euphrates Valley, the southern Shefela and parts of the northern Negev and southern Jordan, all of which have yielded remains of mouflon dating to this period. However, similar environmental conditions should also have been found in parts of the moist and dry steppe zones of the Jordanian plateau and western parts of the Syrian desert (Zohary 1973, van Zeist and Bottema 1991). It is therefore somewhat surprising that these areas have so far yielded no evidence for the presence of mouflon during the late Pleistocene and early Holocene, although it should be noted that the number of published faunal assemblages is rather limited. Having thus established, so far as possible, the area within which the domestication of mouflon could have occurred, i.e.: the overall geographical range of the species, variation in its abundance within this area is explored below in an attempt to identify the locations in which mouflon domestication is most likely to have occurred, i.e.: where it was especially abundant and had played an important role as prey species prior to domestication.

Table 6.2 therefore shows the proportion of mouflon in south-west Asian faunal assemblages which predate Period 3 (major medium and large herbivores only, data taken from Tables 5.3 and 5.5). Faunal assemblages containing a significant proportion (arbitrarily defined as >25%) of mouflon are highlighted in bold type.

The data in Table 6.2 strongly suggest that the mouflon, like the wild goat, was not evenly distributed throughout its overall geographical range during the late Pleistocene and early Holocene. Likewise, this variation seems to have been related not to chronology but to geographical area and local environmental conditions, especially altitude. The faunal assemblages in Table 6.2 can be divided into three broad groups on the basis of the proportions of mouflon (see also Figure 6.3): those containing significant proportions of mouflon (>25%), those in which mouflon was present but rare (<25%) and those in which mouflon was absent altogether.

Six faunal assemblages contained significant proportions of mouflon. Five of these (Karim Shahir, Hallan Çemi, Zawi Chemi Shanidar, Shanidar Cave, M'lefaat) are located at elevations between 400 and 850m. a.s.l. in the rolling hill-country which characterises the piedmont zones of the Taurus and Zagros Mountains in the northern Fertile Crescent. The sixth (Wadi Judayid 2) is located in a very different environmental setting in the southernmost Levant at an elevation of 1100m. a.s.l. on the edge of the arid Hisma basin of southern Jordan. Mouflon was present but rare in a further six faunal assemblages from four sites (Palegawra, Abu Hureyra, Mureybet, Jericho), which represent a rather varied set of environmental conditions. Palegawra is located in the Zagros uplands at an elevation of almost 1000m. a.s.l., Abu Hureyra and Mureybet are both located in the undulating steppe flanking the Euphrates Valley at elevations of 250

Site	Period	Area	Alt	n	Hrb	Ovi	Source
Karim Shahir	2	ZP	500	193	94.2	**61.4**	Stampfli 1983
Hallan Çemi	2	TP	640	?	93.6	**49.4**	Rosenberg 1998
Zawi Chemi Shanidar	2	ZP	425	1221	100.0	**43.9**	Perkins 1964
Shanidar Cave B1	2	ZP	822	63	100.0	**42.9**	Perkins 1964
M'lefaat	2	ZP	400	142	92.9	**37.9**	Turnbull 1983
Wadi Judayid 2	1	SJ	1100	193	98.8	**33.9**	Henry and Turnbull 1985
Palegawra	0	ZU	990	2459	96.9	15.2	Turnbull and Reed 1974
Abu Hureyra	1	EV	250	154	91.3	11.8	Legge 1975 and 1996
Mureybet III	2	EV	300	?	100.0	5.8	Ducos 1978b
Mureybet Ia	1	EV	300	1559	79.3	3.0	Helmer 1991
Jericho	2	JV	-200	548	74.1	1.1	Clutton-Brock 1979
Mureybet II	2	EV	300	?	100.0	0.7	Ducos 1978b
Shanidar Cave B2	1	ZP	822	?	?	x	Perkins 1964
Hatoula	1	CP	250	89	76.4	x	Davis 1985, Davis et al.1994
Hatoula (Kh)	2	CP	250	82	23.1	x	Davis 1985, Davis et al.1994
Hatoula (Su)	2	CP	250	72	37.5	x	Davis 1985, Davis et al.1994
Rosh Horesha	1	NG	900	990	98.7	x	Butler et al. 1977,Davis et al. 1982
Abu Salem	2	NG	970	1155	99.0	x	Butler et al. 1977,Davis et al. 1982
Ramat Harif	2	NG	1000	632	100.0	x	Goring-Morris 1987
Warwasi	0	ZU	1000	15	100.0	absent	Turnbull 1975
Zarzi	0	ZU	1000	12	?	absent	Garrod 1930
Saaide II	1	BV	1035	284	65.9	absent	Churcher 1994
Abu Usba	1	PC	140	?	?	absent	Stekelis and Haas 1952
Nahal Oren	1	PC	50	1846	100.0	absent	Noy et al. 1973
El Wad B	1	MC	30	1474	93.2	absent	Garrard 1980
Kebara	1	MC	50	327	64.5	absent	Saxon 1974
Rakefet	1	MC	300	1002	95.5	absent	Garrard 1980
Hayonim Cave	1	CP	250	?	99.0	absent	Bar-Yosef and Tchernov 1966
Hayonim Terrace	1	CP	250	4572	98.9	absent	Henry et al. 1981
Shukbah	1	CP	100	368	96.8	absent	Garrod and Bate 1942
Fazael VI	1	JV	-200	120	68.3	absent	Tchernov 1993
Mallaha II-IV	1	JV	100	687	100.0	absent	Bouchud 1987
Wadi Hammeh 27	1	JV	-50	212	90.6	absent	Edwards et al. 1988
Mallaha I	1	JV	100	905	100.0	absent	Bouchud 1987
Salibiya I	1	JV	-200	370	86.5	absent	Crabtree et al. 1991
Rosh Zin	1	NG	650	15	100.0	absent	Tchernov 1976
'Ain Rahub	1	NJ	410	240	98.8	absent	Shiyab 1997
Azraq 18	1	EJ	550	290	99.0	absent	Martin 1994
Khallat Anaza	1	EJ		34	88.3	absent	Martin 1994
Beidha	1	SJ	1300	139	98.6	absent	Hecker 1989
Nahr el Homr	2	EV	450	227	99.9	absent	Clason and Buitenhuis 1975
Nahal Oren	2	PC	50	516	100.0	absent	Noy, Legge and Higgs 1973
El Khiam	2	CP	500	134	100.0	absent	Ducos 1997
Gesher	2	JV		65	93.9	absent	Horwitz and Garfinkel 1991
Gilgal I	2	JV	-200	21	62.0	absent	Noy et al. 1980
Netiv Hagdud	2	JV	50	420	31.4	absent	Tchernov 1994

Table 6.2: Percentage of *Ovis orientalis* in Period 0, 1 and 2 Faunal Assemblages from South-West Asia (>25% in bold)

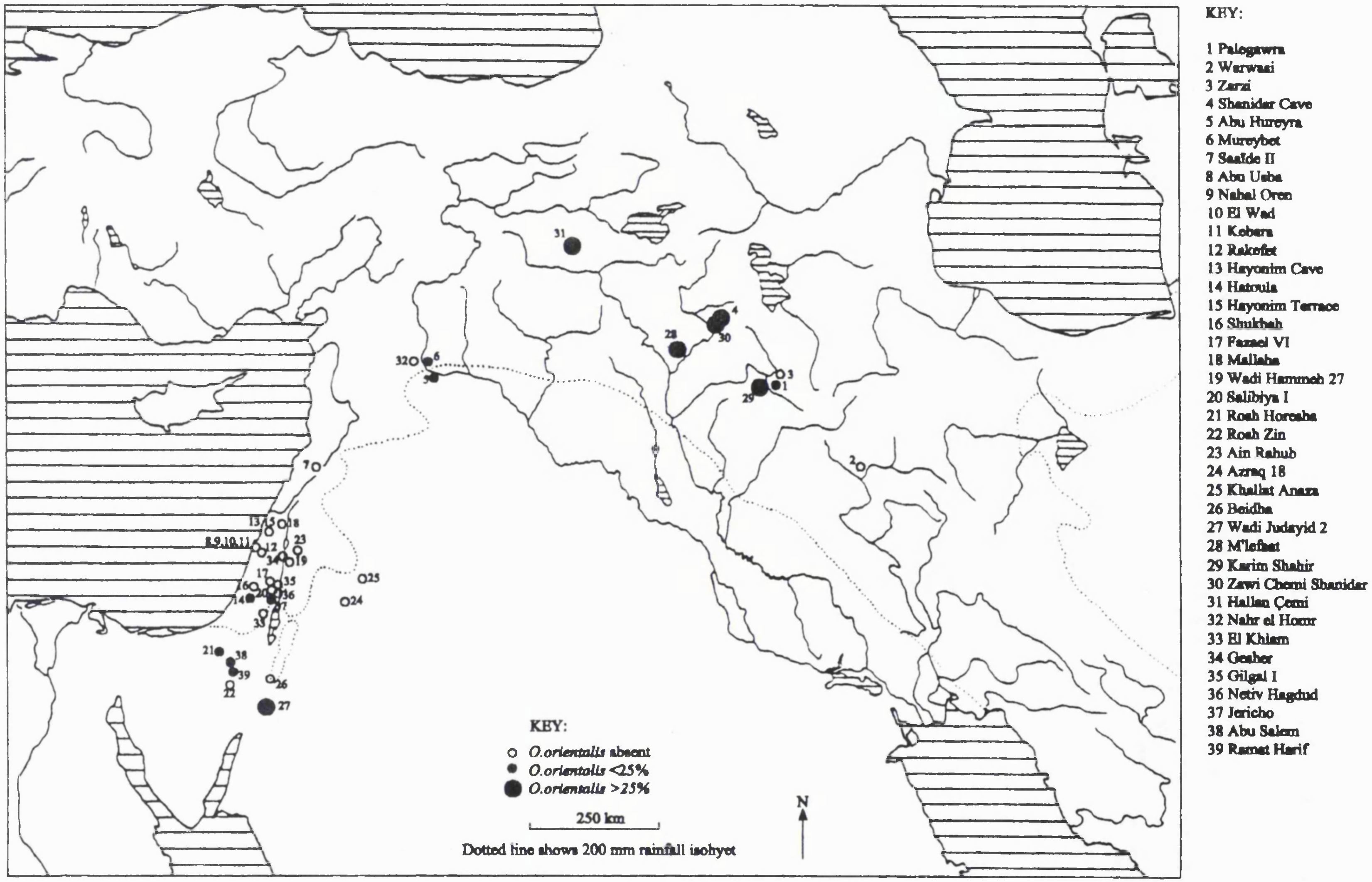


Figure 6.3: Distribution and Abundance of *O.orientalis* in South-West Asia During Periods 0, 1 and 2

and 300m. a.s.l. respectively, whereas Jericho is located on the floor of the Jordan Valley at more than 200m. b.s.l. (it should however be noted that a number of researchers, including Tchernov (1994, p.74), have cast doubt on the provenance of the Period 2 and 3 *Ovis* spp. remains from Jericho, believing them to be intrusive from later periods). In addition, non-quantitative data has confirmed the presence, if not an abundance, of mouflon at a further four sites in the southern Levant situated in the rolling hill-country of the southern Shefela (Hatoula) and on the undulating Negev plateau (Rosh Horesha, Abu Salem, Ramat Harif). Mouflon appears to have been absent altogether in 27 faunal assemblages from 25 sites. The environmental conditions around these sites vary considerably, but include high mountainous terrain (Warwasi, Zarzi, Saaïde II. Beidha) and craggy broken hill-country (Abu Usba, Nahal Oren, El Wad, Kebara, Rakefet, Hayonim Cave, Hayonim Terrace, Shukbah) which would have supported woodland or forest vegetation of one type or another, and the Jordan Valley and rift margins (Fazael VI, Mallaha, Wadi Hammeh 27, Salibiya I, Gesher, Gilgal, Netiv Hagdud).

The data in Table 6.2 and Figure 6.3 therefore strongly suggest that although the overall geographical range of the mouflon during the late Pleistocene and early Holocene would have included all parts of the northern and southernmost Fertile Crescent where rolling hill-country or steppic terrain coincided with open woodland, dwarf shrubland or grassland vegetation, it was only present in significant numbers in the relatively cool, well-watered piedmont zones of the Taurus and Zagros mountains. These should therefore be regarded as the locations within or immediately adjacent to which mouflon domestication was most likely to have occurred. All evidence suggests that although the overall geographical range of the mouflon during the late Pleistocene and early Holocene evidently included hotter, drier rolling hill-country and steppic terrain, in such areas, e.g.: the Euphrates Valley or parts of the southernmost Levant, it seems to have been relatively uncommon and/or only present on a seasonal basis.

Having examined the zoogeography of caprines in south-west Asia during the late Pleistocene and early Holocene in 6.2.3 above, the data with which domestic caprines can be identified in the archaeological record are now discussed in 6.2.4 to 6.2.9.

6.2.4: Changes in Caprine Frequency and Import of Caprines as Foreign Species:

A number of researchers have drawn attention to the fact that the frequency of caprine remains in faunal assemblages from south-west Asia seems to have been significantly greater during the PPNB (Periods 3 and 4), than during the Natufian and PPNA (Periods 1 and 2), and have used this apparent increase to support claims of caprine domestication or proto-domestication at this time (e.g.: Davis 1987, Horwitz 1989). The increase in the frequency of caprines is particularly apparent at a number of sites in the southern Levant, where caprines replaced gazelle as the most common taxon "either relative to previous strata at the site or compared to previous periods" (Horwitz 1989, p.171). However, examination of the data in Tables 5.2 to 5.19 clearly demonstrates that the situation over south-west Asia as whole was considerably more complex, with caprines increasing in frequency in different areas at different times. It is also apparent that in some areas the high frequencies of caprines observable between Periods 3 and 5 were preceded by equally high frequencies of caprines during Periods 1 and 2. These factors are of crucial importance to zooarchaeologists examining caprine domestication as the intial process of domestication clearly needs to be distinguished from the subsequent diffusion of domesticates throughout the region.

This section therefore attempts to explore the introduction of caprines to areas outside their late Pleistocene and early Holocene ranges and changes in caprine frequency in the different areas of south-west Asia more closely. It was decided to restrict this discussion to faunal assemblages known to predate the beginning of Period 6, i.e.: 7,600b.p., as a clear 'terminus ante quem' for the process of caprine domestication is provided by the apparent introduction during Period 5 of mixed herds of domestic goats and sheep to the dry steppe and sub-desert zones of Jordan, which seem to have lain outside the ranges of wild goat and mouflon during the late Pleistocene and early Holocene (Garrard et al. 1996, p.204). Tables 6.3 to 6.11 therefore show the proportions of caprines (here defined as wild goat, domestic goat, mouflon and domestic sheep) in south-west Asian faunal assemblages which predate the beginning of Period 6 (major medium and large herbivores only; data taken from Tables 5.3, 5.5, 5.7, 5.9 and 5.11). Each table represents a different geographical area and within each table the faunal assemblages are arranged in chronological order.

Where sites lying within the probable late Pleistocene and early Holocene range of Nubian ibex have yielded remains identified only as *Capra* spp. (i.e.: Beidha, Netiv Hagdud, Jericho, Wadi Fidan A, Wadi Fidan C, Khallat Anaza, Rosh Horesha, Rosh Zin, Wadi Judayid 2, El Khiam, Abu Salem, Ramat Harif, Nahal Divshon, Nahal Issaron, Wadi Tbeik, Ujrat el Mehed), wild/domestic goat is assumed to be absent unless their horncores have been positively identified (i.e.: Beidha, Wadi Fidan A, Wadi Fidan C, Jericho). In the cases of Beidha (Periods 1 and 3) and Wadi Fidan C, where horncores of both Nubian ibex and wild/domestic goat have been identified, the proportion of wild/domestic goat in faunal assemblages has been calculated using the ratio of wild/domestic goat horncores to Nubian ibex horncores, i.e.: 1:3 at Beidha Period 1 (Hecker 1975, p.385), 4:1 at Beidha Period 3 (Hecker 1975, p.385) and 11:5 at Wadi Fidan C (Richardson 1997, p.504). In the cases of Wadi Fidan A and Jericho, which have yielded horncores of wild/domestic goat, but not of Nubian ibex , all *Capra* spp. remains are assumed to be of wild/domestic goat.

6.2.4.1: Central Levantine Corridor:

Site	Period	n	Hrb	C+O	Cpr	Ovi	Source
Saaide II	1	284	65.9	**53.0**	**53.0**	absent	Churcher 1994
Tell Aswad I-II	2+3	2815	100.0	**44.6**	**44.6**	0.04	Ducos 1993a
Ghoraife I	3	321	100.0	**51.5**	**38.9**	12.6	Ducos 1993a
Ghoraife II	4	721	99.6	**63.8**	15.2	**48.6**	Ducos 1993a
Ramad I	4	3043	100.0	**75.8**	18.7	**57.1**	Ducos 1993a
Labweh	5	940	99.5	**75.0**	36.7	**38.2**	Bökönyi 1978

Taxa Codes: Hrb=% of major medium and large herbivores in n, C+O=total *Capra aegagrus*, *Capra hircus*, *Ovis orientalis* and *Ovis aries*, Cpr=*Capra aegagrus* or *Capra hircus*, Ovi=*Ovis orientalis* or *Ovis aries*
Quantitative Data: all % NISP execept: x= taxon present (excluded from n and % NISP calculations), X=most abundant taxon (excluded from n and NISP calculations), Bold Type=most common taxon in faunal assemblage (major medium and large herbivores only)

Table 6.3: Changes in Caprine Frequency between Periods 1 and 5 Central Levantine Corridor

The data in Table 6.3 suggest that the central Levantine Corridor was one the areas of south-west Asia in which high frequencies of caprines between Periods 3 and 5 had been preceded by high frequencies of caprines during Periods 1 and 2. The predominance of goat in the Period 1 faunal assemblage from Saaïde II is unsurprising, given the location of this site immediately adjacent to the Anti-Lebanon Mountains where wild goat would almost certainly have been especially abundant during the late

Pleistocene and early Holocene (see 6.2.3 above). However, the predominance of goat in the Period 2 to 3 faunal assemblage from Tell Aswad I-II, from the beginning of the site's occupation at c.9,800b.p. (Ducos 1993a), is more intriguing. The location of this site, just below the modern 200mm. p.a. isohyet close to the shoreline of the former Lake Aateibé in the Damascus Basin, would most probably have been outside, or at least on the extreme margins, of the late Pleistocene and early Holocene range of the wild goat (see 6.2.3 above). Although Period 1 faunal data from the Damascus Basin are lacking, zoogeographic evidence strongly suggests that the predominance of goat at Tell Aswad would at the very least have represented a marked increase in the frequency of goat in this area during the second half of Period 2 and potentially even the introduction of goat to an area lying outside its geographical range. Sheep, in contrast, were absent from all areas of the central Levantine Corridor until their appearance in extremely small numbers at Tell Aswad II during the second half of Period 3 (Ducos 1993a). Their frequency in the Damascus Basin seems to have steadily increased throughout the remainder of the second half of Period 3 at Ghoraife I, and more rapidly into Period 4 at Ghoraife II where sheep were the most common taxon, comprising c.50% of the faunal assemblage. This suggests that the central Levantine Corridor was outside the late Pleistocene and early Holocene range of mouflon and that sheep may have been introduced to Tell Aswad II during the second half of Period 3.

6.2.4.2: Southern Levantine Corridor:

The data in Table 6.4 suggest that there was a sudden increase in the frequency of caprines in faunal assemblages from the southern Levantine Corridor during Period 3. Although goats were present in most Period 1 and 2 faunal assemblages from this area, their frequency seems to have been extremely low, generally less than 10%, especially on the central and southern Jordan Valley floor. However, by Period 3 there had been a significant increase in the frequency of goat in all parts of the southern Levantine Corridor. Subsequently goat was the most common taxon in all faunal assemblages from this area, typically with frequencies in excess of 50%. With the exception of the questionable Period 2 and 3 data from Jericho (see 6.2.3 above) sheep were absent in all faunal assemblages predating Period 4 from the southern Levantine Corrior. However, during Period 4 sheep seem to have appeared in the area in significant numbers, typically in frequencies of c.30%. This suggests that the southern Levantine Corridor was outside the late Pleistocene and early Holocene range of mouflon and that sheep may have been introduced to the area during Period 4.

Site	Period	n	Hrb	C+O	Cpr	Ovi	Source
Fazael VI	1	120	68.3	3.7	3.7	absent	Tchernov 1993
Mallaha II-IV	1	687	100.0	6.1	6.1	absent	Bouchud 1987
Wadi Hammeh 27	1	212	90.6	7.8	7.8	absent	Edwards et al. 1988
Mallaha I	1	905	100.0	4.0	4.0	absent	Bouchud 1987
Salibiya I	1	370	86.5	1.6	1.6	absent	Crabtree et al. 1991
Ain Rahub	1	240	98.8	11.4	11.4	absent	Shiyab 1997
Beidha	1	139	98.6	16.4	16.4	absent	Hecker 1989
Gesher	2	65	93.9	absent	absent	absent	Horwitz and Garfinkel 1991
Gilgal I	2	21	62.0	absent	absent	absent	Noy et al. 1980
Netiv Hagdud	2	420	31.4	absent	absent	absent	Tchernov 1994
Jericho	2	548	74.1	4.9	3.8	1.1	Clutton-Brock 1979
Iraq ed Dubb	2	?	?	x	n.d.	n.d.	Kuijt et al. 1991
Munhatta	3	566	99.1	**33.3**	**33.3**	absent	Ducos 1968
Jericho	3	795	89.9	**54.3**	**52.0**	2.3	Clutton-Brock 1979
Beidha II-V	3	5141	98.4	**71.1**	**71.1**	absent	Hecker 1975
Beisamoun	4	78	97.5	**53.9**	**53.9**	absent	Davis 1978
Es-Sifiyeh	4	?	70.0	**100.0**	**64.3**	35.7	Mahasneh 1997
Basta	4	35192	99.7	**84.8**	**50.9**	33.9	Becker 1991
Wadi Fidan A	4	757	99.1	**90.8**	**63.3**	27.6	Richardson 1997
Wadi Fidan C	5	468	96.3	**47.0**	**33.6**	13.4	Richardson 1997

Taxa Codes: Hrb=% of major medium and large herbivores in n, C+O=total *Capra aegagrus*, *Capra hircus*, *Ovis orientalis* and *Ovis aries*, Cpr=*Capra aegagrus* or *Capra hircus*, Ovi=*Ovis orientalis* or *Ovis aries*

Quantitative Data: all % NISP execept: x= taxon present (excluded from n and % NISP calculations), X=most abundant taxon (excluded from n and NISP calculations), Bold Type=most common taxon in faunal assemblage (major medium and large herbivores only)

Table 6.4: Changes in Caprine Frequency between Periods 1 and 5
Southern Levantine Corridor

6.2.4.3: Woodland and Moist Steppe Zones to West of Southern Levantine Corridor:

The data in Table 6.5 suggests that there was a slight rise in the frequency of caprines in the woodland and moist steppe zones to the west of the southern Levantine Corridor during Period 3 and a much more significant increase during Period 4. Although goats were present in a number of Period 1 and 2 faunal assemblages from this area, their frequency seems to have been extremely low, generally less than 10%. Although it seems there was a slight rise in the frequency of goats in the area during Period 3, it should be noted that at this stage they were still greatly outnumbered by gazelle. However, there appears to have been a much more significant increase in the frequency of goat, to c.45%-55%, in the woodland and moist steppe zones to the west of the southern Levantine Corridor between Periods 3 and 4. Although the remains of mouflon have been identified in the Period 1 and 2 faunal assemblages from Hatoula in the southern Shefela, sheep appear to have been completely absent in elsewhere in the woodland and moist steppe zones to the west of the southern Levantine Corridor between Periods 1 and 5. It therefore seems probable that sheep were not introduced to the area until after the end of Period 5.

Site	Period	n	Hrb	C+O	Cpr	Ovi	Source
El Wad B	1	1474	93.2	0.2	0.2	absent	Garrard 1980
Kebara	1	327	64.5	absent	absent	absent	Saxon 1974
Rakefet	1	1002	95.5	0.9	0.9	absent	Garrard 1980
Abu Usba	1	?	?	x	x	absent	Stekelis and Haas 1952
Nahal Oren	1	1846	100.0	0.2	0.2	absent	Noy, Legge and Higgs 1973
Hayonim Cave	1	?	99.0	6.1	6.1	absent	Bar-Yosef and Tchernov 1966
Hatoula	1	89	76.4	x	absent	x	Davis 1985, Davis et al.1994
Hayonim Terrace	1	4572	98.9	0.5	0.5	absent	Henry et al. 1981
Shukbah	1	368	96.8	absent	absent	absent	Garrod and Bate 1942
Nahal Oren	2	516	100.0	3.1	3.1	absent	Noy, Legge and Higgs 1973
Hatoula	2	82	23.1	x	absent	x	Davis 1985, Davis et al.1994
Hatoula	2	72	37.5	x	absent	x	Davis 1985, Davis et al.1994
Rakefet	3	718	95.7	0.4	0.4	absent	Garrard 1980
Nahal Oren	3	570	100.0	13.9	13.9	absent	Noy, Legge and Higgs 1973
Yiftahel	3	?	15.0	15.0	15.0	absent	Horwitz 1987
Kfar Hahoresh	3	420	93.9	24.4	24.4	absent	Goring-Morris et al. 1995
Abou Gosh	4	3612	99.9	**56.0**	**56.0**	absent	Ducos 1978a
Atlit-Yam	4+5	322	99.8	**45.1**	**45.1**	absent	Galili et al. 1993

Taxa Codes: Hrb=% of major medium and large herbivores in n, C+O=total *Capra aegagrus*, *Capra hircus*, *Ovis orientalis* and *Ovis aries*, Cpr=*Capra aegagrus* or *Capra hircus*, Ovi=*Ovis orientalis* or *Ovis aries*

Quantitative Data: all % NISP execept: x= taxon present (excluded from n and % NISP calculations), X=most abundant taxon (excluded from n and NISP calculations), Bold Type=most common taxon in faunal assemblage (major medium and large herbivores only)

Table 6.5: Changes in Caprine Frequency between Periods 1 and 5

Woodland and Moist Steppe Zones to West of Southern Levantine Corridor

6.2.4.4: Dry Steppe and Sub-Desert Zones to East of Levantine Corridor:

The data in Table 6.6 demonstrate that caprines were absent from the dry steppe amd sub-desert zones to the east of the Levantine Corridor until Period 4, suggesting that the area lay outside the late Pleistocene and early Holocene range of both wild goat and mouflon. Although goats and sheep both seem to have appeared in the area in extremely low frequencies during Period 4, it was during Period 5 that there was a significant increase in the frequencies of sheep and, to a lesser extent, goats. Caprines were the most common taxon in most Period 5 faunal assemblages from the area, typically with frequencies well in excess of 50%. This suggests that goats and sheep had both been introduced to the area by the beginning of Period 5.

Site	Period	n	Hrb	C+O	Cpr	Ovi	Source
Azraq 18	1	290	99.0	absent	absent	absent	Martin 1994
Khallat Anaza	1	34	88.3	absent	absent	absent	Martin 1994
Wadi Jilat 7 1	3	317	42.9	absent	absent	absent	Martin 1994
Wadi Jilat 7 2-4	3	1080	57.5	absent	absent	absent	Martin 1994
Wadi Jilat 26	3	12	33.3	absent	absent	absent	Martin 1994
Wadi Jilat 7 5	3+4	89	46.1	absent	absent	absent	Martin 1994
Wadi Jilat 32	3+4	156	2.6	absent	absent	absent	Martin 1994
Azraq 31	4	56	89.3	4.0	n.d.	n.d.	Martin pers.comm.
Ibn el-Ghazzi	4	18	88.9	absent	absent	absent	Martin 1994
Dhuweila 1	4	2693	97.8	0.1	absent	0.1	Martin 1994
Azraq 31	5	1151	59.1	41.3	8.7	32.5	Martin pers.comm.
Wadi Jilat 13 1-3	5	2933	52.7	**52.0**	15.0	37.0	Martin 1994
Wadi Jilat 25 e-l	5	149	73.8	**91.9**	5.9	**85.9**	Martin 1994
Umm el Tlel 2	5	267	97.7	**75.8**	6.8	**69.1**	Helmer 1993
Qdeir I early	5	?	62.0	**100.0**	x	**X**	Stordeur 1993
El Kowm II Caracol	5	?	?	**X**	x	**X**	Stordeur 1989

Taxa Codes: Hrb=% of major medium and large herbivores in n, C+O=total *Capra aegagrus*, *Capra hircus*, *Ovis orientalis* and *Ovis aries*, Cpr=*Capra aegagrus* or *Capra hircus*, Ovi=*Ovis orientalis* or *Ovis aries*

Quantitative Data: all % NISP execept: x= taxon present (excluded from n and % NISP calculations), X=most abundant taxon (excluded from n and NISP calculations), Bold Type=most common taxon in faunal assemblage (major medium and large herbivores only)

Table 6.6: Changes in Caprine Frequency between Periods 1 and 5

Dry Steppe and Sub-Desert Zones to East of Levantine Corridor

6.2.4.5: Dry Steppe and Sub-Desert Zones to South and South-West of Levantine Corridor:

Site	Period	n	Hrb	C+O	Cpr	Ovi	Source
Rosh Horesha	1	990	98.7	x	absent	x	Butler et al. 1977,Davis et al. 1982
Rosh Zin	1	15	100.0	absent	absent	absent	Tchernov 1976
Wadi Judayid 2	1	193	98.8	**33.9**	absent	**33.9**	Henry and Turnbull 1985
El Khiam	2	134	100.0	absent	absent	absent	Ducos 1997
Abu Salem	2	1155	99.0	x	absent	x	Butler et al. 1977, Davis et al. 1982
Ramat Harif	2	632	100.0	x	absent	x	Goring-Morris 1987
Nahal Divshon	3	?	?	absent	absent	absent	Tchernov 1976
Nahal Issaron	4	?	?	absent	absent	absent	Goring-Morris and Gopher 1983
Wadi Tbeik	4	937	34.9	absent	absent	absent	Tchernov and Bar-Yosef 1982
Ujrat el-Mehed	4	2479	93.2	absent	absent	absent	Dayan et al. 1986

Taxa Codes: Hrb=% of major medium and large herbivores in n, C+O=total *Capra aegagrus*, *Capra hircus*, *Ovis orientalis* and *Ovis aries*, Cpr=*Capra aegagrus* or *Capra hircus*, Ovi=*Ovis orientalis* or *Ovis aries*

Quantitative Data: all % NISP execept: x= taxon present (excluded from n and % NISP calculations), X=most abundant taxon (excluded from n and NISP calculations), Bold Type=most common taxon in faunal assemblage (major medium and large herbivores only)

Table 6.7: Changes in Caprine Frequency between Periods 1 and 5

Dry Steppe and Sub-Desert Zones to South and South-West of Levantine Corridor

The late Pleistocene and early Holocene range of the Nubian ibex is known to have included large parts of the dry steppe and sub-desert zones to the south and south-west of the Levantine Corridor. As there is no evidence to suggest that the Nubian ibex and the wild goat have ever been sympatric it is most unlikely that wild goat would have been found in significant numbers in this area during the late Pleistocene and early Holocene (see 6.2.3 above). Furthermore, as none of the faunal assemblages listed in Table 6.7 have yielded identifiable horncores of either wild or domestic goat it seems probable that goats were not introduced to the area until after the end of Period 5. Although the remains of mouflon have been identified in a number of Period 1 and 2 faunal assemblages from the dry steppe and sub-desert zones to the south and south-west of the Levantine Corridor there is no evidence for the presence of sheep in the area between Periods 3 and 5. This suggests firstly that the presence of mouflon in this area was restricted to Periods 1 and 2, i.e.: the Pleistocene-Holocene boundary, and secondly that sheep were not introduced to the area until after the end of Period 5.

Unfortunately as one moves around the arc of the Fertile Crescent from the southern Levant into the northern Levant and Iraq-Iran the quantity and/or quality of published faunal data from Periods 1 to 5 (Periods 0 to 5 in the Zagros uplands; see Chapter 5) decreases. It is therefore more difficult to examine changes in caprine frequency in this vast and environmentally diverse area in detail and much of the dicussion below is based more on guesswork using the limited data available than hard evidence.

6.2.4.6: Taurus Piedmont and Upper Euphrates Valley:

Site	**Period**	**n**	**Hrb**	**C+O**	**Cpr**	**Ovi**	**Source**
Hallan Çemi	2	?	93.6	**52.1**	2.8	**49.4**	Rosenberg 1998
Çayönü Earlier	3	?	99.9	23.4	15.1	8.3	Lawrence 1982
Çayönü Upper	3	?	100.0	**81.3**	26.0	**55.3**	Lawrence 1982
Cafer Hoyuk	3	1628	85.0	**68.1**	**39.7**	28.4	Helmer 1991b

Taxa Codes: Hrb=% of major medium and large herbivores in n, C+O=total *Capra aegagrus*, *Capra hircus*, *Ovis orientalis* and *Ovis aries*, Cpr=*Capra aegagrus* or *Capra hircus*, Ovi=*Ovis orientalis* or *Ovis aries*
Quantitative Data: all % NISP execept: x= taxon present (excluded from n and % NISP calculations), X=most abundant taxon (excluded from n and NISP calculations), Bold Type=most common taxon in faunal assemblage (major medium and large herbivores only)

Table 6.8: Changes in Caprine Frequency between Periods 1 and 5

Taurus Piedmont and Upper Euphrates Valley

The rather limited data in Table 6.8 suggest that the Taurus Piedmont and upper Euphrates Valley was one of the ~~one the~~ areas of south-west Asia in which high frequencies of caprines between Periods 3 and 5. The predominance of sheep in the Period 2 faunal assemblages from Hallan Çemi is unsurprising, given the location of this site in the Taurus piedmont zone where mouflon would almost certainly have been especially abundant during the late Pleistocene and early Holocene (see 6.2.3 above). Rather more significant is the sharp increase in the frequency of sheep between the first and second halves of Period 3 at Çayönü, from 8.3% in the lower layers to 55.3% in the upper layers. Although wild goat was present in the Period 2 faunal assemblage from Hallan Çemi, its frequency was low. Although the frequency of goat at Çayönü did increase slightly between the first and second halves of Period 3, from 15.1% in the lower layers to 26.0% in the upper layers, and goats were the most common taxon in the Period 3 faunal assemblage from ~~from~~ Cafer Höyük, it is apparent that no really significant increase in the frequency of goat can be demonstrated in the Taurus Piedmont and upper Euphrates Valley with the limited faunal data available.

6.2.4.7: Northern Levantine Corridor and Central Euphrates Valley:

Site	Period	n	Hrb	C+O	Cpr	Ovi	Source
Abu Hureyra	1	154	91.3	11.8	absent	11.8	Legge 1975 and 1996
Mureybet Ia	1	1559	79.3	3.0	absent	3.0	Helmer 1991a
Nahr el Homr	2	227	99.9	absent	absent	absent	Clason and Buitenhuis 1975
Mureybet II	2	?	100.0	0.7	absent	0.7	Ducos 1978b
Mureybet III	2	?	100.0	5.8	absent	5.8	Ducos 1978b
Abu Hureyra 2A	3	1500	99.0	6.3	x	X	Legge 1975
Mureybet IVb	3	?	99.9	8.0	absent	8.0	Ducos 1978b
Tel Molla Assad	4	59	96.7	29.8	22.3	7.4	Clutton-Brock 1985
Gritille	4	1394	99.3	**76.6**	19.7	**57.0**	Stein 1989
Tell Assouad I-VI	4	616	99.4	**55.4**	**32.4**	23.0	Helmer 1985a
Abu Hureyra 2B	4	504	97.9	**72.0**	x	**X**	Legge 1975
Tell es-Sinn	4	590	99.7	**92.3**	32.0	**60.3**	Clason 1980
Hayaz Hoyuk	4	2215	99.1	**64.6**	31.6	**33.0**	Buitenhuis 1988
Bouqras	4	5015	99.9	**88.7**	37.8	**50.9**	Buitenhuis 1988
Abu Hureyra PN	5	341	99.0	**69.4**	x	**X**	Legge 1975

Taxa Codes: Hrb=% of major medium and large herbivores in n, C+O=total *Capra aegagrus*, *Capra hircus*, *Ovis orientalis* and *Ovis aries*, Cpr=*Capra aegagrus* or *Capra hircus*, Ovi=*Ovis orientalis* or *Ovis aries*

Quantitative Data: all % NISP execept: x= taxon present (excluded from n and % NISP calculations), X=most abundant taxon (excluded from n and NISP calculations), Bold Type=most common taxon in faunal assemblage (major medium and large herbivores only)

Table 6.9: Changes in Caprine Frequency between Periods 1 and 5

Northern Levantine Corridor and Central Euphrates Valley

The data in Table 6.9 suggest that there was a sudden increase in the frequency of caprines in faunal assemblages from the northern Levantine Corridor and central Euphrates Valley during Period 4. Although sheep were present in most Period 1, 2 and 3 faunal assemblages from this area, their frequency seems to have been extremely low, generally less than 10%. However, by the beginning of Period 4 there had been a sudden and significant increase in the frequency of sheep in all parts of the northern Levantine Corridor and central Euphrates Valley. Subsequently sheep tended to be the most common taxon in all faunal assemblages from this area, typically with frequencies in excess of 50%. Goats seem to have been absent from all faunal assemblages from the area which predate Period 4, with the exception of Abu Hureyra 2A where they were present in extremely low numbers during Period 3. However, by the beginning of Period 4 there has been a significant increase in the frequency of goat in the area, typically to c.30%. This suggests that the northern Levantine Corridor and central Euphrates Valley was outside the late Pleistocene and early Holocene range of wild goat and that goats may have been introduced to the area during Period 3.

6.2.4.8: Zagros Uplands:

Site	Period	n	Hrb	C+O	Cpr	Ovi	Source
Palegawra	0	2459	96.9	26.1	10.9	15.2	Turnbull and Reed 1974
Zarzi	0	12	?	X	X	absent	Garrod 1930
Warwasi	0	15	100.0	40.0	40.0	absent	Turnbull 1975
Ganj Dareh	3	29381	93.7	**98.1**	**87.6**	10.4	Hesse 1984
Tepe Asiab	3	1104	68.1	35.5	24.8	10.8	Bökönyi 1977
Tepe Guran	4+5	2420	?	X	X	x	Flannery 1967 cited in Hesse 1978
Tepe Sarab	5	7093	97.5	**84.5**	24.3	**60.2**	Bökönyi 1977

Taxa Codes: Hrb=% of major medium and large herbivores in n, C+O=total *Capra aegagrus*, *Capra hircus*, *Ovis orientalis* and *Ovis aries*, Cpr=*Capra aegagrus* or *Capra hircus*, Ovi=*Ovis orientalis* or *Ovis aries*
Quantitative Data: all % NISP execept: x= taxon present (excluded from n and % NISP calculations), X=most abundant taxon (excluded from n and NISP calculations), Bold Type=most common taxon in faunal assemblage (major medium and large herbivores only)

Table 6.10: Changes in Caprine Frequency between Periods 0 and 5
Zagros Uplands

Unfortunately the apparent abandonment of the Zagros Uplands between the beginning of Period 1 and the beginning of Period 3 (see 5.2) has meant that there is no continuous sequence of faunal data from the area with which to examine changes in caprine frequency. The limited data in Table 6.10 do however suggest that the Zagros Uplands was one of the areas of south-west Asia in which high frequencies of caprines between

Periods 3 and 5 had been preceded by high frequencies of caprines in earlier periods. The presence of varied but generally significant frequencies of wild goat in all Period 0 faunal assemblages from the area is unsurprising given that wild goats would almost certainly have been especially abundant in the Zagros Uplands during the late Pleistocene and early Holocene (see 6.2.3 above). However, there is evidence to suggest that by the time settlement in the Zagros uplands was re-established at beginning of Period 3 there had been a significant increase in the frequency of goat in at least some parts of the area. With a frequency of 87.6% goats were easily the most common taxon in the Period 3 faunal assemblage from Ganj Dareh, from the beginning of the site's occupation at c.9,000b.p.. Although sheep were present in a number of Period 0 and 3 faunal assemblages from the Zagros uplands, their frequency seems to have been low, generally less than 15%. Unfortunately quantitative faunal data from Period 4 is lacking, however evidence from Tepe Sarab, where sheep comprised 60.2% of the faunal assemblage and were the most common taxon, suggests that by Period 5 there had been significant increase in the frequency of sheep in at least some parts of the area, however their presence during Period 4 cannot be ruled out at the current stage of research.

6.2.4.9: Zagros Piedmont:

Site	Period	n	Hrb	C+O	Cpr	Ovi	Source
Shanidar Cave B2	1	?	?	**X**	**X**	x	Perkins 1964
M'lefaat	2	142	92.9	37.9	absent	37.9	Turnbull 1983
Karim Shahir	2	193	94.2	**68.2**	6.8	**61.4**	Stampfli 1983
Shanidar Cave B1	2	63	100.0	**100.0**	**57.1**	42.9	Perkins 1964
Zawi Chemi Shanidar	2	1221	100.0	**51.0**	7.1	43.9	Perkins 1964
Ali Kosh BM	3	1858	99.6	**72.1**	**72.1**	absent	Hole, Flannery and Neely 1969
Ali Kosh AK	4	4430	99.5	**60.5**	**59.1**	1.4	Hole, Flannery and Neely 1969
Jarmo	4+5	6642	98.1	**83.2**	**55.2**	27.9	Stampfli 1983
Ali Kosh MJ	5	1342	97.3	**53.9**	**40.9**	12.9	Hole, Flannery and Neely 1969
Tepe Tula'i	5	2576	98.2	**98.0**	**98.0**	absent	Hole 1974

Taxa Codes: Hrb=% of major medium and large herbivores in n, C+O=total *Capra aegagrus*, *Capra hircus*, *Ovis orientalis* and *Ovis aries*, Cpr=*Capra aegagrus* or *Capra hircus*, Ovi=*Ovis orientalis* or *Ovis aries*
Quantitative Data: all % NISP execept: x= taxon present (excluded from n and % NISP calculations), X=most abundant taxon (excluded from n and NISP calculations), Bold Type=most common taxon in faunal assemblage (major medium and large herbivores only)

Table 6.11: Changes in Caprine Frequency between Periods 1 and 5

Zagros Piedmont

The limited data in Table 6.11 suggest that the Zagros Piedmont was one of the areas of south-west Asia in which high frequencies of caprines between Periods 3 and 5 had been preceded by equally high frequencies of caprines during Periods 1 and 2. Goat was present in most Period 1 and 2 faunal assemblages from the area; although its frequency seems to have varied widely. From Period 3 onwards goat seems to have been present in high frequencies, generally in excess of 50%, in all faunal assemblages from the area and was typically the most common taxon. It should however be stressed that only one Period 3 faunal assemblage, i.e. Ali Kosh BM, has been published from the Zagros Piedmont. This apparent increase in the frequency of goat from Period 3 onwards may therefore be linked to the location of Ali Kosh outside the probable late Pleistocene and early Holocene range of mouflon. The fact that goat was the most common taxon in the Period 4/5 faunal assemblage from Jarmo, which is situated in an area potentially more suited to mouflon than wild goat, does however suggest that there may have been a significant increase in the frequency of goats in parts of the Zagros Piedmont during Period 4. The presence of sheep in high frequencies, typically in excess of 35%, in the Period 1 and 2 faunal assemblages from northern parts of the Zagros Piedmont is unsurprising, as mouflon would almost certainly have been especially abundant in this area during the late Pleistocene and early Holocene (see 6.2.3 above). However, mouflon seems to have been absent in the Period 3 faunal assemblage from Ali Kosh BM, which suggests that the Deh Luran plain lay outside its late Pleistocene and early Holocene range. During Period 4 sheep appeared on the Deh Luran plain for the first time at Ali Kosh AK, albeit in extremely low numbers, and during Period 5 their frequency increased to 12.9% at Ali Kosh MJ. This suggests that sheep may have been introduced to this part of the Zagros Piedmont during Period 4.

6.2.5: Size Change:

It has long been recognised that a degree of size reduction accompanied the domestication of caprines (Bökönyi 1969, Boessneck and von den Driesch 1978). As the wild or domestic status of caprines at late Pleistocene and early Holocene sites in south-west Asia is potentially uncertain, almost all analyses of caprine remains from these sites include some discussion of size change relative to other strata at the same site and/or to other sites in the vicinity. Notwithstanding the fact that there are a number of problems associated with the use of observed size reduction to identify early domesticates (see 6.2.2 above), a number of researchers (Uerpmann 1979, Helmer 1989, Legge 1996) have published reviews which draw together the results of some of these metrical analyses of caprine remains from late Pleistocene and early Holocene sites throughout south-west Asia. This section draws on the results of these reviews in an attempt to examine the geography and chronology of caprine size change more closely.

6.2.5.1: Uerpmann (1979):

Uerpmann (1979) employed a size-index method, using a modern adult female mouflon from western Iran and the average of a modern adult male and female wild goat from the Taurus Mountains as the respective standard animals, to examine size change in caprine remains from a series of south-west Asian faunal assemblages which date from the Palaeolithic to the Bronze Age. With regard to the late Pleistocene and early Holocene goat remains, the Epipalaeolithic period is represented by Jitta (Period 0) and Palegawra (Period 0), the Proto-Neolithic by Jericho (Period 2), Zawi Chemi Shanidar (Period 2), Karim Shahir (Period 2) and Tepe Asiab (Period 3), the Early Neolithic by Çayönü Lower-Upper (Period 3), Ganj Dareh A-E (Period 3), Asikli Höyük (Period 3) and Can Hasan III (Period 4), and the Pottery Neolithic by Tepe Sarab (Period 5), Hajji Firuz (Period 6) and Belt Cave (Period 6). With regard to the late Pleistocene and early Holocene sheep remains, the Epipalaeolithic period is represented by Palegawra (Period 0), the Proto-Neolithic by Mureybet II-III (Period 2), Zawi Chemi Shanidar (Period 2), Karim Shahir (Period 2) and Tepe Asiab (Period 3), the Early Neolithic by Çayönü Lower-Upper (Period 3), Askili Höyük (Period 3), Can Hassan III (Period 4) and Bouqras (Period 4), and the Pottery Neolithic by Tepe Sarab (Period 5), Hajji Firuz (Period 6) and Belt Cave (Period 6).

This review suggested that although there was no significant size change in either goat or sheep remains from these faunal assemblages through the late Palaeolithic, Epipalaeolithic and Proto-Neolithic periods (Period 2 and first half of Period 3), by the Early Neolithic period (i.e.: second half of Period 3 and Period 4) both taxa had undergone a significant episode of size reduction which continued into the Pottery Neolithic (Periods 5 and 6). However, as Legge (1996, p.241) has previously noted, there are a number of problems with Uerpmann's (1979) review. Some of the samples of caprine remains are rather small and, more problematically, combine material from sites which are widely separated in time and space into a single sample for each of the main periods. Consequently, it seems highly probable that both wild and domestic caprines are represented in the important Early Neolithic samples, for example: "it is likely, on the basis of their large size, that the goat bones from Askili Höyük and

Çayönü (early levels) are from wild animals, whereas those from Ganj Dareh are domestic" (Legge 1996, p.241).

6.2.5.2: Helmer (1989):

Helmer (1989), in his review of size change in caprine remains from 15 south-west Asian sites dating from Period 3 to Period 5, employed a log-ratio method using specimens of wild goat and mouflon from Cafer Höyük as standard animals, but in contrast to Uerpmann (1979) examined the data from each site separately. Although this approach reduced already small sample sizes still further, some consistent patterns emerged in the results which add important chronological and geographical detail to Uerpmann's conclusion that goats and sheep underwent an episode of significant size reduction in south-west Asia during Period 3 and 4. Helmer's (1989) review is especially valuable because it focuses primarily on the comparatively under-explored northern Levant. The results of Helmer's (1989) review are summarised in Tables 6.12 and 6.13 for goats and sheep respectively. The size range of samples are described relative to each other and to modern reference material in the comments column: 'large' for samples in the size-range of modern wild caprines, and 'small' and 'very small' for samples in the size range of modern domestic caprines.

1) Goats: Helmer's reveiw of late Pleistocene and early Holocene goat remains from south-west Asia demonstrated that although the goat remains from Tepe Asiab (first half of Period 3) and Cafer Höyük (second half of Period 3) were large and almost certainly represent wild animals, those from Ganj Dareh A-E (second half of Period 3), Tell Assouad I-VI (Period 4), Bouqras (Period 4), Tepe Sarab (Period 5), Qdeir 1 (Period 5) and El Kowm 2 Inf-Sup (Period 5) were significantly smaller and almost certainly represent domesticates. The measurements from Beidha (second half of Period 3), Ras Shamra VC1 (Period 4) and Abou Gosh (Period 4) displayed a large range of variation, with a numerical bias towards the smaller end of the range, which overlapped the samples of wild and domestic goats described above (Helmer 1989, Fig.8 and Fig.9). These samples have previously been interpreted as representing morphological wild animals, subject to cultural control (Hecker 1975) or proto-élevage (Ducos 1978a) in the form of selective culling of young males. However, Helmer presents strong evidence to suggest that the majority of specimens in these samples represent fully domestic goats: "il indique clairement qu'il s'agit d'un mélange de domestiques et de sauvages et, qu'en fait, la majorité des restes appartient à des animaux élevés. Le "cultural control" de Hecker est en réalité une domestication vraie remontant à la fin de la période 3" (Helmer 1989, p.117).

Helmer (1989) has thus demonstrated that goats had undergone a significant size reduction in parts of the Zagros Mountains and southern Levantine Corridor by the second half of Period 3. Goats of this smaller size seem to have appeared in the the woodland and moist steppe zones to the west of the northern and southern Levantine Corridor by Period 4 and in the dry steppe and sub-desert zones to the east of the northern Levantine Corridor by Period 5.

Site	Period	Area	Size	Comments
Tepe Asiab	3	ZU	wild	Large
Ganj Dareh (E)	3	ZU	domestic	Small
Ganj Dareh (A)	3	ZU	domestic	Small
Cafer Höyük	3	EV	wild	Large
Beidha	3	SJ	domestic	Small with a few large specimens
Tell Assouad (I-VI)	4	EV	domestic	Small
Bouqras	4	EV	domestic	Small
Ras Shamra VC1	4	SC	domestic	Small with a few large specimens
Abou Gosh	4	CP	domestic	Small with a few large specimens
Tepe Sarab	5	ZU	domestic	Small
Qdeir 1	5	KB	domestic	Small
El Kowm 2 (inf)	5	KB	domestic	Small
El Kowm 2 (sup)	5	KB	domestic	Small

Table 6.12: Summary of the Results of Helmer's (1989) Review of Size Change in Goats in South-West Asia during the Early Holocene

2) Sheep: Helmer's reveiw of late Pleistocene and early Holocene sheep remains from south-west Asia demonstrated that although the Period 3 sheep remains from Tepe Asiab, Ganj Dareh A-E, Mureybet IVB and Asikli Höyük were large and almost certainly represent wild animals, the Period 4 and 5 sheep remains from Tell Assouad I-VI, Bouqras, Tell es Sinn, Ras Shamra VC1, Qdeir 1 and El Kowm 2 Inf-Sup were significantly smaller and almost certainly represent domesticates. The remains of probable domestic sheep in the latter group of faunal assemblages fall into two size categories, with smaller specimens at the earlier sites of Tell Assouad I-VI (Period 4), Ras Shamra VC1 (Period 4) and larger specimens at the rather later sites of Bouqras (Period 4), Tell es Sinn (Period 4), Qdeir 1 (Period 5), all located in the dry steppe and sub-desert zones to the east of the northern Levantine Corridor. The sheep remains from the Period 5 site of El Kowm 2 seem to have undergone a progressive size reduction from the latter to the former category between the earlier and later phases of occupation. Helmer has suggested that "la différence peut être due à un degré d'évolution plus avancé pour le groupe Assouad-Ras Shamra VC1. Cette hypothèse implique une colonisation du désert par des éleveurs de chèvres qui auriaent domestiqué plus tardivement, et sur place, le mouflon" (Helmer 1989, p.115).

Helmer (1989) has thus demonstrated that sheep had undergone a significant size reduction in moister parts of the central Euphrates Valley and woodland and moist steppe zones to the west of the northern Levantine Corridor by Period 4. In the more arid areas of the central Euphrates Valley and in the dry steppe and sub-desert zones to the east of the northern Levantine Corridor it seems that although sheep had undergone some size reduction by Period 4, it was not until Period 5 that they were of the same small size as the Period 4 sheep remains from further to the west. "Sa forte stature dans les sites PPNB proches du désert, Bouqras, Qdeir, es Sinn et El Kowm 2, pourrait y être, en revanche, l'indice d'une domestication tardive en regard des zones plus tempérées comme le littoral ou la Djezireh. Si cela s'avérait vrai, la zone d'origine serait à rechercher ici aussi dans les collines et montagnes bordant le croissant fertile" (Helmer 1989, p.118).

Site	Period	Area	Size	Comments
Tepe Asiab	3	ZU	wild	Large
Ganj Dareh (A-E)	3	ZU	wild	Large
Cafer Höyük	3	TP	wild	Large
Mureybet (IVB)	3	EV	wild	Large
Asikli Höyük	3	AP	wild	Large
Tell Assouad (I-VI)	4	EV	domestic	Very small
Bouqras	4	EV	domestic	Small
Tell es Sinn	4	EV	domestic	Small
Ras Shamra (VC1)	4	SC	domestic	Very small
Qdeir 1	5	KB	domestic	Small
El Kowm 2 (inf)	5	KB	domestic	Small
El Kowm 2 (sup)	5	KB	domestic	Very small

Table 6.13: Summary of the Results of Helmer's (1989) Review of Size Change in Sheep in South-West Asia during the Early Holocene

6.5.2.3: Legge (1996):

The most comprehensive review to date of size change in late Pleistocene and early Holocene caprine remains from south-west Asia is that of Legge (1996). This study includes a detailed discussion of the problems involved in the use of observed size reduction to identify early domesticates and highlights the difficulties encountered when attempting to make comparisons between faunal assemblages which have all too often been analysed by different researchers using different methodologies. Legge employed both a log-ratio method and direct comparisons of individual measurements on various skeletal elements to examine caprine size change at 16 south-west Asian sites dating from Period 1 to Period 5 and like Helmer (1989) examined the data from each site separately. Although Legge's (1996) review discusses some of the data previously reviewed by Helmer (1989) and, in each instance, presents the same interpretation of these data, it includes significantly more data from the southern Levant which add important chronological and geographical detail. The results of Legge's review of size change in caprines in south-west Asia during the late Pleistocene and early Holocene are summarised in Tables 6.14 and 6.15 for goats and sheep respectively. The size range of samples are described relative to each other and to modern reference material in the comments column: 'large' for samples in the size-range of modern wild caprines, and 'small' and 'very small' for samples in the size range of modern domestic caprines.

1) Goats: Legge's (1996) review of late Pleistocene and early Holocene goat remains from south-west Asia demonstrated that the goat remains from Wadi Judayid 2 (Period 1), Tepe Asiab (first half of Period 3), Cayönü Lower (first half of Period 3), Asikli Höyük (second half of Period 3) and Cafer Höyük (second half of Period 3) were large and probably represent wild animals. However, it seems that goats had undergone a significant size reduction in the central Levantine Corridor (Tell Aswad) by the second half of Period 2 and in parts of the southern Levantine Corridor (Jericho, Beidha), Zagros Mountains (Ganj Dareh A-E), Taurus Piedmont/upper Euphrates Valley (Cayönü Upper) and central Euphrates Valley (Abu Hureyra 2A) by the second half of Period 3. The inclusion of the goat remains from Cayönü and Abu Hureyra 2A, which were not discussed by Helmer (1989), in Legge's (1996) review therefore provides important evidence for the presence of goats of this smaller size in parts of the Taurus Piedmont/upper Euphrates Valley and central Euphrates Valley during the second half of Period 3.

Site	Period	Area	Size	Comments
Wadi Judayid 2	1	SJ	Wild	Large
Tell Aswad	2+3	DB	Domestic	Small
Tepe Asiab	3	ZU	Wild	Large
Ganj Dareh (A-E)	3	ZU	Domestic	Small
Asikli Höyük	3	AP	Wild	Large
Çayönü (lower)	3	TP	Wild	Large
Çayönü (upper)	3	TP	Domestic	Small
Abu Hureyra 2A	3	EV	Domestic	Small
Cafer Höyük	3	EV	Wild	Large
Jericho	3	JV	Domestic	Small
Beidha	3	SJ	Domestic	Very small
Ghoraife	3+4	DB	Domestic	Small
Gritille	4	EV	Domestic	Small
Abu Hureyra 2B	4	EV	Domestic	Small
Tell Ramad	4	DB	Domestic	Small
Basta	4	SJ	Domestic	Small
Tepe Sarab	5	ZU	Domestic	Small

Table 6.14: Summary of the Results of Legge's (1996) Review of Size Change in Goats in South-West Asia during the Late Pleistocene and Early Holocene

2) Sheep: Legge's analysis of late Pleistocene and early Holocene sheep remains from south-west Asia demonstrated that the sheep remains from Wadi Judayid 2 (Period 1), Tepe Asiab (first half of Period 3), Cayönü Lower (first half of Period 3), Ganj Dareh A-E (second half of Period 3), Asikli Höyük (second half of Period 3) and Cafer Höyük (second half of Period 3) were large and probably represent wild animals. However, it seems that sheep had undergone a significant size reduction in the Taurus Piedmont/upper Euphrates Valley (Cayönü Upper) and the central Euphrates Valley (Abu Hureyra 2A) by the second half of Period 3. In the southern Levantine Corridor the situation remains somewhat confusing. Although Legge has argued that the four measurable sheep bones from Jericho (second half of Period 3) were of this smaller size, the provenance of this sample is unreliable (e.g.: Tchernov 1994, p.74) and is in any case too small to provide any conclusive evidence for size reduction. The earliest reliable evidence for the presence of sheep remains of this small size in the southern Levantine Corridor comes from Basta and dates to Period 4. By Period 5 similarly sized sheep were also present in parts of the Zagros Mountains (Tepe Sarab). The inclusion of the sheep remains from Cayönü and Abu Hureyra 2A, which were not discussed by Helmer (1989), in Legge's (1996) review therefore provides important evidence for the presence of sheep of this smaller size in parts of the Taurus Piedmont/upper Euphrates Valley and central Euphrates Valley during the second half of Period 3.

Site	Period	Area	Size	Comments
Wadi Judayid 2	1	SJ	Wild	Large
Tepe Asiab	3	ZU	Wild	Large
Ganj Dareh (A-E)	3	ZU	Wild	Large
Asikli Höyük	3	AP	Wild	Large
Çayönü (lower)	3	TP	Wild	Large
Çayönü (upper)	3	TP	Domestic	Small
Abu Hureyra 2A	3	EV	Domestic	Small
Cafer Höyük	3	EV	Wild	Large
Jericho	3	JV	Domestic	Small
Abu Hureyra 2B	4	EV	Domestic	Small
Basta	4	SJ	Domestic	Small
Tepe Sarab	5	ZU	Domestic	Small

Table 6.15: Summary of the Results of Legge's (1996) Review of Size Change in Sheep in South-West Asia during the Late Pleistocene and Early Holocene

6.5.2.4: Other Data:

Horwitz (1989) and Bar-Yosef and Meadow (1995) have discussed some important additional data relating to size change in early Holocene caprines from the woodland and moist steppe zones to the west of the southern Levantine Corridor and the Zagros Piedmont respectively. Horwitz has argued that there is no evidence for size reduction in goat remains dating to Period 3 from Yiftahel and to Periods 4 and 5 from Atlit Yam, whereas Bar-Yosef and Meadow have noted that the Period 4 and 5 sheep remains from Jarmo (Stampfli 1983) are similar in size to those from Cayönü in that the "bones come from relatively small animals" (Bar-Yosef and Meadow 1995, p.89), although it is unclear whether the earlier or later sheep remains from Cayönü are being referred to.

6.2.6: Population Structure:

A potential difference between wild and domestic caprine populations is that in wild populations mortality patterns tend to be dictated by a variety of natural factors, whereas in domestic populations they tend to be dictated by humans who may manipulate the population structure in order to maximise the economic return. Specifically, "a maximum return (of carcass weight) on feed is obtained by slaughtering shortly before an animal reaches maturity. For sheep and goats this may be between 6 and 12 months, and the juveniles are often the males not required for stud purposes, the females (mostly) being kept longer for reproduction" (Davis 1987, p.150). Consequently, the presence of high frequencies of both immature bones and adult female bones in a faunal assemblage is commonly used to support claims for the presence of domestic caprines. Unfortunately there are a number of serious problems with the use of population structures to support claims for the presence of domesticates (see 6.2.2 above) and as a result any such claims which are not supported by other lines of evidence should be treated with a high degree of caution. For the purposes of this study it was therefore not felt worthwhile to review the population structures of all late Pleistocene and early Holocene faunal assemblages from south-west Asia, as any claims for the presence of domestic caprines made on this basis would have to be supported by other more reliable lines of evidence which have already been reviewed in detail. However Legge (1996), in his review of size change in late Pleistocene and early Holocene caprine remains from south-west Asia, also reviewed some additional data on the population structures of some of these remains with which he supported arguments for the presence or absence of domesticates which were based on size change. This section therefore briefly summarises, in Tables 6.16 and 6.17 for goats and sheep respectively, the data reviewed by Legge (1996) in order to illustrate the population structures associated with early Holocene caprine remains interpreted as wild or domestic on the basis of other lines of evidence, especially size.

1) Goats: The data in Table 6.16 suggest that the population structures, i.e.: age and sex ratios, typically associated with domestic goats seem to have occurred in parts the central Levantine Corridor (Tell Aswad) by Period 2 and in parts of the southern Levantine Corridor (Beidha), northern Levantine Corridor/central Euphrates Valley (Abu Hureyra 2A) and Zagros Uplands (Ganj Dareh A-E) by Period 3 (but see below).

2) Sheep: Less data on population structures is available for sheep than goats, primarily because the less extreme sexual dimorphism in sheep makes is more difficult to estimate sex ratios on the basis of measurements. However, the data in Table 6.17 suggest that the population structures, i.e.: age and sex ratios, typically associated with domestic sheep seem to have occurred in parts the northern Levantine Corridor/central Euphrates Valley (Abu Hureyra 2A) by Period 3 (but see below).

Site	Period	Area	Size	Age/Sex data
Tell Aswad	2+3	DB	Domestic	Peak in mortality between 1 and 2 years; bias to smaller females evident in measurements of fused bone
Tepe Asiab	3	ZU	Wild	18% killed before maturity
Ganj Dareh (A-E)	3	ZU	Domestic	70% killed before maturity; preferential cull of juvenile males evident in measurements of unfused bone; bias to smaller females in measurements of fused bone
Asikli Höyük	3	AP	Wild	Peak in mortality between 1 and 3 years in combined sample of goats and sheep
Çayönü (l+u)	3	TP	Wild+Dom	35% killed before maturity in combined sample of goats and sheep from lower and upper strata
Abu Hureyra 2A	3	EV	Domestic	30%-40% killed before 18-24 months; c.65% killed before 3 years; bias to smaller females evident in measurements of fused bone
Cafer Höyük	3	EV	Wild	No bias to smaller females evident in measurements of fused bone
Beidha	3	SJ	Domestic	60% killed before 2 years
Gritille	4	EV	Domestic	65% killed before 3 years in combined sample of goats and sheep
Abu Hureyra 2B	4	EV	Domestic	30%-40% killed before 18-24 months; c.65% killed before 3 years; bias to smaller females evident in measurements of fused bone
Tepe Sarab	5	ZU	Domestic	33%-40% killed before maturity

Table 6.16: Summary of Legge's (1996) Review of the Population Structure of Late Pleistocene and Early Holocene Goat Remains from South-West Asia

Site	Period	Area	Size	Age/Sex data
Asikli Höyük	3	AP	Wild	Peak in mortality between 1 and 3 years in combined sample of goats and sheep
Çayönü (l+u)	3	TP	Wild+Dom	35% killed before maturity in combined sample of goats and sheep from lower and upper strata
Abu Hureyra 2A	3	EV	Domestic	30%-40% killed before 18-24 months; c.65% killed before 3 years
Gritille	4	EV	Domestic	65% killed before 3 years in combined sample of goats and sheep
Abu Hureyra 2B	4	EV	Domestic	30%-40% killed before 18-24 months; c.65% killed before 3 years

Table 6.17: Summary of Legge's (1996) Review of the Population Structure of Late Pleistocene and Early Holocene Sheep Remains from South-West Asia

Although it appears from the data in Tables 6.16 and 6.17 that there seems to be a general tendency for juvenile mortality and the proportion of adult females to be higher in caprine populations interpreted as domestic on the basis of other lines of evidence, there is also considerable variation in juvenile mortality rates between the various domestic populations as well as an overlap in juvenile mortality rates between wild and domestic. Juvenile mortality in the domestic goat populations reviewed by Legge (1996) ranges from 33%-40% at Tepe Sarab to c.70% at Ganj Dareh, whereas in the wild goat populations reviewed by Legge (1996) it ranges from 18% at Tepe Asiab to a peak in mortality between one and three years at Asikli Höyük. This provides further evidence of the potential ambiguities inherent in caprine population structures.

6.2.7: Morphology:

Caprines are known to have undergone various morphological changes with domestication, of which those affecting horncores are generally considered to be the most useful in distinguishing between wild and domestic populations. Numerous criteria relating to horncore morphology have been used to support claims for the presence of domestic caprines at early Holocene sites in south-west Asia, however there are a number of problems with their use. These have been succinctly summarised by Meadow: "the difficulty is that a number of factors are operating: for example, change in population distributions and in horncore morphology through many generations, inter-individual variation, and inter-individual age and nutrition-related changes. Thus there are problems of space, deep time, and shallow time and any truly satisfactory resolution will involve defining trends in horncores from narrowly defined regions covering extensive periods of time" (Meadow 1989b, p.34). Unfortunately in south-west Asia this has only been seriously attempted in four areas: the Kermanshah valley (Bökönyi 1977) in the Zagros Uplands, the Deh Luran plain (Hole, Flannery and Neely 1969) and Jarmo (Stampfli 1983) in the Zagros Piedmont, and Jericho in the Jordan Valley (Zeuner 1955 and 1963, Clutton-Brock 1971 and 1979). An additional problem with examining morphological change in caprine horncores, especially those of sheep, is that these elements tend to be poorly preserved in comparison with post-cranial material, which raises the possibility that they may not be representative of the population as a whole.

This section therefore describes the horncores of wild goat and mouflon, discusses some of the morphological changes which are thought to have occurred with domestication and attempts to summarise where and when these changes have been documented in south-west Asia during the late Pleistocene and early Holocene. Heavy use had been made of Grigson's (1996) detailed review of caprine horncore morphology.

6.2.7.1: Wild Goat Horncore Morphology:

The horncores of modern adult male wild goats are typically described as being long, curved backwards in a scimitar shape with thick solid walls, pronounced antero-lateral compression and a sharp anterior keel, the angle of which tends to be 45° or less (Zeuner 1955, Flannery 1969, Hecker 1975, Bökönyi 1977, Stampfli 1983, Davis 1987, Uerpmann 1987, Gautier 1990, Harrison and Bates 1991). The antero-lateral surface is usually flat or concave and is separated from the postero-lateral surface by a distinct rounded angle which merges into the rounded or indistinctly angular posterior surface. The medial surface tends to be broken by a moderate angle about half way between the anterior and posterior surfaces. These characteristics give rise to a characteristic quadrangular or diamond-shaped cross-section. The horncores of modern adult female wild goats are much less diagnostic than those of adult males and are typically described as being much smaller, with minimal antero-lateral compression, a symmetrical almond-shaped or elliptical cross-section and a rounded rather than keeled anterior surface (Zeuner 1955, Hecker 1975, Bökönyi 1977, Harrison and Bates 1991).

6.2.7.2: Changes in Goat Horncore Morphology Associated with Domestication:

Although it seems certain that the morphology of goat horncores underwent significant changes during the domestication process, with the result that modern domestic goat horncores can relatively easily be distinguished from those of wild goat, the horncore morphology of early Holocene goats in the early stages of domestication is extremely confusing. Almost all of the criteria which have been used to support claims for the presence of domestic goats have also been documented in modern wild goat populations and/or in early Holocene populations interpreted as wild on the basis of non-morphological criteria. These include changes in size, rounding of cross-sections, medial flattening and the appearance of twisting.

The horncores of male goats seem to have undergone significant size reduction during domestication (Bökönyi 1977, Clutton-Brock 1979 and 1987, Gautier 1990, Reed 1960, Stampfli 1983). However, the length and diameter of wild and domestic male goat horncores are both known to be significantly affected by the age of the animal (Harrison and Bates 1991, Grigson 1996). The resulting high degree of variability in horncore size raises the possibility of overlap between wild and domestic populations and makes size reduction of horncores a potentially unreliable criterion on which to base a claim for the presence of domestic goats. Furthermore, although it is known that the horncores of modern adult male domestic goat horncores are smaller than those of modern adult male wild goats, they are still larger than those of modern wild or domestic females (Bökönyi 1977). In contrast, the horncores of female goats seem to have become longer with domestication (Clutton-Brock 1979 and Bökönyi 1977).

Another morphological criterion which has been used to support claims for the presence of domestic goats is deviation from the quadrangular cross-section typically associated with male wild goat horncores, whether in the form of rounding to a symmetrical lozenge/almond shape or medial flattening (Zeuner 1955 and 1963, Reed 1959 and 1960, Bökönyi 1977, Clutton-Brock 1979, Smith 1995). However, Hole, Flannery and Neely (1969) and Bökönyi (1977) have both described modern male wild goat horncores with more rounded than quadrangular cross-sections, although Hole, Flannery and Neely (1969) claimed that regardless of the overall cross-section wild male goats always have a convex medial surface up to a third of the way up from the base. These data suggest that "male scimitar-shaped horncores of both quadrate and almond-shaped cross-section, as well as intermediate forms, were present in almost all sites and should be regarded as two extremes of a natural range of variation, regardless of their presumed wild or domestic status" (Grigson 1996, p.6). The appearance of medially flattened goat horncores in the Period 4 faunal assemblage from Ali Kosh AK, following their absence at Ali Kosh BM during Period 3, has been used to support claims for the appearance of domestic goats at this time (Hole, Flannery and Neely 1969). However, an extremely large goat horncore with an almost plano-convex cross-section from Period 3 strata at Jericho which was originally described as domestic on the basis of its cross-section by Zeuner (1963) has been re-interpreted by Clutton-Brock (1971) and Stampfli (1983) as wild on the basis of its size. Similarly large goat horncores with rounded cross-sections and medial flattening which date to Period 4 have also been found at Jarmo. These were likewise originally interpreted as domestic on the basis of their cross-sections by Reed (1960), but have been re-interpreted as wild on the basis of their size by Stampfli (1983) who concedes that they may belong a distinct breed or sub-species of wild goat, i.e.: the 'Jarmo wild goat'. The use of changes in cross-section of goat horncores to support claims for the presence of domesticates is therefore problematic. In male wild goats there seems to be a "continuous range of variation in the shape of the cross-section, from quadrate to medially-flat, and there is no one character that reliably indicates domestication" (Grigson 1996, p.7). The cross-section of female goat horncores appears to have changed relatively little with domestication, typically remaining almond-shaped with a rounded anterior edge. However, some medial flattening has been documented in Period 3 female goat horncores from Ganj Dareh (Hesse 1978).

Corkscrew-type twisting of both male and female horncores has long been considered to be a reliable indicator of domestication. Although this was the typical form at many Chalcolithic and Bronze Age sites throughout south-west Asia (Grigson 1996), it is unclear if this extreme twisting was commonly found in the earliest stages of goat domestication. Although claims have been made for the presence of a small number of goat horncores with corkscrew-type twisting in Period 3 strata at Jericho (Clutton-Brock 1979), these would be unique during this period in south-west Asia and "one does wonder whether their presence...might be explained by contamination from the later levels of the site" (Grigson 1996, p.8). Less extreme twisting has been widely used to support claims for the presence of early domestic goats, at Tepe Sarab (Bökönyi 1977) and Ali Kosh MJ (Hole, Flannery and Neely 1969) during Period 5, and at Hajji Firuz during Period 6 (Meadow 1983). However, slight twisting has also been described in Period 3 wild goat horncores from Tepe Asiab (Uerpmann quoted in Gautier 1990). Following a detailed review of the evidence, Grigson concluded that "while true screw horned goats may have appeared for the first time in the sixth millennium, it seems that they did not become common until the Chalcolithic in the late fifth or early fourth millennium b.c." (Grigson 1996, p.8). This suggests that corkscrew-type twisting may be a reliable indicator of an advanced stage of domestication.

It is therefore clear that no single marker of domestication in goat horncores exists. As flattening and twisting occur independently of each other in the Period 4 and 5 goat horncores from Jarmo (Reed 1960) it may well be that the various criteria which have been used to support claims for the presence of domestic goats are controlled by separate genes. Some of these criteria have been identified in goat horncores from sites where non-morphological data suggest that the populations were domestic. However, as many of these criteria have also been identified in goat horncores thought to represent wild populations ~~be~~ on the basis of non-morphological data a high degree of caution is x called for in their use to support claims for the presence of domestic goats. However, there is some evidence to suggest that goat horncores may have undergone some of the morphological changes generally associated with domestication by Period 3 at Ganj Dareh (Hesse 1978) and Jericho (Zeuner 1955, Clutton-Brock 1979), by Period 4 at Ali Kosh AK (Hole, Flannery and Neely 1969) and Jarmo (Stampfli 1983), and by Period 5 at Tepe Sarab (Bökönyi 1977). Some additional data relating to the southern Levant has been discussed by Horwitz (1989), who argued that there is no evidence for morphological changes generally associated with domestication in goat horncores dating to Period 3 from Beidha and Beisamoun, to Period 4 from Abou Gosh and to Periods 4 and 5 from Atlit Yam.

6.2.7.3: Mouflon Horncore Morphology:

The horncores of modern adult male mouflon are typically described as being thick, robust, widely divergent and arcuate (Gautier 1990, Harrison and Bates 1991). The horns of male sheep have evolved more for strength than those of male wild goats, owing to the more antagonistic fighting between rival males which characterises sheep in general (Clutton-Brock et al. 1990). Consequently, the anterior surface of adult male mouflon horncores tends to be broader than the posterior surface and the sinuses are generally greatly reduced. Both characteristics confer strength on the horncore, the basal area of which has to bear the brunt of impact during butting (Reed and Schaffer 1972). The basal cross-sections of adult male mouflon horncores tend to be roughly triangular, with flat or slightly convex medial and anterior surfaces and a more strongly convex or even angled lateral surface. The posterior surface is generally sharply convex (Bökönyi 1977, Hole, Flannery and Neely 1969, Meadow 1989b, Valdez 1982 and Stampfli 1983). Less data is available on the horncores of female mouflon, which in modern populations seem to range from being completely hornless to having relatively well developed horns, although these are always far smaller than those of males (Hole, Flannery and Neely 1969, Boessneck and von den Driesch 1979, Stampfli 1983, Gautier 1990, Harrison and Bates 1991). The cross-sections of modern and Period 4 female mouflon horncores from Jarmo published by Stampfli (1983) are all small, generally symmetrical and roughly oval in shape. The posterior surface on some of these specimens is more sharply convex than the anterior surface. Data published by Clutton-Brock et al. (1990) on the horncores of modern female Soay sheep from Hirta may well apply to female mouflon and are therefore presented here. The female Soay sheep were shown to be much more variable in their horncore morphology than males, with hornless and fully horned conditions being "the extremes in a range of structures, covering a continuum of horn and horn-like structures" (Clutton-Brock et al. 1990, p.13). Where present, the female Soay horncores typically had sharp keel shaped anterior and posterior surfaces and were flattened medio-laterally.

Unfortunately mouflon seem to be particularly prone to massive variation in horncore morphology, particularly between eastern and western population groups (Meadow 1989b). The form of modern male mouflon horncores can vary from curving laterally in a single supracervical plane to curving round to form a circle at the side of the head (Harrison and Bates 1991). Similarly extensive variation has been documented in the cross-sections of modern mouflon horncores. Modern adult male Armenian mouflon horncores typically have rounded fronto-orbital edges and frontal surfaces, with sharp fronto-nuchal edges, whereas those of modern adult male Laristani mouflon typically have flat frontal surfaces with sharp angles (Valdez 1982). The cross-sections of early Holocene mouflon horncores published by Bökönyi (1977), Hole, Flannery and Neely (1969), Meadow (1989b) and Stampfli (1983) also exhibit extensive inter and intra-site variation. In addition, Stampfli (1983) has shown that the size and morphology of modern male mouflon horncores change considerably with age and describes modern juvenile mouflon which have much flatter horncores than adults.

6.2.7.4: Changes in Sheep Horncore Morphology Associated with Domestication:

Although it seems certain that the morphology of sheep horncores underwent significant changes with domestication, these are even more poorly understood than those affecting goat horncores. The limited data available suggests that a substantial overlap between wild and domestic forms can be expected. Bökönyi (1977) concluded that Period 5 and 9 domestic male sheep horncores from Tepe Sarab, Tepe Siahbid and Tepe Dehsavar were very similar to those of male wild sheep, differing from them only in size. Similarly, with the exception of a reduction in size, Stampfli (1983) was unable to describe any characteristic typical of domestication in sheep during Periods 4 and 5 at Jarmo.

There is some evidence to suggest that the broad, flattened anterior surface characteristic of adult male mouflon horncores, which conferred strength on the horns, gave way to a more rounded anterior surface in domesticates. Zeuner (1963) and Hole, Flannery and Neely (1969) have both suggested that this weakening of the horncore base caused the horncores of domestic sheep to drop away to the side of the skull instead of rising steeply. Hole, Flannery and Neely (1969) have described Period 4 and 5 sheep horncores from Ali Kosh with this weakened cross-section and interpreted them as domestic on this basis.

Hornlessness in female sheep has long been considered a reliable indicator of domestication in female sheep. A single hornless sheep skull was found at Ali Kosh BM (Period 3) and was used to support claims for the presence of domestic sheep at the site at this time (Hole, Flannery and Neely 1969). However, this condition has been documented in modern wild female mouflon and Soay sheep, although it is generally considered to be rare (Grigson 1996). A single hornless sheep specimen dating to Period 3 has also been described from Ganj Dareh, in a population interpreted as wild on the basis of a range of non-morphological data (Hesse 1978). There is however some evidence to suggest that high frequencies of hornlessness in female sheep may be more characteristic of domestic populations. At the Period 5 and 9 sites of Tepe Sarab, Tepe Siahbid and Tepe Dehsavar between a third and a half of the sheep seem to have been hornless and non-morphological data suggest that these populations were domestic (Bökönyi 1977).

It is therefore clear that as in the case of goats, no single marker of domestication in sheep horncores exists. Some of the criteria which have been used to support claims for the presence of domestic sheep have also been documented in modern wild populations and early Holocene populations interpreted as wild on the basis of non-morphological data. This suggests that a high degree of caution is called for in their use. However, there is some evidence to suggest that sheep horncores may have undergone some of the morphological changes generally associated with domestication by Period 4 at Ali Kosh AK (Hole, Flannery and Neely 1969) and by Period 5 at Tepe Sarab (Bökönyi 1977).

6.2.8: Pathology:

Köhler-Rollefson (1983, 1997) has identified what she regards as unusually high frequencies of pathological conditions in Period 3 goat remains from 'Ain Ghazal and has used them to support claims for the presence of domesticates, either on the basis that they imply human protection of the animals thus affect~~ing~~ed or that they provide evidence × for tethering. These conditions include "varying degrees of arthritic deformities, ranging in severity from a slight inflammation of the bone to a condition that dramatically reduced an animal's mobility. There is also one case of a healed radius fracture...In one case two first phalanges belonging to the same individual show ring-like bony growth around the shafts that must have been caused by prolonged pressure or tension on the fetlocks" (Köhler-Rollefson 1997, p.562). Similarly, Bökönyi (1977) has used the presence of high frequencies of arthritis and peridontitis in the Period 5 goat remains from Tepe Sarab to support claims for the presence of domestic goats.

6.2.9: Summary of the Evidence for Zoological Domestication in Early Holocene Caprine Remains from South-West Asia:

The various data concerning caprine domestication in south-west Asia discussed in 6.2.4 to 6.2.8 are summarised below in Tables 6.18 and 6.19 for goats and sheep respectively. The periods (see Chapter 5, Table 5.1) during which the presence of domestic goats or sheep is first attested by each of the six criteria of zoological domestication are listed for various regions of south-west Asia. The criteria themselves are listed from left to right in approximate order of reliablity. The periods during which domestic goats or sheep are thought most likely to have appeared in each region, on the basis of the combined weight of evidence from the six criteria of zoological domestication, are listed in the right-hand columns. Unfortunately it is clear from Tables 6.18 and 6.19 that the quality and quantity of data varies significantly from region to region. It should therefore be noted that the periods during which it is suggested that domestic goats or sheep first appeared may in some instances be based on rather limited data.

6.2.9.1: Goats:

The data in Table 6.18 strongly suggest that evidence for the presence of domestic goats is oldest in parts of the central Levantine Corridor, specifically the Damascus Basin (i.e.: Tell Aswad I) where they seem to have been present in high frequencies from the second half of Period 2 onwards. Unfortunately faunal data from the first half of Period

3 is limited, but by the second half of Period 3 there is good evidence for the presence of domestic goats in high frequencies in the parts of the southern Levantine Corridor (i.e.: Beidha, Jericho) and Zagros Uplands (i.e.: Ganj Dareh A-E), and in much lower frequencies in parts of the northern Levantine Corridor/central Euphrates Valley (i.e.: Abu Hureyra 2A) and Taurus Piedmont/upper Euphrates Valley (i.e.: Çayönü upper). By Period 4 domestic goats had increased in frequency in the northern Levantine Corridor/central Euphrates Valley (Abu Hureyra 2B), and there is some evidence to suggest that they were present in the woodland and moist steppe zones to the west of the Levantine Corridor (i.e.: Ras Shamra VC1, Abou Gosh) and the Zagros Piedmont (i.e.: Jarmo, Ali Kosh AK) during the same period. There is good evidence for the presence of domestic goats in the dry steppe and sub-desert zones to the east of the Levantine Corridor (i.e.: Umm el Tlel, Qdeir 1, El Kowm 2, Wadi Jilat 25, Wadi Jilat 13 1-3 and Azraq 31) by Period 5. Domestic goats do not seem to have appeared in the dry steppe and sub-desert zones to the south and south-west of the Levantine Corridor until after the end of Period 5.

Area	**ZG**	**IFS**	**SR**	**PS**	**M**	**P**	**Dom.Goat**
CLC	2	2	2	2	n.a.	n.a.	**2**
SLC	n.a.	3	3	3	3	3	**3**
NLC/CEV	3	4	3	3	n.a.	n.a.	**3**
TP/UEV	n.a.	n.a.	3	n.a.	n.a.	n.a.	**3**
ZU	n.a.	3	3	3	3	5	**3**
W/MS to W. of NLC	n.a.	n.a.	4	n.a.	n.a.	n.a.	**4**
ZP	n.a.	4	n.a.	n.a.	4	n.a.	**4**
W/MS to W. of SLC	n.a.	4	4	n.a.	p.4	n.a.	**4**
DS/SD to E. of NLC	5	5	5	n.a.	n.a.	n.a.	**5**
DS/SD to E. of SLC	5	5	n.a.	n.a.	n.a.	n.a.	**5**
DS/SD to S. and SW of SLC	p.5	n.a.	n.a.	n.a.	n.a.	n.a.	**p.5**

Area Codes: CLC=Central Levantine Corridor, SLC=Southern Levantine Corridor, NLC/CEV=Northern Levantine Corridor/Central Euphrates Valley, TP/UEV=Taurus Piedmont/Upper Euphrates Valley, ZU=Zagros Uplands, W/MS=Woodland/Moist Steppe Zones, ZP=Zagros Piedmont, DS/SD=Dry Steppe/Sub-Desert Zones
Criterion Codes: ZG=Zoogeography (introduction of a foreign species), IFS=Increase in Frequency of Species, SR=Size Reduction, PS=Population Structure, M=Morphology, P=Pathology
Data Codes: n.a.=not applicable, p.=post Period x

Table 6.18: Chronological Summary of the Evidence for Zoological Domestication in Early Holocene Goats from South-West Asia

6.2.9.2: Sheep:

The data in Table 6.19 suggest that evidence for the presence of domestic sheep is oldest in parts of Taurus Piedmont/upper Euphrates Valley (i.e.: Çayönü upper), where they seem to have been present in high frequencies during the second half of Period 3, and parts of the northern Levantine Corridor/central Euphrates Valley (i.e.: Abu Hureyra 2A) and central Levantine Corridor (i.e.: Tell Aswad II) where they seem to have been present, albeit in much lower frequencies, during the same period. By Period 4 domestic sheep were present in parts of the woodland and moist steppe zone to the west of the northern Levantine Corridor (i.e.: Ras Shamra VC1), the Zagros Piedmont (i.e.: Jarmo, Ali Kosh AK) and the southern Levantine Corridor (Es Sifiyeh, Wadi Fidan A) by Period 4, and had increased in frequency in the northern Levantine Corridor/central Euphrates Valley (Abu Hureyra 2B). There is good evidence for their presence in the dry steppe and sub-desert zones to the east of the Levantine Corridor by Period 5 (i.e.: Umm el Tlel, Qdeir 1, El Kowm 2, Wadi Jilat 25, Wadi Jilat 13 1-3 and Azraq 31). Domestic sheep do not seem to have appeared in the woodland and moist steppe zones to the west of the southern Levantine Corridor, or the dry steppe and sub-desert zones to its south and south-west, until after the end of Period 5.

Area	**ZG**	**IFS**	**SR**	**PS**	**M**	**P**	**Dom.Sheep**
TP/UEV	n.a.	3	3	n.a.	n.a.	n.a.	**3**
NLC/CEV	n.a.	4	3	3	n.a.	n.a.	**3**
CLC	3	4	n.a.	n.a.	n.a.	n.a.	**3**
ZP	4	4	n.a.	n.a.	4	n.a.	**4**
W/MS to W of NLC	n.a.	n.a.	4	n.a.	n.a.	n.a.	**4**
SLC	4	4	4	n.a.	n.a.	n.a.	**4**
ZU	5	5	5	n.a.	5	n.a.	**5**
DS/SD to E of NLC	n.a.	5	5	n.a.	n.a.	n.a.	**5**
DS/SD to E of SLC	5	5	n.a.	n.a.	n.a.	n.a.	**5**
W/MS to W of SLC	p.5	n.a.	n.a.	n.a.	n.a.	n.a.	**p.5**
DS/SD to S and SW of SLC	p.5	n.a.	n.a.	n.a.	n.a.	n.a.	**p.5**

Area Codes: TP/UEV=Taurus Piedmont/Upper Euphrates Valley, NLC/CEV=Northern Levantine Corridor/Central Euphrates Valley, CLC=Central Levantine Corridor, ZP=Zagros Piedmont, W/MS=Woodland/Moist Steppe Zones, SLC=Southern Levantine Corridor, ZU=Zagros Uplands,DS/SD=Dry Steppe/Sub-Desert Zones
Criterion Codes: ZG=Zoogeography (introduction of a foreign species), IFS=Increase in Frequency of Species, SR=Size Reduction, PS=Population Structure, M=Morphology, P=Pathology
Data Codes: n.a.=not applicable, p.=post Period x

Table 6.19: Chronological Summary of the Evidence for Zoological Domestication in Early Holocene Sheep from South-West Asia

6.2.10: An Integrated Interpretation of the Emergence of Caprines as Major Early Domesticates in the Levant:

This section attempts to integrate the discussion of caprine domestication in 6.2.4 to 6.2.9 with the environmental, archaeological and subsistence data described in Chapters 3, 4 and 5 in order to generate an up to date, integrated baseline interpretation of the emrgence of caprines as early domesticates in the Levant.

During the Natufian (Period 1) hunter-gatherer groups inhabiting the Levant depended for subsistence on the exploitation of varying combinations of wild plants and animals. These combinations seem to have been determined mainly by local environmental conditions and the habitat preferences of exploited species rather than cultural preferences on the part of humans for one species over another. During this period wild caprines were distributed throughout much of the Fertile Crescent, but on the basis of their representation in faunal assemblages were probably especially abundant where environmental conditions coincided closely with their habitat preferences. Wild goats seem to have been most abundant, and consequently most extensively exploited by humans, in the Lebanon, Anti-Lebanon, Zagros and probably the Taurus Mountains, whereas mouflon appear to have been concentrated in cooler, moister parts of the piedmont zones of the Taurus and Zagros Mountains. Elsewhere within their areas of distribution caprines seem to have been relatively uncommon and/or only present on a seasonal basis.

During the PPNA (Period 2) permanent agricultural villages emerged in the southern and central Levantine Corridor, probably in response to a combination of resource stress and population growth which was triggered by increasing levels of sedentism and the intensification of plant food economies during the preceding Natufian (Period 1). The accelerated population growth and over-exploitation of game around settlements which is thought to have accompanied the emergence of the first agricultural villages would probably have resulted in late Epipalaeolithic strategies of faunal exploitation, which emerged under conditions of higher mobility and smaller group size, coming under increasing strain. Under such conditions of resource stress early agricultural groups may well have attempted to intensify strategies of faunal exploitation to ensure the continued or enhanced availability of protein. However, their options would have been restricted by the range of medium and large herbivores available; carnivores, as secondary consumers, would not have been suited to more intensive exploitation (Garrard 1984).

In the southern Levantine Corridor the spectra of medium and large herbivores appear to have been have been dominated by gazelle throughout the late Pleistocene and into the Holocene. Available data suggests that caprines, here defined as wild goats or mouflon, would have been either relatively rare, only present on a seasonal basis or absent altogether in the southern Levantine Corridor at this time, depending on local environmental conditions. As the behavioural characteristics of gazelle render it unsuitable for domestication (Garrard 1984), the only options available to early agricultural groups in this area would therefore have been to increase the intensity of gazelle hunting or to exploit a wider range of species. Significantly, both adaptations can be demonstrated in PPNA (Period 2) faunal assemblages from the southern Levantine Corridor (i.e.: Hatoula , Netiv Hagdud, Salibiya I) on the basis of lower overall frequencies of gazelle, but higher frequencies of juvenile gazelle and small mammalian species, birds and fish compared to their frequency in Natufian (Period 1) faunal assemblages (Tchernov 1993, Davis et al. 1994).

However, the central Levantine Corridor includes one of the areas of south-west Asia in which the spectrum of medium and large herbivores appears to have been dominated by wild goats during the late Pleistocene and into the Holocene, namely: the Lebanon and Anti-Lebanon Mountains (i.e.: Saaïde II, but see also the Kebaran faunal assemblage from Ksar Akil (Kersten 1989)). The behavioural characteristics of the wild goat render it particularly suitable for intensified exploitation in the form of domestication (Garrard 1984). Evidence for early agricultural villages in the central Levantine Corridor is restricted to the Damascus Basin (i.e.: Tell Aswad I), which is thought to have been beyond or at least on the extreme margins of the late Pleistocene and early Holocene range of wild goat. However, the Damascus Basin is situated immediately adjacent to an area in which wild goats would not only have been especially abundant during Period 2, but one in which they are also known to have been extensively exploited from at least the early Epipalaeolithic onwards. Consequently, the options available to early agricultural groups in the central Levantine Corridor when confronted with conditions of resource stress would not, as in the southern Levantine Corridor, have been restricted to intensified hunting or exploitation of a wider range of species. Such groups would also have had the option of domesticating the wild goat, which was locally abundant, which had previously been extensively exploited by hunter-gatherer groups in the area over long periods of time and which was behaviourally suited to develop a closer relationship with humans than that of hunter and prey. Data from Tell Aswad I, where domestic goats dominated the faunal assemablage from the beginning of the site's occupation at c.9,800 b.p., suggests firstly that domestication of the wild goat was regarded as a more effective means of alleviating resource stress than intensified hunting or exploitation of a wider range of species and secondly that wild goats had been domesticated at the same time as or very shortly after the establishment of the earliest agricultural villages in the central Levantine Corridor during the second half of Period 2. As the Lebanon and Anti-Lebanon Mountains share some topographical similarities with the Zagros Mountains, certain aspects of explanations put forward to account for the beginnings of caprine domestication in the latter area (e.g.: Hesse 1978, Hole 1989 and 1996) may be equally applicable to the central Levantine Corridor and may have provided an additional stimuli for the process.

It may well be significant that in the central Levantine Corridor lithic assemblages dating to the second half of Period 2 are attributed to the early phase of the PPNB tradition (Gopher 1994), which is in turn typically associated with a mixed agricultural way of life. In contrast, contemporary lithic assemblages from the southern Levantine Corridor are typically attributed to the PPNA tradition, which displays some similarities to Natufian lithic traditions and can therefore be regarded as being associated, however loosely, with hunting economies. It is possible that the appearance during the second half of Period 2 of mixed agricultural economies in the central Levantine Corridor, which is implied by the high frequencies of domestic goats at Tell Aswad I, in contrast to the continuation and intensification of earlier hunting traditions documented at early agricultural villages in the southern Levantine Corridor, may be one of the reasons why the PPNA seems to have been so short-lived in the former area (Gopher 1994) and why Early PPNB lithic assemblages have been so elusive in the latter (Kuijt 1997).

During Period 3 permanent agricultural villages are known to have spread from the southern and central Levantine Corridor, where they seem to have first emerged during the Period 2, into all areas of the Fertile Crescent. This spread appears to have been extremely rapid and may well have taken the form of a single wave of advance. By the second half of Period 3 early agricultural villages had appeared at the far end of the Fertile Crescent on the Deh Luran plain in south-western Iran (Hole, Flannery and Neely 1969). There is no reason to suppose that the inhabitants of the agricultural villages that emerged during Period 3 were spared the resource stress that is thought to have accompanied the emergence of early agricultural villages in the central and southern Levantine Corridor during Period 2, or that they were any less likely to have attempted to intensify strategies of faunal exploitation to ensure the continued or enhanced availability of protein.

As early agricultural villages spread throughout the Fertile Crescent, the postulated wave of advance would have passed through at least two further areas of south-west Asia in which the spectra of medium and large herbivores seem to have been dominated by caprines during the late Pleistocene and into the Holocene. Mouflon seems to have been especially abundant in the piedmont zone of the Taurus Mountains and the upper Euphrates Valley (i.e.: Hallan Çemi, Çayönü Lower). The behavioural characteristics of mouflon, like those of wild goat, render it particularly suitable for intensified exploitation in the form of domestication (Garrard 1984). Early agricultural groups in this area would therefore have had the option of alleviating resource stress by domesticating the mouflon which, like the wild goat in the central Levantine Corridor, was locally abundant, had previously been extensively exploited by hunter-gatherer groups in the area over long periods of time and which was behaviourally suited to develop a closer relationship with humans than that of hunter and prey. Data from the upper layers at Çayönü, where domestic sheep dominated the faunal assemblage from approximately 9,000b.p. onwards, suggests that this may have had occurred by the beginning of the second half of Period 3. Similar circumstances may also have led to the independent domestication of wild goats in parts of the Zagros Mountains at about the same time. Wild goat would almost certainly have been especially abundant in this area during the late Pleistocene and into the Holocene and is known to have been extensively exploited by hunter-gatherer groups over long periods of time (i.e.: Warwasi, Zarzi, Tepe Asiab). Data from Ganj Dareh, where domestic goats dominated the faunal assemblage from the beginning of the site's occupation at c.9,000b.p., suggests that this may have occurred by the beginning of the second half of Period 3. Environmental conditions induced by the climatic amelioration that followed the end of the Younger Dryas at c.10,000b.p. may have provided additional stimuli for the process in this area.

Having attempted to explain how wild goat came to be domesticated in the central Levantine Corridor and Zagros Mountains by the second half of Period 2 and the second half of Period 3 respectively, and how mouflon came to domesticated in the piedmont zone of the Taurus Mountains and upper Euphrates Valley by the second half of Period 3, the dispersal of domestic caprines from these potential centres of domestication is examined in more detail below.

Following the initial domestication of wild goat in the central Levantine Corridor by the second half of Period 2 domestic goats seem to have spread extremely rapidly into the southern Levantine Corridor, where intensified gazelle hunting and the exploitation of a wider range of species may have failed to alleviate the resource stress associated with the appearance of early agricultural settlements during Period 2. By the second half of Period 3 domestic goats were predominant in a number of faunal assemblages from the southern Levantine Corridor (i.e.: Jericho, Beidha). The appearance of mixed agricultural economies in the southern Levantine Corridor, implied by the high frequencies of domestic goats at sites such at Jericho and Beidha, appears to have coincided with the appearance of PPNB lithic traditions. However, there is evidence to suggest that in the southern Levantine Corridor PPNA lithic traditions were replaced by those of the Middle PPNB rather than those of the Early PPNB as occurred in the central Levantine Corridor (Kuijt 1997). It is possible that this difference was linked to the fact that mixed agricultural economies first appeared in the southern Levantine Corridor over half a millennium later than they did in the central Levantine Corridor. The southward diffusion of the Byblos point from the northern Levantine Corridor into the southern Levantine Corridor between c.9,600b.p. and c.9,200b.p. may therefore have been only one manifestation of a wider diffusion of information and innovation from north to south that could potentially have 'picked up' domestic goats, or at least the concept of animal domestication, as it passed through the central Levantine Corridor between c.9,600b.p. and c.9,500b.p. (Gopher 1994, p.259 Fig.8.6).

Although domestic goats were present in the southern Levantine Corridor in high frequencies by the second half of Period 3 there seems to have been a substantial delay before they appeared in the woodland and moist steppe zones to the west. Although the data is rather ambiguous, there is some evidence to suggest that domestic goats may have been present at Period 4 sites in the Palestine hill-country such as Abu Gosh (Helmer 1989, Horwitz 1989), however there is little evidence for their presence on the coastal plain at the slightly later site of Atlit-Yam (Horwitz 1989, Galili et al. 1993). It is possible that the widespread disruption to settlement patterns in the southern Levant documented during Period 4 may have interrupted the spread of domestic goats into this area.

In the northern Levantine Corridor and central Euphrates Valley the spectra of medium and large herbivores seem to have been dominated by gazelle and equids during the late Pleistocene and into the Holocene. It is therefore extremely unlikely that caprines were domesticated in this area when permanent agricultural villages spread northwards through the region during Period 3. However, data from Abu Hureyra 2A and 2B suggest that domestic goats and sheep had been introduced to the northern Levantine Corridor and central Euphrates Valley by the end of Period 3; the frequency of both species had increased significantly by Period 4. It is notable that the southwards diffusion of domestic sheep through the Levantine Corridor seems to have been much more rapid than the probable northwards diffusion of domestic goats. Although the initial domestication of mouflon in the Taurus Piedmont and upper Euphrates Valley occurred much later than the initial domestication of the wild goat in parts of the central Levantine Corridor, domestic goats and sheep both seem to have appeared in the northern Levantine Corridor and central Euphrates Valley at the same time. The rapid southwards diffusion of domestic sheep continued through the central Levantine Corridor, where they were present in low frequencies at Tell Aswad II by the end of Period 3, and into the southern Levantine Corridor, where they were present in significant frequencies at Period 4 sites such as Es Sifiyeh, Basta, and Wadi Fidan A. This provides further evidence that the general flow of information and innovation through the Levantine Corridor was from north to south rather than vice versa and may be one of the reasons why the evidence for morphologically domestic goats in the Taurus Piedmont and upper Euphrates Valley during Periods 3 and 4 is so ambiguous (Legge 1996).

It is clear that domestic caprines appeared in the woodland and moist steppe zones of the Levant before they appeared in the dry steppe and sub-desert zones. The woodland and moist steppe zones are broadly delineated by the 200mm. p.a. isohyet, beyond which reliable rainfall agriculture is impossible. This suggests that the initial appearance of domestic caprines in the region was linked to the appearance of permanent agricultural villages. Further support for this argument comes from the fact that the Nubian ibex, whose early Holocene range lay beyond the area within which reliable rainfall agriculture was possible, was not domesticated. The later spread of domestic caprines into the dry steppe and sub-desert zones of the Levant has tended to be linked to the emergence of specialised pastoral economies and is therefore discussed separately below.

The integration of domestic goats and sheep into a system of mixed herding seems to have occurred by Period 5 in all areas of the Levant except the extreme southern and western peripheries, i.e.: parts of the woodland and moist steppe zones to the west of the southern Levantine Corridor and the dry steppe and sub-desert zones to the south and south-west. Once domestic goats and sheep were being herded together, sheep seem to have quickly risen to predominance in all but the most arid and/or mountainous areas of the Levant (e.g.: Wadi Fidan A). The reasons for this are poorly understood and may have varied from area to area, but were probably related to a combination of local topographical and climatic conditions, behavioural and physiological differences between the species (Lancaster and Lancaster 1991, Wasse 1994, Garrard et al. 1996) and the retreat of woodland under herding and cultural pressure (Rollefson and Köhler-Rollefson 1993a, Legge 1996).

6.3: THE EMERGENCE OF MORE SPECIALISED PASTORAL ECONOMIES IN THE DRY STEPPE AND SUB-DESERT ZONES OF THE LEVANT:

One of the most visible characteristics of modern subsistence strategies in the Levant is the existence of separate agricultural and pastoral economies: 'the desert and the sown'. This has led researchers to consider the nature and timing of the disarticulation of animal husbandry from sedentary agriculture (eg: Lees and Bates 1974, Levy 1983 and 1992, Khazanov 1984, Rosen 1984 and 1988, Köhler-Rollefson 1988, 1989c and 1992, Lancaster and Lancaster 1991, Bar-Yosef and Khazanov 1992, Goring-Morris 1993, Rollefson and Köhler-Rollefson 1993a, Perrot 1993a, Ducos 1993a and 1993b, Henry 1995, Garrard et al. 1996). Caprine herding seems to have been introduced to the dry steppe and sub-desert zones to the east of the Levantine Corridor by the beginning of Period 5 (Cauvin 1990, Garrard et al. 1996), possibly in response to conditions of resource stress which may have been caused by a steady influx of hunter-gatherer groups who had been displaced from the woodland and moist steppe zones to the west by expanding early agricultural communities (Byrd 1992). The introduction of domestic caprines to the dry steppe and sub-desert zones of the Levant by Period 5 has led researchers to consider whether specialised pastoral economies could have developed during the Neolithic period.

6.3.1: Types of Pastoral Economy and Definition of Terms used in this Study:

Pastoralism is generally defined as an economic activity involving "mobile and extensive animal husbandry not necessarily divergent from agriculture" (Bar-Yosef and Khazanov 1992, p.1). The key defining factor of any pastoral system tends to be the extent to which agriculture is practised, as this affects mobility, herd composition and level of dependence on outside sources of subsistence (Bar-Yosef and Khazanov 1992, p.2). A wide range of economic strategies involving varying combinations of agriculture and pastoralism lie between the extremes of sedentary agriculture and nomadic pastoralism. Consequently, many different types of economy can be described as pastoralism of one sort or another. The precise definition of the type of pastoral economy under discussion at any one time is therefore of the utmost importance.

Khazanov (1984, pp.19-25) has described four basic types of pastoralism, lying along a continuum of increasing pastoral specialisation in which agriculture and sedentism become progressively less significant.

1) **Sedentary animal husbandry**, in which herds are maintained on pastures adjacent to a fixed settlements as part of a mixed agricultural and pastoral economy.

2) **Distant pastures husbandry**, in which the majority of the population inhabit fixed settlements and are primarily involved in agriculture, whilst herds are maintained on pastures, which may be a substantial distance from the settlement, by a small sub-group of the same population.

3) **Semi-nomadic pastoralism**, which is characterised by extensive pastoralism, periodic changes of pasture during the year and the presence of agriculture in a supplementary capacity.

4) **Pure nomadic pastoralism**, in which agriculture is entirely absent.

Khazanov's (1984) definitions of the different types of pastoral economy form the basis of the terminology used in this study. Here, 'unspecialised pastoral economies' are represented by sedentary animal husbandry, in which agriculture and animal herding are of equal importance and fully integrated into a single economic system. 'More specialised pastoral economies' are represented by distant pastures husbandry, semi-nomadic pastoralism and pure nomadic pastoralism. The decreasing significance of agriculture and sedentism in these economic systems is reflected in increasing levels of specialisation in animal herding.

Cribb (1984 and 1991) has suggested that variation between different types of pastoralism may be related to the fact that although increased specialisation permits higher levels of productivity and autonomy, it is only achieved at the cost of increased risk and instability in economic and social structures.

6.3.2: What Types of Pastoral Economy Might be Anticipated in the Levantine Neolithic and Chalcolithic Archaeological Record?

Exploitation of the earliest domestic goats and sheep in the Levant is most likely to have been in the context of an unspecialised pastoral economy based on sedentary animal husbandry (e.g.: Köhler-Rollefson 1988 and 1992, Rollefson 1996), as the low degree of specialisation in animal herding inherent in this type of pastoral economy ensures that it is both extremely simple and extremely stable.

The subsequent emergence of more specialised pastoral economies in the Levant is poorly understood. Anthropological and historical studies of recent pastoral economies (Redding 1981, Khazanov 1984, Lancaster and Lancaster 1991) have demonstrated that pure nomadic pastoralism is a viable subsistence strategy only if exploitation of animals for meat is combined with dairying. As there is no evidence for the exploitation of animal secondary products such as milk, wool or energy until the Chalcolithic of Period 9 (Sherratt 1981, Davis 1984, Grigson 1987a, Horwitz and Smith 1991) it is most unlikely that prehistoric Levantine pastoral economies took the form of pure nomadic pastoralism. However, there is no reason to suppose that the less specialised distant pastures husbandry and semi-nomadic pastoralism could not have been a feature of pastoral economies in the Levant during the prehistoric period.

This chapter therefore considers whether unspecialised Levantine pastoral economies based on sedentary animal husbandry, on which the earliest exploitation of domestic caprines in the region seems to have been based, developed into more specialised pastoral economies based on distant pastures husbandry or semi-nomadic pastoralism during the Neolithic or Chalcolithic periods.

Any examination of pastoralism in prehistoric periods is inevitably dependent on analyses of various types of archaeological data. Although anthropological and historical data can shed valuable light on the variables affecting pastoral decision making in the recent past, the fact that all modern pastoral societies have had to respond to the existence of market economies imposes severe limitations on its use. "When it comes to elucidating the processes which led to changes in pastoral production in the formative (i.e., prehistoric and protohistoric) periods, one cannot assume the existence of market economies as having continually played a major role in promoting change in pastoral production strategies" (Levy 1992, p.66). Furthermore, it cannot be assumed that modern pastoral societies accurately reflect the full range of variation in their prehistoric antecedents.

The specific methods by which different types of pastoral economy can be recognised in the archaeological record are discussed in more detail in Chapter 10. However, it should be noted here that it has regularly been argued (e.g.: Chang and Koster 1986) that any comprehensive archaeological investigation of pastoralism in prehistoric periods will require analyses of a wide range of archaeological data, including settlement patterns, material culture and palaeoenvironments, in addition to zooarchaeological analyses of faunal remains. Bearing this in mind, previous work on the types of pastoral economies that may have existed in the Levant during the Neolithic and Chalcolithic periods are critically reviewed below.

6.3.4: Previous Work on Levantine Pastoral Economies during the Neolithic and Chalcolithic Periods:

Considerable difference of opinion exists on the origins of more specialised pastoral economies in the Levant. Some researchers have argued such economies developed during the Neolithic period in association with the development of mobile systems of animal husbandry (e.g.: Perrot 1993a, Ducos 1993a, Köhler-Rollefson 1992, Rollefson and Köhler-Rollefson 1993a), whilst others have argued that such economies are more likely to have emerged with the secondary products revolution of the Chalcolithic period (Levy 1992). Rosen (1988) and Henry (1995) have stressed that animal husbandry in the dry steppe and sub-desert zones of the southern Levant may have developed separately and along very different lines to animal husbandry in the woodland and moist steppe zones.

Part of the reason for these differences of opinion is that there is no general agreement on what constitutes a specialised pastoral economy, be it degree of mobility, absence of agriculture, exploitation of secondary products or integration with urban market economies. As a result archaeologists investigating the origins of pastoral specialisation have been identifying very different systems of animal husbandry, lying at varying points along Khazanov's agro-pastoral continuum, and have unsurprisingly been finding that different pastoral economies emerged in different places at different times. This confusion merely reinforces the need for precise definition and use of terms. The general trend, howeverm appears to be one of gradually increasing specialisation between the Neolithic and Chalcolithic as the options available to pastoralists increased with the secondary products revolution.

6.4.3.1: Perrot (1993a and 1993b) and Ducos (1993a, 1993b and 1994):

Perrot and Ducos have both argued that more specialised pastoral economies were introduced to the southern Levant from the northern Levant during the Period 4. They suggest that this development was based on sheep husbandry and "originated from beyond the middle Euphrates, where it seems to take hold with the beginnings of sheep domestication." (Perrot 1993, p.9). This argument is based on the observation that domestic sheep spread rapidly southwards through the Levantine Corridor during the second half of Period 3 and Period 4. Perrot and Ducos have also suggested that the development of goat husbandry in the southern Levant, as opposed to cultural control of morphologically wild goats, was in some way associated with the arrival of domestic sheep from the north (eg: Ducos 1993a, p.164). Ducos (1993a, p.169) has argued that this southward diffusion of herders and sheep may have been prompted by the necessity of searching for pasture once sheep had been taken out of their natural environment.

One weakness of this theory is that although it explains how domestic sheep may have been introduced to the southern Levant, it doesn't account for the disarticulation of animal husbandry from sedentary agriculture. As domestic sheep seem to have entered the southern Levant through the Levantine Corridor, in which the permanent agricultural villages of the region were concentrated, is seems probable that they were introduced in the context of unspecialised pastoral economies based on sedentary animal husbandry. The link made between the spread of domestic sheep on the one hand and the emergence of more specialised pastoral economies on the other seems to be based more on a preconceived association between animal movements and mobile pastoral economies in a modern context than on archaeological evidence. It should be stressed that the southwards flow of information and innovations through the Levantine Corridor was not restricted to domestic sheep. In this sense the appearance of domestic sheep in the southern Levant may have been no different to the appearance of Helwan or Byblos points by the same route (Gopher 1994).

6.4.3.2: Rollefson and Köhler-Rollefson (Köhler-Rollefson 1988 and 1992, Rollefson 1996, Köhler-Rollefson and Rollefson 1990, Rollefson and Köhler-Rollefson 1989 and 1993a):

Rollefson and Köhler-Rollefson have suggested that more specialised pastoral economies may have appeared in the southern Levant at the end of Period 4. However, they have argued that such economies were not introduced from elsewhere but emerged locally in response to culturally induced environmental degradation and were, initially at least, based on goat husbandry. This proposal forms part of a model which attempts to explain more general patterns of cultural change in the southern Levant during Periods 4 and 5. In the southern Levant Period 4 saw the abandonment of many of the earliest agricultural settlements (e.g.: Jericho, Beidha, Yiftah'el), the rapid expansion of others (e.g.: 'Ain Ghazal, Wadi Shu'eib) and the establishment of new settlements in previously unoccupied locations (e.g.: Basta). Rollefson and Köhler-Rollefson have argued that this disruption to established settlement patterns may have resulted from the long term ecological effects of the system of sedentary mixed farming, in which cereal and legume cultivation was combined with goat husbandry, which seems to have characterised permanent agricultural villages in the region during Period 3 and, in some areas, Period 4. Although this combination may initially have been successful in alleviating the resource stress thought to have accompanied the appearance of early agricultural villages during Period 2, it is suggested that it may also have been coupled with a "very one-sided depletion of the environment that resulted in loss of soil fertility and grazing potential" (Köhler-Rollefson 1988, p.88). These factors could eventually have led to relocation of settlement and alterations in subsistence strategies. The well documented damage inflicted on woodland vegetation by browsing goats, in combination with clearance of land for agriculture and felling of trees for fuel and construction may have led to a situation “in which something had to yield, and one or several of these exploitation strategies had to be given up or done elsewhere” (Rollefson and Köhler-Rollefson 1993a, p.40). They suggest that the need to remove livestock from cultivated areas around agricultural settlements during critical stages of crop growth may have led to the development of a mobile system of animal husbandry. Accordingly, livestock could have exploited seasonal vegetation in the dry steppe and sub-desert zones during the autumn, winter and spring, returning to agricultural settlements within the southern Levantine Corridor during the summer to take advantage of permanent water and crop by-products.

One attraction of this theory is that it attempts to explain how animal husbandry may have begun to become disarticulated from sedentary agriculture. However, Martin (in press) has convincingly argued that Period 5 sites in the dry steppe and sub-desert zones of eastern Jordan (i.e.: Wadi Jilat 25, Wadi Jilat 13, Azraq 31) do not represent the specialised pastoral component of larger, primarily agricultural groups from the woodland and moist steppe zones to the west, but are more likely to represent local hunter-cultivator-trapper groups who integrated domestic caprines within their traditional economies.

It should be stressed that the scenario envisaged by Rollefson and Köhler-Rollefson is more reminiscent of the relatively unspecialised distant pastures husbandry than semi-nomadic pastoralism. As many large agricultural settlements (e.g.: ‘Ain Ghazal) were located on the boundary between the moist and dry steppe zones, it is entirely feasible that any seasonal movements made by specialised pastoralists in the context of a more specialised pastoral economy based on distant pastures husbandry could have been over relatively short distances.

6.4.3.3: Levy (1983 and 1992):

Levy has argued that the origins of pastoral specialisation in the southern Levant were associated with “intensive and well-structured exploitation of the secondary products (milk, wool and hair) of domestic herd animals such as sheep and goat” (Levy 1983, p.15), rather than the development of mobile systems of animal husbandry. Drawing heavily on analysis of settlement patterns on the coastal plain and inland foothills of the northern Negev he has concluded that separate pastoral economies first emerged in this area during the Chalcolithic of Period 9. Although few early Neolithic sites have been found in the northern Negev, during the late Neolithic of Period 7 settlement appears to have been confined to the coastal plain. Although domestic goats and sheep were present in the faunal assemblages from Period 7 sites on the coastal plain, no Period 7 sites have been found in the inland foothills. Levy has therefore concluded that pastoralism during this period was "village based and that...grazing probably focused on taking herds short distances away from these coastal plain villages" (Levy 1992, p.72), i.e.: sedentary animal husbandry.

By Period 9 the focus of settlement seems to have shifted away from the coastal plain in favour of the inland foothills as the agricultural villages of the Beersheva valley culture were established. However, the presence during Period 9 of small camps belonging to the same Beersheva valley culture on the coastal plain has been interpreted as evidence for the emergence of a mobile pastoral economy in which livestock were moved on a seasonal basis between the more arid inland foothills and more reliable grazing on the coastal plain. Such an economy could have developed in response to the need to "move herds in response to shifting pasturage and to prevent overgrazing in the fields associated with the inland valleys" (Levy 1992, p.76). Analysis of the remains of goats and sheep from Chalcolithic sites in the northern Negev has suggested that these animals were being exploited for their secondary products (Grigson 1987a). However, as the small camps on the coastal plain appear to have been culturally affiliated with the inland agricultural villages of the Beersheva valley culture the scenario envisaged by Levy is more reminiscent of the relatively unspecialised 'distant pastures husbandry' than 'semi-nomadic' or 'pure nomadic pastoralism'.

6.4.3.4: Discussion:

Implicit in the explanations described above is the assumption that animal domestication and pastoral economies developed in the woodland and moist steppe zones of the Levant in response to conditions resulting from the widespread adoption of sedentary agriculture. "The experience of incipient cultivators alone provided the necessary conditions for the domestication of sheep and goats. A relatively sedentary way of life, the long term knowledge of animal behaviour and the disposal of surplus vegetal food seem to have been indispensable for the process of domestication...The idea that hunter-gatherers, even sedentary ones, were the domesticators of herd animals has no support in the archaeological evidence" (Bar-Yosef and Khazanov 1992, p.4).

This view has been challenged by a number of archaeologists (e.g. Rosen 1984 and 1988, Henry 1995) working in the dry steppe and sub-desert zones of the southern Levant who have drawn on long term diachronic archaeological and faunal data to argue that pastoral economies in these areas may have developed independently during the late Neolithic or Chalcolithic from a hunter-gatherer as opposed to a sedentary agricultural economic base.

6.4.3.5: Rosen (1988):

Rosen has described how subsistence in the southern Negev and Sinai during the Neolithic seems to have been based on a mobile hunter-gatherer economy specially adapted to desert conditions. Archaeological and faunal data suggest that this may have given way to a pastoral nomadic economy based on husbandry of goats and sheep with limited agriculture, i.e.: semi-nomadic pastoralism, during the Chalcolithic of Periods 8 and 9. Rosen has therefore argued that pastoral economies developed in the southern Negev and Sinai in response to a combination of different factors, namely: environmental change, exploitation of secondary products and the development of urban centres (Rosen 1988, p.503) rather than the sedentism and adoption of agriculture which seem to have influenced events in the woodland and moist steppe zones two millennia earlier.

6.4.3.6: Henry (1995):

Henry has argued that subsistence strategies around the Hisma basin in the sub-desert zone of southern Jordan during the late Epipalaeolithic and Neolithic seem to have been based on transhumant hunting and gathering. However, in contrast to the situation in the southern Negev and Sinai, this continued to form the basis of the economy during the Chalcolithic of Period 9 with the addition of goat and sheep husbandry but not agriculture. The fact that varying proportions of wild caprines have been identified in late Epipalaeolithic and early Neolithic faunal assemblages from this region has led Henry (1995, pp.373-374) to suggest that goats and sheep may have been independently domesticated during the late Neolithic within a desert-adapted hunting and gathering tradition and that earlier patterns of transhumance may have provided the impetus for the development of a mobile pastoral economy during the Chalcolithic.

However, zoogeographical considerations suggest that Hisma basin lay within the × geographical range of the Nubian ibex, which is thought never to have been domesticated, rather than the wild goat. These species are not thought to have ever been sympatric (Tchernov and Bar-Yosef 1982). Furthermore, available data suggests that the presence of mouflon in the southernmost Levant was restricted to the Pleistocene-Holocene boundary of Periods 1 and 2. The independent domestication of caprines during Period 9 in an area in which the presence of wild goats or mouflon to domesticate is at best questionable must therefore be considered extremely unlikely.

6.4.4: An Intergrated Interpretation of the Development of More Specialised Pastoral Economies in the Levant:

Available evidence suggests that more specialised pastoral economies based on distant pastures husbandry could potentially have emerged in the Levant during the Neolithic period. Unfortunately, zooarchaeological evidence that would conclusively demonstrate the presence of such economies, such as detailed studies of seasonality (e.g.: Liebermann 1994), is lacking and given the high degree of fragementation characteristic of most Neolithic faunal assemblages this situation is unlikely to be obtained in the near future. If such economies existed during the Neolithic, the fact that there is no evidence for the exploitation of secondary products suggests that they would almost certainly have been focused on meat production. The apparent absence of large-scale systems of exchange during the Neolithic suggests that meat thus produced would have been for local consumption rather than for exchange within a market economy. It should also be stressed that any seasonal movements may have been over comparatively short distances. Evidence for the presence of more specialised pastoral economies based on distant pastures husbandry is slightly more convincing in the Chalcolithic period, which suggests that the secondary products revolution may have encouraged increasing levels of pastoral specialisation.

However, any attempt to argue for the presence of more specialised pastoral economies in the Levant during Neolithic or Chalcolithic periods should bear the cautionary statements of Bar-Yosef and Khazanov (1992) in mind. They have argued that specialised forms of pastoralism known from the recent past could not have come into existence until the widespread adoption in the late 4th and early 3rd millennia BP of horses and camels as riding animals: "developed forms of pastoral nomadism are inseparable from the use of riding animals that serve simultaneously as beasts of burden and as important sources of milk and meat products" (Bar-Yosef and Khazanov 1992, p.5). The dietary requirement for carbohydrates in the form of agricultural products would have made the existence of neighbouring sedentary agricultural communities and a developed system of trade and exchange essential for the development of any specialised pastoral economy.

In the absence of dairy products to exchange for agricultural products, or riding animals to confer military superiority over agricultural communities, it is likely that prehistoric pastoral economies "consisted only of short-lived, isolated, and abortive experiments of evolution, bearing no direct historical or genetic relationship with those forms of pastoral nomadism that were emerging in different parts of the world at the turn of the second millennium BC" (Bar-Yosef and Khazanov 1992, p.6).

6.5: CONCLUSIONS:

This chapter has critically reviewed the environmental, archaeological and subsistence data described in Chapters 3, 4 and 5 and has attempted to generate up to date, integrated baseline interpretations of the emergence of caprines as early domesticates and the development of more specialised pastoral economies in the Levant. These interpretations form the benchmarks against which the results of the zooarchaeological analysis of the faunal assemblage from 'Ain Ghazal are examined in Chapter 11.

CHAPTER 7: INTRODUCTION TO 'AIN GHAZAL

7.1: INTRODUCTION:

'Ain Ghazal is one of the largest and most extensively excavated Neolithic sites in south-west Asia, and in addition has one of the longest unbroken sequences of occupation in the region. Ten seasons of excavation since 1982 have demonstrated that the site was continuously inhabited for over 2000 years, from c.9,250b.p. to c.7,000b.p.. As such it offers an almost unique opportunity to examine the development of goat and sheep herding during the Levantine Neolithic, as it was not only occupied during the period when caprines first emerged as domesticates in the region, but also the period when more specialised pastoral economies based on distant pastures husbandry may first have begun to develop (see Chapter 5). This chapter aims to briefly describe the site, its archaeology, and previous work on the faunal assemblage.

7.2: THE SIGNIFICANCE OF 'AIN GHAZAL:

For a variety of reasons 'Ain Ghazal has attracted a great deal of scholarly attention ever since excavations started in 1982. The site provided the first evidence for occupation in the southern Levant during the first half of the 8th millennium b.p., thus overturning the Palestinian hiatus theory which maintained that the region was largely abandoned at that time. Furthermore, the material culture at 'Ain Ghazal during the first half of the 8th millennium b.p. was sufficiently different from the Middle and Late PPNB material culture of the 9th millennium b.p. for the excavators to introduce the controversial concept of the PPNC to Levantine archaeology (Rollefson, Kafafi and Simmons 1990).

In addition, the fact that 'Ain Ghazal has provided good evidence for an in-situ transition from the PPNC to the Yarmoukian Pottery Neolithic (Rollefson 1993b) has caused researchers to question earlier theories that attributed the appearance of pottery in the southern Levant to the migration into the region of pottery-using groups from the northern Levant during the second half of the 8th millennium b.p.. 'Ain Ghazal has also yielded one of the richest bodies of material and architecture relating to Neolithic ritual and ceremony, which includes the earliest examples of human statuary yet discovered.

Of more relevance to this study is the fact that 'Ain Ghazal has provided strong evidence for massive environmental degradation caused by a combination of extensive deforestation for construction materials and fuel, and the integration of goat husbandry and crop cultivation in a system of mixed farming. The excavators have argued that this environmental degradation may have led to the development of more specialised pastoral economies during the Neolithic period (see Chapter 6).

7.3 THE 'AIN GHAZAL BIBLIOGRAPHY:

The archaeological significance of 'Ain Ghazal has placed it at the forefront of Levantine Neolithic research; consequently the site has been the subject of a vast number of publications. A detailed synopsis of the literature relating to 'Ain Ghazal is beyond the scope of this study, however the most important publications are listed below.

Preliminary excavation reports are provided for the 1982 season by Rollefson et al. (1984), the 1983 season by Rollefson et al. (1985) and Rollefson and Simmons (1985), the 1984 season by Rollefson and Simmons (1986), the 1985 season by Rollefson and Simmons (1987), the 1988 season by Rollefson, Kafafi and Simmons (1990), the 1989 season by Rollefson (1993a), the 1993 season by Rollefson, Kafafi and Wada (1994), the 1994 season by Kafafi and Rollefson (1995), the 1995 season by Rollefson and Kafafi (1996), and the 1996 season by Rollefson and Kafafi (1997). The main results of the six seasons between 1982 and 1989 are summarised in Rollefson, Simmons and Kafafi (1992). The arguments for and against the use of the term PPNC to describe occupation in the southern Levant during the first half of the 8th millennium b.p. are reviewed in detail by Rollefson and Köhler-Rollefson (1993a), and the case for the local origins of the southern Levantine Pottery Neolithic is discussed in Rollefson (1993b).

The results of a short season of archaeological survey in the vicinity of 'Ain Ghazal are described by Simmons and Kafafi (1988). This failed to find any trace of smaller villages, farmsteads or pastoral sites in the vicinity of the settlement, which suggests that it operated as a relatively independent entity. The architecture of 'Ain Ghazal has been discussed in detail by Banning and Byrd (1984 and 1987). The challenging topic of ritual and ceremony at the site, as evidenced by the caches of human statuary, smaller human and animal figurines and structures that are probably best interpreted as shrines, has been dealt with by Rollefson (1983, 1986 and 1998b). The smaller human and animal figurines from the MPPNB period have been described in detail by Macadam (1997).

The theory that a combination of extensive deforestation in the vicinity of the site and the integration of goat husbandry and crop cultivation in a system of mixed farming caused massive local environmental degradation (see Chapter 6) which in turn may have led to the development of more specialised pastoral economies has been discussed in great detail in a series of articles by Rollefson and Köhler-Rollefson (i.e.: Köhler-Rollefson 1988, Köhler-Rollefson and Rollefson 1990, Rollefson and Köhler-Rollefson 1993a, Köhler-Rollefson 1992, Rollefson 1996).

7.4: THE SETTING OF 'AIN GHAZAL:

'Ain Ghazal is located in the Jordanian highlands on the outskirts of the modern city of 'Amman (see Figure 7.1). The site lies on the banks of the Wadi Zarqa at its confluence with two major tributary wadis (see Figure 7.2). The river Zarqa, a small stream which flowed along the wadi bed until the 1950's, is fed by a number of springs in the 'Amman area. Amongst these springs is 'Ain Ghazal ('Spring of Gazelle'), from which the site takes its name.

The site lies at an altitude of between 700 and 740 m. a.s.l. on the eastern edge of a range of broad-topped low mountains which extend to the north, west and south. These low mountains are heavily dissected by relatively narrow, steep-sided wadis, which include the Wadi Zarqa and its tributaries. To the east and north-east the landscape opens out into more gently undulating hill-country and plains. The modern 200mm. p.a. isohyet passes through this more open area to the east and north-east, which is thus "near the limits of dry-farming...except for garden patches in small wadis" (Rollefson 1984). However, the broad tops of the low mountains to the north, west and south of the site are currently able to support reliable rainfall agriculture. The site itself currently receives approximately 275mm. rainfall p.a. (Köhler-Rollefson and Rollefson 1990). 'Ain Ghazal is also situated on the modern boundary between the Mediterranean and Irano-Turanian phyto-geographical zones, which separates the now heavily depleted evergreen broad-leaved and mixed forests of Palestinian oak and Aleppo pine to the west from the steppic grasslands to the east.

7.5: THE ARCHAEOLOGY OF 'AIN GHAZAL:

'Ain Ghazal was discovered during the construction in the 1970's of a new road from Amman to Zarqa, which destroyed an estimated 10% of the site. Ten seasons of rescue orientated excavations have subsequently taken place, in 1982, 1983, 1984, 1985, 1988, 1989, 1993, 1994, 1995 and 1996. Occupation at 'Ain Ghazal is thought to have continued uninterrupted for over 2000 years, from c.9,250 to c.7,000b.p.. Four main cultural horizons, the Middle PPNB, Late PPNB, PPNC and Yarmoukian Pottery Neolithic, have been identified. It should however be stressed that there is as much continuity as difference between the various phases. Also, "the massive disturbance and subsequent mixing of earlier deposits by later inhabitants of 'Ain Ghazal renders some of the phase distinctions suspect" (Rollefson, Simmons and Kafafi 1992, p.447).

Excavations at 'Ain Ghazal have been concentrated in four main areas: the North Field, Central Field and South Field on the west bank of the Wadi Zarqa, and the East Field on the east bank of the wadi (see Figure 7.2). In addition, a number of outlying squares have also been excavated, primarily to examine the horizontal stratigraphy of the site. The four main cultural phases are however not evenly distributed. Briefly, the MPPNB seems to be restricted to the lower terrace of the Central Field, the LPPNB to the North Field, East Field and upper terrace of the Central Field, the PPNC to the South Field, North Field, East Field and upper terrace of the Central Field, and the Yarmoukian to the South Field and upper terrace of the Central Field. The locations of the excavation squares on the west bank of the Wadi Zarqa, on which this zooarchaeological analysis of the faunal assemblage is based, (see Chapter 2) are given in Figure 7.3. The cultural phases represented in each of these excavation squares are listed in Chapter 2, Table 2.1. Drawing heavily on Rollefson, Simmons and Kafafi (1992), the four main cultural phases represented at 'Ain Ghazal are now briefly described below.

7.5.1: Middle PPNB: c.9,250 to c.8,500b.p.:

'Ain Ghazal was established on the west bank of the Wadi Zarqa during the MPPNB at c.9,250b.p., and by c.8,500b.p. covered four or five hectares. The architecture was characterised by rectilinear stone walls and lime plaster floors, decorated with red ochre. Rooms were spacious, up to 5 x 5m. at the beginning of the period, and at least one room in each house had a circular hearth set in the centre of the floor. Room size decreased during the MPPNB, with stone interior walls taking over from timber posts as roof supports. This has been interpreted as reflecting deforestation in the vicinity of the site (Rollefson, Simmons and Kafafi 1992). Dense scatters of flint, representing specialised knapping floors, are also characteristic of the period.

Burial practices in the MPPNB at ‘Ain Ghazal fall into two main categories. A third of the non-infant burials and all infants were found with the skull present in refuse deposits in a variety of postures. Two thirds of the non-infant burials were sub-floor, flexed and with the skull removed after initial burial. This variation “may suggest a distinction in respect paid at the time of death, as well as in life” (Rollefson, Simmons and Kafafi 1992, p.461).

Of the four main cultural horizons at ‘Ain Ghazal, the MPPNB has produced the greatest concentration of ritual and symbolic artefacts. Two caches of lime plaster human statuary and five examples of plastered human skulls can be assigned to this period. In conjunction with the skull removal described above, this evidence has been interpreted as having been associated with an ancestor cult. Small human and animal figurines, made of clay and stone, were relatively abundant with cattle dominating the animal figurine assemblage.

Flotation samples from the MPPNB were “rich and reflected an agricultural base common to the rest of the Levant for the 7th millennium” (Rollefson and Köhler-Rollefson 1993a, p.35), i.e.: dominated by morphologically domestic wheat, barley and legumes.

7.5.2: Late PPNB c.8,500 to c.8,000b.p.:

A sudden expansion seems to have characterised ‘Ain Ghazal during the LPPNB. By c.8,000b.p. the site covered approximately 10 hectares and had spread across the Zarqa river on to the east bank of the wadi. This expansion “argues strongly for new additions to the local population by migrants from the greater ‘Ain Ghazal area, including the possible influx of relatives from recently abandoned farming villages, such as Jericho, in the Jordan Valley” (Rollefson, Simmons and Kafafi 1992, p.446).

Architecturally, it seems that the spacious room layout of the MPPNB had given way by the LPPNB to a layout characterised by a single room surrounded by smaller storage areas. Lime plaster, decorated with red ochre, continued to be manufactured. This layout, and other architectural details, such as the placing of a door some 60cm. above the floor, are closely paralleled at the LPPNB site of Basta. Plant remains reveal the same reliance on agriculture as in the MPPNB.

7.5.3: PPNC c.8,000 to c.8,750b.p.:

The growth of 'Ain Ghazal continued into the PPNC, with the site reaching a maximum size of 12 to 13 hectares, although it should be noted the actual density of housing seems to have been much lower than during the MPPNB. The PPNC inhabitants of 'Ain Ghazal tended to dig into earlier strata during construction work, which has resulted in the truncation of many MPPNB and LPPNB deposits. Standing PPNB structures were occasionally incorporated into PPNC buildings. Altogether, the distinction between the various horizons was considerably clouded by these activities. Two types of structure are associated with the PPNC and both differ considerably from their predecessors.

The first, which was probably the normal dwelling (Rollefson and Köhler-Rollefson 1993a, p.36), consisted of a single room opening on to a courtyard. There is no evidence for the production of lime plaster during this period. Huwwar (crushed chalk and marl), which needs no firing, was used instead. It has been suggested that this may be a further reflection of deforestation in the vicinity of the site. The second is characterised by small rectangular rooms which were "separated by a central corridor leading from the front entrance to the back wall" (Rollefson, Kafafi and Simmons 1992, p.449). These corridor buildings utilised MPPNB lime plaster floors and one example has a flagstone ramp leading from the PPNC land surface to an entrance at a level some 50cm. lower. As there is no evidence that an upper storey ever existed in these corridor buildings and as they contain so little usable floor space, it has been argued that they represent semi-subterranean storage bunkers over which temporary structures could potentially have been erected (Rollefson and Köhler-Rollefson 1993a). Similar buildings have been discovered at Beidha II and III, although these are thought to date to the MPPNB. The fact that these corridor buildings do not seem to have been permanent residences, and the fact that all burials within them are clearly secondary (see below), has led Rollefson and Köhler-Rollefson (1993a) to suggest that they may have been associated with the pastoral component of the envisaged PPNC fluctuating village (see Chapter 6)

Isolated areas of paved and/or plastered courtyards are also characteristic of the PPNC. In contrast to the specialised knapping floors of the MPPNB, PPNC lithics seem to have been manufactured on a far more casual basis as and when tools were needed.

As in the field of architecture, PPNC burials and ritual represent a departure from MPPNB practice. Two categories of burial have been identified: primary burials in courtyards, retaining the skull ("indisputably, the skull cult form of ancestor veneration was no longer practised" (Rollefson and Köhler-Rollefson 1993a, p.38)), and secondary burials of varying completeness in the corridor buildings. Pig bones were associated with both categories. In comparison with the MPPNB very few human or animal figurines can be assigned to the PPNC, indicating a "substantial difference in terms of displaying ritually associated symbolism" (Rollefson and Köhler-Rollefson 1993a, p.38).

Oddly, no plant remains have been recovered from PPNC or Yarmoukian contexts at 'Ain Ghazal, despite the flotation of numerous samples. However, as numerous querns and rubbers have been found it seems certain that the processing of at least plant foods continued into the PPNC. Furthermore, it is difficult to see how a site extending over more than 10 hectares could be sustained without farming, despite the lack of direct evidence.

7.5.4: Yarmoukian Pottery Neolithic c.7,750 to c.7,000b.p.:

By the beginning of the Yarmoukian the extent of 'Ain Ghazal seems to have contracted from its PPNC maximum, as no evidence for this cultural phase has been found on the east bank of the Wadi Zarqa. However, excavations on the west bank of the wadi have exposed an in-situ transition from the PPNC to the Yarmoukian via a transitional phase characterised by very crude, undecorated sherds of proto-Yarmoukian type. The Yarmoukian inhabitants of 'Ain Ghazal retained and even intensified their PPNC predecessors' habit of digging into earlier strata, causing massive disturbance of previous cultural levels. Architecturally this phase seems to have been characterised by the reuse and modification of PPNC corridor buildings and isolated walls and the construction of rectinlinear structures and one apsidal building (Kafafi 1993).

Significantly, the use of huwwar, as opposed to fuel-demanding lime plaster, continued into the Yarmoukian. Also, the Yarmoukian flake based lithic assemblage was very similar to that of the PPNC. Further similarities between the PPNC and Yarmoukian are found in jewellery: polished limestone pendants predominate in both periods but were absent in the MPPNB, and in the decreased frequency of figurines compared with the MPPNB. Indeed the major cultural break at 'Ain Ghazal appears not between the Pre-Pottery Neolithic and Pottery Neolithic, but within the Pre-Pottery Neolithic between the PPNB and PPNC.

With the exception of the use of pottery, the only area in which the Yarmoukian inhabitants of 'Ain Ghazal substantially departed from PPNC practice is in that of burial. No Yarmoukian interments have been discovered at the site; "absence of burials within settlement boundaries appears to be a characteristic of the Yarmoukian, for none have been reported from Tell Abu Thawwab, 'Ain Rahub, Wadi Shu'eib or Munhatta" (Rollefson 1993b, p.97). However, at 'Ain Ghazal no sign of an off-site cemetery has been found either.

7.6: PREVIOUS WORK ON THE FAUNAL ASSEMBLAGE FROM 'AIN GHAZAL:

As this work is focused primarily on the caprine remains from 'Ain Ghazal, it should be read in conjunction with the previous work of researchers who have examined different aspects of the faunal assemblage (i.e.: Gillespie 1984 and 1986, Köhler-Rollefson, Gillespie and Metzger 1988, Köhler-Rollefson, Quintero and Rollefson 1993, Wasse 1994 and 1997, von den Driesch and Wodtke 1997). This section therefore briefly describes the most important results of this previous work.

7.6.1: Köhler-Rollefson et al. (1988 and 1993):

All subsequent researchers have drawn heavily on the extensive analysis of the faunal assemblage from 'Ain Ghazal ~~initialised~~ begun by by Köhler-Rollefson, who examined x approximately 30% of the mammalian remains excavated between 1982 and 1989. This material originated from excavation squares located on the west bank of the Wadi Zarqa. The results of this analysis have been published in Köhler-Rollefson, Gillespie and Metzger (1988) and Köhler-Rollefson, Quintero and Rollefson (1993). Most significantly, Köhler-Rollefson demonstrated that caprines dominated the faunal assemblage from the beginning of the site's occupation at c.9,250b.p., and that the bulk of the MPPNB caprine remains represented goat. These were interpreted as fully domestic, primarily on the basis of high frequencies of juveniles (see Köhler-Rollefson 1989a) and abnormal skeletal pathologies. However, no attempt was made to identify the LPPNB, PPNC and Yarmoukian caprine remains to species, and consequently the question of whether sheep were represented in the faunal assemblage remained unresolved. Köhler-Rollefson also demonstrated that although goat husbandry was supported by a 'broad-spectrum' hunting strategy during the MPPNB, with more than 50 vertebrate species represented in the faunal assemblage, subsequently ~~the~~ both the number and frequency of hunted species rapidly declined, especially in the case of species preferring woodland habitats. This phenomenon was interpreted as being the result of both deforestation in the vicinity of the site, and appearance of increased frequencies of cattle and pigs. Preliminary investigations on rather small samples suggested that domestic cattle and pigs could potentially have been present at 'Ain Ghazal from the LPPNB onwards, as the size of their remains seemed to be slightly reduced in comparison with MPPNB specimens.

7.6.2: Gillespie (1984 and 1986):

Gillespie examined all of the small mammal, amphibian, reptile and bird remains excavated from 'Ain Ghazal between 1982 and 1985. This material originated from excavation squares located on the west bank of the Wadi Zarqa, primarily the lower terrace of the Central Field. The results of this analysis are contained in two unpublished reports, one discussing the material excavated during 1983 (Gillespie 1984) and the other discussing the material excavated in 1982, 1984 and 1985 (Gillespie 1986). Gillespie's work unfortunately did not distinguish between the various cultural phases, but as by far the greater part on the material examined came from MPPNB strata, his results may be taken as being representative of that phase. This work was important in demonstrating the great variety of species hunted during the MPPNB. It was also noted that diurnal birds of prey, rather than species traditionally considered to be game birds, dominated the assemblage of bird remains from 'Ain Ghazal. Unfortunately no interpretation of this observation was put forward. Perhaps the greatest significance of Gillespie's work was that examination of the habitat preferences of the small mammal, amphibian, reptile and bird species represented in the faunal assemblage from 'Ain Ghazal enabled some statements to be made about the likely environment in the vicinity of the site during the MPPNB. This aspect of Gillespie's work is discussed in more detail in Chapter 10.

7.6.3: Wasse (1994 and 1997):

In 1993/4 the present/author examined a small sample of the caprine remains excavated × at 'Ain Ghazal between 1983 and 1989 as part of a B.A. dissertation (Wasse 1994). All of this material originated from excavation squares located on the west bank of the Wadi Zarqa, and all four cultural horizons were represented. The aim was to identify as many of these caprine specimens to species as possible in an attempt to resolve the question of whether sheep were represented in the faunal assemblage from the site. The main results of this analysis have been published in Wasse (1997). This work demonstrated that although the MPPNB caprine remains from 'Ain Ghazal consisted almost entirely of goat, those from the PPNC and Yarmoukian consisted primarily of sheep. Unfortunately the sample of LPPNB material examined was too small to make any statements about the presence or absence of sheep during this phase. In addition, differences in the physiology and behaviour of goats and sheep were examined in an attempt to establish why sheep so rapidly rose to predominance following their first appearance at the site.

7.6.4: Von den Driesch and Wodtke (1997):

In 1995 von den Driesch and Wodtke conducted an extremely detailed analysis of all faunal remains excavated from 'Ain Ghazal between 1993 and 1995, the results of which are published in von den Driesch and Wodtke (1997). As this material originated from both the west and east banks of the Wadi Zarqa, it represents the sole source of information about the faunal remains from the East Field. Many of their observations are reflected in the previous work of Köhler-Rollefson and Gillespie, and in the results this study (see Chapter 9). Unfortunately, the MPPNB proper was not represented in the material examined by von den Driesch and Wodtke, as their earliest material was transitional MPPNB/LPPNB. This work has, however, added significant new information to our knowledge of the faunal assemblage from 'Ain Ghazal, the most important of which concerns the wild or domestic status of the cattle and pig remains from the site. Their detailed analysis suggested that although there may have been some attempts to domesticate cattle at 'Ain Ghazal, these seem ultimately to have been unsuccessful with the result that most cattle remains from the site represent wild animals, even during the latest phases of occupation. No evidence for the presence of domestic pigs at ‘Ain Ghazal was found in the material examined.

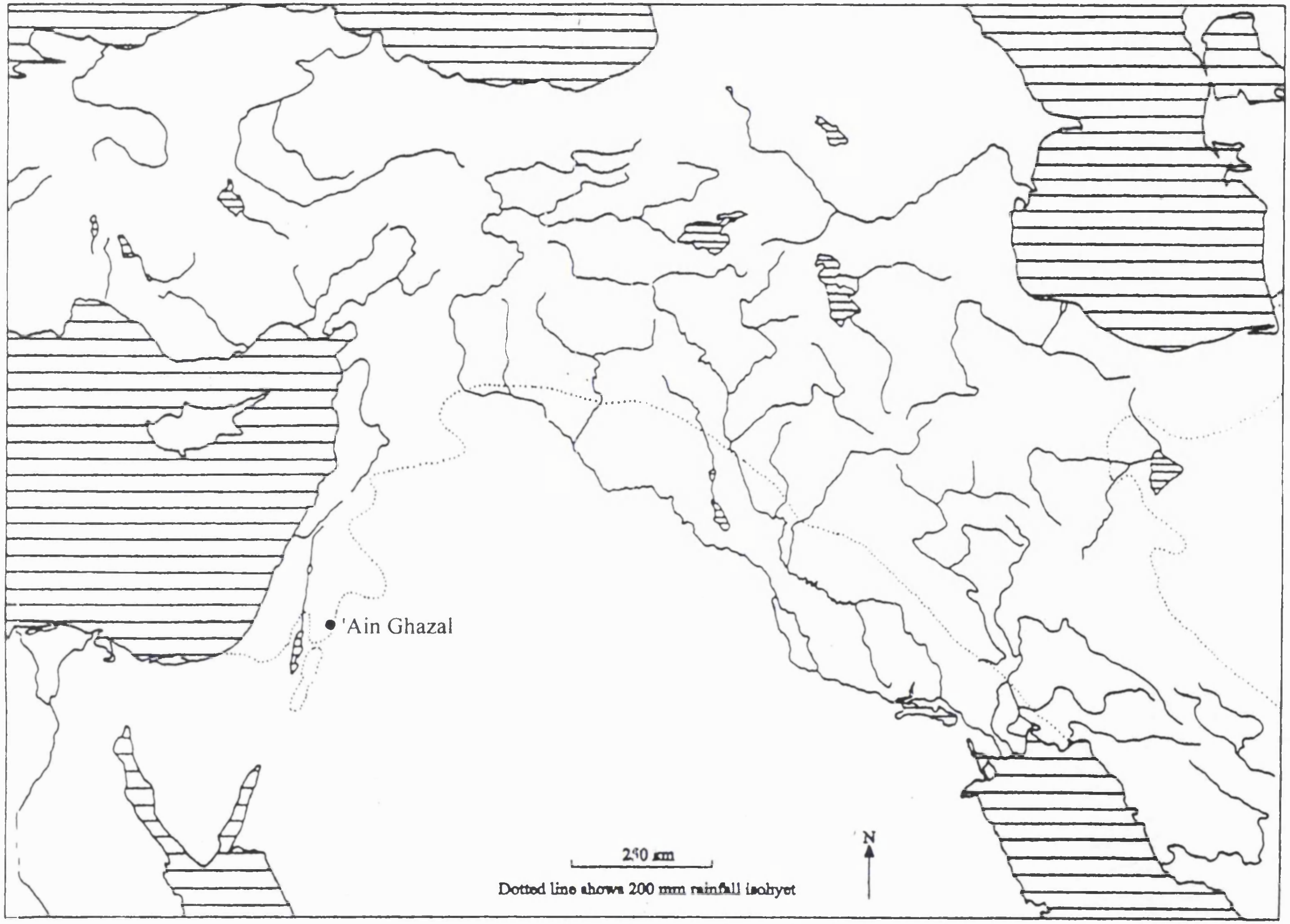


Figure 7.1: Location of 'Ain Ghazal

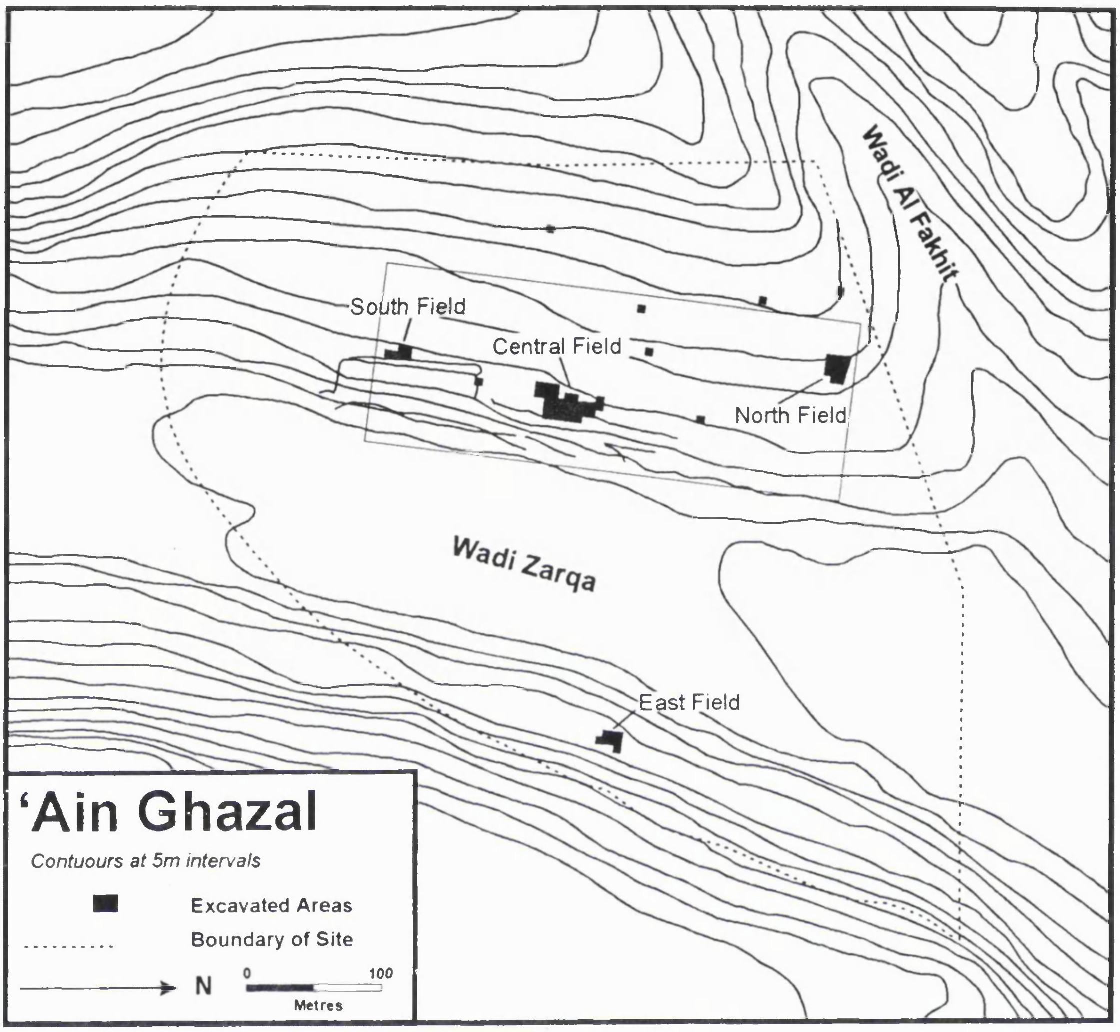


Figure 7.2: 'Ain Ghazal Site Topography and Location of Main Excavation Areas. Area Within Box Shown in More Detail in Figure 7.3 (adapted from von den Driesch and Wodtke 1997, p.513 Figure 1)

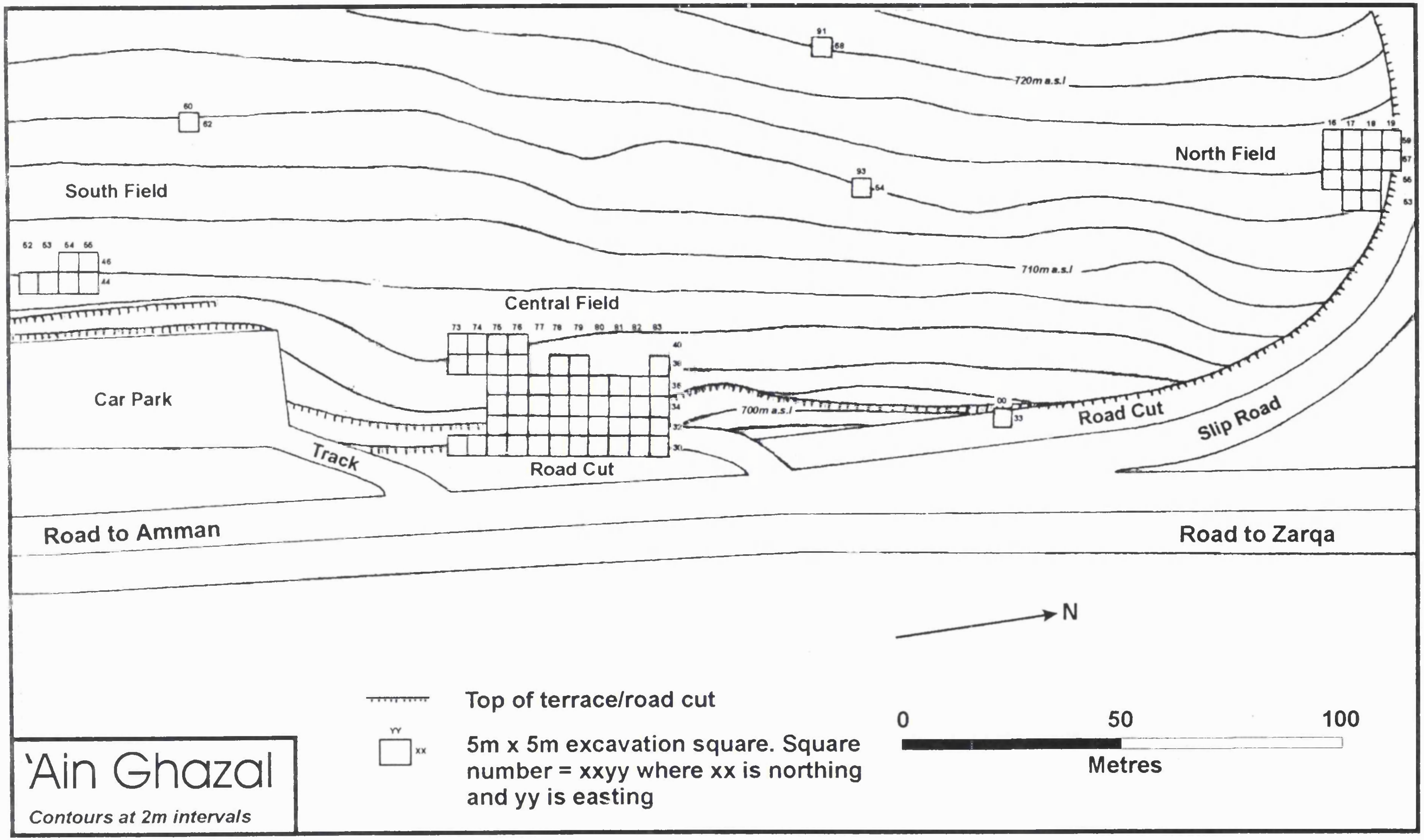


Figure 7.3: Location of the Excavation Squares from which the Faunal Remains Analysed in this Study Originated

7.7: CONCLUSIONS:

Having introduced the site of 'Ain Ghazal, its significance, setting and archaeology, and described the most important results of previous work on its faunal assemblage, the results of this analysis of the 'Ain Ghazal faunal assemblage are described in Chapters 8, 9 and 10.

THE DEVELOPMENT OF GOAT AND SHEEP HERDING DURING THE LEVANTINE NEOLITHIC

Volume 2

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CHAPTER 8: IDENTIFICATION OF 'AIN GHAZAL CAPRINE REMAINS TO SPECIES

8.1: INTRODUCTION:

The identification to species of as large a proportion as possible of the caprine remains from 'Ain Ghazal was undertaken with two key objectives in mind: to generate reliable quantitative, diachronic zooarchaeological data for each species, and to identify the individual morphological characteristics on each POSAC by which an accurate identification to species could be made. To this end the selected caprine remains were subjected to three different analyses (see below and Chapter 2).

In the First Analysis the caprine remains from 'Ain Ghazal were identified to species, where possible, on the basis of traditional methods of comparison with published and unpublished morphological criteria (e.g: Boessneck 1969, Kratochvil 1969, Prummel and Frisch 1986, Helmer and Rocheteau 1994, Wasse n.d.) and modern reference material. The aim was to simply and relatively quickly identify as many POSACs to species as possible. The identifications obtained in this analysis form the basis of the zooarchaeological investigation of the 'Ain Ghazal caprines undertaken in this study. In addition, the potential effect on interpretation of variation in the proportion of each POSAC identifiable to species by this method was examined.

The Second Analysis used metrical techniques (Payne 1969) to identify caprine distal metacarpals to species. The aim was to independently check at least some of the identifications obtained during the First Analysis by an entirely different method before using them as the basis of this zooarchaeological investigation of the 'Ain Ghazal caprines.

The Third Analysis comprised a principal components analysis of the individual morphological characteristics contributing to variation in goat and sheep bone morphology (based on Buitenhuis 1995). The aims of this analysis were threefold: to identify the particular morphological characteristics of each POSAC on which a reliable identification to species could be made, to check the potentially subjective identifications of the First Analysis under controlled, quantitative conditions, and finally to investigate whether this type of principal components analysis has the potential to identify a greater proportion of caprine remains to species than traditional methods.

8.2: FIRST ANALYSIS (COMPARISON WITH PUBLISHED AND UNPUBLISHED MORPHOLOGICAL CRITERIA, AND MODERN REFERENCE MATERIAL):

The sample for this analysis comprised all 4747.5 POSACs (adjusted NISP) from 'Ain Ghazal which were examined during the course of this study. As expected, it proved impossible to identify all specimens to species and a substantial proportion remained in the goat/sheep category. The results of this analysis are listed by phase in Table 8.1.

Phase	n	goat	sheep	gt/sh	% n i.d.	gt:sh
MPPNB	1944.5	1134	7	803.5	58.7	1:0.01
LPPNB	434	138.5	113.5	182	58.1	1:0.8
LPPNB/PPNC	90.5	48	64.5	78	59.1	1:1.3
PPNC	1216.5	220	483.5	513	57.8	1:2.2
Yarmoukian	962	153	321	488	49.3	1:2.1
TOTAL	**4747.5**	**1693.5**	**989.5**	**2064.5**	**56.5**	**1:0.6**

Key: n=adjusted NISP, goat=n identified as goat, sheep=n identified as sheep, gt/sh=n not identified to species, % n i.d.=% n identified to species, gt:sh=ratio of specimens identified as goat to specimens identified as sheep

Table 8.1: Results of First Analysis of 'Ain Ghazal Caprine Bone by Phase

8.2.1: Relative Proportion of Goats and Sheep:

The results in Table 8.1 demonstrate that the proportion of sheep in the 'Ain Ghazal caprine sample increased during the period of the site's occupation. There was a marked shift in the goat to sheep ratio from 1:0.01 during the MPPNB, when sheep were virtually absent, to over 1:2 during the PPNC and Yarmoukian periods. Sheep appear to have been first exploited in large numbers at 'Ain Ghazal from the LPPNB onwards.

8.2.2: Proportion of Caprine Remains Identifiable to Species:

The results in Table 8.1 also demonstrate that the proportion of identifiable specimens from each phase is relatively consistent at just under 60%. The slightly lower proportion of identified specimens from the Yarmoukian is almost certainly a reflection of the higher levels of calcretion affecting this material.

8.2.3: Proportion of Each POSAC Identifiable to Species:

In Table 8.2 the results of the First Analysis are presented for each POSAC in rank order of percentage identified to species.

POSAC	n	goat	sheep	gt/sh	% i.d.	gt:sh
Distal Metacarpal	278	178.5	94.5	5	98.2	1:0.5
Distal Metatarsal	256	159.5	85	11.5	95.5	1:0.5
Distal Radius	175	89	58	28	84.0	1:0.7
Astragalus	530	236	163	131	75.3	1:0.7
Pelvis	162	68	47	47	71.0	1:0.7
Distal Metapodial	54.5	25.5	13	16	70.6	1:0.5
Calcaneum	336	122	70	144	57.1	1:0.6
Distal Humerus	542	154	140	248	54.2	1:0.9
First Phalanx	719	294	95	330	54.1	1:0.3
Distal Tibia	388	110	85	193	50.3	1:0.8
Distal Scapula	414	84	92	238	42.5	1:1.1
Third Phalanx	464	155	39	270	41.8	1:0.3
Distal Femur	90	7	2	81	10.0	1:0.3
Mandible with teeth	322	11	6	322	5.0	1:0.5
TOTAL	**4747.5**	**1693.5**	**989.5**	**2064.5**	**56.5**	**1:0.6**

Key: n=adjusted NISP, goat=n identified as goat, sheep=n identified as sheep, gt/sh=n not identified to species, % n i.d.=% n identified to species, gt:sh=ratio of specimens identified as goat to specimens identified as sheep

Table 8.2: Results of First Analysis of 'Ain Ghazal Caprine Bone by POSAC

The results in Table 8.2 demonstrate that some POSACs are more easily identifiable to species using this method than others. Three categories can be distinguished in the proportions of each POSAC identifiable to species.

1) **>70% identifiable:** distal metacarpal, distal metatarsal, distal radius, astragalus, pelvis and distal metapodial.
2) **40%-60% identifiable:** calcaneum, distal humerus, first phalanx, distal tibia, distal scapula and third phalanx
3) **<10% identifiable:** distal femur and mandible with teeth.

The results in Table 8.2 are broken down by phase in Tables 8.3 to 8.7 to examine whether this pattern is repeated consistently throughout the main phases of occupation at 'Ain Ghazal.

POSAC	MPPNB n	% i.d.	gt;sh
Distal Metacarpal	116	97.4	1:0
Distal Metatarsal	103	93.7	1:0.01
Distal Radius	82	80.5	1:0
Pelvis	13	75.0	1:0
Astragalus	216	74.1	1:0.01
Distal Metapodial	32.5	66.2	1:0
Calcaneum	127	62.2	1:0.03
Distal Tibia	128	57.0	1:0.01
Distal Humerus	166	56.6	1:0.01
First Phalanx	421	53.9	1:0
Distal Scapula	92	43.5	1:0.03
Third Phalanx	315	39.7	1:0
Distal Femur	42	11.9	1:0
Mandible with teeth	52	3.8	1:0
TOTAL	**1944.5**	**58.7**	**1:0.01**

Key: n=adjusted NISP, % n i.d.=% n identified to species, gt:sh=ratio of specimens identified as goat to specimens identified as sheep

Table 8.3: Results of First Analysis of MPPNB Caprine Bone by POSAC

POSAC	LPPNB n	% i.d.	gt;sh
Distal Metacarpal	35	98.6	1:0.5
Distal Metatarsal	29	91.4	1:0.4
Astragalus	50	82.0	1:1.2
Distal Metapodial	4	75.0	1:0.2
Distal Radius	18	72.2	1:2.3
Calcaneum	40	57.5	1:0.6
Distal Tibia	44	56.8	1:0.9
Third Phalanx	29	55.2	1:1
Distal Humerus	52	48.1	1:1.3
Pelvis	13	46.2	1:1
First Phalanx	39	43.6	1:0.3
Distal Scapula	54	37.0	1:1.5
Distal Femur	4	25.0	1:0
Mandible with teeth	22	4.3	0:1
TOTAL	**434**	**58.1**	**1:0.8**

Key: n=adjusted NISP, % n i.d.=% n identified to species, gt:sh=ratio of specimens identified as goat to specimens identified as sheep

Table 8.4: Results of First Analysis of LPPNB Caprine Bone by POSAC

	LPPNB/PPNC		
POSAC	**n**	**% i.d.**	**gt;sh**
Distal Metacarpal	14	100.0	1:1.5
Distal Metatarsal	12	100.0	1:1.4
Pelvis	9	88.9	1:1.7
Astragalus	21	85.7	1:2
Distal Radius	6	83.3	1:1.5
Distal Humerus	24	62.5	1:1.5
First Phalanx	23	60.9	1:0.8
Distal Metapodial	2.5	60.0	1:2
Distal Scapula	11	54.5	1:0.5
Distal Tibia	24	45.8	1:0.8
Distal Calcaneum	11	36.4	0:1
Third Phalanx	12	25.0	1:0.5
Mandible with teeth	15	6.7	0:1
Distal Femur	6	0.0	0:1
TOTAL	**90.5**	**59.1**	**1:1.3**

Key: n=adjusted NISP, % n i.d.=% n identified to species, gt:sh=ratio of specimens identified as goat to specimens identified as sheep

Table 8.5: Results of First Analysis of LPPNB/PPNC Caprine Bone by POSAC

	PPNC		
POSAC	**n**	**% i.d.**	**gt;sh**
Distal Metacarpal	71	100.0	1:2.2
Distal Metatarsal	63.5	97.6	1:1.9
Distal Radius	47	91.5	1:2.3
Distal Metapodial	9	83.3	1:14
Pelvis	48	72.9	1:1.1
Astragalus	154	69.5	1:2.2
Calcaneum	93	57.0	1:1.5
First Phalanx	130	53.8	1:1.9
Distal Humerus	178	52.8	1:4.2
Distal Tibia	104	51.9	1:3.2
Third Phalanx	80	50.0	1:1.2
Distal Scapula	139	43.9	1:3.4
Distal Femur	25	8.0	1:1
Mandible with teeth	75	5.3	1:0
TOTAL	**1216.5**	**57.8**	**1:2.2**

Key: n=adjusted NISP, % n i.d.=% n identified to species, gt:sh=ratio of specimens identified as goat to specimens identified as sheep

Table 8.6: Results of First Analysis of PPNC Caprine Bone by POSAC

POSAC	Yarmoukian n	% i.d.	gt;sh
Distal Metatarsal	48.5	97.9	1:1.6
Distal Metacarpal	42	96.4	1:1.6
Distal Radius	22	90.0	1:4
Astragalus	89	82.0	1:2.8
Distal Metapodial	6.5	76.9	1:9
Pelvis	40	67.5	1:3.5
First Phalanx	106	57.5	1:1.8
Distal Humerus	122	54.1	1:1.5
Calcaneum	65	50.8	1:2.3
Distal Scapula	118	41.5	1:1.6
Distal Tibia	88	36.4	1:4.3
Third Phalanx	28	35.7	1:4
Distal Femur	13	7.7	0:1
Mandible with teeth	174	5.2	1:0.8
TOTAL	**962**	**49.3**	**1:2.1**

Key: n=adjusted NISP, % n i.d.=% n identified to species, gt:sh=ratio of specimens identified as goat to specimens identified as sheep

Table 8.7: Results of First Analysis of Yarmoukian Caprine Bone by POSAC

The results in Tables 8.3 to 8.7 demonstrate firstly that the same POSACs are consistently easier to identify to species, and secondly that the proportion of each POSAC identified to species is similar in each phase. This was expected in light of the consistency in the overall proportion of POSACs identified to species from each phase (see 8.2.2 and Table 8.1).

8.2.4: Effect of the Proportion of Caprine Specimens Not Identified to Species on the Goat to Sheep Ratio:

The results in Tables 8.2 to 8.7 also suggest that a goat to sheep ratio calculated on the basis of less easily identified POSACs is more likely to diverge from that of the sample as a whole than a goat to sheep ratio calculated on the basis of a more easily identified POSAC. This is more clearly demonstrated in Table 8.8 where the mean and standard deviation of the goat to sheep ratios for the six highest ranking POSACs (excluding unassigned distal metapodia) is compared with mean and standard deviation of the goat to sheep ratios for the six lowest ranking POSACs.

POSAC	mean	min	max	std.dev
6 highest ranking	1:0.617	1:0.5	1:0.7	0.098
6 lowest ranking	1:0.550	1:0.3	1:1.1	0.333

Table 8.8: Means, Minima, Maxima and Standard Deviations of Goat to Sheep Ratios of Six Most Identifiable and Six Least Identifiable POSACs (see Table 8.2)

The higher standard deviation of the six lowest ranking POSACs suggests that goat to sheep ratios obtained from caprine samples in which the proportion of specimens unidentified to species is high should be treated with caution. The data in Table 8.8 are presented for each phase in Table 8.9 to examine whether this pattern is repeated consistently throughout the main phases of occupation at 'Ain Ghazal (unassigned distal metapodia excluded throughout).

Phase	POSAC	mean	min	max	std.dev
MPPNB	6 highest ranking	1:0.008	1:0	1:0.03	0.0116
MPPNB	6 lowest ranking	1:0.007	1:0	1:0.03	0.0121
LPPNB	6 highest ranking	1:0.983	1:0.4	1:2.3	0.708
LPPNB	6 lowest ranking	1:0.683	1:0	1:1.5	0.668
LPPNB/PPNC	6 highest ranking	1:1.600	1:1.4	1:2	0.219
LPPNB/PPNC	6 lowest ranking	1:0.300	1:0	1:0.8	0.346
PPNC	6 highest ranking	1:1.867	1:1.1	1:2.3	0.476
PPNC	6 lowest ranking	1:2.167	1:0	1:4.2	1.656
Yarmoukian	6 highest ranking	1:2.550	1:1.6	1:4	1.043
Yarmoukian	6 lowest ranking	1:2.167	1:0	1:4.3	1.721

Table 8.9: Means, Minima, Maxima and Standard Deviations of Goat to Sheep Ratios of Six Most Identifiable and Six Least Identifiable POSACs by Phase (see Tables 8.3 to 8.7)

In four out of the five phases in Table 8.9 the goat to sheep ratio of the lowest ranking skeletal elements has a higher standard deviation than the goat to sheep ratio of the highest ranking skeletal elements. This suggests the problems associated with obtaining representative goat to sheep ratios from caprine samples with a high proportion of specimens which are not identified to species are, if not universal, at least a regularly recurring phenomenon. In addition, the results in Table 8.9 draw attention to the fact that this problem is more pronounced in samples which contain large numbers of both species, such the PPNC and Yarmoukian, than in samples which are dominated by one species or the other, such as the MPPNB.

8.2.5: Effect of Variation in the Proportion of Each POSACs Identified to Species on Construction of Age Profiles:

The methods used in the First Analysis to separate samples of caprine bone clearly and consistently result in the identification of varying proportions of each POSAC, as demonstrated above. This poses a significant problem with regard to the construction of separate age profiles for goats and sheep.

In small samples, such the LPPNB and LPPNB/PPNC, the number of less easily identified POSACs assigned to one species or the other is tiny, owing to the high number of bones remaining in the unidentified goat/sheep category. Unfortunately epiphyseal fusion data from a number of these POSACs, including the distal humerus, first phalanx, distal tibia and distal femur, are commonly used to generate age profiles. It is therefore clear that if this method is used to separate small samples of goat and sheep bone, it will be extremely difficult to construct detailed age profiles for each species which draw on data from less easily identifiable POSACs. Even if samples are large, the fact that the goat to sheep ratio of these elements may not be representative of the sample as a whole (see 8.2.4) means that any age profiles thus generated should be treated with extreme caution.

8.3: SECOND ANALYSIS (METRICAL SEPARATION OF DISTAL METACARPALS):

The sample for this analysis (Payne 1969) comprised the entire sample of 'Ain Ghazal caprine distal metacarpals on which w.cond and w.troch measurements could be taken. It was possible to obtain these measurements on a total of 217 individual metacarpal condyles (see Table 8.10). These included both medial and lateral, and fused and unfused specimens. As each metacarpal has two condyles this was equivalent to an adjusted NISP count of 108.5, or 39.0% of the total sample of 278 (adjusted NISP) caprine distal metacarpals examined during the course of this study (see Table 8.2). The measured condyles were inevitably amongst the best preserved and as a result all but one had been identified to species during the First Analysis. In Figures 8.1 to 8.6 the measured metacarpal condyles are categorised on the graphs according to their identification as goat, sheep or goat/sheep in the previous analysis.

8.3.1: Independent Check of Caprine POSAC Identifications Obtained in the First Analysis:

The w.cond and w.troch measurements of the entire sample of caprine metacarpal condyles from 'Ain Ghazal measured during the course of this study are plotted in Figure 8.1.

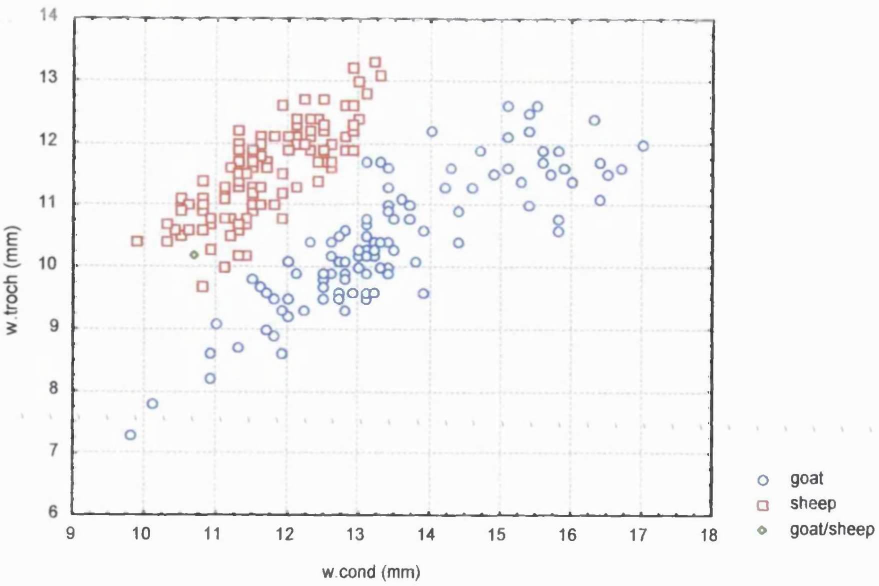


Figure 8.1: Metrical Separation of All 'Ain Ghazal Caprine Metacarpal Condyles

In Figure 8.1 it is clear that the specimens identified as goat or sheep in the First Analysis fall into two clear clusters with no intermediate specimens, confirming the initial identification in each instance. This suggests that Payne's (1969) metrical separation of goat and sheep metacarpals can correctly identify the great majority of distal metacarpal condyles on which w.cond and w.troch measurements can be taken. In addition, it is clear from Figure 8.1 that the single previously unidentified metacarpal condyle should be identified as sheep.

Although the distal metacarpal was one of the easiest POSACs to identify to species in the First Analysis (see 8.2.3), these results suggest that the traditional use of published/unpublished morphological criteria and modern reference material to identify caprine remains to species can produce accurate identifications of a large proportion of specimens. Therefore, as a result of the Second Analysis confidence in the identifications of other POSACs obtained in the First Analysis is increased.

8.3.2: Independent Check of Goat to Sheep Ratios Obtained in the First Analysis:

As it was possible to identify each measured metacarpal condyle to species it was also possible to calculate exact goat to sheep ratios for this POSAC during each phase of occupation. The data in Figure 8.1 are therefore broken down by phase in Figures 8.2 to

8.7 to independently check the goat to sheep ratios for each phase obtained in the First Analysis.

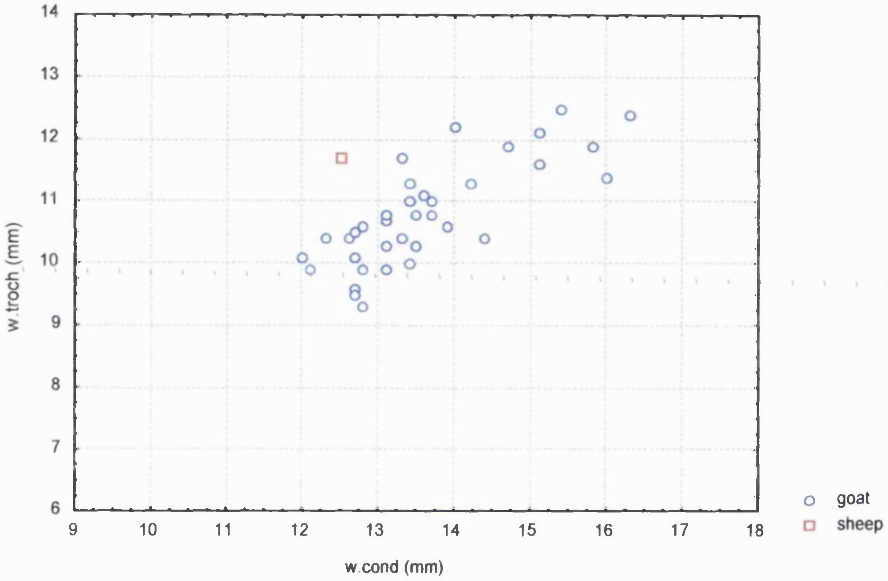


Figure 8.2: Metrical Separation of MPPNB 'Ain Ghazal Caprine Metacarpal Condyles

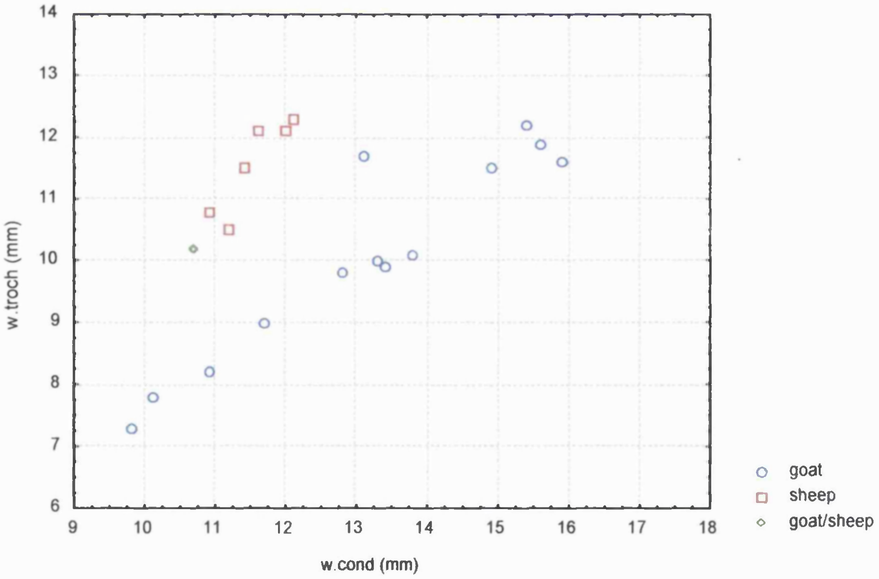


Figure 8.3: Metrical Separation of LPPNB 'Ain Ghazal Caprine Metacarpal Condyles

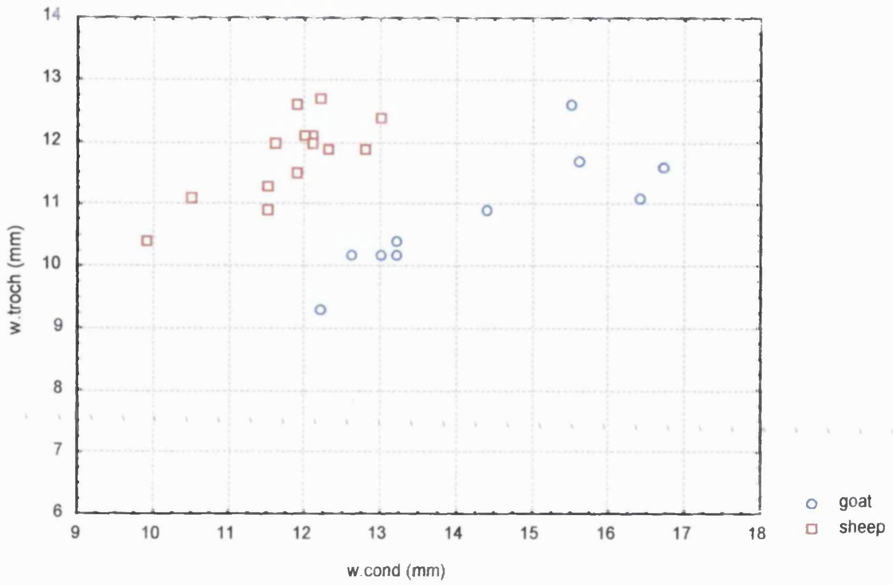


Figure 8.4: Metrical Separation of LPPNB/PPNC 'Ain Ghazal Caprine Metacarpal Condyles

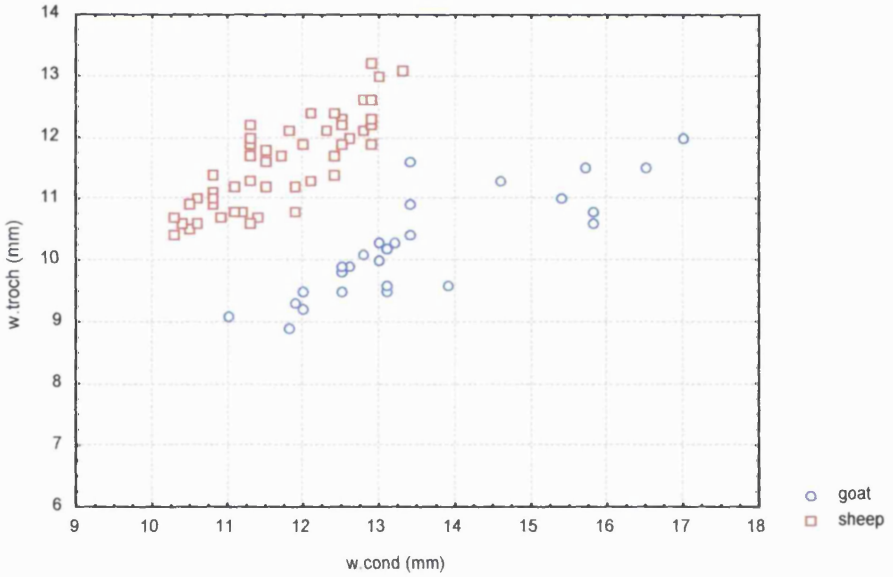


Figure 8.5: Metrical Separation of PPNC 'Ain Ghazal Caprine Metacarpal Condyles

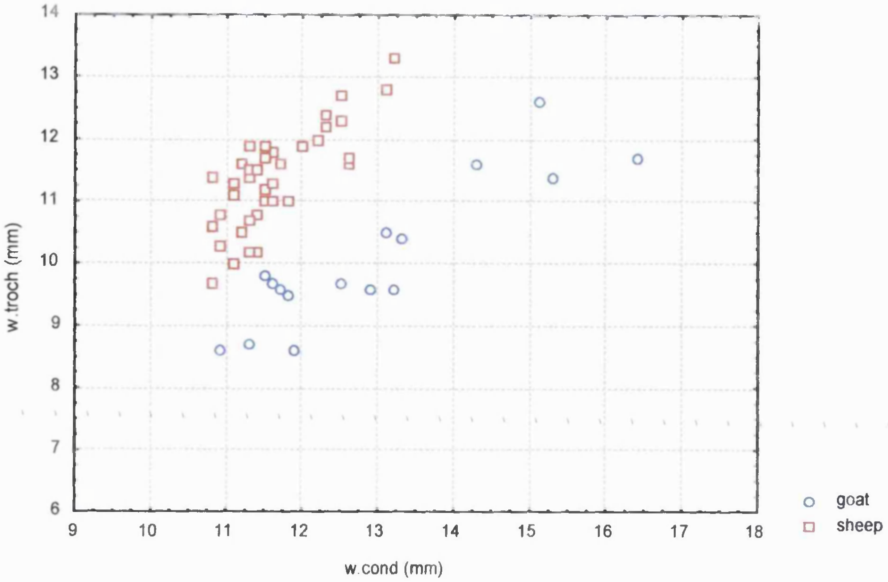


Figure 8.6: Metrical Separation of Yarmoukian 'Ain Ghazal Caprine Metacarpal Condyles

Goat to sheep ratios of metrically separated distal metacarpals for each phase were calculated on the basis of the results in Figures 8.2 to 8.6 and are listed in Table 8.10, where they are compared with the mean goat to sheep ratios of all POSACs obtained in the First Analysis (see Table 8.1).

Phase	n goat	n sheep	n total	2nd Analysis gt:sh	1st Analysis gt:sh
MPPNB	37	1	38	1:0.03	1:0.01
LPPNB	14	7	21	1:0.5	1:0.8
LPPNB/PPNC	10	14	24	1:1.4	1:1.3
PPNC	28	52	80	1:1.9	1:2.2
Yarmoukian	16	38	54	1:2.4	1:2.1
TOTAL	**105**	**112**	**217**	**1:1.1**	**1:0.6**

Key: n=NISP, n goat=n specimens identified as goat in Second Analysis, n sheep=n specimens identified as sheep in Second Analysis, gt:sh=ratio of specimens identified as goat to specimens identified as sheep

Table 8.10: Goat to Sheep Ratios of Metrically Separated 'Ain Ghazal Caprine Metacarpal Condyles (see Figures 8.2 to 8.6), Compared with Mean Goat to Sheep Ratios of all POSACs Obtained in First Analysis (see Table 8.1)

The results in Table 8.10 demonstrate that the goat to sheep ratios for each phase obtained through metrical analysis of metacarpal condyles, in which the entire sample was identified to species, are broadly comparable with the mean goat to sheep ratios of all POSACs for each phase obtained in the First Analysis, despite the fact that in the First

Analysis not all POSACs were identified to species. Confidence is thus increased in the mean goat to sheep ratios for each phase obtained in the First Analysis.

8.4: THIRD ANALYSIS (PRINCIPAL COMPONENTS ANALYSIS):

It was decided to exclude a number of POSACs from this analysis: the pelvis because of the difficulty of distinguishing inter-sexual from inter-species variation, the distal femur because of the paucity of published species-specific morphological characteristics and generally poor state of preservation, and mandibles with teeth because these were identified to species, in the few cases where it was possible, on the basis of dental morphology (Payne 1985b) which is affected by the stage of dental wear.

Unfortunately it was not possible to subject the entire remaining sample of 'Ain Ghazal caprine POSACs owing to the time required to record the requisite data. A sub-sample of 1514, or approximately one third, of the selected POSACs, was therefore drawn from the sample as a whole (see Table 8.11). These were selected on the basis of a subjective assessment of their state of preservation, owing to the need to record as many morphological characteristics as possible on each specimen. It was decided that for a specimen to qualify for inclusion at least two morphological characteristics would have to be recorded. The raw data for this analysis, i.e.: the scores for each specimen, are contained in Appendix A.

POSAC	n	n goat	n sheep	n goat/sheep
Distal Scapula	153	50	46	57
Distal Humerus	189	50	82	57
Distal Radius	69	28	38	3
Distal Tibia	141	49	48	44
Distal Metacarpal	124	62	61	1
Distal Metatarsal	122	70	50	2
First Phalanx	274	118	68	88
Third Phalanx	107	43	23	41
Astragalus	220	105	90	25
Calcaneum	115	46	43	26
TOTAL	**1514**	**621**	**549**	**349**

Key: n=NISP, n goat=n specimens identified as goat in First Analysis, nsheep=n specimens identified as sheep in First Analysis, n goat/sheep=n specimens identified as goat/sheep in First Analysis

Table 8.11: The Sample of 'Ain Ghazal Caprine POSACs Subjected to Principal Components Analysis

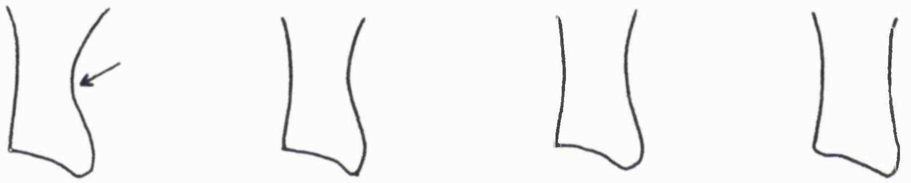
In the results presented below the selected specimens are categorised according to their previous identification as goat, sheep or goat/sheep in the First Analysis. It should also be noted that in the plots of factor scores for each POSAC presented below (Figures 8.7 to 8.16) the number of plotted points is less than the number of analysed specimens owing to the fact that the same combination of character scores were in some instances recorded on more than one specimen. NISP, rather than adjusted NISP counts, are used throughout.

8.4.1: Principal Components Analysis of Caprine Distal Scapulae:

Schematic drawings of the various distal scapula morphological characteristics are provided in Figure 8.7.

1 Very Thick
2 Thick
3 Slender
4 Very Slender

Characteristic B23: General Form of Neck of Scapula (Boessneck 1969)



1 Very Strong
2 Strong
3 Light
4 Very Light

Characteristic B24/PF5: Curvature of Margo Cervicalis (Boessneck 1969, Prummel and Frisch 1986)

1 Very Strong
2 Strong
3 Light
4 Very Light

Characteristic B25: Pecten on Collum (Boessneck 1969)

Figure 8.7: Schematic Drawings of Caprine Distal Scapula Morphological Characteristics

1 Elongated Round
2 Lightly Angular
3 Rounded with Break
4 Strongly Angular

Characteristic B26/PF6: Supraglenoid Tubercle (Boessneck 1969, Prummel and Frisch 1986)

1 Strongly Elliptic
2 Elliptic
3 Lightly Elliptic
4 Round

Characteristic B27/PF8: Shape of Glenoid Cavity (Boessneck 1969, Prummel and Frisch 1986)

1 Short and Clear
2 Long and Clear
3 Long and Unclear
4 Short and Unclear

Characteristic B29: Subscapular Fossa (Boessneck 1969)

Figure 8.7 (cont): Schematic Drawings of Caprine Distal Scapula Morphological Characteristics

1 Very Strong

2 Strong

3 Light

4 Very Light

Characteristic PF7: Distal Extension of Coracoid Process (Prummel and Frisch 1986)

1 Unclear/Missing

2 Wide and Deep

3 Narrow and Deep

4 Short and Narrow/Fused

Characteristic BU1: Fossa Synovialis in Fovea Articularis (Buitenhuis 1995)

1 Very Strong

2 Strong

3 Slight

4 None

Characteristic HR1: Hollow for Muscle Attachment on Supraglenoid Tubercle (Helmer and Rocheteau 1994)

Figure 8.7 (cont): Schematic Drawings of Caprine Distal Scapula Morphological Characteristics

The score counts and calculated factor loadings for the various distal scapula morphological characteristics are listed in Tables 8.12 and 8.13 respectively.

characteristic	**species**	**n**	**score 1**	**score 2**	**score 3**	**score 4**	**missing data**
B23	Goat	50	0	4	7	4	35
B23	Sheep	46	0	3	12	3	28
B23	Goat/Sheep	57	0	2	11	15	29
B24/PF5	Goat	50	0	3	15	13	19
B24/PF5	Sheep	46	5	18	3	0	20
B24/PF5	Goat/Sheep	57	0	16	15	5	21
B25	Goat	50	0	3	13	24	10
B25	Sheep	46	4	14	11	1	16
B25	Goat/Sheep	57	0	8	16	25	8
B26/PF6	Goat	50	1	1	20	15	13
B26/PF6	Sheep	46	25	17	0	0	4
B26/PF6	Goat/Sheep	57	1	10	9	2	35
B27/PF8	Goat	50	0	4	22	22	2
B27/PF8	Sheep	46	14	24	6	0	2
B27/PF8	Goat/Sheep	57	2	16	17	5	17
B29	Goat	50	0	3	14	14	19
B29	Sheep	46	11	1	3	2	29
B29	Goat/Sheep	57	11	6	9	14	17
PF7	Goat	50	0	5	25	14	6
PF7	Sheep	46	15	18	11	0	2
PF7	Goat/Sheep	57	4	8	13	2	30
BU1	Goat	50	0	1	12	21	16
BU1	Sheep	46	4	22	3	0	17
BU1	Goat/Sheep	57	8	4	6	1	38
HR1	Goat	50	0	1	13	29	7
HR1	Sheep	46	12	18	11	1	4
HR1	Goat/Sheep	57	2	6	7	10	32

Key: characteristic=see Figure 8.7, species=identification obtained in First Analysis, n=NISP, score X=n specimens scoring X for the particular characteristic, missing data=n specimens on which the particular characteristic was not preserved

Table 8.12: Score Counts for Caprine Distal Scapula Characteristics

characteristic	**Factor 1**	**Factor 2**
B23	0.086408	0.830729
B24_PF5	0.651516	0.057998
B25	0.5333	0.556045
B26_PF6	0.743196	-0.06754
B27_PF8	0.682669	-0.26356
B29	0.471412	0.167147
PF7	0.706736	-0.28125
BU1	0.64138	-0.09029
HR1	0.703351	0.002696
Eigenvalue	3.362502	1.191885
Prp.Totl	0.373611	0.132432

Table 8.13: Factor Loadings for Caprine Distal Scapula Characteristics (Highest Factor Loadings in Red)

The relative contribution of each characteristic to the overall morphological variation between distal scapulae of goats and sheep is demonstrated by the factor loadings in

Table 8.13. Factor 1 was affected mainly by B26-PF6, PF7, HR1 and B27-PF8, and Factor 2 by B23. As the eigenvalue of both factors is greater than one, the morphological variation incorporated in each factor can be regarded as significant The five characteristics affecting factors 1 and 2 may thus be regarded as the most reliable criteria by which to make an identification of caprine distal scapulae to species and are presented in rank order of reliability in Table 8.14.

Rank	Characteristic	Description
1	B26-PF6	Shape of supraglenoid tubercle
2	PF7	Distal extension of coracoid process
3	HR1	Hollow for muscle attachment on supraglenoid tubercle
4	B27-PF8	Shape of glenoid cavity
5	B23	General form of neck of scapula

Table 8.14: Most Reliable Caprine Distal Scapula Characteristics in Rank Order

The factor loadings of each analysed distal scapula are plotted in Figure 8.8.

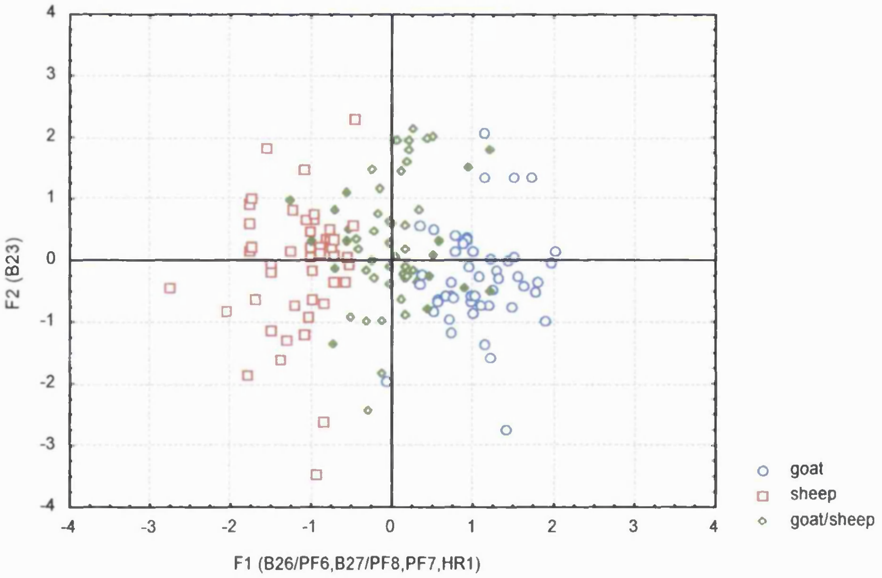
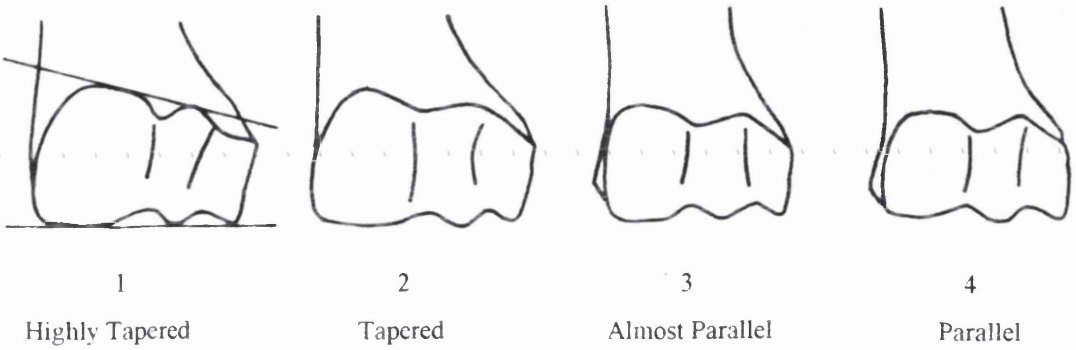


Figure 8.8: Factor Scores of Each Analysed Caprine Distal Scapula

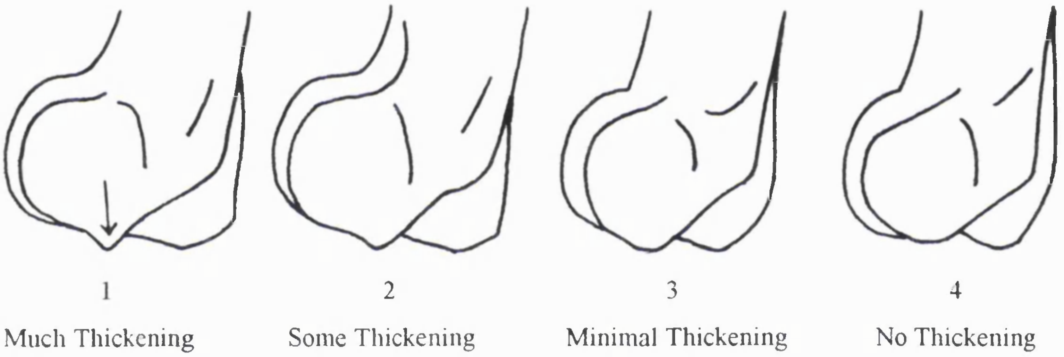
In Figure 8.8 the factor loadings of distal scapulae identified to species in the First Analysis fall into two separate clusters, one consisting of specimens previously identified as goats and the other consisting of specimens previously identified as sheep. This confirms that the clusters are a reflection of the morphological variation between the two species and suggests that all identifications obtained during the First Analysis are correct. The factor loadings of caprine specimens which could not be identified to species during the First Analysis fall into an intermediate cluster. 17 of these previously unidentified specimens, marked solid in Figure 8.8, fall within the range of morphological variation of either goats and sheep as represented by the clusters of previously identified specimens and could therefore be assigned to one species or the other. The remaining 40 unidentified specimens fall in between the goat and sheep clusters and could not be identified to species by this method.

8.4.2: Principal Components Analysis of Caprine Distal Humeri:

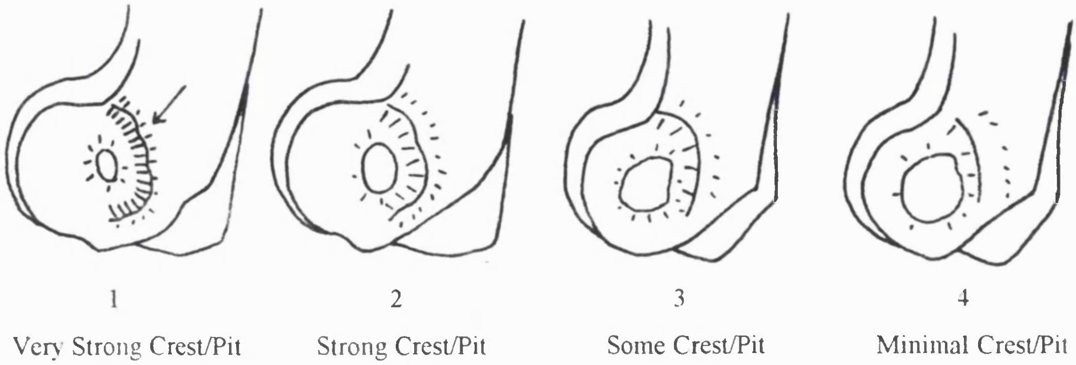
Schematic drawings of the various distal humerus morphological characteristics are provided in Figure 8.9.



Characteristic B33: Form of Trochlea Humeri (Boessneck 1969)



Characteristic B34: Granular Thickening at Lateral Border of Trochlea Surface (Boessneck 1969)



Characteristic B35: Pit of Lateral Epicondyle (Boessneck 1969)

Figure 8.9: Schematic Drawings of Caprine Distal Humerus Morphological Characteristics

1 Not Cut Back

2 Slightly Cut Back

3 Cut Back

4 Heavily Cut Back

Characteristic B36: Form of Distal Part of Medial Epicondyle (Boessneck 1969)

1 Major Drop

2 Drop

3 Slight Drop

4 No Drop

Characteristic U1: Uerpmann's Variation on B36 (Uerpmann pers. comm.)

1 Great Angle

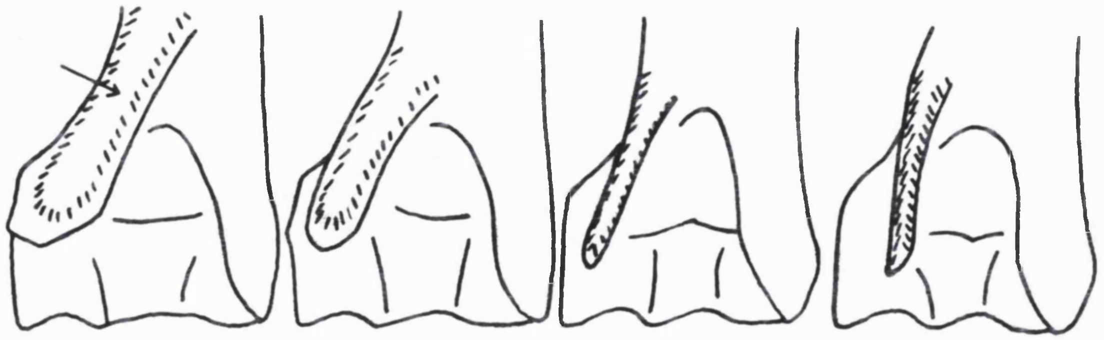
2 Medium Angle

3 Slight Angle

4 Almost Straight

Characteristic PF9: Transition from Shaft to Lateral Epicondyle (Prummel and Frisch 1986)

Figure 8.9 (cont): Schematic Drawings of Caprine Distal Humerus Morphological Characteristics



1 Very Broad Ridge

2 Broad Ridge

3 Sharp Ridge

4 Very Sharp Ridge

Characteristic B15: Transition from Shaft to Lateral Epicondyle (Boessneck 1969)

1 Halfway

2 Just Over Halfway

3 Just Below Top

4 Almost to Top

Characteristic PF10: Articulation at Distal End of Medial Epicondyle (Prummel and Frisch 1986)

1 Short and Very Curved

2 Short and Curved

3 Long and Slightly Curved

4 Long and Parallel

Characteristic AW1: Form of Distal End of Lateral Epicondyle (Wasse n.d.)

Figure 8.9 (cont): Schematic Drawings of Caprine Distal Humerus Morphological Characteristics

The score counts and calculated factor loadings for the various morphological characteristics of caprine humeri are presented in Tables 8.15 and 8.16 respectively.

characteristic	species	n	score 1	score 2	score 3	score 4	missing data
B33	Goat	50	6	18	18	1	7
B33	Sheep	82	13	42	21	0	6
B33	Goat/Sheep	57	10	20	16	2	9
B34	Goat	50	0	10	10	14	16
B34	Sheep	82	5	20	25	9	23
B34	Goat/Sheep	57	0	3	5	11	38
B35	Goat	50	0	7	17	18	8
B35	Sheep	82	12	42	17	5	6
B35	Goat/Sheep	57	4	10	15	12	16
B36	Goat	50	0	4	18	19	9
B36	Sheep	82	27	31	6	0	18
B36	Goat/Sheep	57	3	7	9	0	38
U1	Goat	50	3	11	17	10	9
U1	Sheep	82	14	28	20	3	17
U1	Goat/Sheep	57	3	6	7	4	37
PF9	Goat	50	0	3	22	14	11
PF9	Sheep	82	19	42	8	1	12
PF9	Goat/Sheep	57	4	24	3	6	20
B15	Goat	50	0	12	16	9	13
B15	Sheep	82	17	39	12	0	14
B15	Goat/Sheep	57	3	12	20	0	22
PF10	Goat	50	0	1	7	33	9
PF10	Sheep	82	38	25	2	0	17
PF10	Goat/Sheep	57	2	4	10	1	40
AW1	Goat	50	0	2	20	20	8
AW1	Sheep	82	36	27	6	0	13
AW1	Goat/Sheep	57	1	15	7	0	34

Key: characteristic=see Figure 8.9, species=identification obtained in First Analysis, n=NISP, score X=n specimens scoring X for the particular characteristic, missing data=n specimens on which the particular characteristic was not preserved

Table 8.15: Score Counts for Caprine Distal Humerus Characteristics

Characteristic	Factor 1	Factor 2
B33	0.125455	-0.7151
B34	0.321674	-0.56373
B35	0.554699	-0.45107
B36	0.710232	0.295117
U1	0.371667	0.214533
PF9	0.684588	0.230008
B15	0.599436	-0.06976
PF10	0.826917	0.175986
AW1	0.702	-0.04167
Eigenvalue	3.074049	1.256213
Prp.Totl	0.341561	0.139579

Table 8.16: Factor Loadings for Caprine Distal Humerus Characteristics

(Highest Factor Loadings in Red)

The relative contribution of each characteristic to the overall morphological variation between distal humeri of goats and sheep is demonstrated by the factor loadings in Table 8.16. Factor 1 was affected mainly by PF10, B36, AW1 and PF9 and Factor 2 by B33. As the eigenvalue of both factors is greater than one, the morphological variation incorporated in each factor can be regarded as significant. The five characteristics affecting factors 1 and 2 may thus be regarded as the most reliable criteria by which to make an identification of caprine distal humeri to species and are presented in rank order of reliability in Table 8.17

Rank	Characteristic	Description
1	PF10	Length of facet on distal medial epicondyle
2	B36	Form of distal medial epicondyle
3	AW1	Form of distal lateral epicondyle
4	PF9	Transition from shaft to lateral epicondyle
5	B33	Form of trochlea humeri

Table 8.17: Most Reliable Distal Humerus Characteristics in Rank Order

The factor loadings of each analysed distal humerus are plotted in Figure 8.10.

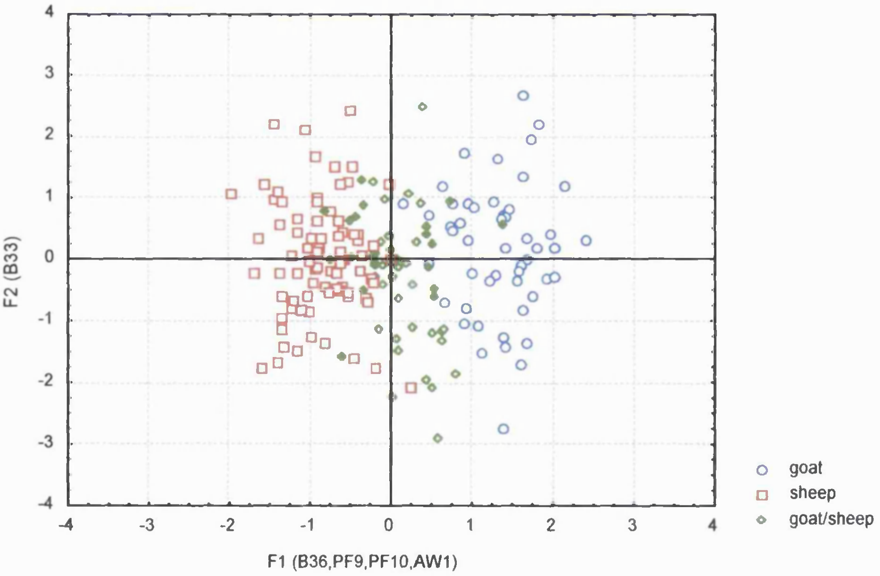


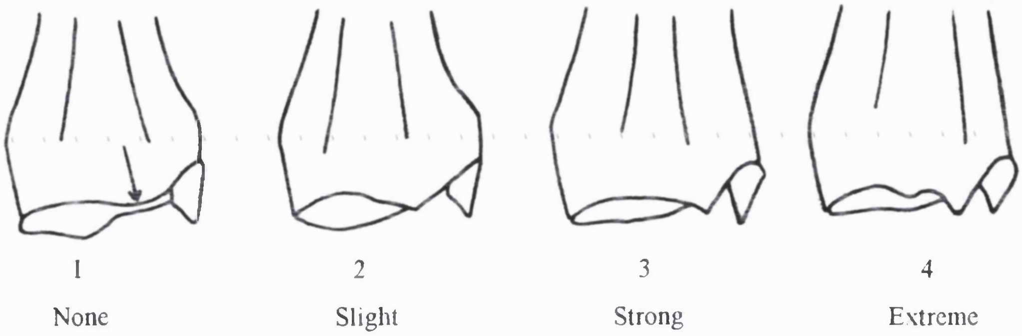
Figure 8.10: Factor Scores of Each Analysed Caprine Distal Humerus

In Figure 8.10 the factor loadings of distal humeri identified to species in the First Analysis fall into two clusters, one consisting of specimens previously identified as goats and the other consisting of specimens previously identified as sheep. This confirms that the clusters are a reflection of the morphological variation between the two species and suggests that all identifications obtained during the First Analysis are correct. The factor loadings of caprine specimens which could not be identified to species during the First

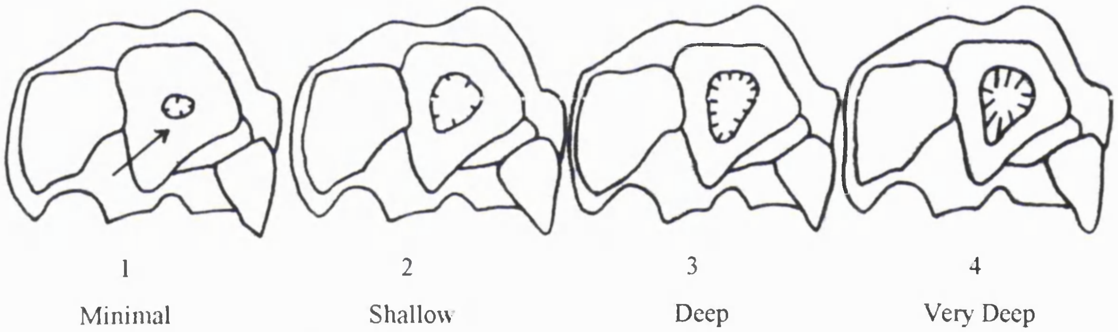
Analysis fall into an intermediate cluster. 21 of these previously unidentified specimens, marked solid in Figure 8.10, fall within the range of morphological variation of either goats and sheep as represented by the clusters of previously identified specimens and could therefore be assigned to one species or the other. The remaining 36 caprine specimens fall in between the goat and sheep clusters and could therefore not be identified to species by this method.

8.4.3: Principal Components Analysis of Caprine Distal Radii:

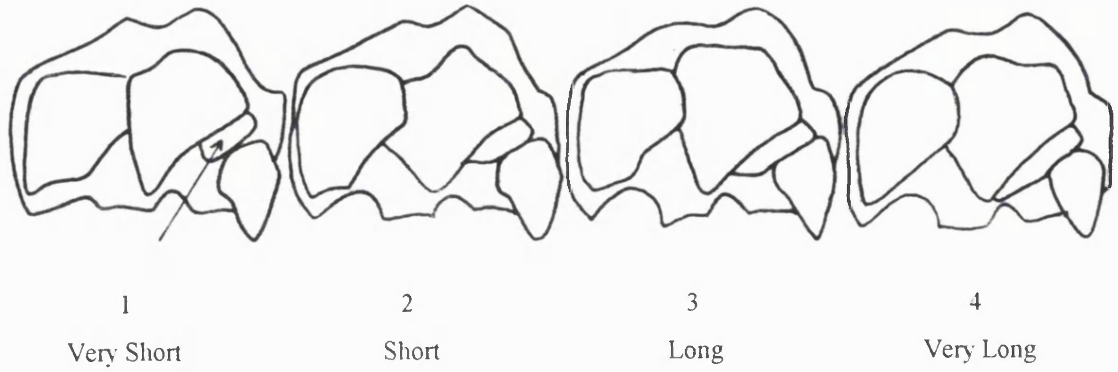
Schematic drawings of the various distal radius morphological characteristics are provided in Figure 8.11.



Characteristic B904: Distal Extension of Dorsal Edge of Intermedium Facet (Boessneck 1969)



Characteristic B42: Indentation in Intermedium Facet (Boessneck 1969)



Characteristic B905: Small Facet on Intermedium Facet (Boessneck 1969)

Figure 8.11: Schematic Drawings of Caprine Distal Radius Morphological Characteristics

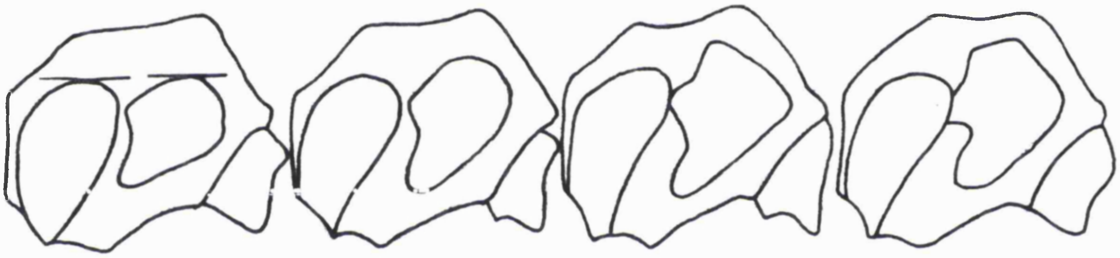
1 Long Drop Shape

2 Short Drop Shape

3 Short, Angular Drop Shape

4 Very Broad and Angular

Characteristic B43: Shape of Radial Facet (Boessneck 1969)



1 Same as Radial Facet

2 Slightly Above Radial Facet

3 Above Radial Facet

4 Well Above Radial Facet

Characteristic B906: Height of Intermedium Facet (Boessneck 1969)

Figure 8.11 (cont): Schematic Drawings of Caprine Distal Radius Morphological Characteristics

The score counts and calculated factor loadings for the various morphological characteristics of caprine radii are presented in Tables 8.15 and 8.16 respectively.

characteristic	species	n	score 1	score 2	score 3	score 4	missing data
B904	Goat	28	0	1	13	14	0
B904	Sheep	38	22	14	1	0	1
B904	Goat/Sheep	3	1	0	1	0	1
B42	Goat	28	0	3	16	9	0
B42	Sheep	38	23	14	1	0	0
B42	Goat/Sheep	3	0	0	0	0	3
B905	Goat	28	0	0	13	15	0
B905	Sheep	38	27	11	0	0	0
B905	Goat/Sheep	3	0	0	0	0	3
B43	Goat	28	0	3	14	8	3
B43	Sheep	38	12	20	5	0	1
B43	Goat/Sheep	3	0	1	2	0	0
B906	Goat	28	18	5	3	0	2
B906	Sheep	38	36	1	0	0	1
B906	Goat/Sheep	3	0	0	0	0	3

Key: characteristic=see Figure 8.11, species=identification obtained in First Analysis, n=NISP, score X=n specimens scoring X for the particular characteristic, missing data=n specimens on which the particular characteristic was not preserved

8.18: Score Counts for Caprine Radius Characteristics

Characteristic	Factor 1	Factor 2
B904	-0.91866	0.031247
B42	-0.91137	0.087294
B905	-0.88255	0.15383
B43	-0.80794	0.199198
B906	-0.45692	-0.88629
Eigenvalue	3.314989	0.857445
Prp.Totl	0.662998	0.171489

8.19: Factor Loadings for Caprine Radius Characteristics (Highest Loadings in Red, Eigenvalue <1.0 in Blue)

The relative contribution of each characteristic to the overall morphological variation between distal radii of goats and sheep is demonstrated by the factor loadings in Table 8.19. Factor 1 was affected mainly by B904, B42, B905 and B43 and Factor 2 by B906. Although the eigenvalue of factor 1 is greater than one, that of factor 2 is not. Therefore only the morphological variation incorporated in factor 1 can be regarded as making a significant contribution to overall morphological variation. The four characteristics affecting factor 1 may thus be regarded as the most reliable criteria by which to make an identification of caprine distal radii to species and are presented in rank order of reliability in Table 8.20.

Rank	Characteristic	Description
1	B904	Distal extension of dorsal edge of intermedium facet
2	B42	Indentation in intermedium facet
3	B905	Small facet on intermedium facet
4	B43	Shape of radial facet

Table 8.20: Most Reliable Distal Radius Characteristics in Rank Order

The factor loadings of each analysed distal radius are plotted in Figure 8.12.

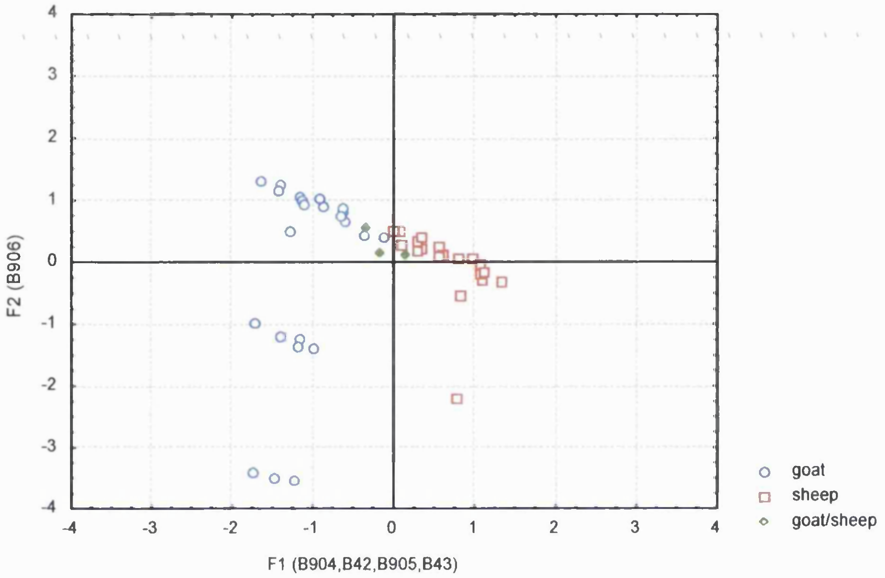
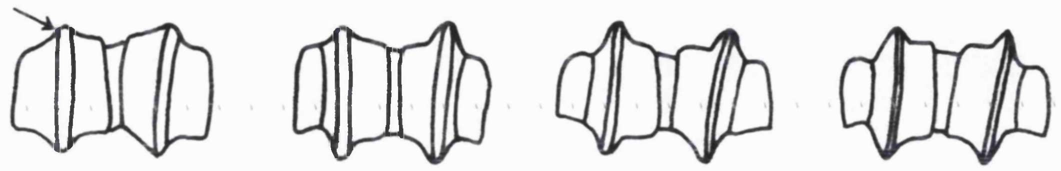


Figure 8.12: Factor Scores of Each Analysed Caprine Distal Radius

When interpreting Figure 8.12 it should be recalled that the eigenvalue of factor 2 for distal radii was less than one (see Table 8.19) and can therefore be ignored. In Figure 8.12 the factor 1 loadings of distal radii identified to species in the First Analysis fall into two clusters, one consisting of specimens previously identified as goats and the other consisting of specimens previously identified as sheep. This confirms that the clusters are a reflection of the morphological variation between the two species and suggests that all identifications obtained during the First Analysis are correct. The factor loadings of caprine specimens which could not be identified to species during the First Analysis fall into an intermediate cluster. All of these previously unidentified specimens, marked solid in Figure 8.12, fall within the range of morphological variation of either goats or sheep as represented by the clusters of previously identified specimens and could therefore be assigned to one species or the other

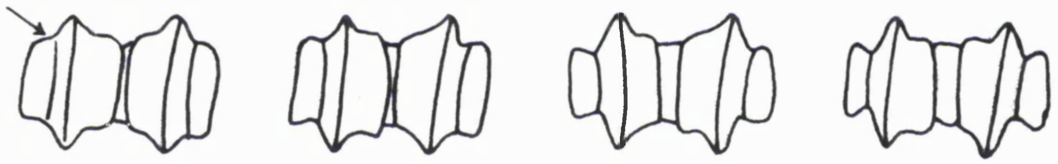
8.4.4: Principal Components Analysis of Caprine Distal Metacarpals:

Schematic drawings of the various distal metacarpal morphological characteristics are provided in Figure 8.13.



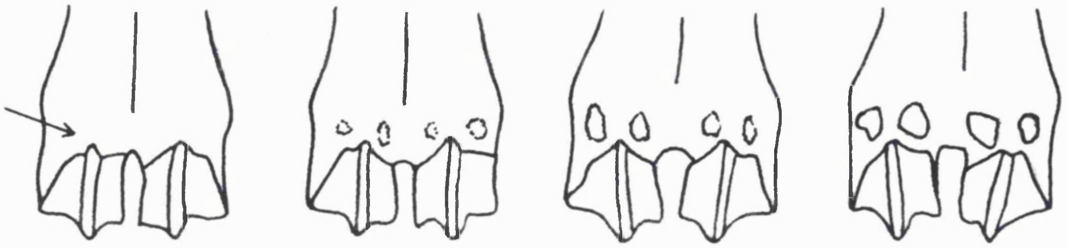
1 Very Rounded | 2 Rounded and Shallow | 3 Sharp and Steep | 4 Very Sharp and Steep

Characteristic B71: Sharpness and Steepness of Verticilli on Trochlea (Boessneck 1969)



1 No Neck | 2 Hint of Neck | 3 Slight Neck | 4 Clear Neck

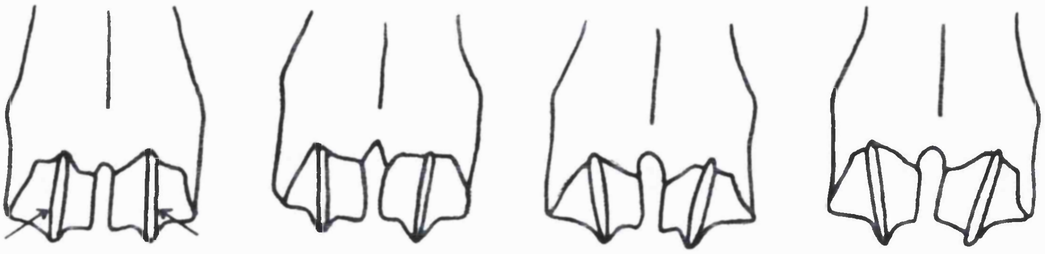
Characteristic B207: Definition of Trochlea by Neck at Verticilli (Boessneck 1969)



1 Minimal | 2 Slightly Developed | 3 Strongly Developed | 4 Very Strongly Developed

Characteristic B208: Extent of Fossulae (Boessneck 1969)

Figure 8.13: Schematic Drawings of Caprine Distal Metacarpal Morphological Characteristics



1 Parallel | 2 Slight Angle | 3 Strong Angle | 4 Very Strong Angle

Characteristic B209: Degree of Convergence of Verticilli (Boessneck 1969)

Figure 8.13 (cont): Schematic Drawings of Caprine Distal Metacarpal Morphological Characteristics

The score counts and calculated factor loadings for the various morphological characteristics of caprine metacarpals are presented in Tables 8.21 and 8.22 respectively.

characteristic	species	n	score 1	score 2	score 3	score 4	missing data
B71	Goat	62	0	7	30	17	8
B71	Sheep	61	3	25	30	1	2
B71	Goat/Sheep	1	0	1	0	0	0
B207	Goat	62	1	12	27	21	1
B207	Sheep	61	14	40	6	0	1
B207	Goat/Sheep	1	0	0	1	0	0
B208	Goat	62	2	10	19	28	3
B208	Sheep	61	25	25	6	0	5
B208	Goat/Sheep	1	1	0	0	0	0
B209	Goat	62	0	5	9	5	43
B209	Sheep	61	8	22	0	0	31
B209	Goat/Sheep	1	0	0	0	0	1

Key: characteristic=see Figure 8.13, species=identification obtained in First Analysis, n=NISP, score X=n specimens scoring X for the particular characteristic, missing data=n specimens on which the particular characteristic was not preserved

Table 8.21: Score Counts for Caprine Metacarpal Characteristics

Characteristic	Factor 1	Factor 2
B71	-0.6548	0.275478
B207	-0.81479	0.198062
B208	-0.80357	0.155232
B209	-0.57433	-0.81226
Eigenvalue	2.068217	0.798978
Prp.Totl	0.517054	0.199745

Table 8.22: Factor Loadings for Caprine Metacarpal Characteristics (Highest Factor Loadings in Red, Eigenvalue <1.0 in Blue)

The relative contribution of each characteristic to the overall morphological variation between distal metacarpals of goats and sheep is demonstrated by the factor loadings in Table 8.22. Factor 1 was affected mainly by B207 and B208 and Factor 2 by B209. Although the eigenvalue of factor 1 is greater than one, that of factor 2 is not. Therefore only the morphological variation incorporated in factor 1 can be regarded as making a significant contribution to overall morphological variation. The two characteristics affecting factor 1 may thus be regarded as the most reliable criteria by which to make an identification of caprine distal metacarpals to species and are presented in rank order of reliability in Table 8.23.

Rank	Characteristic	Description
1	B207	Definition of trochlear by neck at verticilli
2	B208	Extent of fossulae

Table 8.23: Most Reliable Distal Metacarpal Characteristics in Rank Order

The factor loadings of each analysed distal metacarpal are plotted in Figure 8.14.

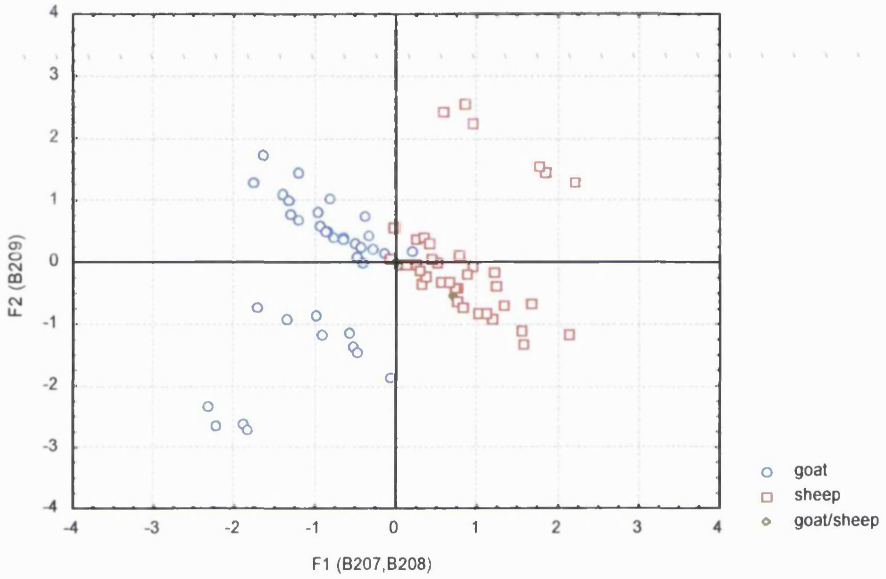
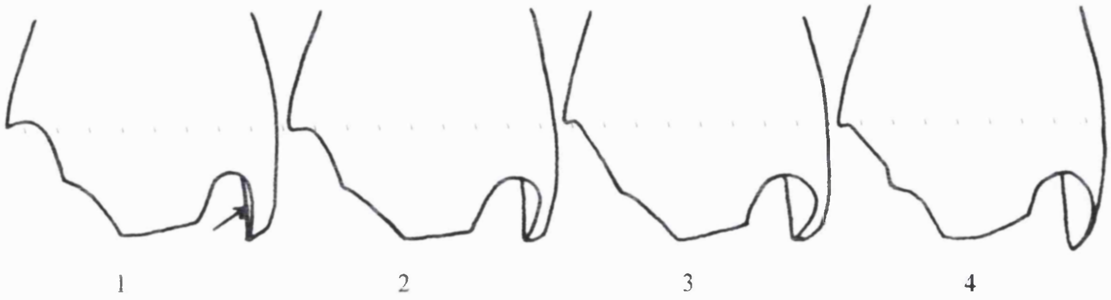


Figure 8.14: Factor Scores of Each Analysed Caprine Distal Metacarpal

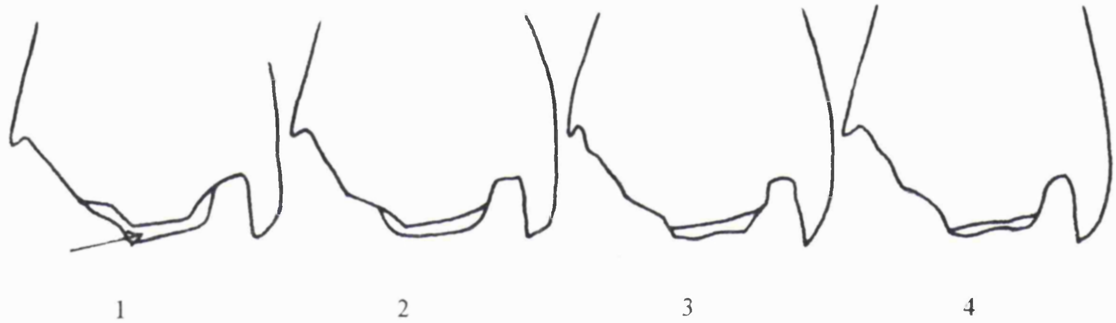
When interpreting Figure 8.14 it should be recalled that the eigenvalue of factor 2 for distal metacarpals was less than one (see Table 8.22) and can therefore be ignored. The factor 1 loadings of specimens identified to species in the First Analysis fall into two clusters, one consisting of specimens previously identified as goats and the other consisting of specimens previously identified as sheep. This confirms that the clusters are a reflection of the morphological variation between the two species. However, the two clusters overlap slightly and seven specimens identified during the First Analysis lie within the zone of overlap. As a result not all of these identifications can be confirmed by this method. Fortunately in the case of the distal metacarpal, all identifications obtained during the First Analysis were confirmed by the metrical Second Analysis. The single specimen which could not be identified to species during the First Analysis falls within the range of morphological variation of sheep and could therefore be assigned to this species, as it was in the Second Analysis.

8.4.5: Principal Components Analysis of Caprine Distal Tibiae:

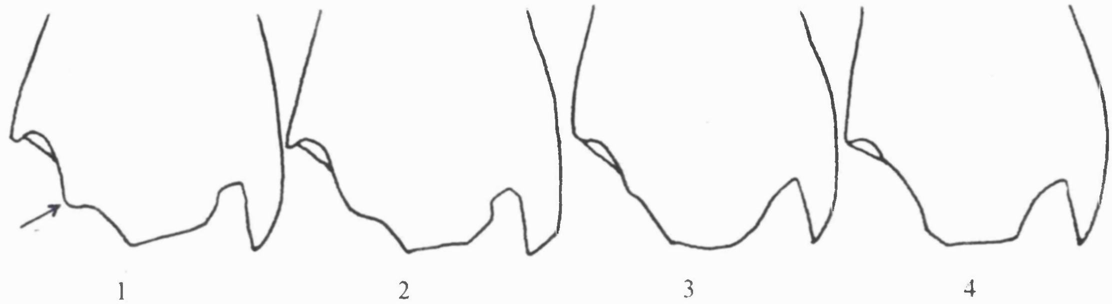
Schematic drawings of the various distal tibia morphological characteristics are provided in Figure 8.15.



Characteristic K1: Periphery of Medial Articular Surface on Prominence (dorsal view)
(Kratochvil 1969)

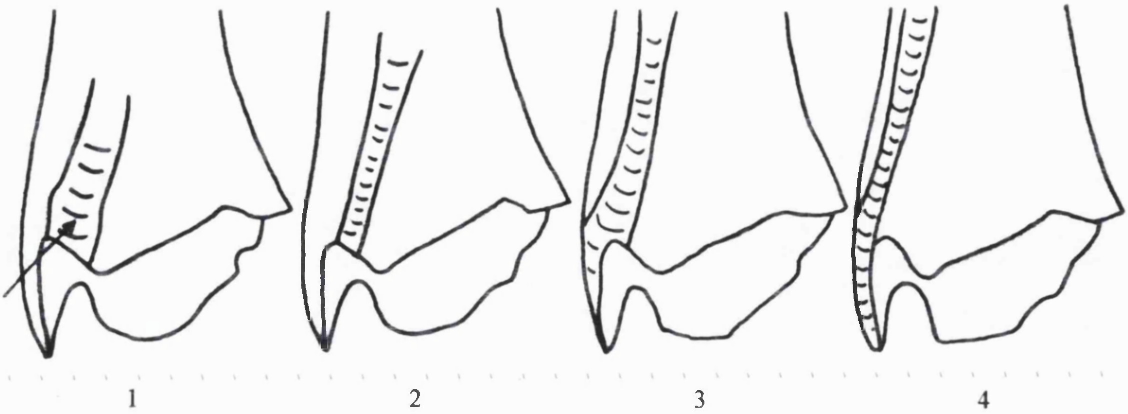


Characteristic K2: Distal Articular Surface (dorsal view)
(Kratochvil 1969)

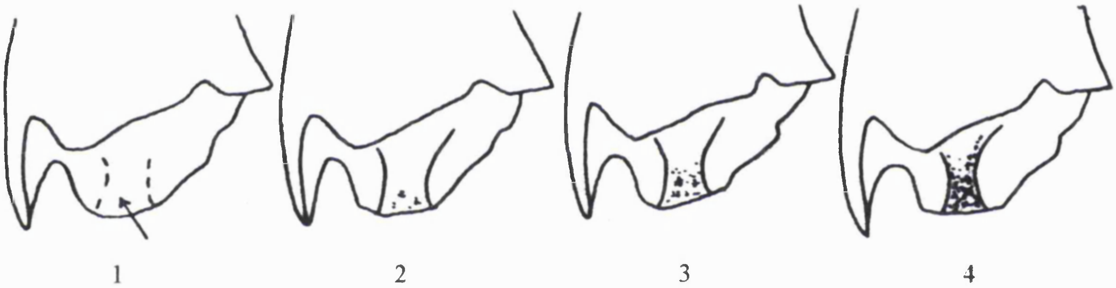


Characteristic K3: Periphery of Dorsal Prominence on Lateral Side (dorsal view)
(Kratochvil 1969)

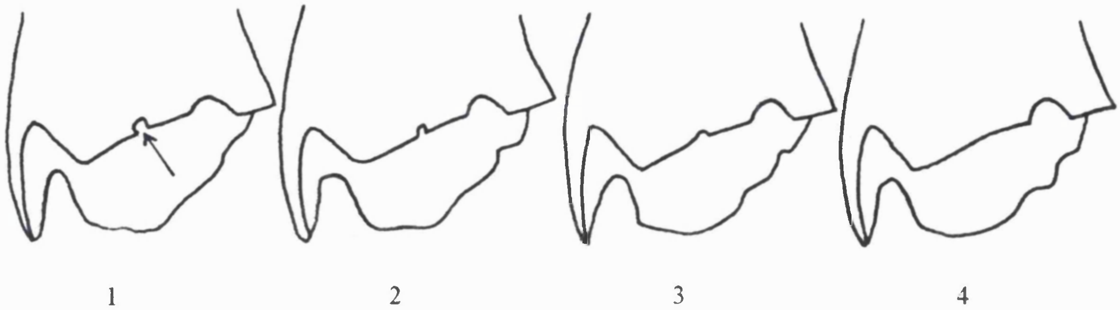
Figure 8.15: Schematic Drawings of Caprine Distal Tibia Morphological Characteristics



Characteristic K4: Sulcus Malleolaris (plantar view)
(Kratochvil 1969)

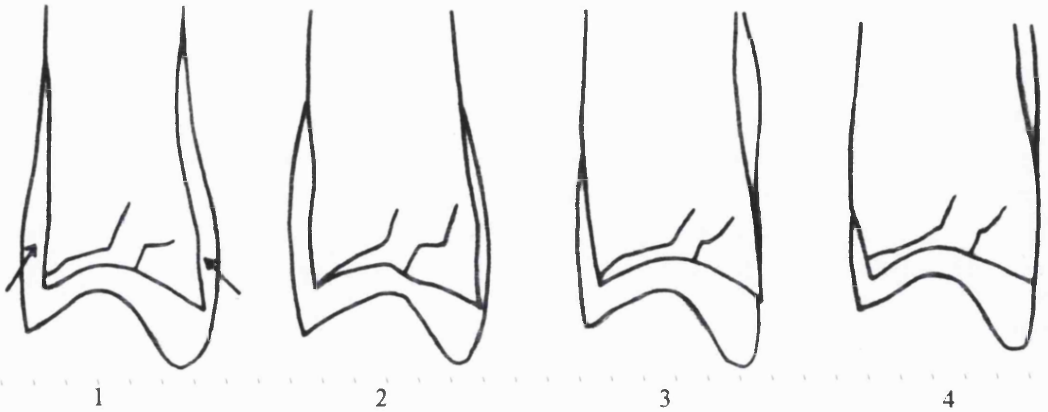


Characteristic K5: Articular Surface and Synovial Foveola on Dorsal Prominence (plantar view)
(Kratochvil 1969)

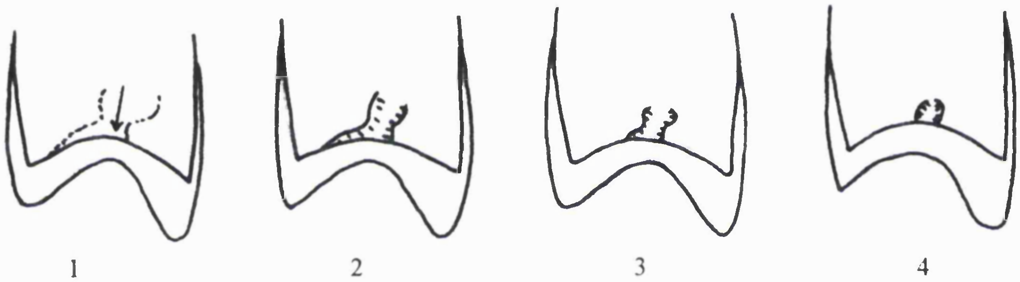


Characteristic K6: Prolapse in Middle of Plantar Edge of Articular Surface (palmar view)
(Kratochvil 1969)

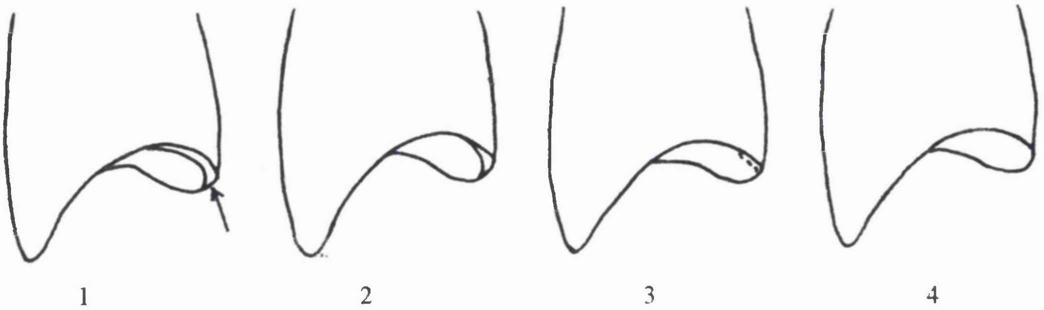
Figure 8.15 (cont): Schematic Drawings of Caprine Distal Tibia Morphological Characteristics



Characteristic K7: Visibility of Medial Half of Tibia (lateral view)
(Kratochvil 1969)

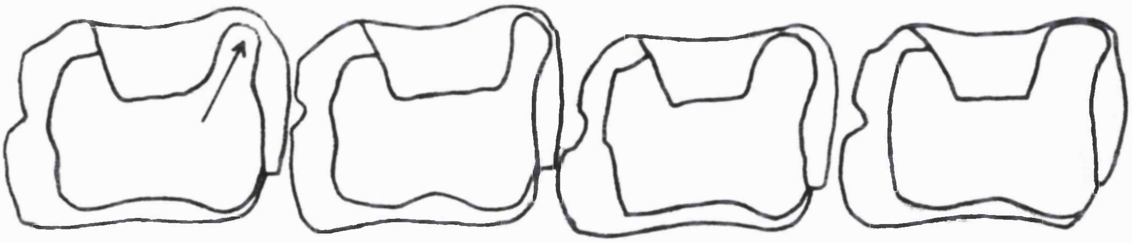


Characteristic K8: Incision and Articular Surface for Os Malleolare (lateral view)
(Kratochvil 1969)

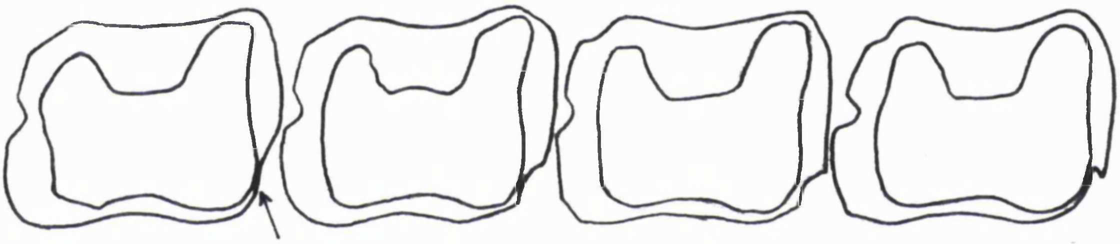


Characteristic K9: Lip on Medio-Plantar Limbus of Articular Surface (medial view)
(Kratochvil 1969)

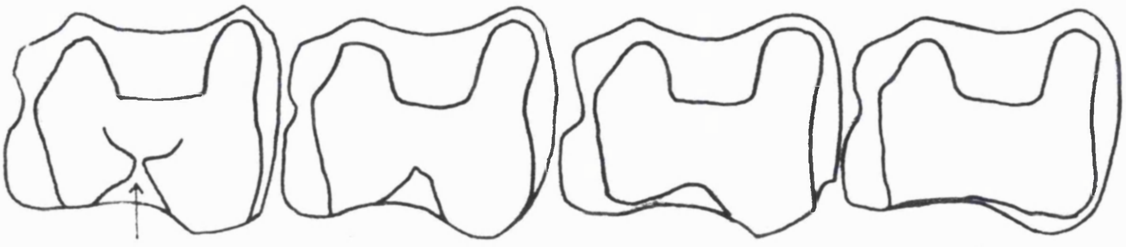
Figure 8.15 (cont): Schematic Drawings of Caprine Distal Tibia Morphological Characteristics



Characteristic K10: Dorso-Medial Section of Articular Surface (distal view)
(Kratochvil 1969)

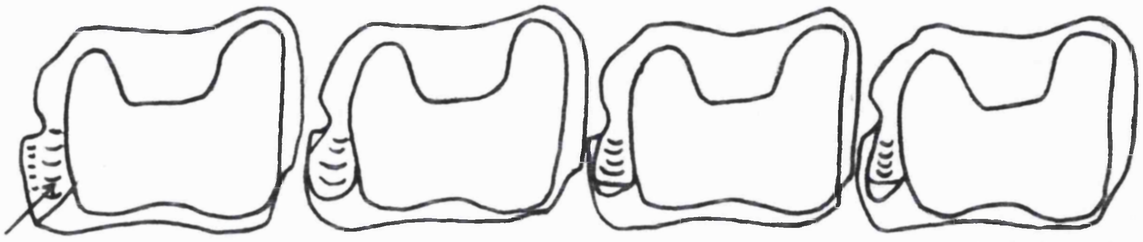


Characteristic K11: Sulcus Malleolaris (distal view)
(Kratochvil 1969)



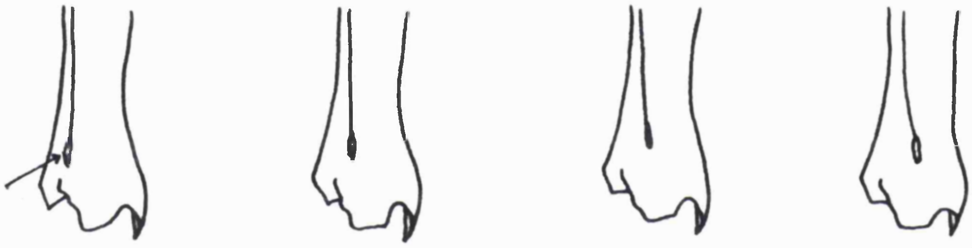
Characteristic K12: Interruption of Plantar Limbus of Articular Surface (distal view)
(Kratochvil 1969)

Figure 8.15 (cont): Schematic Drawings of Caprine Distal Tibia Morphological Characteristics



Characteristic K13: Articular Surface for Os Malleolare (distal view)

(Kratochvil 1969)



Characteristic K14: Protuberantia on Anterior Face

(Kratochvil 1969)

Figure 8.15 (cont): Schematic Drawings of Caprine Distal Tibia Morphological Characteristics

The score counts and calculated factor loadings for the various morphological characteristics of caprine tibiae are presented in Tables 8.24 and 8.25 respectively.

characteristic	Species	n	score 1	score 2	score 3	score 4	missing data
K1	Goat	49	0	0	16	22	11
K1	Sheep	48	5	19	3	0	21
K1	Goat/Sheep	44	1	9	12	5	17
K2	Goat	49	0	7	29	11	2
K2	Sheep	48	22	20	2	0	4
K2	Goat/Sheep	44	10	16	11	2	5
K3	Goat	49	0	9	27	12	1
K3	Sheep	48	8	17	18	4	1
K3	Goat/Sheep	44	7	15	14	5	3
K4	Goat	49	0	7	23	8	11
K4	Sheep	48	22	17	2	0	7
K4	Goat/Sheep	44	4	20	9	1	10
K5	Goat	49	5	11	11	12	10
K5	Sheep	48	10	21	4	1	12
K5	Goat/Sheep	44	6	11	7	3	17
K6	Goat	49	0	0	8	38	3
K6	Sheep	48	3	12	15	17	1
K6	Goat/Sheep	44	1	5	10	24	4
K7	Goat	49	0	0	21	17	11
K7	Sheep	48	12	19	9	1	7
K7	Goat/Sheep	44	3	11	18	3	9
K8	Goat	49	0	3	24	12	10
K8	Sheep	48	9	24	13	1	1
K8	Goat/Sheep	44	4	10	18	3	9
K9	Goat	49	0	1	11	27	10
K9	Sheep	48	6	16	11	4	11
K9	Goat/Sheep	44	2	4	13	8	17
K10	Goat	49	0	7	19	18	5
K10	Sheep	48	14	22	2	0	10
K10	Goat/Sheep	44	7	9	15	1	12
K11	Goat	49	0	17	13	9	10
K11	Sheep	48	18	15	10	1	4
K11	Goat/Sheep	44	7	9	18	8	2
K12	Goat	49	0	4	31	12	2
K12	Sheep	48	18	23	6	0	1
K12	Goat/Sheep	44	6	15	19	1	3
K13	Goat	49	2	13	22	6	6
K13	Sheep	48	13	25	4	0	6
K13	Goat/Sheep	44	9	19	9	0	7
K14	Goat	49	0	9	11	4	25
K14	Sheep	48	16	10	0	0	22
K14	Goat/Sheep	44	2	10	4	0	28

Key: characteristic=see Figure 8.15, species=identification obtained in First Analysis, n=NISP, score X=n specimens scoring X for the particular characteristic, missing data=n specimens on which the particular characteristic was not preserved

Table 8.24: Score Counts for Caprine Tibia Characteristics

Characteristic	Factor 1	Factor 2
K1	0.644989	0.106749
K2	0.700887	0.120218
K3	0.368706	-0.40635
K4	0.720177	-0.30098
K5	0.294747	0.51794
K6	0.55653	0.40684
K7	0.685734	0.077343
K8	0.608301	-0.33316
K9	0.584178	-0.1414
K10	0.660533	0.24578
K11	0.471431	-0.42153
K12	0.689869	0.389662
K13	0.604428	-0.2159
K14	0.563579	-0.06267
Eigenvalue	4.957404	1.292784
Prp.Totl	0.3541	0.092342

Table 8.25: Factor Loadings for Caprine Tibia Characteristics (Highest Factor Loadings in Red)

The relative contribution of each characteristic to the overall morphological variation between distal tibiae of goats and sheep is demonstrated by the factor loadings in Table 8.25. Factor 1 was affected mainly by K4, K2, K12, K7, K10 and K1 and Factor 2 by K5, K11 and K3. As the eigenvalue of both factors is greater than one, the morphological variation incorporated in each factor can be regarded as significant. The nine characteristics affecting factors 1 and 2 may thus be regarded as the most reliable criteria by which to make an identification of caprine distal tibiae to species and are presented in rank order of reliability in Table 8.26.

Rank	Characteristic	Description
1	K4	Sulcus malleolaris (plantar view)
2	K2	Distal articular surface (dorsal view)
3	K12	Interruption of plantar limbus of articular surface (distal view)
4	K7	Visibility of medial half of tibia (lateral view)
5	K10	Dorso-medial section of articular surface (distal view)
6	K1	Periphery of medial articular surface on prominence (dorsal view)
7	K5	Articular surface and synoveal foveola on plantar dorsal prominence
8	K11	Sulcus malleolaris (distal view)
9	K3	Periphery of lateral side of dorsal prominence (dorsal view)

Table 8.26: Most Reliable Distal Tibia Characteristics in Rank Order

The factor loadings of each analysed distal tibia are plotted in Figure 8.16

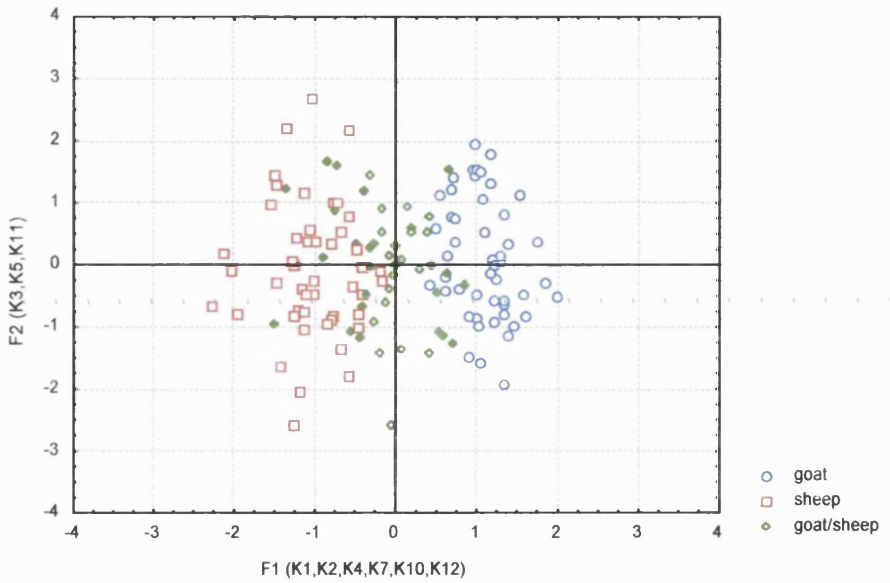


Figure 8.16: Factor Scores of Each Analysed Caprine Distal Tibia

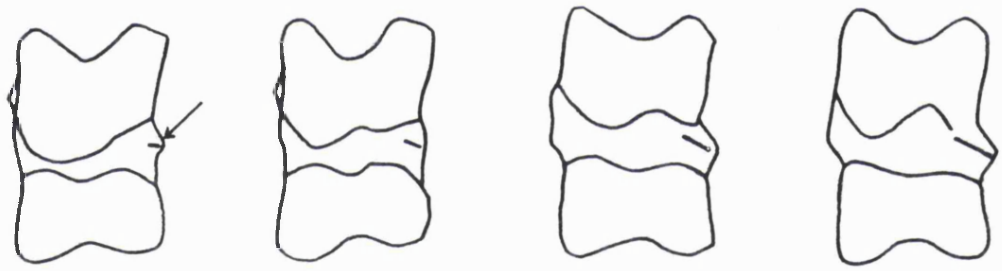
In Figure 8.16 the factor loadings of distal tibiae identified to species in the First Analysis fall into two separate clusters, one consisting of specimens previously identified as goats and the other consisting of specimens previously identified as sheep. This confirms that the clusters are a reflection of the morphological variation between the two species and suggests that all identifications obtained during the First Analysis are correct. The factor loadings of caprine specimens which could not be identified to species during the First Analysis fall into an intermediate cluster. 23 of these previously unidentified specimens, marked solid in Figure 8.16, fall within the range of morphological variation of either goats and sheep as represented by the clusters of previously identified specimens and could therefore be assigned to one species or the other. The remaining 21 unidentified specimens fall in between the goat and sheep clusters and could not be identified to species by this method.

8.4.6: Principal Components Analysis of Caprine Astragali:

Schematic drawings of the various astragalus morphological characteristics are provided in Figure 8.17.

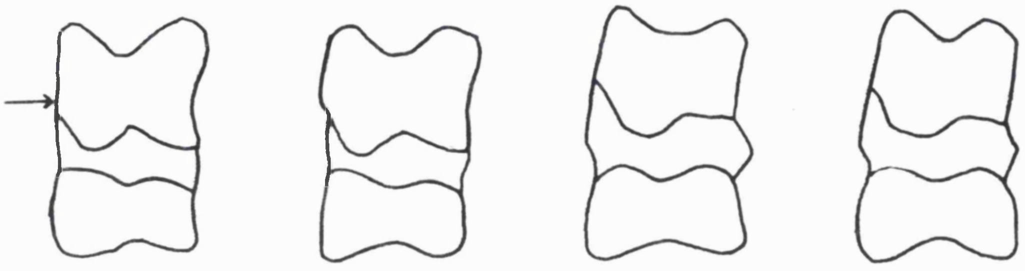
1	2	3	4
Very High	High	Medium	Low

Characteristic B51: Projection at Proximo-Plantar Angle of Medial Articular Ridge (Boessneck 1969)



1	2	3	4
Small and Horizontal	Small and Angled	Large and Angled	Large and Highly Angled

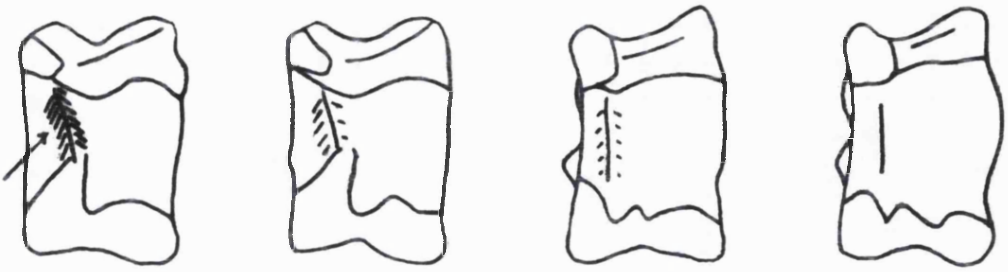
Characteristic B62: Distal End of Medial Articular Ridge (Boessneck 1969)



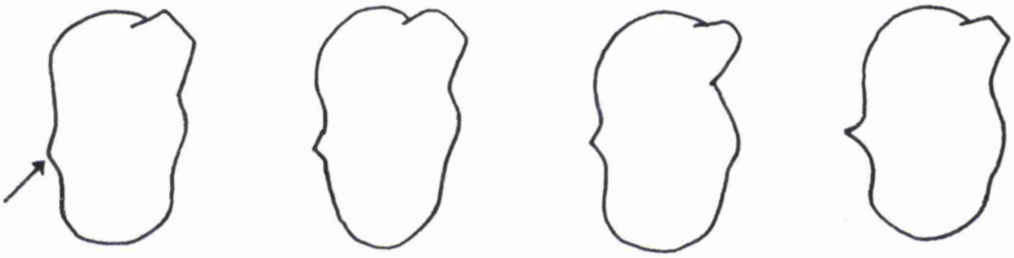
1	2	3	4
Straight	Slightly Angled	Angled	Highly Angled

Characteristic B63: Lateral Articular Ridge (Boessneck 1969)

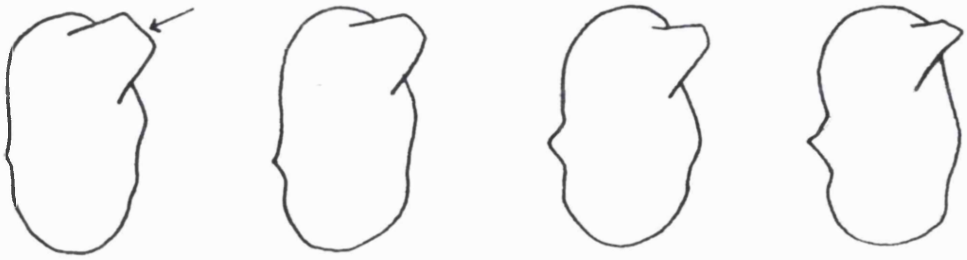
Figure 8.17: Schematic Drawings of Caprine Astragalus Morphological Characteristics


1 Very Strong Ridge
2 Strong Ridge
3 Hint of Ridge
4 No Ridge

Characteristic B64: Articular Surface for Calcaneum (Boessneck 1969)


1 Hint
2 Weak
3 Large
4 Very Large

Characteristic PF26: Protuberance on Medial-Antero Face (Prummel and Frisch 1986)


1 Rectangular
2 Angular
3 Pointed
4 Very Pointed

Characteristic PF27: End of Medial Condyle (Prummel and Frisch 1986)

Figure 8.17 (cont): Schematic Drawings of Caprine Astragalus Morphological Characteristics

Falls Over **Wobbles but Stays Upright**

1 2 3 4

Characteristic PF28: Capsize Test (Prummel and Frisch 1986)

Figure 8.17 (cont): Schematic Drawings of Caprine Astragalus Morphological Characteristics

The score counts and calculated factor loadings for the various morphological characteristics of caprine astragali are presented in Tables 8.27 and 8.28 respectively.

characteristic	species	n	score 1	score 2	score 3	score 4	missing data
B51	Goat	105	0	0	35	51	19
B51	Sheep	90	36	36	11	0	7
B51	Goat/Sheep	25	1	6	3	3	12
B62	Goat	105	0	6	43	42	14
B62	Sheep	90	46	38	3	0	3
B62	Goat/Sheep	25	3	8	7	1	6
B63	Goat	105	2	25	48	20	10
B63	Sheep	90	46	36	4	0	4
B63	Goat/Sheep	25	5	3	7	1	9
B64	Goat	105	0	6	45	47	7
B64	Sheep	90	44	36	4	0	6
B64	Goat/Sheep	25	2	4	8	1	10
PF26	Goat	105	0	30	37	20	18
PF26	Sheep	90	57	20	4	0	9
PF26	Goat/Sheep	25	3	5	4	1	12
PF27	Goat	105	0	13	29	37	26
PF27	Sheep	90	11	44	16	1	18
PF27	Goat/Sheep	25	0	5	4	1	15
PF28	Goat	105	4	1	4	75	21
PF28	Sheep	90	71	3	1	5	10
PF28	Goat/Sheep	25	9	1	0	6	9

Key: characteristic=see Figure 8.17, species=identification obtained in First Analysis, n=NISP, score X=n specimens scoring X for the particular characteristic, missing data=n specimens on which the particular characteristic was not preserved

Table 8.27: Score Counts for Caprine Astragalus Characteristics

Characteristic	Factor 1	Factor 2
B51	0.849438	0.14709
B62	0.846567	0.09876
B63	0.70534	-0.48773
B64	0.808618	-0.20372
PF26	0.788942	0.20899
PF27	0.680041	0.529302
PF28	0.798753	-0.28123
Eigenvalue	4.312481	0.713698
Prp.Totl	0.616069	0.101957

Table 8.28: Factor Loadings for Caprine Astragalus Characteristics (Highest Factor Loadings in Red, Eigenvalue <1.0 in Blue)

The relative contribution of each characteristic to the overall morphological variation between astragali of goats and sheep is demonstrated by the factor loadings in Table 8.28. Factor 1 was affected mainly by B51, B62, B64, PF28 and PF26 and Factor 2 by PF27 and B63. Although the eigenvalue of factor 1 is greater than one, that of factor 2 is not. Therefore only the morphological variation incorporated in factor 1 can be regarded as making a significant contribution to overall morphological variation. The five characteristics affecting factor 1 may thus be regarded as the most reliable criteria by which to make an identification of caprine astragali to species and are presented in rank order of reliability in Table 8.29.

Rank	Characteristic	Description
1	B51	Projection at proximo-plantar angle of medial articular ridge
2	B62	Distal end of medial articular ridge
3	B64	Articular surface for calcaneum
4	PF28	Capsize test
5	PF26	Protuberance on medial-antero face

Table 8.29: Most Reliable Astragalus Characteristics in Rank Order

The factor loadings of each analysed astragalus are plotted in Figure 8.18.

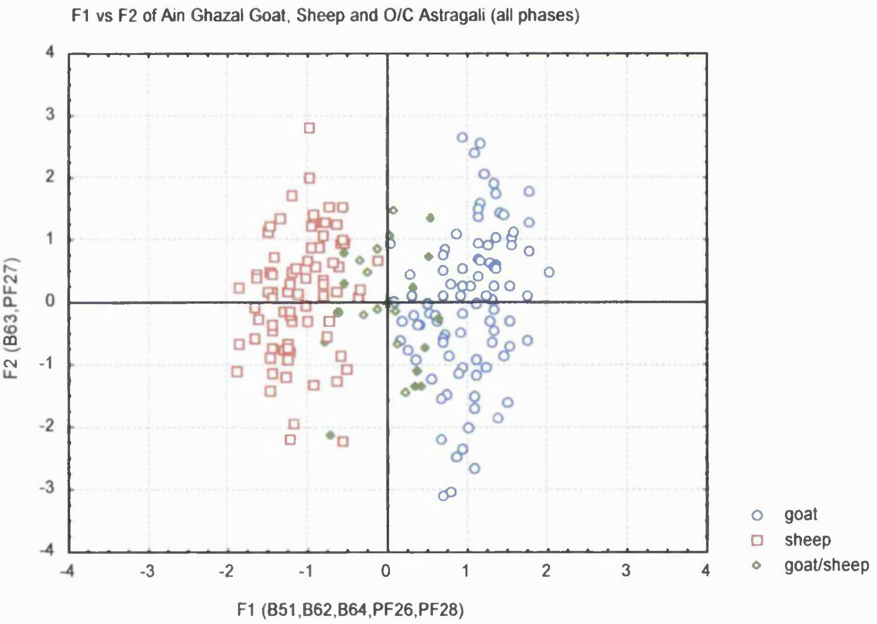
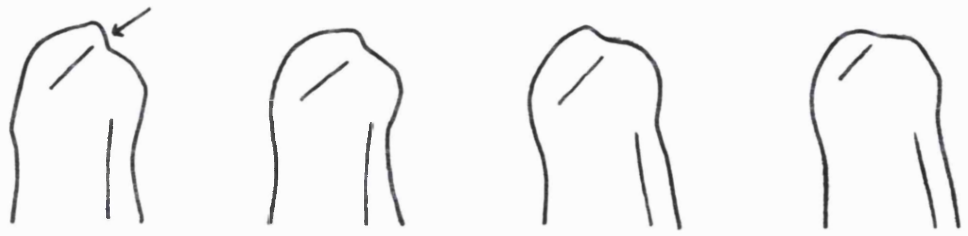


Figure 8.18: Factor Scores of Each Analysed Caprine Astragalus

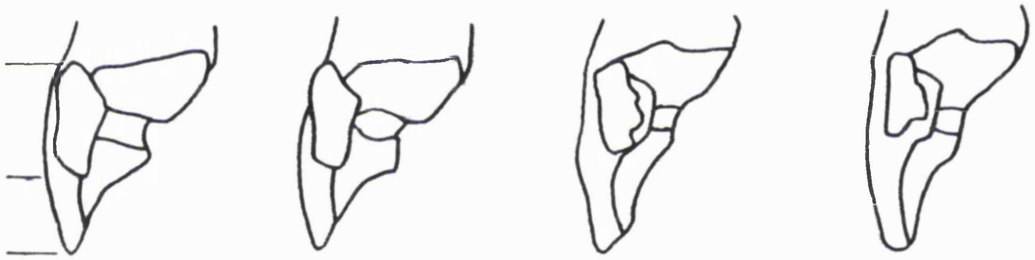
When interpreting Figure 8.18 it should be recalled that the eigenvalue of factor 2 for astragali was less than one (see Table 8.28) and can therefore be ignored. The factor 1 loadings of astragali identified to species during the First Analysis fall into two clusters, one consisting of specimens previously identified as goats and the other consisting of specimens previously identified as sheep. This confirms that the clusters are a reflection of the morphological variation between the two species and suggests that all identifications obtained during the First Analysis are correct. The factor loadings of caprine specimens which could not be identified to species during the First Analysis fall into an intermediate cluster. 15 of these previously unidentified specimens, marked solid in Figure 8.18, fall within the range of morphological variation of either goats and sheep as represented by the clusters of previously identified specimens and could therefore be assigned to one species or the other. The remaining 10 unidentified specimens fall in between the goat and sheep clusters and could not be identified to species by this method.

8.4.7: Principal Components Analysis of Caprine Calcanea:

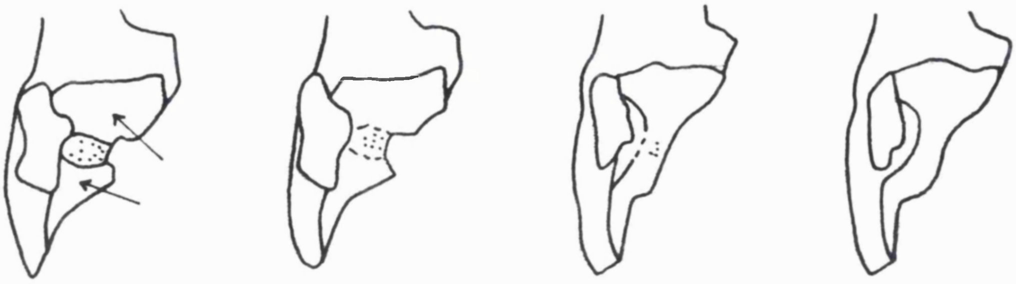
Schematic drawings of the various calcaneum morphological characteristics are provided in Figure 8.19.



Characteristic B65: Top of Tuber Calcanei (Boessneck 1969)

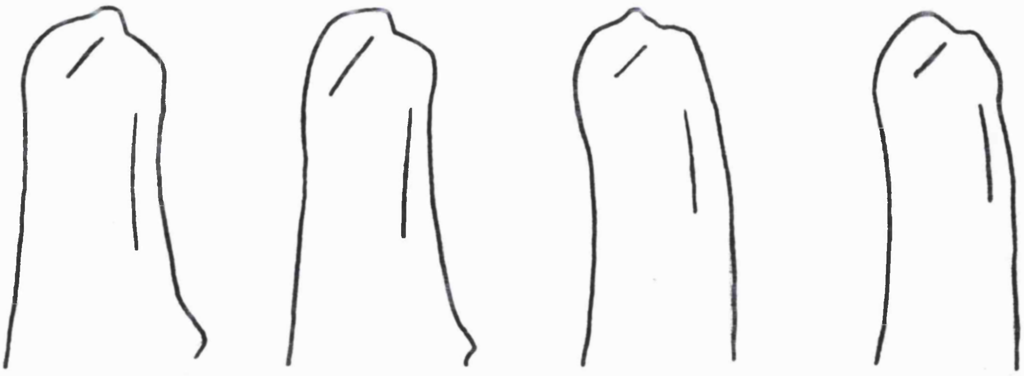


Characteristic B66: Articular Area of Lateral Process (Boessneck 1969)



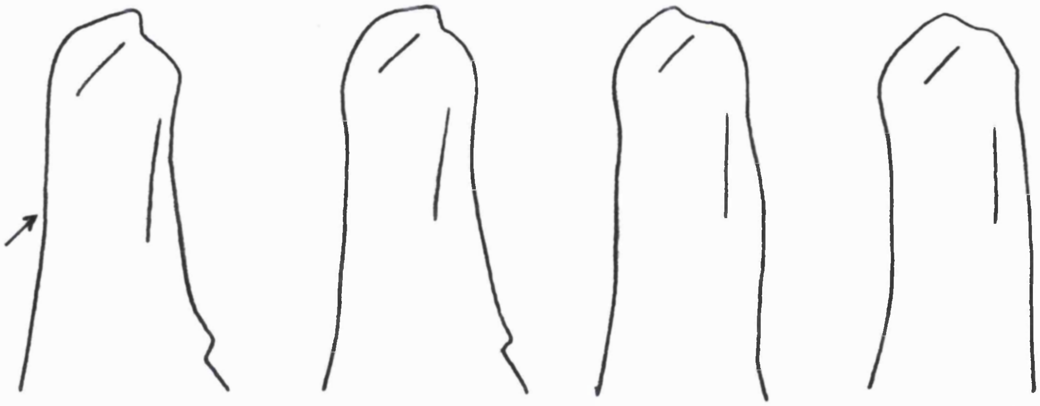
Characteristic B68: Articular Surface for Astragalus (Boessneck 1969)

Figure 8.19: Schematic Drawings of Caprine Calcaneum Morphological Characteristics



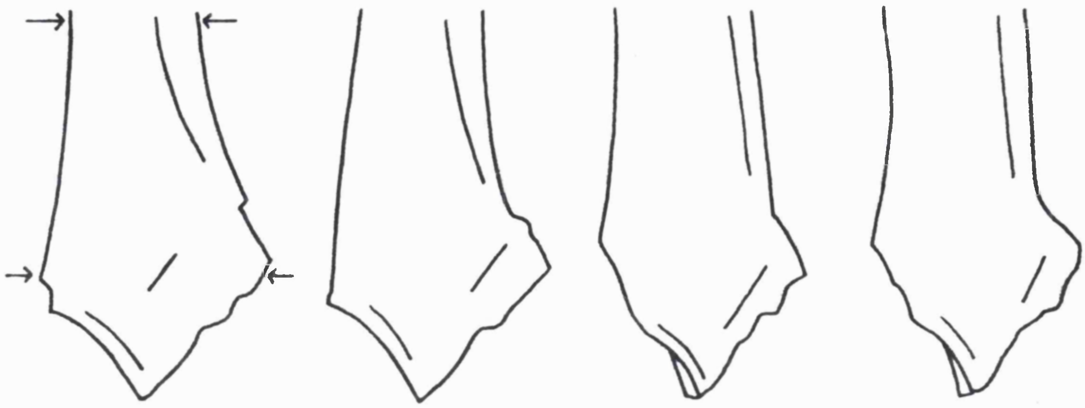
1 Very Broad and Short | 2 Broad and Short | 3 Long and Narrow | 4 Very Long and Narrow

Characteristic B401: Length and Build of Shaft (Boessneck 1969)



1 No Curve | 2 Slight Curve | 3 Strong Curve | 4 Very Strong Curve

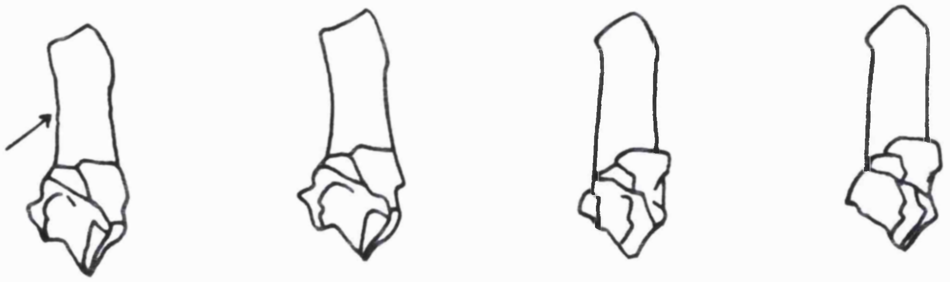
Characteristic B402: Extent of Plantar Curve of Shaft (Boessneck 1969)



1 Much Widening | 2 Some Widening | 3 Slight Widening | 4 Minimal Widening

Characteristic B403: Extent of Distal Widening (Boessneck 1969)

Figure 8.19 (cont): Schematic Drawings of Caprine Calcaneum Morphological Characteristics



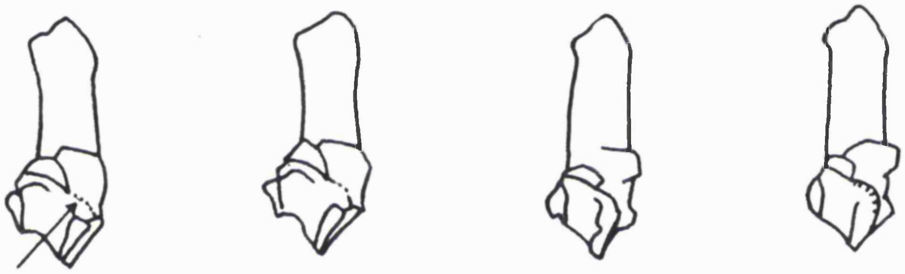
1 Strongly Concave

2 Concave

3 Straight

4 Convex

Characteristic PF29: Curve of Corpus Calcanei (Prummel and Frisch 1986)



1 Obvious Hollow

2 Slight Hollow

3 Ridge

4 Clear Ridge

Characteristic PF30: Shape Between Sustenaculum Tali and Medial Articular Surface of Processus Anterior (Prummel and Frisch 1986)

Figure 8.19 (cont): Schematic Drawings of Caprine Calcaneum Morphological Characteristics

The score counts and calculated factor loadings for the various morphological characteristics of caprine calcanea are presented in Tables 8.30 and 8.31 respectively.

characteristic	Species	n	score 1	score 2	score 3	score 4	missing data
B65	Goat	46	0	4	10	8	24
B65	Sheep	43	2	14	6	0	21
B65	Goat/Sheep	26	0	2	4	0	20
B66	Goat	46	0	1	16	20	9
B66	Sheep	43	12	16	6	0	9
B66	Goat/Sheep	26	2	3	9	3	9
B68	Goat	46	0	0	10	33	3
B68	Sheep	43	23	11	5	1	3
B68	Goat/Sheep	26	3	4	4	2	13
B401	Goat	46	0	3	17	14	12
B401	Sheep	43	5	14	13	2	9
B401	Goat/Sheep	26	0	10	6	2	8
B402	Goat	46	3	16	13	4	10
B402	Sheep	43	19	17	1	0	6
B402	Goat/Sheep	26	7	9	4	0	6
B403	Goat	46	0	7	15	15	9
B403	Sheep	43	8	15	14	0	6
B403	Goat/Sheep	26	2	12	3	3	6
PF29	Goat	46	0	1	19	18	8
PF29	Sheep	43	9	22	5	1	6
PF29	Goat/Sheep	26	1	9	12	0	4
PF30	Goat	46	0	0	12	31	3
PF30	Sheep	43	21	10	7	0	5
PF30	Goat/Sheep	26	3	3	10	2	8

Key: characteristic=see Figure 8.19, species=identification obtained in First Analysis, n=NISP, score X=n specimens scoring X for the particular characteristic, missing data=n specimens on which the particular characteristic was not preserved

Table 8.30: Score Counts for Caprine Calcaneum Characteristics

Characteristic	Factor 1	Factor 2
B65	0.518016	-0.1657
B66	0.592948	0.51324
B68	0.803055	0.439678
B401	0.580298	-0.60799
B402	0.633469	-0.09386
B403	0.702952	-0.52887
PF29	0.763126	-0.16539
PF30	0.793016	0.427081
Eigenvalue	3.708234	1.352102
Prp.Totl	0.463529	0.169013

Table 8.31: Factor Loadings for Caprine Calcaneum Characteristics (Highest Factor Loadings in Red)

The relative contribution of each characteristic to the overall morphological variation between calcanea of goats and sheep is demonstrated by the factor loadings in Table 8.31. Factor 1 was affected mainly by B68, PF30 and PF29 and factor 2 by B401, B403 and B66. As the eigenvalue of both factors is greater than one, the morphological variation incorporated in each factor can be regarded as significant. The six characteristics affecting factors 1 and 2 may thus be regarded as the most reliable criteria by which to make an identification of caprine calcanea to species and are presented in rank order of reliability in Table 8.32.

Rank	Characteristic	Description
1	B68	Articular surface for astragalus
2	PF30	Shape between sustenaculum tali and med. artic. surface of anterior process
3	PF29	Curve of corpus calcanei
4	B401	Length and build of shaft
5	B403	Extent of distal widening
6	B66	Articular area of lateral process

Table 8.32: Most Reliable Calcaneum Characteristics in Rank Order

The factor loadings of each analysed calcaneum are plotted in Figure 8.20.

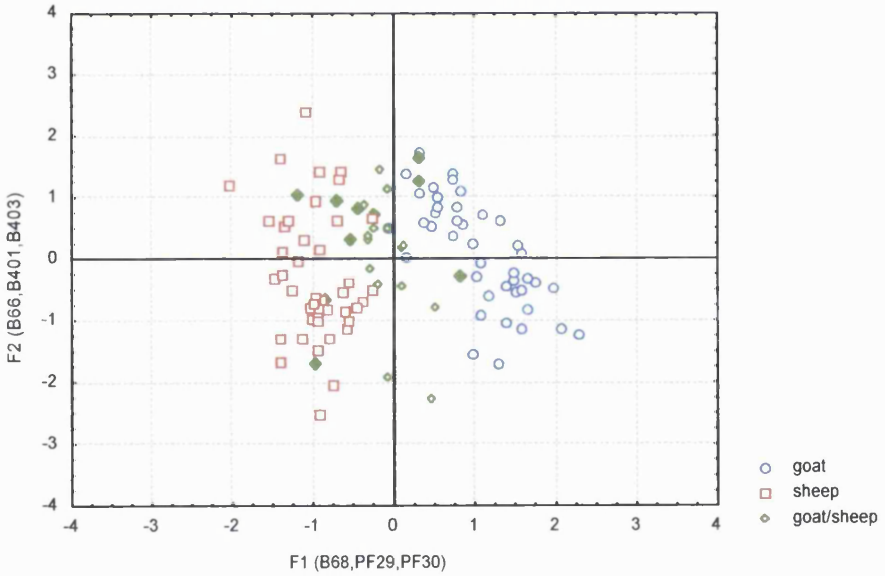
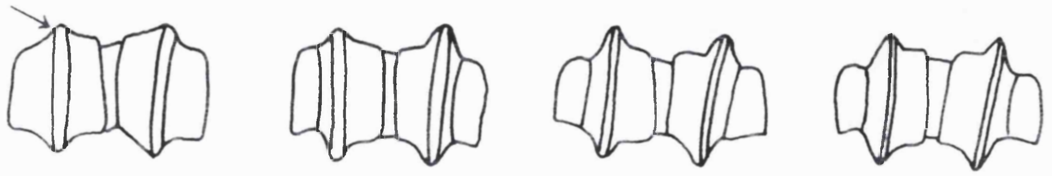


Figure 8.20: Factor Scores of Each Analysed Caprine Calcaneum

In Figure 8.20 the factor loadings of calcanea identified to species in the First Analysis fall into two separate clusters, one consisting of specimens previously identified as goats and the other consisting of specimens previously identified as sheep. This confirms that the clusters are a reflection of the morphological variation between the two species and suggests that all identifications obtained during the First Analysis are correct. The factor loadings of caprine specimens which could not be identified to species during the First loadings of caprine specimens which could not be identified to species during the First Analysis fall into an intermediate cluster. Nine of these previously unidentified specimens, marked solid in Figure 8.20, fall within the range of morphological variation of either goats and sheep as represented by the clusters of previously identified specimens and could therefore be assigned to one species or the other. The remaining 17 unidentified specimens fall in between the goat and sheep clusters and could not be identified to species by this method.

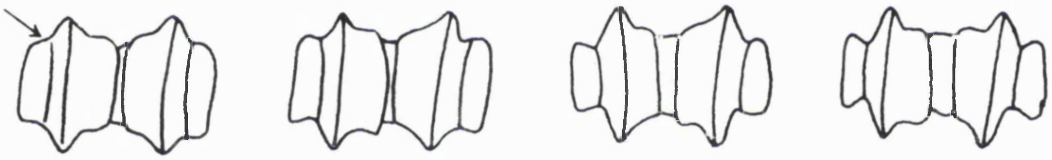
8.4.8: Principal Components Analysis of Caprine Distal Metatarsals:

Schematic drawings of the various metatarsal morphological characteristics are provided in Figure 8.21.



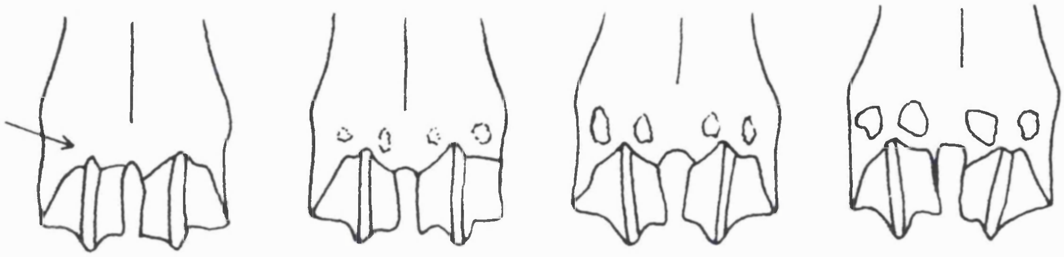
1 Very Rounded
2 Rounded and Shallow
3 Sharp and Steep
4 Very Sharp and Steep

Characteristic B305: Sharpness and Steepness of Verticilli on Trochlea (Boessneck 1969)



1 No Neck
2 Hint of Neck
3 Slight Neck
4 Clear Neck

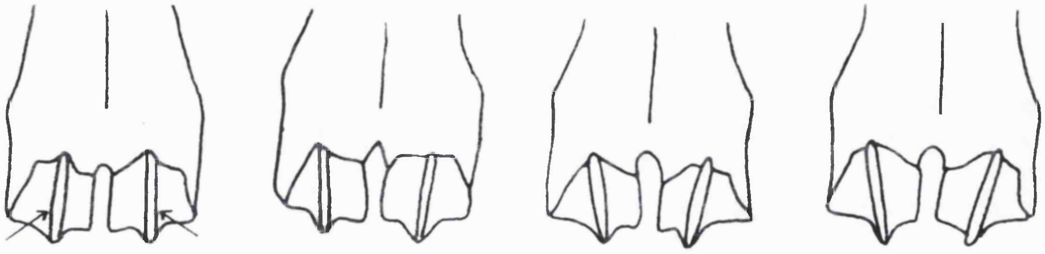
Characteristic B306: Definition of Trochlea by Neck at Verticilli (Boessneck 1969)



1 Minimal
2 Slightly Developed
3 Strongly Developed
4 Very Strongly Developed

Characteristic B307: Extent of Fossulae (Boessneck 1969)

Figure 8.21: Schematic Drawings of Caprine Distal Metatarsal Morphological Characteristics



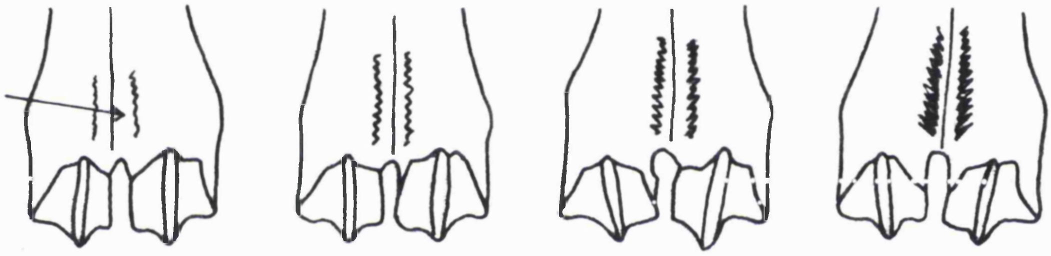
1 Parallel

2 Slight Angle

3 Strong Angle

4 Very Strong Angle

Characteristic B308: Degree of Convergence of Verticilli (Boessneck 1969)



1 Very Faint

2 Faint

3 Clear and Deep

4 Very Clear and Deep

Characteristic B309: Clarity of Sulcus at Distal End (Boessneck 1969)

Figure 8.21 (cont): Schematic Drawings of Caprine Distal Metatarsal Morphological Characteristics

The score counts and calculated factor loadings for the various morphological characteristics of caprine distal metatarsals are presented in Tables 8.33 and 8.34 respectively.

characteristic	species	n	score 1	score 2	score 3	score 4	missing data
B305	Goat	70	0	8	35	26	1
B305	Sheep	50	2	27	21	0	0
B305	Goat/Sheep	2	0	0	0	0	2
B306	Goat	70	1	22	28	17	2
B306	Sheep	50	25	21	4	0	0
B306	Goat/Sheep	2	0	2	0	0	0
B307	Goat	70	0	11	33	13	13
B307	Sheep	50	16	25	2	0	7
B307	Goat/Sheep	2	0	0	0	0	2
B308	Goat	70	0	23	13	2	32
B308	Sheep	50	11	13	1	0	25
B308	Goat/Sheep	2	0	0	0	0	2
B309	Goat	70	0	6	21	12	31
B309	Sheep	50	20	6	0	0	24
B309	Goat/Sheep	2	0	0	0	0	2

Key: characteristic=see Figure 8.21, species=identification obtained in First Analysis, n=NISP, score X=n specimens scoring X for the particular characteristic, missing data=n specimens on which the particular characteristic was not preserved

Table 8.33: Score Counts for Caprine Metatarsal Characteristics

Characteristic	Factor 1	Factor 2
B305	0.679527	0.404499
B306	0.686587	0.43058
B307	0.753126	-0.0326
B308	0.612531	-0.6642
B309	0.792441	-0.17554
Eigenvalue	2.503515	0.822057
Prp.Totl	0.500703	0.164411

Table 8.34: Factor Loadings for Caprine Metatarsal Characteristics
(Highest Factor Loadings in Red, Eigenvalue <1.0 in Blue)

The relative contribution of each characteristic to the overall morphological variation between distal metatarsals of goats and sheep is demonstrated by the factor loadings in Table 8.34. Factor 1 was affected mainly by B309 and B307 and Factor 2 by B308. However, although the eigenvalue of factor 1 is greater than one, that of factor 2 is not. Only the morphological variation incorporated in factor 1 can be regarded as making a significant contribution to the overall morphological variation. The two characteristics affecting factor 1 may thus be regarded as the most reliable criteria by which to make an identification of caprine distal metatarsals to species and are presented in rank order of reliability in Table 8.35.

Rank	Characteristic	Description
1	B309	Clarity of sulcus at distal end
2	B307	Extent of fossulae

Table 8.35: Most Reliable Distal Metatarsal Characteristics in Rank Order

The factor loadings of each analysed distal metatarsal are plotted in Figure 8.22.

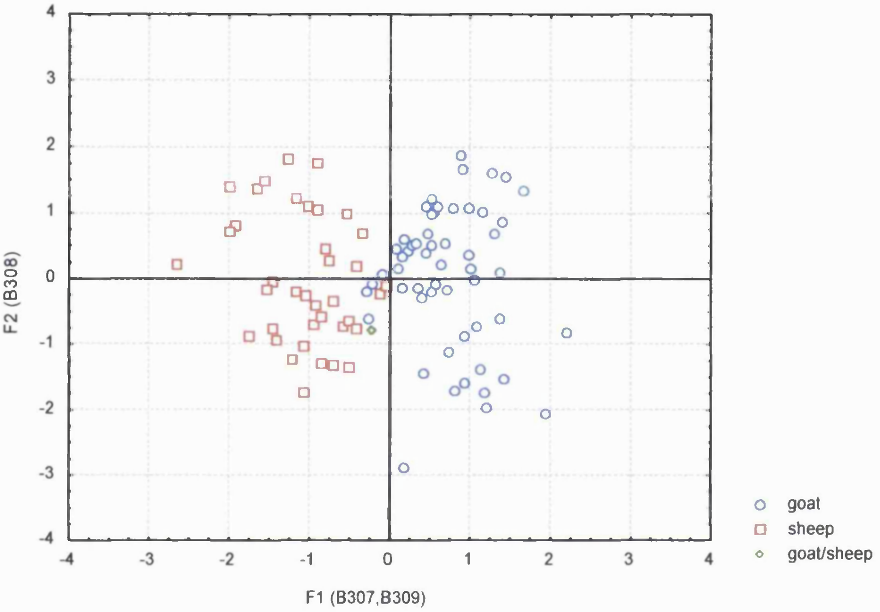
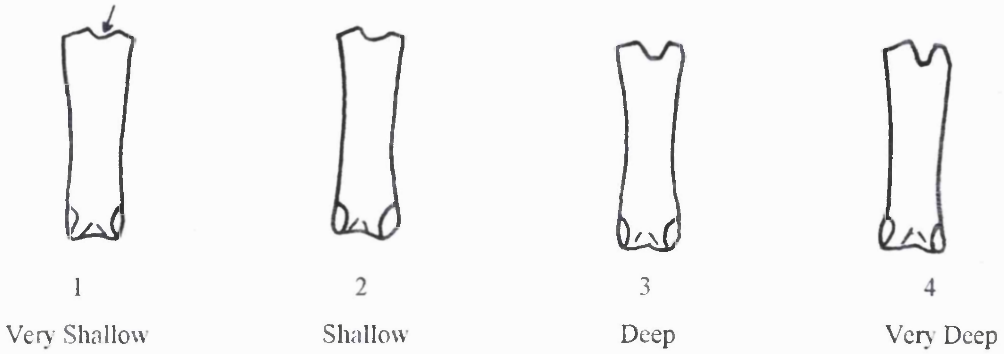


Figure 8.22: Factor Scores of Each Analysed Caprine Distal Metatarsal

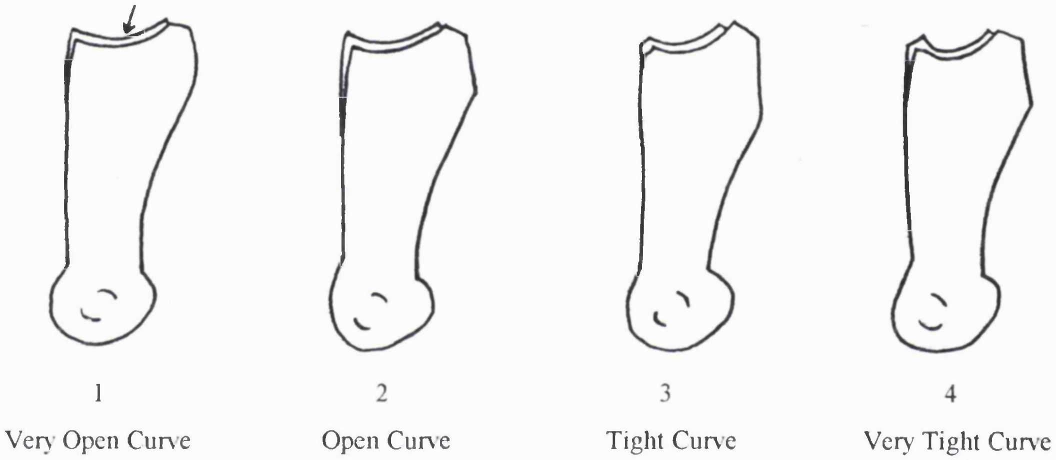
When interpreting Figure 8.22 it should be recalled that the eigenvalue of factor 2 for distal metatarsals was less than one (see Table 8.34) and can therefore be ignored. The factor 1 loadings of specimens identified to species in the First Analysis fall into two clusters, one consisting of specimens previously identified as goats and the other consisting of specimens previously identified as sheep. This confirms that the clusters are a reflection of the morphological variation between the two species. However, the two clusters overlap slightly and seven specimens identified during the First Analysis lie within the zone of overlap. As a result not all of these identifications can be confirmed by this method. The two specimens unidentified in the First Analysis lie within the area of overlap between previously identified goats and sheep and cannot therefore be identified to species

8.4.9: Principal Components Analysis of Caprine First Phalanges:

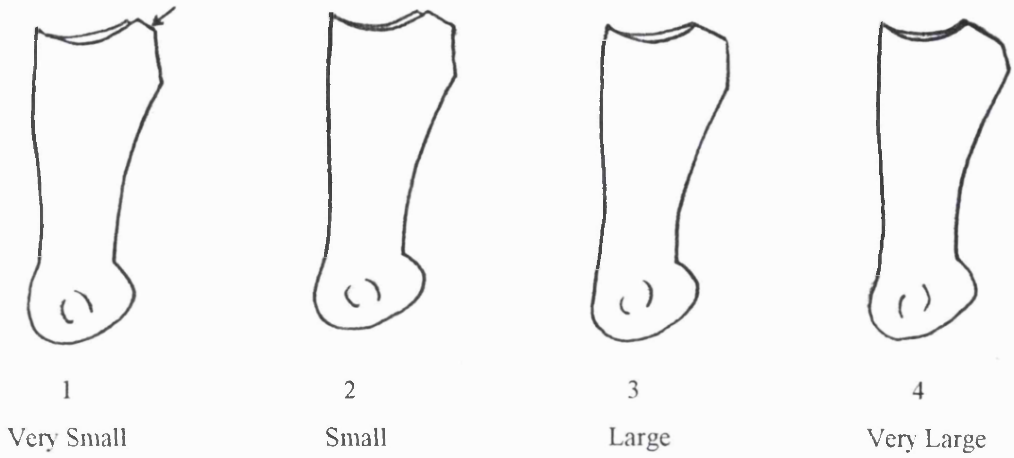
Schematic drawings of the various first phalanx morphological characteristics are provided in Figure 8.23.



Characteristic B500: Groove at Proximal End (dorsal view) (Boessneck 1969)

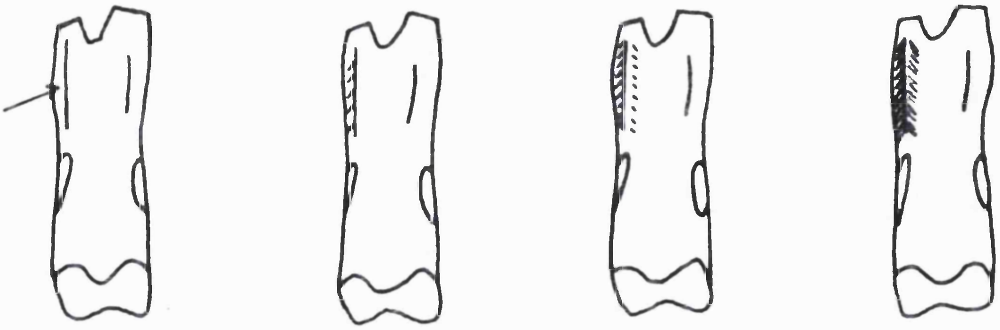


Characteristic B73: Curve of Proximal Articulation (axial view) (Boessneck 1969)



Characteristic B501: Small Articular Surfaces at Proximal End (Boessneck 1969)

Figure 8.23: Schematic Drawings of Caprine First Phalanx Morphological Characteristics



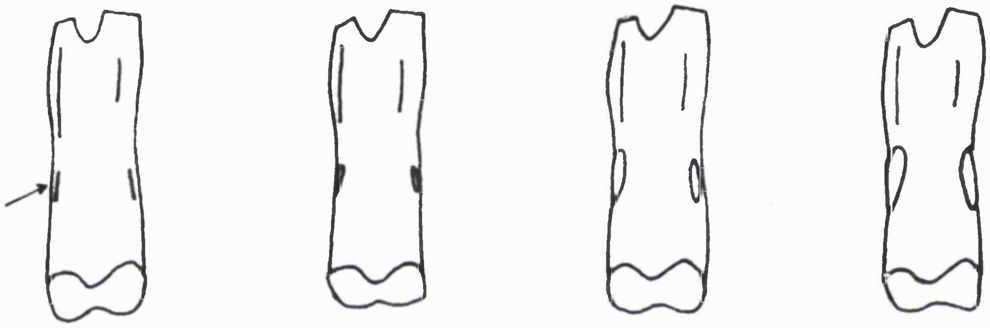
1 Minimal or Absent

2 Weak Ridge

3 Strong Ridge

4 Very Strong Ridge

Characteristic B502: Ridging of Axial Ligament Tubercle (Boessneck 1969)



1 Very Weak

2 Weak

3 Strong

4 Very Strong

Characteristic B75: Originating Points for Ligaments (Boessneck 1969)

Convex	Slightly Convex	Slightly Concave	Concave
1	2	3	4

Characteristic B74: Posterior Side of Shaft (Boessneck 1969)

Figure 8.23 (cont): Schematic Drawings of Caprine First Phalanx Morphological Characteristics

1 Minimal Angle

2 Obtuse Angle

3 Right Angle

4 Acute Angle

Characteristic B76: Angle at Posterior Edge of Distal Articular Surface (Boessneck 1969)

Figure 8.23 (cont): Schematic Drawings of Caprine First Phalanx Morphological Characteristics

The score counts and calculated factor loadings for the various morphological characteristics of caprine first phalanges are presented in Tables 8.36 and 8.37 respectively.

characteristic	species	n	score 1	score 2	score 3	score 4	missing data
B500	Goat	118	3	26	59	23	7
B500	Sheep	68	31	34	2	0	1
B500	Goat/Sheep	88	13	36	34	2	3
B73	Goat	118	0	11	61	38	8
B73	Sheep	68	14	38	14	0	2
B73	Goat/Sheep	88	2	29	45	5	7
B501	Goat	118	0	17	41	37	23
B501	Sheep	68	17	36	5	0	10
B501	Goat/Sheep	88	5	27	26	3	27
B502	Goat	118	2	26	55	27	8
B502	Sheep	68	24	35	4	2	3
B502	Goat/Sheep	88	8	34	14	2	30
B75	Goat	118	0	9	37	62	10
B75	Sheep	68	22	29	6	0	11
B75	Goat/Sheep	88	2	26	17	3	40
B74	Goat	118	11	40	56	4	7
B74	Sheep	68	10	40	4	0	14
B74	Goat/Sheep	88	4	22	21	1	40
B76	Goat	118	2	34	44	23	15
B76	Sheep	68	23	30	1	0	14
B76	Goat/Sheep	88	6	19	12	2	49

Key: characteristic=see Figure 8.23, species=identification obtained in First Analysis, n=NISP, score X=n specimens scoring X for the particular characteristic, missing data=n specimens on which the particular characteristic was not preserved

Table 8.36: Score Counts for Caprine First Phalanx Characteristics

Characteristic	Factor 1	Factor 2
B500	0.718488	-0.38801
B73	0.706023	-0.21554
B501	0.660612	-0.31304
B502	0.653839	0.258479
B75	0.762016	0.096529
B74	0.328717	0.825217
B76	0.643846	0.192488
Eigenvalue	2.981867	1.089167
Prp.Totl	0.425981	0.155595

Table 8.37: Factor Loadings for Caprine First Phalanx Characteristics (Highest Factor Loadings in Red)

The relative contribution of each characteristic to the overall morphological variation between first phalanges of goats and sheep is demonstrated by the factor loadings in Table 8.37. Factor 1 was affected mainly by B75, B500 and B73 and factor 2 by B74. As the eigenvalue of both factors is greater than one, the morphological variation incorporated in each factor can be regarded as significant. The four characteristics affecting factors 1 and 2 may thus be regarded as the most reliable criteria by which to make an identification of caprine first phalanges to species and are presented in rank order of reliability in Table 8.38.

Rank	Characteristic	Description
1	B75	Originating points for ligaments
2	B500	Groove at proximal end (dorsal view)
3	B73	Curve of proximal articulation (axial view)
4	B74	Posterior side of shaft

Table 8.38: Most Reliable First Phalanx Characteristics in Rank Order

The factor loadings of each analysed first phalanx are plotted in Figure 8.24.

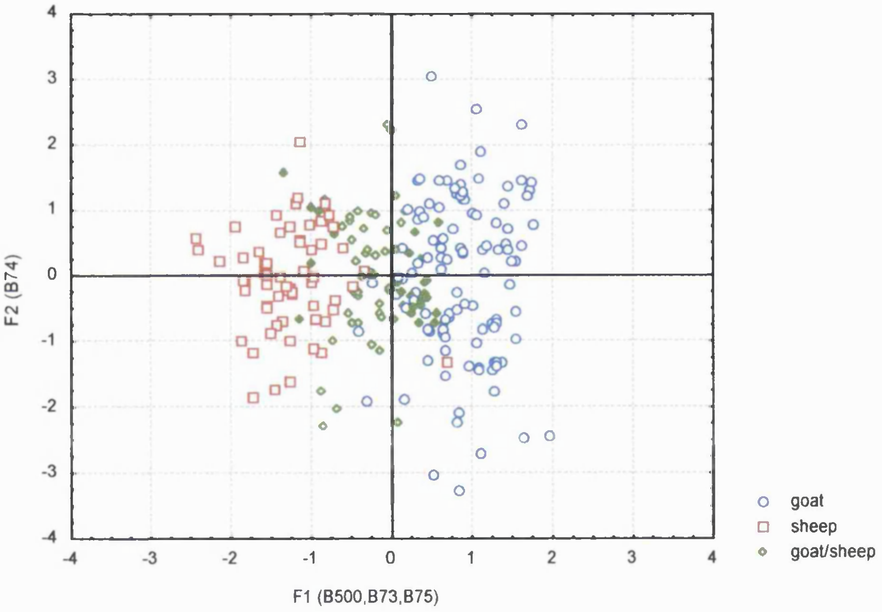


Figure 8.24: Factor Scores of Each Analysed Caprine First Phalanx

In Figure 8.24 the factor loadings of first phalanges identified to species during the First Analysis fall into two clusters, one consisting of specimens previously identified as goats, with one exception, and the other consisting of specimens previously identified as sheep. This confirms that the clusters are a reflection of the morphological variation between the two species. However, the two clusters overlap slightly and three specimens identified during the First Analysis lie within the zone of overlap. As a result not all of these identifications can be confirmed by this method. The single previously identified sheep in the goat cluster may well have been misidentified and should be re-examined. The factor loadings of caprine specimens which could not be identified to species during the First Analysis fall into an intermediate cluster. 31 of these previously unidentified specimens, marked solid in Figure 8.24, fall within the range of morphological variation of either goats and sheep as represented by the clusters of previously identified specimens and could therefore be assigned to one species or the other. The remaining 57 unidentified specimens fall in between the goat and sheep clusters and could not be identified to species by this method.

8.4.10: Principal Components Analysis of Caprine Third Phalanges:

Schematic drawings of the various third phalanx morphological characteristics are provided in Figure 8.25.

Very Blunt **Blunt** **Sharp** **Very Sharp**

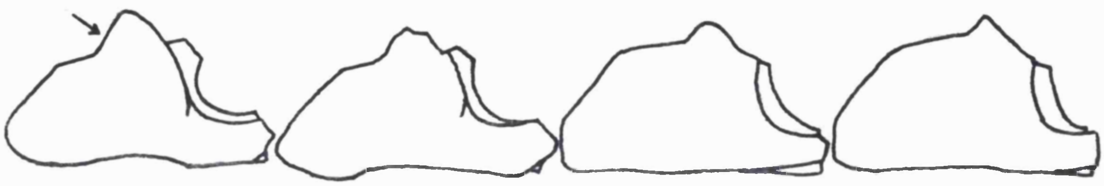
1 2 3 4

Characteristic B80: Sharpness of Dorsal Angle (Boessneck 1969)

1 2 3 4

Very Slight Slight Clear Very Clear

Characteristic B701 (cross-section): Extent of Pinching on Anterior Half (Boessneck 1969)

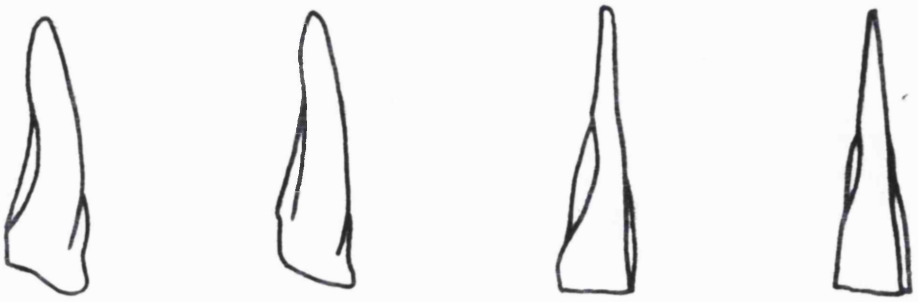


1 2 3 4

Very Large Large Small Very Small

Characteristic B81: Size of Processus Extensorius (Boessneck 1969)

Figure 8.25: Schematic Drawings of Caprine Third Phalanx Morphological Characteristics



1 Very Curved

2 Curved

3 Triangular and Curved

4 Triangular and Straight

Characteristic B702: Plan of Sole (Boessneck 1969)

1 Very Curved

2 Curved

3 Obtuse Angle

4 Right Angle

Characteristic B703 (cross-section): Merging of Axial Side into Sole (Boessneck 1969)

Figure 8.25 (cont): Schematic Drawings of Caprine Third Phalanx Morphological Characteristics

The score counts and calculated factor loadings for the various morphological characteristics of caprine third phalanges are presented in Tables 8.39 and 8.40 respectively.

characteristic	species	n	score 1	score 2	score 3	score 4	missing data
B80	Goat	43	0	3	18	4	18
B80	Sheep	23	0	9	8	1	5
B80	Goat/Sheep	41	0	4	6	2	29
B701	Goat	43	0	3	18	15	7
B701	Sheep	23	5	15	0	0	3
B701	Goat/Sheep	41	0	7	6	1	27
B81	Goat	43	0	0	21	18	4
B81	Sheep	23	3	6	5	0	9
B81	Goat/Sheep	41	0	3	11	5	22
B702	Goat	43	0	0	20	23	0
B702	Sheep	23	8	14	1	0	0
B702	Goat/Sheep	41	0	6	12	1	22
B703	Goat	43	0	2	20	20	1
B703	Sheep	23	11	11	0	0	1
B703	Goat/Sheep	41	1	10	19	6	5

Key: characteristic=see Figure 8.25, species=identification obtained in First Analysis, n=NISP, score X=n specimens scoring X for the particular characteristic, missing data=n specimens on which the particular characteristic was not preserved

Table 8.39: Score Counts for Caprine Third Phalanx Characteristics

Characteristic	Factor 1	Factor 2
B80	0.429845	0.88135
B701	0.85562	0.149331
B81	0.648126	-0.17327
B702	0.811073	-0.28209
B703	0.832623	-0.19879
Expl.Var	2.68802	0.948194
Prp.Totl	0.537604	0.189639

Table 8.40: Factor Loadings for Caprine Third Phalanx Characteristics (Highest Factor Loadings in Red, Eigenvalue <1.0 in Blue)

The relative contribution of each characteristic to the overall morphological variation between third phalanges of goats and sheep is demonstrated by the factor loadings in Table 8.40. Factor 1 was affected mainly by B701, B703 and B702 and Factor 2 by B80. However, although the eigenvalue of factor 1 is greater than one, that of factor 2 is not. Only the morphological variation incorporated in factor 1 can be regarded as making a significant contribution to the overall morphological variation. The three characteristics affecting factor 1 may thus be regarded as the most reliable criteria by which to make an identification of caprine third phalanges to species and are presented in rank order of reliability in Table 8.41.

Rank	Characteristic	Description
1	B701	Extent of pinching in anterior half
2	B703	Merging of axial side into sole
3	B702	Plan of sole

Table 8.41: Most Reliable Third Phalanx Characteristics in Rank Order

The factor loadings of each analysed third phalanx are plotted in Figure 8.26

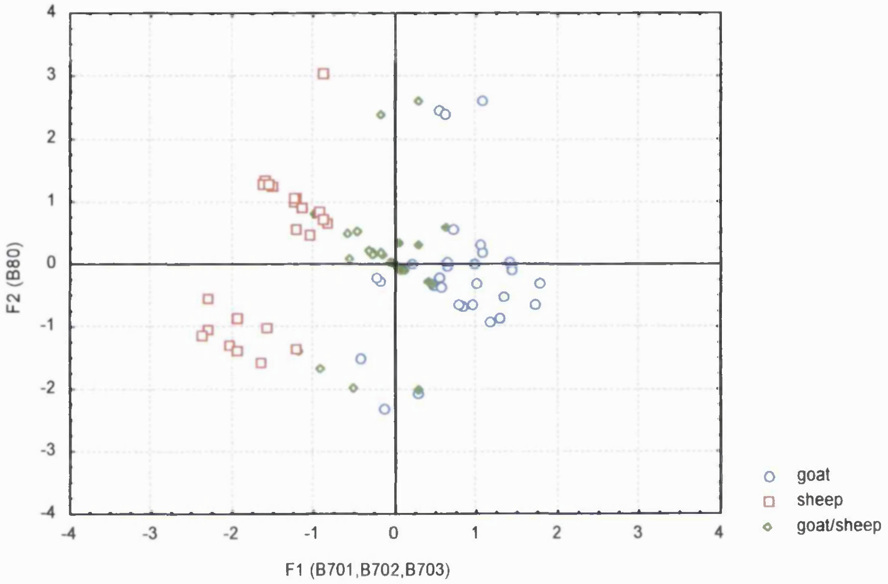


Figure 8.26: Factor Scores of Each Analysed Caprine Third Phalanx

When interpreting Figure 8.26 it should be recalled that the eigenvalue of factor 2 for third phalanges was less than one (see Table 8.40) and can therefore be ignored. The factor 1 loadings of third phalanges identified to species during the First Analysis fall into two clusters, one consisting of specimens previously identified as goats and the other consisting of specimens previously identified as sheep. This confirms that the clusters are a reflection of the morphological variation between the two species and suggests that all identifications obtained during the First Analysis are correct. The factor loadings of caprine specimens which could not be identified to species during the First Analysis fall into an intermediate cluster. 18 of these previously unidentified specimens, marked solid in Figure 8.26, fall within the range of morphological variation of either goats and sheep as represented by the clusters of previously identified specimens and could therefore be assigned to one species or the other. The remaining 23 unidentified specimens fall in between the goat and sheep clusters and could not be identified to species by this method.

8.4.11: Summary of the Most Reliable Morphological Characteristics:

The morphological characteristics identified by the principal components analysis as being the most reliable in yielding an accurate identification to species are summarised for each POSAC in Table 8.42, in decreasing order of reliability from left to right.

POSAC	Most Reliable Characteristics
Distal Scapula	B26/PF6, PF7, HR1, B27/PF8, B23
Distal Humerus	PF10, B36, AW1, PF9, B33
Distal Radius	B904, B42, B905, B43
Distal Metacarpal	B207, B208
Distal Tibia	K4, K2, K12, K7, K10, K1, K5, K11, K3
Astragalus	B51, B62, B64, PF28, PF26
Calcaneum	B68, PF30, PF29, B401, B403, B66
Distal Metatarsal	B309, B307
Proximal Phalanx	B75, B500, B73, B74
Distal Phalanx	B701, B703, B702

Table 8.42: The Most Reliable Morphological Characteristics on Each POSAC

The most reliable characteristic on each POSAC is that whose score count is the most likely to be at the extremes of the range of observed morphological variation i.e. 1 or 4, rather than in the middle of the range i.e. 2 or 3. A clear separation of goats from sheep, with a low proportion of intermediate specimens, should therefore be obtained from the most reliable characteristics.

The results in Table 8.42 may therefore serve as a guide to the individual morphological characteristics which should be relied on for preference when separating samples of goat and sheep bone. However the extent to which these results may be specific to the caprine sample from 'Ain Ghazal remains unknown.

8.4.12: Independent Check of Identifications Obtained in the First Analysis by Principal Components Analysis:

The percentage of identifications obtained in the First Analysis confirmed by the principal components analysis as being correct is presented for each POSAC in Table 8.43.

POSAC	n	n i.d.	n c.	n ic.	N unc.	% c.
Distal Scapula	153	96	96	0	0	100.0
Distal Humerus	189	132	132	0	0	100.0
Distal Radius	69	66	66	0	0	100.0
Distal Metacarpal	124	123	116	0	7	94.3
Distal Tibia	141	97	97	0	0	100.0
Astragalus	220	195	195	0	0	100.0
Calcaneum	115	89	89	0	0	100.0
Distal Metatarsal	122	120	113	0	7	94.2
First Phalanx	274	186	182	1	3	97.8
Third Phalanx	107	66	66	0	0	100.0
TOTAL	**1514**	**1170**	**1152**	**1**	**17**	**98.5**

Key: n=NISP, n i.d.=n identified to species in First Analysis, n c.=n First Analysis identifications shown to be correct by Third Analysis, n ic.= n First Analysis identifications shown to be incorrect by Third Analysis, n unc.=n First Analysis identifications unconfirmed as correct or incorrect by Third Analysis, % c.=% First Analysis identifications shown to be correct by Third Analysis

Table 8.43: Independent Check of Identifications Obtained in First Analysis by Principal Components Analysis

The results in Table 8.43 confirm that well over 90% of the identifications of each POSAC obtained in the First Analysis were correct. The actual proportion of correct identifications may be even higher. The fact that only one specimen out of a total 1170 had been incorrectly identified means there is little reason to assume that the identifications of the 17 unconfirmed specimens were in fact incorrect. The results of the principal components analysis demonstrate that although subjective, traditional methods of separating goat and sheep bones can result in specimens of the same morphology being consistently identified as the same species. As all the morphological characteristics on which this analysis was based were formulated with reference to modern material of known species one can be reasonably confident that accurate identifications are being obtained.

8.4.13: Potential of Principal Components Analysis to Identify a Greater Proportion of Caprine POSACs to Species than Traditional Methods:

The proportion of each POSAC identified to species in the First Analysis is compared with the proportion potentially identifiable through principal components analysis in Table 8.44. The POSACs are listed in rank order of the proportion identified to species in the First Analysis (see Table 8.2).

POSAC	n	n i.d. 1	% i.d. 1	n i.d. 3	% i.d. 3	% inc.
Distal Metacarpal	124	123	99.2	124	100	0.8
Distal Metatarsal	122	120	98.4	120	98.4	0.0
Distal Radius	69	66	95.7	67	97.1	1.4
Astragalus	220	195	88.6	210	95.5	6.8
Calcaneum	115	89	77.4	98	85.2	7.8
Distal Humerus	189	132	69.8	153	81.0	11.1
First Phalanx	274	186	67.9	217	79.2	11.3
Distal Tibia	141	97	68.8	120	85.1	16.3
Distal Scapula	153	96	62.7	113	73.9	11.1
Third Phalanx	107	66	61.7	84	78.5	16.8

Key: n=NISP, n i.d. 1=n identified to species in First Analysis, % i.d. 1=% identified to species in First Analysis, n i.d. 3=n identified to species in Third Analysis, % i.d. 3=% identified to species in Third Analysis, % inc.=% increase in n identified specimens in Third Analysis compared to First Analysis

Table 8.44: Comparison of Proportions of Caprine POSACs Identified to Species By Traditional Methods and Principal Components Analysis

It should be noted that as the sub-sample of specimens selected for principal components analysis was better preserved than average, the proportion of the sub-sample identified to species in the First Analysis is higher than that of the sample of caprine bones from 'Ain Ghazal as a whole. From the results in Table 8.44 it is clear that in the case of each POSAC a higher percentage of specimens could potentially be identified to species using principal components analysis than by using traditional methods. Furthermore, it is also apparent that this percentage is proportionally higher in those POSACs which were less easily identifiable using traditional methods, and as a result there is less overall variation in the proportion of each POSAC identified to species. This suggests that this type of principal components analysis may be one way to tackle the problems associated with variation in the proportion of each POSAC identified using traditional methods (see 8.2.4 and 8.2.5).

However, although the sub-sample selected was better preserved than average and therefore more amenable to this type of analysis, as at least two morphological characteristics could be recorded on each selected specimen, the actual potential percentage increase in the number of identifiable specimens is relatively low. As missing data is replaced by mean values in this type of principal components analysis, which draws the calculated factor loadings towards 0, the inclusion of large numbers of poorly preserved specimens on which only one morphological characteristic could be recorded is unlikely to result in the identification to species of a significantly larger number of specimens.

A further problem with this type of principal components analysis is that although a clear separation of goats and sheep may be made on the basis of a single reliable characteristic, when that characteristic is combined into a single factor with others the initial clear separation may blur into a continuum of morphological variation. This phenomenon can be seen extremely clearly by examining the score counts of distal radius characteristics and the associated plot of factor scores (Table 8.18 and Figure 8.12).

8.5: CONCLUSIONS:

These three analyses undertaken on the 'Ain Ghazal caprine bones have been effective in fulfilling the objectives set out in 8.1, namely: to generate reliable quantitative diachronic archaeozoological data for each species, and to identify the individual morphological characteristics on each POSAC with which an accurate identification to species could be made.

56.5% of caprine bones were identified to species in the First Analysis, which used traditional methods based on comparisons with published and unpublished morphological criteria, and modern reference material. The Second and Third Analyses suggest that virtually all of these identifications were correct and that they can confidently be used as the basis of this zooarchaeological investigation of caprines at 'Ain Ghazal.

Unfortunately 43.5% of the sample of caprine bones proved impossible to identify to species by traditional methods. The unidentified specimens are unevenly distributed throughout the skeleton, with some POSACs being consistently harder to identify than others. Study of this phenomenon has demonstrated that goat to sheep ratios obtained from samples with a high proportion of unidentified specimens are more likely to deviate from the norm and should therefore be treated with caution. In addition, this phenomenon leads to difficulties in constructing separate age profiles for each species. The proportion of unidentified specimens is dependent on the state of bone preservation as well as skeletal element.

Payne's (1969) metrical separation of caprine distal metacarpals proved highly effective in identifying those specimens on which w.cond and w.troch measurements could be taken, however this applied to only 39% of distal metacarpal POSACs.

Finally, the results of the principal components analysis suggest that this method has only limited potential to increase the proportion of caprine bones identified to species as it only works effectively on well preserved specimens which can in most cases be identified by traditional methods. Furthermore, the time required to record the requisite data for this type of analysis precludes its use on large assemblages. The real value of the principal components analysis lies in its ability to identify the morphological characteristics which are most reliable in yielding an accurate identification.

The results of these three analyses suggest that traditional methods can generate accurate and highly consistent data. However, confidence in the identifications thus obtained could be improved by a preliminary principal components analysis of a sub-sample of better preserved specimens in order to identify the individual morphological characteristics which are most reliable for the particular assemblage under analysis. These could then form the basis of an separation of goats and sheep using traditional methods. Inevitably it will be impossible to identify all archaeological caprine bones to species. However, rather than developing ever more time-consuming methods of identification it is probably more effective to focus on those skeletal elements and morphological characteristics on which an accurate identification can relatively quickly and simply be obtained and to be aware of the limitations which the presence of unidentified specimens imposes on interpretation.

CHAPTER 9: REPRESENTATION OF TAXA AT 'AIN GHAZAL

9.1: INTRODUCTION:

Although this zooarchaeological analysis of the faunal assemblage from 'Ain Ghazal is focused primarily on caprines, the bones of several other taxa were quantified using the same methodology to allow the changing representation of goats and sheep at the site to be discussed in the context of the wider faunal economy. As not all of the small mammal, reptile and bird bone were available for analysis, it was decided to confine this analysis to the main medium and large ~~herbivores~~ ungulates found in the assemblage, namely: goat, sheep, gazelle, cattle, pig and equid.

In her analysis of part of the 'Ain Ghazal faunal assemblage which was excavated between 1982 and 1989, Köhler-Rollefson found that these six taxa comprised the great majority of identified specimens: 80.8% in the MPPNB, 97.0% in the LPPNB, 98.1% in the PPNC and 97.7% in the Yarmoukian (Köhler-Rollefson et al. 1993, p.96). More recent work by von den Driesch and Wodtke on the 'Ain Ghazal faunal assemblage excavated between 1993 and 1995 has yielded similar results. The proportion of these six taxa in their samples of identified specimens was 98.2% in the late MPPNB/early LPPNB, 97.9% in the LPPNB, 99.0% in the transitional LPPNB/PPNC, 99.3% in the PPNC and 98.1% in the Yarmoukian (von den Driesch and Wodtke, 1997, p.542). As virtually all of the bones analysed by Köhler-Rollefson and a large proportion of those analysed by von den Driesch and Wodtke were included in this analysis of the 'Ain Ghazal faunal assemblage, it was thought reasonable to assume that goats, sheep, gazelle, cattle, pigs and equids would make up a similarly high proportion of the assemblage analysed during the course of this study.

Although not all taxa were examined during the course of this study, it is clear those which were made by far the most significant contribution to the 'Ain Ghazal faunal economy. Although it is important not to underestimate the potential significance of minor taxa such as fox, hare, felid or canid, they were present in such low numbers in the results of Köhler-Rollefson and in the results of von den Driesch and Wodtke, that their impact on the changing representation of goats and sheep at the site was felt to be relatively insignificant.

It was therefore decided that it would be acceptable to draw on the representation of minor taxa in the published results of Köhler-Rollefson et al. (1988, 1993) and von den Driesch and Wodtke (1997). However, it should be noted that the taxa counts and percentages of Köhler-Rollefson and of von den Driesch and Wodtke are not directly compatible with those of this study because different systems were used to record and count the material.

As this study focuses on the caprine remains from 'Ain Ghazal, gazelle, cattle, pigs and equids were not examined in detail. They were quantified solely to provide a backdrop against which the changing representation of goats and sheep could be discussed and were only identified to genus level. Fortunately, these genera have been examined in more detail in the previous work of Köhler-Rollefson and von den Driesch and Wodtke; as a result the range of species present at the site within each genus is reasonably clear.

This chapter consists of three main sections. The first discusses the late Pleistocene and early Holocene zoogeography of gazelle, cattle, pigs and equids, and makes some comments on their ecology and ethology (the late Pleistocene and early Holocene zoogeography of caprines has already been discussed in detail in Chapter 6). The full range of non-caprine medium and large herbivore species (i.e.: gazelle, cattle, pigs and equids) identified during the course of previous work on the faunal assemblage are described, as are the results of previous attempts to establish the wild or domestic status of cattle and pigs at the site (the wild or domestic status of the 'Ain Ghazal caprines is discussed separately in Chapter 10). The second section describes the representation of the six main medium and large herbivore taxa in the results of the analysis of the 'Ain Ghazal faunal assemblage which was undertaken as part of this study. The third section describes the representation of minor taxa in the results of Köhler-Rollefson and of von den Driesch and Wodtke, and discusses the problems involved in interpreting this data and integrating it with the results of this study.

9.2: LATE PLEISTOCENE AND EARLY HOLOCENE ZOOGEOGRAPHY OF THE FOUR MAIN NON-CAPRINE, MEDIUM AND LARGE HERBIVORE TAXA REPRESENTED AT 'AIN GHAZAL:

As discussed in Chapter 6, zoogeographical and zooarchaeological data suggest that of the caprines only wild goat *Capra aegagrus*, domestic goat *Capra hircus*, and domestic sheep *Ovis aries* should be anticipated in the faunal assemblage from 'Ain Ghazal. This section therefore discusses the remaining four main, non-caprine medium and large herbivore taxa (i.e.: gazelle, cattle, pigs and equids) in an attempt to assess which other species should also be anticipated in this part of the faunal assemblage.

9.2.1: Gazelle:

Three species of gazelle are known to have occurred in southwest Asia: the mountain gazelle *Gazella gazella*, the dorcas gazelle *Gazella dorcas* and the goitred gazelle *Gazella subgutturosa*. All still exist in limited numbers in the wild today. The mountain gazelle inhabits a wide range of moister environments throughout the region, which include mountains, low hills and the coastal plain. The dorcas gazelle favours more arid environments such as gravel plains and occasionally sand deserts; its distribution largely coincides with that of *Acacia* spp.. Examination of modern (Harrison and Bates 1991) and ancient (Uerpmann 1987) distribution maps for these species suggests that both can be expected in the faunal assemblage from 'Ain Ghazal. The goitred gazelle inhabits sand deserts, gravel plains and limestone plateaux. Although the area around 'Ain Ghazal is close to the western limits of its distribution (Harrison and Bates 1991, p.203) its presence in the steppe to the east of the site cannot, in contrast to the view of von den Driesch and Wodtke (1997, p.519), be discounted on zoogeographical grounds. Far from being confined to "the northern mountain regions of the Fertile Crescent" (von den Driesch and Wodtke 1997, p.519), the goitred gazelle is known to have inhabited the eastern deserts of Jordan and has in relatively recent times been identified in the vicinity of al-Qatrana, approximately 100km to the south of the site (Harrison and Bates 1991, p.203). The post-cranial skeletal elements of the genus *Gazella* are extremely similar and "only differences in size can give some hints as to the specific identity of archaeological gazelle remains" (Uerpmann 1987, p.90, but see also Compagnoni 1978, pp.119-128). Of the three gazelle species under discussion goitred gazelle is the largest and dorcas gazelle the smallest. However, identification of gazelle remains to species is most reliably achieved not on the basis of size but on the basis of horncore morphology.

The gazelle horncores from 'Ain Ghazal examined by von den Driesch and Wodtke (1997, p.524) consisted predominantly of mountain gazelle alongside lower frequencies of dorcas gazelle. These identifications are tentatively supported by their metrical analysis of the post-cranial skeleton, which suggests that larger and smaller specimens are present. However, their assertion that the larger gazelle bones from 'Ain Ghazal consist exclusively of mountain gazelle fails to take into account the fact that Uerpmann (in Köhler-Rollefson et al. 1988, p.425) claims to have identified a number of goitred gazelle horncores in the faunal assemblage from 'Ain Ghazal excavated between 1982 and 1989. The possibility that some of the larger post-cranial elements in the sample are in fact goitred gazelle cannot therefore be ruled out. This rather contradictory available evidence therefore suggests that the gazelle remains from 'Ain Ghazal consist predominantly of mountain gazelle, alongside some dorcas gazelle and potentially goitred gazelle as well. The relative abundance of mountain gazelle is unsurprising, as the area around 'Ain Ghazal in the early Holocene would have coincided well with its favoured habitat.

9.2.2: Cattle:

Although extinct since 1627 the wild ancestor of domestic cattle *Bos taurus*, the aurochs *Bos primigenius*, is known to have inhabited parts of southwest Asia well into the historical period (Uerpmann 1987, p.72). The former wide range of this animal attests to its tolerance of a variety of different environments. In the southern Levant although it probably inhabited open woodland or dense grassland, its distribution was probably restricted more by the availability of water than by any specific vegetation (Uerpmann 1979, p.125 and 1987, p.72). The steppe wisent *Bison bison* and the wild ancestor of the water buffalo *Bubalus arnee* are also known to have inhabited parts of southwest Asia during the early Holocene (Uerpmann 1987), although neither are found in the region today. Neither species can be anticipated in the faunal assemblage from 'Ain Ghazal on zoogeographical grounds. The steppe wisent favoured open grasslands and on the basis of admittedly limited data seems only to have inhabited the northern Levant and Anatolia (Uerpmann 1987, pp.76-78, von den Driesch and Wodtke 1997, p.528). The water buffalo has more restricted environmental requirements and would have been confined to riverine forests and fresh-water swamps, neither of which are found in the vicinity of the site (Uerpmann 1987, p.78). It can therefore be assumed that of the large *Bovinae* only the aurochs is likely to have inhabited the area around 'Ain Ghazal. This assumption is supported by the results of von den Driesch and Wodtke (1997, p.528). Despite checking the cattle bones from the site against the limited osteological criteria by the which the aurochs and steppe wisent can be separated (Boessneck et al. 1963) they found no evidence for the presence of the latter species. No evidence for the presence of hartebeest *Alcelaphus buselaphus* has been found in the 'Ain Ghazal faunal assemblage.

In general, the cattle bones from 'Ain Ghazal were highly fragmented and poorly preserved. As a result von den Driesch and Wodtke (1997, pp.528-530) encountered difficulties in establishing the wild or domestic status of cattle at the site. The few teeth which could be assessed for dental wear suggested that extremely young animals were not present, although this may have been at least partially the effect of differential preservation. However, examination of epiphyseal fusion yielded similar results: specimens from animals over one and a half years of age were predominant and the proportion of animals over three years of age was over 30% in all phases except the Yarmoukian. Few measurements could be taken on the cattle bones owing to the generally poor state of preservation and the majority of the measurements which were taken came from early fusing elements which continue to grow after fusion has taken place. Von den Driesch and Wodtke's sample of cattle bone measurements from 'Ain Ghazal is therefore small and potentially unreliable. Notwithstanding these problems, their comparison of 'Ain Ghazal cattle bone measurements with those of 9th and 8th millennia b.c. aurochs from Denmark and Mureybet, and Bronze Age and Iron Age domestic cattle from Lidar Höyük and Bastam II has demonstrated that the cattle bones from 'Ain Ghazal were much larger than the domestic comparative specimens, but very slightly smaller than the comparative aurochs specimens (von den Driesch and Wodtke 1997, p.529). Surprisingly, the largest specimens at 'Ain Ghazal came from the Yarmoukian, whilst the smallest came from the PPNC. Von den Driesch and Wodtke have therefore argued that: "the villagers of 'Ain Ghazal had already captured aurochs calves and tried to breed them in the settlement in the PPNB. The descendants of these animals no longer attained the sizes of their wild relatives. We certainly can suppose that people with experience in goat domestication and breeding sheep and goats were able to try domesticating aurochs. That this process took a long time and had setbacks, that aurochs calves again and again escaped or died, and that eventually this process at the end was not successful, is evidenced by the high proportion of young animals and the measurements for the Yarmoukian, in which bone sizes increase again" (von den Driesch and Wodtke 1997, p.530). If this supposition is correct then the cattle bones from 'Ain Ghazal can be assumed to represent a mixture of aurochs and early domestic cattle.

9.2.3: Pig:

The wild boar, *Sus scrofa*, has been the only member of its genus to inhabit southwest Asia for approximately 50,000 years (Uerpmann 1987, p.42) and survives in large numbers in parts of the region today. Although it is primarily an inhabitant of riverine thickets and reed beds, it is adapted to a wide variety of environments and is also found in wooded hills, forests and occasionally in semi-desert (Dar 1976, Harrsion and Bates 1991), however it does not inhabit the arid deserts. A large population of wild boar inhabited the reed beds along the Wadi Zarqa until relatively recently (Merrill 1881, p.396).

The work of von den Driesch and Wodtke (1997, pp.525-529) on the pig remains from 'Ain Ghazal failed to identify the presence of domesticates with any degree of certainty. Although the proportion of juvenile animals in their sample was extremely high, between 92% and 97.5% of specimens came from animals which died before the age of three years and between 15% and 40% from animals which died at one year or under, they suggest that this is more likely to be a reflection of the natural population structure in wild pigs than selective culling of domestic animals. Furthermore, the measurements of pig bones from 'Ain Ghazal were much larger than Bronze Age domestic pigs from Lidar Höyük, being similar in size to pigs from Hesban interpreted as wild. Von den Driesch and Wodtke have therefore concluded that the pig remains from 'Ain Ghazal most probably consist entirely of wild *Sus scrofa*, predominantly easily hunted piglets, which would have inhabited thickets and reed beds along the Wadi Zarqa close to the site.

9.2.4: Equid:

Four species of equid are known to have inhabited southwest Asia during the late Pleistocene: the wild horse *Equus ferus*, the onager *Equus hemionus*, the wild ass *Equus africanus* and the european wild ass *Equus hydruntinus*. However, both the wild horse and european wild ass appear m(3Uto have become extinct in the Levant by the end of the Pleistocene, although the former and possibly the latter survived into the Holocene in Anatolia (Uerpmann 1987). In contrast, the onager was widespread across the more arid areas of Levant during the early Holocene and only became extinct between 50 and 60 years ago. Its range seems to have been restricted to the eastern slopes of the Levantine mountains and the steppe beyond. Its distribution overlapped with early Holocene range of the wild ass, which is likewise believed to be extinct in the region today though the difficulty of distinguishing it from feral donkeys makes it difficult to be certain. Like the onager the wild ass would have inhabited relatively arid areas. However, whereas the former preferred open steppe with firm soils the latter would have favoured more rocky, dissected terrain (Uerpmann 1987, p.37). Both environments can be found in the vicinity of 'Ain Ghazal.

Although extremely similar, the remains of onager and wild ass can be distinguished on the basis of differences in the pattern of enamel folds on the molars and differences in the proportions of the metacarpals (Davis 1987, pp.33-34). The detailed work of von den Driesch and Wodtke (1997, pp.530-533) on the equid remains from 'Ain Ghazal suggested that both species are represented in the assemblage. Although they found no complete metacarpals in their sample, all of the equid teeth which could be identified to species belonged to the wild ass. However, measurements taken on a range of post-cranial skeletal elements suggest that the equid remains fall into two size categories. The larger is interpreted by von den Driesch and Wodtke (1997, p.531) as representing the remains of onager and the smaller the remains of wild ass. However, it is admitted that these identifications should be regarded as tentative owing to the poor state of preservation and small number of measurements. However, zoogeographic evidence suggests that the presence of both onager and wild ass in the faunal assemblage from 'Ain Ghazal would not be entirely unexpected.

9.3: REPRESENTATION OF THE SIX MAIN MEDIUM AND LARGE HERBIVORE TAXA IN THE RESULTS OF THIS STUDY:

9.3.1: Comparison Between NISP and Adjusted NISP Counts:

NISP and adjusted NISP counts for the main medium and large herbivore taxa in the 'Ain Ghazal faunal assemblage identified during the course of this study, and less precisely identified specimens categorised as goat/sheep or small ruminant, are presented below in Tables 9.1 and 9.2. As discussed in Chapter 2, adjusted NISP counts form the basic unit of quantification throughout this study, as they take varying anatomical frequencies of metapodia and phalanges into account.

Comparison of the NISP counts in Table 9.1 with the adjusted NISP counts in Table 9.2 demonstrates that there is actually very little difference between the two sets of results. However, as the adjusted NISP count will continue to produce consistent results even if the large samples from each phase are broken down into smaller sub-samples, which may potentially contain higher than normal frequencies of metapodia and phalanges, it has been retained as the basic unit of quantification.

	MPPNB		LPPNB		LPPNB/PPNC		PPNC		Yarmoukian	
taxon	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
goat	1240	37.0	154	21.9	56	17.2	236	12.1	165	11.5
sheep	8	0.2	120	17.0	72	22.1	526	27.0	340	23.6
goat/sheep	819	24.4	184	26.1	79	24.2	515	26.4	491	34.1
gazelle	830	24.8	88	12.5	30	9.2	208	10.7	138	9.6
sm.rum.	183	5.5	40	5.7	31	9.5	121	6.2	82	5.7
cattle	147	4.4	26	3.7	27	8.3	80	4.1	53	3.7
pig	120	3.6	79	11.2	27	8.3	215	11.0	86	6.0
equid	4	0.1	13	1.8	4	1.2	50	2.6	85	5.9
TOTAL	**3351**	**100.0**	**704**	**100.0**	**326**	**100.0**	**1951**	**100.0**	**1440**	**100.0**

Table 9.1: Representation of Taxa in the Results of this Study (NISP)

	MPPNB		LPPNB		LPPNB/PPNC		PPNC		Yarmoukian	
taxon	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
goat	1134	35.8	138.5	20.9	48	15.9	220	11.8	153	10.8
sheep	7	0.2	113.5	17.1	64.5	21.4	483.5	25.9	321	22.7
goat/sheep	803.5	25.4	182	27.5	78	25.9	513	27.5	488	34.5
gazelle	790	25.0	78	11.8	25.5	8.5	194	10.4	135	9.5
sm.rum.	176	5.6	39	5.9	30.5	10.1	119	6.4	81	5.7
cattle	141	4.5	25	3.8	24.5	8.1	72	3.9	52	3.7
pig	109	3.4	71	10.7	25	8.3	205	11.0	81	5.7
equid	5	0.2	16	2.4	5	1.7	57	3.1	103	7.3
TOTAL	**3165.5**	**100.0**	**663**	**100.0**	**301**	**100.0**	**1863.5**	**100.0**	**1414**	**100.0**

Table 9.2: Representation of Taxa in the Results of this Study (adjusted NISP)

9.3.2: Representation of the Six Main Medium and Large Herbivore Taxa in the Results of this Study:

The adjusted NISP percentage counts in Table 9.2 are plotted by phase in Figure 9.1.

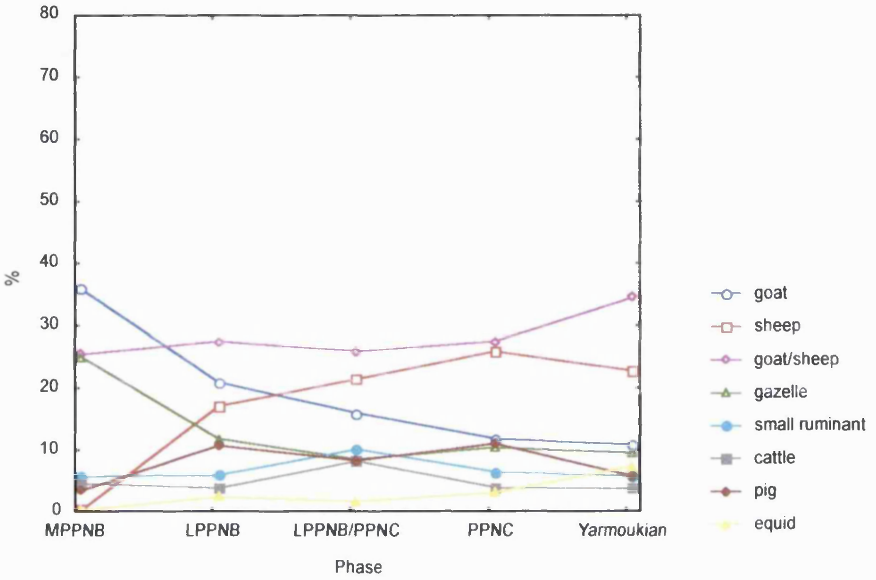


Figure 9.1: Representation of Taxa in the Results of this Study (adjusted NISP)

A number of temporal trends in the representation of the six main medium and large herbivore taxa at 'Ain Ghazal are visible in Figure 9.1: the proportions of goat and gazelle steadily decrease, the proportions of sheep and equid steadily increase and the proportions of cattle and pig appear to fluctuate. The clear increase in the proportion of goat/sheep during the Yarmoukian can be attributed to the higher levels of calcretion affecting much of this material.

However, as Figure 9.1 includes the adjusted NISP percentage counts of specimens categorised as goat/sheep or small ruminant these trends are partially obscured, as it is difficult to establish what the overall proportion of goat, sheep and gazelle in each phase might have been. However, the metrical separation of goat and sheep distal metacarpals demonstrated that the goat to sheep ratios obtained for each phase are reasonably representative of the sample as whole (see Chapter 8, Table 8.10). It was therefore decided to divide the specimens identified only as goat/sheep and small ruminant amongst the goats, sheep and gazelle according to the relative proportions of these three species in the identified sample. The results of this calculation are presented in Table 9.3 and are plotted in Figure 9.2.

	MPPNB		LPPNB		LPPNB/PPNC		PPNC		Yarmoukian	
taxon	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
goat	2036	64.3	254.9	38.4	91.9	30.5	409.6	22.0	330.8	23.4
sheep	12.5	0.4	208.9	31.5	123.5	41.0	900.2	48.3	694.2	49.1
gazelle	862	27.2	87.2	13.2	31.1	10.3	219.7	11.8	153	10.8
cattle	141	4.5	25	3.8	24.5	8.1	72	3.9	52	3.7
pig	109	3.4	71	10.7	25	8.3	205	11.0	81	5.7
equid	5	0.2	16	2.4	5	1.7	57	3.1	103	7.3
TOTAL	**3165.5**	**100.0**	**663**	**100.0**	**301**	**100.0**	**1863.5**	**100.0**	**1414**	**100.0**

Table 9.3: Representation of the Six Main Medium and Large Herbivore Taxa in the Results of this Study (adjusted NISP with Goat/Sheep and Small Ruminant Divided Between Goat, Sheep and Gazelle)

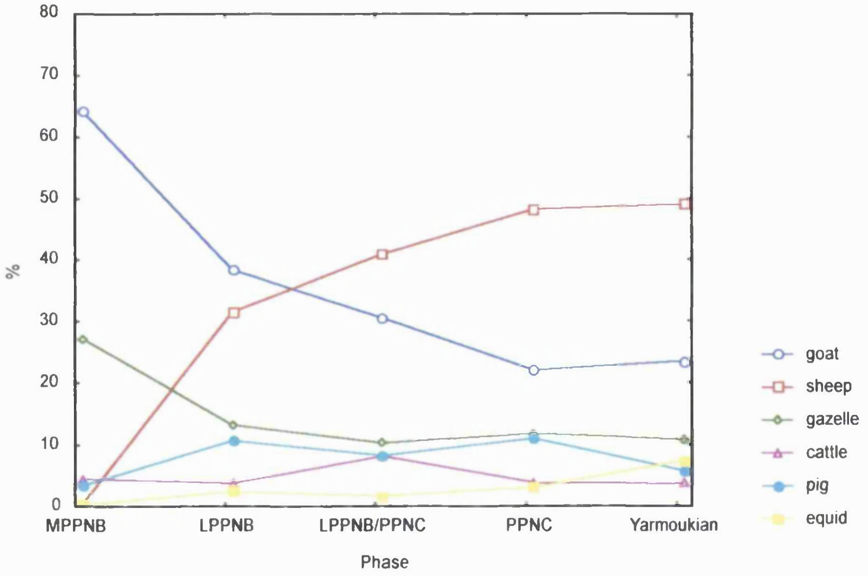


Figure 9.2: Representation of the Six Main Medium and Large Herbivore Taxa in the Results of this Study (adjusted NISP with Goat/Sheep and Small Ruminant Divided Between Goat, Sheep and Gazelle)

The basic trends already noted in the data in Table 9.2 and Figure 9.1 are greatly clarified with the division of the goat/sheep and small ruminant specimens between goats, sheep and gazelle in Table 9.3 and Figure 9.2. The latter data therefore form the basis of the following discussion.

9.3.2.1: Goat:

It is clear that goats were present at 'Ain Ghazal from the beginning of its occupation and that they were the predominant species during the MPPNB, when they comprised 64.3% of the sample. However, the frequency of the species subsequently decreased, dropping to 38.4% in the LPPNB, 30.5% in the transitional LPPNB/PPNC and 22% in the PPNC. At this point the decline in the frequency of goat appears to have stabilised, as it maintained a similar proportion, 23.4%, into the Yarmoukian.

9.3.2.2: Sheep:

Sheep comprised only 0.4% of the MPPNB sample. It is therefore tempting to regard these 12.5 POSACs as intrusive from later phases, given the widespread pit digging and terracing characteristic of the PPNC and Yarmoukian at 'Ain Ghazal, were it not for the fact that several came from sealed MPPNB contexts. The presence of very small numbers of sheep at 'Ain Ghazal during the MPPNB therefore seems likely. However, the frequency of the species subsequently increased enormously; sheep comprised 31.5% of the LPPNB sample and by the transitional LPPNB/PPNC had replaced goat as the predominant species at the site, when they comprised 41% of the sample. The increase in the frequency of sheep continued into the PPNC, rising to 48.3% of the sample, after which it maintained a similar frequency, 49.1%, into the Yarmoukian.

9.3.2.3: Gazelle:

During the MPPNB gazelle was the second most common species at 'Ain Ghazal, comprising 27.2% of the sample from this phase. However, its frequency had declined sharply by the LPPNB, when it comprised 13.2% of the sample, and continued to do so into the transitional LPPNB/PPNC when its decline stabilised at 10.3%. The frequency of gazelle then continued at similar levels, 11.8% and 10.8% respectively, throughout the PPNC and Yarmoukian.

9.3.2.4: Cattle:

With the exception of the transitional LPPNB/PPNC, the proportion of cattle was relatively stable during the main phases of occupation at 'Ain Ghazal. The frequency of cattle was similar during the MPPNB and LPPNB, comprising 4.5% and 3.8% of these respective samples. This proportion jumped to 8.1% during the transitional LPPNB/PPNC before dropping back to 3.9% and 3.7% respectively in the PPNC and

Yarmoukian samples. The unusually high proportion of cattle during the transitional LPPNB/PPNC may be associated with the smaller sample size from this phase, despite the fact that it is clear in Figure 9.2 that the frequency of goat, sheep, gazelle and equid in this phase are all in line with long term trends.

9.3.2.5: Pig:

The frequency of pig at 'Ain Ghazal appears to have fluctuated throughout the main phases of occupation at the site. It was most common during the LPPNB, transitional LPPNB/PPNC and PPNC, comprising 10.7%, 8.3% and 11% respectively, and was least common during the MPPNB and Yarmoukian, when it comprised 3.4% and 5.7% of these respective samples. Of these fluctuations, the increase in its frequency between the MPPNB and LPPNB and the decrease between the PPNC and Yarmoukian are clearly the most significant.

9.3.2.6: Equid:

The frequency of equids at 'Ain Ghazal exhibited a general upward trend throughout the main phases of the occupation, rising from 0.2% in the MPPNB to 2.4% in the LPPNB. Although during the transitional LPPNB/PPNC it dropped back to 1.7%, by the PPNC it had risen again to 3.1% and by the Yarmoukian to 7.3% when it was more common at the site than either cattle or pig.

9.3.3: Summary of the Representation of the Six Main Medium and Large Herbivore Taxa in the Results of this Study:

Drawing on the results presented in 9.3.2 above it is possible to summarise the main temporal trends in the representation of the six main medium and large herbivore taxa at 'Ain Ghazal. Throughout the entire period of the site's occupation caprines were by far the dominant species, comprising over 60% of the analysed sample in all phases. Their frequency exhibited a steady, though relatively slight, increase over time which was interrupted only by a barely discernible drop during the PPNC. Although the caprine assemblage was made up almost entirely of goats during the MPPNB, over time they were largely replaced by sheep. During the PPNC and Yarmoukian sheep outnumbered goats by approximately 2 to 1. Cattle and pigs were much less common at 'Ain Ghazal than caprines and neither exceeded 11% in any phase. Both increased in frequency from their relatively low MPPNB representation during intermediate periods of occupation at

'Ain Ghazal, but by the time of the Yarmoukian had declined back to approximately their frequency during the MPPNB. Although the rise in the frequency of pigs had occurred by the LPPNB and continued at a similarly high level until the PPNC, cattle were only present in higher than normal numbers during the transitional LPPNB/PPNC and this apparent increase may well be linked to the small sample size. Of the species known for certain to have been wild throughout the period of occupation at 'Ain Ghazal, gazelle were by far the most abundant and represented almost 30% of the MPPNB sample. However, their frequency declined significantly between the MPPNB and transitional LPPNB/PPNC, after which they maintained a low, though stable, presence at just over 10%. In contrast to gazelle, equids increased in frequency over time from 0.2% of the MPPNB sample to over 7% by the Yarmoukian; the most significant increases were between the MPPNB and LPPNB and between the PPNC and Yarmoukian.

It is apparent from Figure 9.2 that the increases in the proportion of caprines and pigs between the MPPNB and LPPNB was primarily at the expense of gazelle, and that the increase in the proportion of caprines at this time was associated with the introduction of large numbers of sheep. Between the LPPNB and Yarmoukian the proportion of caprines was relatively stable, demonstrating that subsequent increases in the number of sheep were met by a corresponding decline in numbers of goats. The apparent increase in the frequency of cattle during the transitional LPPNB/PPNC was primarily at the expense of pigs and gazelle, both of which increased back to roughly their LPPNB levels in the PPNC proper. Finally, the increase in the proportion of equids between the PPNC and Yarmoukian was associated with a sharp drop in the number of pigs, although gazelle also declined slightly at this point.

9.4: REPRESENTATION OF MINOR TAXA IN THE PUBLISHED RESULTS OF KÖHLER-ROLLEFSON ET AL. (1988 AND 1993) AND VON DEN DRIESCH AND WODTKE (1997):

Between them, the six taxa quantified during the course of this study and discussed above make up the greater part of the faunal assemblage from 'Ain Ghazal (see 9.1). However, the previous work of Köhler-Rollefson et al. (1988 and 1993) and von den Driesch and Wodtke (1997) has demonstrated that a wide range of minor taxa are also represented in the faunal assemblage, though in relatively small numbers. Although these minor taxa were not analysed during the course of this study, it has been possible to draw on the published results of Köhler-Rollefson et al. (1993) and von den Driesch and Wodtke (1997) to investigate their representation at the site and the extent this may have been linked to any changes in the representation of the six main medium and large herbivore taxa.

Unfortunately for three reasons the species counts and percentages of Köhler-Rollefson and of von den Driesch and Wodtke are not directly compatible with those obtained from this study. Firstly, their results are based on the analysis of all zones of all skeletal elements using NISP counts and percentages as the basic unit of quantification, rather than the adjusted NISP counts and percentages of a restricted set of POSACs used here. Secondly, the material analysed by von den Driesch and Wodtke and, to a lesser extent, by Köhler-Rollefson, includes samples from different areas of the site to those which form the basis of this study. Thirdly, the phasing of the material analysed by von den Driesch and Wodtke differs slightly from that analysed here. The MPPNB is not represented in their material, the earliest of which belongs to a transitional late MPPNB/early LPPNB phase from the East Field which is conversely not represented in the material from the South, Central and North Fields on which this study is based.

It is therefore only possible to use the results of Köhler-Rollefson's and von den Driesch and Wodtke's analyses of the minor taxa as a rough guide to the results which might have been expected had the POSACs of minor taxa been examined during the course of this study. Köhler-Rollefson's data on the representation of minor taxa at 'Ain Ghazal is reproduced in Table 9.4 and presented graphically in Figures 9.3 and 9.4. The data of von den Driesch and Wodtke is reproduced in Table 9.5 and presented graphically in Figures 9.5 and 9.6.

	MPPNB		LPPNB		PPNC		Yarmoukian	
taxon	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
6main taxa	5681	80.80	886	96.94	2519	97.98	1523	97.69
small carnivore	532	7.57	1	0.11	0	0.00	2	0.13
Vulpes sp.	201	2.86	6	0.66	10	0.39	4	0.26
Testudo sp.	176	2.50	7	0.77	12	0.47	4	0.26
Lepus sp.	146	2.08	2	0.22	7	0.27	4	0.26
bird	132	1.88	4	0.44	2	0.08	3	0.19
rodent	53	0.75	0	0.00	4	0.16	6	0.38
Felis sp.	47	0.67	3	0.33	2	0.08	1	0.06
insectivore	19	0.27	0	0.00	0	0.00	2	0.13
Canis sp.	13	0.18	2	0.22	3	0.12	4	0.26
reptile	10	0.14	1	0.11	2	0.08	0	0.00
Cervus sp.	8	0.11	0	0.00	0	0.00	0	0.00
Meles sp.	6	0.09	1	0.11	0	0.00	0	0.00
crab	4	0.06	0	0.00	1	0.04	0	0.00
Vivirridae	2	0.03	0	0.00	0	0.00	0	0.00
Spalax sp.	1	0.01	1	0.11	0	0.00	4	0.26
Cervus sp. ?	0	0.00	0	0.00	3	0.12	0	0.00
Martes sp.	0	0.00	0	0.00	3	0.12	2	0.13
Herpestes sp.	0	0.00	0	0.00	1	0.04	0	0.00
amphibian	0	0.00	0	0.00	1	0.04	0	0.00
fish	0	0.00	0	0.00	1	0.04	0	0.00
TOTAL	**7031**	**100.0**	**914**	**100.0**	**2571**	**100.0**	**1559**	**100.0**

Table 9.4: Representation of Minor Taxa (NISP and %NISP) in the Results of Köhler-Rollefson et al. (1993)

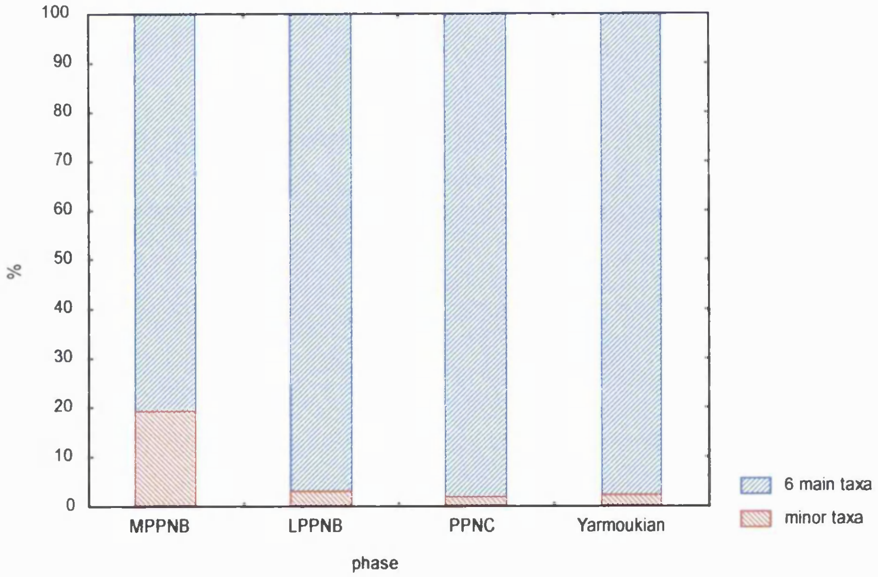


Figure 9.3: Proportion of Minor Taxa (% NISP) in Each Phase in the Results of Köhler-Rollefson et al. (1993)

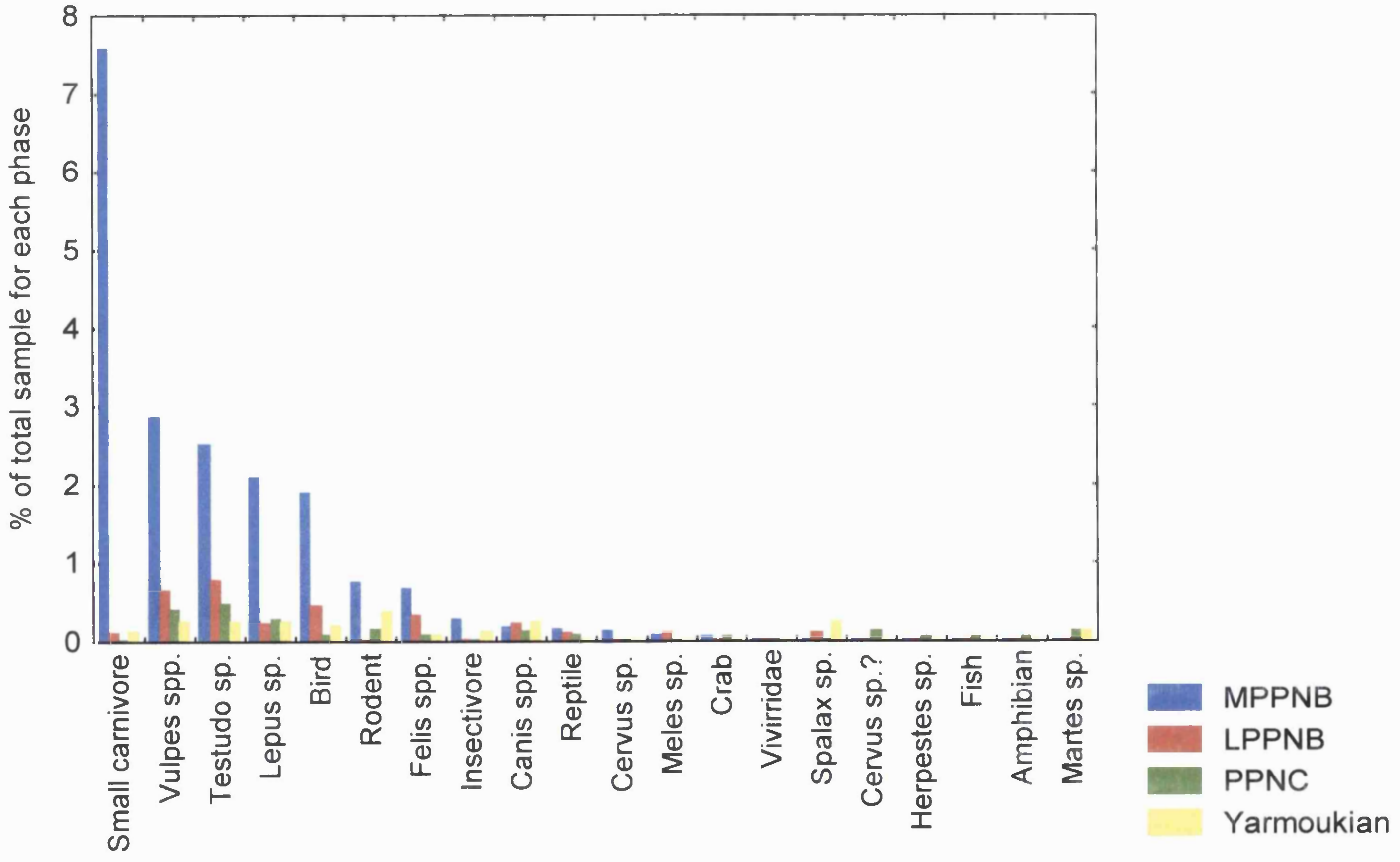
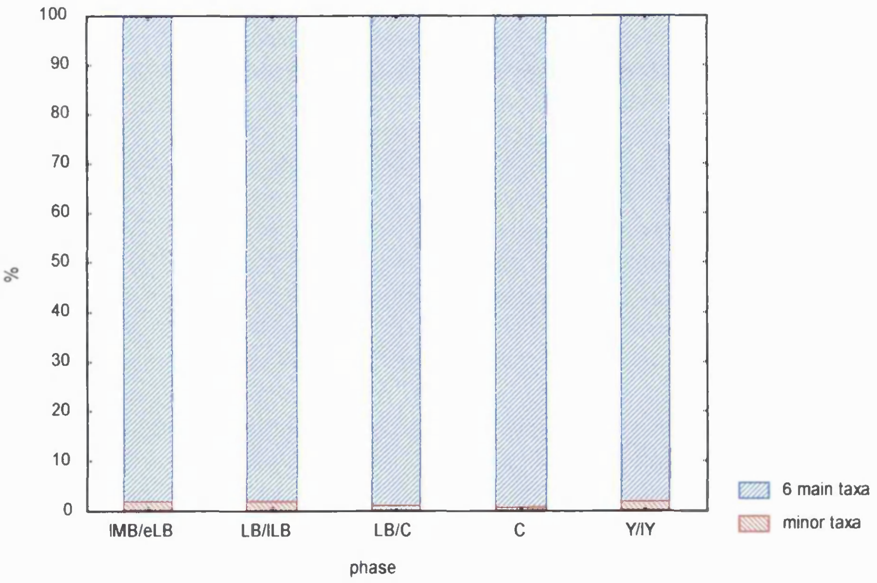


Figure 9.4: Representation of Minor Taxa (% NISP) in the Results of Köhler-Rollefson et al. (1993)

taxon	lMB/eLB n	lMB/eLB %	LB/lLB n	LB/lLB %	LB/C n	LB/C %	C n	C %	Y/lY n	Y/lY %
6 main taxa	3066	98.17	4242	97.92	2760	99.03	4959	99.34	5020	98.1
Vulpes vulpes	20	0.64	46	1.06	8	0.29	8	0.16	24	0.47
Bird	11	0.35	6	0.14	1	0.04	2	0.04	1	0.02
Lepus capensis	7	0.22	12	0.28	1	0.04	0	0.00	4	0.08
Felis silvestris	6	0.19	5	0.12	2	0.07	3	0.06	2	0.04
Testudo graeca	4	0.13	1	0.02	2	0.07	4	0.08	2	0.04
Canis aureus/Dog	2	0.06	1	0.02	0	0.00	0	0.00	8	0.16
Erinacaeus concolor	2	0.06	1	0.02	2	0.07	0	0.00	2	0.04
Crab (*Potamon* sp.)	2	0.06	1	0.02	0	0.00	0	0.00	0	0.00
Canis aureus	1	0.03	0	0.00	0	0.00	1	0.02	1	0.02
Dog	1	0.03	10	0.23	5	0.18	8	0.16	25	0.49
Mellivora capensis	1	0.03	1	0.02	0	0.00	0	0.00	1	0.02
Cervus elaphus	0	0.00	0	0.00	2	0.07	0	0.00	1	0.02
Vulpes rüpelli	0	0.00	0	0.00	1	0.04	0	0.00	0	0.00
Canis lupus	0	0.00	2	0.05	0	0.00	2	0.04	0	0.00
Panthera pardus	0	0.00	1	0.02	0	0.00	0	0.00	0	0.00
Felis caracal	0	0.00	0	0.00	0	0.00	0	0.00	1	0.02
Meles meles	0	0.00	3	0.07	2	0.07	1	0.02	7	0.14
Martes foina	0	0.00	0	0.00	0	0.00	1	0.02	0	0.00
Spalax ehrenbergi	0	0.00	0	0.00	0	0.00	0	0.00	2	0.04
Hemiechinus auritus	0	0.00	0	0.00	0	0.00	0	0.00	1	0.02
Mollusc	0	0.00	0	0.00	1	0.04	3	0.06	15	0.29
TOTAL	**3123**	**100.0**	**4332**	**100.0**	**2787**	**100.0**	**4992**	**100.0**	**5117**	**100.0**

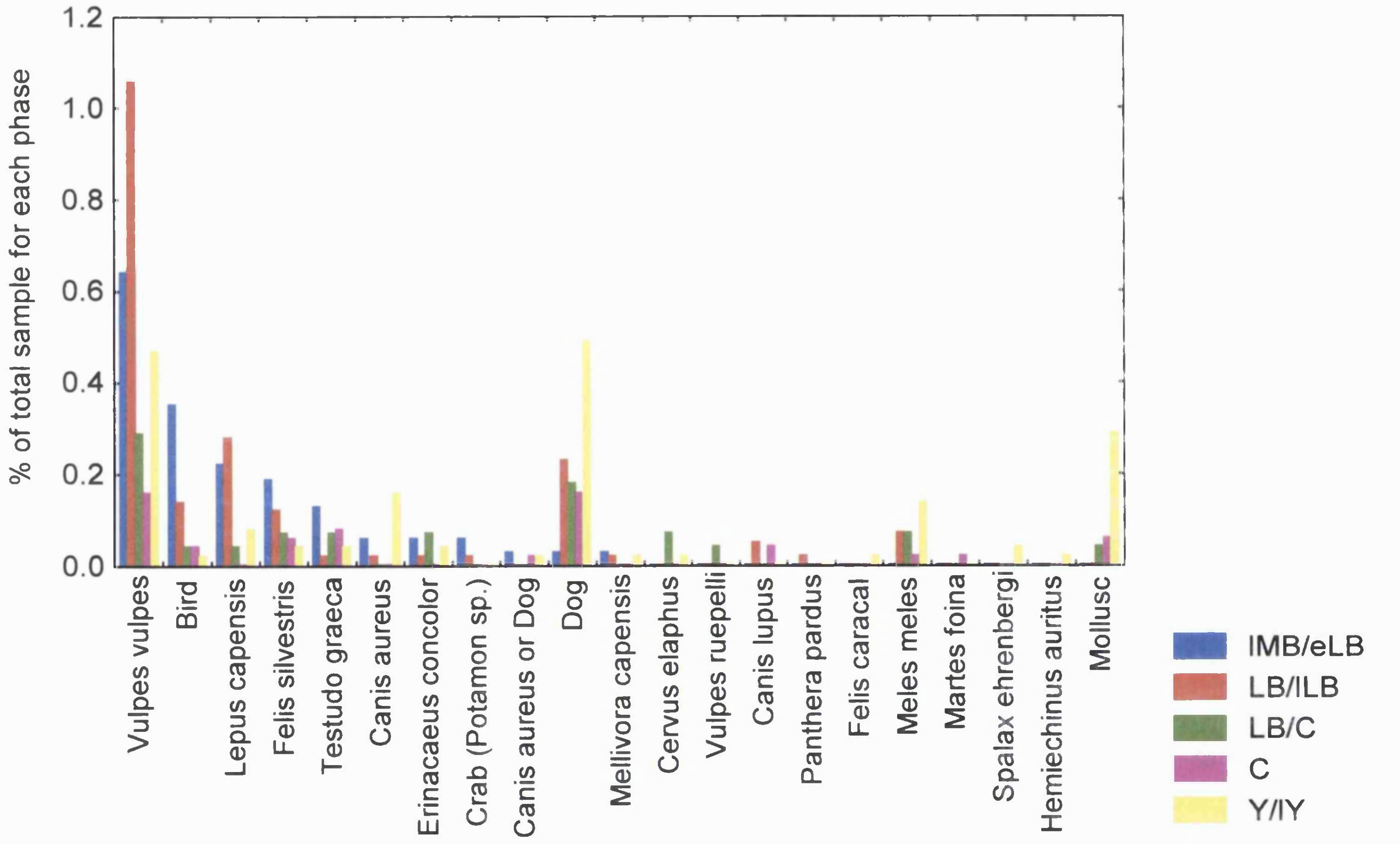
Key: lMB/eLB=late MPPNB/early LPPNB, LB/lLB=LPPNB/late LPPNB, LB/C=LPPNB/PPNC, C=PPNC, Y/lY=Yarmoukian/late Yarmoukian

Table 9.5: Representation of Minor Taxa (NISP and % NISP) in the Results of von den Driesch and Wodtke (1997)



Key: lMB/eLB=late MPPNB/early LPPNB, LB/lLB=LPPNB/late LPPNB, LB/C=LPPNB/PPNC, C=PPNC, Y/lY=Yarmoukian/late Yarmoukian

Figure 9.5: Proportion of Minor Taxa (%NISP) in Each Phase in the Results of von den Driesch and Wodtke (1997)



Key: lMB/eLB=late MPPNB/early LPPNB, LB/lLB=LPPNB/late LPPNB, LB/C=LPPNB/PPNC, C=PPNC, Y/lY=Yarmoukian/late Yarmoukian

Figure 9.6: Representation of Minor Taxa (% NISP) in the Results of von den Driesch and Wodtke (1997)

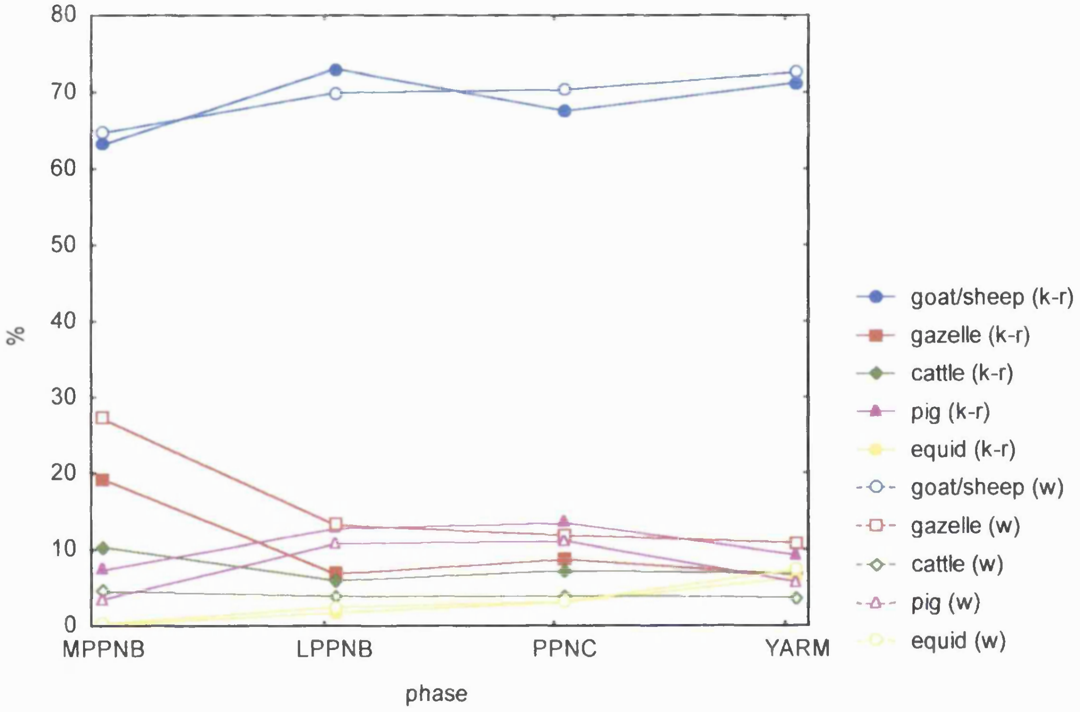
Comparison of Figures 9.4 and 9.6 demonstrates that although a similar range of minor taxa are represented in the results of Köhler-Rollefson and of von den Driesch and Wodtke, there are significant differences in their proportional representation. In general, minor taxa are more frequent in the samples analysed by Köhler-Rollefson than in those analysed by von den Driesch and Wodtke, especially in the earliest phase of each set of results (see Figures 9.3 and 9.5). As the earliest phase of von den Driesch and Wodtke, the transitional late MPPNB/early LPPNB, is slightly later than the earliest phase of Köhler-Rollefson et al., the MPPNB proper, it is possible that a decline in the frequency of minor taxa had occurred prior to the transitional late MPPNB/early LPPNB. This would mean that an important shift in the representation of these taxa is not represented in the results of von den Driesch and Wodtke (1997). In an attempt to establish which set of results would most closely replicate the results which might have been expected had the POSACs of minor taxa been analysed in this study, the representation of the six main medium and large herbivore taxa in the published results of Köhler-Rollefson et al. (1993) and von den Driesch and Wodtke (1997) were compared with the representation of the same six main medium and large herbivore taxa in the results of this study (see Table 9.3 and Figure 9.2).

9.4.1: Representation of the Six Main Medium and Large Herbivore Taxa in the Published Results of Köhler-Rollefson et al. (1993) and von den Driesch and Wodtke (1997):

The published NISP counts and percentages of Köhler-Rollefson et al. (1993) for the six main medium and large herbivore taxa are presented in Table 9.6 and are plotted in Figure 9.7 together with the adjusted NISP counts and percentages for the same six taxa obtained during this study (see Table 9.3 and Figure 9.2). As Köhler-Rollefson did not attempt to identify her caprine sample to species, the goat and sheep counts from this study have been combined into a single goat/sheep sample in Figure 9.7 for the purpose of comparison. Also, the data from the transitional LPPNB/PPNC phase has been omitted in Table 9.6 and Figure 9.7 as Köhler-Rollefson analysed no material from this phase.

	MPPNB		LPPNB		PPNC		Yarmoukian	
taxon	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
goat/sheep	3585	63.1	647	73.0	1700	67.5	1085	71.2
gazelle	1090	19.2	60	6.8	220	8.7	100	6.6
cattle	583	10.3	52	5.9	182	7.2	104	6.8
pig	415	7.3	113	12.7	341	13.4	140	9.2
equid	8	0.1	14	1.6	76	3.0	94	6.2
TOTAL	**5681**	**100.0**	**886**	**100.0**	**2519**	**100.0**	**1523**	**100.0**

Table 9.6: NISP Counts and Percentages for the Six Main Medium and Large Herbivore Taxa in the Results of Köhler-Rollefson et al. (1993)



Key: k-r=Köhler-Rollefson et al. (1993), w=Wasse (this study)

Figure 9.7: Comparison of the NISP Percentages of Köhler-Rollefson et al. (1993) and the Adjusted NISP Percentages from this Study for the Six Main Medium and Large Herbivore Taxa

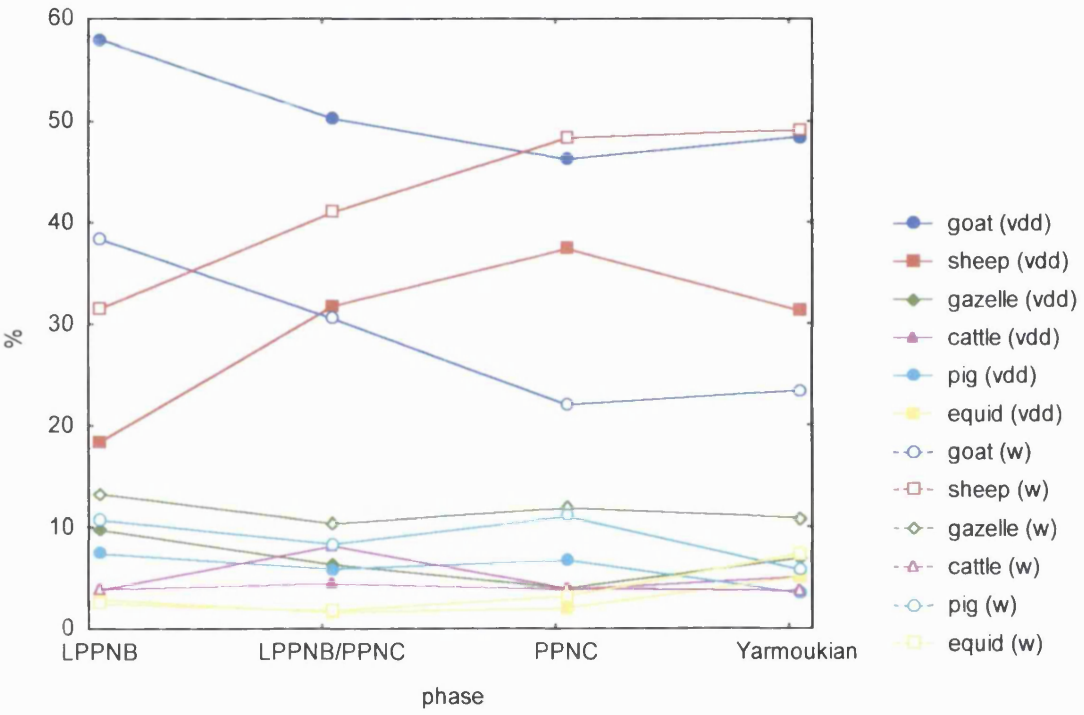
It is clear from Figure 9.7 that the general trends in the representation of the six main medium and large herbivore taxa in the results of this study and those of Köhler-Rollefson are broadly comparable, although there are some differences in detail. Most of these differences can be explained by the use of different methodologies to sample and quantify the material. The slightly lower representation of equids and slightly higher representation of pigs in Köhler-Rollefson's NISP percentages is almost certainly linked to the modification, to take their anatomical frequency into account, of equid and pig metapodial and phalanx counts in the adjusted NISP percentages used in this study. This discrepancy would be further magnified by the fact that the NISP percentages of Köhler-Rollefson include second phalanges, which as non-POSACs were excluded from this analysis. The higher representation of cattle, especially in the MPPNB sample, and lower representation of gazelle in results of Köhler-Rollefson is harder to explain. With regard to cattle, it is possible that the highly fragmented state of this material has contributed to this discrepancy, as in this study a POSAC was only counted if more than half of it was present. The exclusion of second phalanges from this analysis may also have had an effect, as this element survives well and would therefore feature strongly in Köhler-Rollefson's NISP percentages. With regard to gazelle, it is possible that similar factors may have been at work; on the whole the gazelle remains from 'Ain Ghazal were less fragmented than those of other taxa, which may have led to the over-representation of gazelle POSACs in the adjusted NISP percentages of this study for the same reasons.

To summarise, the representation of the six main medium and large herbivore taxa in the results of Köhler-Rollefson is broadly comparable with the representation of the same six taxa in the results of this study. The minor differences between these two sets of results can be attributed to the use of different methodologies. These results are unsurprising given that the samples analysed by Köhler-Rollefson formed a significant part of the material analysed in this study.

The published NISP counts and percentages of von den Driesch and Wodtke (1997) for the six main medium and large herbivore taxa are presented in Table 9.7 and are plotted in Figure 9.8 together with the adjusted NISP counts and percentages for the same six taxa obtained during this study (see Table 9.3 and Figure 9.2). As the results of von den Driesch and Wodtke contained an extremely large proportion of caprine specimens which were not identified to species, these were divided amongst the goats and sheep according to the relative proportions of these two species in the identified sample. In addition, as the MPPNB is not represented in their material and as their transitional late MPPNB/early LPPNB phase is not represented in the material analysed in this study, both phases are omitted in Table 9.7 and Figure 9.8.

	LPPNB		LPPNB/PPNC		PPNC		Yarmoukian	
species	n	%	n	%	n	%	n	%
goat	2460	58.0	1387	50.3	2292	46.2	2432	48.4
sheep	777	18.3	876	31.7	1855	37.4	1570	31.3
gazelle	410	9.7	173	6.3	194	3.9	345	6.9
cattle	163	3.8	122	4.4	188	3.8	251	5.0
pig	313	7.4	160	5.8	332	6.7	171	3.4
equid	119	2.8	42	1.5	98	2.0	251	5.0
TOTAL	**4242**	**100.0**	**2760**	**100.0**	**4959**	**100.0**	**5020**	**100.0**

Table 9.7: NISP Counts and Percentages for the Six Main Medium and Large Herbivore Taxa in the Results of von den Driesch and Wodtke (1997)



Key: vdd=von den Driesch and Wodtke (1997), w=Wasse (this study)

Figure 9.8: Comparison of the NISP Percentages of von den Driesch and Wodtke (1997) and Adjusted NISP Percentages from this Study for the Six Main Medium and Large Herbivore Taxa

It is clear from Figure 9.8 that there are some major differences in the representation of the six main medium and large herbivore taxa in the results of von den Driesch and Wodtke (1997) and in the results of this study. The most significant discrepancy concerns the proportions of goats and sheep in the two sets of results. The key difference is not so much in the overall proportion of caprines, but in the goat to sheep ratios. These are consistently more heavily skewed in favour of goats in von den Driesch and

Wodtke's results. Three factors could potentially have caused these differences; these are critically discussed below:

1) The fact that horncores are included in von den Driesch and Wodtke's NISP counts would almost certainly have led to goats being over-represented, owing to the preservational biases acting against sheep horncores. However, it is clear from their results (von den Driesch and Wodtke 1997, p.542 Table 2) that this alone is not enough to account for the differences between the two sets of data.

2) The differences between the two sets of results could be a reflection of spatial variation in the goat to sheep ratios in samples from different areas of the site. As exactly the same transitional LPPNB/PPNC material was analysed in both studies, von den Driesch and Wodtke's goat to sheep ratio for this phase was compared with that obtained during this study. Of the 2263 transitional LPPNB/PPNC caprine bones analysed by von den Driesch and Wodtke, 182 were identified as goat and 115 as sheep (von den Driesch and Wodtke 1997, p.542 Table 2), giving a goat to sheep ratio of 1:0.6. This compares with a goat to sheep ratio of 1:1.3 obtained during this study (see Chapter 7, Table 7.1). The fact that von den Driesch and Wodtke obtained a higher goat to sheep ratio from their analysis of exactly the same material examined in this study suggests that their results are consistently more heavily skewed in favour of goat regardless of the area of the site from which their samples originated. The transitional LPPNB/PPNC goat to sheep ratio of 1:1.3 obtained in the First Analysis of this study (see Chapter 8) using traditional methods of separation was confirmed by the metrical separation of goat and sheep distal metacarpals of the Second Analysis of this study (see Chapter 8). The Second Analysis resulted in the identification to species of the entire sample of transitional LPPNB/PPNC caprine distal metacarpals and gave an identical goat to sheep ratio for this phase of 1:1.3 (see Figure 8.4 and Table 8.10).

3) A more likely reason for the discrepancies between these two sets of goat to sheep ratios is that different methodologies were used to identify and quantify the material. Specifically, von den Driesch and Wodtke included elements and parts of elements in their analysis which can, given long experience, be identified as caprine (von den Driesch and Wodtke 1997, p.515) but can rarely be identified to species (e.g.:

proximal ends and shafts of long bones, vertebrae, ribs, carpals, some tarsals and sesamoids). This raises the possibility that the proportion of caprine specimens identified to species may have been too low for their goat to sheep ratios to be representative of their samples as a whole (see Chapter 8). The likelihood that this is indeed the case is increased by the fact that their identifications of caprine astragali (of which 68.6% were identified to species compared to 12.8% of their caprine sample as a whole (calculated from data in von den Driesch and Wodtke 1997, p.542 Table 2)) show sheep to have outnumbered goats at 'Ain Ghazal from the transitional LPPNB/PPNC onwards.

In addition to differences in the representation of goats and sheep in the results of von den Driesch and Wodtke (1997) and those of this study, there are also significant differences in the representation of other taxa. The proportions of gazelle, pigs and equids in von den Driesch and Wodtke's samples are lower in all phases, including the transitional LPPNB/PPNC material which was also analysed in this study (see Figure 9.8).

The lower proportion of pigs in the results of von den Driesch and Wodtke is difficult to explain, as it is exactly the opposite trend which would be expected if it were primarily the result of the difference between NISP and adjusted NISP percentages and the inclusion of second phalanges in their samples. It also should be noted that there is no sign of any rise in the proportion of cattle in the results of von den Driesch and Wodtke during the transitional LPPNB/PPNC. This suggests the rise in the proportion of cattle during the transitional LPPNB/PPNC which was documented in the results of this study is probably linked to the small sample size, as caused by the exclusion of non-POSACs from this analysis.

There are further discrepancies which are difficult to attribute to the use of different methdologies or the effects of sample size. In particular the pattern of rise and fall over time in the proportions of some species, such as gazelle between the transitional LPPNB/PPNC and Yarmoukian, differs significantly in the two sets of results (see Figure 9.8). The fact that the material analysed in this study includes PPNC and Yarmoukian samples from the South Field not examined by von den Driesch and Wodtke, and that their material included transitional late MPPNB/early LPPNB samples from the East

Field not included here, raises the possibility that some of these differences may be a reflection of intra-site variation in taxonomic representation.

In sum, whilst most of the differences between the representation of the six main medium and large herbivore taxa in the results of this study and those of von den Driesch and Wodtke can be attributed to the use of different methodologies, significant discrepancies remain which are more likely to be a reflection of intra-site spatial variation in taxonomic representation.

To conclude, this comparison has demonstrated that the representation of the six main medium and large herbivore taxa in the results of this study is more comparable with the representation of the same six taxa in the published results of Köhler-Rollefson et al. (1988 and 1993) than in the published results of von den Driesch and Wodtke (1997). This strongly suggests that the proportions of minor taxa in the results of Köhler-Rollefson are more likely to reflect their probable proportions in the samples which form the basis of this study, had the material been examined. For this reason, and the fact that the MPPNB proper is not represented in the results of von den Driesch and Wodtke, it was decided to use the NISP counts and percentages of Köhler-Rollefson (see Table 9.4) as the quantitative basis for the following discussion of the representation of the minor taxa at 'Ain Ghazal. However, as some of the categories of taxa quantified by Köhler-Rollefson et al. (1993) are rather broad (e.g.: *Canis* sp., *Felis* sp.) the results of von den Driesch and Wodtke (1997) are also referred to where more detailed identification is required.

9.4.2: Representation of Minor Taxa at 'Ain Ghazal:

Two aspects of the proportions of minor taxa in the results of Köhler-Rollefson stand out. Firstly, it appears that minor taxa were most common during the MPPNB but had decreased sharply in frequency by the LPPNB and continued to be present at the site in similarly small numbers during the PPNC and Yarmoukian. The results of von den Driesch and Wodtke suggest that the decline in the proportion of minor taxa had probably occurred by the transitional late MPPNB/early LPPNB. Secondly, one of the reasons why minor taxa were relatively frequent in Köhler-Rollefson's MPPNB sample is that the faunal assemblage from a single MPPNB house, in square 3082, was dominated by the bones of small carnivores (Köhler-Rollefson 1989b, p.23).

Although it is clear that the overall proportion of minor taxa in the MPPNB was increased by the composition of this particular assemblage, it does not necessarily mean that their relatively high frequency during this phase is an departure from the norm. Even if entirely different MPPNB structures had been excavated it is still possible that one or even more of them may have produced a faunal assemblage similarly dominated by minor taxa.

The interpretation of these two factors is complicated by the fact that many of these minor taxa may have been hunted and trapped for resources other than their meat, such as fur. If it is assumed that these minor taxa were trapped and hunted primarily for consumption, the decline in their frequency may indicate that game had become depleted in the vicinity of the site by the end of the MPPNB, or that cultural preferences had led to the development of a faunal economy dominated by the six main medium and large herbivore taxa, predominantly goats and sheep (Köhler-Rollefson 1989b, p.23). However, if it assumed that many of these minor taxa were also trapped and hunted for resources other than meat, the decrease in their numbers over time might also indicate that some of resources, such as hides and leather, were subsequently obtained from the increasing number of domesticates at the site (von den Driesch and Wodtke 1997, p.534). It should be noted that disentangling the exploitation of animals for consumption and for other activities on the basis of a part of the faunal assemblage which was not analysed during this study is problematic and as such warrants a separate study of its own.

Having discussed some of the problems associated with the interpretation of the remains of many minor taxa, their representation in the published results of Köhler-Rollefson et al. (1993) is described below. Taxa are described in declining order of their frequency in the MPPNB sample (see Table 9.5 and Figure 9.4). It should be noted that the percentage NISPs of these taxa are extremely low, often less than 1%, owing to the predominance of the six main medium and large herbivore taxa in the faunal assemblage. Consequently, the variation documented in the representation of minor taxa may be more significant that the percentage NISPs at first suggest.

9.4.2.1: Small Carnivores:

As *Vulpes* spp., *Felis* spp. and *Canis* spp. bones in the MPPNB sample excavated during 1983 were not identified to genus or species, they were categorised as 'small carnivore' instead (Köhler-Rollefson 1993, p.96). These three genera are therefore under-represented in the MPPNB NISP counts and percentages. This shortfall is made up by the 'small carnivore' category. The representation of small carnivores mirrors the general pattern for minor taxa as a whole. From a MPPNB peak of 7.57%, the proportion of small carnivores decreased sharply to 0.11% in the LPPNB, 0% in the PPNC and 0.13% in the Yarmoukian. However, as the small carnivore category is primarily applicable to the MPPNB sample excavated in 1983, the small carnivore NISP counts and percentages for the subsequent three phases are of little relevance.

9.4.2.2: *Vulpes* spp.:

Fox was easily the most common of the minor taxa at 'Ain Ghazal in all phases. The frequency of this genus declined rapidly from 2.86% in the MPPNB, to 0.66% in the LPPNB and subsequently more steadily to 0.39% and 0.26% in the PPNC and Yarmoukian samples respectively. The proportion of fox in the MPPNB sample was actually much higher than the figure of 2.86% suggests, for the reasons outlined in 9.4.2.1 above. Preliminary metrical analysis of the fox remains by Köhler-Rollefson (1989b, p.22) demonstrated that although the red fox *Vulpes vulpes* was predominant, a smaller species was also present in the assemblage. The more detailed metrical analysis by von den Driesch and Wodtke (1997, p.534) ascribed the majority of fox bones to the small red fox sub-species *Vulpes vulpes palaestina* and a minority of smaller specimens to sand fox *Vulpes ruepelli*.

9.4.2.3: *Testudo* sp.:

Amongst the minor taxa identified to species, the remains of the Moorish tortoise, *Testudo graeca*, were second only to fox in frequency within the MPPNB sample analysed by Köhler-Rollefson, comprising 2.5% of the sample. However, its frequency declined steadily over time to 0.77% in the LPPNB, 0.47% in the PPNC and 0.26% in the Yarmoukian samples. The relative abundance of tortoise during the MPPNB hints at the systematic exploitation of their carapaces for containers (Köhler-Rollefson et al. 1988, p.424).

9.4.2.4: *Lepus* sp.:

Like the majority of other minor taxa, the frequency of hare declined sharply from 2.08% during the MPPNB to 0.22% by the LPPNB and maintained comparable frequencies of 0.27% and 0.26% into the PPNC and Yarmoukian respectively. Metrical analysis by von den Driesch and Wodtke (1997, p.534) has demonstrated that the hare remains are relatively small, as the southerly location of 'Ain Ghazal would suggest.

9.4.2.5: Bird:

Bird bone was also relatively well represented in the MPPNB sample at 1.88%, despite the preservational biases acting against this material, but subsequently declined to 0.44% in the LPPNB, 0.08% in the PPNC and 0.19% in the Yarmoukian samples. A variety of game birds, such as quail, partridge and rock dove, and corvids have been identified, but in addition the remains of large birds of prey such as eagles, hawks and vultures were also relatively common, especially during the MPPNB (Köhler-Rollefson et al. 1988, p.424, Gillespie 1984 and 1986). It is therefore conceivable that birds may have been hunted as much for their feathers as their meat (von den Driesch and Wodtke 1997, p.535).

9.4.2.6: Small Rodents:

Although the proportion of small rodent bones was relatively low in the majority of excavated sediments, which were sieved through a 5mm. mesh, analysis of flotation samples suggests that they may have been much more common than their representation in the sieved samples examined by Köhler-Rollefson suggests (Gillespie 1984, p.11). It is doubtful that small rodents were procured for consumption and all the evidence suggests that their excavated remains represent wild animals living and dying within the area of the site. The great majority of small rodent specimens have been identified as the house mouse *Mus musculus*, suggesting that this species was a commensal occupant of the site and potentially quite a pest (Gillespie 1984, p.11), although squirrels *Sciurus* sp., voles *Microtus* sp., jirds *Meriones* sp. and rats *Rattus* sp. have also been identified in small numbers. The proportion of small rodents in the samples analysed by Köhler-Rollefson ranged between 0% and 0.75%.

9.4.2.7: *Felis* spp.:

The proportion of felid remains in the faunal assemblage declined steadily over time, from 0.67% in the MPPNB to 0.06% in the Yarmoukian, and thus follows the typical pattern for minor taxa. The proportion of felids in the MPPNB sample was actually much higher than the figure of 0.67% suggests, for the reasons outlined in 9.4.2.1 above The great majority of felid remains from 'Ain Ghazal have been ascribed to wild cat *Felis sylvestris* (Köhler-Rollefson 1989b, p.22), although single specimens each of lynx *Felis lynx* and caracal *Felis caracal* have also been identified (Köhler-Rollefson 1989b, p.23, von den Driesch and Wodtke 1997, p.534).

9.4.2.8: Insectivore:

Insectivores are represented in the faunal assemblage from 'Ain Ghazal by two species of hedgehog: the long-eared hedgehog *Hemiechinus auritus*, and the european hedgehog *Erinaceus europaeus* (Köhler-Rollefson et al. 1988, p.424) or eastern hedgehog *Erinaceus concolor* (von den Driesch and Wodtke 1997, p.534). These were most frequent during the MPPNB, when they comprised 0.27% of the sample, but subsequently declined in frequency.

9.4.2.9: *Canis* spp.:

The proportion of canid remains in the faunal assemblage from 'Ain Ghazal departs from the typical trend for minor taxa of decline over time. Instead, Köhler-Rollefson found the highest proportion of canids in the Yarmoukian period, as did von den Driesch and Wodtke (1997) to an even greater extent. In the results of Köhler-Rollefson, canid remains comprised 0.18% of the MPPNB, 0.22% of the LPPNB, 0.12% of the PPNC and 0.26% of the Yarmoukian samples. The proportion of canid during the MPPNB was probably slightly higher, as a number of specimens identified only as small carnivore may belong to this genus (Köhler-Rollefson et al. 1993, p.96) (see 9.4.2.1 above).

Interpretation of the representation of canid remains at 'Ain Ghazal is complicated by the fact that three species have been identified within this category: the domestic dog *Canis familiaris*, the wolf *Canis lupus* and the jackal *Canis aureus* (von den Driesch and Wodtke 1997, Quintero and Köhler-Rollefson 1997). Of the three canid species, the domestic dog was easily the most common; it has been identified at 'Ain Ghazal in all phases of occupation on the basis of metrical (von den Driesch and Wodtke 1997, p.533) and morphological (Quintero and Köhler-Rollefson 1997) criteria. The results of von den Driesch and Wodtke (1997, p.533) demonstrate that the increase in the proportion of canids during the Yarmoukian was made up by an increase in the frequency of domestic dog, rather than wolf or jackal, and suggest that this may have been linked to their use in connection with animal herding. Wolf and jackal bones have been identified in extremely small numbers in most phases of occupation (von den Driesch and Wodtke 1997, p.534).

9.4.2.10: Others:

The nine taxa described above make up the great majority of the already tiny proportion of minor taxa in the faunal assemblage from 'Ain Ghazal. However, both Köhler-Rollefson and von den Driesch and Wodtke have in addition identified a handful of specimens belonging to the following species: red deer *Cervus elaphus*, badger *Meles meles*, molerat *Spalax ehrenbergi*, beech marten *Martes foina*, mongoose *Herpestes* sp., leopard *Panthera pardus*, fresh-water crab *Potamon* sp., and assorted Vivirridae (civets/genets), reptiles, amphibians, molluscs and fish. As these are present in such small numbers (see Tables 9.5 and 9.6) their representation is not discussed further here.

9.4.3: Summary of the Representation of Minor Taxa at 'Ain Ghazal:

On the basis of the published results of Köhler-Rollefson et al. (1993), it appears that by far the most common minor taxon at 'Ain Ghazal was fox, followed by tortoise, hare, bird, assorted small rodents, felid, hedgehog and canid. With the exception of dog, the sole domesticate amongst them, the representation of all of these minor taxa followed the same pattern of decline over time. This decline was most pronounced between the MPPNB and LPPNB, but continued into the PPNC and Yarmoukian, and mirrors the decline in the goats and gazelle which dominated the MPPNB faunal economy. In addition extremely small quantities of reptile, cervid, badger, genet/civet, molerat, mongoose, marten, amphibian and fish bone have also been identified at the site. Some of these may have been exploited by the inhabitants of 'Ain Ghazal, however it is also possible that some of specimens are intrusive from comparatively recent times; for example the molerat, which lives underground, is most common in Yarmoukian strata which generally lie extremely close to the modern ground surface.

9.5: CONCLUSIONS:

If the proportions of the six main medium and large herbivore taxa in the 'Ain Ghazal faunal assemblage obtained during the course of this study are combined with the proportions of minor taxa published by Köhler-Rollefson et al. (1993) the tables which form the basis of Chapter 5 can be updated to include the information presented in Tables 9.8 and 9.9.

To do so the total proportion of the six main medium and large herbivore taxa for each phase obtained by Köhler-Rollefson (see Table 9.4 and Figure 9.3) has been divided according to the proportions of these taxa obtained in this study (see Table 9.3). The total proportions of minor taxa for each phase obtained by Köhler-Rollefson (see Table 9.4 and Figure 9.3) have been divided according to her proportions of the relevant minor taxa. The small carnivore category for each phase has been divided between *Canis* spp., *Vulpes* spp. and *Felis* spp. according to their proportions in her identified sample. Although the adjusted NISP percentages of this study and the NISP percentages of Köhler-Rollefson are not entirely compatible, the proportions of minor taxa in the 'Ain Ghazal faunal assemblage are so low that this was not felt to pose a serious problem.

Site	Period	Area	n	Equ	Bos	Sus	Gaz	Alc	C+O	(C/O)	(Cpr)	(Ovi)	Cer	Dam	Cap	Lep	Can	Vul	Fel	Mus	Eri	Source
Ain Ghazal ~~'Ain Ghazal~~	3	JH	>3351	0.2	3.6	2.7	22.0		52.3		52.0	0.3	0.1			2.9	0.5	11.9	2.8	0.1	0.4	Wasse (this study)/Köhler-Rollefson et al (1993)
'Ain Ghazal	4	JH	>704	2.3	3.7	10.4	12.8		67.8		37.2	30.5				0.4	0.4	1.3	0.8	0.2		Wasse (this study)/Köhler-Rollefson et al (1993)
'Ain Ghazal	4/5	JH	>326	1.7	8.1	8.3	10.3		71.5		30.5	41.0										Wasse (this study)/Köhler-Rollefson et al (1993)
'Ain Ghazal	5	JH	>1951	3.0	3.8	10.8	11.6		68.9		21.6	47.3				0.6	0.2	0.8	0.2	0.2		Wasse (this study)/Köhler-Rollefson et al (1993)
'Ain Ghazal	6	JH	>1440	7.1	3.6	5.6	10.6		70.8		22.9	48.0				0.6	0.6	0.6	0.2	0.2	0.2	Wasse (this study)/Köhler-Rollefson et al (1993)

S.Levant Area Codes: JH=Jordanian Highlands
Taxa Codes: Equ=*Equus* spp., Bos=*Bos* spp., Sus=*Sus* spp., Gaz=*Gazella* spp., Alc=*Alelaphus buselaphus*, C+O=total Subfamily Caprinae i.e. C/O+Cpr+Ovi, (C/O)=*Capra* spp. or *Ovis* spp., (Cpr)=*Capra* spp., (Ovi)=*Ovis* spp., Cer=*Cervus elaphus*, Dam=*Dama mesopotamica*, Cap=*Capreolus capreolus*, Lep=*Lepus capensis*, Can=*Canis* spp., Vul=*Vulpes* spp., Fel=Family Felidae, Mus=Family Mustelidae, Eri=Family Erinaceidae
Quantitative Data: Equ, Bos, Sus, Gaz, C+O, (Cpr) and (Ovi)=adjusted % NISP, all other taxa=% NISP

Table 9.8: Proportions of Taxa in Faunal Assemblage from 'Ain Ghazal between Periods 3 and 6

Site	Period	Area	n	Hrb	Equ	Bos	Sus	Gaz	C+O	(Cpr)	(Ovi)	(C:O)	(id)	Cer	Dam	Cap	Source
'Ain Ghazal	3	JH	>3351	80.8	0.2	4.5	3.4	27.2	64.7	64.2	0.4	1:0.01	58.7	0.1			Wasse (this study)
'Ain Ghazal	4	JH	>704	96.9	2.4	3.8	10.7	13.2	69.9	38.4	31.5	1:0.8	58.1				Wasse (this study)
'Ain Ghazal	4/5	JH	>326	100.0	1.7	8.1	8.3	10.3	71.6	30.5	41.0	1:1.3	59.1				Wasse (this study)
'Ain Ghazal	5	JH	>1951	98.0	3.1	3.9	11.0	11.8	70.3	22.0	48.3	1:2.2	57.8				Wasse (this study)
'Ain Ghazal	6	JH	>1440	97.7	7.3	3.7	5.7	10.8	72.5	23.4	49.1	1:2.1	49.3				Wasse (this study)

S.Levant Area Codes: JH=Jordanian Highlands
Taxa Codes: Hrb=% of major medium and large herbivores in n, Equ=*Equus* spp., Bos=*Bos* spp., Sus=*Sus* spp., Gaz=*Gazella* spp., C+O=total Subfamily Caprinae, (Cpr)=*Capra* spp., (Ovi)=*Ovis* spp., (C:O)=ratio *Capra* spp.:*Ovis* spp., (id)=% of total Subfamily Caprinae identified to genus, Cer=*Cervus elaphus*, Dam=*Dama mesopotamica*, Cap=*Capreolus capreolus*
Quantitative Data: all % adjusted NISP

Table 9.9: Proportions of Major Medium and Large Herbivores in Faunal Assemblage from 'Ain Ghazal Between Periods 3 and 6

CHAPTER 10: CAPRINE DOMESTICATION AND MORE SPECIALISED PASTORAL ECONOMIES AT 'AIN GHAZAL

10.1: INTRODUCTION:

As described in Chapter 6, the zooarchaeology of caprines in south-west Asia between 12,500b.p. and 5,200b.p. has been dominated by two key themes: firstly, the initial emergence of caprines as major early domesticates and secondly, the subsequent role of domestic caprines in the development of more specialised pastoral economies. This chapter therefore discusses the 'Ain Ghazal caprine remains in detail in an attempt to establish their wild or domestic status, and to examine whether there is any evidence to suggest that these animals were managed within the context of a more specialised pastoral economy.

10.2: THE WILD OR DOMESTIC STATUS OF CAPRINES AT 'AIN GHAZAL:

This section discusses the caprine remains from 'Ain Ghazal which were examined during this study in the context of the main criteria by which zoological domesticates can be identified in archaeological faunal assemblages (see Chapter 6). The 'Ain Ghazal caprine remains are tested against each of these criteria, with the exception of pathology which did not form part of this study, in an attempt to establish the wild or domestic status of caprines at the site during each of the main phases of occupation.

10.2.1: Import of a Foreign Species and Changes in the Frequency of Species:

Any examination of whether caprines were imported to 'Ain Ghazal as foreign species will inevitably be based on examination of zoogeographical data. This section therefore aims to assess whether wild goats and mouflon would have inhabited the area around the site during the early Holocene, and whether there were any significant changes in their frequency during the period of the site's occupation which might relate to their presence as domesticates.

The present environmental setting of 'Ain Ghazal has already been described in Chapter 7. Reconstructions of environmental conditions in the vicinity of the site during the early Holocence are now discussed below.

All available data suggests that environmental conditions around 'Ain Ghazal during the early Holocene would have been rather similar to that of today, prior to recent deforestation. Many small mammal and non-mammal species are ecologically specific and can thus be used to reconstruct environmental conditions in the vicinity of the site. The MPPNB small mammal and non-mammal assemblage from 'Ain Ghazal contains both woodland species such as vole, squirrel, badger, European hedgehog and goshawk, and steppic species such as Egyptian mongoose, long-eared hedgehog and chukar partridge (Köhler-Rollefson and Rollefson 1990, p.4). In addition, analysis of MPPNB charred wood fragments has provided evidence for the presence of oak, tamarisk and poplar in the vicinty of the site (Rollefson 1984, p.152). These data strongly suggest that during the Early Holocene 'Ain Ghazal was located close to the boundary between the Mediterranean and Irano-Turanian phyto-geographical zones, as it is today. The low mountains to the north, west and south of the site would probably have been dominated by evergreen broad-leaved and mixed forests, whilst the more open terrain to the east would probably have been dominated by a combination of steppic dwarf-shrublands and grasslands. The presence of poplar suggests that gallery forests would have been found along the Wadi Zarqa and its tributaries.

The geographical and environmental setting of 'Ain Ghazal during the early Holocene would therefore not have corresponded with the cool, high mountainous terrain and cold deciduous forest vegetation in which wild goat seems to have been especially abundant during the late Pleistocene and early Holocene (see Chapter 6). However, limited numbers of wild goat may well have inhabited the evergreen broad-leaved and mixed forests which are thought to have covered the low mountains to the north, west and south of the site, though perhaps only on a seasonal basis. Unfortunately no faunal assemblages dating to Periods 1 and 2 are available from the immediate vicinity of 'Ain Ghazal against which this hypothesis can be tested. However, it should be noted that the Period 2 site of Iraq ed Dubb, located further to the north in an area of the Jordanian Highlands which would also have supported evergreen broad-leaved and mixed forests during the early Holocene, has yielded a faunal assemblage dominated by gazelle, although wild caprines were also present in lower frequencies (Kuijt et al. 1991).

The undulating hill-country and plains to the east and north-east of 'Ain Ghazal, which would probably have supported dwarf-shrubland and grass-land vegetation during the early Holocene, correspond well with the favoured habitat of the mouflon elsewhere in south-west Asia (see Chapter 6). However, as there is currently no evidence for the presence of mouflon in the moist and dry steppe zones of the Jordanian plateau and western parts of the Syrian desert during the early Holocene, its presence around ‘Ain Ghazal at this time must be considered extremely unlikely.

In sum, although it is probable that wild goat would have been present in low numbers in the vicinity of ‘Ain Ghazal during the early Holocene, mouflon would probably have been absent. The data relating to changes in caprine frequency at ‘Ain Ghazal, which are presented below in Table 10.1, should therefore be viewed in this context. These data are based on the proportion of caprines within the assemblage of major medium and large herbivores from ‘Ain Ghazal (see Chapter 9, Table 9.9).

Site	Period	n	Hrb	C+O	Cpr	Ovi
‘Ain Ghazal (MPPNB)	3	3165.5	100.0	**64.7**	**64.3**	0.4
‘Ain Ghazal (LPPNB)	4	663	100.0	**69.9**	**38.4**	31.5
‘Ain Ghazal (LPPNB/PPNC)	4/5	301	100.0	**71.6**	30.6	**41.0**
‘Ain Ghazal (PPNC)	5	1863.5	100.0	**70.3**	22.0	**48.3**
‘Ain Ghazal (Yarmoukian)	6	1414	100.0	**72.5**	23.4	**49.1**

Taxa Codes: Hrb=% of major medium and large herbivores in n, C+O=total *Capra aegagrus, Capra hircus, Ovis orientalis* and *Ovis aries*, Cpr=*Capra aegagrus* or *Capra hircus*, Ovi=*Ovis orientalis* or *Ovis aries*
Quantitative Data: all % Adjusted NISP, Bold Type=most common taxon in faunal assemblage

Table 10.1: Changes in Caprine Frequency at ‘Ain Ghazal

Goats were the most common taxon at ‘Ain Ghazal during the MPPNB, comprising 64.3% of the faunal assemblage. This extremely high frequency strongly suggests that fully domesticated goats were present at the site from the time of its first occupation at c.9,250b.p.. It should be stressed that no Period 1 or 2 site in any part of the southern Levant has yielded a faunal assemblage in which wild goat is known to have been present in frequencies in excess of 17% (see Chapter 6, Table 6.1). In contrast, sheep were virtually absent at ‘Ain Ghazal during the MPPNB, comprising only 0.4% of the faunal assemblage. Significantly, sheep were entirely absent during the last quarter of the tenth millennium b.p. in sub-phases MPPNB 1 and 2 (Rollefson, Simmons and Kafafi 1992, p.445 Table 1), and first appeared in extremely low frequencies during the first half of the 9th millennium b.p. in sub-phases MPPNB 3 and 4 (Rollefson, Simmons and Kafafi 1992, p.445 Table 1). Subsequently the frequency of sheep at ‘Ain Ghazal rapidly increased, reaching 31.5% during the LPPNB and 41.0% by the transitional

LPPNB/PPNC, by which time they had replaced goats as the most common taxon. This suggests firstly that mouflon were not present in the vicinity of the site during the early Holocene and, secondly, that sheep were introduced as domesticates in extremely small numbers during the first half of the 9th millennium b.p..

10.2.2: Size Change in Caprines at 'Ain Ghazal:

Although the sample sizes of individual measurements of caprine remains from 'Ain Ghazal appear to be reassuringly large at first glance, the exclusion of unfused and fusing specimens, burnt specimens and specimens in the goat/sheep category vastly reduces the amount of data available. When the remaining specimens are categorised by phase, sample sizes for each phase are relatively small, especially during the LPPNB and transitional LPPNB/PPNC. The problem of sample size is accentuated still further by the fact that goats are less common in the later phases of occupation and that sheep are less common in the earlier. Humerus Bd measurements of specimens identified as goat and sheep are plotted in Figures 10.1 and 10.4 respectively to illustrate the problem of sample size if individual measurements are considered separately.

It was therefore decided to use a log ratio method, by which small samples of individual measurements can be combined through comparison with a 'standard animal', to examine size change in caprine remains from 'Ain Ghazal. The methodology and 'standard animal' measurements described by Uerpmann and Uerpmann (1994) were used in this study. The results are plotted by phase in Figures 10.2 and 10.5 for goats and sheep respectively.

The same method was used to generate log ratios of caprine measurements from a series of south-west Asian sites dating from the late Pleistocene to the mid Holocene with which to compare the results from 'Ain Ghazal. These sites were selected on the basis that published individual measurements of specimens identified as goat or sheep were required to generate the log ratios, that where possible the comparative material should originate from the Levant rather than other areas of south-west Asia, that the wild or domestic status of the caprine remains should not be in doubt and that sample sizes for each species should ideally be in excess of 15. The selection of comparative measurements was effectively determined by the fact that an extremely limited number of sites fulfilled all of these criteria.

Unfortunately, this approach meant that it was not possible to restrict the selection of comparative measurements to those collected and described according to the system of von den Driesch (1976a) which was used on the caprine remains from 'Ain Ghazal. However, it was felt more acceptable to risk small inconsistencies resulting from the use of comparative measurements collected and described according to slightly different systems, but restricted to the Levant, rather than to risk the potentially greater inconsistencies which may have resulted from the inclusion of comparative measurements collected and described to the system of von den Driesch (1976a), but originating from widely varying geographical and climatic regions of south-west Asia.

The log ratios of goat measurements from 'Ain Ghazal are therefore compared to log ratios of wild goat measurements from Natufian Mallaha I (Bouchud 1987), Natufian Saaïde II (Churcher 1994) and, as these sample sizes are comparatively small, to wild goat measurements from Early Neolithic Tepe Asiab in the Zagros Uplands (Bökönyi 1977), and to log ratios of domestic goat measurements from LPPNB Bouqras (Clason 1980) and Late Neolithic/Chalcolithic Arjoune (Grigson 1996).

The log ratios of sheep measurements from 'Ain Ghazal are compared to log ratios of mouflon measurements from Natufian Wadi Judayid 2 (Henry and Turnbull 1985) and Natufian/PPNA Mureybet Ia, II and III ((Helmer 1991a, Ducos et al. 1978), and to log ratios of domestic sheep measurements from LPPNB Bouqras (Clason 1980), FPPNB Umm el Tlel (Helmer 1993) and Late Neolithic/Chalcolithic Arjoune (Grigson 1996). These log ratios of comparative measurements are plotted in Figures 10.3 and 10.6 for goats and sheep respectively. As many of these samples of comparative measurements are included in Helmer's (1989) and Legge's (1996) reviews of size change in caprines from all areas of south-west Asia, which are summarised in Chapter 6, Tables 6.12, 6.13, 6.14 and 6.15, it is possible to relate the data from 'Ain Ghazal to additonal data not included in Figures 10.3 and 10.6.

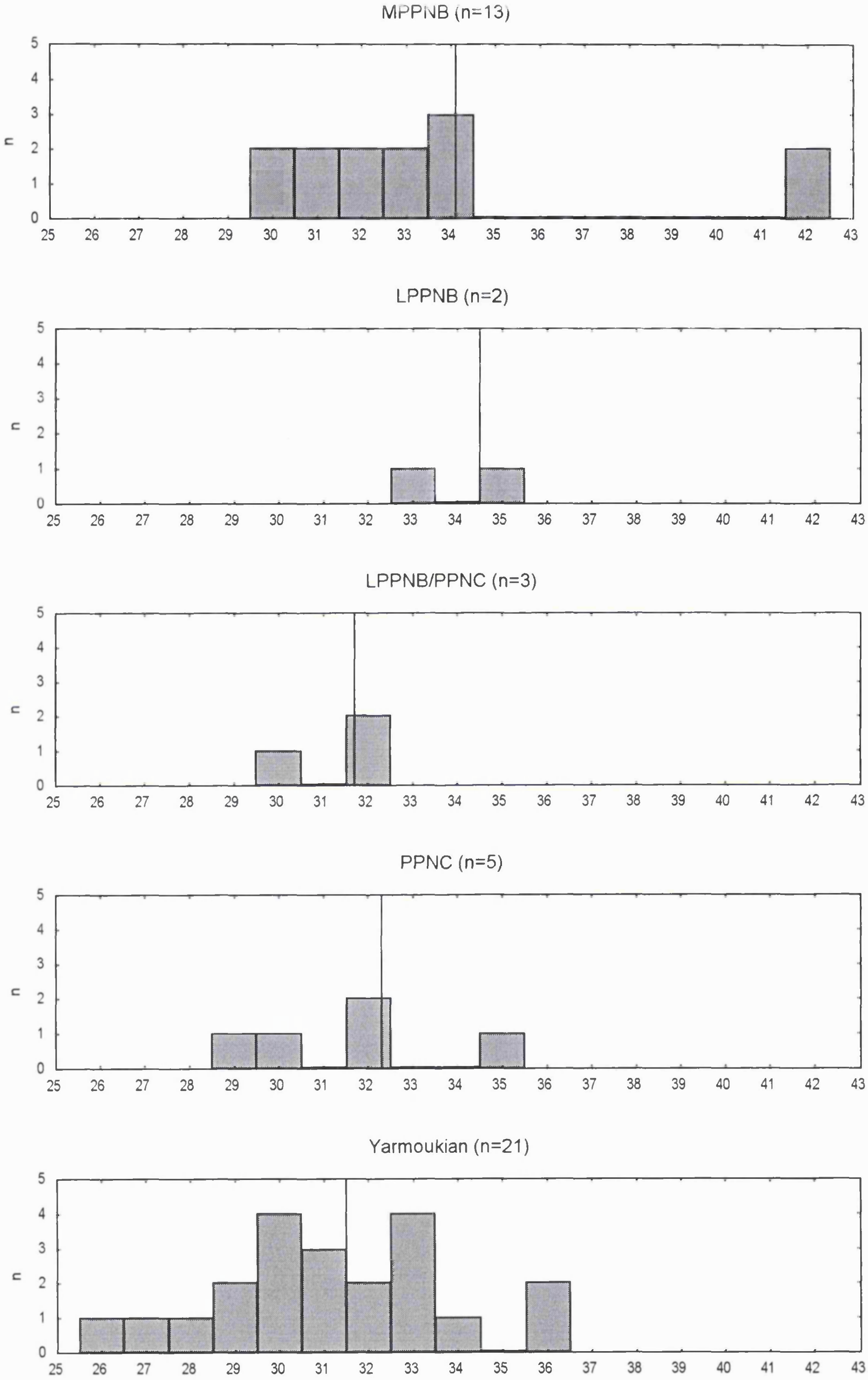


Figure 10.1: 'Ain Ghazal Goat Humerus Bd by Phase (mm)

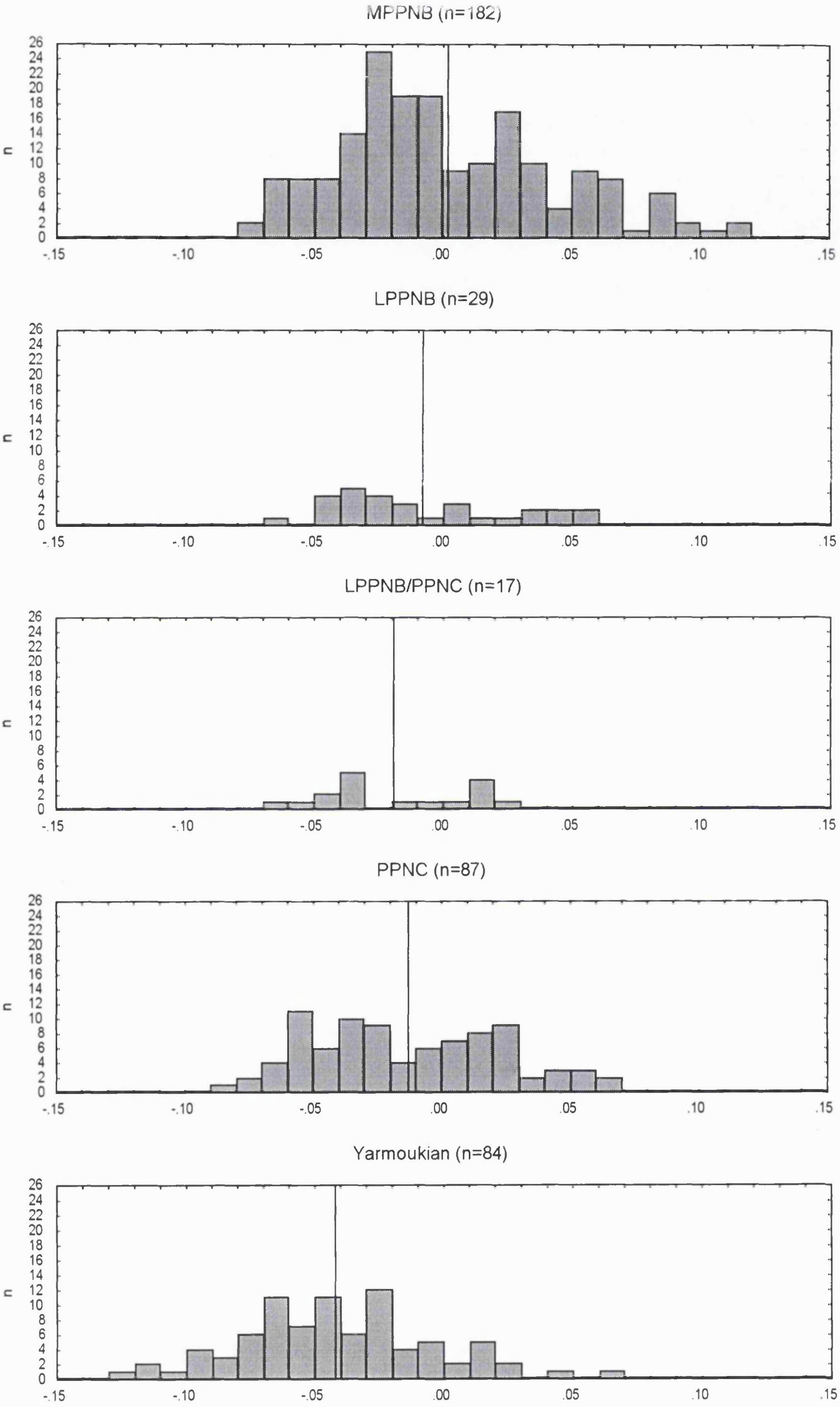


Figure 10.2: 'Ain Ghazal Goat Measurements (log ratios and mean by phase)

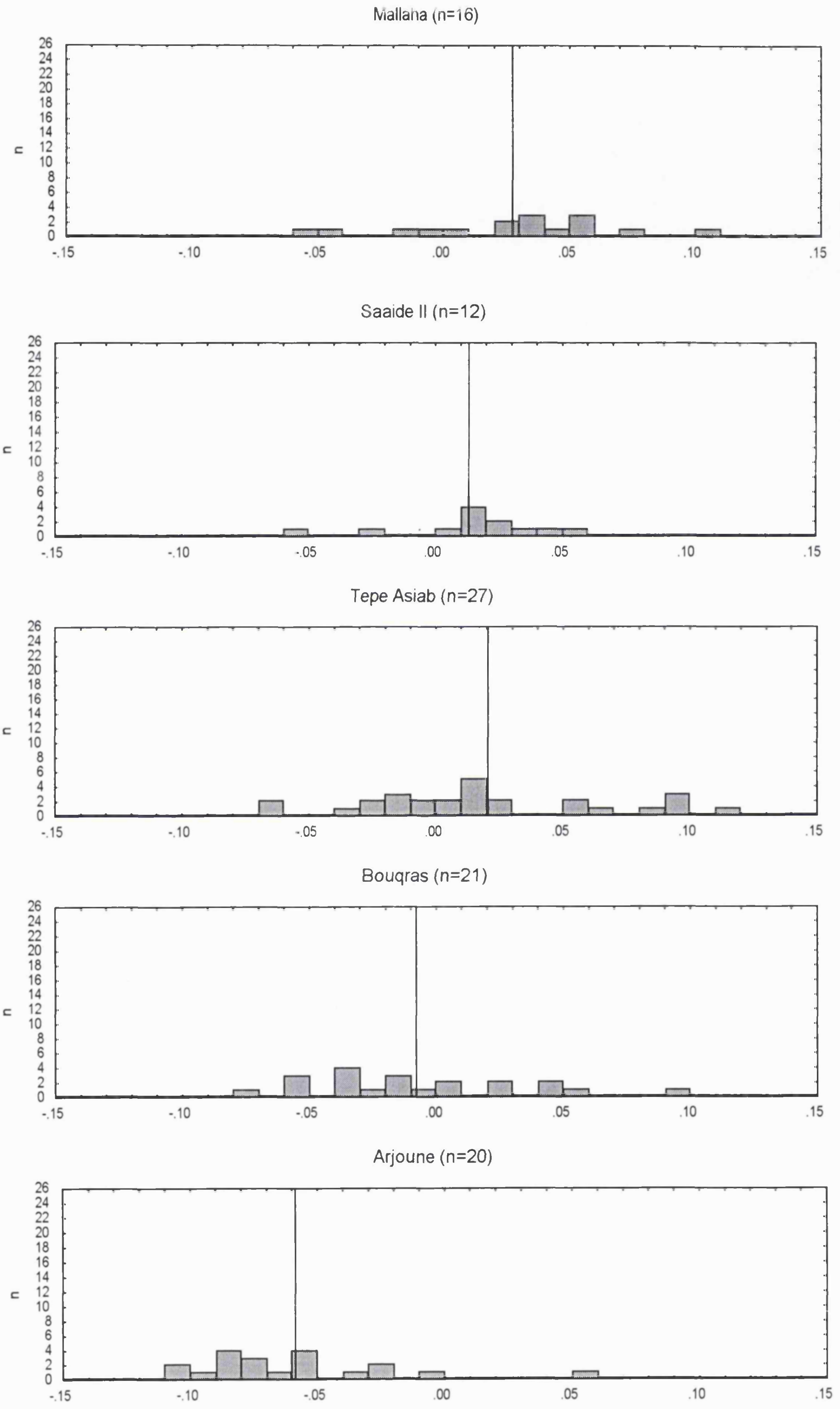


Figure 10.3: Comparative Goat Measurements (log ratios and mean by site)

The data in Figure 10.2 demonstrates that there were significant changes in the size of the goat remains from 'Ain Ghazal across the various periods of occupation at the site. The MPPNB goat measurements display a wide range of variation, including some extremely large specimens, but are clearly biased towards the smaller end of the range. Notwithstanding the fact that LPPNB and transitional LPPNB/PPNC sample sizes are rather small, it seems that the LPPNB, LPPNB/PPNC and PPNC goat measurements are all relatively similar. The range of variation is much lower than in the MPPNB goat measurements. Although the minimum size is almost unchanged, the extremely large specimens evident during the MPPNB are absent. In addition, the bias towards the smaller end of the range is no longer apparent. There is relatively little difference between the means of the MPPNB, LPPNB, LPPNB/PPNC and PPNC goat measurements. The Yarmoukian goat measurements are generally smaller than those of the preceding phases. Although the maximum end of the range is unchanged, there is a significant reduction in both the minimum end of the range and the mean. A slight bias in favour of the smaller measurements is thus apparent. These trends are also apparent in the goat humerus Bd measurements from 'Ain Ghazal in Figure 10.1, even though these sample sizes are relatively small.

It is clear from the comparative goat measurements in Figure 10.3 that the wild goat measurements from Mallaha, Saaïde II and Tepe Asiab all display a similarly wide range of variation. Although the mean of the early domestic goat measurements from Bouqras is much lower, the minimum end of the range is virtually unchanged from that of the comparative wild goat measurements. This suggests that the size reduction which was almost certainly linked to the process of domestication occurred mainly at the larger end of the range and was thus primarily associated with males. It may thus have been that sexual dimorphism in early domestic goats was lower than in wild goats, and that both wild and early domestic females were of a similar size. The Late Neolithic/Chalcolithic domestic goat measurements from Arjoune are generally smaller than those of the early domestic goats from Bouqras, especially at the minimum end of the range, which hints at size reduction in females as well as males by this time.

The wide range of variation evident in the MPPNB goat measurements from 'Ain Ghazal extends across the full range of variation of both wild and early domestic goats. Although the mean of the MPPNB goat measurements from 'Ain Ghazal is slightly lower than those of the wild goats from Mallaha, Saaïde II and Tepe Asiab, being similar to that of the early domestic goats from Bouqras, it should be stressed that the largest MPPNB specimens from 'Ain Ghazal are as large as the largest wild goat specimens from Tepe Asiab in the Zagros Uplands. As both wild and early domestic female goats appear to have been of similar size, the MPPNB goat measurements from 'Ain Ghazal could therefore represent an entirely wild population, with a clear bias in favour of females, or combination of wild and early domestic goats, with a clear bias in favour of early domesticates. Zoogeographical considerations and the high frequency of goats at 'Ain Ghazal during the MPPNB suggest that the latter scenario is more likely to be correct. If correct, the data in Figure 10.3 suggest firstly that hunting of wild goats at 'Ain Ghazal was restricted to the MPPNB, secondly that there was virtually no size change in domestic goats at 'Ain Ghazal between the MPPNB and PPNC, with these specimens being of a similar size to early domestic goats from Bouqras, and thirdly that there was a significant reduction in the size of some domestic goats at 'Ain Ghazal during the Yarmoukian. The smaller Yarmoukian goat measurements from 'Ain Ghazal are of a similar size to the Late Neolithic/Chalcolithic domestic goat measurements from Arjoune, whilst the larger specimens are of a similar size to the early domestic goat measurements from Bouqras.

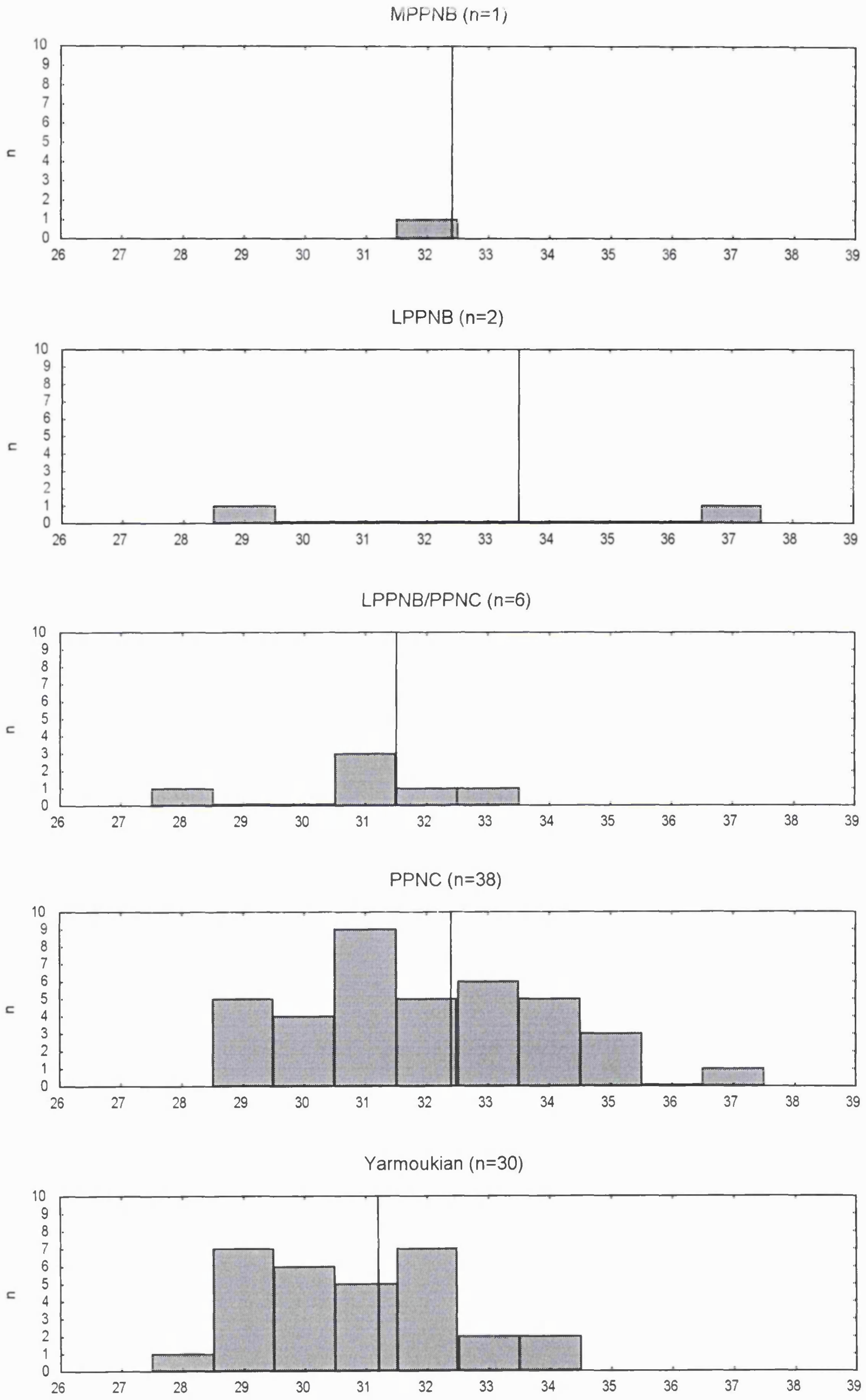


Figure 10.4: 'Ain Ghazal Sheep Humerus Bd by Phase (mm)

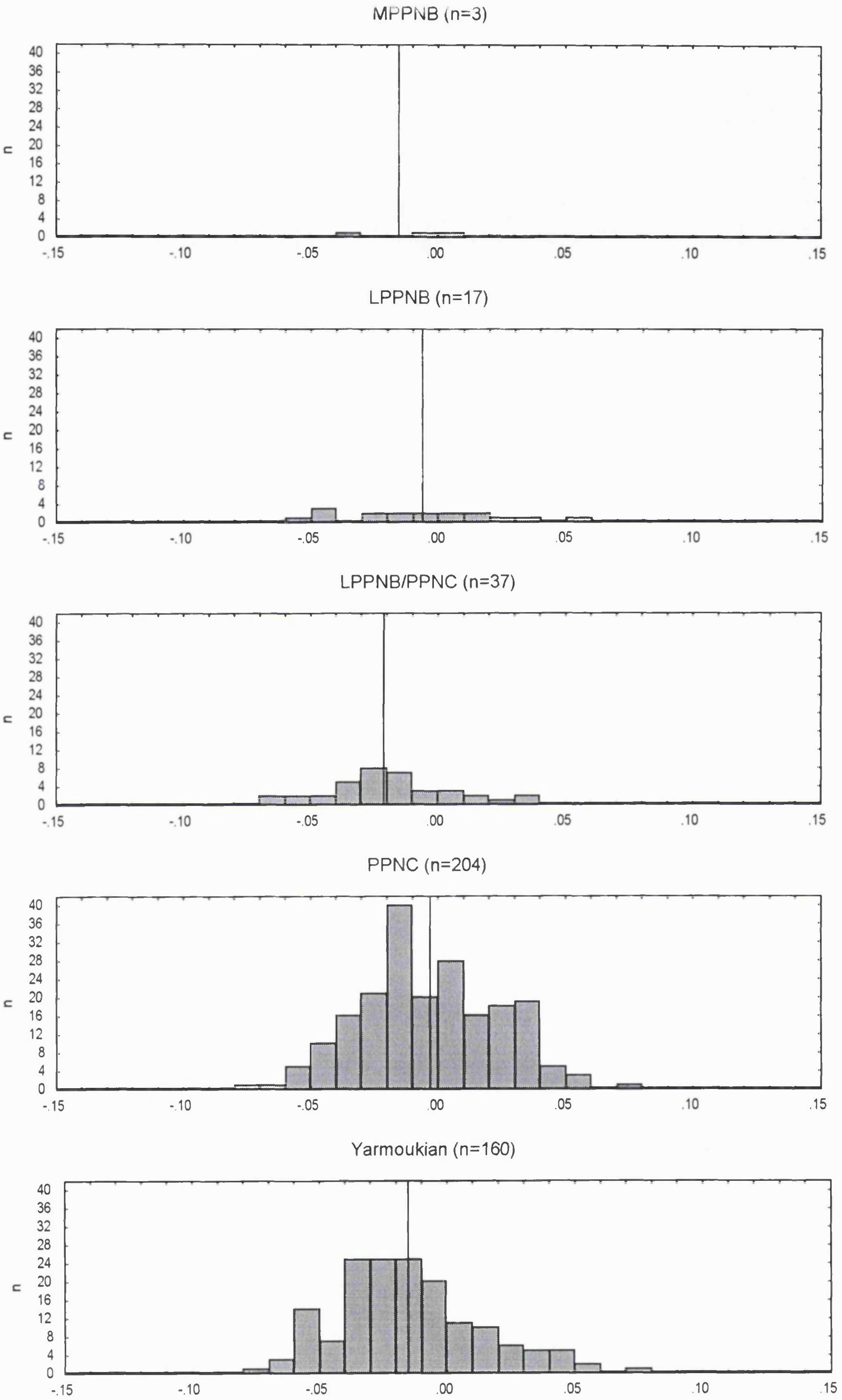
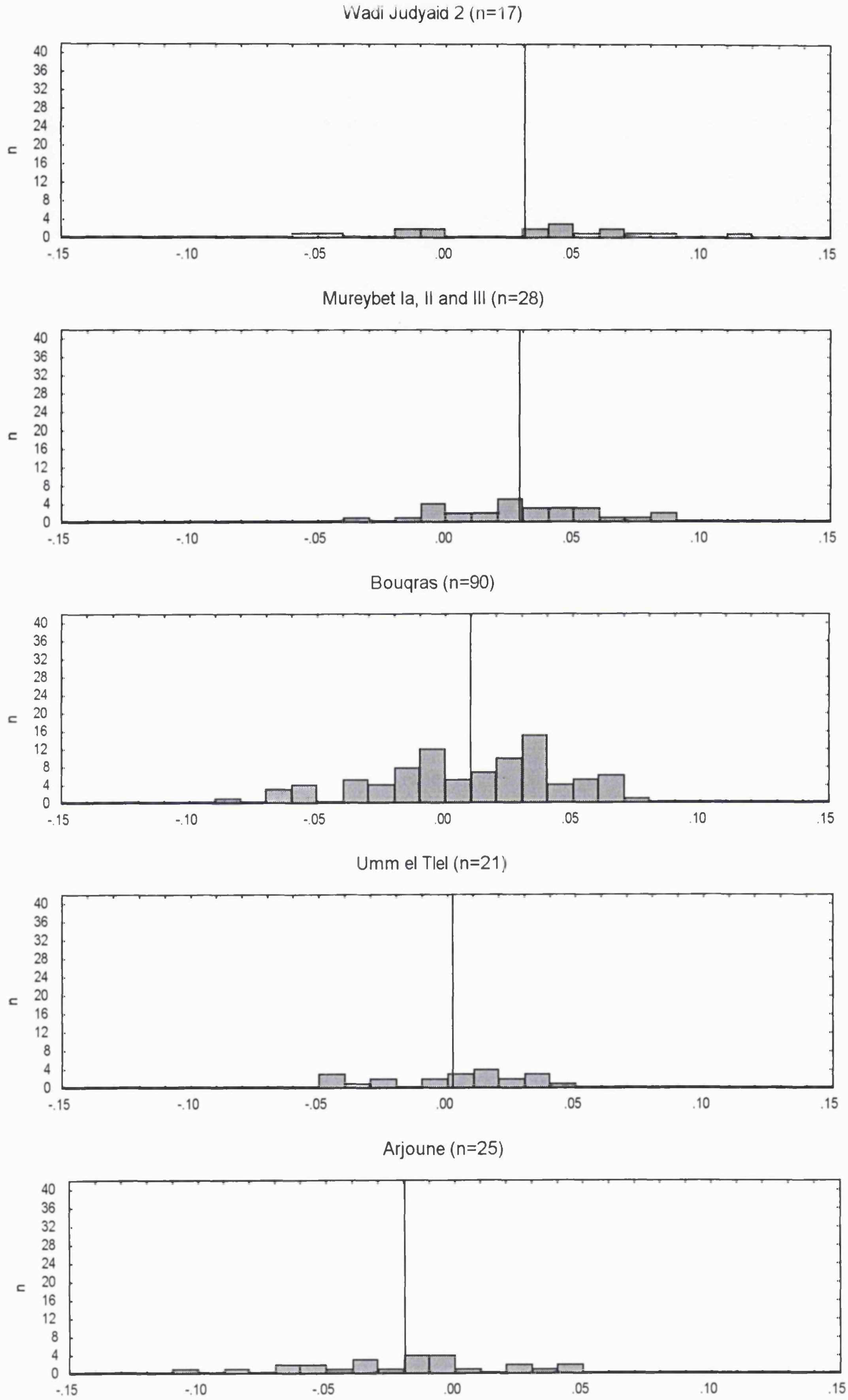


Figure 10.5: 'Ain Ghazal Sheep Measurements (log ratios and mean by phase)


Wadi Judyaid 2 (n=17)

Mureybet Ia, II and III (n=28)

Bouqras (n=90)

Umm el Tlel (n=21)

Arjoune (n=25)

Figure 10.6: Sheep Comparative Measurements (log ratios and mean by site)

It is clear from the data in Figure 10.5 that there were no significant changes in the size of the sheep remains from 'Ain Ghazal across the various periods of occupation at the site. Although the sample sizes of MPPNB, LPPNB and LPPNB/PPNC sheep measurements from 'Ain Ghazal are relatively small, which probably accounts for the fluctuations in the means of these phases, it is clear that they all fall within the range of the much larger samples of PPNC and Yarmoukian sheep measurements. However, there seems to have been a significant shift in the distribution of sheep measurements between the MPPNB, LPPNB, LPPNB/PPNC and PPNC sheep measurements on the one hand and the Yarmoukian sheep measurements on the other. During the earlier phases larger and smaller measurements seem to be fairly evenly distributed, whereas during the Yarmoukian there appears to have been a clear bias in favour of the smaller specimens. These trends are also apparent in the sheep humerus Bd measurements from 'Ain Ghazal in Figure 10.4, even though these sample sizes are relatively small.

It is clear from the comparative sheep measurements in Figure 10.6 that the size reduction associated with the process of domestication was much less extensive in sheep than goats. Th~~is~~e reasons for this are not entirely clear, but could potentially have been × associated with the more extreme sexual dimorphism of wild goats. Nevertheless, it is clear that the early domestic sheep measurements from Bouqras and Umm el Tlel are rather smaller than the mouflon measurements from Wadi Judayid 2 and Mureybet 1a, II and III, at both the maximum and minimum ends of the range. This suggests that male and female early domestic sheep may both have been slightly smaller than their wild progenitors. The Late Neolithic/Chalcolithic domestic sheep measurements from Arjoune are generally smaller than those of early domestic sheep from Bouqras and Umm el Tlel, which hints at further size reduction in males and females by this time.

The means and ranges of variation in sheep measurements from all phases of occupation at 'Ain Ghazal are similar to those of early domestic sheep from Bouqras and Umm el Tlel. They are slightly smaller than the measurements of mouflon from Wadi Judayid 2 and Mureybet 1a, II and III and are rather larger than the measurements of Late Neolithic/Chalcolithic domestic sheep from Arjoune. This suggests firstly that sheep were introduced to 'Ain Ghazal as early domesticates, and secondly that there was subsequently no change in their size at the site. The further size reduction in domestic sheep hinted at by the Late Neolithic/Chalcolithic measurements from Arjoune may well have occurred after the end of the Yarmoukian. Although there seems to have been no size change in early domestic sheep at ‘Ain Ghazal the clear bias in favour of the smaller specimens, i.e. adult females, in the Yarmoukian sheep measurements suggests that there may well have been a shift towards selective culling of young males during this period.

10.2.3: Population Structure of Caprines at ‘Ain Ghazal:

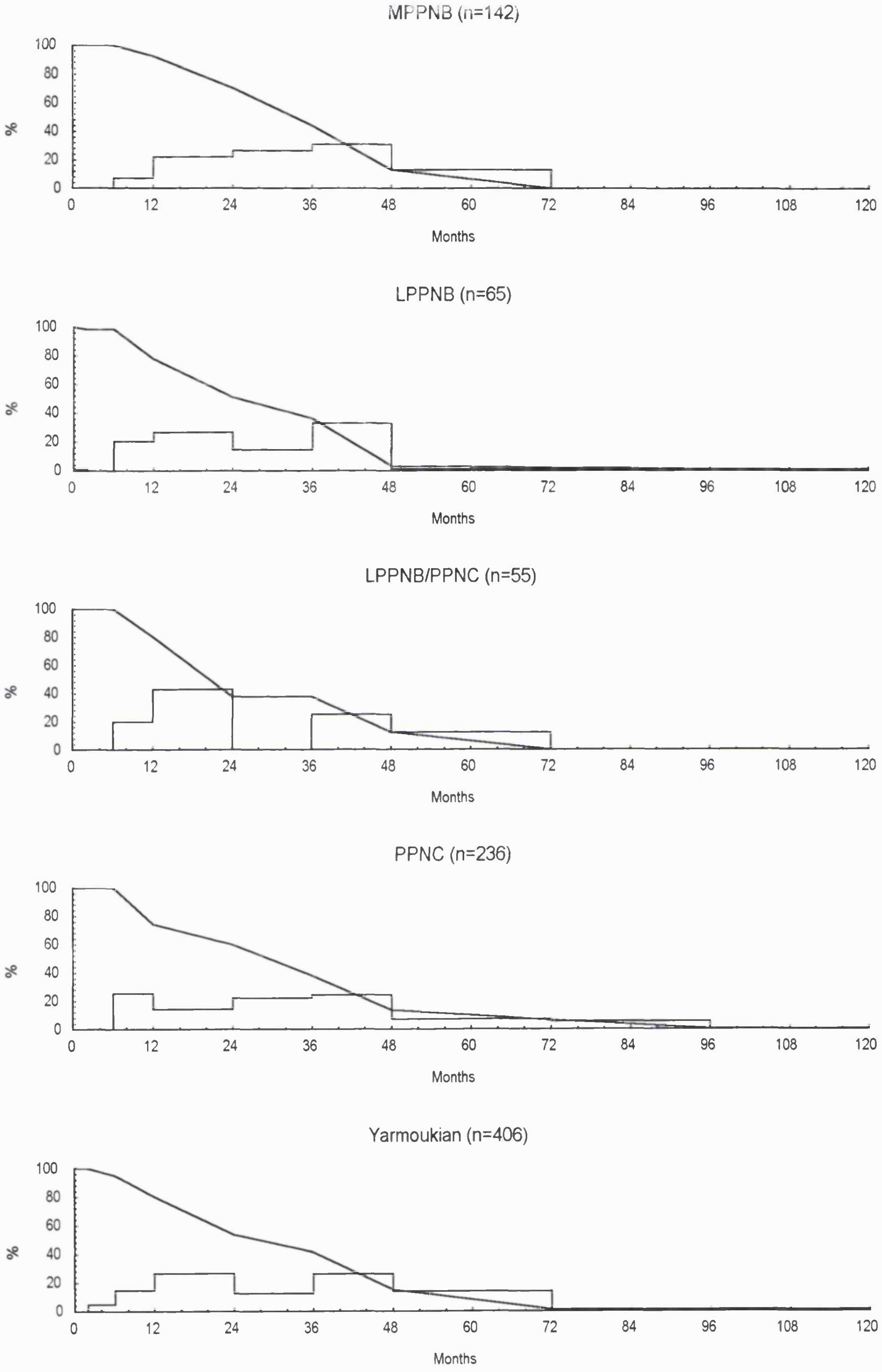
The population structure of caprines at ‘Ain Ghazal was assessed through examination of dental wear and epiphyseal fusion.

Mandibular teeth were assessed for eruption/wear and categorised according to the method described by Payne (1973). Although it is occasionally possible to identify some deciduous caprine teeth to species (Payne 1985b), this is rarely possible in the case of permanent teeth. Rather than attempt to assess the dental wear of goats and sheep separately on the basis of the few teeth which could be identified to species, it was decided to lump all caprine teeth from ‘Ain Ghazal into a single combined goat/sheep category in an attempt to ensure that the sample sizes for each phase were as large as possible. The proportions of caprine teeth from ‘Ain Ghazal in each of Payne’s (1973) wear stages are listed by phase in Table 10.2, alongside calculated percentage survival rates. Both sets of data are plotted by phase in Figure 10.7.

Stage	Months	MB		LB		LB/C		C		Yarm	
		% n	% sv	% n	% sv	% n	% sv	% n	% sv	% n	% sv
A	0-2	0.0	100.0	1.5	98.5	0.0	100.0	0.0	100.0	0.0	100.0
B	2-6	0.0	100.0	0.0	98.5	0.0	100.0	0.0	100.0	4.9	95.1
C	6-12	7.3	92.7	20.5	78.0	19.8	80.2	25.5	74.5	14.8	80.3
D	12-24	22.0	70.7	26.9	51.1	42.7	37.5	14.4	60.1	26.5	53.8
E	24-36	26.5	44.2	14.6	36.5	0.0	37.5	22.2	37.9	12.5	41.3
F	36-48	31.1	13.0	33.2	3.3	24.9	12.5	24.3	13.6	26.2	15.1
G	48-72	13.0	0.0	1.1	2.2	12.5	0.0	7.1	6.5	14.1	1.0
H	72-96	0.0	0.0	1.1	1.1	0.0	0.0	5.9	0.5	0.0	1.0
I	96-120	0.0	0.0	1.1	0.0	0.0	0.0	0.5	0.0	1.0	0.0
	n	142		65		55		236		406	

Key: % n=% of teeth in each wear stage, % sv=percentage survival beyond stage x, MB=MPPNB, LB=LPPNB, LB/C=LPPNB/PPNC, C=PPNC, Yarm=Yarmoukian

Table 10.2: Mandibular Tooth Wear by Phase in Caprines (Goat, Sheep and Goat/Sheep Combined) from ‘Ain Ghazal



MPPNB (n=142)

LPPNB (n=65)

LPPNB/PPNC (n=55)

PPNC (n=236)

Yarmoukian (n=406)

Figure 10.7: Mandibular Tooth Wear in Caprines (Goat, Sheep and Goat/Sheep Combined) from 'Ain Ghazal by Phase

(Data Taken from Table 10.2: Line Graph = % n, Histogram = % sv)

Although age profiles of the type presented in Figure 10.7 are notoriously difficult to interpret, a number of general trends are apparent in the mandibular tooth wear of caprines from 'Ain Ghazal.

1) The general rate of juvenile mortality is extremely high in all phases, with 60% to 65% of animals being killed before the age of 3 years, i.e. before stage F. This corresponds well with the rate of juvenile mortality in a number of early domestic caprine populations from south-west Asia, e.g.: Ganj Dareh (Hesse 1978), Abu Hureyra 2A and 2B (Legge 1996), Beidha (Hecker 1975), Gritille (Stein 1989), and tentatively suggests that the caprines from 'Ain Ghazal may have been domestic during all phases of occupation.

2) The proportion of caprines killed before the age of six months, i.e. during stages A and B, appears to be extremely low in all phases. The possibility that the teeth of extremely young animals may have been more severely affected by taphonomic processes than the teeth of older animals should however be borne in mind.

3) The proportion of animals surviving beyond the age of four years, i.e. beyond stage F, is extremely low in all phases. It is therefore apparent that most caprines were killed between the age of six months and four years, i.e. between stages C and F, during all phases of occupation at 'Ain Ghazal.

4) In all phases except the MPPNB, varying degrees of bimodality are apparent in the proportions of teeth in each of Payne's (1973) wear stages. In the LPPNB, LPPNB/PPNC and Yarmoukian there seem to be peaks in mortality between one and two years, i.e. during stage D, and between three and four years, i.e. during stage F. Similarly, in the PPNC there seem to be slight peaks in mortality between six months and one year, i.e. during stage C, and between two years and four years, i.e. during stages E and F.

5) In the MPPNB, the proportion of animals killed between six months and one year, i.e. during stage C, is significantly lower than in subsequent phases. In addition, the proportions of teeth in each of Payne's (1973) wear stages steadily increase between six months and four years, i.e. from stage C to stage F, with no bimodality.

> Unfortunately it is difficult to assess whether these differences between the MPPNB and subsequent phases are significant, as it seems that the MPPNB caprine sample contains a proportion of hunted wild goat in addition to early domestic goats. The age classes of wild goat hunted by the MPPNB inhabitants of ‘Ain Ghazal may well have differed from those of herded early domestic goats. It is also unclear whether the timing of mandibular tooth eruption in these two species is comparable.

In extremely general terms, the population structure of caprines during all phases of occupation at ‘Ain Ghazal, as evidenced by mandibular tooth wear, is reminiscent of a fully domestic herd. The management of these animals, as evidenced by mandibular tooth wear, is discussed in detail in 10.3 below.

The population structure of the caprine remains from ‘Ain Ghazal was also assessed by comparing the ratio of fused to fusing/unfused specimens of earlier and later fusing skeletal elements. Unfortunately there are a number of problems with the use of epiphyseal fusion to assess the population structure of caprines. Unlike dental wear stages, many of which can be attributed to a relatively well defined period of time with clear upper and lower limits, examination of epiphyseal fusion can only demonstrate whether a specimen is older or younger than the age at which the skeletal element is known to fuse. Once all skeletal elements have fused, which in caprines has generally occurred by about four years, there is no further means of ageing the animal.

In addition, although the sequence in which the various skeletal elements fuse is genetically predetermined for each species and does not usually vary, the age at which the various skeletal elements fuse is subject to a great deal of poorly understood variation. Available data (Silver 1969, Noddle 1974) suggests that wild or feral caprines tend to fuse later than domestic caprines, that males tend to fuse later than females and that goats tend to fuse later than sheep. Factors such as nutritional circumstances and local environmental conditions may also affect the age at which the various skeletal elements fuse. Later fusing elements seem to be subject to more variation in the age at which they fuse than early fusing elements. It should also be noted that unfused bones are more fragile than fused bones and may therefore be under-represented in archaeological faunal assemblages.

In sum, assessment of population structure through epiphyseal fusion tends to be less accurate and subject to much wider variation than assessment of population structure through dental eruption and wear. It does however have the advantage that many of the earlier and later fusing skeletal elements in caprines can relatively easily be identified to species, allowing the population structure of goats and sheep to be considered separately.

Epiphyseal fusion in the 'Ain Ghazal caprines was assessed on the basis of four POSACs which fuse at different ages. The ages of fusion are based on Noddle's (1974) data relating to various British domestic goats and to feral goats from Galloway and Rhum. The selected POSACs and their approximate age at fusion were: the distal scapula diaphysis (9 to 12 months), distal tibia epiphysis (18 to 24 months), distal metapodial epiphysis (24 to 26 months) and distal radius epiphysis (36 to 48 months).

The distal humerus and first phalanx, which are also commonly used in analyses of epiphyseal fusion in caprines, were excluded from this analysis. The POSACs on these elements, i.e. the distal epiphysis and proximal epiphysis respectively (see Chapter 2), can be extremely fragile and may well be under-represented in the highly fragmented faunal assemblage from 'Ain Ghazal. The proportions of fused specimens in the 'Ain Ghazal caprine remains, i.e.: goat, sheep and goat/sheep combined, are listed and plotted below by phase for each of the four selected POSACs in Table 10.3 and Figure 10.8 respectively.

Phase	POSAC	Months	n F	n fg/uf	Total	% F
MPPNB	Distal Scapula	9-12	58	21	79	73.4
	Distal Tibia	18-24	74	53	98	58 .3
	Distal Metapodial	24-36	105	135	240	43.8
	Distal Radius	36-48	14	67	81	17.3
LPPNB	Distal Scapula	9-12	37	7	44	84.1
	Distal Tibia	18-24	34	9	43	79.1
	Distal Metapodial	24-36	45.5	20.5	66	68.9
	Distal Radius	36-48	8	10	18	44.4
LPPNB/PPNC	Distal Scapula	9-12	6	4	10	60.0
	Distal Tibia	18-24	21	3	24	87.5
	Distal Metapodial	24-36	18	9	27	66.7
	Distal Radius	36-48	2	4	6	33.3
PPNC	Distal Scapula	9-12	89	22	111	80.2
	Distal Tibia	18-24	81	22	103	78.6
	Distal Metapodial	24-36	95	46.5	141.5	66.9
	Distal Radius	36-48	24	23	47	51.1
Yarmoukian	Distal Scapula	9-12	66	26	92	71.7
	Distal Tibia	18-24	80	8	88	90.9
	Distal Metapodial	24-36	73	21.5	94.5	77.2
	Distal Radius	36-48	12	10	22	54.5

Key: n=n adjusted NISP, F=fused, fg=fusing, uf=unfused

Table 10.3: Epiphyseal Fusion Stages (Noddle 1974) and Percentage Survivorship of 'Ain Ghazal Caprines by Phase (Goat, Sheep and Goat/Sheep combined)

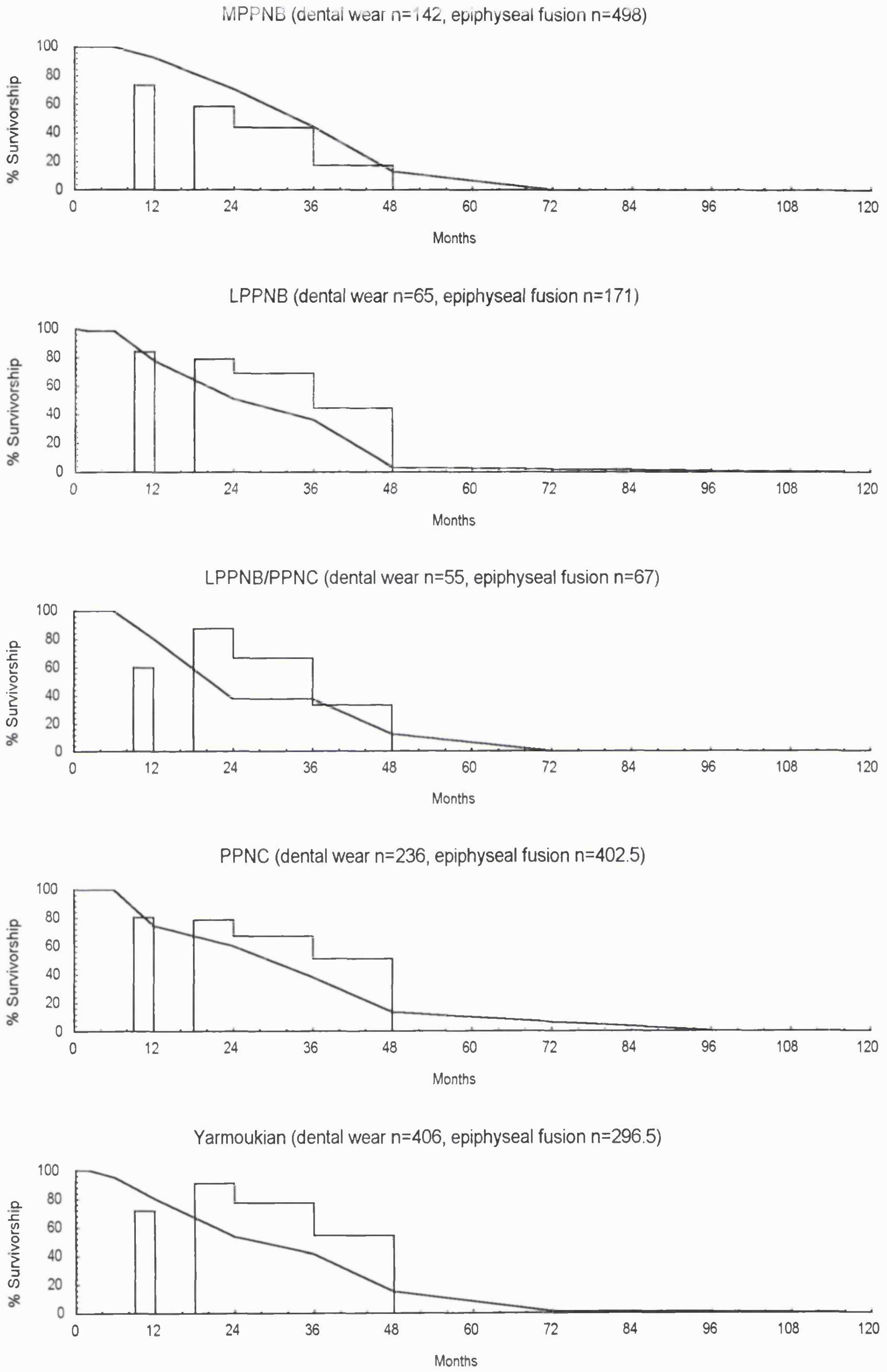


Figure 10.8: Percentage Survivorship of 'Ain Ghazal Caprines (Goat, Sheep and Goat/Sheep combined) by Phase According to Mandibular Tooth Wear (line graph) and Epiphyseal Fusion (histogram)

The population structures of caprines from ‘Ain Ghazal as evidenced by epiphyseal fusion are rather ambiguous, owing to the fact that there are some significant differences between them and the population structures evidenced by dental eruption and wear.

In the MPPNB, these two lines of evidence are in broad agreement, if allowance is made for the inevitable inconsistencies associated with assessment of population structure by different methods. Epiphyseal fusion suggests that juvenile mortality in the MPPNB was high, with 56.2% of caprines being killed before the age of three years and only 17.3% surviving beyond the age of four years. Dental wear provides similar proportions of 65.8% and 13.0% respectively. Figure 10.8 suggests that in the MPPNB epiphyseal fusion in caprines may well have been occurring at or just beyond the later end of the range for each element.

However, epiphyseal fusion suggests in subsequent phases of occupation at ‘Ain Ghazal the proportion of caprines surviving into adulthood was significantly greater than in the MPPNB. In the LPPNB, LPPNB/PPNC, PPNC and Yarmoukian the proportion of caprines that seem to have been killed before the age of three years ranges from 22.8% to 33.3%, with the proportion surviving beyond the age of four years ranging from 45.5% to 66.7%. Dental wear, in contrast, suggests that juvenile mortality was as high in the LPPNB, LPPNB/PPNC, PPNC and Yarmoukian as is was in the MPPNB.

Several different factors could account for these differences between the population structures evidenced by epiphyseal fusion in LPPNB, LPPNB/PPNC, PPNC and Yarmoukian and those evidenced by dental wear.

1) Cranial and post-cranial elements could come from different animals. It is however difficult to envisage a scenario which would have caused only the cranial elements of young animals and post-cranial elements of older animals to be deposited on-site.

2) Unfused epiphyses could be under-represented in the faunal assemblage owing to poor preservation. This seems unlikely as the proportion of unfused epiphyses is consistently higher in the oldest phase, i.e. the MPPNB, which predates the youngest, i.e. the Yarmoukian, by approximately two millennia.

3) The increased frequencies of sheep in the LPPNB, LPPNB/PPNC, PPNC and Yarmoukian could have led to an increase in the number of fused specimens of any given element in these phases, as there is some evidence to suggest that sheep fuse earlier than goats (Silver 1969, Noddle 1974).

4) Goats and sheep could both be fusing earlier in the LPPNB, LPPNB, LPPNB/PPNC, PPNC and Yarmoukian. There is some evidence to suggest that domestic caprines fuse earlier than wild or feral caprines (Noddle 1974). Furthermore, evidence for wild caprines at 'Ain Ghazal seems to be restricted to the MPPNB.

In order to test the possibility that sheep may have been fusing earlier than goats during the later phases of occupation at 'Ain Ghazal, epiphyseal fusion in PPNC/Yarmoukian goats and sheep was assessed separately. Fused and fusing/unfused caprine specimens which could not be identified to species were allocated to goats and sheep respectively on the basis of the relative proportions of identifiable fused and fusing/unfused specimens, using the method described by Grigson (1987b). These results are presented in Table 10.4 and Figures 10.9 and 10.10.

POSAC	Months	Taxon	Raw		Corrected		n Total	% F	% sp.
			n F	n fg/uf	n F	n fg/uf			
Distal Scapula	9-12	Goat	28	2	46	11	57	80.7	28.1
		Sheep	66	7	109	37	146	74.7	71.9
		Goat/Sheep	61	39					
		Total	155	48	155	48	203	76.4	
Distal Tibia	18-24	Goat	17	2	36	6	42	85.7	22.0
		Sheep	59	8	125	24	149	83.9	78.0
		Goat/Sheep	85	20					
		Total	161	30	161	30	191	84.3	
Distal Metapodial	24-36	Goat	56	22	56	23.5	79.5	70.4	33.7
		Sheep	111	41.5	112	44.5	156.5	71.6	66.3
		Goat/Sheep	1	4.5					
		Total	168	68	168	68	236	71.2	
Distal Radius	36-48	Goat	9	8	10	9	19	52.6	27.5
		Sheep	25	21	26	24	50	52.0	72.5
		Goat/Sheep	2	4					
		Total	36	33	36	33	69	52.2	

Key: n=adjusted NISP, F=fused, fg/uf=fusing/unfused, % sp.=% of each species i.e. goat and sheep

Table 10.4: Epiphyseal Fusion in PPNC/Yarmoukian Goats and Sheep from 'Ain Ghazal

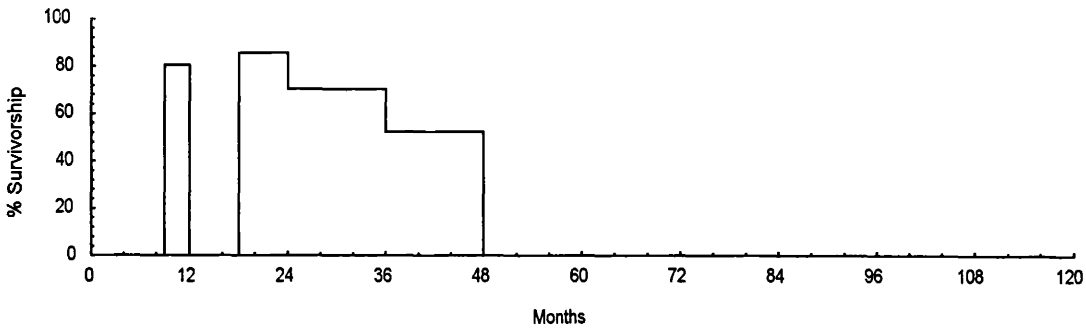


Figure 10.9: Epiphyseal Fusion in PPNC/Yarmoukian Goats from 'Ain Ghazal

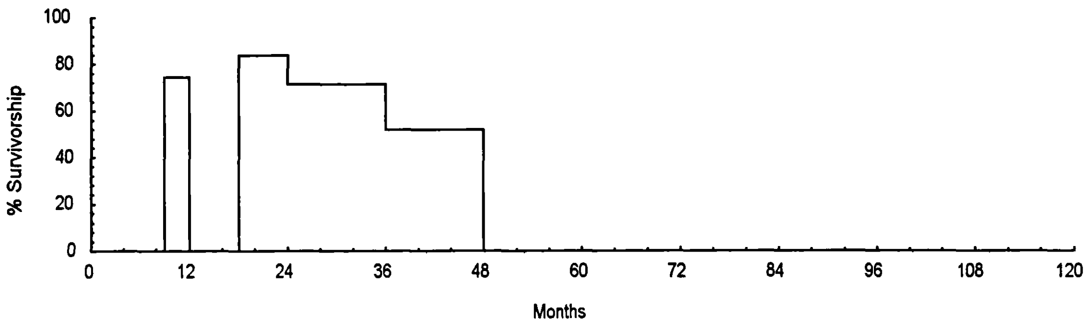


Figure 10.10: Epiphyseal Fusion in PPNC/Yarmoukian Sheep from 'Ain Ghazal

It is immediately apparent from the data in Table 10.4 and Figures 10.9 and 10.10 that there is no difference between the population structures of goats and sheep in the PPNC/Yarmoukian, as evidenced by epiphyseal fusion. The proportion of animals killed before the age of three years and surviving beyond the age of four years is 29.6% and 52.6% respectively in goats, and 28.4% and 52.0% respectively in sheep. This strongly suggests that increased frequencies of sheep in the LPPNB, LPPNB/PPNC, PPNC and Yarmoukian does not account for the differences between the population structures as evidenced by epiphyseal fusion and dental wear during these phases. It therefore seems that the most likely explanation for these differences is that goats and sheep were both fusing earlier in the LPPNB, LPPNB/PPNC, PPNC and Yarmoukian than goats were fusing in the MPPNB.

Two factors may have been associated with this phenomenon. Firstly, analysis of size change in caprines at 'Ain Ghazal has suggested that the MPPNB sample contains both wild and early domestic goats. If wild goats were fusing at a later age than early domestic goats or sheep, the proportion of unfused specimens in the MPPNB sample would naturally be higher than in the LPPNB, LPPNB/PPNC, PPNC and Yarmoukian samples, even if the actual age at which the animals were slaughtered was relatively constant through time, as suggested by dental wear.

Secondly, it is clear from Figure 10.8 that even if the potential later fusing of wild goats is taken into account, the proportion of adult animals in the LPPNB, LPPNB/PPNC, PPNC and Yarmoukian as evidenced by epiphyseal fusion is still significantly higher than the proportion of adult animals evidenced by dental wear. However, if it is assumed that the skeletal elements of domestic goats and sheep at 'Ain Ghazal were fusing at or just below the lower ends of the age ranges suggested by Noddle (1974), and that the skeletal elements of wild goats were fusing at or just above the upper ends of the age ranges, it is possible that fusing/unfused specimens of domestic goats and sheep may have been younger and consequently more fragile than fusing/unfused specimens of wild goat. This could potentially have led to young animals being under-represented in the LPPNB, LPPNB/PPNC, PPNC and Yarmoukian caprine samples from 'Ain Ghazal.

In sum, the population structures of caprines at 'Ain Ghazal as evidenced by epiphyseal fusion are extremely ambiguous and difficult to interpret. As numerous inter-connected and poorly understood factors are known to affect the relative proportions of fused to fusing/unfused specimens in any faunal assemblage, it is felt that the population structures evidenced by dental wear are probably a more accurate reflection of the actual population structures of caprines at 'Ain Ghazal. These suggest that juvenile mortality in caprines was extremely high during all phases of occupation, resembling the levels of juvenile mortality found in a number of other early domestic caprine populations from south-west Asia (see Chapter 6, Tables 6.16 and 6.17).

Unfortunately the uncertainty surrounding the ages at which the various caprine skeletal elements of caprines were fusing makes it extremely difficult to reliably assess the relative proportions of juvenile male and female goats in the faunal assemblage from 'Ain Ghazal. Any attempt to calculate the proportion of unfused specimens which are larger than adult female specimens and can thus be attributed to juvenile males (c.f. Hesse 1984) could be affected by the facts that unfused MPPNB goat specimens could potentially be the exactly the same age as fused goat specimens from later phases, and that unfused goat specimens from later phases could be under-represented owing to differential preservation. This type of analysis was therefore not attempted as part of this study.

10.2.4: Morphological Change in Caprines at 'Ain Ghazal:

As sheep horncores are extremely poorly preserved in the faunal assemblage from 'Ain Ghazal, no attempt has been made to assess morphological change in the sheep remains. However, well-preserved goat horncore fragments are much more numerous and are therefore discussed in more detail below.

The maximum and minimum basal diameters of the goat horncores from 'Ain Ghazal are plotted below in Figure 10.11. It should be noted that goat horncores on which it was possible to measure maximum and minimum basal diameters represent a relatively small proportion of the total number of goat horncore fragments from the site. Comparative horncore measurements of modern wild goats (Stampfli 1983), early Holocene wild goats from Jarmo (Stampfli 1983) and Tepe Asiab (Bökönyi 1977), and early to mid Holocene domestic goats from Jarmo (Stampfli 1983), Tepe Sarab (Bökönyi 1977) and Arjoune (Grigson 1996) are plotted in Figures 10.12 and 10.13 respectively.

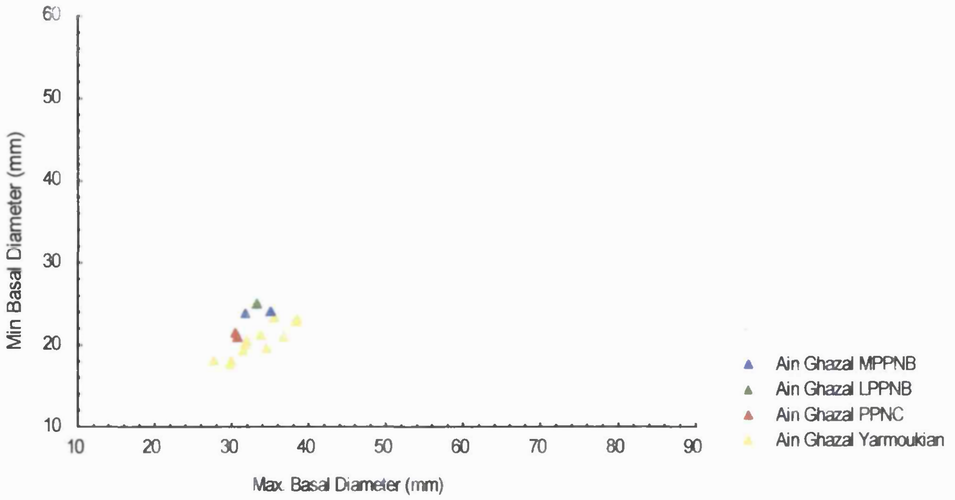


Figure 10.11: Goat Horncore Max BD and Min MD from 'Ain Ghazal by Phase

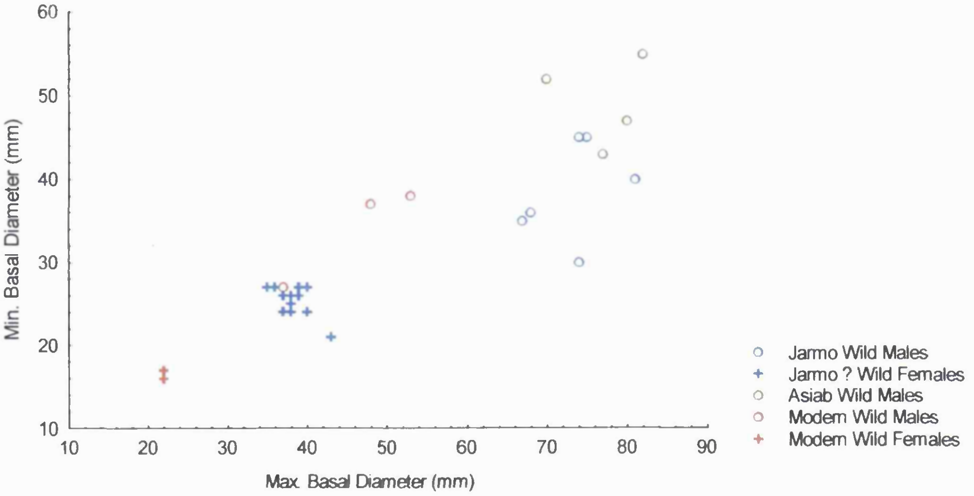


Figure 10.12: Comparative Wild Goat Horncore Max BD and Min BD

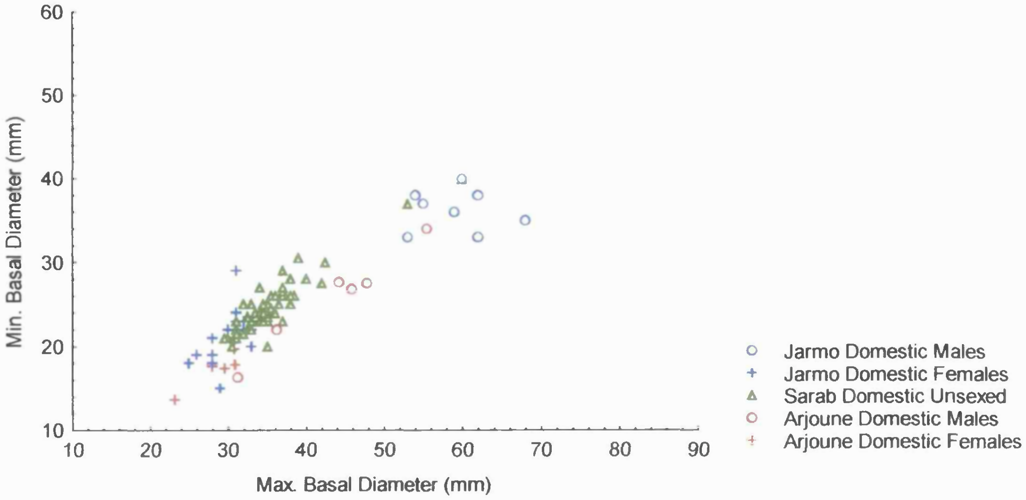


Figure 10.13: Comparative Domestic Goat Horncore Max BD and Min BD

Figure 10.11 demonstrates that the measurable goat horncores from 'Ain Ghazal are extremely small in all phases, falling within the range of wild and domestic adult females and of wild and domestic juvenile males. No measurable goat horncores from 'Ain Ghazal fall within the range of adult wild males or adult domestic males. Although sample sizes are extremely small, this observation forms the strongest evidence at 'Ain Ghazal for the preferential culling of juvenile males and adult females typically associated with domestic goat populations. Although there is no overall size change in the goat horncores from 'Ain Ghazal over the various phases of occupation, a decrease in the minimum diameter is apparent in the Yarmoukian. This is almost certainly linked to the appearance of medial flattening (see below).

As the samples of measurable goat horncores were so small, the cross-sections of all specimens in which more than 75% of the basal portion, lower third or mid third of the horncore was preserved were drawn in attempt to assess changes in goat horncore morphology in more detail. Although sample sizes are again relatively small, a simple seriation of horncore cross-sections demonstrated the existence of five shape categories, albeit with some overlap between them, which are described below. The number of specimens in each group are listed by phase in Table 10.5, and samples of horncore cross-sections in each shape category are drawn in Figures 10.14 to 10.18 (anterior to top of page, lateral to right of page, cross-sections taken from the same horncore joined by a line). The LPPNB/PPNC yielded no well preserved goat horncores at all and is therefore excluded.

Group A: Cross-sections typically associated with wild goat, whether on the basis of size, quadrilateral shape or pronounced antero-lateral concavity.

Group B: Assymetrical triangular or almond-shaped cross-sections with a sharp anterior keel, relatively flat antero-lateral surface and a clear angle between the antero-lateral and postero-lateral surfaces.

Group C: Relatively symmetrical oval cross-sections, with a reduced anterior keel or rounded anterior surface.

Group D: Symmetrical lozenge or almond-shaped cross-sections, with a sharp anterior keel and relatively sharp posterior surface. Typically associated with slight anti-clockwise twisting of the right horncore and slight clockwise twisting of the left (seen from above).

Group E: Assymmetrical cross-sections with an extremely flat medial face, sharp anterior ridge and relatively flat antero-lateral surface.

Group	MPPNB	LPPNB	PPNC	Yarmoukian
A	3	1	absent	absent
B	6	5	4	4
C	3	1	2	5
D	absent	absent	absent	8
E	absent	absent	absent	8

Table 10.5: Numbers of Goat Horncores from 'Ain Ghazal in Each Shape Category by Phase

The data in Table 10.5 suggest that there were significant changes in goat horncore morphology over the various phases of occupation at 'Ain Ghazal which are not immediately apparent in the small sample of measurable specimens.

Horncores of Group A, which probably represent wild goat or extremely early domestic goat, are most common in the MPPNB (including one unequivocal adult male wild goat horncore fragment), much rarer in the LPPNB and absent in the PPNC and Yarmoukian. This fits well with the metrical data, which suggest that in the 'Ain Ghazal faunal assemblage wild goats were restricted to the MPPNB. It is extremely unlikely that the entire MPPNB goat sample consisted of wild goat as Group A horncores were outnumbered by Group B and Group C horncores. Group B and Group C horncores are the most common category at 'Ain Ghazal and, most significantly, are found in all phases of occupation. The fact that Group B and Group C horncores were the only categories found in the PPNC, during which there is no metrical evidence for the presence of wild goat, strongly suggests that they represent early domestic goats. In addition it is clear that the Group B and Group C goat horncore cross-sections from 'Ain Ghazal closely resemble Period 5 early domestic goat horncore cross-sections from Tepe Sarab (Bökönyi 1977) (see Figures 10.15 and 10.16). It therefore seems that the MPPNB goat sample from ‘Ain Ghazal consists of a few wild goats and substantially more early domestic goats, whose horncore cross-sections fall into two shape categories.

With the exception of a single LPPNB Group A horncore, the LPPNB and PPNC samples consist entirely of Groups B and C which, as described above, probably represent early domestic goats. Although the Group B horncores have the sharp anterior ridge typically associated with males and the Group C horncores have the symmetrical oval cross-section typically associated with females it is clear from the illustrations in Figures 10.15 and 10.16 that they are of a similar size. It is therefore possible that Group B represents juvenile males and that Group C represents adult females. If this supposition is correct, it is clear from the data in Table 10.5 that juvenile male early domestic goats would have outnumbered adult female early domestic goats at ‘Ain Ghazal in the MPPNB, LPPNB and PPNC. This provides additional evidence for the preferential culling of juvenile males which is typically associated with domestic herds.

Although the Group B and Group C horncores of early domestic goats were present in the Yarmoukian sample, these were outnumbered by two new categories of horncore shape, i.e. Groups D and E. The fact that Group D and E horncores are only found in the Yarmoukian suggests that they developed for the first time during this phase. The small size of these horncores suggests that, like Groups B and C, they represent domestic goats. In addition, the slight twisting and pronounced medial flattening of Group D and E respectively are both characteristics typically associated with domesticates. This suggests that the size reduction evident in the Yarmoukian goat remains may have been accompanied by changes in horncore morphology. However, the fact that slight twisting and pronounced medial flattening first appear almost two millennia after the earliest evidence for the presence of domestic goats at ‘Ain Ghazal suggests that these characteristics were associated with a relatively late stage of the domestication process and were not a feature of early domestic goats. These data therefore suggest that a smaller breed of domestic goat with Group D and Group E type horncores may have been present at ‘Ain Ghazal during the Yarmoukian, alongside slightly larger early domestic goats with Group B and Group C type horncores.

In sum, horncore morphology provides a good deal of information about the goat populations at ‘Ain Ghazal during the various phases of occupation, despite the fact that sample sizes are relatively small. Domestic goats were clearly present at 'Ain Ghazal from the MPPNB onwards. In the MPPNB, LPPNB and PPNC (probable) juvenile male early domestic goats with Group B horncores seem to have outnumbered (probable) adult female early domestic goats with Group C horncores. Although some wild goats were being hunted in the MPPNB, this practice subsequently declined in importance and seems to have been abandoned altogether by the end of the LPPNB. Domestic goats with Group D and Group E horncores appeared at 'Ain Ghazal for the first time in the Yarmoukian. These animals may well have been slightly smaller than the early domestic goats of the MPPNB, LPPNB and PPNC. However, it is clear that (probable) juvenile male and (probable) adult female early domestic goats with Group B and Group C horncores were also present at 'Ain Ghazal during this phase.

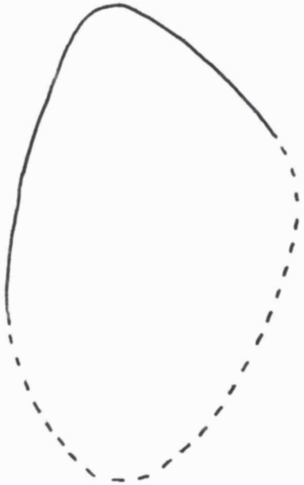
Location X-Section	‘Ain Ghazal MPPNB	‘Ain Ghazal LPPNB	‘Ain Ghazal PPNC	‘Ain Ghazal Yarmoukian
Mid 1/3			ABSENT	ABSENT
Basal				

Figure 10.14: Group A Goat Horncore Cross-Sections from ‘Ain Ghazal (Probable Wild Goat)

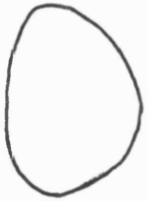
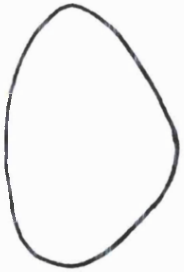
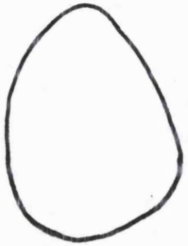
Location X-Section	‘Ain Ghazal MPPNB	‘Ain Ghazal LPPNB	‘Ain Ghazal PPNC	‘Ain Ghazal Yarmoukian	Tepe Sarab (Bökönyi 1977)
Mid 1/3					
Lower 1/3					
Basal					 

Figure 10.15: Group B Goat Horncore Cross-Sections from ‘Ain Ghazal (Probable Juvenile Male Early Domestic Goat)

and Tepe Sarab

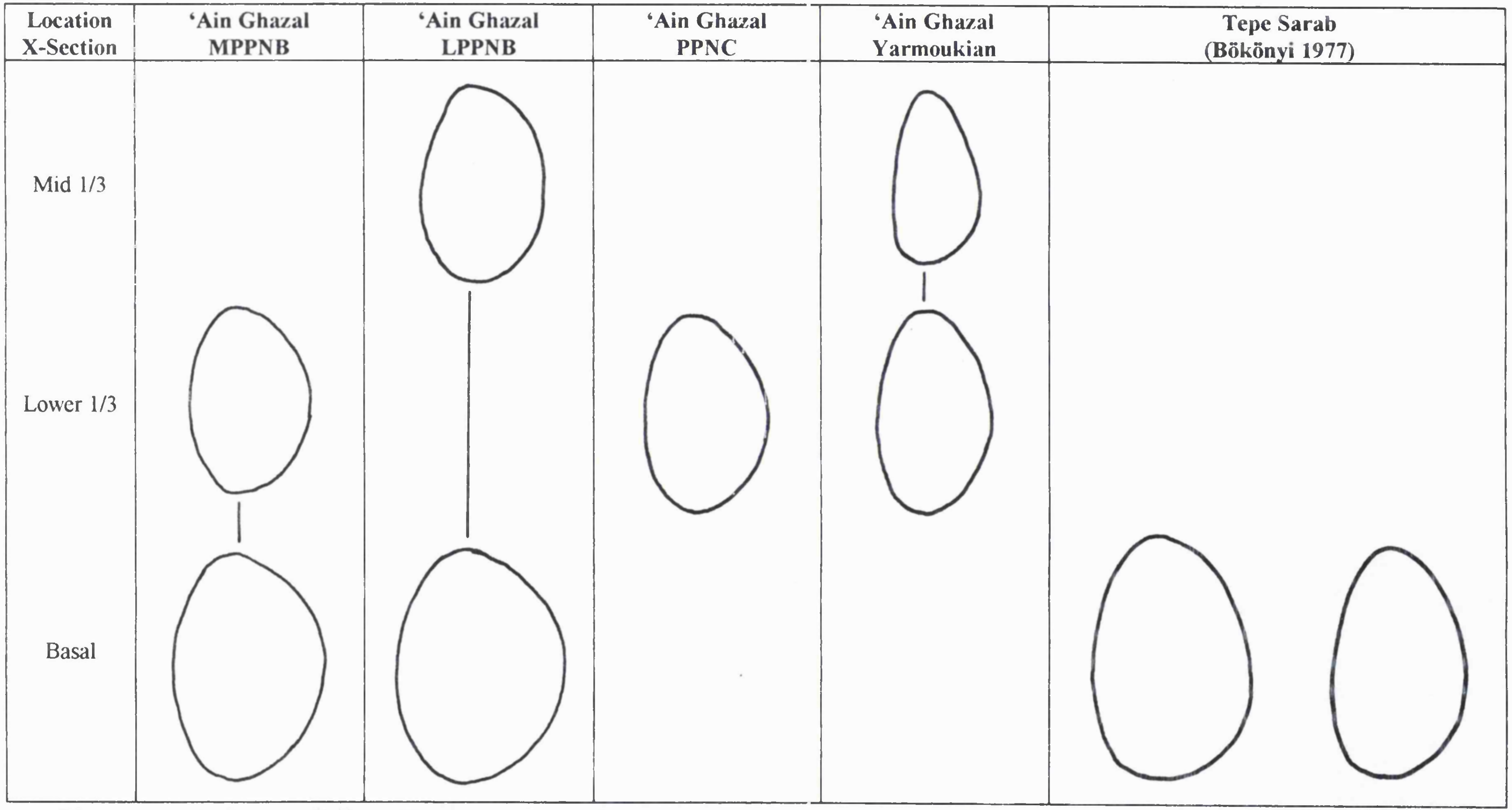


Figure 10.16: Group C Goat Horncore Cross-Sections from 'Ain Ghazal (Probable Adult Female Early Domestic Goat)

and Tepe Sarab

×

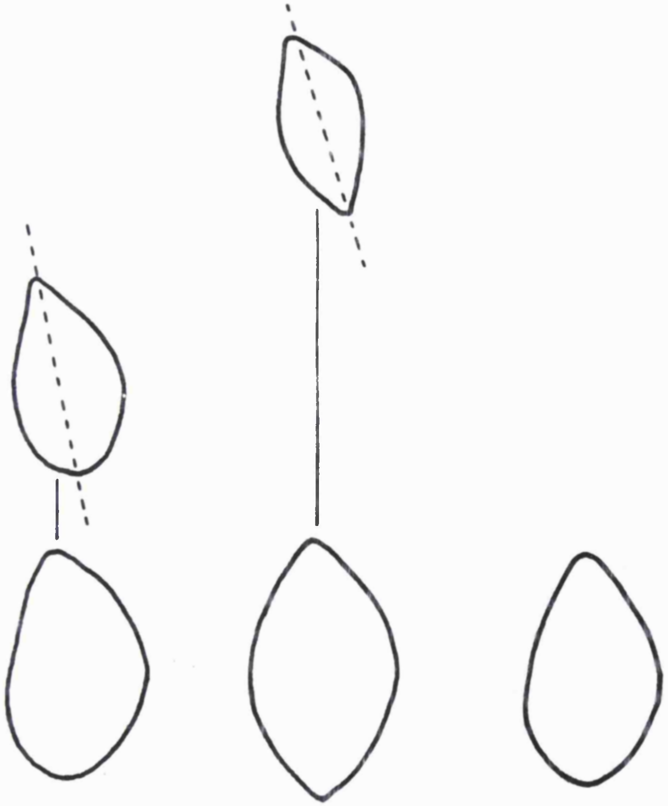
Location X-Section	'Ain Ghazal MPPNB	'Ain Ghazal LPPNB	'Ain Ghazal PPNC	'Ain Ghazal Yarmoukian
Mid 1/3				
Lower 1/3	ABSENT	ABSENT	ABSENT	
Basal				

Figure 10.17: Group D Goat Horncore Cross-Sections from 'Ain Ghazal (Probable Smaller Breed of Domestic Goat)

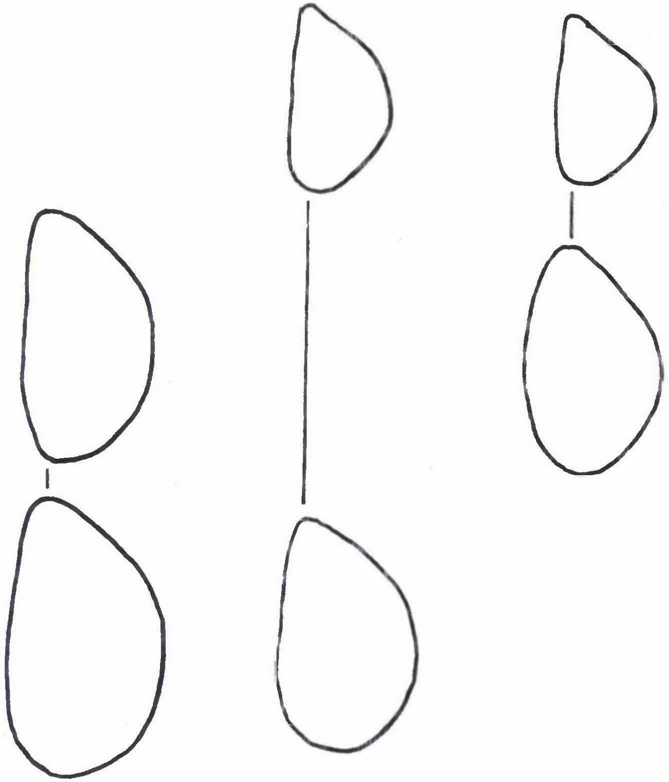
Location X-Section	'Ain Ghazal MPPNB	'Ain Ghazal LPPNB	'Ain Ghazal PPNC	'Ain Ghazal Yarmoukian
Mid 1/3				
Lower 1/3	ABSENT	ABSENT	ABSENT	
Basal				

Figure 10.18: Group E Goat Horncore Cross-Sections from 'Ain Ghazal (Probable Smaller Breed of Domestic Goat)

10.2.5: Conclusions:

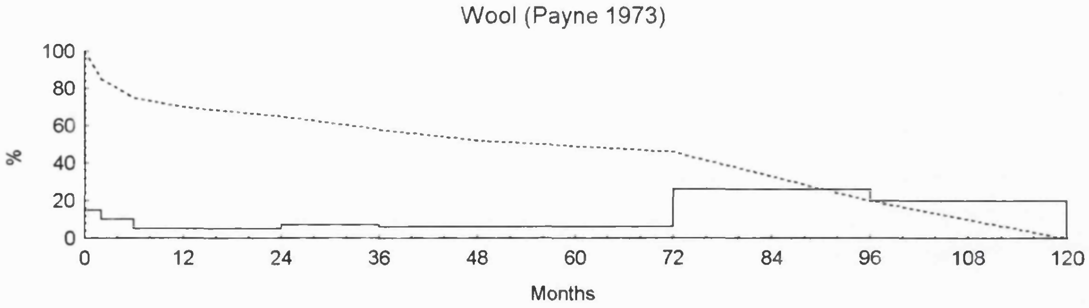
This assessment of the wild or domestic status of the 'Ain Ghazal caprines strongly suggests that zoologically domestic goats were present at the site from the beginning of its occupation at c.9,250b.p.. During the MPPNB exploitation of domestic goats seems to have been backed up by the hunting of a smaller proportion of wild goats, but by the LPPNB this practice seems to have been largely abandoned. Zoologically domestic sheep seem to have been introduced to 'Ain Ghazal in extremely small numbers during the latter part of the MPPNB, during the first half of the 9th millennium b.p., and subsequently their numbers rapidly increased. There is no evidence for the presence of mouflon in the 'Ain Ghazal faunal assemblage. There is some evidence to suggest that a smaller breed of domestic goat may have appeared at 'Ain Ghazal during the Yarmoukian Pottery Neolithic. It is possible that the appearance of these animals may be linked to the appearance of medially flattened and slightly twisted goat horncores in the faunal assemblage at the same time.

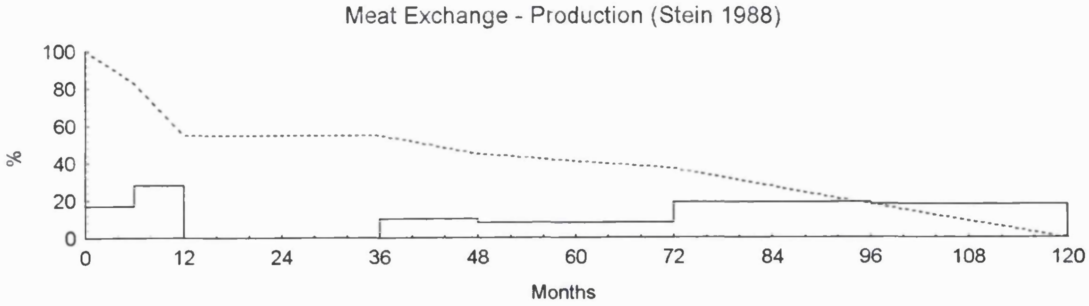
10.3: MORE SPECIALISED PASTORAL ECONOMIES AT 'AIN GHAZAL:

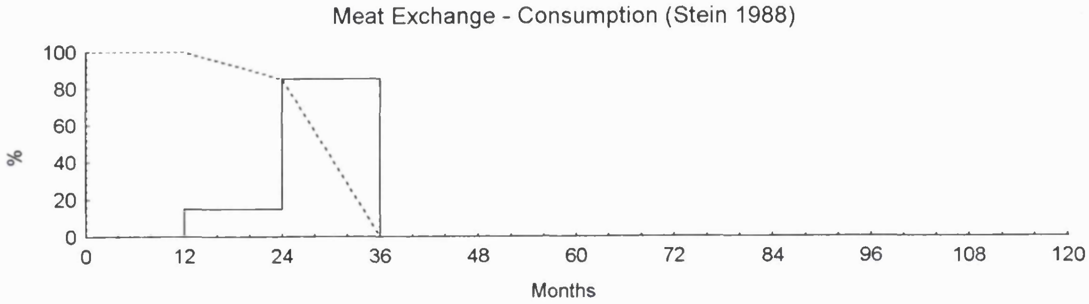
One of the key variables manipulated by pastoralists according to the type of pastoral economy being practised is the population structure, or age and sex ratios, of the herd. Fortunately, this variable tends to be reflected in archaeological caprine assemblages. Although it can be difficult to produce reliable sex ratios for archaeological caprine assemblages, it is comparatively easy to produce age ratios, or survivorship curves, on the basis of either mandibular tooth eruption and wear or on the basis of epiphyseal fusion.

Typically, the population structure of a domestic herd is largely a reflection of the primary goals of the herder. Within the recent past, the more specialised the type of pastoral economy, the greater the focus on production of secondary products has tended to be. This is because secondary products, such as milk or milk products, can be ~~both~~ consumed by the herder or exchanged for carbohydrates in the form of agricultural products without affecting the size or security of the herd, as their production does not involve the slaughter of any component of that herd.

Researchers have therefore produced modelled caprine survivorship curves for a variety of production strategies, against which archaeological caprine survivorship curves can be compared. It was therefore decided to compare the ‘Ain Ghazal caprine survivorship curves, based on mandibular tooth wear rather than epiphyseal fusion (see 10.2.3 above) with published, modelled caprine survivorship curves for generalised, subsistence orientated meat production (Payne 1973), specialised milk production (Payne 1973), and specialised wool production (Payne 1973), herd security (Redding 1981), and specialised meat production within an exchange economy (Stein 1988). The rationale behind these modelled survivorship curves is fully discussed in the publications listed above, and will not be repeated here. However, the cumulative survivorship curves themselves, and histograms of the relative proportions of animals in each age class, are reproduced in Figure 10.19 below.


Wool (Payne 1973)


Meat Exchange - Production (Stein 1988)


Meat Exchange - Consumption (Stein 1988)

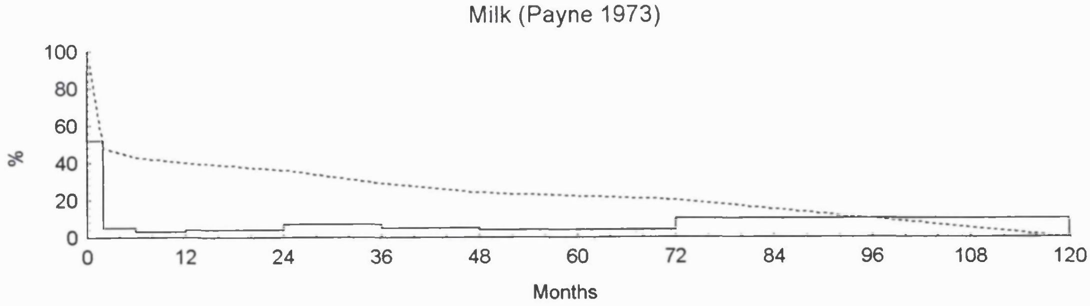
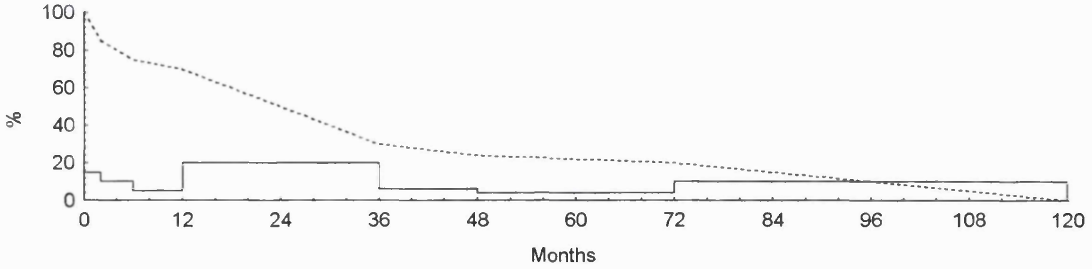

Milk (Payne 1973)

Figure 10.19: Published Modelled Caprine Survivorship Curves for Different Production Strategies (continued overleaf)

Meat (Payne 1973)



Security (Redding 1981)

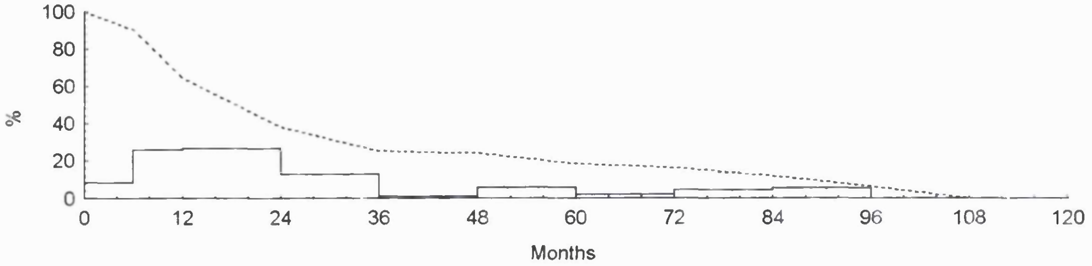


Figure 10.19 (cont.): Published Modelled Caprine Survivorship Curves for Different Production Strategies

10.3.1: Comparison of 'Ain Ghazal Caprine Survivorship Curves with Published, Modelled Survivorship Curves for Different Production Strategies:

The 'Ain Ghazal caprine survivorship curves, as evidenced by mandibular tooth eruption and wear (goat, sheep and goat/sheep combined, see Table 10.2 and Figure 10.7), are plotted against the modelled survivorship curves for generalised, subsistence orientated meat production (Payne 1973), specialised milk production (Payne 1973), specialised wool production (Payne 1973), herd security (Redding 1981), and specialised meat production within an exchange economy (Stein 1988) in Figure 10.20. It should be noted that the population structure of a herd may often be a reflection of more than one of these goals, with the result that the differences between the modelled population structures may be more ambiguous in reality. This should be borne in mind when interpreting these results.

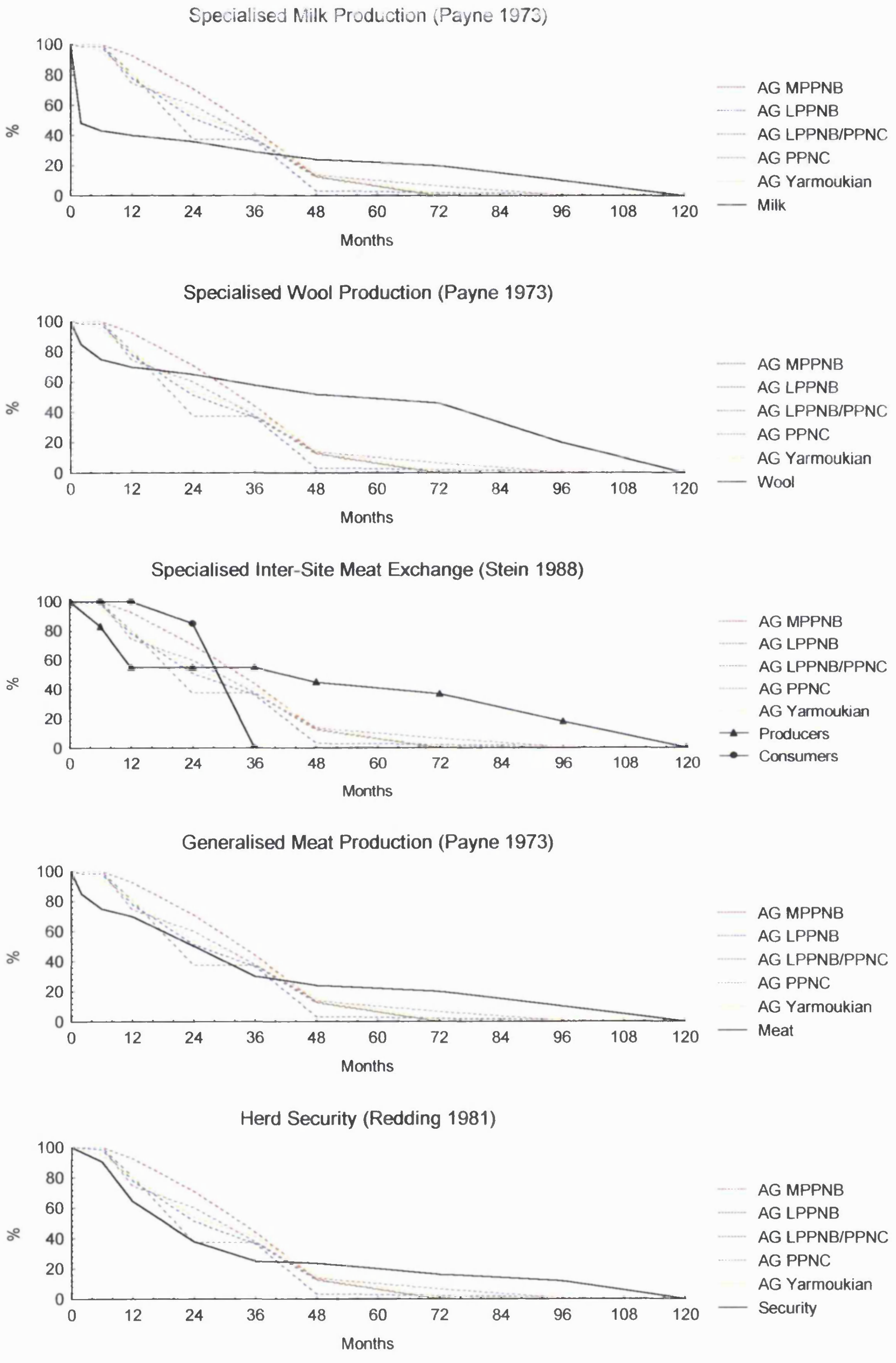


Figure 10.20: Comparison of 'Ain Ghazal Caprine Survivorship Curves with Published Modelled Caprine Survivorship Curves for Different Production Strategies

It is immediately clear that the survivorship curves of the 'Ain Ghazal caprines do not fit well with the modelled curves for strategies focused on the production of secondary products, i.e. milk or wool, or of meat for exchange during any phase of occupation. The extremely high survivorship of 'Ain Ghazal caprines during the first year of life does not conform to strategies which emphasise milk production (Payne 1973), whilst the extremely low survivorship among 'Ain Ghazal caprines older than four years does not conform to strategies emphasising wool production (Payne 1973). The fact that prime-aged animals in the two to three year age range are well represented at 'Ain Ghazal means that the survivorship curves do not conform to strategies emphasising meat production for exchange (Stein 1988).

A rather better fit is obtained if the 'Ain Ghazal caprine survivorship curves are compared with the modelled curves for generalised, subsistence orientated strategies emphasising meat production for local consumption (Payne 1973) or herd security (Redding 1981). Payne (1973) has argued that the type of bimodality evident at 'Ain Ghazal in the proportions of caprine teeth in each wear stage during the LPPNB, LPPNB/PPNC, PPNC and Yarmoukian (see Figure 10.7) may, in herds managed primarily for generalised, subsistence orientated meat production, be a reflection of the preferential slaughter of young males not required for breeding and of barren adult females.

However, it should be noted that these later peaks in mortality at 'Ain Ghazal are at least three years earlier than the modelled later peak which, it is suggested (Payne 1973), occurs between six and ten years. Furthermore, at 'Ain Ghazal the proportion of animals killed, or dying of natural causes, before the age of six months is much lower than the modelled curve for generalised, subsistence orientated meat production.

There are, however, a number of similarities between the 'Ain Ghazal caprine survivorship curves and the modelled curve for consumers in a system of meat exchange (Stein 1988). The virtual absence of animals less than six months old and more than four years old during all phases of occupation at 'Ain Ghazal is broadly compatible with a system of production in which prime-aged animals were supplied to the site by producers maintaining extremely young animals and older breeding stock elsewhere. However, at

'Ain Ghazal the killing of animals seems to have started earlier and continued for longer than in Stein's (1988) modelled curve.

This comparison of modelled caprine survivorshop curves for a variety of production strategies with those from 'Ain Ghazal strongly suggests that during no phase of the site's occupation were caprines being managed to emphasise the specialised production of meat or secondary products for exchange. Instead, the 'Ain Ghazal caprine survivorship curves from all phases of occupation seem to fit well with production strategies aimed at maintaining the supply of meat to the site and ensuring herd security. What is unclear is the extent to which the 'Ain Ghazal caprine survivorship curves represent subsistence orientated meat production for local consumption within a system of sedentary animal husbandry centred on the settlement (Payne 1973), the maintenance of herd security (Redding 1981), or the consumption of meat supplied to the settlement from elsewhere (Stein 1988).

Although the 'Ain Ghazal caprine survivorship curves fit reasonably well with those of strategies emphasising subsistence-orientated meat production for local consumption and herd security, they also display a number of characteristics which raise the possibility that the inhabitants of 'Ain Ghazal may have been obtaining at least part of their meat supply from elsewhere. In a typical subsistence orientated strategy of meat production all age groups should be represented in the resulting faunal assemblage. Natural juvenile mortality should result in the presence of animals less than one year old, the slaughter of most males on reaching their maximum meat weight should result in the presence of animals between two and three years old, whilst the slaughter of barren females should result in the presence of animals between five and eight years old (Payne 1973, p.301). However, the 'Ain Ghazal caprine survivorship curves suggest that the proportion of animals younger than six months and older than four years was extremely low during all phases of occupation. This could be accounted for by a number of factors.

1) The mandibles and teeth of animals less than six months old could be under-represented in the faunal assemblage from 'Ain Ghazal owing to preservational biases. It should however be noted that these would not account for the under-representation of animals older than four years. Furthermore, the density of mandibles and teeth is known to be relatively high (Payne 1973, Binford and Bertram 1977, Lyman 1994).

2) The inhabitants of 'Ain Ghazal may have slaughtered breeding females at a relatively early age, despite the fact that this would have seriously reduced the reproductive security of the herd.

3) Neolithic domestic herds kept under conditions of restricted mobility may have faced lower levels of nutrition and higher levels of disease, than the modern herds on which the modelled curves are based (e.g.: Meadow 1989a). It is therefore possible that few 'Ain Ghazal caprines survived beyond the age of four years owing to the severity of the conditions under which they were kept

4) An alternative explanation might be that animals between the age of one and four years were brought to 'Ain Ghazal for slaughter from herds maintained elsewhere. This would fit well with the fluctuating village model of Köhler-Rollefson and Rollefson (1993a). If the 'Ain Ghazal caprines were, as suggested by Köhler-Rollefson and Rollefson, being maintained in the dry steppe and sub-desert zones to the north-east and east of 'Ain Ghazal during the autumn, winter and spring, birthing would have occurred off-site (Lancaster and Lancaster 1991) with the result that animals less than six months old would be under-represented in the faunal assemblage from the settlement itself. It is at least conceivable that prime-meat animals may have been supplied to 'Ain Ghazal on a regular basis from herds maintained off-site for the greater part of the year by small groups of specialist herders, who for their part could have secured a stable supply of meat by slaughtering barren females. This would result in the under-representation of older animals in the faunal assemblage from the settlement itself. Although the proportion of animals younger than six months and older than four years is extremely low during all phases of occupation at 'Ain Ghazal, and not just the PPNC phase with which the fluctuating village model of Köhler-Rollefson and Rollefson is primarily associated, it should be noted that the proportion of animals killed between the age of six months and one year seems to have been slightly higher during the LPPNB, LPPNB/PPNC, PPNC and Yarmoukian than during the MPPNB (see Figure 10.7). Although the reasons for this slight shift in survivorship are unclear, it is conceivable that in the context of the fluctuating village model of Köhler-Rollefson and Rollefson a proportion of each year's crop of young animals might have been slaughtered during their first summer on site, i.e.: between six months and one year of age if a late winter/early spring birth is assumed (Lancaster

and Lancaster 1991), to provide young meat for the permanent inhabitants of the 'Ain Ghazal. Therefore, if a fluctuating village of the type modelled by Köhler-Rollefson and Rollefson (1993a) existed at all at 'Ain Ghazal, the balance of evidence suggests that is most likely to have emerged during the LPPNB and would therefore have coincided with the significant increase in the frequency of sheep at 'Ain Ghazal during this period. Although it is accepted that most of the discussion in the above paragraph is based more on guesswork than hard evidence, it should be stressed that the 'Ain Ghazal caprine survivorship curves provide no evidence, e.g.: in the form of high proportions of extremely young animals that could only have been born in the immediate vicinity of the site, that such a fluctuating village economy did not exist.

10.3.2: Conclusions:

This examination of the 'Ain Ghazal caprine survivorship curves strongly suggests that caprines were being managed to maximise meat production and herd security during all phases of occupation. There are also extremely tentative hints, primarily from the LPPNB, LPPNB/PPNC, PPNC and Yarmoukian, that at least some breeding stock may have been maintained off-site for a substantial part of the year, which would have included the late winter/early spring birthing period. The 'Ain Ghazal caprine survivorship curves provide no evidence for the exploitation of secondary products during any phase of occupation. As all available data (e.g.: Khazanov 1984, Lancaster and Lancaster 1991) suggests that high levels of pastoral specialisation are linked to the production of secondary products both for consumption and exchange, it seems most likely that the 'Ain Ghazal caprines were managed within a system of sedentary animal husbandry focused on generalised, subsistence orientated meat production and herd security. There is some evidence to suggest that a system of distant pastures husbandry, i.e.: a more specialised pastoral economy, also focused on generalised, subsistence orientated meat production and herd security, may have developed during the LPPNB. However, it should be stressed that this evidence, such as it is, is far from conclusive.

CHAPTER 11: DISCUSSION AND CONCLUSIONS

11.1: INTRODUCTION:

This chapter discusses the results of the zooarchaeological analysis of the 'Ain Ghazal faunal assemblage in the context of the baseline interpretations of the emergence of caprine as major early domesticates and the development of more specialised pastoral economies in the Levant, and presents the major conclusions of this study. However, it should also be noted that this study has also yielded some important zooarchaeological methodological conclusions relating to the identification of caprine remains to species (see Chapter 8). These are briefly discussed below.

Firstly, it has been demonstrated that the proportion of caprine remains identified to species has a clear impact on the goat to sheep ratios thus generated. In samples with a high proportion of specimens remaining in the goat/sheep category, the goat to sheep ratio is more likely to diverge from the actual goat to sheep ratio than in samples with a low proportion of specimens remaining in the goat/sheep category. This means that goat to sheep ratios generated from samples in which the proportion of specimens identified to species is low should be treated with caution.

Secondly, this study has demonstrated that traditional methods of identifying caprine remains to species, based on comparisons with published/unpublished morphological criteria established on modern reference material of known species and/or on comparisons with modern reference material itself, can generate highly accurate and consistent results.

Thirdly, the results of this study suggest that principal components analysis of caprine bone morphology has only a limited potential to identify a greater proportion of caprine remains to species tha~~t~~n traditional methods. However, the value of principal components analysis of caprine bone morphology lies in its ability to identify the particular morphological characteristics which are most reliable in yielding an accurate identification of caprine remains to species.

Having thus summarised the main conclusions of this study which relate to zooarchaeological methodology, the results of the zooarchaeological analysis of the 'Ain

Ghazal faunal assemblage presented in Chapters 9 and 10 are discussed below in the context of the two baseline interpretations presented in Chapter 6.

11.2: THE EMERGENCE OF CAPRINES AS MAJOR EARLY DOMESTICATES IN THE LEVANT:

The baseline interpretation presented in Chapter 6 suggested that goat domestication first occurred in or immediately adjacent to the Lebanon or Anti-Lebanon Mountains during the PPNA (i.e.: Period 2), in response to resource stress linked to the establishment of earliest agricultural villages. However, it argues that the PPNA inhabitants of early agricultural villages in the southern Levant may have responded to this resource stress in a different manner, through a combination of intensified gazelle hunting and exploitation of a wider range of species than hitherto, owing to the scarcity of wild goat in this region. The baseline interpretation suggests that domestic goats, or at least the concept of domestication, did not appear in the southern Levant until the Middle PPNB (i.e.: Period 3). Within this region domestic goats seem to have appeared in the southern Levantine Corridor up to a millennium before they appeared in the woodland and moist steppe zones to its west (see Chapter 6). The appearance of domestic goats in the southern Levantine Corridor seems to have been followed shortly afterwards, during the latter part of the Middle PPNB and during the Late PPNB (i.e.: late Period 3 and Period 4) by the appearance of domestic sheep. These are thought to have diffused south from the piedmont zone of the Taurus Mountains and the upper Euphrates Valley, where they seem to have been first domesticated during the second half of the Middle PPNB (i.e.: the second half of Period 3) (see Chapter 6).

The data from 'Ain Ghazal fits extremely well with this interpretation. Substantial numbers of zoologically domestic goats have been identified in the Middle PPNB faunal assemblage from the site (see Chapters 9 and 10). The initial domestication of these animals is unlikely to have been a southern Levantine phenomenon, owing to the extreme scarcity of wild goats in all Natufian and PPNA faunal assemblages from the region. It must therefore be considered likely that goats were first domesticated elsewhere, probably in or immediately adjacent to the Lebanon and Anti-Lebanon Mountains (see Chapter 6), prior to their appearance in substantial numbers in the southern Levantine Corridor at sites such as 'Ain Ghazal by at least c.9,250b.p..

During the MPPNB at 'Ain Ghazal, exploitation of domestic goats was accompanied by the hunting of an extremely wide range of other species, predominantly gazelle, however subsequently this practice rapidly declined (e.g.: Köhler-Rollefson et al. 1988 and 1993, von den Driesch and Wodtke 1997). The results of von den Driesch and Wodtke (1997) suggest that this decline in the importance of hunting and in the range of species exploited may have started by the transitional Middle PPNB/Late PPNB (i.e.: during the latter part of the first half of the 9th millennium b.p.). It is possible that the high frequencies of gazelle and minor taxa in the 'Ain Ghazal Middle PPNB faunal assemblage may have been a final manifestation of the intensified gazelle hunting and exploitation of a wider range of species by which the PPNA inhabitants of the southern Levant seem to have responded to the resource stress commonly linked to the emergence of the earliest sedentary agricultural communities (see Chapter 6). It is perhaps unsurprising that following the first appearance of domestic goats these interim responses to resource stress were rapidly abandoned in favour of this more effective means securing and increasing supplies of protein.

Data from 'Ain Ghazal suggest that domestic sheep had been introduced to the southern Levantine Corridor (see Chapter 6) in extremely small numbers towards the end of the Middle PPNB, and that subsequently their numbers rapidly increased (see Chapters 9 and 10). By the transitional Late PPNB/PPNC domestic sheep were the most common species in the 'Ain Ghazal faunal assemblage and had displaced goats from their former predominance. The decline in the frequency of goat at 'Ain Ghazal from the end of the Middle PPNB onwards is complicated by the fact that during the Middle PPNB exploitation of domestic goats seems to have been accompanied by the hunting of wild goats (see Chapter 10). It is therefore possible that this apparent decline in the frequency of goat may have been at least partially due to the virtual abandonment of wild goat hunting by the end of the Middle PPNB, which was clearly a reflection of the general decline in the significance of hunting at this time (see Chapter 5), rather than in the large-scale replacement of domestic goats by domestic sheep.

Data from 'Ain Ghazal demonstrate that despite the virtual abandonment of wild goat hunting by the end of the Middle PPNB, the overall frequency of caprines increased into the Late PPNB and beyond (see Chapter 9), and that this increase was primarily the result of an influx of large numbers of domestic sheep. This in turn suggests that exploitation of domestic caprines intensified once it was possible to maintain mixed herds of goats and sheep, rather than herds made up of goats alone. It is entirely possible that the Middle PPNB system of mixed farming, in which agriculture and goat husbandry were integrated into a single sedentary system of production, may have led to the type of environmental degradation described by Rollefson and Köhler-Rollefson (e.g.: Köhler-Rollefson 1988 and 1992, Köhler-Rollefson and Rollefson 1990, Rollefson and Köhler-Rollefson 1989 and 1993a, Rollefson 1996). The well known adverse effects of goat husbandry in an agricultural context may have effectively precluded any intensification of this system of production until sheep, which are commonly regarded as being easier to control than goats (tending to bunch together rather than spreading out across the landscape (e.g.: Ducos 1993a, p.169)) which may therefore have made them more desirable in areas supporting crop cultivation, became available. Another reason for the rapid rise to predominance of sheep in the 'Ain Ghazal faunal assemblage may have been that sheep, which prefer to graze annuals (Lancaster and Lancaster 1991, p.130), would have had a considerable advantage over goats, which prefer to graze perennials, in the type of degraded woodland environment thought by Rollefson and Köhler-Rollefson (see above) to have characterised the vicinity of 'Ain Ghazal from the beginning of the Late PPNB onwards.

11.3: THE DEVELOPMENT OF MORE SPECIALISED PASTORAL ECONOMIES IN THE LEVANT:

The baseline interpretation presented in Chapter 6 suggested that exploitation of the earliest caprine domesticates was likely to have been a form of sedentary animal husbandry focused on generalised, subsistence orientated meat production. Although there is evidence to suggest that some specialisation may have occurred during the Neolithic period, in the form of the possible development of distant pastures husbandry (though still focused on generalised, subsistence orientated meat production), there is no evidence for any increased specialisation, in the form of the possible development of semi-nomadic pastoralism, until after the secondary products revolution of the Chalcolithic period. Whatever the degree of pastoral specialisation that developed in the Levant during the Neolithic and Chalcolithic periods, it seems clear that highly mobile types of extremely specialised pastoral economies known from the recent past could not have developed until the widespread adoption of horses and camels as riding animals during the late fourth and early third millennia b.p..

Again, the data from ‘Ain Ghazal fit extremely well with this interpretation. It is clear that the caprine survivorship curves from ‘Ain Ghazal do not fit well with modelled survivorship curves for strategies focused on the exploitation of secondary products during any of the main periods of occupation. Instead, the ’Ain Ghazal caprine survivorship curves fit well with modelled survivorship curves of strategies focused on generalised, subsistence orientated meat production and on herd security during all phases (see Chapter 10).

There are however some extremely tentative hints in the ‘Ain Ghazal caprine survivorship curves that from the Late PPNB onwards the inhabitants of the site may have been obtaining at least part of their meat supply from elsewhere, as consumers in a primitive system of meat exchange (see Chapter 10). If this was indeed the case, it would fit well with Rollefson and Köhler-Rollefson’s suggestion that a fluctuating village economy developed at ‘Ain Ghazal in response to environmental degradation caused by the combination during the MPPNB of agriculture and goat husbandry in a single sedentary system of mixed farming (e.g.: Köhler-Rollefson 1992, Rollefson and Köhler-Rollefson 1993a, Rollefson 1996). Furthermore, the general trend of increased frequencies of equid remains in the ‘Ain Ghazal faunal assemblage over time (see Chapter 9) hints at an intensification in the exploitation of the dry-steppe zone lying immediately to the east and north-east of the site.

The ‘Ain Ghazal caprine survivorship curves therefore suggest that if such a fluctuating village economy developed at all, it did so during the Late PPNB. If this was the case, it would have been associated with the introduction of large numbers of domestic sheep at the site and would tend to support the suggestions of Perrot (1993a) and Ducos (1993a) that more mobile forms of pastoralism than sedentary animal husbandry developed in association with sheep, rather than goat, herding.

In sum, the data from ‘Ain Ghazal tend to confirm that caprine husbandry during the Neolithic was based on sedentary animal husbandry focused on generalised, subsistence orientated meat production, and that any potential pastoral specialisation during this period was restricted to the development of distant pastures husbandry which, if it existed at all, would have remained focused on generalised, subsistence orientated meat production throughout the Neolithic.

11.4: CONCLUSIONS:

The zooarchaeological analysis of the 'Ain Ghazal faunal assemblage has, as described above, yielded data which strongly support the baseline interpretations presented in Chapter 6 of the emergence of caprines as major early domesticates and the development of more specialised pastoral economies in the Levant. Acceptance of these interpretations raises two key issues:

11.4.1: The 'Gap' Between the Establishment of the Earliest Agricultural Economies and the Development of Animal Husbandry:

The results of this study suggest that the long held belief that the establishment of the earliest agricultural economies preceded the development of animal husbandry by up to a millennium may need to be reconsidered. The examination of published zooarchaeological data from Tell Aswad I (Ducos 1993a) in Chapter 6 suggests that in the central Levantine Corridor domestic goats were being exploited in significant numbers from at least c.9,800b.p., or in other words from the time of or shortly after the establishment of the earliest permanent agricultural villages in this area. Zoogeographical considerations suggest that the most likely initial centre of goat domestication would have been in or immediately adjacent to the Lebanon and Anti-Lebanon Mountains (see Chapter 6).

It is possible that the concept of there having been a gap of up to a millennium between the establishment of the earliest agricultural villages and the beginnings of animal husbandry may have been the result of the concentration of archaeological research in the southern Levant. The apparent gap between the establishment of the earliest agricultural villages and the appearance of the earliest animal domesticates in this area may well be a reflection of the time taken for domestic goats, or at least the concept of domestication, to diffuse through the Levantine Corridor into this region from the central Levant.

11.4.2: The Existence of Long Periods of 'Loose Herding' Prior to the First Appearance of Zoologically Domestic Caprines in the Southern Levant:

A number of researchers have argued that long periods of loose herding, variously described as 'cultural control' (Hecker 1975), 'proto-élevage' (Ducos 1993a) or 'incipient domestication' (Horwitz 1989), may have characterised human exploitation of caprines in the southern Levant during the 9th millennium b.p. prior to the eventual appearance of zoologically domestic caprines at the beginning of the 8th millennium b.p.. This scenario is considered unlikely on three counts. Firstly, data from the Damascus Basin suggests that the establishment of permanent agricultural villages and the domestication of wild goats were almost simultaneous events. Secondly, this study has yielded good evidence for the presence of zoologically domestic goats in the southern Levantine Corridor at 'Ain Ghazal during the last quarter of the 10th millennium b.p.. Thirdly, implicit in the concepts of 'cultural control', 'proto-élevage' or 'incipient domestication' is the assumption that the wild progenitors of eventual domesticates were present in sufficient numbers to be intensively exploited in a manner that approached, but fell just short of, full domestication. However, the examination of late Pleistocene and early Holocene caprine zoogeography which forms part of this study has suggested that mouflon were absent from the southern Levant during the early Holocene and that wild goats, if not absent during this period, were either relatively rare or only present on a seasonal basis.

It is possible that one of the reasons why researchers have experienced difficulties in identifying zoologically domestic caprines in the southern Levant prior to the 8th millennium b.p. (e.g.: Horwitz 1989) may be that prior to the intensification in exploitation of domestic caprines associated with introduction of substantial numbers of domestic sheep (see above), which occurred during the Late PPNB in the southern Levantine Corridor but not until after the end of the PPNC in the woodland and moist steppe zones to its west (see Chapter 6), exploitation of domestic goats was commonly accompanied by continued hunting of a range of wild taxa. In the southern Levant the range of wild taxa thus exploited would often have included a proportion of wild goat. Any faunal assemblage containing both wild and domestic goat remains would to a certain extent combine characteristics of both hunting and herding strategies (see also Helmer 1989). Consequently interpretations such as 'cultural control' (Hecker 1975), 'proto-élevage' (Ducos 1993a) or 'incipient domestication' (Horwitz 1989), which attempt to reconcile the blurring of boundaries between wild and domestic, may have seemed appropriate.

11.5: POSTSCRIPT:

This study has attempted to highlight the extent to which the physical and environmental diversity of the Levant has been reflected in the diversity of subsistence strategies that human groups developed during the late Epipalaeolithic, Neolithic and Chalcolithic periods to ensure survival. The emergence of caprines as major early domesticates and the development of more specialised pastoral economies were an integral part of this process, and as such reflect the same geographical and chronological variation.

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APPENDIX A

Morphological Criteria Score Counts of 'Ain Ghazal Caprine POSACs Subjected to Principal Components Analysis

Phase	Fusion	Species	B23	B24	B25	B26	B27	B29	PF7	BU1	HR1
MPPNB	F	Goat	2		3	4	4	3	3	4	4
MPPNB	F	Goat	3	3	4	3	3	4	3	4	4
MPPNB	F	Goat	2	3	4	3	2	4	3	4	4
MPPNB	F	Goat	3	3	4		4	4	4	4	4
MPPNB	F	Goat	3	3	3	1	3	3	3	4	4
MPPNB	F	Goat	4		4	4	3	3	3	4	4
MPPNB	F	Goat				2	3		3	4	4
MPPNB	F	Goat	4	3	4	3	4	4	3	4	4
MPPNB	F	Goat	2		4	4	3	4	3		4
MPPNB	F	Goat		2	3		4		3	3	4
MPPNB	F	Goat		4	3	4	4	3	4	4	3
MPPNB	F	Goat				3	3		4		3
MPPNB	F	Goat		3	4	4	3	4	4	4	4
MPPNB	F	Goat		4	2	3	4	2	3	2	4
MPPNB	F	Goat			4		2		3	3	4
MPPNB	F	Goat		3	2	4	2	4	3		4
MPPNB	F	Goat		4	3	4	3	4	3	4	3
MPPNB	F	Goat/Sheep	3	4	4			3			
MPPNB	F	Goat/Sheep	3	2	3		3	1	3		
MPPNB	F	Goat/Sheep	3	2	4			1			
MPPNB	F	Goat/Sheep		3	4	2	3	4	2		3
MPPNB	F	Sheep	3		3	2	1		2	2	2
MPPNB	fg	Goat	3	3	4	3	3	4	2	3	4
MPPNB	uf	Goat/Sheep	4	3	4		4	3			4
MPPNB	uf	Goat/Sheep	4	3	4		3	4		4	4
MPPNB	uf	Goat/Sheep	4		4		2	4			
MPPNB	uf	Goat/Sheep	4		4			4			
LPPNB	F	Goat				4	3		3	4	4
LPPNB	F	Goat		4	3	4	3	3	3	4	4
LPPNB	F	Goat				3	4		4	3	3
LPPNB	F	Sheep	2	2		1			2	1	2
LPPNB	F	Sheep				2	1		2	2	2
LPPNB	uf	Goat/Sheep		2	4		2	1	1	1	
LPPNB/PPNC	F	Goat			4		3		3	4	4
LPPNB/PPNC	F	Goat				3	4		2		3
LPPNB/PPNC	F	Sheep			3	1	1		1	2	1
LPPNB/PPNC	F	Sheep				2	2		2		1
LPPNB/PPNC	uf	Goat		3	4		4	4			
PPNC	?	Goat/Sheep	4	2	3			3			
PPNC	?	Goat/Sheep	4	3	4			4			
PPNC	?	Goat/Sheep	3		3			4			
PPNC	?	Goat/Sheep	3		4			2			
PPNC	?	Goat/Sheep			3	3		3			
PPNC	F	Goat	3	2	3	3	4	3	2	4	3
PPNC	F	Goat				3	3		4		3
PPNC	F	Goat	4	4	4		2	4	3	3	4
PPNC	F	Goat	3		4	3	3	3	3	3	4
PPNC	F	Goat	4	3	4		4	3	3	3	4
PPNC	F	Goat		3	4	3	4	3	2		4
PPNC	F	Goat		4	4		4	2			
PPNC	F	Goat				3	4		3	4	3
PPNC	F	Goat			3	4	3		3	4	3
PPNC	F	Goat/Sheep			2	4	1		2	3	3
PPNC	F	Goat/Sheep				3	2		2	2	1
PPNC	F	Goat/Sheep	2	2	3	4	2	4	3	1	
PPNC	F	Goat/Sheep	4	2	2		3	1		1	
PPNC	F	Goat/Sheep	4	3	4	3	3	2	3	1	3
PPNC	F	Goat/Sheep		3			2	4	1		1
PPNC	F	Goat/Sheep				1	4		1		3

Table A.1: Principal Components Analysis Score Counts for 'Ain Ghazal Caprine Scapulae

Phase	Fusion	Species	B23	B24	B25	B26	B27	B29	PF7	BU1	HR1
PPNC	F	Goat/Sheep		3	3	2	2	1	3	1	3
PPNC	F	Goat/Sheep		2	4	3	2		1	2	
PPNC	F	Goat/Sheep		4	2	2	3		3	1	4
PPNC	F	Goat/Sheep		3	4	2	3		2	3	2
PPNC	F	Goat/Sheep		4	3	3	4		3		4
PPNC	F	Goat/Sheep			3		3	4	3	3	2
PPNC	F	Goat/Sheep		4	3	3	3	3	4	2	3
PPNC	F	Goat/Sheep		2	3	3	2	4	2	1	3
PPNC	F	Goat/Sheep				2	2		3	3	2
PPNC	F	Sheep		3	2	2	1	1	1		2
PPNC	F	Sheep		1		1	2		3	2	3
PPNC	F	Sheep			3	2	2		2	2	2
PPNC	F	Sheep			2	2	2		2		3
PPNC	F	Sheep			3	1	2			2	2
PPNC	F	Sheep	3	2	2	1	3	2	3	2	1
PPNC	F	Sheep	2	2	1	1	3	3	3	3	2
PPNC	F	Sheep	3		2	2	2		2	2	2
PPNC	F	Sheep	3	2	2	1	3	1	2	2	2
PPNC	F	Sheep	3	2		1	2	1	2	2	2
PPNC	F	Sheep	3			1	2		3	2	1
PPNC	F	Sheep	3	3	2	2	2	3	2	3	1
PPNC	F	Sheep	3	2	2	1	2		2	2	1
PPNC	F	Sheep	4	3	4	1	2		2	2	3
PPNC	F	Sheep	3			1	2		3	1	4
PPNC	F	Sheep				2	2		3	2	1
PPNC	F	Sheep	3	1	2	1	1	1	1	2	1
PPNC	F	Sheep				2	2		3	1	2
PPNC	F	Sheep				1	1		2		2
PPNC	F	Sheep			2	1	2		1	1	2
PPNC	F	Sheep				1	1		1	2	1
PPNC	F	Sheep		2	3	1	1	1	1	2	3
PPNC	uf	Goat			3		4	3			
PPNC	uf	Goat/Sheep	4		4		2	4			
Yarmoukian	?	Goat/Sheep	3		3		4	2			
Yarmoukian	?	Goat/Sheep	4		4						
Yarmoukian	?	Goat/Sheep	4	3	2			2			
Yarmoukian	?	Goat/Sheep	2		3		3	1			
Yarmoukian	?	Goat/Sheep	3	3	2			3			
Yarmoukian	?	Goat/Sheep	4	3	4		3	1			
Yarmoukian	F	Goat			3	4	4		3	3	4
Yarmoukian	F	Goat		3	4	3	3	3	4		4
Yarmoukian	F	Goat	3	3	4	3	3	3	3	4	4
Yarmoukian	F	Goat				3	3		4	3	3
Yarmoukian	F	Goat		4	3	3	3		4		3
Yarmoukian	F	Goat		4	3	4	3	2	4	3	4
Yarmoukian	F	Goat		4		3	4	4	3	3	2
Yarmoukian	F	Goat		3	2		4	4		4	
Yarmoukian	F	Goat		4	3		4	3	4		
Yarmoukian	F	Goat			4	3	4		4		4
Yarmoukian	F	Goat		2	4	4		3	2		3
Yarmoukian	F	Goat		4	4	4	3	4	4	3	4
Yarmoukian	F	Goat		4	4	3	4		4	4	3
Yarmoukian	F	Goat		3	4	4	3		3	4	4
Yarmoukian	F	Goat/Sheep	3	3	3		3	2	2	2	4
Yarmoukian	F	Goat/Sheep				3	3		3		2
Yarmoukian	F	Goat/Sheep		3	3	2		1	4	3	4
Yarmoukian	F	Goat/Sheep	3	2	2			1			
Yarmoukian	F	Goat/Sheep	3		4		3				4
Yarmoukian	F	Goat/Sheep				2	3		3	3	4

Table A.1: Principal Components Analysis Score Counts for 'Ain Ghazal Caprine Scapulae

Phase	Fusion	Species	B23	B24	B25	B26	B27	B29	PF7	BU1	HR1
Yarmoukian	F	Goat/Sheep		2	4	2	3	4	2		2
Yarmoukian	F	Goat/Sheep		2	4	2	2	3	3		4
Yarmoukian	F	Goat/Sheep		3		3	2		2		
Yarmoukian	F	Goat/Sheep		3	4	2	2	3	3		2
Yarmoukian	F	Goat/Sheep		4	2		2	4			
Yarmoukian	F	Goat/Sheep		2	2		3	2	3	1	4
Yarmoukian	F	Sheep		2	2	2	2	1	2	3	2
Yarmoukian	F	Sheep	2	2	2	1	2		3		3
Yarmoukian	F	Sheep	3	2	2	1	3	1	2		3
Yarmoukian	F	Sheep	4	2	3	2	2	1	1		
Yarmoukian	F	Sheep			3		2		1		2
Yarmoukian	F	Sheep		2	3	2	1		1	2	3
Yarmoukian	F	Sheep		2	2	2	2	4	1	2	2
Yarmoukian	F	Sheep		2	1				1		
Yarmoukian	F	Sheep					1		2		3
Yarmoukian	F	Sheep		2		1	2		3		3
Yarmoukian	F	Sheep		2	3		1	3	1		
Yarmoukian	F	Sheep		1	1	2	1	1	1		3
Yarmoukian	F	Sheep		1	1	1	3	1	3		1
Yarmoukian	F	Sheep				2	1		3	2	2
Yarmoukian	F	Sheep				1	2		2	2	2
Yarmoukian	F	Sheep	4	2	3	1	1	1	1		3
Yarmoukian	F	Sheep	3			1	3				1
Yarmoukian	fg	Sheep		1	3	2	2		2		
Yarmoukian	fg	Sheep		2	2	1	2	4	1	2	1
Yarmoukian	uf	Goat		4	4		4				
Yarmoukian	uf	Goat/Sheep	3		4						
Yarmoukian	uf	Goat/Sheep		2	4		2	1			
Yarmoukian	uf	Goat/Sheep	4	2	4			4			
Yarmoukian	uf	Goat/Sheep	4	2	4			1			
Yarmoukian	uf	Goat/Sheep		2	3		1	3			
Yarmoukian	uf	Goat/Sheep	4		4		2				

Table A.1: Principal Components Analysis Score Counts for 'Ain Ghazal Caprine Scapulae

Phase	Fusion	Species	B33	B34	B35	B36	U1	PF9	B15	PF10	AW1
MPPNB	F	Goat	2	2	3	4	1	3	2	4	2
MPPNB	F	Goat	3	2	4	3	3	4	3	4	4
MPPNB	F	Goat				3	3			4	
MPPNB	F	Goat	1			3	3	4	4	3	
MPPNB	F	Goat				3	2	3		4	
MPPNB	F	Goat	2		2	3	1	4	4	4	3
MPPNB	F	Goat	2	2	3			3	2		4
MPPNB	F	Goat	2	4	3	4	4	3	3	4	3
MPPNB	F	Goat	2	3	3	4	1			4	3
MPPNB	F	Goat	3	2	2	4	2	3	4	4	3
MPPNB	F	Goat	2	2	2	4	3	3			4
MPPNB	F	Goat	3	3	4	3	2	2	2	4	3
MPPNB	F	Goat	1	3							3
MPPNB	F	Goat	3	2	3	3	4	3	2	4	4
MPPNB	F	Goat/Sheep	2		3						
MPPNB	F	Goat/Sheep						2	3		
MPPNB	F	Goat/Sheep				3	4				
MPPNB	F	Sheep	2		4	2	3	2	2	1	
MPPNB	fg	Goat	4	4	4			3	3		4
MPPNB	fg	Goat			4	3	3	3	4	4	
MPPNB	fg	Goat	3	4	4	3	3			4	3
MPPNB	fg	Goat/Sheep	3	4	4						2
MPPNB	fg	Goat/Sheep	3	4	4			3	3		2
LPPNB	F	Goat	3		3			3	2		4
LPPNB	F	Goat	3	4	4			4	3		4
LPPNB	F	Goat				4	2			4	
LPPNB	F	Goat/Sheep	2	3	2		1	2	1	2	3
LPPNB	F	Goat/Sheep	2	4	4						3
LPPNB	F	Sheep	2	2	1	1	4	3	3	2	1
LPPNB	F	Sheep	3	1	2			2	2	2	2
LPPNB	fg	Goat/Sheep	3		3	2	4	2	3	3	
LPPNB	fg	Sheep	3	3	2	1	2	1	3	1	2
LPPNB/PPNC	F	Goat	3	2	2	3	4	3	3	3	3
LPPNB/PPNC	F	Goat	3		3	2	4	3	3	4	3
LPPNB/PPNC	F	Goat	3	3	4	4	2	3	3	4	3
LPPNB/PPNC	F	Sheep	1	3	2						1
LPPNB/PPNC	F	Sheep	2		3					1	2
LPPNB/PPNC	F	Sheep	2		2	2	3			2	1
LPPNB/PPNC	F	Sheep	2	3	2			2	2		1
LPPNB/PPNC	F	Sheep	3	3	2	2	3			1	2
LPPNB/PPNC	F	Sheep	2	3	2	1	2	3	3	1	1
LPPNB/PPNC	fg	Sheep	3		3	2	1	1	2	1	1
PPNC	?	Goat/Sheep	2		4						
PPNC	?	Goat/Sheep						2	2		
PPNC	F	Goat	2	4	3	4	3	3	3	4	3
PPNC	F	Goat	3	4	3			3	3		4
PPNC	F	Goat	1	3	3	4	4	3	2	4	4
PPNC	F	Goat	2	3	4	4	3	3	4	4	4
PPNC	F	Goat				4	3			4	
PPNC	F	Goat/Sheep	2		4	1	3	3	3	3	
PPNC	F	Goat/Sheep	3		2						
PPNC	F	Goat/Sheep	1		2				2		2
PPNC	F	Goat/Sheep	2		3	2	2	2			
PPNC	F	Goat/Sheep	3	4	4			2	3		2
PPNC	F	Goat/Sheep	1		2						
PPNC	F	Goat/Sheep	1		4			2	3		3
PPNC	F	Goat/Sheep	2								
PPNC	F	Goat/Sheep		2	2						2
PPNC	F	Goat/Sheep	2	4	2						

Table A.2: Principal Components Analysis Score Counts for 'Ain Ghazal Caprine Humeri

Phase	Fusion	Species	B33	B34	B35	B36	U1	PF9	B15	PF10	AW1
PPNC	F	Goat/Sheep	2	3	3	3	1	2	3	1	2
PPNC	F	Goat/Sheep	3	4	3			4	2		
PPNC	F	Goat/Sheep	2		3			2	1		2
PPNC	F	Sheep	2	2	3	2	3	1	2	2	1
PPNC	F	Sheep	3	1	2	2	2	3	2	1	3
PPNC	F	Sheep				2	3	2	1	2	
PPNC	F	Sheep	2	2	2	2	3	2	2	2	1
PPNC	F	Sheep	1	1	2	2	2			1	
PPNC	F	Sheep	2	3	1	1	4	2	2	1	1
PPNC	F	Sheep		3	3	3	2			1	2
PPNC	F	Sheep	2	2	1	3	1	1	2	2	3
PPNC	F	Sheep	2	3	2	2	2	2	3	1	1
PPNC	F	Sheep	3	3	3	2	1	2	2	2	1
PPNC	F	Sheep	3	3	2	1	1	2	2	2	
PPNC	F	Sheep			2			1	2		
PPNC	F	Sheep	1	1	2			2	2		3
PPNC	F	Sheep	3		2	2	2	3	2	2	1
PPNC	F	Sheep	2	2	3	2	2	2	2	2	1
PPNC	F	Sheep	3	2	4	1	1	1	2	1	1
PPNC	F	Sheep	2	3	3	1	2	1	2	2	2
PPNC	F	Sheep	3	2	2	2	1	3	2	3	2
PPNC	F	Sheep	1	2	4	2	4	2	2		2
PPNC	F	Sheep	2	4	3	3	2	2	2	2	1
PPNC	F	Sheep	2	2	3	1		2		1	2
PPNC	F	Sheep	3	2	2	2	3	1	2	1	2
PPNC	F	Sheep	1		1	1	3	2	1	1	
PPNC	F	Sheep	2	2	2	1	2	3	2	1	1
PPNC	F	Sheep	2	2	2	1	2	2	2	1	1
PPNC	F	Sheep	2	4	2			2	3		1
PPNC	F	Sheep	2	2	1	2	1	2	2	2	1
PPNC	F	Sheep	2	4	2	1	2	2	1	1	2
PPNC	F	Sheep	2	4	2	2	1	2	1	2	1
PPNC	F	Sheep	2	3	1	1	2	1	3	1	1
PPNC	F	Sheep	1	3	2	2	3	2	1	1	1
PPNC	F	Sheep	1		2			3	1		2
PPNC	F	Sheep	3	2	3			1	2		1
PPNC	F	Sheep	3	3	1	1	3	2	1		1
PPNC	F	Sheep	2		3	2	1	2	2	2	2
PPNC	F	Sheep	2	4	2	2	3	1	2		2
PPNC	F	Sheep	1	3	2	2	1	1	2	2	2
PPNC	F	Sheep	2	3	2	3	2	1	1	1	2
PPNC	fg	Goat				3	4	4	3	3	
PPNC	fg	Goat/Sheep	3	4	3	1	2	2	3	2	3
PPNC	fg	Goat/Sheep	3		3	2	2	1	3	1	
PPNC	fg	Goat/Sheep						2	2		
PPNC	fg	Goat/Sheep	4	4	4			2	3		2
PPNC	fg	Goat/Sheep	3	4	3	2	4	2	3	3	2
PPNC	fg	Sheep						1	1		
PPNC	fg	Sheep	3	4	4	1	2	4	2	2	2
PPNC	fg	Sheep	3		4	2	2	2	3	1	2
PPNC	fg	Sheep				1	3			1	
Yarmoukian	?	Goat/Sheep	2		3						
Yarmoukian	F	Goat	1		3	4	4	4	3	4	
Yarmoukian	F	Goat	2		4	2	3	3	3	3	3
Yarmoukian	F	Goat	3	3	3	4	3			4	4
Yarmoukian	F	Goat	3	4	2	3	3	4	3	4	4
Yarmoukian	F	Goat	1	3	4	4	2	4	2	4	3
Yarmoukian	F	Goat	2	3	3	4	3	2	2	4	4
Yarmoukian	F	Goat	2	4	4	3	3	4	3	4	3

Table A.2: Principal Components Analysis Score Counts for 'Ain Ghazal Caprine Humeri

Phase	Fusion	Species	B33	B34	B35	B36	U1	PF9	B15	PF10	AW1
Yarmoukian	F	Goat	3	3	4	3	2	3	2	4	2
Yarmoukian	F	Goat	2		4	4	2	4	3	2	3
Yarmoukian	F	Goat	2	2	3	3	2	3	2	3	4
Yarmoukian	F	Goat	2		4	4	2	4	3	3	3
Yarmoukian	F	Goat	2	4	3	2	3	3	2	4	4
Yarmoukian	F	Goat	2	2	4	3	4	4	4	4	3
Yarmoukian	F	Goat	3	4	2	4	3			4	4
Yarmoukian	F	Goat	2	4	4	2	3			3	4
Yarmoukian	F	Goat	3	4	3	3	4			4	4
Yarmoukian	F	Goat	2		4			3	4	4	3
Yarmoukian	F	Goat	1	2	2	4	2	4	4	4	3
Yarmoukian	F	Goat	3	4	3			4	4		4
Yarmoukian	F	Goat/Sheep	2		1	2	2	4	3	3	2
Yarmoukian	F	Goat/Sheep	1		1	3	3	4	2	3	
Yarmoukian	F	Goat/Sheep	1					1	1		
Yarmoukian	F	Goat/Sheep	1		3	1	3	4	3	3	3
Yarmoukian	F	Goat/Sheep	2					2	2		
Yarmoukian	F	Goat/Sheep	1		3			3	3		
Yarmoukian	F	Goat/Sheep	3	2	1						2
Yarmoukian	F	Goat/Sheep	1		4			2	3		
Yarmoukian	F	Goat/Sheep	2	4	2	3	3	4	3	4	
Yarmoukian	F	Goat/Sheep	2			3	3	2	2	2	
Yarmoukian	F	Goat/Sheep	2	3	1	2	4	1	3		2
Yarmoukian	F	Goat/Sheep	3	2	2	2	2	2	2	3	3
Yarmoukian	F	Goat/Sheep	3	4		3	2			3	
Yarmoukian	F	Goat/Sheep	2		2	3	1	2		3	
Yarmoukian	F	Goat/Sheep	3		2	3	3	2	3	3	
Yarmoukian	F	Goat/Sheep	2		3			4			2
Yarmoukian	F	Sheep	2	2	1	1	3	2	2	1	
Yarmoukian	F	Sheep	1		2			2			1
Yarmoukian	F	Sheep	2		2	3	2			1	
Yarmoukian	F	Sheep	3	3	1	1	3	1	2	1	3
Yarmoukian	F	Sheep	1			3	2	1	1	1	2
Yarmoukian	F	Sheep	2	1	1			2	1		1
Yarmoukian	F	Sheep	2		2	2	2	2	1	2	
Yarmoukian	F	Sheep	3		2	1	1	2	1	2	2
Yarmoukian	F	Sheep	2	3	2	1	2	3	3	1	2
Yarmoukian	F	Sheep	1	4	3	1	3	1	2	1	2
Yarmoukian	F	Sheep	2	3	2	2	2	2	2	2	1
Yarmoukian	F	Sheep	2	4	2			1	2		1
Yarmoukian	F	Sheep	3	2	3	1	3	2	2	1	1
Yarmoukian	F	Sheep	2			2	2			2	1
Yarmoukian	F	Sheep	2		2	1	2	2	3	1	2
Yarmoukian	F	Sheep	2	3	2	2	3	2	3	2	2
Yarmoukian	F	Sheep	1	3	3	2	3	2	1	1	2
Yarmoukian	F	Sheep	2	4	3	1	1	2	3	2	2
Yarmoukian	F	Sheep	3	3	2	2	2	2	1	1	
Yarmoukian	F	Sheep	2		2		3	2	3	2	1
Yarmoukian	F	Sheep	2	2	3	1	1	1	2	1	3
Yarmoukian	F	Sheep	2	3	2		2			1	1
Yarmoukian	F	Sheep	2	3	2						1
Yarmoukian	F	Sheep	3	3	2	1	1	2	2	1	2
Yarmoukian	F	Sheep	2	2	1	1	3	2	1	1	1
Yarmoukian	F	Sheep	1		1			2	2		1
Yarmoukian	F	Sheep	2	2	3	2	2	2	2	1	3
Yarmoukian	fg	Goat	3	4	4	3	4	2	2	4	3
Yarmoukian	fg	Goat/Sheep	3	3	4	3	3	2	3	2	1
Yarmoukian	fg	Goat/Sheep	3		4			2	2		2
Yarmoukian	fg	Goat/Sheep			4			2	2		

Table A.2: Principal Components Analysis Score Counts for 'Ain Ghazal Caprine Humeri

Phase	Fusion	Species	B33	B34	B35	B36	U1	PF9	B15	PF10	AW1
Yarmoukian	fg	Goat/Sheep	2	3	3			2	2		2
Yarmoukian	fg	Goat/Sheep	3		3			1	2		3
Yarmoukian	fg	Sheep	3	2	2	2	2	2	1	3	1

Table A.2: Principal Components Analysis Score Counts for 'Ain Ghazal Caprine Humeri

Phase	Fusion	Species	B904	B42	B905	B43	B906
MPPNB	F	Goat	4	3	3	3	3
MPPNB	F	Goat	4	3	4	3	2
MPPNB	fg	Goat	4	4	4	4	1
MPPNB	fg	Goat/Sheep	3	2	4	2	1
MPPNB	uf	Goat	3	3	3	4	1
MPPNB	uf	Goat	3	2	4	3	1
MPPNB	uf	Goat	4	4	4		
MPPNB	uf	Goat	3	3	4	3	1
MPPNB	uf	Goat	3	3	4	2	1
MPPNB	uf	Goat	4	3	3	4	1
MPPNB	uf	Goat	3	2	3	2	1
MPPNB	uf	Goat	4	2	3	2	1
MPPNB	uf	Goat	4	4	3	4	1
MPPNB	uf	Goat	3	3	4	3	1
MPPNB	uf	Goat	2	3	4	3	1
LPPNB	F	Sheep	2	2	2	3	1
LPPNB	uf	Goat	3	3	4	3	2
LPPNB	uf	Goat	4	4	3	4	2
LPPNB	uf	Sheep	1	2	1	2	1
LPPNB	uf	Sheep	1	1	1	2	1
LPPNB	uf	Sheep	1	1	1	2	2
LPPNB/PPNC	F	Sheep	1	1	2	1	1
LPPNB/PPNC	F	Sheep	2	2	2	2	1
LPPNB/PPNC	fg	Sheep	2	1	1	1	1
LPPNB/PPNC	uf	Goat	3	4	4	4	1
LPPNB/PPNC	uf	Goat	3	3	4		2
PPNC	F	Goat	4	3	3	3	2
PPNC	F	Goat	4	4	3	3	3
PPNC	F	Goat	4	3	4	3	1
PPNC	F	Goat	3	4	4	3	1
PPNC	F	Goat	4	4	3	4	1
PPNC	F	Sheep	1	2	1	2	1
PPNC	F	Sheep	2	1	1	3	1
PPNC	F	Sheep	2	1	2	2	1
PPNC	F	Sheep	3	2	2	2	1
PPNC	F	Sheep	2	1	1	1	1
PPNC	F	Sheep	1	2	1	1	1
PPNC	F	Sheep		2	2	3	1
PPNC	F	Sheep	2	1	1	1	1
PPNC	F	Sheep	1	2	1	2	1
PPNC	F	Sheep	1	1	1	2	1
PPNC	F	Sheep	2	1	1	1	1
PPNC	uf	Goat	3	3	3	4	1
PPNC	uf	Goat	4	3	4	3	1
PPNC	uf	Goat	4	4	4		
PPNC	uf	Sheep	1	1	1		1
PPNC	uf	Sheep	2	3	1	2	1
PPNC	uf	Sheep	1	1	1	1	1
PPNC	uf	Sheep	1	1	1	2	1
PPNC	uf	Sheep	1	2	1	2	1
PPNC	uf	Sheep	1	1	1	2	1
PPNC	uf	Sheep	1	1	1	2	1
PPNC	uf	Sheep	1	1	1	2	1
PPNC	uf	Sheep	1	2	1	2	1
PPNC	uf	Sheep	1	2	1	1	1
PPNC	uf	Sheep	2	1	2	2	1
Yarmoukian	F	Goat	3	3	3	3	3
Yarmoukian	F	Sheep	2	2	1	3	1
Yarmoukian	F	Sheep	1	1	1	2	1

Table A.3: Principal Components Analysis Score Counts for 'Ain Ghazal Caprine Radii

Phase	Fusion	Species	B904	B42	B905	B43	B906
Yarmoukian	F	Sheep	1	1	1	2	1
Yarmoukian	F	Sheep	2	1	2	1	
Yarmoukian	F	Sheep	2	1	2	3	1
Yarmoukian	F	Sheep	1	1	2	1	1
Yarmoukian	fg	Goat	3	3	3	3	1
Yarmoukian	fg	Goat/Sheep	1			3	
Yarmoukian	uf	Sheep	2	2	1	2	1
Yarmoukian	uf	Sheep	1	2	1	1	1
Yarmoukian	uf	Sheep	1	1	2	1	1

Table A.3: Principal Components Analysis Score Counts for 'Ain Ghazal Caprine Radii

Phase	Fusion	Species	B71	B207	B208	B209
MPPNB	F	Goat		3	4	
MPPNB	F	Goat	4	3	3	
MPPNB	F	Goat	4	4	4	
MPPNB	F	Goat		3	4	
MPPNB	F	Goat	3	3	3	3
MPPNB	F	Goat	3	4	3	3
MPPNB	F	Goat	2	3	4	
MPPNB	F	Goat	3	4	4	3
MPPNB	F	Goat	3	4	3	
MPPNB	F	Goat	2	3	2	3
MPPNB	fg	Goat	4	3	4	2
MPPNB	fg	Goat	3	3	2	3
MPPNB	uf	Goat	4	3	3	
MPPNB	uf	Goat	2	2	2	
MPPNB	uf	Goat	3	4	4	
MPPNB	uf	Goat	4	4	3	
MPPNB	uf	Goat	3	3	2	
MPPNB	uf	Goat	3	4	4	
MPPNB	uf	Goat	2	3	4	
MPPNB	uf	Goat	3	4	4	
LPPNB	?	Sheep	2	2	2	
LPPNB	F	Goat	4	3	4	
LPPNB	F	Goat	3		4	
LPPNB	F	Goat	4	3	3	
LPPNB	F	Goat	4	3	3	4
LPPNB	F	Goat	4	4	4	2
LPPNB	F	Sheep	2	2	2	
LPPNB	F	Sheep	3	2	2	
LPPNB	uf	Goat		4	4	
LPPNB	uf	Goat	3	2	2	
LPPNB	uf	Goat	3	2	2	
LPPNB	uf	Goat	3	4	4	
LPPNB	uf	Goat/Sheep	2	3	1	
LPPNB	uf	Sheep	3	1		
LPPNB	uf	Sheep	3	2		2
LPPNB/PPNC	F	Goat	4	4	3	4
LPPNB/PPNC	F	Goat	3	3	2	
LPPNB/PPNC	F	Goat	3	3	2	
LPPNB/PPNC	F	Goat		3	4	
LPPNB/PPNC	F	Sheep	3	2	2	2
LPPNB/PPNC	F	Sheep	1	2	1	
LPPNB/PPNC	F	Sheep	3	3	1	
LPPNB/PPNC	F	Sheep	2	2	1	
LPPNB/PPNC	F	Sheep	3	2	2	1
LPPNB/PPNC	uf	Goat	3	3		
LPPNB/PPNC	uf	Goat		2	3	
LPPNB/PPNC	uf	Sheep	2	2	2	
LPPNB/PPNC	uf	Sheep	2	2	3	2
LPPNB/PPNC	uf	Sheep	2	1		
LPPNB/PPNC	uf	Sheep	2	3	2	
PPNC	?	Sheep	3	2		
PPNC	F	Goat	3	3	4	
PPNC	F	Goat	3	3	3	
PPNC	F	Goat	3	4	3	2
PPNC	F	Goat	2	4	3	
PPNC	F	Goat	2	1	3	4
PPNC	F	Goat	4	2	4	4
PPNC	F	Goat	4	2		
PPNC	F	Goat	3	2	3	3

Table A.4: Principal Components Analysis Score Counts for 'Ain Ghazal Caprine Metacarpals

Phase	Fusion	Species	B71	B207	B208	B209
PPNC	F	Goat	3	3	3	2
PPNC	F	Goat	3	3	3	2
PPNC	F	Goat		4	3	
PPNC	F	Goat	4	4	4	
PPNC	F	Goat	3	4	4	3
PPNC	F	Sheep	2	2	3	2
PPNC	F	Sheep	3	2	2	2
PPNC	F	Sheep	3	2	2	
PPNC	F	Sheep	2	1	2	1
PPNC	F	Sheep	2	1	2	1
PPNC	F	Sheep	3	3	1	2
PPNC	F	Sheep	1	1	1	2
PPNC	F	Sheep	1	2	2	2
PPNC	F	Sheep	2	3	2	2
PPNC	F	Sheep	3	1	3	
PPNC	F	Sheep	3	2	1	
PPNC	F	Sheep	3	2	2	2
PPNC	F	Sheep	2	1	1	2
PPNC	F	Sheep	3	2	1	2
PPNC	F	Sheep	3	2	3	1
PPNC	F	Sheep	3	2	2	1
PPNC	F	Sheep	3	2	2	
PPNC	F	Sheep	3	2	2	
PPNC	F	Sheep	2	2	1	
PPNC	F	Sheep	2	1	2	
PPNC	F	Sheep	2	2	1	
PPNC	F	Sheep	2	2	1	
PPNC	F	Sheep	3	2	1	
PPNC	fg	Goat	4	2	1	
PPNC	fg	Goat	3	4	4	
PPNC	uf	Goat	4	3	4	
PPNC	uf	Goat		2	1	
PPNC	uf	Sheep	3	2	1	
PPNC	uf	Sheep	3	2	2	
PPNC	uf	Sheep	3	1	2	
PPNC	uf	Sheep	2	1	1	
PPNC	uf	Sheep	3	2	3	
PPNC	uf	Sheep		1	2	2
PPNC	uf	Sheep	3	2	1	
Yarmoukian	F	Goat	3	3	3	
Yarmoukian	F	Goat	3	3	4	
Yarmoukian	F	Goat	3	4	4	4
Yarmoukian	F	Goat	4	2	2	3
Yarmoukian	F	Goat	3	2	4	
Yarmoukian	F	Sheep	3	2	1	2
Yarmoukian	F	Sheep	4	2	1	1
Yarmoukian	F	Sheep	3	2	1	2
Yarmoukian	F	Sheep	2	2	2	2
Yarmoukian	F	Sheep	3	3	2	2
Yarmoukian	F	Sheep	3	2	1	2
Yarmoukian	F	Sheep	3	1	1	2
Yarmoukian	F	Sheep	2	1	1	1
Yarmoukian	F	Sheep	2	3	2	2
Yarmoukian	F	Sheep	3	2	1	2
Yarmoukian	F	Sheep	2	2	1	1
Yarmoukian	F	Sheep	2	2	1	2
Yarmoukian	fg	Goat	4	3	2	3
Yarmoukian	fg	Goat	3	2	4	
Yarmoukian	uf	Goat	3	4	4	

Table A.4: Principal Components Analysis Score Counts for 'Ain Ghazal Caprine Metacarpals

Phase	Fusion	Species	B71	B207	B208	B209
Yarmoukian	uf	Goat	2	3	4	
Yarmoukian	uf	Sheep	2	2	2	
Yarmoukian	uf	Sheep	2	2	1	
Yarmoukian	uf	Sheep	2	1	3	

Table A.4: Principal Components Analysis Score Counts for 'Ain Ghazal Caprine Metacarpals

Phase	Fusion	Species	K1	K2	K3	K4	K5	K6	K7	K8	K9	K1	K11	K12	K13	K14
MPPNB	F	Goat		2	3	4	2	3	3	4	4	3	4	3	2	4
MPPNB	F	Goat	3	3	3	3	4	4	4	3	4	2	3	3		4
MPPNB	F	Goat	4	3	2	3	1	4	3	3	4	4	4	4	1	3
MPPNB	F	Goat	3	3	3	2		4	3	4		3		3		2
MPPNB	F	Goat	4	2	3	3		3	3	3	4	3	2	3	3	2
MPPNB	F	Goat		2	2	3	3	4	4	4		3		3	3	4
MPPNB	F	Goat	4	3	2	2	4	3	4	3	4	3	2	3	2	4
MPPNB	F	Goat	4	3	3	4	3	4	4	3	4	4	4	3	3	
MPPNB	F	Goat	3	3	3	3	4	4	3	4		4	4	4	3	3
MPPNB	F	Goat	3	2	3	3	4	4	3	3	4	3	2	2	3	
MPPNB	F	Goat	4	3	3	3	2	4	3	3	4	3	3	3	4	
MPPNB	F	Goat	3	3	4	4	3	4	3	4	4	3	3	3	2	
MPPNB	F	Goat/Sheep		3	4	2	1	3	3	3	1		2	3	2	
MPPNB	fg	Goat	3	4	3		4	4	4	2	3	3		3	3	
MPPNB	fg	Goat		2	3		2	4	4					4	2	
MPPNB	fg	Goat	3	3	2	2	2		4		3	3	2	4		
MPPNB	fg	Goat/Sheep	4	4	2	2	3	4	3	2	3	3	3	3	2	
MPPNB	uf	Goat		4	3		4	4		3		4	2	3	3	
MPPNB	uf	Goat	4	3	2		3	4		3	4	3	2	3	2	
MPPNB	uf	Goat	4	4	3		3	3		4	4	3		2	3	
MPPNB	uf	Goat	4	3	3		4	4			4	4		3	2	
MPPNB	uf	Goat	3	4	4		4	4				4		3	3	
MPPNB	uf	Goat	4	3	3		4	4			3	4		4	3	
MPPNB	uf	Goat	3	4	3		4	4		3	4	3		3	1	
MPPNB	uf	Goat	4	2	2		4	4		3	3	4		4	3	
MPPNB	uf	Goat	3	3	4		1	4	3	3	3	4	2	3	2	
LPPNB	?	Sheep	3	2	3	1	2	4	1	1	2	2	1	2	1	1
LPPNB	F	Goat	3	2	3	3	2	4	3			4	2	4	2	
LPPNB	F	Goat	4			3							3			
LPPNB	F	Goat	4	3	3	3	3	3	3	2	4	3	2	3	4	3
LPPNB	F	Goat	4	3	3	3	4	4	3	3		4	2	3	2	
LPPNB	F	Goat		3	3	4		4	4	4			3	3	3	3
LPPNB	F	Goat/Sheep	2			3		2	3	2			3	1	1	3
LPPNB	F	Goat/Sheep	2	1	1	2	3	4	3	3	3		3	3	2	
LPPNB	F	Goat/Sheep	2	2	2	1	3	3	2	2	1	2	2	2	1	
LPPNB	F	Sheep		3	3	2	2	4		2		1		1	2	
LPPNB	F	Sheep	2	1	2	1	3	2	1	2	3	1	2	1	1	1
LPPNB	F	Sheep		1	2	2	2	4	3	3	2	1	3	2	2	2
LPPNB	F	Sheep		2	3	1	2	1	2	2	3	1	3	1	2	1
LPPNB	uf	Goat/Sheep	2	2	3		2	4				3	2	3	2	
LPPNB	uf	Goat/Sheep		3	3		2	4			2	3	2	3		
LPPNB	uf	Goat/Sheep	4	2	3		2	4				4	1	2	3	
LPPNB/PPNC	F	Goat	3	3	4	2	1		3		4	4	2	3		
LPPNB/PPNC	F	Goat	4	3	4	3	2	4	3		4	2	3	3	3	3
LPPNB/PPNC	F	Goat		3	3	4	3	4		4	4	2	3	4	3	
LPPNB/PPNC	F	Goat	4	4	3	2	3	4	4	4	3	4	3	4	2	
LPPNB/PPNC	F	Goat/Sheep		2	2	2	2	4	3	2	4	1	3	3	2	
LPPNB/PPNC	F	Goat/Sheep	2	1	3	3		4	3	3	3	1	1	3	2	2
LPPNB/PPNC	F	Goat/Sheep	2	1	2	2	2	2	3	3	3	3	4	2	1	
LPPNB/PPNC	F	Goat/Sheep		2	1	1	2	4	1	1			3	2	3	
LPPNB/PPNC	F	Goat/Sheep	3	1	3	3	4	3	3	3	3	1	3	1	1	2
LPPNB/PPNC	F	Goat/Sheep	3	3	1	2	3	4	2	2	2	2	3	2	2	2
LPPNB/PPNC	F	Sheep	2	1	3	1	3	4	3	2		2	2	1		
LPPNB/PPNC	F	Sheep	1	1	2	2	2	4	2	1	3		2	2	2	
LPPNB/PPNC	F	Sheep		1	2	1	1	3	2	2	2	2	1	3	3	2
LPPNB/PPNC	F	Sheep	3	2	2	1		2	1	2		1	2	1	3	
LPPNB/PPNC	F	Sheep		1	3	1	2	1	2	1	2	1	2	1	1	2
PPNC	F	Goat	4	3	3	3	2	4	4	3	4	4	4	3	3	2
PPNC	F	Goat	4	4	2	4		3	3		3	2	4			3

Table A.5: Principal Components Analysis Score Counts for 'Ain Ghazal Caprine Tibiae

Phase	Fusion	Species	K1	K2	K3	K4	K5	K6	K7	K8	K9	K1	K11	K12	K13	K14
PPNC	F	Goat	3	4	3	3	2	4	4	3	4	4	2	4	2	2
PPNC	F	Goat	4	3	4	4		4	4	3	4	3	3	3	3	2
PPNC	F	Goat	4	4	2	3	2	4	4	3	2	2	4	3	3	3
PPNC	F	Goat		3	4	2	3	4	4	3	4		2	4	3	
PPNC	F	Goat	3	3	4	3		4	3	3	4	3	4	3	3	3
PPNC	F	Goat		3	3	3		4	3	3	4	4	2	3	4	
PPNC	F	Goat	4	4	3	3	2	4	4	4	3	4	3	3	4	3
PPNC	F	Goat	3	3	3	4	3	4	4	2	3	2	4	3	4	2
PPNC	F	Goat/Sheep	3	2	4	3	1	4	3	3	4	3	3	3		2
PPNC	F	Goat/Sheep		3	2	2	3	4	2	3	4		2	3	3	2
PPNC	F	Goat/Sheep	2	2	2		2	4		3	3	3		2	1	
PPNC	F	Goat/Sheep	3	2	2		1	4	1	3	2	3	3	3	3	
PPNC	F	Goat/Sheep		1	3	2	2	1	1	2			1	1	1	
PPNC	F	Goat/Sheep		2	2	2		3	2	3		2	3	2	2	2
PPNC	F	Goat/Sheep	3	2	3	2		3	3	4	4	1	2	1	2	
PPNC	F	Goat/Sheep	3	1	1	3		4	2	3	2	3	4	4		2
PPNC	F	Goat/Sheep		2	3	2		4	3	1		2	3	2	2	1
PPNC	F	Goat/Sheep		1	3	2		4	3	3	3		1	2	2	
PPNC	F	Goat/Sheep	3	1	2	3	3	4	4	3	4	2	4	3	2	
PPNC	F	Sheep	2	1	3	3		2	2	3	2	1	3	1	2	1
PPNC	F	Sheep	2	2	3	2	1	3				2	3	1		
PPNC	F	Sheep	1	2	4	2	2	3	1	4	3	3	2	2		1
PPNC	F	Sheep		2	2	1	2	3	1	2	1	3	1	1	1	
PPNC	F	Sheep			1		4			2	4		1	2	1	1
PPNC	F	Sheep	2	1	3	2		4	1	2	1	2	2		2	
PPNC	F	Sheep	2	1	4	2	1	4	1	2	3	2	1	3	2	1
PPNC	F	Sheep	2	1	3	1	1	4	2	3		2	4	3	2	2
PPNC	F	Sheep	2	1	3	1	2	3	2	3	3	1	3	2	2	1
PPNC	F	Sheep	1	2	1	1	2	3	3	2	2	2	1	2	1	
PPNC	F	Sheep		2	2	2	1	3	2	2				1	2	2
PPNC	F	Sheep		2	3	1	2	3	2	3	2	2	3	2	3	2
PPNC	F	Sheep		3	2	1	1	2	3	2	2		2	1	2	1
PPNC	F	Sheep	2	1	2	1	2	1	1	2	1	1	1	1	2	
PPNC	F	Sheep	2	1	2	2	2	3	2	3	1	1	3	2	2	2
PPNC	F	Sheep	2	1	2			4	3	2	2		1	2	2	2
PPNC	F	Sheep	2	2	3	1	2	2	1	1	2	2	1	1	1	1
PPNC	F	Sheep		1	1	1	2	4	3	3	1	1	1	2	2	
PPNC	F	Sheep	1	2	3	1	2	3	4	3	3	2	3	1	1	
PPNC	F	Sheep			2	2	2	2	1	2	2		1	2	1	
PPNC	fg	Goat	4	3	3	2	3	4	3	3	3	3	3	3	2	2
PPNC	fg	Goat/Sheep	3	1	2			4		1	3	3	1	2	1	
PPNC	fg	Goat/Sheep		3	3	2	3	3	3	3	4	2	2	3	3	2
PPNC	fg	Goat/Sheep	2	3	3	2	1	4	3	3	3	2	3	2	2	1
PPNC	uf	Goat/Sheep	3	1	1			3		2		1	3	2	1	
PPNC	uf	Goat/Sheep	1	2	2	1	4				4	1	1	3	1	
PPNC	uf	Sheep	2	2	2		1	4		1	2	2		2	1	
PPNC	uf	Sheep		1	1		3	3		2	2		2	2	2	
PPNC	uf	Sheep			3		2	4		3	2	2		2	2	
PPNC	uf	Sheep	2	1	2			4		2	4	2	2	2	2	
Yarmoukian	F	Goat		3	4	3	2	4	3	4	4		2	3	3	2
Yarmoukian	F	Goat	4	3	2	3	1	3	4	3	4	2	3	2	3	3
Yarmoukian	F	Goat	3	3	4	3		3	3	4	3	3	2	2	4	3
Yarmoukian	F	Goat			4	3		4		3	4	3	3	3	3	
Yarmoukian	F	Goat		4	4	3	1	4	3	3	4	4	2	4	2	2
Yarmoukian	F	Goat/Sheep		3		2	2	3	3			3	3	3		
Yarmoukian	F	Goat/Sheep		2	3	4	2	2	2	3			4	1	2	
Yarmoukian	F	Goat/Sheep	3	2	4	3		4	4	2		3	3	2		2
Yarmoukian	F	Goat/Sheep	4	4	2	2			2	4	4	3	3	2	2	3
Yarmoukian	F	Goat/Sheep	2		1	3		4			3	2	4	3	2	2

Table A.5: Principal Components Analysis Score Counts for 'Ain Ghazal Caprine Tibiae

Phase	Fusion	Species	K1	K2	K3	K4	K5	K6	K7	K8	K9	K1	K11	K12	K13	K14
Yarmoukian	F	Goat/Sheep	4	3	2	2		3	2			1	4	1	3	3
Yarmoukian	F	Goat/Sheep		3	4	2		2	3	4	3	3	2	3	3	
Yarmoukian	F	Goat/Sheep			3	3	1		3	3			4	3	2	
Yarmoukian	F	Goat/Sheep			2	1		4	4		3		3	3	2	
Yarmoukian	F	Goat/Sheep		2	4	2		4	2	1		3	4		2	
Yarmoukian	F	Goat/Sheep	3	3	2	2	2	3	3	2		2	1		3	
Yarmoukian	F	Sheep	3	2	1	2	2	2	2	3		1	2	2		1
Yarmoukian	F	Sheep	2	1	2	2	1	3	2	3	2	2	1	1	2	
Yarmoukian	F	Sheep		2	3	1	2	2	2	1		1	1	2		
Yarmoukian	F	Sheep	2	2	1	1	1	2	2	3		2	2	2	1	1
Yarmoukian	F	Sheep		2	1	1	2	3	2	2	3		3	3	2	2
Yarmoukian	F	Sheep		2	4	2	3	4	2	1	3	2	1	1	2	
Yarmoukian	F	Sheep		2	3	2		3	2	3	3		1	2	2	2
Yarmoukian	F	Sheep	2	1	3	2		2	2	2	4	2	1	2		1
Yarmoukian	F	Sheep		2	1	1		4	3	1	3	2	1	3	1	1
Yarmoukian	F	Sheep		2	2	1		4	2	1	1	1	1	3	1	
Yarmoukian	F	Sheep	2	1	2			2	3	2		2	2	1	3	
Yarmoukian	F	Sheep	1			2		3	1	2	2		2	2	2	1
Yarmoukian	F	Sheep		1	3	3		4	3	2		2	2	2	2	
Yarmoukian	F	Sheep	2	1	4	2	1	2	1	2	4	2	3	1	2	1
Yarmoukian	uf	Goat/Sheep	4	3	3		1	4	2	3			3	2	3	3
Yarmoukian	uf	Goat/Sheep	3	2	1		4	2	2	2	3	3	2	3		

Table A.5: Principal Components Analysis Score Counts for 'Ain Ghazal Caprine Tibiae

Phase	Species	B51	B62	B63	B64	PF26	PF27	PF28
MPPNB	Goat	4	3	4	3	2	2	4
MPPNB	Goat	4	3	2	2	3	3	4
MPPNB	Goat	4	3	3	2	3	3	
MPPNB	Goat	4	4	3	3	2	4	4
MPPNB	Goat	3	4	3	3	4	4	4
MPPNB	Goat	4	4	3	3	4	4	4
MPPNB	Goat	4	4	3	4	3	3	
MPPNB	Goat	3	3	1	3	3	2	4
MPPNB	Goat	4	3	2	4	4	3	4
MPPNB	Goat	4	3		4	4	2	
MPPNB	Goat	4	2	2	4	3	3	4
MPPNB	Goat	4	4	3	3	3	2	4
MPPNB	Goat	4	3	4	2	2	2	4
MPPNB	Goat	4	4	4	3	4	3	4
MPPNB	Goat	4	3	2	3	3	4	4
MPPNB	Goat	3	4	3	4	3	2	4
MPPNB	Goat	4	3	4	4	3	4	1
MPPNB	Goat	4	3	3	4	2	4	1
MPPNB	Goat	4	3		4	3	3	
MPPNB	Goat	3	4	4		3	3	4
MPPNB	Goat	4	4	3	3	3	3	4
MPPNB	Goat	3	4	3	4	3	3	4
MPPNB	Goat		3	3	3	2		4
MPPNB	Goat	3	3	3	4	2	2	4
MPPNB	Goat	3		4	4		2	4
MPPNB	Goat		3	4	4	2		4
MPPNB	Goat		3			2		
MPPNB	Goat	3	3	2	3	2	3	1
MPPNB	Goat	4	3		4	3	2	
MPPNB	Goat	4	3	3	4	2	3	4
MPPNB	Goat			3	4			4
MPPNB	Goat	3	3	3	3	3		
MPPNB	Goat	3			4			
MPPNB	Goat			2				4
MPPNB	Goat		3		4			
MPPNB	Goat	4						4
MPPNB	Goat	4	4	1	3	3	4	4
MPPNB	Goat	4	4	3	3	3	4	4
MPPNB	Goat		4	2	3			4
MPPNB	Goat		4	4	4	3		4
MPPNB	Goat	4	4	2	4	3	4	1
MPPNB	Goat	3			4			
MPPNB	Goat	3		3	4			4
MPPNB	Goat			3	3			
MPPNB	Goat	4	4	4	3	3	4	4
MPPNB	Goat	4	3	4	4	4		
MPPNB	Goat		3	2	3	4		4
MPPNB	Goat		4	3	3	2	4	4
MPPNB	Goat	4	4	4	3	3	4	4
MPPNB	Goat	3	3	2	3	2	3	4
MPPNB	Goat/Sheep		2			2		
MPPNB	Sheep	1	2	1	1	2	2	1
LPPNB	Goat	3	4	2	3	3	2	4
LPPNB	Goat	4	4	3	3	2	4	4
LPPNB	Goat		3	2	4	2		
LPPNB	Goat		3	4	4	2		4
LPPNB	Goat	4	4	3	2	4	3	4
LPPNB	Goat	3	4	4	3	2	3	4
LPPNB	Goat	3		3	4			4

Table A.6: Principal Components Analysis Score Counts for 'Ain Ghazal Caprine Astragali

Phase	Species	B51	B62	B63	B64	PF26	PF27	PF28
LPPNB	Goat	3	4	3	3	4		4
LPPNB	Goat	4		3	4		4	4
LPPNB	Goat	4	4	3	3	4	4	4
LPPNB	Goat	3	2	4	4		2	4
LPPNB	Goat	3	3	3	4	2	2	4
LPPNB	Goat/Sheep	2	3	3	3	2		4
LPPNB	Goat/Sheep	2	2	1	3	1	3	1
LPPNB	Sheep	1	1	2	2	1		1
LPPNB	Sheep	1	2	3	2	2	3	1
LPPNB	Sheep	2	1		1	1		
LPPNB	Sheep	1	2	2	1	3	1	1
LPPNB	Sheep	3	1	2	2	2	3	1
LPPNB	Sheep	2	1	2	2	1	2	3
LPPNB	Sheep	2	1	1	2	1	2	1
LPPNB/PPNC	Goat	4	4	2	3	3	3	4
LPPNB/PPNC	Goat	3	4	2	3	2	3	4
LPPNB/PPNC	Goat	4	3	3	3	2	4	4
LPPNB/PPNC	Goat	3	3	3	4	2	3	4
LPPNB/PPNC	Sheep	3	1	1		2	2	1
LPPNB/PPNC	Sheep	2	2	1	2	3	1	1
LPPNB/PPNC	Sheep	2	2	2	1	3	2	2
LPPNB/PPNC	Sheep	2	2	2	1	2		1
LPPNB/PPNC	Sheep	2	1	2	2	1	2	1
LPPNB/PPNC	Sheep	1	1	2	2	1	3	1
LPPNB/PPNC	Sheep	1	1	1	2	1	2	1
LPPNB/PPNC	Sheep	2	1	2	1	1	2	1
LPPNB/PPNC	Sheep	1	2	2	1	1	2	1
PPNC	Goat		3	3	2	2		4
PPNC	Goat	4	4	2	3	3	4	3
PPNC	Goat	4	3	3	3	4	4	4
PPNC	Goat	4	4	2	4	3	4	
PPNC	Goat	4	2	3	4	2	4	4
PPNC	Goat	4	2	3	3	2	4	
PPNC	Goat	4	3	3	4	4	4	4
PPNC	Goat	4	4		4	3	3	
PPNC	Goat			3	4			4
PPNC	Goat	4	4	2	3	3	4	4
PPNC	Goat	3	2	3	3	3	3	4
PPNC	Goat	3	3	2	3	2	3	
PPNC	Goat	4	3	2	4	2	4	4
PPNC	Goat	3	4	3	4	4	3	4
PPNC	Goat	4	3	3		3	4	4
PPNC	Goat	4	4	2	3	4	3	4
PPNC	Goat		4	4	3	3		
PPNC	Goat	4	3	3	3	4	4	3
PPNC	Goat	4	3	4	4	2	4	4
PPNC	Goat	4	4	4	4	4	4	3
PPNC	Goat	4	4	2	3	2	4	4
PPNC	Goat	3	3	3	4	4	3	4
PPNC	Goat	4	4	2	4	4	4	4
PPNC	Goat	3	4	2	3	3	4	4
PPNC	Goat	3	3	3	3	3	3	4
PPNC	Goat/Sheep	3	3		1	2	2	1
PPNC	Goat/Sheep				2			1
PPNC	Goat/Sheep	4	2		3		2	
PPNC	Goat/Sheep		1	1				
PPNC	Goat/Sheep		3			4		
PPNC	Goat/Sheep			2	4			4
PPNC	Goat/Sheep	2	2	3	3			4

Table A.6: Principal Components Analysis Score Counts for 'Ain Ghazal Caprine Astragali

Phase	Species	B51	B62	B63	B64	PF26	PF27	PF28
PPNC	Goat/Sheep			3				4
PPNC	Goat/Sheep	3	3	2	2	1	2	1
PPNC	Goat/Sheep	2	2	3	1		2	1
PPNC	Goat/Sheep	2	1	3		1	2	
PPNC	Goat/Sheep	1	3	1		3		1
PPNC	Goat/Sheep	2	3	1	2	2	3	4
PPNC	Sheep	1	1	2	2	1	2	1
PPNC	Sheep	2	1		2	1	3	
PPNC	Sheep	1	2	1	2	2	2	4
PPNC	Sheep	1	3	1	1	2	3	4
PPNC	Sheep	1	1	2	3	1	2	1
PPNC	Sheep	1	1	1	1	1	2	1
PPNC	Sheep	2		1	2		1	4
PPNC	Sheep	1	1	2		1		1
PPNC	Sheep	2	1	1	2	1	2	1
PPNC	Sheep	2	2	1		1		1
PPNC	Sheep	1	1	1	1	1		
PPNC	Sheep	2	1	2	2	1	1	
PPNC	Sheep	1	1	1	1	1	2	1
PPNC	Sheep	2	2	1	2	2	2	1
PPNC	Sheep	2	2		3	2	1	
PPNC	Sheep	1	1	1	2	1	2	1
PPNC	Sheep	2	1	1	1	1	2	1
PPNC	Sheep	1	1	2	1	1	2	1
PPNC	Sheep	3	1	2	2		3	1
PPNC	Sheep	2	2	1	2	1	2	1
PPNC	Sheep	2	2	1	2	2	2	1
PPNC	Sheep	3	1	1	1	1	3	1
PPNC	Sheep	1	1	1	1	1	2	1
PPNC	Sheep	2	1	1	1	1	2	1
PPNC	Sheep	1	1	2	1	1	2	1
PPNC	Sheep		1	1	1	1		1
PPNC	Sheep		1	1				1
PPNC	Sheep	2	2	1	2	2	2	1
PPNC	Sheep	1	2	2	1	2	1	1
PPNC	Sheep	1	2	1	2		2	1
PPNC	Sheep	2	2		1	1	1	
PPNC	Sheep	2	3	2	2	1	2	
PPNC	Sheep	2	1	1	1	1	2	1
PPNC	Sheep	2	2	1	3	2	2	1
PPNC	Sheep	2	2	2	1	1	2	1
PPNC	Sheep		1	3	2	1		
PPNC	Sheep	3	2	1	2	1	3	2
PPNC	Sheep	2	2	2	1	3	3	1
PPNC	Sheep		1	2	1	1		1
PPNC	Sheep	3	2	1	3	2	2	1
PPNC	Sheep	1	2	1	1	1	2	1
PPNC	Sheep	2	2	2	1	2	1	1
PPNC	Sheep	1		1	2			1
PPNC	Sheep	3	2	2	1	1	3	1
PPNC	Sheep	1	1	3	1	1	2	1
Yarmoukian	Goat	4	4	3	4	2	4	4
Yarmoukian	Goat	3	3	3	3		4	4
Yarmoukian	Goat	3	3	3	4	2	3	4
Yarmoukian	Goat	3		4	4		3	4
Yarmoukian	Goat	3	2	3	3	3	3	4
Yarmoukian	Goat		3	3	3	3		4
Yarmoukian	Goat	3	4	2	2	4	4	
Yarmoukian	Goat	3	3	3	4	3	4	4

Table A.6: Principal Components Analysis Score Counts for 'Ain Ghazal Caprine Astragali

Phase	Species	B51	B62	B63	B64	PF26	PF27	PF28
Yarmoukian	Goat	4	4	4	4	2	3	4
Yarmoukian	Goat	3	3	4	4	3	2	4
Yarmoukian	Goat	4	4	2	3	3	4	3
Yarmoukian	Goat	3	4	3	4	4	4	2
Yarmoukian	Goat/Sheep	4	2	4	3	3	3	1
Yarmoukian	Goat/Sheep		3	2		3		1
Yarmoukian	Goat/Sheep		2	3	3	2		4
Yarmoukian	Goat/Sheep	3	2	1	3	3	3	
Yarmoukian	Goat/Sheep	4		3	2		4	2
Yarmoukian	Sheep	1	1	2	1	1	2	1
Yarmoukian	Sheep	1	2	1	1	1	1	1
Yarmoukian	Sheep	2	3	2	1	2	2	1
Yarmoukian	Sheep	1	1	1	2	1	1	1
Yarmoukian	Sheep	2	2	1		1	2	1
Yarmoukian	Sheep	1	2	2	1	1	2	2
Yarmoukian	Sheep	2	1	2	2	1	3	1
Yarmoukian	Sheep	1	1	1	2	1	2	1
Yarmoukian	Sheep	2	2	1	2	1	1	1
Yarmoukian	Sheep	2	2	1	1	2	3	1
Yarmoukian	Sheep	1	1	2	1	1		1
Yarmoukian	Sheep	1	1	1	1	1	2	
Yarmoukian	Sheep	1	2	1	1	1		1
Yarmoukian	Sheep	3	1	3	1	1	3	1
Yarmoukian	Sheep	3	2	2	2		3	
Yarmoukian	Sheep	2	1	2	1	1	2	1
Yarmoukian	Sheep	1	2	2	2	1	2	1
Yarmoukian	Sheep	1	2	1	2	1	2	1
Yarmoukian	Sheep	3	2	1	1		2	1
Yarmoukian	Sheep	3	1	2	1	1	2	1
Yarmoukian	Sheep		1	1	2	2		1
Yarmoukian	Sheep		1	2	2			1
Yarmoukian	Sheep		2	1		1		4
Yarmoukian	Sheep	2	2	2	1	2	3	4
Yarmoukian	Sheep	1	1	2	1	1	3	1
Yarmoukian	Sheep	2	1	1	1	1		1
Yarmoukian	Sheep	2		1	2			1
Yarmoukian	Sheep	1	2	1	1	2	4	1

Table A.6: Principal Components Analysis Score Counts for 'Ain Ghazal Caprine Astragali

Phase	Fusion	Species	B65	B66	B68	B401	B402	B403	PF29	PF30
MPPNB	?	Goat		4	4					4
MPPNB	?	Goat			4					4
MPPNB	?	Goat			3				3	
MPPNB	F	Goat	4		3	3	3	3	4	4
MPPNB	F	Goat	4	3	4	4	3	4	4	4
MPPNB	F	Goat	2	4	4	4	3	4	4	3
MPPNB	F	Goat	3	4	4	4	2	4	4	4
MPPNB	F	Goat	3	3	4	3	4	2	3	4
MPPNB	F	Goat	4	3	4	4	3	3	3	4
MPPNB	F	Goat	4			3	3	3	4	
MPPNB	F	Goat	3	3	4	3	4	3	4	4
MPPNB	F	Goat/Sheep		3	1	3	1	2	3	1
MPPNB	uf	Goat		3	4	4	3	3	4	4
MPPNB	uf	Goat		3	3				3	4
MPPNB	uf	Goat		3	3	3	1	2	3	3
MPPNB	uf	Goat		4	4	3	2	3	3	3
MPPNB	uf	Goat		4	3		3	2	3	3
MPPNB	uf	Goat		3	4	3	1	2	3	4
MPPNB	uf	Goat		4	4	3	2	2	3	4
MPPNB	uf	Goat		4	4	4	2	4	4	4
MPPNB	uf	Goat			4	2	2	3	4	4
MPPNB	uf	Goat		4	4			3		4
MPPNB	uf	Goat/Sheep			3	3	2	1	2	3
MPPNB	uf	Goat/Sheep				2	1	2	3	
MPPNB	uf	Goat/Sheep				2	3	2	2	
MPPNB	uf	Goat/Sheep		4	2	2	2	2	3	3
LPPNB	?	Goat		4	4					4
LPPNB	?	Goat		4	4					4
LPPNB	?	Goat/Sheep		3						3
LPPNB	F	Goat	2			4	3	4	4	
LPPNB	F	Goat	3	4	4	4	3	4	4	4
LPPNB	F	Goat	4	3	4	3	3	4	4	3
LPPNB	fg	Goat	2	4	3	4	2	4	3	4
LPPNB	fg	Goat/Sheep	3			2			2	
LPPNB	uf	Goat		3	4	3	3	4	4	4
LPPNB	uf	Goat/Sheep					1		3	2
LPPNB	uf	Goat/Sheep		3	4	2	2	3	2	4
LPPNB	uf	Sheep			1	2	2	2	2	2
LPPNB	uf	Sheep		1	1	3	1	2	2	3
LPPNB/PPNC	?	Sheep		2	2					2
LPPNB/PPNC	F	Goat/Sheep	3	1		4	2	4	3	
LPPNB/PPNC	F	Sheep	2		1	3	1	3	2	2
LPPNB/PPNC	uf	Goat/Sheep		2				3	3	3
LPPNB/PPNC	uf	Sheep				1	1	2	3	
PPNC	?	Goat		4	3					4
PPNC	?	Goat		3	4					3
PPNC	?	Goat/Sheep		3	3					
PPNC	?	Sheep		1	1					3
PPNC	?	Sheep		2	1					1
PPNC	?	Sheep		2	1					
PPNC	?	Sheep		2	2		1	2		1
PPNC	F	Goat	3	4	4	4	2	3	3	3
PPNC	F	Goat	4	3	4	4	4	4	4	4
PPNC	F	Goat	3	4	4	3	2	4	4	4
PPNC	F	Goat	3	2	4	3	2	4	4	4
PPNC	F	Goat	3	4	3	3	2	3	3	4
PPNC	F	Goat	4	4	4	3	2	3	3	4
PPNC	F	Goat			4	3	2	3	4	4
PPNC	F	Goat/Sheep	3	3	1	4	2	3	3	1

Table A.7: Principal Components Analysis Score Counts for 'Ain Ghazal Caprine Calcanea

Phase	Fusion	Species	B65	B66	B68	B401	B402	B403	PF29	PF30
PPNC	F	Goat/Sheep	2			3	3	4	3	
PPNC	F	Sheep	1	3	4	2	2	1	1	
PPNC	F	Sheep	2	1	1	3	2	2	2	1
PPNC	F	Sheep	2	1	1	2	2	3	3	1
PPNC	F	Sheep	2	2	3	1	2	2	2	
PPNC	F	Sheep	2	1	1	3	1	3	2	1
PPNC	F	Sheep	2	1	2	3	1	3	2	3
PPNC	F	Sheep	3	2	2	2	2	3	2	2
PPNC	F	Sheep		2	3		2	3	2	2
PPNC	F	Sheep	2	2	2	3	1	3	2	1
PPNC	F	Sheep	3	1	3	3	2	3	1	2
PPNC	F	Sheep	2	2	1	3	1	2	2	2
PPNC	F	Sheep	2	2	1	2	1	3	4	1
PPNC	uf	Goat		4	4	3	2	3	3	3
PPNC	uf	Goat		3	4		3	2	2	4
PPNC	uf	Goat		4	3	2	2	2	3	4
PPNC	uf	Goat/Sheep				2	2	2	3	
PPNC	uf	Goat/Sheep				2	1	2	2	
PPNC	uf	Goat/Sheep		1	1					1
PPNC	uf	Goat/Sheep		2	3		3	2	1	3
PPNC	uf	Sheep		3	2	2	1	2	1	1
PPNC	uf	Sheep		3	1	2	2	1	1	1
PPNC	uf	Sheep			1	1	1	1	1	1
PPNC	uf	Sheep			2	2	2	1	2	2
PPNC	uf	Sheep			2	1	1	1	2	2
PPNC	uf	Sheep		2	3	1	1	2	3	3
PPNC	uf	Sheep		1	2	2	2	1	1	3
PPNC	uf	Sheep				2	2		2	3
Yarmoukian	?	Goat		3	4					3
Yarmoukian	?	Goat/Sheep		2	2					3
Yarmoukian	?	Sheep		3	1					1
Yarmoukian	F	Goat			4	3	2	3	3	4
Yarmoukian	F	Goat	3	3	4	4	4	4	3	3
Yarmoukian	F	Goat	2	3	4	2	1	3	3	4
Yarmoukian	F	Goat	4	4	3	4	2	4	3	3
Yarmoukian	F	Goat	3			4	3	4	4	3
Yarmoukian	F	Goat/Sheep	2	3		3	2	2	2	2
Yarmoukian	F	Goat/Sheep	3	4		3	2	4	3	3
Yarmoukian	F	Sheep	3	1	1	4	1	3	2	1
Yarmoukian	F	Sheep	2	2	1	2	3	1	3	1
Yarmoukian	F	Sheep	2		2	2	2	2	2	1
Yarmoukian	F	Sheep	2	1	1	3	2	2	2	1
Yarmoukian	F	Sheep	2	1	1	2		3	3	2
Yarmoukian	F	Sheep	2	1	3	3	1	3	2	3
Yarmoukian	F	Sheep	1			3	2	2	2	
Yarmoukian	F	Sheep	3	2	1	4	2	3	1	1
Yarmoukian	F	Sheep	3	2	1	3	1	3	2	1
Yarmoukian	F	Sheep	3	2	2	3	1	2	2	1
Yarmoukian	uf	Goat/Sheep		4		2	1	2	3	3
Yarmoukian	uf	Goat/Sheep			2	2	1	1	2	2
Yarmoukian	uf	Goat/Sheep		3	4	2	3	2	2	4
Yarmoukian	uf	Goat/Sheep		3	3	3	1	2	3	3
Yarmoukian	uf	Goat/Sheep		3	2		2	2	2	3
Yarmoukian	uf	Sheep		2	1	2	1	2	2	1
Yarmoukian	uf	Sheep		3	1		1	2	1	1
Yarmoukian	uf	Sheep		3	1		2	1	1	1

Table A.7: Principal Components Analysis Score Counts for 'Ain Ghazal Caprine Calcanea

Phase	Fusion	Species	B305	B306	B307	B308	B309
MPPNB	?	Goat	3	3			
MPPNB	F	Goat	3	2	3	2	3
MPPNB	F	Goat	3	4	2	2	3
MPPNB	F	Goat	4	4	2	3	3
MPPNB	F	Goat	4	3	3	2	3
MPPNB	F	Goat	4	4	2	2	3
MPPNB	F	Goat	3	4	3	3	3
MPPNB	F	Goat	3	4	3	2	2
MPPNB	F	Goat	3	4	3	2	4
MPPNB	F	Goat	4	4	3	2	3
MPPNB	F	Goat	4	3	3	2	3
MPPNB	F	Goat	3	3		2	
MPPNB	F	Goat	4	4	3	2	4
MPPNB	F	Goat	3	2		2	
MPPNB	F	Goat	2	4			
MPPNB	F	Goat	3	2	3	3	3
MPPNB	F	Goat	3	3	3	2	4
MPPNB	fg	Goat	3	3	4	2	3
MPPNB	fg	Goat	2	3	4		4
MPPNB	fg	Goat	3	2	3	3	2
MPPNB	uf	Goat	3	3			
MPPNB	uf	Goat	4	3			
MPPNB	uf	Goat	3	4			
MPPNB	uf	Goat	4	2			
MPPNB	uf	Goat	3	3	2		
MPPNB	uf	Goat	2	2	3	2	
LPPNB	F	Goat	3	3	3		2
LPPNB	F	Goat	4	2	3	2	3
LPPNB	F	Goat	3	2	4	3	3
LPPNB	F	Goat	3	2	4	3	
LPPNB	F	Goat	3	2	3	3	4
LPPNB	F	Goat	4	3	3	4	3
LPPNB	fg	Goat	3	2	2		
LPPNB	uf	Goat	4	3			
LPPNB	uf	Goat	4	2			
LPPNB	uf	Goat	2	4			
LPPNB	uf	Goat	4	2	3		
LPPNB	uf	Goat	3	2	2		
LPPNB/PPNC	?	Sheep	2	1	2		
LPPNB/PPNC	F	Goat	3		3		2
LPPNB/PPNC	F	Goat	3	2	4	2	3
LPPNB/PPNC	F	Goat	4	3	3		
LPPNB/PPNC	F	Goat	3	2	3		3
LPPNB/PPNC	F	Sheep	2	2	1	1	1
LPPNB/PPNC	F	Sheep	2	2	2	1	1
LPPNB/PPNC	F	Sheep	3	1	2	1	
LPPNB/PPNC	F	Sheep	2	2	1		
LPPNB/PPNC	uf	Goat	3	2	3		
LPPNB/PPNC	uf	Sheep	2	1	2		
LPPNB/PPNC	uf	Sheep	3	2			
PPNC	F	Goat	2	4	3	3	4
PPNC	F	Goat	4	3	3	2	3
PPNC	F	Goat	3	3	3		4
PPNC	F	Goat	4	3	4		3
PPNC	F	Goat	4	3	4		3
PPNC	F	Goat	2	4			
PPNC	F	Goat	4	2	3	2	
PPNC	F	Goat	4	2	3	3	
PPNC	F	Goat	4	4	3	2	2

Table A.8: Principal Components Analysis Score Counts for 'Ain Ghazal Caprine Metatarsals

Phase	Fusion	Species	B305	B306	B307	B308	B309
PPNC	F	Sheep	3	1	2	1	2
PPNC	F	Sheep	2	1			
PPNC	F	Sheep	3	1	2	1	1
PPNC	F	Sheep	3	3	1	2	1
PPNC	F	Sheep	3	2	2	2	1
PPNC	F	Sheep	2	2	1	1	1
PPNC	F	Sheep	2	1	1		1
PPNC	F	Sheep	2	1	3		
PPNC	F	Sheep	3	1	2		
PPNC	F	Sheep	2	2	1		
PPNC	F	Sheep	3	1	2		1
PPNC	F	Sheep	3	1	2	2	2
PPNC	F	Sheep	2	1	2		1
PPNC	F	Sheep	3	1	1	2	1
PPNC	F	Sheep	3	2	2	2	2
PPNC	F	Sheep	2	1	2	2	2
PPNC	F	Sheep	2	1	2	1	1
PPNC	fg	Goat	3	3	2	3	4
PPNC	uf	Goat	3	3	3		
PPNC	uf	Goat	3	2	4		
PPNC	uf	Goat	4	3	4		
PPNC	uf	Sheep	2	2	2		
PPNC	uf	Sheep	2	2			
PPNC	uf	Sheep	2	1	2		
PPNC	uf	Sheep	2	2	1		
PPNC	uf	Sheep	3	1	2		
PPNC	uf	Sheep	3	1	1	2	
PPNC	uf	Sheep	2	2			
PPNC	uf	Sheep	3	1	1		
Yarmoukian	F	Goat	3	3	2	2	4
Yarmoukian	F	Goat	3	4	3	2	4
Yarmoukian	F	Goat	3	4	3	2	2
Yarmoukian	F	Goat	4	3	4	3	4
Yarmoukian	F	Goat	3	3	2	3	3
Yarmoukian	F	Goat	3	3	3	2	4
Yarmoukian	F	Goat	2	1	3	3	3
Yarmoukian	F	Goat	4	3	3	4	3
Yarmoukian	F	Goat	4	4	4		
Yarmoukian	F	Sheep	3	3	2	2	1
Yarmoukian	F	Sheep	2	2	2	2	1
Yarmoukian	F	Sheep	2	1	3		
Yarmoukian	F	Sheep	3	2	2		1
Yarmoukian	F	Sheep	1	2	2	1	1
Yarmoukian	F	Sheep	2	1	1		
Yarmoukian	F	Sheep	2	2	1	3	1
Yarmoukian	F	Sheep	2	1	2		
Yarmoukian	F	Sheep	2	1	2	2	1
Yarmoukian	F	Sheep	3	2	2	1	2
Yarmoukian	F	Sheep	3	2	1	1	2
Yarmoukian	F	Sheep	3	2	2	2	1
Yarmoukian	F	Sheep	2	2	1	2	1
Yarmoukian	F	Sheep	1	1	1	1	1
Yarmoukian	uf	Goat	3	2	4		
Yarmoukian	uf	Goat	2	3	2		
Yarmoukian	uf	Goat	4	3	2		
Yarmoukian	uf	Goat	4	2			
Yarmoukian	uf	Goat/Sheep	2	2	3		
Yarmoukian	uf	Sheep	2	3			
Yarmoukian	uf	Sheep	2	1			

Table A.8: Principal Components Analysis Score Counts for 'Ain Ghazal Caprine Metatarsals

Phase	Fusion	Species	B305	B306	B307	B308	B309
Yarmoukian	uf	Sheep	3	2			
Yarmoukian	uf	Sheep	3	3	1	2	

Table A.8: Principal Components Analysis Score Counts for 'Ain Ghazal Caprine Metatarsals

Phase	Fusion	Species	B500	B73	B501	B502	B75	B74	B76
MPPNB	?	Goat/Sheep	2	2	2				
MPPNB	F	Goat	3	3	4	3	4	1	2
MPPNB	F	Goat	3	3	3	3	4	2	2
MPPNB	F	Goat	3	3	4	4	4	2	2
MPPNB	F	Goat	4	3	4	2	3	1	2
MPPNB	F	Goat	3	4	3	3	2	3	2
MPPNB	F	Goat	2			4	4	3	2
MPPNB	F	Goat	4	4	4	4	3	1	3
MPPNB	F	Goat	2	2		3	3	2	2
MPPNB	F	Goat	3	3		3	4	3	2
MPPNB	F	Goat	3	3	4	4	3	3	2
MPPNB	F	Goat	4	4	4	3	4	1	4
MPPNB	F	Goat	4	3	2	4	4	1	3
MPPNB	F	Goat	3	4	4	4	4	2	2
MPPNB	F	Goat				4	4	2	3
MPPNB	F	Goat	4	3	4	3	4	2	
MPPNB	F	Goat	3			2	4	3	4
MPPNB	F	Goat	3	3	4	3	4	2	3
MPPNB	F	Goat	3	4	3	2	3	2	2
MPPNB	F	Goat	3	4	4	4	2	3	2
MPPNB	F	Goat	3	4	2	2	4	2	2
MPPNB	F	Goat	3	3	4	4	4	2	2
MPPNB	F	Goat	4	3	4	3	2	2	3
MPPNB	F	Goat				3	4	3	3
MPPNB	F	Goat	3			2	4	2	4
MPPNB	F	Goat	2	3	2	4	2	2	3
MPPNB	F	Goat	4	4	3	3	4	2	2
MPPNB	F	Goat	3	3	3	2	4	3	2
MPPNB	F	Goat	3	3	2	2	3	1	2
MPPNB	F	Goat	3	3	2	3			
MPPNB	F	Goat	3	4	4	2	4	2	3
MPPNB	F	Goat				3	3	2	2
MPPNB	F	Goat	3	3	3	2	3	3	3
MPPNB	F	Goat	4	3	4	3	3	2	
MPPNB	F	Goat	4	3	4	3	4	2	2
MPPNB	F	Goat	3	3	2	3	4	3	3
MPPNB	F	Goat	4	4	4	2	3	1	2
MPPNB	F	Goat	2	3	4	2	2	3	1
MPPNB	F	Goat	3	4	4	4	3	3	
MPPNB	F	Goat	4	4	3	2	4	3	3
MPPNB	F	Goat	4	3			4	1	3
MPPNB	F	Goat	2	3		4	4	2	3
MPPNB	F	Goat	3	4	3	3	4	2	3
MPPNB	F	Goat	4	3	3				
MPPNB	F	Goat	3	4	4	4		3	
MPPNB	F	Goat	3	3	3	4	4	4	3
MPPNB	F	Goat	3	3	3	4	4	3	4
MPPNB	F	Goat	4	3	3	3	4	3	3
MPPNB	F	Goat	3	2		3	4	2	2
MPPNB	F	Goat	2	3	2	3	3	3	3
MPPNB	F	Goat	3	3	3	2	3	2	4
MPPNB	F	Goat	2	2	3	3	4	3	3
MPPNB	F	Goat	2	3	3	4	3	3	3
MPPNB	F	Goat	3	4	3	3	4	2	
MPPNB	F	Goat	3	3	4	4	4	3	2
MPPNB	F	Goat	3	4	3	3	4	2	3
MPPNB	F	Goat	3	3	4	3	4	2	4
MPPNB	F	Goat	2	4	3	2	3	3	3
MPPNB	F	Goat	2	3	3	3	3	3	2

Table A.9: Principal Components Analysis Score Counts for 'Ain Ghazal Caprine First Phalanges

Phase	Fusion	Species	B500	B73	B501	B502	B75	B74	B76
MPPNB	F	Goat	3	3	3	2	4	2	4
MPPNB	F	Goat				3	4	3	4
MPPNB	F	Goat	3	2	2	3	4	2	2
MPPNB	F	Goat	3	4	4	2	3	3	2
MPPNB	F	Goat	3	3		3	4	3	3
MPPNB	F	Goat	2	4	2	3	3	3	2
MPPNB	F	Goat	3	3	4	3	4	2	4
MPPNB	F	Goat/Sheep	3	3		1	2	2	3
MPPNB	F	Goat/Sheep	2	3		2	2	2	2
MPPNB	F	Goat/Sheep	3	3					
MPPNB	F	Goat/Sheep	3	3	3	2	2		
MPPNB	F	Goat/Sheep	2	2					
MPPNB	F	Goat/Sheep	3	3	4				
MPPNB	F	Goat/Sheep	4	3	2	2	3	1	
MPPNB	F	Goat/Sheep	3	3		2			
MPPNB	F	Goat/Sheep	2	3	2	2	3	3	2
MPPNB	F	Goat/Sheep	2	3		1			
MPPNB	F	Goat/Sheep	2	2	3	3			
MPPNB	F	Goat/Sheep	3	2		3	2	3	3
MPPNB	F	Goat/Sheep	2	3	3	3	3	2	1
MPPNB	F	Goat/Sheep	2	3	3	2	2	2	2
MPPNB	F	Goat/Sheep				3	3	3	1
MPPNB	F	Goat/Sheep	3	3	2	2			
MPPNB	F	Goat/Sheep				1	2	2	3
MPPNB	F	Goat/Sheep	3	3	2				
MPPNB	F	Goat/Sheep	3	3	2	2	4	2	3
MPPNB	F	Goat/Sheep	3	3	2				
MPPNB	F	Goat/Sheep	3	3	3	2		3	
MPPNB	F	Goat/Sheep	3	4	3				
MPPNB	F	Goat/Sheep	3	4	2			2	
MPPNB	fg	Goat	2	3	3	2	3	2	1
MPPNB	fg	Goat	3	3	2	1	3	2	4
MPPNB	fg	Goat/Sheep	2	3	2	1	1	2	
MPPNB	fg	Goat/Sheep	3	3	2	1	2	1	2
MPPNB	uf	Goat/Sheep	3	3					
MPPNB	uf	Goat/Sheep	2	2					
MPPNB	uf	Goat/Sheep	2	2	2				
MPPNB	uf	Goat/Sheep	3	3	2				
MPPNB	uf	Goat/Sheep	2	2					
MPPNB	uf	Goat/Sheep	2	2					
MPPNB	uf	Goat/Sheep	4	3					
LPPNB	F	Goat	3	3		2	3	1	3
LPPNB	F	Goat	2	3	3	3	4	3	3
LPPNB	F	Goat		3	3	4	2	3	2
LPPNB	F	Goat	2	3	3	2	4	3	4
LPPNB	F	Goat/Sheep	3	3	3				
LPPNB	F	Goat/Sheep	3	3	2	3	2	3	
LPPNB	F	Sheep	1	2	2	2	2	1	1
LPPNB	F	Sheep	1	1	2	2	1	2	1
LPPNB	uf	Goat	1	3	4				
LPPNB/PPNC	F	Goat	4	3	4	2	4	1	3
LPPNB/PPNC	F	Goat	2	2	3	3	4	3	4
LPPNB/PPNC	F	Goat		4	3	3	4	3	3
LPPNB/PPNC	F	Goat	4	4	3	2	4	2	3
LPPNB/PPNC	F	Goat	3	4	2	4	4	3	4
LPPNB/PPNC	F	Goat	2	4	4	3			
LPPNB/PPNC	F	Goat	1	4	2	3	4	3	2
LPPNB/PPNC	F	Goat/Sheep	1	3		2	3	2	4
LPPNB/PPNC	F	Goat/Sheep	3	3		2	3	3	2

Table A.9: Principal Components Analysis Score Counts for 'Ain Ghazal Caprine First Phalanges

Phase	Fusion	Species	B500	B73	B501	B502	B75	B74	B76
LPPNB/PPNC	F	Goat/Sheep	3	3	3	2	2	2	2
LPPNB/PPNC	F	Goat/Sheep	3	3	3	2			
LPPNB/PPNC	F	Goat/Sheep	1	2	2	2	3	2	3
LPPNB/PPNC	F	Sheep	2	3		2	1	2	2
LPPNB/PPNC	F	Sheep	1	2	2	1	2	2	1
LPPNB/PPNC	F	Sheep	2	1	2	2	1	2	2
LPPNB/PPNC	F	Sheep	1	3	2	2	2	2	1
LPPNB/PPNC	F	Sheep	2	1	2	1	1	3	1
PPNC	F	Goat	4	4	2	3	4	2	3
PPNC	F	Goat	3	3		3	4	3	3
PPNC	F	Goat	3	2	4	4	4	3	4
PPNC	F	Goat	3	3	2	4	4	3	2
PPNC	F	Goat	4	3	3	3	4	3	3
PPNC	F	Goat	4	2		3	3	1	4
PPNC	F	Goat	3	3	3	2	3	2	3
PPNC	F	Goat	4	4	4	3	3	2	2
PPNC	F	Goat	2	3	4	3	2	2	3
PPNC	F	Goat	2	3		3	4	2	4
PPNC	F	Goat	3	3	2	3	3	3	4
PPNC	F	Goat	4	2	4	3	2	2	3
PPNC	F	Goat	2	4	3	2	4	4	3
PPNC	F	Goat	3	3	4				
PPNC	F	Goat	3	2	4	4	3	3	4
PPNC	F	Goat	2	4	4				
PPNC	F	Goat	1	4	4	2			
PPNC	F	Goat	3	3	3	2	3	3	
PPNC	F	Goat	3	3	4	3	4	2	3
PPNC	F	Goat/Sheep				4	3	3	1
PPNC	F	Goat/Sheep	2	3	3	3	3	2	3
PPNC	F	Goat/Sheep	2	2		2			
PPNC	F	Goat/Sheep	2	2	1	1			
PPNC	F	Goat/Sheep	2	2	1	1			
PPNC	F	Goat/Sheep	2	3	4				
PPNC	F	Goat/Sheep	2	3	2				
PPNC	F	Goat/Sheep	2			2			
PPNC	F	Goat/Sheep	2	2	2				
PPNC	F	Goat/Sheep	2	3	2	2	2	4	3
PPNC	F	Goat/Sheep	3	2	2	3	2	2	2
PPNC	F	Goat/Sheep	2		3	2	3	1	1
PPNC	F	Goat/Sheep	3				3	2	3
PPNC	F	Goat/Sheep	1	2			2	2	2
PPNC	F	Goat/Sheep	2	3	2	2	3	2	2
PPNC	F	Goat/Sheep	3	4	3	2	2	3	
PPNC	F	Goat/Sheep	3	2	3	3	2	3	1
PPNC	F	Goat/Sheep	3	4	2	2			
PPNC	F	Goat/Sheep	1	2					
PPNC	F	Goat/Sheep	3	4					
PPNC	F	Goat/Sheep	1	3	3	2	3	3	3
PPNC	F	Goat/Sheep	2	2	4	2	3	2	4
PPNC	F	Goat/Sheep	1	2	2				
PPNC	F	Goat/Sheep	2	2	2	3			
PPNC	F	Goat/Sheep	3	3	2	3	2	3	
PPNC	F	Sheep	1	1	2	3	2	3	2
PPNC	F	Sheep	1	2		2	2	2	2
PPNC	F	Sheep	1	1	2	2			
PPNC	F	Sheep	2	1	2	1	2	2	2
PPNC	F	Sheep	2	1		2	2	2	1
PPNC	F	Sheep	2	2	2	1	2	1	1
PPNC	F	Sheep	1	1	1	1	2	2	1

Table A.9: Principal Components Analysis Score Counts for 'Ain Ghazal Caprine First Phalanges

Phase	Fusion	Species	B500	B73	B501	B502	B75	B74	B76
PPNC	F	Sheep	2	3	2	2	2	2	2
PPNC	F	Sheep	2	2	3	2			
PPNC	F	Sheep	1	2	2	2	1		
PPNC	F	Sheep	1	2	2	2	3	2	
PPNC	F	Sheep	3	3		4	3	1	3
PPNC	F	Sheep	1	2		2	1	2	2
PPNC	F	Sheep	2	2	1	3	1	2	1
PPNC	F	Sheep	2	1	3	1	2	1	2
PPNC	F	Sheep	1	2	2	4	1	2	2
PPNC	F	Sheep	1	2	1	2			
PPNC	F	Sheep	1	2	1	1			
PPNC	F	Sheep	1	2	2	2			
PPNC	F	Sheep	1	2	2	1	1		
PPNC	F	Sheep	2	2	2	2	1	2	2
PPNC	F	Sheep	1	3		1	2	2	1
PPNC	F	Sheep	2	3	2	1	2	2	2
PPNC	F	Sheep	1	3		2	2	1	1
PPNC	F	Sheep	1	2	2	1	1	2	2
PPNC	F	Sheep	2	3	2	2	1	2	2
PPNC	F	Sheep	1	2	3	2	3	1	2
PPNC	F	Sheep	2	2	2	2	1	2	1
PPNC	F	Sheep	1	2	2	2	1	2	2
PPNC	F	Sheep	2	2	2	2			
PPNC	F	Sheep	2	3	1	1	2	2	2
PPNC	fg	Sheep	2	2	1	2	2	2	1
PPNC	fg	Sheep	1	2	2	1	1		
PPNC	uf	Goat/Sheep	1	1					
PPNC	uf	Goat/Sheep	1	1	1				
PPNC	uf	Sheep	2	2	1				
Yarmoukian	F	Goat	3	2		3	3	3	3
Yarmoukian	F	Goat	3	3	4	4	2	2	2
Yarmoukian	F	Goat	3	3		4	4	3	4
Yarmoukian	F	Goat	2	3		3	3	3	2
Yarmoukian	F	Goat	3	4				3	
Yarmoukian	F	Goat	3	4	3	3	3	3	3
Yarmoukian	F	Goat	3	4	3	1	4	2	4
Yarmoukian	F	Goat	4	4		4	3	3	3
Yarmoukian	F	Goat	2	4	3			3	
Yarmoukian	F	Goat			4	3	3	3	2
Yarmoukian	F	Goat	3	3	2	3	3	3	3
Yarmoukian	F	Goat	3	4	3	3	4	3	4
Yarmoukian	F	Goat	3	3	3	2	3	3	2
Yarmoukian	F	Goat	2	3		3	4	3	3
Yarmoukian	F	Goat	2	4	3	4	3	3	4
Yarmoukian	F	Goat	2	3	3	3	3	4	4
Yarmoukian	F	Goat	2	2	2	3	4	4	3
Yarmoukian	F	Goat	4	3	3	3	4	3	3
Yarmoukian	F	Goat	3	4	3		4	3	3
Yarmoukian	F	Goat	3	4	3	4	3	3	3
Yarmoukian	F	Goat/Sheep	3	3		2	2	3	1
Yarmoukian	F	Goat/Sheep	2	2	1	4	4	3	2
Yarmoukian	F	Goat/Sheep	2	2	3	1	2	1	3
Yarmoukian	F	Goat/Sheep	1	2	1	3	3	2	2
Yarmoukian	F	Goat/Sheep	3	3	3	2	2		
Yarmoukian	F	Goat/Sheep	3	2	3	2	3	3	3
Yarmoukian	F	Goat/Sheep	2	3	3	2			
Yarmoukian	F	Goat/Sheep	2				2	3	
Yarmoukian	F	Goat/Sheep	1	2	3	2	2	3	2
Yarmoukian	F	Goat/Sheep	1	3	3	2	2	3	

Table A.9: Principal Components Analysis Score Counts for 'Ain Ghazal Caprine First Phalanges

Phase	Fusion	Species	B500	B73	B501	B502	B75	B74	B76
Yarmoukian	F	Goat/Sheep	2	3	3	3	2	2	2
Yarmoukian	F	Goat/Sheep	2	3	2		2	3	2
Yarmoukian	F	Goat/Sheep	3	3	2	3	2	2	3
Yarmoukian	F	Goat/Sheep	3	2	3	3	4	3	2
Yarmoukian	F	Goat/Sheep	2	3	2	2	2	3	2
Yarmoukian	F	Goat/Sheep	2	3	3	2	3	2	2
Yarmoukian	F	Goat/Sheep	1	3	3	2	2	3	2
Yarmoukian	F	Goat/Sheep	2	3	3	2			
Yarmoukian	F	Goat/Sheep	2	2	2				
Yarmoukian	F	Goat/Sheep	1	2					
Yarmoukian	F	Sheep	2	2	2	2	2	2	2
Yarmoukian	F	Sheep	1	2	2	2	3	2	2
Yarmoukian	F	Sheep	1	1	1	2	1	2	1
Yarmoukian	F	Sheep	2	2	1	2	1	2	1
Yarmoukian	F	Sheep	1	3	1	3	2	1	1
Yarmoukian	F	Sheep	1		1	2	3	1	1
Yarmoukian	F	Sheep	2						1
Yarmoukian	F	Sheep	2	2	1	2	2	2	1
Yarmoukian	F	Sheep	2	3	1	2	2	2	2
Yarmoukian	F	Sheep	2	2	2	1	1	2	2
Yarmoukian	F	Sheep		2			1	3	2
Yarmoukian	F	Sheep	2	3	2	1	2	2	2
Yarmoukian	F	Sheep	2	1	2	1	2	2	2
Yarmoukian	F	Sheep	3	2	2	2	2	2	2
Yarmoukian	F	Sheep	1	1		2	1	1	2
Yarmoukian	F	Sheep	2	1	2	1	2	2	2
Yarmoukian	F	Sheep	2	2	2	2	2	3	2
Yarmoukian	F	Sheep	2	2	3	1	2	2	1
Yarmoukian	F	Sheep	1	3	2	1	2	2	2
Yarmoukian	F	Sheep	1	2	1	2	3	2	2
Yarmoukian	F	Sheep	2	2	2	1	2	1	1
Yarmoukian	F	Sheep	2	2	2	3	1	2	1
Yarmoukian	F	Sheep	2	3	3	1	1	2	2
Yarmoukian	F	Sheep	1	2	2	1			
Yarmoukian	F	Sheep	2	2	1	1			
Yarmoukian	fg	Goat/Sheep	3	2	3	2	1	2	2
Yarmoukian	fg	Sheep	1	2	1	1			
Yarmoukian	fg	Sheep	2	1	1	2	2	2	1

Table A.9: Principal Components Analysis Score Counts for 'Ain Ghazal Caprine First Phalanges

Phase	Species	B80	B701	B81	B702	B703
MPPNB	Goat		3	4	4	3
MPPNB	Goat		2	4	3	2
MPPNB	Goat	3	3	4	4	4
MPPNB	Goat	3	3	4	4	3
MPPNB	Goat			4	4	4
MPPNB	Goat			3	3	4
MPPNB	Goat	3	3	4	3	3
MPPNB	Goat	3	3	4	4	4
MPPNB	Goat	3	3	3	4	3
MPPNB	Goat		4	4	4	4
MPPNB	Goat		4	4	4	4
MPPNB	Goat		4	3	3	4
MPPNB	Goat	3	4	3	4	3
MPPNB	Goat	3	4		4	4
MPPNB	Goat				4	4
MPPNB	Goat	3	4	3	4	3
MPPNB	Goat		4	4	4	4
MPPNB	Goat		2	3	3	3
MPPNB	Goat	4	4	3	3	3
MPPNB	Goat			4	3	3
MPPNB	Goat			3	4	4
MPPNB	Goat	3	4	3	3	4
MPPNB	Goat		3	4	4	4
MPPNB	Goat	3	4	4	4	3
MPPNB	Goat/Sheep				3	3
MPPNB	Goat/Sheep			3		3
MPPNB	Goat/Sheep		3	2	4	2
MPPNB	Goat/Sheep			3		2
MPPNB	Goat/Sheep			3		3
MPPNB	Goat/Sheep			3		3
MPPNB	Goat/Sheep	3	4	3	3	
LPPNB	Goat	3	4	4	3	4
LPPNB	Goat	3	3	3	4	3
LPPNB	Goat		3	3	3	3
LPPNB	Goat			3	4	4
LPPNB	Goat/Sheep	2	2		3	3
LPPNB	Sheep	2	1	2	2	2
LPPNB	Sheep	2	2	3	1	2
LPPNB	Sheep	3	2	3	1	2
LPPNB	Sheep	3	2		2	2
LPPNB/PPNC	Goat	2	2		4	3
LPPNB/PPNC	Goat/Sheep				3	4
LPPNB/PPNC	Goat/Sheep	3	3	4	3	3
LPPNB/PPNC	Goat/Sheep	3	2	2	2	
LPPNB/PPNC	Goat/Sheep	4	3	3	3	2
LPPNB/PPNC	Sheep	3	2	2	1	2
PPNC	Goat	3	4	3	3	4
PPNC	Goat	3	4	4	4	4
PPNC	Goat	3	3		3	3
PPNC	Goat		3	3	3	4
PPNC	Goat	3	4	4	3	4
PPNC	Goat	4	3	3	3	
PPNC	Goat	2	3	3	3	2
PPNC	Goat	4	3	3	3	3
PPNC	Goat		3	3	4	3
PPNC	Goat	3	4	3	3	3
PPNC	Goat	3	3	4	3	3
PPNC	Goat			4	4	4
PPNC	Goat/Sheep	4	2	3	3	2

Table A.10: Principal Components Analysis Score Counts for 'Ain Ghazal Caprine Third Phalanges

Phase	Species	B80	B701	B81	B702	B703
PPNC	Goat/Sheep			4		2
PPNC	Goat/Sheep		2		2	3
PPNC	Goat/Sheep	3	3		3	3
PPNC	Goat/Sheep		3		2	2
PPNC	Goat/Sheep			3	3	2
PPNC	Goat/Sheep	2	2	2	3	3
PPNC	Goat/Sheep			3	3	3
PPNC	Goat/Sheep	2	2		2	2
PPNC	Sheep	3	2	1	2	2
PPNC	Sheep	2	1		1	1
PPNC	Sheep				1	2
PPNC	Sheep	2	2	3	2	2
PPNC	Sheep	3	2	2	2	2
PPNC	Sheep	2	1	3	2	2
PPNC	Sheep		2		2	1
PPNC	Sheep	3	2		1	1
PPNC	Sheep	3	2	3	1	1
PPNC	Sheep	4	2	2	2	2
PPNC	Sheep				1	1
PPNC	Sheep				2	1
PPNC	Sheep		2	2	2	
PPNC	Sheep	2	1	1	3	1
Yarmoukian	Goat	4	3	3	3	3
Yarmoukian	Goat	2	3	3	4	3
Yarmoukian	Goat/Sheep			4		1
Yarmoukian	Goat/Sheep	2	3	4	3	3
Yarmoukian	Goat/Sheep	3	2	4	2	3
Yarmoukian	Goat/Sheep				2	2
Yarmoukian	Sheep	2	1		2	1
Yarmoukian	Sheep	3	2		2	1
Yarmoukian	Sheep	2	2	2	2	1
Yarmoukian	Sheep	2	2	1	2	1

Table A.10: Principal Components Analysis Score Counts for 'Ain Ghazal Caprine Third Phalanges

APPENDIX B

‘Ain Ghazal Goat and Sheep Bone Measurements (Burnt Specimens not Included)

Phase	Fusion	SLC	BG	LG	GLP
MPPNB	F		27.3	33.7	40.9
MPPNB	F	21.2	22.5	27.1	34.3
MPPNB	F	20.0	27.1	33.0	40.2
MPPNB	F	20.6	22.3	26.0	
MPPNB	F	23.1	25.9	31.3	39.8
MPPNB	F	19.4	21.4	26.1	31.8
MPPNB	F		22.0	25.1	32.3
MPPNB	F	18.0	20.4	25.2	29.9
MPPNB	F	23.9	24.6	30.3	37.5
MPPNB	F		23.1	27.1	
MPPNB	F		27.2	32.6	40.3
MPPNB	F		21.8	25.8	31.1
MPPNB	F		26.8	30.5	
MPPNB	F		23.9		
MPPNB	F		22.2	28.0	34.7
MPPNB	F				40.1
MPPNB	F		24.9	31.5	38.9
MPPNB	fg	19.2	23.7	28.3	33.0
LPPNB	F		22.4	28.9	34.2
LPPNB	F		25.4	28.2	36.8
LPPNB	F		22.4	24.7	33.8
LPPNB/PPNC	F		22.7		
LPPNB/PPNC	F		25.8	28.4	37.3
LPPNB/PPNC	uf		21.5		
PPNC	F	21.1	24.5	30.0	35.9
PPNC	F		24.3	30.9	38.2
PPNC	F	17.9	21.4	26.0	31.4
PPNC	F	23.2	24.1	28.2	36.1
PPNC	F	18.1	21.3	25.9	
PPNC	F		19.9	24.3	29.7
PPNC	F		21.8	25.2	
PPNC	F		26.1	29.6	37.2
PPNC	F		22.2	28.9	36.7
PPNC	uf		25.4	27.1	
Yarmoukian	?		23.0		
Yarmoukian	F		20.3	24.4	30.2
Yarmoukian	F		26.3	29.0	37.5
Yarmoukian	F	21.7	24.1	29.3	36.4
Yarmoukian	F		24.5	29.3	36.0
Yarmoukian	F				37.1
Yarmoukian	F		22.0	25.9	30.7
Yarmoukian	F		22.6	26.6	32.7
Yarmoukian	F		20.5	22.7	
Yarmoukian	F		21.1		29.4
Yarmoukian	F		21.1	24.8	31.2
Yarmoukian	F			24.6	31.6
Yarmoukian	F		24.9	29.6	38.0
Yarmoukian	F		19.4	21.4	27.8
Yarmoukian	F		19.1	23.0	28.0
Yarmoukian	uf		24.3		

Table B.1: ‘Ain Ghazal Goat Scapula Measurements (mm)

Phase	Fusion	Bd
MPPNB	F	33.3
MPPNB	F	30.2
MPPNB	F	31.3
MPPNB	F	31.9
MPPNB	F	42.9
MPPNB	F	33.1
MPPNB	F	30.1
MPPNB	F	34.2
MPPNB	F	34.9
MPPNB	F	32.6
MPPNB	F	32.0
MPPNB	F	34.1
MPPNB	F	42.3
MPPNB	fg	29.6
MPPNB	fg	29.2
LPPNB	F	35.6
LPPNB	F	33.3
LPPNB/PPNC	F	30.7
LPPNB/PPNC	F	32.0
LPPNB/PPNC	F	32.4
PPNC	F	30.6
PPNC	F	32.6
PPNC	F	29.9
PPNC	F	32.6
PPNC	F	35.7
Yarmoukian	F	29.1
Yarmoukian	F	29.1
Yarmoukian	F	33.0
Yarmoukian	F	31.1
Yarmoukian	F	30.2
Yarmoukian	F	33.3
Yarmoukian	F	32.3
Yarmoukian	F	30.6
Yarmoukian	F	31.3
Yarmoukian	F	28.1
Yarmoukian	F	33.2
Yarmoukian	F	27.9
Yarmoukian	F	31.8
Yarmoukian	F	30.0
Yarmoukian	F	33.2
Yarmoukian	F	32.3
Yarmoukian	F	30.0
Yarmoukian	F	36.8
Yarmoukian	F	34.8
Yarmoukian	F	26.2
Yarmoukian	F	36.6
Yarmoukian	fg	27.4

Table B.2: 'Ain Ghazal Goat Humerus Measurements (mm)

Phase	Fusion	Bd	BFd
MPPNB	F	31.8	27.2
MPPNB	F	32.4	29.0
MPPNB	fg	40.9	36.4
MPPNB	uf	39.6	33.7
MPPNB	uf	36.5	32.7
MPPNB	uf	29.9	27.3
MPPNB	uf	31.1	29.4
MPPNB	uf	39.7	37.0
MPPNB	uf	29.9	28.3
MPPNB	uf	28.8	27.3
MPPNB	uf	34.8	33.2
MPPNB	uf	31.2	29.6
MPPNB	uf	26.4	25.3
MPPNB	uf	35.3	30.5
LPPNB	uf	29.2	25.8
LPPNB	uf	33.4	31.2
LPPNB/PPNC	uf	39.5	34.9
PPNC	F	31.5	26.5
PPNC	F		27.2
PPNC	F	30.8	26.5
PPNC	F	30.3	27.5
PPNC	F	31.5	27.9
PPNC	uf	33.6	32.7
PPNC	uf		32.5
PPNC	uf	32.1	29.7
Yarmoukian	F		25.9
Yarmoukian	fg	26.7	24.2

Table B.3: ‘Ain Ghazal Goat Radius Measurements (mm)

Phase	Fusion	Bd	W.troch (Med)	W.cond (Med)	W.troch (Lat)	W.cond (Lat)	W.troch (?)	W.cond (?)
MPPNB	?						11.4	14.4
MPPNB	F						13.3	
MPPNB	F						11.3	14.2
MPPNB	F						10.7	13.1
MPPNB	F						10.5	12.7
MPPNB	F	29.6	10.8	13.7	10.4	13.3		
MPPNB	F	29.3	10.6	13.9	10.3	13.5		
MPPNB	F						12.5	15.4
MPPNB	F						11.1	13.6
MPPNB	F						11.4	16.0
MPPNB	F						9.9	12.8
MPPNB	F						10.4	14.4
MPPNB	F						10.3	13.1
MPPNB	F						10.4	12.3
MPPNB	F	29.9	11.0	13.7	10.8	13.5		
MPPNB	fg	30.4	11.7	13.3	11.3	13.4		
MPPNB	fg	29.3	10.3	13.1	10.1	12.7		
MPPNB	uf						10.6	12.8
MPPNB	uf						9.9	12.1
MPPNB	uf						10.8	13.1
MPPNB	uf						10.1	12.0
MPPNB	uf						10.4	12.6
MPPNB	uf						11.6	15.1
MPPNB	uf						11.9	15.8
MPPNB	uf						12.4	16.3
MPPNB	uf	30.5	9.9	13.1	9.3	12.8		
MPPNB	uf						11.9	14.7
MPPNB	uf						11.7	12.5
MPPNB	uf						12.1	15.1
MPPNB	uf						9.6	12.7
MPPNB	uf						10.0	13.4
MPPNB	uf						9.5	12.7
MPPNB	uf						11.0	13.4
MPPNB	uf						12.2	14.0
LPPNB	?						12.3	15.7
LPPNB	F		10.0	13.3				
LPPNB	F						9.8	12.8
LPPNB	F						10.1	13.8
LPPNB	F				11.7	13.1		
LPPNB	F	34.5	11.9	15.6	11.3			
LPPNB	uf						12.2	15.4
LPPNB	uf		7.8	10.1				
LPPNB	uf				7.3	9.8		
LPPNB	uf						11.6	15.9
LPPNB	uf						10.5	11.2
LPPNB	uf		9.0	11.7	8.2	10.9		
LPPNB	uf						9.9	13.4
LPPNB	uf						11.5	14.9
LPPNB/PPNC	?						10.2	12.7
LPPNB/PPNC	F						11.7	15.6

Table B.4: 'Ain Ghazal Goat Metacarpal Measurements (mm)

Phase	Fusion	Bd	W.troch (Med)	W.cond (Med)	W.troch (Lat)	W.cond (Lat)	W.troch (?)	W.cond (?)
LPPNB/PPNC	F						10.2	12.6
LPPNB/PPNC	F						9.3	12.2
LPPNB/PPNC	F						10.2	13.0
LPPNB/PPNC	F		12.6	15.5	10.9	14.4		
LPPNB/PPNC	uf						10.4	13.2
LPPNB/PPNC	uf						10.2	13.2
PPNC	F						9.5	13.1
PPNC	F						10.3	13.2
PPNC	F	27.2	9.5	12.0	8.9	11.8		
PPNC	F						11.5	15.7
PPNC	F	28.2	10.4	13.4	9.5	12.5		
PPNC	F	28.9	10.1	12.8	9.9	12.6		
PPNC	F						11.6	13.4
PPNC	F						12.3	12.9
PPNC	F	27.5	9.3	11.9	9.2	12.0		
PPNC	F	27.9	10.2	13.1	9.8	12.5		
PPNC	F	35.3	10.8	15.8	10.6	15.8		
PPNC	F		10.0	13.0	9.9	12.5		
PPNC	F						9.6	13.1
PPNC	F						11.0	15.4
PPNC	F	35.4	11.5	16.5	11.3	14.6		
PPNC	fg						10.3	13.0
PPNC	fg						9.1	11.0
PPNC	fg						11.6	11.5
PPNC	uf						9.6	13.9
PPNC	uf						12.0	17.0
PPNC	uf						11.0	15.4
PPNC	uf						10.9	13.4
Yarmoukian	F						8.6	10.9
Yarmoukian	F						9.5	11.8
Yarmoukian	F	27.5	10.5	13.1	9.6	13.2		
Yarmoukian	F	26.0	9.7	11.6	9.8	11.5		
Yarmoukian	F						11.6	12.6
Yarmoukian	F						9.7	12.5
Yarmoukian	F	35.3	11.7	16.4	11.4	15.3		
Yarmoukian	fg	26.9			12.4	12.3		
Yarmoukian	fg						8.6	11.9
Yarmoukian	fg						12.6	15.1
Yarmoukian	uf						11.6	14.3
Yarmoukian	uf		9.6	11.7	8.7	11.3		
Yarmoukian	uf						9.6	12.9
Yarmoukian	uf						10.4	13.3

Table B.4 (cont.): ‘Ain Ghazal Goat Metacarpal Measurements (mm)

Phase	Fusion	Bd
MPPNB	fg	46.2
MPPNB	fg	44.9
PPNC	uf	40.1

Table B.5: ‘Ain Ghazal Goat Femur Measurements (mm)

Phase	Fusion	Bd
MPPNB	F	27.7
MPPNB	F	28.4
MPPNB	F	34.2
MPPNB	F	28.4
MPPNB	F	26.5
MPPNB	F	26.8
MPPNB	F	29.0
MPPNB	F	29.7
MPPNB	F	29.0
MPPNB	F	29.2
MPPNB	F	27.8
MPPNB	F	28.5
MPPNB	fg	28.1
MPPNB	uf	31.2
MPPNB	uf	27.5
MPPNB	uf	27.3
MPPNB	uf	24.7
MPPNB	uf	29.7
MPPNB	uf	28.1
MPPNB	uf	30.7
MPPNB	uf	31.4
MPPNB	uf	27.9
LPPNB	F	26.1
LPPNB	F	26.5
LPPNB	F	29.9
LPPNB	F	27.1
LPPNB/PPNC	F	29.5
LPPNB/PPNC	F	31.4
PPNC	F	27.5
PPNC	F	27.0
PPNC	F	27.1
PPNC	F	26.5
PPNC	F	32.1
PPNC	F	30.7
PPNC	F	31.2
PPNC	F	26.5
PPNC	F	29.7
PPNC	fg	30.4
PPNC	uf	32.1
Yarmoukian	F	23.7
Yarmoukian	F	25.3
Yarmoukian	F	27.8
Yarmoukian	F	26.8
Yarmoukian	F	31.1
Yarmoukian	F	25.8

Table B.6: 'Ain Ghazal Goat Tibia Measurements (mm)

Phase	GLl	GLm	Dl	Bd
MPPNB	33.1	30.6	18.7	22.6
MPPNB	32.7	30.3	17.8	22.5
MPPNB		30.8		
MPPNB	33.9	30.1	18.3	21.8
MPPNB	35.4	32.6	19.1	23.7
MPPNB	30.9	28.8	16.6	19.6
MPPNB		28.0		
MPPNB	31.1		17.2	19.4
MPPNB	34.9	32.2	18.8	21.8
MPPNB	30.6	28.6	16.3	18.9
MPPNB	31.5	29.3	16.6	19.2
MPPNB	33.2	31.0	18.6	20.7
MPPNB	31.5		17.1	18.9
MPPNB	29.3	27.7	16.3	18.8
MPPNB	30.1	27.6	16.6	20.2
MPPNB	32.2	28.0	17.2	20.5
MPPNB	33.2	30.2	17.9	20.4
MPPNB		28.5		18.8
MPPNB	34.6		18.8	
MPPNB	33.2	30.7	19.1	23.5
MPPNB	30.2	27.3	16.0	19.3
MPPNB		30.7	18.3	
MPPNB	32.1	29.6	16.8	21.6
MPPNB	31.6	29.2	17.8	20.2
MPPNB	29.0	26.1	15.4	18.9
MPPNB		32.2	19.4	
MPPNB	30.6	29.3	15.9	19.1
MPPNB		30.7		20.3
MPPNB	31.8	28.6	16.9	19.7
MPPNB	31.6	29.2	17.8	19.9
MPPNB		32.6	19.7	
MPPNB		30.9		
MPPNB	34.9	31.3	18.6	23.3
MPPNB	35.9		19.7	
MPPNB	37.3	34.9	20.6	25.1
MPPNB	34.5	31.0	19.1	23.7
MPPNB			19.4	22.6
MPPNB	31.3	28.2	17.1	20.5
MPPNB	33.1	30.3	18.4	23.2
MPPNB		28.5		
MPPNB		30.3		20.2
MPPNB			18.5	
MPPNB	34.9	30.9	18.8	23.0
MPPNB				22.0
MPPNB	31.8	29.9	17.0	20.9
MPPNB	34.5		18.7	22.4
MPPNB	31.6	29.2	17.0	19.3
MPPNB	32.8	30.0	17.4	21.3
MPPNB	34.4	31.8	18.1	
MPPNB	27.9	26.8	16.0	17.5

Table B.7: 'Ain Ghazal Goat Astragalus Measurements (mm)

Phase	GLl	GLm	Dl	Bd
LPPNB	34.0	31.6	19.2	22.1
LPPNB	28.8	27.1	15.8	19.5
LPPNB	30.1	27.0	16.0	18.1
LPPNB	30.3	27.6	16.6	18.8
LPPNB	31.2	28.7	16.5	19.7
LPPNB	36.3	33.8	19.4	23.3
LPPNB	32.7	29.2	18.3	22.7
LPPNB	30.6		16.6	
LPPNB	33.3	31.2	18.6	22.2
LPPNB	30.2	27.2	16.8	19.8
LPPNB	29.4	25.8		18.0
LPPNB/PPNC	34.9	32.1	18.8	23.5
LPPNB/PPNC	30.2	27.5	16.4	20.1
LPPNB/PPNC	28.5	25.7	15.1	19.1
LPPNB/PPNC	28.7	26.4	16.5	18.4
LPPNB/PPNC	31.8	29.2	16.4	19.1
PPNC	30.5	28.5	17.1	21.3
PPNC	31.4	28.5	16.8	19.4
PPNC	32.9	31.5	18.0	22.2
PPNC	29.3	27.1	15.2	17.9
PPNC		27.0		18.4
PPNC	35.5	32.4	19.2	23.2
PPNC		31.2		
PPNC	28.7	25.9	15.2	18.2
PPNC	32.8	30.5	17.6	21.7
PPNC	30.1	28.3	16.9	19.8
PPNC	32.3	30.4	18.2	21.3
PPNC	29.1	25.9	15.9	18.3
PPNC	32.1	30.0	17.3	22.0
PPNC	29.7	26.7	15.2	17.9
PPNC	29.0	28.0	15.7	18.0
PPNC	32.3	30.2	18.2	20.0
PPNC	29.6	27.6	15.7	18.9
PPNC	32.1		17.6	
PPNC	28.7	26.8	15.1	18.2
PPNC	34.8	31.0	18.9	23.0
PPNC	32.0	29.0	17.6	21.3
PPNC	30.3	27.8	16.8	19.6
PPNC	34.2	32.2	19.3	22.4
PPNC	30.5	28.7	16.7	20.4
PPNC	31.1	29.1	16.9	18.9
PPNC	32.2		17.6	
Yarmoukian	30.9	28.2	17.2	22.2
Yarmoukian	29.5	26.8	16.6	20.2
Yarmoukian	30.0	27.4	16.3	19.0
Yarmoukian	32.7		17.7	21.8
Yarmoukian	27.1	25.8	14.6	17.2
Yarmoukian	32.8	31.0	18.2	22.5
Yarmoukian	28.6	26.3		18.1
Yarmoukian	29.4	27.0	16.0	
Yarmoukian	28.3	26.4	15.3	18.1
Yarmoukian	28.8	26.3	15.0	16.9

Table B.7 (cont.): 'Ain Ghazal Goat Astragalus Measurements (mm)

Phase	Fusion	GL	GB
MPPNB	?		19.9
MPPNB	?		21.2
MPPNB	F		17.8
MPPNB	F	62.4	21.6
MPPNB	F	66.8	23.5
MPPNB	F	64.9	
MPPNB	F		20.7
MPPNB	F	60.9	19.5
MPPNB	F	62.7	22.1
MPPNB	uf		20.5
MPPNB	uf		24.1
MPPNB	uf		22.7
MPPNB	uf		20.1
MPPNB	uf		24.1
MPPNB	uf		23.5
MPPNB	uf		22.6
LPPNB	F	59.7	21.3
LPPNB	F	58.9	21.0
LPPNB	fg	63.3	21.2
LPPNB	uf		17.5
PPNC	?		23.8
PPNC	?		24.8
PPNC	F	57.3	20.5
PPNC	F	53.6	18.2
PPNC	F	60.4	
PPNC	F	68.2	
PPNC	F	64.7	23.5
PPNC	F	56.6	20.4
PPNC	F		22.0
PPNC	uf		18.0
PPNC	uf		17.4
PPNC	uf		22.0
PPNC	uf		21.2
Yarmoukian	?		23.6
Yarmoukian	F		19.5
Yarmoukian	F	55.8	19.4
Yarmoukian	F	61.1	22.2
Yarmoukian	F	52.3	18.3
Yarmoukian	uf		16.2

Table B.8: Goat Calcaneum Measurements (mm)

Phase	Fusion	Bd	W.troch (Med)	W.cond (Med)	W.troch (Lat)	W.cond (Lat)	W.troch (?)	W.cond (?)
MPPNB	?						11.8	14.4
MPPNB	F	27.1	10.7	12.7	10.4	12.5		
MPPNB	F	31.8	11.4	14.5	12.0	13.4		
MPPNB	F	26.7	10.1	12.2	10.0	11.4		
MPPNB	F	26.7	9.7	12.0	10.1	11.5		
MPPNB	F	26.4	10.0	11.7	10.3	11.4		
MPPNB	F	33.3	12.1	15.6	12.6	14.2		
MPPNB	F	32.4	11.4	14.8	12.0	14.4		
MPPNB	F	27.2	10.4	12.7	10.7	12.1		
MPPNB	F	32.8	12.2	15.3	12.7	14.5		
MPPNB	F	32.9	12.0	14.8	12.6	14.4		
MPPNB	F		10.1	12.3	10.6	11.6		
MPPNB	F	28.1	10.3	12.7	10.5	11.9		
MPPNB	F		11.7	15.2	11.7	14.5		
MPPNB	F						10.1	12.6
MPPNB	F	25.8	9.3	11.9	9.5	11.2		
MPPNB	F	26.1	9.3	11.6	9.8	11.4		
MPPNB	fg	27.8	10.3	12.4	10.8	12.3		
MPPNB	fg				12.1			
MPPNB	fg	26.2	10.1	12.1	9.7	11.5		
MPPNB	uf						11.7	14.0
MPPNB	uf						12.6	14.0
MPPNB	uf						12.0	15.1
MPPNB	uf						10.9	13.1
MPPNB	uf						11.1	13.0
MPPNB	uf						10.0	11.4
MPPNB	uf						11.4	13.1
MPPNB	uf		10.2	11.9	10.0	11.3		
MPPNB	uf	25.2	10.2	11.3	10.5			
MPPNB	uf						9.2	11.0
MPPNB	uf						10.3	10.8
MPPNB	uf						11.0	12.9
MPPNB	uf						9.9	12.3
LPPNB	F						9.7	11.7
LPPNB	F	27.1	10.5	11.8	9.8	12.4		
LPPNB	F	28.1	11.5		11.1	13.1		
LPPNB	F						12.2	13.8
LPPNB	F	31.1	12.6	14.1	12.3	14.5		
LPPNB	F	32.4	12.0	14.1	11.7	13.9		
LPPNB	F				8.8	10.5		
LPPNB	F						11.6	14.2
LPPNB	fg						10.5	12.8
LPPNB	uf		8.9	10.0	8.4	10.1		
LPPNB	uf						9.8	11.5
LPPNB	uf						10.9	13.8
LPPNB	uf						9.8	11.4
LPPNB	uf						10.8	12.3
LPPNB	uf		10.7	12.2	9.9	11.0		
LPPNB/PPNC	F						8.6	11.0
LPPNB/PPNC	F		11.9	13.8	11.7	13.8		

Table B.9: 'Ain Ghazal Goat Metatarsal Measurements (mm)

Phase	Fusion	Bd	W.troch (Med)	W.cond (Med)	W.troch (Lat)	W.cond (Lat)	W.troch (?)	W.cond (?)
LPPNB/PPNC	F	29.6	11.7	16.6	9.3	11.4		
LPPNB/PPNC	F						9.6	11.4
LPPNB/PPNC	uf						9.2	11.2
LPPNB/PPNC	uf						11.5	13.4
PPNC	F	30.1	11.4	14.1	11.2	13.5		
PPNC	F	25.1	10.1	11.5	10.3	11.2		
PPNC	F	29.8	11.7	13.7	12.3	13.4		
PPNC	F				9.8	11.4		
PPNC	F						12.2	14.7
PPNC	F	25.8	9.7	11.6	9.7			
PPNC	F						12.2	16.0
PPNC	F	31.4	11.5	13.9	11.5	14.2		
PPNC	F	26.1	11.3	12.1	10.3	11.2		
PPNC	F	32.2	11.4	14.2	11.3	13.4		
PPNC	F						11.0	11.7
PPNC	F						9.5	10.2
PPNC	F	25.4	10.5	12.1				
PPNC	fg	25.7	9.5	11.3	9.5	10.8		
PPNC	uf		12.3	13.6	11.7	13.6		
PPNC	uf						11.9	13.4
PPNC	uf						10.3	14.3
PPNC	uf						12.1	13.3
PPNC	uf						10.4	10.7
PPNC	uf		9.7	11.8	9.9	11.0		
Yarmoukian	F	23.7	9.0	10.9	9.1	10.9		
Yarmoukian	F	24.6	8.9		8.7			
Yarmoukian	F						10.3	11.4
Yarmoukian	F	27.8						
Yarmoukian	F	27.8	9.2	12.7	10.1	11.8		
Yarmoukian	F	22.8	8.2	10.3	8.1	9.7		
Yarmoukian	F	26.1	10.1	12.3	10.0	11.7		
Yarmoukian	F	24.4	9.9	11.1	10.1	10.1		
Yarmoukian	F	25.8	9.8		10.1	11.7		
Yarmoukian	F	27.7	12.3	13.3	11.4	11.7		
Yarmoukian	F	25.7	10.3	11.8	10.2	11.1		
Yarmoukian	F						11.3	13.3
Yarmoukian	F						10.2	12.8
Yarmoukian	uf						10.5	11.6
Yarmoukian	uf		10.0	11.5	10.1	10.5		
Yarmoukian	uf						8.6	10.7
Yarmoukian	uf						9.9	11.5

Table B.9 (cont): 'Ain Ghazal Goat Metatarsal Measurements (mm)

Phase	Fusion	GLpe	Bp	SD	Bd
MPPNB	F	38.7	13.1	9.9	11.7
MPPNB	F	40.8	13.3	10.1	12.2
MPPNB	F	41.1	13.2	10.2	12.4
MPPNB	F	39.9	13.6	10.5	12.9
MPPNB	F	42.9	13.6	11.3	14.0
MPPNB	F		14.4	11.4	13.8
MPPNB	F	40.4	13.4	10.8	12.2
MPPNB	F		14.0	10.2	13.5
MPPNB	F		16.7	15.1	16.8
MPPNB	F	45.0	16.5	14.3	16.8
MPPNB	F	40.9	14.1	11.7	13.2
MPPNB	F	41.2	13.8	10.5	12.1
MPPNB	F	42.5	14.8	11.3	14.1
MPPNB	F		14.4	11.7	15.2
MPPNB	F		15.7		
MPPNB	F		11.8	9.5	12.2
MPPNB	F	46.9	15.0	11.4	13.9
MPPNB	F	39.6	13.8	11.3	13.2
MPPNB	F	50.1	18.1	14.8	16.7
MPPNB	F	39.4	12.9	10.9	12.1
MPPNB	F	48.4	17.9	14.0	16.7
MPPNB	F	47.9	16.6	13.2	16.2
MPPNB	F		15.7	12.5	14.3
MPPNB	F			10.3	11.4
MPPNB	F	41.1	14.1	11.8	13.9
MPPNB	F	38.8	12.7	11.1	11.9
MPPNB	F	44.5	16.0	13.7	16.6
MPPNB	F	44.5	15.6	11.6	14.3
MPPNB	F		16.7		
MPPNB	F	41.0	13.9	10.5	13.2
MPPNB	F	39.9	13.3	10.5	13.0
MPPNB	F	40.1	13.6	11.9	14.2
MPPNB	F	40.0	14.2	10.4	13.1
MPPNB	F	41.7	13.7	11.3	13.1
MPPNB	F	38.7	12.5	10.3	11.7
MPPNB	F	41.0	12.7	9.7	12.3
MPPNB	F	47.6	16.4	14.0	16.1
MPPNB	F		14.8		
MPPNB	F	41.9	13.7	11.4	13.1
MPPNB	F		12.2	10.7	12.2
MPPNB	F	46.8	16.5	12.9	15.8
MPPNB	F			10.7	12.2
MPPNB	F		12.7		
MPPNB	F		16.4		
MPPNB	F	47.0	16.8	15.3	16.0
MPPNB	F		13.7		
MPPNB	F	40.4	13.6		15.0
MPPNB	F	48.2	14.0		
MPPNB	F	50.5	15.3	13.4	14.9
MPPNB	F	50.5		14.5	15.2

Table B.10: 'Ain Ghazal Goat First Phalanx Measurements (mm)

Phase	Fusion	GLpe	Bp	SD	Bd
MPPNB	F		13.0	10.9	12.2
MPPNB	F	51.0	18.0	16.4	17.6
MPPNB	F	39.1	11.7	9.0	11.5
MPPNB	F	38.1	12.3	10.3	12.2
MPPNB	F	49.3	18.2	16.3	17.3
MPPNB	F	38.5	12.7	10.1	
MPPNB	F		13.8		14.4
MPPNB	F			14.1	
MPPNB	F	40.4	14.5	11.9	14.4
MPPNB	F	48.6	16.4	13.3	15.4
MPPNB	F	40.5	13.6	10.8	12.9
MPPNB	F	38.8	13.3	12.9	14.0
MPPNB	F	50.0	16.1	14.1	17.6
MPPNB	F	39.5	12.1	9.7	11.5
MPPNB	F		15.1	12.7	14.7
MPPNB	F		13.6		
MPPNB	F	49.0	15.4	12.5	14.9
MPPNB	F	45.8	14.9	12.7	15.2
MPPNB	F	41.3	14.2	12.4	14.4
MPPNB	F	44.4	15.2	12.2	14.3
MPPNB	F		15.0		
MPPNB	F	53.3	18.3	15.7	18.3
MPPNB	F		12.6	10.9	13.3
MPPNB	F		15.5		
MPPNB	F	46.8	15.4	12.3	15.1
MPPNB	fg	48.4	14.8	11.4	14.7
MPPNB	fg	40.9	12.7	10.4	11.6
MPPNB	uf		14.1		
LPPNB	F	45.3	15.8	12.6	15.2
LPPNB	F	36.8	13.3	11.8	13.6
LPPNB	F		15.9		
LPPNB	F	40.9	12.8	10.4	12.7
LPPNB	F	36.8	12.4	9.7	11.6
LPPNB	uf		14.4		
LPPNB/PPNC	F	41.7	14.2	11.1	13.8
LPPNB/PPNC	F	44.9	14.5	11.7	14.3
LPPNB/PPNC	F	40.1	12.6	10.4	12.6
LPPNB/PPNC	F	36.4	12.5	10.3	13.0
LPPNB/PPNC	F		15.1		
LPPNB/PPNC	F	41.4	15.2	11.7	14.5
PPNC	F	38.9	12.2	10.1	10.7
PPNC	F	41.9	14.3	11.6	14.1
PPNC	F	45.3	16.7	12.5	14.9
PPNC	F	39.6	13.5	11.9	13.6
PPNC	F	44.9	14.7	11.7	13.7
PPNC	F	42.6	14.7	11.1	11.7
PPNC	F	45.8	15.9	13.3	16.0
PPNC	F	39.9	13.2	9.6	11.7
PPNC	F	42.8	14.3	11.0	13.3
PPNC	F	38.2	11.9	9.5	11.2
PPNC	F	42.2	12.2	8.9	11.1

Table B.10 (cont): ‘Ain Ghazal Goat First Phalanx Measurements (mm)

Phase	Fusion	GLpe	Bp	SD	Bd
PPNC	F	37.7	13.8	11.9	14.0
PPNC	F		15.6		
PPNC	F		15.0		
PPNC	F	47.1	16.1	13.3	
PPNC	F		15.6		
PPNC	F		16.0		
PPNC	F		15.1		
PPNC	F	44.5	15.5	11.8	14.2
Yarmoukian	F	43.4	15.4	13.0	16.1
Yarmoukian	F	35.5	12.3	9.2	11.8
Yarmoukian	F		12.9		12.4
Yarmoukian	F		13.7	11.3	14.2
Yarmoukian	F	39.1	13.1	10.2	12.9
Yarmoukian	F	36.5	13.6	12.5	12.3
Yarmoukian	F	37.4	12.8	10.6	12.6
Yarmoukian	F	40.8	15.7	12.4	15.3
Yarmoukian	F		14.1		
Yarmoukian	F		12.7	10.9	12.6
Yarmoukian	F	35.4	13.1	11.9	13.1
Yarmoukian	F	34.7	12.3	9.8	11.2
Yarmoukian	F	36.6	13.5	10.9	13.9
Yarmoukian	F	42.8	13.5	10.9	12.7
Yarmoukian	F	36.1	13.1	11.7	12.9
Yarmoukian	F	34.0	11.1	9.0	9.9
Yarmoukian	F	36.0	12.4	10.6	12.2
Yarmoukian	F	35.1	12.1	10.3	11.7
Yarmoukian	F	40.2	14.4	11.1	13.7
Yarmoukian	F	36.4	13.6	11.8	13.3

Table B.10 (cont): 'Ain Ghazal Goat First Phalanx Measurements (mm)

Phase	DLS	Ld	MBS
MPPNB			5.7
MPPNB	37.1	29.0	5.9
MPPNB		29.3	5.6
MPPNB	35.5	27.8	5.2
MPPNB			6.3
MPPNB			5.0
MPPNB			4.8
MPPNB	42.3	35.2	7.4
MPPNB	34.8	27.3	4.1
MPPNB			5.3
MPPNB			5.3
MPPNB	39.3	32.2	5.6
MPPNB			4.2
MPPNB			4.5
MPPNB			5.5
MPPNB	24.1	16.8	3.3
MPPNB			5.1
MPPNB			6.9
MPPNB	39.2	31.2	7.2
MPPNB			7.1
MPPNB			5.2
MPPNB	40.6	33.9	7.1
MPPNB	38.0	29.4	5.8
LPPNB	36.6	29.9	5.8
LPPNB	36.3	30.2	5.9
LPPNB/PPNC	30.8	23.9	5.8
PPNC	33.8	28.8	5.7
PPNC	44.2	36.5	7.6
PPNC			3.6
PPNC	36.1	30.4	5.9
PPNC	40.8	34.0	7.0
PPNC	28.9	23.6	
PPNC	29.6	23.8	5.1
PPNC	29.9	25.1	4.9
PPNC			4.5
PPNC	32.0	25.4	
PPNC	36.3	30.5	7.0
Yarmoukian	34.5	29.0	6.1
Yarmoukian	31.9	25.5	5.4

Table B.11: 'Ain Ghazal Goat Distal Phalanx Measurements (mm)

Phase	Max BD	Min BD
MPPNB	31.8	23.8
MPPNB	35.0	24.0
LPPNB	33.3	24.9
PPNC	30.4	21.5
PPNC	30.7	20.9
Yarmoukian	38.5	23.0
Yarmoukian	36.8	20.9
Yarmoukian	38.4	22.8
Yarmoukian	30.1	18.0
Yarmoukian	35.6	23.3
Yarmoukian	32.1	20.4
Yarmoukian	33.9	21.2
Yarmoukian	27.6	18.0
Yarmoukian	31.4	19.4
Yarmoukian	29.8	17.6
Yarmoukian	31.7	20.1
Yarmoukian	34.6	19.5

Table B.12: 'Ain Ghazal Goat Basal Horncore Measurements (mm)

Phase	Fusion	SLC	BG	LG	GLP
MPPNB	F	19.8	20.1	27.2	34.4
LPPNB	F		21.7	28.1	35.7
LPPNB/PPNC	F		19.5	24.7	32.8
LPPNB/PPNC	F		20.5	24.4	
PPNC	F		21.1	28.0	33.9
PPNC	F			27.7	34.4
PPNC	F		20.3	25.6	31.1
PPNC	F		21.1	24.8	32.0
PPNC	F	21.6	21.4	26.2	33.1
PPNC	F	23.4	24.7	28.2	36.5
PPNC	F	21.6	21.4	29.2	33.9
PPNC	F	21.3	22.2	26.6	34.6
PPNC	F	21.7	23.4	29.3	38.2
PPNC	F	21.4	22.6	27.6	37.2
PPNC	F	20.0	21.4	26.4	34.4
PPNC	F	18.1	19.0	24.1	31.5
PPNC	F	17.8	20.3	24.4	32.8
PPNC	F	18.2	19.6	26.8	32.9
PPNC	F		22.5	28.2	38.0
PPNC	F	20.8		29.2	
PPNC	F		23.9	28.1	36.9
PPNC	F				35.0
PPNC	F		19.3	24.6	30.5
PPNC	F			28.7	
PPNC	F		20.4	27.0	35.0
Yarmoukian	F		21.4	26.6	34.6
Yarmoukian	F	21.6	19.9	25.7	33.4
Yarmoukian	F	20.0	20.5	25.4	31.3
Yarmoukian	F	17.3	19.9	24.6	30.9
Yarmoukian	F		19.5	26.2	32.6
Yarmoukian	F		20.4	27.2	32.6
Yarmoukian	F		23.7		
Yarmoukian	F			30.7	38.9
Yarmoukian	F		19.7	25.1	30.6
Yarmoukian	F		23.0	30.4	
Yarmoukian	F		17.9	22.8	29.8
Yarmoukian	F		22.5	27.1	33.7
Yarmoukian	F		21.8	28.2	36.9
Yarmoukian	F		21.2	26.5	34.0
Yarmoukian	F	18.2	20.4	26.2	33.6
Yarmoukian	F	20.7	22.3	25.8	
Yarmoukian	fg		20.0	25.9	32.3
Yarmoukian	fg			26.1	32.7

Table B13: 'Ain Ghazal Sheep Scapula Measurements (mm)

Phase	Fusion	Bd
MPPNB	F	32.4
LPPNB	F	37.1
LPPNB	F	29.8
LPPNB	fg	28.9
LPPNB/PPNC	F	33.5
LPPNB/PPNC	F	31.9
LPPNB/PPNC	F	31.9
LPPNB/PPNC	F	31.2
LPPNB/PPNC	F	32.1
LPPNB/PPNC	F	28.5
LPPNB/PPNC	fg	30.9
PPNC	F	35.2
PPNC	F	35.6
PPNC	F	31.8
PPNC	F	37.7
PPNC	F	31.1
PPNC	F	31.5
PPNC	F	32.6
PPNC	F	29.1
PPNC	F	30.5
PPNC	F	29.2
PPNC	F	33.4
PPNC	F	29.6
PPNC	F	32.8
PPNC	F	32.9
PPNC	F	31.2
PPNC	F	33.7
PPNC	F	34.6
PPNC	F	30.5
PPNC	F	34.2
PPNC	F	29.9
PPNC	F	31.8
PPNC	F	30.6
PPNC	F	31.2
PPNC	F	33.1
PPNC	F	31.6
PPNC	F	32.3
PPNC	F	32.4
PPNC	F	31.5
PPNC	F	34.6
PPNC	F	33.1
PPNC	F	33.5
PPNC	F	33.3
PPNC	F	31.7
PPNC	F	34.8
PPNC	F	29.7
PPNC	F	35.7
PPNC	F	30.0
PPNC	F	34.5

Table B.14: 'Ain Ghazal Sheep Humerus Measurements (mm)

Phase	Fusion	Bd
PPNC	fg	26.7
PPNC	fg	30.0
Yarmoukian	F	32.4
Yarmoukian	F	31.3
Yarmoukian	F	32.7
Yarmoukian	F	29.2
Yarmoukian	F	32.5
Yarmoukian	F	29.4
Yarmoukian	F	32.0
Yarmoukian	F	33.3
Yarmoukian	F	30.1
Yarmoukian	F	29.1
Yarmoukian	F	32.4
Yarmoukian	F	30.2
Yarmoukian	F	32.7
Yarmoukian	F	30.4
Yarmoukian	F	31.6
Yarmoukian	F	30.9
Yarmoukian	F	29.3
Yarmoukian	F	31.6
Yarmoukian	F	29.1
Yarmoukian	F	29.2
Yarmoukian	F	28.1
Yarmoukian	F	31.7
Yarmoukian	F	34.9
Yarmoukian	F	30.3
Yarmoukian	F	30.8
Yarmoukian	F	34.1
Yarmoukian	F	31.2
Yarmoukian	F	29.5
Yarmoukian	F	32.0
Yarmoukian	F	33.0
Yarmoukian	fg	28.2

Table B.14 (cont): 'Ain Ghazal Sheep Humerus Measurements (mm)

Phase	Fusion	Bd	BFd
LPPNB	F	28.4	26.0
LPPNB	uf	31.9	26.2
LPPNB	uf	29.8	25.5
LPPNB	uf		26.9
LPPNB/PPNC	F	28.7	24.3
LPPNB/PPNC	F	30.8	25.0
LPPNB/PPNC	fg	30.9	25.8
PPNC	F	31.8	26.4
PPNC	F	28.8	24.6
PPNC	F	29.5	24.5
PPNC	F		24.9
PPNC	F	29.3	23.0
PPNC	F	29.8	24.3
PPNC	F	31.7	28.4
PPNC	F	31.1	26.2
PPNC	F	29.6	25.9
PPNC	F	26.5	22.5
PPNC	F	29.4	24.5
PPNC	uf	27.6	24.1
PPNC	uf	28.5	23.4
PPNC	uf	25.9	22.4
PPNC	uf		26.8
PPNC	uf	30.1	23.3
PPNC	uf	28.7	
PPNC	uf	29.8	26.4
PPNC	uf	27.4	25.2
PPNC	uf	29.7	25.6
PPNC	uf	27.1	24.8
PPNC	uf		26.2
PPNC	uf	34.1	27.0
Yarmoukian	F	30.0	25.6
Yarmoukian	F	27.9	23.2
Yarmoukian	F	27.8	24.1
Yarmoukian	F	29.2	24.6
Yarmoukian	F	28.9	24.1
Yarmoukian	F	27.6	25.8
Yarmoukian	uf	26.7	22.2
Yarmoukian	uf	24.9	23.2
Yarmoukian	uf	30.3	26.0

Table B.15: 'Ain Ghazal Sheep Radius Measurements (mm)

Phase	Fusion	Bd	W.troch (Med)	W.cond (Med)	W.troch (Lat)	W.cond (Lat)	W.troch (?)	W.cond (?)
LPPNB	?						10.7	11.7
LPPNB	F						12.3	12.1
LPPNB	F						10.8	10.9
LPPNB	uf						12.1	11.6
LPPNB	uf	27.6	12.1	12.0	11.5	11.4		
LPPNB/PPNC	F	26.6	11.5	11.9	10.9	11.5		
LPPNB/PPNC	F						12.1	12.1
LPPNB/PPNC	F	24.6	11.1	10.5	10.4	9.9		
LPPNB/PPNC	F						11.9	12.3
LPPNB/PPNC	F						12.1	12.0
LPPNB/PPNC	F		12.0	12.1				
LPPNB/PPNC	uf						11.3	11.5
LPPNB/PPNC	uf	29.7	12.4	13.0	11.9	12.8		
LPPNB/PPNC	uf		12.6	11.9	12.0	11.6		
LPPNB/PPNC	uf						12.7	12.2
PPNC	?						12.6	12.7
PPNC	F	28.8	11.4	12.4	11.3	12.1		
PPNC	F	25.6	11.3	11.3	11.4			
PPNC	F						12.4	12.4
PPNC	F	24.4	11.2	11.5	10.5	10.5		
PPNC	F				10.4	10.3		
PPNC	F	28.4	12.6	12.8	11.7	12.4		
PPNC	F	30.0	13.1	13.3				
PPNC	F	24.9	11.4	10.8	10.9	10.8		
PPNC	F	24.5	11.2	11.1	10.6	10.6		
PPNC	F						11.9	11.3
PPNC	F				10.6	11.3		
PPNC	F	24.3	12.0	11.3	11.0	10.6		
PPNC	F	27.4	13.2	12.9	12.6	12.9		
PPNC	F		10.9	10.5	10.6	10.4		
PPNC	F	28.8	12.1	12.8	12.2	12.9		
PPNC	F	28.6	12.2	12.9	11.9	12.9		
PPNC	F						10.8	11.2
PPNC	F						12.4	12.1
PPNC	F						11.2	11.9
PPNC	F						11.9	12.0
PPNC	F						10.7	10.9
PPNC	F						10.8	11.1
PPNC	F						12.3	12.5
PPNC	F	29.4	13.0	13.0	12.2	12.5		
PPNC	F						12.1	11.8
PPNC	uf						10.7	11.4
PPNC	uf						12.0	12.6
PPNC	uf						11.1	10.8
PPNC	uf						10.8	11.9
PPNC	uf						11.7	11.7
PPNC	uf	27.3	11.8	11.5	11.0	10.8		
PPNC	uf						12.3	12.5

Table B.16: 'Ain Ghazal Sheep Metacarpal Measurements (mm)

Phase	Fusion	Bd	W.troch (Med)	W.cond (Med)	W.troch (Lat)	W.cond (Lat)	W.troch (?)	W.cond (?)
PPNC	uf						12.1	12.3
PPNC	uf						11.9	12.5
PPNC	uf						12.2	11.3
PPNC	uf						11.7	11.3
PPNC	uf						10.7	10.3
Yarmoukian	?						13.1	13.3
Yarmoukian	F	24.6	11.0	11.5	10.0	11.1		
Yarmoukian	F	24.8	10.7	11.3	10.2	11.4		
Yarmoukian	F	29.1	13.3	13.2	12.8	13.1		
Yarmoukian	F	25.0						
Yarmoukian	F	24.8	11.1	11.1	10.5	11.2		
Yarmoukian	F	25.6	11.9	12.0	11.4	11.3		
Yarmoukian	F	25.5	11.8	11.6	10.8	11.4		
Yarmoukian	F	26.8	12.7	12.5	12.0	12.2		
Yarmoukian	F	24.3	11.9	11.5	11.6	11.2		
Yarmoukian	F	26.1	11.0	11.6	10.3	10.9		
Yarmoukian	F						11.2	11.5
Yarmoukian	F						10.6	10.8
Yarmoukian	F	28.9	12.3	12.5	11.7	12.6		
Yarmoukian	F						11.5	11.3
Yarmoukian	F	25.1	11.9	11.3	11.3	11.1		
Yarmoukian	F	25.9	11.7	11.5	11.0	11.8		
Yarmoukian	F	25.0	11.5	11.4	10.8	10.9		
Yarmoukian	F						11.6	11.7
Yarmoukian	F	23.6	10.2	11.3	9.7	10.8		
Yarmoukian	uf						12.2	12.3
Yarmoukian	uf						11.9	11.3
Yarmoukian	uf						11.4	10.8
Yarmoukian	uf						11.3	11.6

Table B.16 (cont): 'Ain Ghazal Sheep Metacarpal Measurements (mm)

Phase	Fusion	Bd
PPNC	F	42.1
Yarmoukian	F	37.2

Table B.17: 'Ain Ghazal Sheep Femur Measurements (mm)

Phase	Fusion	Bd
LPPNB	?	25.9
LPPNB	F	25.6
LPPNB	F	25.3
LPPNB	F	27.5
LPPNB	F	27.6
LPPNB/PPNC	F	28.6
LPPNB/PPNC	F	25.4
LPPNB/PPNC	F	29.0
LPPNB/PPNC	F	24.9
LPPNB/PPNC	F	25.2
PPNC	F	26.8
PPNC	F	27.5
PPNC	F	26.6
PPNC	F	27.1
PPNC	F	26.1
PPNC	F	27.0
PPNC	F	27.9
PPNC	F	28.4
PPNC	F	27.3
PPNC	F	25.4
PPNC	F	27.1
PPNC	F	25.7
PPNC	F	26.4
PPNC	F	27.2
PPNC	F	28.5
PPNC	F	27.5
PPNC	F	26.3
PPNC	F	29.3
PPNC	uf	25.7
PPNC	uf	28.0
PPNC	uf	23.1
Yarmoukian	F	28.5
Yarmoukian	F	27.2
Yarmoukian	F	26.8
Yarmoukian	F	24.3
Yarmoukian	F	27.4
Yarmoukian	F	27.2
Yarmoukian	F	25.1
Yarmoukian	F	29.1
Yarmoukian	F	25.8
Yarmoukian	F	25.9
Yarmoukian	F	24.5
Yarmoukian	F	26.2
Yarmoukian	F	25.6
Yarmoukian	F	27.2

Table B.18: 'Ain Ghazal Sheep Tibia Measurements (mm)

Phase	GLl	GLm	Dl	Bd
MPPNB	28.2	26.8	16.1	18.5
LPPNB	31.6	29.9	17.9	19.7
LPPNB	30.8	29.4	17.2	19.0
LPPNB	27.8	26.9	15.9	17.1
LPPNB	30.2	28.9	17.6	19.4
LPPNB	29.3	28.1	16.4	18.7
LPPNB	27.7	26.3	16.4	17.3
LPPNB	31.9	29.5	17.5	19.1
LPPNB/PPNC	29.1		16.4	18.3
LPPNB/PPNC	29.6	28.8	17.2	18.8
LPPNB/PPNC	30.5	29.1	17.3	19.5
LPPNB/PPNC	31.8	29.7	18.5	20.3
LPPNB/PPNC	31.1	28.9	17.4	20.4
LPPNB/PPNC	28.9	28.3	17.4	19.9
LPPNB/PPNC	28.1	27.4	16.3	17.3
LPPNB/PPNC	31.8	29.8	17.8	20.0
LPPNB/PPNC	20.4	19.3	18.7	19.8
LPPNB/PPNC	29.9		15.3	
PPNC	28.0	26.7	15.9	18.4
PPNC		28.6		19.8
PPNC	31.2	29.1	18.3	21.0
PPNC	29.1	27.7	16.6	18.5
PPNC	26.6	25.1	15.9	18.4
PPNC	28.1	26.6	16.2	18.5
PPNC	31.3		18.4	
PPNC	29.5	28.4	17.2	
PPNC		26.8		
PPNC	30.2	28.9	17.6	19.4
PPNC	29.9	29.1	17.0	
PPNC	29.1	27.6	17.8	18.7
PPNC	32.1	29.9	18.5	19.8
PPNC	33.4	32.1	18.5	20.4
PPNC		28.6		18.9
PPNC	31.8	29.8	17.9	19.8
PPNC	29.2	28.7	16.9	18.9
PPNC	30.5	29.2	17.4	20.0
PPNC	29.0	26.8	17.1	18.5
PPNC	29.6	28.2	16.8	18.8
PPNC			17.0	
PPNC	27.3	27.1	15.5	17.4
PPNC	28.3	27.2	16.2	19.9
PPNC	30.7	29.0	17.2	19.2
PPNC	29.3	28.1	17.0	19.8
PPNC	30.0	28.7	16.8	18.3
PPNC	27.9	26.5	15.7	17.9
PPNC	29.1	28.0	17.3	19.5
PPNC	30.1	29.2	17.3	19.5
PPNC		28.5		19.8
PPNC	30.9	29.7		19.5

Table B.19: ‘Ain Ghazal Sheep Astragalus Measurements (mm)

Phase	GLl	GLm	Dl	Bd
PPNC	29.4	28.7	16.9	19.4
PPNC	31.7	30.2	18.7	21.2
PPNC	29.7	28.7	16.9	18.7
PPNC	29.9	28.0	16.0	18.4
PPNC	27.2	26.7	15.9	18.5
PPNC	25.7	24.8	14.6	15.4
PPNC	32.8	31.0	18.1	20.0
PPNC	33.2		19.6	21.0
PPNC	29.0	28.3	16.9	18.6
PPNC	29.0	27.6	16.9	19.3
PPNC	30.1	29.3	18.0	19.5
PPNC	31.1	30.0	17.3	19.2
PPNC	29.9	29.0	17.3	18.9
PPNC	29.2	28.7	17.5	20.3
PPNC	32.5	30.6	17.9	19.3
PPNC	32.9	31.7	19.2	21.1
Yarmoukian	29.9	27.8	16.7	18.1
Yarmoukian	29.4	27.9	17.1	20.6
Yarmoukian	30.7	29.9	17.0	18.9
Yarmoukian	29.5	27.6	16.9	19.6
Yarmoukian		29.6	17.7	21.1
Yarmoukian	30.7	28.9	18.0	20.1
Yarmoukian	32.4	30.2	19.2	21.4
Yarmoukian	28.2	27.2	16.9	18.5
Yarmoukian	32.0	30.4	18.6	21.1
Yarmoukian	28.5	27.4	16.6	17.8
Yarmoukian		28.4		19.0
Yarmoukian		26.4	16.5	18.6
Yarmoukian	31.9	30.3	18.3	20.0
Yarmoukian	30.3	28.6	17.7	20.4
Yarmoukian	28.9	26.5		
Yarmoukian	28.4	27.2	16.2	18.1
Yarmoukian	28.2	26.5	16.2	18.5
Yarmoukian	27.8	26.0	15.6	18.8
Yarmoukian		27.7		18.5
Yarmoukian		28.7	17.3	
Yarmoukian	29.3	28.1	16.1	18.5
Yarmoukian	30.7		16.5	
Yarmoukian	19.3	17.8	16.6	18.5
Yarmoukian	30.0	28.5	16.4	19.4
Yarmoukian	29.9	28.6	16.8	
Yarmoukian	34.4	32.8	19.4	22.6
Yarmoukian	31.5	30.9	18.8	21.3
Yarmoukian	30.8	29.3	18.3	20.6
Yarmoukian			17.6	
Yarmoukian	29.4	27.9	16.8	17.6

Table B.19 (cont): 'Ain Ghazal Sheep Astragalus Measurements (mm)

Phase	Fusion	GL	GB
LPPNB	uf		20.5
LPPNB	uf		21.2
LPPNB/PPNC	F		19.2
LPPNB/PPNC	?		20.3
PPNC	F	65.2	21.0
PPNC	F	57.5	20.9
PPNC	uf		18.8
PPNC	F		19.8
PPNC	uf		19.8
PPNC	F		22.2
PPNC	F	58.8	20.8
PPNC	uf		20.7
PPNC	F		19.7
PPNC	?		21.2
PPNC	F	64.2	22.1
PPNC	F	62.9	21.7
PPNC	?		18.8
PPNC	F	61.5	21.7
PPNC	uf		19.8
PPNC	?		20.7
PPNC	F	65.1	22.4
PPNC	F	61.2	
PPNC	F	63.7	20.3
Yarmoukian	F	57.8	21.1
Yarmoukian	F	58.1	21.8
Yarmoukian	F		21.5
Yarmoukian	F	54.4	19.6
Yarmoukian	F	57.4	19.2
Yarmoukian	F	54.5	18.8
Yarmoukian	F	57.5	
Yarmoukian	F	58.7	19.2
Yarmoukian	F	54.5	20.3
Yarmoukian	F	70.5	24.3
Yarmoukian	uf		20.2
Yarmoukian	uf		19.1
Yarmoukian	?		20.9

Table B.20: 'Ain Ghazal Sheep Calcaneum Measurements (mm)

Phase	Fusion	Bd	W.troch (Med)	W.cond (Med)	W.troch (Lat)	W.cond (Lat)	W.troch (?)	W.cond (?)
LPPNB	F						10.1	10.4
LPPNB	F						10.4	9.6
LPPNB/PPNC	F	26.7	12.2	12.6	11.7	11.5		
LPPNB/PPNC	F	23.1	11.1	10.8	10.5	9.9		
LPPNB/PPNC	F	23.9	10.5	11.4	10.1	10.5		
LPPNB/PPNC	F						11.7	12.1
LPPNB/PPNC	F						11.1	11.0
LPPNB/PPNC	F						10.6	10.6
LPPNB/PPNC	uf						10.8	10.5
LPPNB/PPNC	uf						10.5	10.2
LPPNB/PPNC	uf						10.8	10.2
LPPNB/PPNC	uf						9.1	10.4
PPNC	F				9.9	10.1		
PPNC	F				11.1	11.3		
PPNC	F	23.9						
PPNC	F	25.4	11.5	11.5	10.9	10.6		
PPNC	F	26.3	11.5	12.2	10.9	11.1		
PPNC	F	25.7	11.8	11.9	11.4	10.6		
PPNC	F	26.3	11.5	12.1	10.7	11.4		
PPNC	F	25.4	10.9	11.5	10.9	10.7		
PPNC	F				10.4	9.5		
PPNC	F						11.0	10.0
PPNC	F						11.1	10.9
PPNC	F						12.0	12.6
PPNC	F	25.3	10.6		10.1	10.1		
PPNC	F	24.7	11.3	11.4	10.5	10.2		
PPNC	F						11.5	11.0
PPNC	F						10.8	10.7
PPNC	F	25.7	11.5	11.5	10.8	10.7		
PPNC	F	27.0	11.3	12.0	10.9	11.3		
PPNC	F	27.4	11.9	12.4	11.5	11.7		
PPNC	F	25.4	11.5	11.7	11.1	10.8		
PPNC	F		11.2	11.1	10.5	10.0		
PPNC	uf						12.2	12.0
PPNC	uf		11.0	11.3	10.8	10.3		
PPNC	uf						10.4	10.2
PPNC	uf						11.5	11.7
PPNC	uf		12.2	12.3	11.5	11.2		
PPNC	uf						10.3	10.4
PPNC	uf		12.2	11.9	11.5	11.6		
PPNC	uf						11.2	12.1
PPNC	uf						11.0	11.0
PPNC	uf	25.3	11.3	11.2	10.4	10.5		
PPNC	uf						10.7	10.6
Yarmoukian	F	25.2	11.3	11.6	10.6	10.4		
Yarmoukian	F	23.6	10.3	11.0	9.9	10.5		
Yarmoukian	F	24.5	10.8	11.0	10.6	9.9		
Yarmoukian	F						12.4	12.1
Yarmoukian	F						10.0	11.0
Yarmoukian	F	28.0	12.8	13.1	12.7	12.5		

Table B.21: 'Ain Ghazal Sheep Metatarsal Measurements (mm)

Phase	Fusion	Bd	W.troch (Med)	W.cond (Med)	W.troch (Lat)	W.cond (Lat)	W.troch (?)	W.cond (?)
Yarmoukian	F				11.5	11.1		
Yarmoukian	F						12.6	12.5
Yarmoukian	F	24.1	12.2	11.1	11.5	10.0		
Yarmoukian	F						10.6	10.9
Yarmoukian	F	24.4	10.6	10.7	10.3	9.7		
Yarmoukian	F						11.7	12.2
Yarmoukian	F	29.8						
Yarmoukian	F	25.1	10.3	10.9				
Yarmoukian	F						11.2	11.5
Yarmoukian	F	22.7	10.1	10.1	9.7	9.3		
Yarmoukian	F	23.5	11.0	11.1				
Yarmoukian	F	24.1	10.2	10.9	10.2	10.2		
Yarmoukian	F	22.7	9.9	10.3	9.3	9.9		
Yarmoukian	F	25.0	10.6	11.1	10.3	10.5		
Yarmoukian	F	24.8	11.6	11.0	10.5	10.7		
Yarmoukian	uf						12.0	11.8
Yarmoukian	uf						11.3	10.9
Yarmoukian	uf						10.6	10.8
Yarmoukian	uf						9.2	9.2
Yarmoukian	uf	25.3	11.1	11.1	10.5	10.5		

Table B.21 (cont): 'Ain Ghazal Sheep Metatarsal Measurements (mm)

Phase	Fusion	GLpe	Bp	SD	Bd
LPPNB	F	38.6	11.2	8.0	10.3
LPPNB	F	41.6	13.2	11.0	13.7
LPPNB/PPNC	F	44.1	12.8	10.3	
LPPNB/PPNC	F		11.7		
LPPNB/PPNC	F	38.4	11.5	8.3	10.9
LPPNB/PPNC	F	38.1	12.1	8.4	10.7
LPPNB/PPNC	F	36.8	11.7		12.2
LPPNB/PPNC	F	34.9	11.1	8.9	10.1
PPNC	F	40.6	13.4	10.5	12.7
PPNC	F	42.7	12.7	9.7	12.0
PPNC	F		12.4		
PPNC	F	41.4	12.8	9.8	12.0
PPNC	F	41.2	12.9	10.2	12.3
PPNC	F	39.1	11.8	8.7	10.7
PPNC	F	36.8	10.9	8.5	10.7
PPNC	F	39.2	12.8	10.4	11.3
PPNC	F		14.2		
PPNC	F		12.0		
PPNC	F		12.7		
PPNC	F	46.8	14.3	12.2	14.7
PPNC	F	43.3	13.0	11.1	13.3
PPNC	F	41.1	13.9	11.2	13.3
PPNC	F	40.0	12.0	9.3	11.4
PPNC	F	41.2	12.7	11.0	13.1
PPNC	F		13.6		
PPNC	F				12.8
PPNC	F		13.9		
PPNC	F		13.7		
PPNC	F	37.6	12.1	9.7	12.0
PPNC	F	40.7	13.7	10.3	12.7
PPNC	F	37.6	11.4	9.3	11.9
PPNC	F	38.2	12.1	8.9	11.1
PPNC	F	39.4	11.3	8.9	10.9
PPNC	F	37.6	11.5	8.4	10.5
PPNC	F	38.4	12.1	9.1	10.6
PPNC	F	36.0	11.4	8.6	10.8
PPNC	F	36.3	10.9	8.2	10.3
PPNC	F		13.0		
PPNC	F		12.6		
PPNC	F	39.0	12.3	8.9	11.2
PPNC	fg	37.9	11.6	9.8	11.9
PPNC	fg		12.5	9.5	
PPNC	uf				12.2
PPNC	uf		11.7		
Yarmoukian	F	37.2	12.6	8.9	11.0
Yarmoukian	F	34.9	13.1	10.2	11.8
Yarmoukian	F	36.9	11.5	8.9	11.0
Yarmoukian	F	40.9	12.5	10.4	12.3
Yarmoukian	F	43.1	13.9	11.1	13.4
Yarmoukian	F	33.2	10.5	8.2	10.3

Table B.22: 'Ain Ghazal Sheep First Phalanx Measurements (mm)

Phase	Fusion	GLpe	Bp	SD	Bd
Yarmoukian	F				11.6
Yarmoukian	F	40.1	12.0	8.9	11.6
Yarmoukian	F	37.9	13.2	11.4	13.5
Yarmoukian	F	37.3	13.1		
Yarmoukian	F	35.8	11.2	8.2	
Yarmoukian	F	37.7	11.8	8.9	10.9
Yarmoukian	F	35.2	10.7	8.5	10.6
Yarmoukian	F	34.8	11.2	8.6	10.5
Yarmoukian	F	39.8	11.4	9.7	11.0
Yarmoukian	F	35.7	10.8	8.1	10.0
Yarmoukian	F	40.5	13.5	11.1	12.4
Yarmoukian	F		12.1		11.2
Yarmoukian	F	35.2	11.5	9.8	11.8
Yarmoukian	F	37.4	11.6	8.4	10.8
Yarmoukian	F	38.4	12.3	9.2	11.4
Yarmoukian	F	40.8	13.4	10.4	12.4
Yarmoukian	F	39.7	12.0	9.2	11.6
Yarmoukian	F		13.0		
Yarmoukian	F		11.9		
Yarmoukian	fg		12.2		
Yarmoukian	fg		12.5	9.8	12.4

Table B.22 (cont): ‘Ain Ghazal Sheep First Phalanx Measurements (mm)

Phase	DLS	Ld	MBS
LPPNB	28.1	23.6	5.2
LPPNB	32.7	25.7	6.4
LPPNB			6.1
LPPNB			6.1
LPPNB/PPNC	27.8	22.9	5.7
PPNC	32.1	25.8	7.1
PPNC			6.4
PPNC	31.9	25.7	6.6
PPNC	27.8	23.2	5.1
PPNC	27.2	21.7	5.2
PPNC	29.5	23.4	5.3
PPNC			5.4
PPNC	37.0	29.7	6.9
PPNC	37.6	30.7	6.8
PPNC	33.1	28.1	5.9
PPNC			6.5
PPNC			5.5
PPNC	33.8	27.8	6.4
PPNC	30.0	24.6	6.3
Yarmoukian			7.4
Yarmoukian	40.9	33.4	7.9
Yarmoukian	34.1	26.3	6.6
Yarmoukian	25.2	20.0	5.3

Table B.23: 'Ain Ghazal Sheep Third Phalanx Measurements (mm)

APPENDIX C

Bone Counts Obtained in this Analysis of the 'Ain Ghazal Faunal Assemblage by Phase (NISP and adjusted NISP)

		Gt	Gt	Gt	Gt	Gt	Sp	Sp	Sp	Sp	Sp	Gt/Sp	Gt/Sp	Gt/Sp	Gt/Sp	Gt/Sp	Gz	Gz	Gz	Gz	Gz	SR	SR	SR	SR	SR	Ct	Ct	Ct	Ct	Ct	Pg	Pg	Pg	Pg	Pg	Eq	Eq	Eq	Eq	Eq
POSAC	**Side**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**
Scapula	Left		1	21	2	**24**					**0**	10		14	4	**28**	3	1	34	1	**39**	5		3	4	**12**					**0**	2		1	1	**4**					**0**
Scapula	Right			13	1	**14**			1		**1**	10		9	5	**24**	3		20	2	**25**	8		3	1	**12**	1		1	1	**3**	5		4	1	**10**					**0**
Scapula	Unknown				1	**1**					**0**					**0**					**0**					**0**					**0**					**0**					**0**
Humerus	Left		1	50		**51**			1		**1**	4	8	27	1	**40**	1	6	36		**43**	2	3	9		**14**	1		7		**8**	1	1			**2**					**0**
Humerus	Right		7	35		**42**					**0**	5	4	23		**32**	1	8	47	1	**57**	3	1	7	1	**12**			5		**5**	2		3		**5**					**0**
Humerus	Unknown					**0**					**0**					**0**					**0**	1				**1**	1				**1**	2				**2**					**0**
Radius	Left	27	4	6		**37**					**0**	5	1	3		**9**	4		9		**13**			1	1	**2**	1				**1**			1		**1**					**0**
Radius	Right	23	2	4		**29**					**0**	5		1	1	**7**	2		8	1	**11**	1				**1**			4		**4**	2				**2**					**0**
Radius	Unknown					**0**					**0**					**0**					**0**					**0**					**0**					**0**					**0**
Pubis	Left	2		15	9	**26**					**0**			4	1	**5**	10		15	3	**28**	5		3	1	**9**	2		3		**5**	1		4	2	**7**					**0**
Pubis	Right	2		6	5	**13**					**0**	2		3	3	**8**	5		13	9	**27**	1		3	9	**13**			1		**1**	2			2	**4**					**0**
Pubis	Unknown					**0**					**0**					**0**					**0**					**0**					**0**					**0**					**0**
Femur	Left		1			**1**					**0**	11	2	6		**19**	4	1	4		**9**	6		2		**8**				1	**1**	2				**2**				1	**1**
Femur	Right	3	1			**4**					**0**	11	1	6		**18**	12		6		**18**	9		4	1	**14**					**0**		1			**1**					**0**
Femur	Unknown					**0**					**0**					**0**					**0**					**0**					**0**					**0**					**0**
Tibia	Left	7	4	22		**33**			1		**1**	15	1	19		**35**	4	1	15		**20**	1		2		**3**	1				**1**	4	1	2		**7**					**0**
Tibia	Right	11	5	22	1	**39**					**0**	9	1	10		**20**	5	1	18		**24**			4		**4**			1		**1**			2		**2**					**0**
Tibia	Unknown					**0**					**0**					**0**	1				**1**					**0**					**0**					**0**					**0**
Metacarpal	Left	8	2	15		**25**					**0**					**0**	1		4		**5**					**0**	1				**1**					**0**					**0**
Metacarpal	Right	9	1	17		**27**					**0**				1	**1**			6		**6**					**0**			2		**2**					**0**					**0**
Metacarpal	Unknown	1		1		**2**					**0**	1				**1**	2	1	14	1	**18**					**0**	1		2		**3**					**0**					**0**
Metacarpal 1/2	L.Med/R.Lat	39		12	6	**57**					**0**					**0**	6		3	2	**11**					**0**			1		**1**					**0**					**0**
Metacarpal 1/2	R.Med/L.Lat	35		18		**53**					**0**	2				**2**	8		11	2	**21**					**0**			1		**1**			1		**1**					**0**
Metacarpal 1/2	Unknown		3	5		**8**					**0**					**0**			2		**2**					**0**					**0**					**0**					**0**
Metatarsal	Left	8	3	20	1	**32**					**0**			1		**1**			6		**6**					**0**	2				**2**					**0**					**0**
Metatarsal	Right	12	3	19		**34**					**0**	1		1		**2**			8		**8**					**0**	1		1		**2**					**0**					**0**
Metatarsal	Unknown	2				**2**					**0**					**0**	1		8		**9**					**0**					**0**					**0**					**0**
Metatarsal 1/2	L.Med/R.Lat	14		3	3	**20**	1				**1**					**0**	2		8		**10**					**0**					**0**	2		3		**5**					**0**
Metatarsal 1/2	R.Med/L.Lat	30		3	2	**35**			1		**1**	4		2	1	**7**	4		7		**11**	2				**2**					**0**	2		1		**3**					**0**
Metatarsal 1/2	Unknown					**0**					**0**					**0**			1		**1**					**0**					**0**					**0**					**0**
Metapodial	Left	1		1		**2**					**0**					**0**					**0**					**0**			1		**1**					**0**					**0**
Metapodial	Right					**0**					**0**					**0**			2		**2**					**0**					**0**					**0**					**0**
Metapodial	Unknown					**0**					**0**					**0**	1				**1**					**0**					**0**					**0**					**0**
Metapodial 1/2	L.Med/R.Lat	9		6	2	**17**					**0**	11		1		**12**	3		6	1	**10**	4				**4**	3		1		**4**	3		2		**5**					**0**
Metapodial 1/2	R.Med/L.Lat	11	1	6	1	**19**					**0**	6		1	1	**8**	3		9	2	**14**	4		2	2	**8**			2		**2**	1		6		**7**					**0**
Metapodial 1/2	Unknown			1	2	**3**					**0**			1	1	**2**					**0**					**0**			2	2	**4**	1				**1**					**0**
First Phalanx	L.Med/R.Lat	4	3	94		**101**					**0**	23	5	78		**106**	5	2	65		**72**	2		3		**5**	3	1	12		**16**	4	2	5		**11**					**0**
First Phalanx	R.Med/L.Lat	2	2	122		**126**					**0**	21	8	58	1	**88**	1	2	76		**79**	3		5		**8**	2		20		**22**	3	1	4		**8**					**0**
First Phalanx	Unknown					**0**					**0**					**0**				1	**1**					**0**					**0**	1		2		**3**			1		**1**
Third Phalanx	L.Med/R.Lat				65	**65**					**0**				100	**100**				60	**60**				7	**7**				22	**22**				3	**3**					**0**
Third Phalanx	R.Med/L.Lat				60	**60**					**0**				90	**90**				60	**60**				6	**6**				16	**16**				3	**3**					**0**
Third Phalanx	Unknown					**0**					**0**					**0**					**0**					**0**					**0**					**0**					**0**
Astragalus	Left				67	**67**				1	**1**				31	**31**				22	**22**				7	**7**				6	**6**				3	**3**				1	**1**
Astragalus	Right				92	**92**					**0**				25	**25**				23	**23**				4	**4**				3	**3**				3	**3**					**0**
Astragalus	Unknown					**0**					**0**					**0**					**0**					**0**					**0**					**0**					**0**
Calcaneum	Left	23		13	5	**41**					**0**	10		2	10	**22**	9		17	6	**32**	6		2	6	**14**				4	**4**	1		1	2	**4**			1		**1**
Calcaneum	Right	18	1	13	4	**36**	2				**2**	17		2	7	**26**	3		11	6	**20**	12				**12**				4	**4**			4	4	**8**					**0**
Calcaneum	Unknown					**0**					**0**					**0**					**0**					**0**					**0**					**0**					**0**
Mandible with teeth	Left				1	**1**					**0**				20	**20**				5	**5**					**0**					**0**				1	**1**					**0**
Mandible with teeth	Right				1	**1**					**0**				30	**30**				6	**6**				1	**1**					**0**					**0**					**0**
Mandible with teeth	Unknown					**0**					**0**					**0**					**0**					**0**					**0**				2	**2**					**0**
	TOTAL					**1240**					**8**					**819**					**830**					**183**					**147**					**120**					**4**

		Gt	Gt	Gt	Gt	Gt	Sp	Sp	Sp	Sp	Sp	OC	OC	OC	OC	OC	Gz	Gz	Gz	Gz	Gz	SR	SR	SR	SR	SR	Ct	Ct	Ct	Ct	Ct	Pg	Pg	Pg	Pg	Pg	Eq	Eq	Eq	Eq	Eq
Non POSAC	**Side**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**
Mandibular tooth	Left					**0**					**0**				27	**27**				7	**7**				3	**3**				2	**2**					**0**					**0**
Mandibular tooth	Right				2	**2**					**0**				26	**26**				2	**2**				3	**3**				5	**5**					**0**					**0**
Mandibular tooth	Unknown					**0**					**0**					**0**					**0**					**0**					**0**				14	**14**				1	**1**
Horncore	Left				15	**15**					**0**				1	**1**				10	**10**					**0**					**0**					**0**					**0**
Horncore	Right				8	**8**					**0**				1	**1**				10	**10**					**0**					**0**					**0**					**0**
Horncore	Unknown				1	**1**					**0**				9	**9**				12	**12**				10	**10**				2	**2**					**0**					**0**
	TOTAL					**26**					**0**					**64**					**41**					**16**					**9**					**14**					**1**

Species	**NISP**	**%**
Goat	1240	37.0
Sheep	8	0.2
Goat/Sheep	819	24.4
Gazelle	830	24.8
Small Ruminant	183	5.5
Cattle	147	4.4
Pig	120	3.6
Equid	4	0.1
TOTAL	**3351**	**100.0**

Table C.1: 'Ain Ghazal Middle PPNB Bone Counts (NISP)

		Gt	Gt	Gt	Gt	Gt	Sp	Sp	Sp	Sp	Sp	Gt/Sp	Gt/Sp	Gt/Sp	Gt/Sp	Gt/Sp	Gz	Gz	Gz	Gz	Gz	SR	SR	SR	SR	SR	Ct	Ct	Ct	Ct	Ct	Pg	Pg	Pg	Pg	Pg	Eq	Eq	Eq	Eq	Eq
POSAC	**Side**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**
Scapula	Left		1	21	2	**24**					**0**	10		14	4	**28**	3	1	34	1	**39**	5		3	4	**12**					**0**	2		1	1	**4**					**0**
Scapula	Right			13	1	**14**			1		**1**	10		9	5	**24**	3		20	2	**25**	8		3	1	**12**	1		1	1	**3**	5		4	1	**10**					**0**
Scapula	Unknown				1	**1**					**0**					**0**					**0**					**0**					**0**					**0**					**0**
Humerus	Left		1	50		**51**			1		**1**	4	8	27	1	**40**	1	6	36		**43**	2	3	9		**14**	1		7		**8**	1	1			**2**					**0**
Humerus	Right		7	35		**42**					**0**	5	4	23		**32**	1	8	47	1	**57**	3	1	7	1	**12**			5		**5**	2		3		**5**					**0**
Humerus	Unknown					**0**					**0**					**0**					**0**	1				**1**	1				**1**	2				**2**					**0**
Radius	Left	27	4	6		**37**					**0**	5	1	3		**9**	4		9		**13**			1	1	**2**	1				**1**			1		**1**					**0**
Radius	Right	23	2	4		**29**					**0**	5		1	1	**7**	2		8	1	**11**	1				**1**			4		**4**	2				**2**					**0**
Radius	Unknown					**0**					**0**					**0**					**0**					**0**					**0**					**0**					**0**
Pubis	Left	2		15	9	**26**					**0**			4	1	**5**	10		15	3	**28**	5		3	1	**9**	2		3		**5**	1		4	2	**7**					**0**
Pubis	Right	2		6	5	**13**					**0**	2		3	3	**8**	5		13	9	**27**	1		3	9	**13**			1		**1**	2			2	**4**					**0**
Pubis	Unknown					**0**					**0**					**0**					**0**					**0**					**0**					**0**					**0**
Femur	Left		1			**1**					**0**	11	2	6		**19**	4	1	4		**9**	6		2		**8**				1	**1**	2				**2**				1	**1**
Femur	Right	3	1			**4**					**0**	11	1	6		**18**	12		6		**18**	9		4	1	**14**					**0**		1			**1**					**0**
Femur	Unknown					**0**					**0**					**0**					**0**					**0**					**0**					**0**					**0**
Tibia	Left	7	4	22		**33**			1		**1**	15	1	19		**35**	4	1	15		**20**	1		2		**3**	1				**1**	4	1	2		**7**					**0**
Tibia	Right	11	5	22	1	**39**					**0**	9	1	10		**20**	5	1	18		**24**			4		**4**			1		**1**			2		**2**					**0**
Tibia	Unknown					**0**					**0**					**0**	1				**1**					**0**					**0**					**0**					**0**
Metacarpal	Left	8	2	15		**25**					**0**					**0**	1		4		**5**					**0**	1				**1**					**0**					**0**
Metacarpal	Right	9	1	17		**27**					**0**				1	**1**			6		**6**					**0**			2		**2**					**0**					**0**
Metacarpal	Unknown	1		1		**2**					**0**	1				**1**	2	1	14	1	**18**					**0**	1		2		**3**					**0**					**0**
Metacarpal 1/2	L.Med/R.Lat	39		12	6	**28.5**					**0**					**0**	6		3	2	**5.5**					**0**			1		**0.5**					**0**					**0**
Metacarpal 1/2	R.Med/L.Lat	35		18		**26.5**					**0**	2				**1**	8		11	2	**10.5**					**0**			1		**0.5**			1		**0.5**					**0**
Metacarpal 1/2	Unknown		3	5		**4**					**0**					**0**			2		**1**					**0**					**0**					**0**					**0**
Metatarsal	Left	8	3	20	1	**32**					**0**			1		**1**			6		**6**					**0**	2				**2**					**0**					**0**
Metatarsal	Right	12	3	19		**34**					**0**	1		1		**2**			8		**8**					**0**	1		1		**2**					**0**					**0**
Metatarsal	Unknown	2				**2**					**0**					**0**	1		8		**9**					**0**					**0**					**0**					**0**
Metatarsal 1/2	L.Med/R.Lat	14		3	3	**10**	1				**0.5**					**0**	2		8		**5**					**0**					**0**	2		3		**2.5**					**0**
Metatarsal 1/2	R.Med/L.Lat	30		3	2	**17.5**			1		**0.5**	4		2	1	**3.5**	4		7		**5.5**	2				**1**					**0**	2		1		**1.5**					**0**
Metatarsal 1/2	Unknown					**0**					**0**					**0**			1		**0.5**					**0**					**0**					**0**					**0**
Metapodial	Left	1		1		**2**					**0**					**0**					**0**					**0**			1		**1**					**0**					**0**
Metapodial	Right					**0**					**0**					**0**			2		**2**					**0**					**0**					**0**					**0**
Metapodial	Unknown					**0**					**0**					**0**	1				**1**					**0**					**0**					**0**					**0**
Metapodial 1/2	L.Med/R.Lat	9		6	2	**8.5**					**0**	11		1		**6**	3		6	1	**5**	4				**2**	3		1		**2**	3		2		**2.5**					**0**
Metapodial 1/2	R.Med/L.Lat	11	1	6	1	**9.5**					**0**	6		1	1	**4**	3		9	2	**7**	4		2	2	**4**			2		**1**	1		6		**3.5**					**0**
Metapodial 1/2	Unknown			1	2	**1.5**					**0**			1	1	**1**					**0**					**0**			2	2	**2**	1				**0.5**					**0**
First Phalanx	L.Med/R.Lat	4	3	94		**101**					**0**	23	5	78		**106**	5	2	65		**72**	2		3		**5**	3	1	12		**16**	4	2	5		**11**					**0**
First Phalanx	R.Med/L.Lat	2	2	122		**126**					**0**	21	8	58	1	**88**	1	2	76		**79**	3		5		**8**	2		20		**22**	3	1	4		**8**					**0**
First Phalanx	Unknown					**0**					**0**					**0**				1	**1**					**0**					**0**	1		2		**3**			1		**2**
Third Phalanx	L.Med/R.Lat				65	**65**					**0**				100	**100**				60	**60**				7	**7**				22	**22**				3	**3**					**0**
Third Phalanx	R.Med/L.Lat				60	**60**					**0**				90	**90**				60	**60**				6	**6**				16	**16**				3	**3**					**0**
Third Phalanx	Unknown					**0**					**0**					**0**					**0**					**0**					**0**					**0**					**0**
Astragalus	Left				67	**67**				1	**1**				31	**31**				22	**22**				7	**7**				6	**6**				3	**3**				1	**1**
Astragalus	Right				92	**92**					**0**				25	**25**				23	**23**				4	**4**				3	**3**				3	**3**					**0**
Astragalus	Unknown					**0**					**0**					**0**					**0**					**0**					**0**					**0**					**0**
Calcaneum	Left	23		13	5	**41**					**0**	10		2	10	**22**	9		17	6	**32**	6		2	6	**14**				4	**4**	1		1	2	**4**			1		**1**
Calcaneum	Right	18	1	13	4	**36**	2				**2**	17		2	7	**26**	3		11	6	**20**	12				**12**				4	**4**			4	4	**8**					**0**
Calcaneum	Unknown					**0**					**0**					**0**					**0**					**0**					**0**					**0**					**0**
Mandible with teeth	Left				1	**1**					**0**				20	**20**				5	**5**					**0**					**0**				1	**1**					**0**
Mandible with teeth	Right				1	**1**					**0**				30	**30**				6	**6**				1	**1**					**0**					**0**					**0**
Mandible with teeth	Unknown					**0**					**0**					**0**					**0**					**0**					**0**				2	**2**					**0**
	TOTAL					**1134**					**7**					**803.5**					**790**					**176**					**141**					**109**					**5**

		Gt	Gt	Gt	Gt	Gt	Sp	Sp	Sp	Sp	Sp	Gt/Sp	Gt/Sp	Gt/Sp	Gt/Sp	Gt/Sp	Gz	Gz	Gz	Gz	Gz	SR	SR	SR	SR	SR	Ct	Ct	Ct	Ct	Ct	Pg	Pg	Pg	Pg	Pg	Eq	Eq	Eq	Eq	Eq
Non POSAC	**Side**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**
Mandibular tooth	Left					**0**					**0**				27	**27**				7	**7**				3	**3**				2	**2**					**0**					**0**
Mandibular tooth	Right				2	**2**					**0**				26	**26**				2	**2**				3	**3**				5	**5**					**0**					**0**
Mandibular tooth	Unknown					**0**					**0**					**0**					**0**					**0**					**0**				14	**14**				1	**1**
Horncore	Left				15	**15**					**0**				1	**1**				10	**10**					**0**					**0**					**0**					**0**
Horncore	Right				8	**8**					**0**				1	**1**				10	**10**					**0**					**0**					**0**					**0**
Horncore	Unknown				1	**1**					**0**				9	**9**				12	**12**				10	**10**				2	**2**					**0**					**0**
	TOTAL					**26**					**0**					**64**					**41**					**16**					**9**					**14**					**1**

Species	**adj NISP**	**%**
Goat	1134	35.8
Sheep	7	0.2
Goat/Sheep	803.5	25.4
Gazelle	790	25.0
Small Ruminant	176	5.6
Cattle	141	4.5
Pig	109	3.4
Equid	5	0.2
TOTAL	**3165.5**	**100.0**

Table C.2: 'Ain Ghazal Middle PPNB Bone Counts (adjusted NISP)

		Gt	Gt	Gt	Gt	Gt	Sp	Sp	Sp	Sp	Sp	Gt/Sp	Gt/Sp	Gt/Sp	Gt/Sp	Gt/Sp	Gz	Gz	Gz	Gz	Gz	SR	SR	SR	SR	SR	Ct	Ct	Ct	Ct	Ct	Pg	Pg	Pg	Pg	Pg	Eq	Eq	Eq	Eq	Eq
POSAC	**Side**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**
Scapula	Left			7		7			4		4	2		8	3	13	1		1		2	1		1	2	4			1		1			3		3			1		1
Scapula	Right			1		1			8		8	5		9	7	21			3		3	1		1	1	3				1	1			4	1	5					0
Scapula	Unknown					0					0					0					0					0					0					0					0
Humerus	Left			5		5			7		7	1	3	9		13		1	2		3			1	1	2	1		1		2	2		5		7	1				1
Humerus	Right			6		6		2	5		7		3	10		13			2		2	1		2		3					0	1		2		3			1		1
Humerus	Unknown					0					0	1				1					0					0					0					0					0
Radius	Left	1				1			3		3	1		3		4			1		1					0			1		1					0					0
Radius	Right	3				3	4		2		6	1				1			1		1					0					0					0					0
Radius	Unknown					0					0					0					0					0					0					0					0
Pubis	Left			1		1				1	1	2		3		5			2		2	1			1	2			1		1	1			2	3					0
Pubis	Right			2		2	1			1	2			1	1	2			1	1	2			1	2	3				2	2	1		2	1	4					0
Pubis	Unknown					0					0					0					0					0					0					0					0
Femur	Left	1				1					0	1		1		2			1		1	5				5			1		1	2				2					0
Femur	Right					0					0	1				1					0	2				2			2		2					0					0
Femur	Unknown					0					0					0					0					0					0					0					0
Tibia	Left			5		5			6		6	5		7		12			2		2	1				1					0			3		3					0
Tibia	Right			8		8			5	1	6	4	1	2		7			2		2					0	1		1		2					0					0
Tibia	Unknown					0					0					0					0					0					0					0					0
Metacarpal	Left	1		4		5			3		3					0	1		1		2					0					0					0			1		1
Metacarpal	Right	2		5		7	1		5		6					0	1		1		2					0					0					0					0
Metacarpal	Unknown			1		1					0					0					0					0					0					0					0
Metacarpal 1/2	L.Med/R.Lat	6	1	4		11			1	1	2	1				1			1		1					0			1		1	1		1		2					0
Metacarpal 1/2	R.Med/L.Lat	3		3	1	7	2		2		4					0	1		1		2			1		1					0			1		1					0
Metacarpal 1/2	Unknown	1				1					0					0					0					0					0					0					0
Metatarsal	Left	1		11		12			2		2			1		1			1		1					0					0					0					0
Metatarsal	Right	2		1		3			2		2					0			4		4					0					0					0					0
Metatarsal	Unknown					0					0					0					0					0					0					0					0
Metatarsal 1/2	L.Med/R.Lat	3		3		6	1		3		4	1		1		2	1		3		4					0					0	1				1					0
Metatarsal 1/2	R.Med/L.Lat	1	1	1		3			2		2	1				1	1		8		9					0					0					0					0
Metatarsal 1/2	Unknown					0					0					0					0					0					0					0					0
Metapodial	Left					0					0	1				1					0					0					0					0					0
Metapodial	Right	1				1					0					0					0					0					0					0					0
Metapodial	Unknown					0					0					0					0					0					0					0			3		3
Metapodial 1/2	L.Med/R.Lat					0				1	1					0			2		2			1		1					0	3		1		4					0
Metapodial 1/2	R.Med/L.Lat	1		1	1	3					0					0	1		1		2					0	2				2	3	1	4		8					0
Metapodial 1/2	Unknown					0					0					0					0					0					0					0					0
First Phalanx	L.Med/R.Lat	1		5		6			1		1	2	1	7		10			7		7					0					0	2		3		5					0
First Phalanx	R.Med/L.Lat			7		7			3		3	2		10		12	2		8		10					0			3		3			3		3					0
First Phalanx	Unknown					0					0					0					0					0					0					0			1		1
Third Phalanx	L.Med/R.Lat				4	4				4	4				7	7				4	4				1	1				1	1				1	1					0
Third Phalanx	R.Med/L.Lat				4	4				4	4				6	6				2	2				2	2				3	3				8	8					0
Third Phalanx	Unknown					0					0					0					0					0					0					0				2	2
Astragalus	Left				9	9				14	14				4	4				3	3				5	5				1	1				1	1					0
Astragalus	Right				10	10				8	8				5	5				3	3				3	3				1	1				7	7				2	2
Astragalus	Unknown					0					0					0					0					0					0					0					0
Calcaneum	Left	2	1	3	2	8	2		1	2	5	1	1	2	2	6			1	2	3	1				1					0	2			1	3			1		1
Calcaneum	Right			1	5	6	2		1	1	4		5	1	5	11			4	1	5			1		1				1	1	1				1					0
Calcaneum	Unknown					0					0					0					0					0					0					0					0
Mandible with teet	Left					0				1	1				15	15				1	1					0					0					0					0
Mandible with teet	Right					0					0				7	7					0					0					0				1	1					0
Mandible with teet	Unknown					0					0					0					0					0					0				3	3					0
	TOTAL					**154**					**120**					**184**					**88**					**40**					**26**					**79**					**13**

		Gt	Gt	Gt	Gt	Gt	Sp	Sp	Sp	Sp	Sp	Gt/Sp	Gt/Sp	Gt/Sp	Gt/Sp	Gt/Sp	Gz	Gz	Gz	Gz	Gz	SR	SR	SR	SR	SR	Ct	Ct	Ct	Ct	Ct	Pg	Pg	Pg	Pg	Pg	Eq	Eq	Eq	Eq	Eq
Non POSAC	**Side**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**
Mandibular tooth	Left					0					0				11	11				3	3					0					0					0					0
Mandibular tooth	Right					0					0				20	20				1	1					0					0				3	3				1	1
Mandibular tooth	Unknown					0					0					0				1	1					0				1	1				1	1				1	1
Horncore	Left				5	5					0					0				4	4					0					0					0					0
Horncore	Right				5	5					0				1	1				9	9					0					0					0					0
Horncore	Unknown				1	1					0				2	2				3	3				11	11				2	2					0					0
	TOTAL					**11**					**0**					**34**					**21**					**11**					**3**					**4**					**2**

Species	**NiSP**	**%**
Goat	154	21.9
Sheep	120	17.0
Goat/Sheep	184	26.1
Gazelle	88	12.5
Small Ruminant	40	5.7
Cattle	26	3.7
Pig	79	11.2
Equid	13	1.8
TOTAL	**704**	**100.0**

Table C.3: 'Ain Ghazal Late PPNB Bone Counts (NISP)

		Gt	Gt	Gt	Gt	Gt	Sp	Sp	Sp	Sp	Sp	Gt/Sp	Gt/Sp	Gt/Sp	Gt/Sp	Gt/Sp	Gz	Gz	Gz	Gz	Gz	SR	SR	SR	SR	SR	Ct	Ct	Ct	Ct	Ct	Pg	Pg	Pg	Pg	Pg	Eq	Eq	Eq	Eq	Eq
POSAC	**Side**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**
Scapula	Left			7		**7**			4		**4**	2		8	3	**13**	1		1		**2**	1		1	2	**4**			1		**1**			3		**3**			1		**1**
Scapula	Right			1		**1**			8		**8**	5		9	7	**21**			3		**3**	1		1	1	**3**				1	**1**			4	1	**5**					**0**
Scapula	Unknown					**0**					**0**					**0**					**0**					**0**					**0**					**0**					**0**
Humerus	Left			5		**5**			7		**7**	1	3	9		**13**		1	2		**3**			1	1	**2**	1		1		**2**	2		5		**7**	1				**1**
Humerus	Right			6		**6**		2	5		**7**		3	10		**13**			2		**2**	1		2		**3**					**0**	1		2		**3**			1		**1**
Humerus	Unknown					**0**					**0**	1				**1**					**0**					**0**					**0**					**0**					**0**
Radius	Left	1				**1**			3		**3**	1		3		**4**			1		**1**					**0**			1		**1**					**0**					**0**
Radius	Right	3				**3**	4		2		**6**	1				**1**			1		**1**					**0**					**0**					**0**					**0**
Radius	Unknown					**0**					**0**					**0**					**0**					**0**					**0**					**0**					**0**
Pubis	Left			1		**1**				1	**1**	2		3		**5**			2		**2**	1			1	**2**			1		**1**	1			2	**3**					**0**
Pubis	Right			2		**2**	1			1	**2**			1	1	**2**			1	1	**2**			1	2	**3**				2	**2**	1		2	1	**4**					**0**
Pubis	Unknown					**0**					**0**					**0**					**0**					**0**					**0**					**0**					**0**
Femur	Left	1				**1**					**0**	1		1		**2**			1		**1**	5				**5**			1		**1**	2				**2**					**0**
Femur	Right					**0**					**0**	1				**1**					**0**	2				**2**			2		**2**					**0**					**0**
Femur	Unknown					**0**					**0**					**0**					**0**					**0**					**0**					**0**					**0**
Tibia	Left			5		**5**			6		**6**	5		7		**12**			2		**2**	1				**1**					**0**			3		**3**					**0**
Tibia	Right			8		**8**			5	1	**6**	4	1	2		**7**			2		**2**					**0**	1		1		**2**					**0**					**0**
Tibia	Unknown					**0**					**0**					**0**					**0**					**0**					**0**					**0**					**0**
Metacarpal	Left	1		4		**5**			3		**3**					**0**	1		1		**2**					**0**					**0**					**0**			1		**1**
Metacarpal	Right	2		5		**7**	1		5		**6**					**0**	1		1		**2**					**0**					**0**					**0**					**0**
Metacarpal	Unknown			1		**1**					**0**					**0**					**0**					**0**					**0**					**0**					**0**
Metacarpal 1/2	L.Med/R.Lat	6	1	4		**5.5**			1	1	**1**	1				**0.5**			1		**0.5**					**0**			1		**1**	1		1		**1**					**0**
Metacarpal 1/2	R.Med/L.Lat	3		3	1	**3.5**	2		2		**2**					**0**	1		1		**1**			1		**0.5**					**0**			1		**0.5**					**0**
Metacarpal 1/2	Unknown	1				**0.5**					**0**					**0**					**0**					**0**					**0**					**0**					**0**
Metatarsal	Left	1		11		**12**			2		**2**			1		**1**			1		**1**					**0**					**0**					**0**					**0**
Metatarsal	Right	2		1		**3**			2		**2**					**0**			4		**4**					**0**					**0**					**0**					**0**
Metatarsal	Unknown					**0**					**0**					**0**					**0**					**0**					**0**					**0**					**0**
Metatarsal 1/2	L.Med/R.Lat	3		3		**3**	1		3		**2**	1		1		**1**	1		3		**2**					**0**					**0**	1				**0.5**					**0**
Metatarsal 1/2	R.Med/L.Lat	1	1	1		**1.5**			2		**1**	1				**0.5**	1		8		**4.5**					**0**					**0**					**0**					**0**
Metatarsal 1/2	Unknown					**0**					**0**					**0**					**0**					**0**					**0**					**0**					**0**
Metapodial	Left					**0**					**0**	1				**1**					**0**					**0**					**0**					**0**					**0**
Metapodial	Right	1				**1**					**0**					**0**					**0**					**0**					**0**					**0**					**0**
Metapodial	Unknown					**0**					**0**					**0**					**0**					**0**					**0**					**0**			3		**3**
Metapodial 1/2	L.Med/R.Lat					**0**				1	**0.5**					**0**			2		**1**			1		**0.5**					**0**	3		1		**2**					**0**
Metapodial 1/2	R.Med/L.Lat	1		1	1	**1.5**					**0**					**0**	1		1		**1**					**0**	2				**1**	3	1	4		**4**					**0**
Metapodial 1/2	Unknown					**0**					**0**					**0**					**0**					**0**					**0**					**0**					**0**
First Phalanx	L.Med/R.Lat	1		5		**6**			1		**1**	2	1	7		**10**			7		**7**					**0**					**0**	2		3		**5**					**0**
First Phalanx	R.Med/L.Lat			7		**7**			3		**3**	2		10		**12**	2		8		**10**					**0**			3		**3**			3		**3**					**0**
First Phalanx	Unknown					**0**					**0**					**0**					**0**					**0**					**0**					**0**			1		**2**
Third Phalanx	L.Med/R.Lat				4	**4**				4	**4**				7	**7**				4	**4**				1	**1**				1	**1**				1	**1**					**0**
Third Phalanx	R.Med/L.Lat				4	**4**				4	**4**				6	**6**				2	**2**				2	**2**				3	**3**				8	**8**					**0**
Third Phalanx	Unknown					**0**					**0**					**0**					**0**					**0**					**0**					**0**				2	**4**
Astragalus	Left				9	**9**				14	**14**				4	**4**				3	**3**				5	**5**				1	**1**				1	**1**					**0**
Astragalus	Right				10	**10**				8	**8**				5	**5**				3	**3**				3	**3**				1	**1**				7	**7**				2	**2**
Astragalus	Unknown					**0**					**0**					**0**					**0**					**0**					**0**					**0**					**0**
Calcaneum	Left	2	1	3	2	**8**	2		1	2	**5**	1	1	2	2	**6**			1	2	**3**	1				**1**					**0**	2			1	**3**			1		**1**
Calcaneum	Right			1	5	**6**	2		1	1	**4**		5	1	5	**11**			4	1	**5**			1		**1**				1	**1**	1				**1**					**0**
Calcaneum	Unknown					**0**					**0**					**0**					**0**					**0**					**0**					**0**					**0**
Mandible with teet	Left					**0**				1	**1**				15	**15**				1	**1**					**0**					**0**					**0**					**0**
Mandible with teet	Right					**0**					**0**				7	**7**					**0**					**0**					**0**				1	**1**					**0**
Mandible with teet	Unknown					**0**					**0**					**0**					**0**					**0**					**0**				3	**3**					**0**
	TOTAL					**138.5**					**113.5**					**182**					**78**					**39**					**25**					**71**					**16**

		Gt	Gt	Gt	Gt	Gt	Sp	Sp	Sp	Sp	Sp	Gt/Sp	Gt/Sp	Gt/Sp	Gt/Sp	Gt/Sp	Gz	Gz	Gz	Gz	Gz	SR	SR	SR	SR	SR	Ct	Ct	Ct	Ct	Ct	Pg	Pg	Pg	Pg	Pg	Eq	Eq	Eq	Eq	Eq
Non POSAC	**Side**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**
Mandibular tooth	Left					**0**					**0**				11	**11**				3	**3**					**0**					**0**					**0**					**0**
Mandibular tooth	Right					**0**					**0**				20	**20**				1	**1**					**0**					**0**				3	**3**				1	**1**
Mandibular tooth	Unknown					**0**					**0**					**0**				1	**1**					**0**				1	**1**				1	**1**				1	**1**
Horncore	Left				5	**5**					**0**					**0**				4	**4**					**0**					**0**					**0**					**0**
Horncore	Right				5	**5**					**0**				1	**1**				9	**9**					**0**					**0**					**0**					**0**
Horncore	Unknown				1	**1**					**0**				2	**2**				3	**3**				11	**11**				2	**2**					**0**					**0**
	TOTAL					**11**					**0**					**34**					**21**					**11**					**3**					**4**					**2**

Species	**adj NISP**	**%**
Goat	138.5	20.9
Sheep	113.5	17.1
Goat/Sheep	182	27.5
Gazelle	78	11.8
Small Ruminant	39	5.9
Cattle	25	3.8
Pig	71	10.7
Equid	16	2.4
TOTAL	**663**	**100.0**

Table C.4: 'Ain Ghazal Late PPNB Bone Counts (adjusted NISP)

		Gt	Gt	Gt	Gt	Gt	Sp	Sp	Sp	Sp	Sp	Gt/Sp	Gt/Sp	Gt/Sp	Gt/Sp	Gt/Sp	Gz	Gz	Gz	Gz	Gz	SR	SR	SR	SR	SR	Ct	Ct	Ct	Ct	Ct	Pg	Pg	Pg	Pg	Pg	Eq	Eq	Eq	Eq	Eq
POSAC	**Side**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**
Scapula	Left	1		2		3			1		1	1			1	2			2		2				1	1				2	2			1	1	2					0
Scapula	Right			1		1			1		1	2		1		3				1	1					0					0				1	1					0
Scapula	Unknown					0					0					0					0					0					0					0					0
Humerus	Left			3		3		1	6		7			4		4			2		2			1		1			1		1			2		2			1		1
Humerus	Right			3		3		1	1		2	1	1	3		5					0			2		2	1		2		3					0			1		1
Humerus	Unknown					0					0					0					0					0					0					0					0
Radius	Left	1				1			1		1		1			1					0					0					0					0					0
Radius	Right	1				1		1	1		2					0	1				1					0			1		1					0					0
Radius	Unknown					0					0					0					0					0					0					0					0
Pubis	Left	1		2		3			1	3	4					0					0	1			1	2				1	1	1		1	1	3					0
Pubis	Right					0				1	1				1	1				1	1	2			4	6					0					0					0
Pubis	Unknown					0					0					0					0					0					0					0					0
Femur	Left					0					0	3		2		5					0					0			2		2	1				1					0
Femur	Right					0					0			1		1					0	1				1					0	1				1					0
Femur	Unknown					0					0					0					0					0					0					0					0
Tibia	Left			1		1			2		2	2		4		6					0	1				1	2		2		4					0					0
Tibia	Right			5		5			3		3	1		6		7		1			1					0					0					0			1		1
Tibia	Unknown					0					0					0					0					0					0					0					0
Metacarpal	Left			1		1	2		3		5					0					0					0					0					0					0
Metacarpal	Right					0			1		1					0					0					0					0					0					0
Metacarpal	Unknown					0					0					0					0					0					0					0					0
Metacarpal 1/2	L.Med/R.Lat	1		3		4	1		1		2					0	1				1					0					0					0					0
Metacarpal 1/2	R.Med/L.Lat	1		3	1	5	1		2		3					0			2		2					0			2		2					0					0
Metacarpal 1/2	Unknown					0					0					0					0					0					0					0					0
Metatarsal	Left			1		1			1		1					0			1		1					0					0					0					0
Metatarsal	Right			1		1			2		2					0					0					0					0					0					0
Metatarsal	Unknown					0					0					0					0					0					0					0					0
Metatarsal 1/2	L.Med/R.Lat					0	1		2		3					0				1	1					0					0					0					0
Metatarsal 1/2	R.Med/L.Lat	3		3		6	3		2		5					0			2		2					0					0					0					0
Metatarsal 1/2	Unknown					0					0					0					0					0					0					0					0
Metapodial	Left					0					0					0					0					0					0					0					0
Metapodial	Right					0					0					0					0					0					0					0					0
Metapodial	Unknown					0					0					0					0					0					0	1				1					0
Metapodial 1/2	L.Med/R.Lat					0					0					0	1		1		2					0					0	1		1		2					0
Metapodial 1/2	R.Med/L.Lat				1	1	2				2					0			1		1					0					0	1				1					0
Metapodial 1/2	Unknown					0					0	1			1	2					0	1				1			1	2	3					0					0
First Phalanx	L.Med/R.Lat			4		4			4		4	2		1		3			1		1	2				2			1		1	1		1		2					0
First Phalanx	R.Med/L.Lat	1		3		4			2		2	1		5		6					0					0	1		2		3			1		1					0
First Phalanx	Unknown					0					0					0					0					0					0			1		1					0
Third Phalanx	L.Med/R.Lat					0				1	1				3	3				2	2				2	2				2	2				2	2					0
Third Phalanx	R.Med/L.Lat				2	2					0				6	6				2	2					0				1	1				3	3					0
Third Phalanx	Unknown					0					0					0					0					0					0					0				1	1
Astragalus	Left				2	2				7	7				1	1				2	2				3	3					0					0					0
Astragalus	Right				4	4				5	5				2	2				1	1				4	4					0				1	1					0
Astragalus	Unknown					0					0					0					0					0					0					0					0
Calcaneum	Left					0			1		1	1				1			1		1	3			1	4				1	1			1	1	2					0
Calcaneum	Right					0	2			1	3	2		1	3	6			1		1	1				1					0				1	1					0
Calcaneum	Unknown					0					0					0					0					0					0					0					0
Mandible with teet	Left					0				1	1				7	7				1	1					0					0					0					0
Mandible with teet	Right					0					0				7	7				1	1					0					0					0					0
Mandible with teet	Unknown					0					0					0					0					0					0					0					0
	TOTAL					56					72					79					30					31					27					27					4

		Gt	Gt	Gt	Gt	Gt	Sp	Sp	Sp	Sp	Sp	Gt/Sp	Gt/Sp	Gt/Sp	Gt/Sp	Gt/Sp	Gz	Gz	Gz	Gz	Gz	SR	SR	SR	SR	SR	Ct	Ct	Ct	Ct	Ct	Pg	Pg	Pg	Pg	Pg	Eq	Eq	Eq	Eq	Eq
Non POSAC	**Side**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**
Mandibular tooth	Left					0					0				22	22				2	2					0				2	2					0					0
Mandibular tooth	Right					0					0				17	17				3	3					0					0				1	1				1	1
Mandibular tooth	Unknown					0					0					0					0					0					0				2	2					0
Horncore	Left					0				1	1					0					0					0					0					0					0
Horncore	Right					0					0					0					0					0					0					0					0
Horncore	Unknown					0					0					0					0				2	2					0					0					0
	TOTAL					0					1					39					5					2					2					3					1

Species	**NISP**	**%**
Goat	56	17.2
Sheep	72	22.1
Goat/Sheep	79	24.2
Gazelle	30	9.2
Small Ruminant	31	9.5
Cattle	27	8.3
Pig	27	8.3
Equid	4	1.2
TOTAL	326	100.0

Tbale C.5: 'Ain Ghazal Transitional Late PPNB/PPNC Bone Counts (NISP)

		Gt	Gt	Gt	Gt	Gt	Sp	Sp	Sp	Sp	Sp	Gt/Sp	Gt/Sp	Gt/Sp	Gt/Sp	Gt/Sp	Gz	Gz	Gz	Gz	Gz	SR	SR	SR	SR	SR	Ct	Ct	Ct	Ct	Ct	Pg	Pg	Pg	Pg	Pg	Eq	Eq	Eq	Eq	Eq
POSAC	**Side**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**
Scapula	Left	1		2		3			1		1	1			1	2			2		2				1	1				2	2			1	1	2					0
Scapula	Right			1		1			1		1	2		1		3				1	1					0					0				1	1					0
Scapula	Unknown					0					0					0					0					0					0					0					0
Humerus	Left			3		3		1	6		7			4		4			2		2			1		1			1		1			2		2			1		1
Humerus	Right			3		3		1	1		2	1	1	3		5					0			2		2	1		2		3					0			1		1
Humerus	Unknown					0					0					0					0					0					0					0					0
Radius	Left	1				1			1		1		1			1					0					0					0					0					0
Radius	Right	1				1		1	1		2					0	1				1					0			1		1					0					0
Radius	Unknown					0					0					0					0					0					0					0					0
Pubis	Left	1		2		3			1	3	4					0					0	1			1	2				1	1	1		1	1	3					0
Pubis	Right					0				1	1				1	1				1	1	2			4	6					0					0					0
Pubis	Unknown					0					0					0					0					0					0					0					0
Femur	Left					0					0	3		2		5					0					0			2		2	1				1					0
Femur	Right					0					0			1		1					0	1				1					0	1				1					0
Femur	Unknown					0					0					0					0					0					0					0					0
Tibia	Left			1		1			2		2	2		4		6					0	1				1	2		2		4					0					0
Tibia	Right			5		5			3		3	1		6		7		1			1					0					0					0			1		1
Tibia	Unknown					0					0					0					0					0					0					0					0
Metacarpal	Left			1		1	2		3		5					0					0					0					0					0					0
Metacarpal	Right					0			1		1					0					0					0					0					0					0
Metacarpal	Unknown					0					0					0					0					0					0					0					0
Metacarpal 1/2	L.Med/R.Lat	1		3		2	1		1		1					0	1				0.5					0					0					0					0
Metacarpal 1/2	R.Med/L.Lat	1		3	1	2.5	1		2		1.5					0			2		1					0			2		1					0					0
Metacarpal 1/2	Unknown					0					0					0					0					0					0					0					0
Metatarsal	Left			1		1			1		1					0			1		1					0					0					0					0
Metatarsal	Right			1		1			2		2					0					0					0					0					0					0
Metatarsal	Unknown					0					0					0					0					0					0					0					0
Metatarsal 1/2	L.Med/R.Lat					0	1		2		1.5					0				1	0.5					0					0					0					0
Metatarsal 1/2	R.Med/L.Lat	3		3		3	3		2		2.5					0			2		1					0					0					0					0
Metatarsal 1/2	Unknown					0					0					0					0					0					0					0					0
Metapodial	Left					0					0					0					0					0					0					0					0
Metapodial	Right					0					0					0					0					0					0					0					0
Metapodial	Unknown					0					0					0					0					0					0					0					0
Metapodial 1/2	L.Med/R.Lat					0					0					0	1		1		1					0					0	2		1		1.5					0
Metapodial 1/2	R.Med/L.Lat				1	0.5	2				1					0			1		0.5					0					0	1				0.5					0
Metapodial 1/2	Unknown					0					0	1			1	1					0	1				0.5			1	2	1.5					0					0
Phalanx I	L.Med/R.Lat			4		4			4		4	2		1		3			1		1	2				2			1		1	1		1		2					0
Phalanx I	R.Med/L.Lat	1		3		4			2		2	1		5		6					0					0	1		2		3			1		1					0
Phalanx I	Unknown					0					0					0					0					0					0			1		1					0
Phalanx III	L.Med/R.Lat					0				1	1				3	3				2	2				2	2				2	2				2	2					0
Phalanx III	R.Med/L.Lat				2	2					0				6	6				2	2					0				1	1				3	3					0
Phalanx III	Unknown					0					0					0					0					0					0					0				1	2
Astragalus	Left				2	2				7	7				1	1				2	2				3	3					0					0					0
Astragalus	Right				4	4				5	5				2	2				1	1				4	4					0				1	1					0
Astragalus	Unknown					0					0					0					0					0					0					0					0
Calcaneum	Left					0			1		1	1				1			1		1	3			1	4				1	1			1	1	2					0
Calcaneum	Right					0	2			1	3	2		1	3	6			1		1	1				1					0				1	1					0
Calcaneum	Unknown					0					0					0					0					0					0					0					0
Mandible with teet	Left					0				1	1				7	7				1	1					0					0					0					0
Mandible with teet	Right					0					0				7	7				1	1					0					0					0					0
Mandible with teet	Unknown					0					0					0					0					0					0					0					0
	TOTAL					48					64.5					78					25.5					30.5					24.5					25					5
		Gt	**Gt**	**Gt**	**Gt**	**Gt**	**Sp**	**Sp**	**Sp**	**Sp**	**Sp**	**Gt/Sp**	**Gt/Sp**	**Gt/Sp**	**Gt/Sp**	**Gt/Sp**	**Gz**	**Gz**	**Gz**	**Gz**	**Gz**	**SR**	**SR**	**SR**	**SR**	**SR**	**Ct**	**Ct**	**Ct**	**Ct**	**Ct**	**Pg**	**Pg**	**Pg**	**Pg**	**Pg**	**Eq**	**Eq**	**Eq**	**Eq**	**Eq**
Non POSAC	**Side**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**
Mandibular tooth	Left					0					0				22	22				2	2					0				2	2					0					0
Mandibular tooth	Right					0					0				17	17				3	3					0					0				1	1				1	1
Mandibular tooth	Unknown					0					0					0					0					0					0				2	2					0
Horncore	Left					0				1	1					0					0					0					0					0					0
Horncore	Right					0					0					0					0					0					0					0					0
Horncore	Unknown					0					0					0					0				2	2					0					0					0
	TOTAL					0					1					39					5					2					2					3					1

Species	**adj NISP**	**%**
Goat	48	15.9
Sheep	64.5	21.4
Goat/Sheep	78	25.9
Gazelle	25.5	8.5
Small Ruminant	30.5	10.1
Cattle	24.5	8.1
Pig	25	8.3
Equid	5	1.7
TOTAL	**301**	**100.0**

Table C.6: 'Ain Ghazal Transitional Late PPNB/PPNC Bone Counts (adjusted NISP)

		Gt	Gt	Gt	Gt	Gt	Sp	Sp	Sp	Sp	Sp	Gt/Sp	Gt/Sp	Gt/Sp	Gt/Sp	Gt/Sp	Gz	Gz	Gz	Gz	Gz	SR	SR	SR	SR	SR	Ct	Ct	Ct	Ct	Ct	Pg	Pg	Pg	Pg	Pg	Eq	Eq	Eq	Eq	Eq
POSAC	**Side**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**
Scapula	Left	1		7		**8**		2	22	1	**25**	8		17	13	**38**			8		**8**	4	1		2	**7**			1		**1**	4	1	6		**11**					**0**
Scapula	Right			5	1	**6**	2		19	1	**22**	9		19	12	**40**			6	3	**9**	1		1	1	**3**					**0**	2		6	7	**15**	1		1		**2**
Scapula	Unknown					**0**					**0**					**0**					**0**					**0**					**0**					**0**					**0**
Humerus	Left		1	8		**9**		1	35		**36**	1	8	26		**35**			11		**11**	1	4	15		**20**			2		**2**	1	2	8		**11**			2		**2**
Humerus	Right			9		**9**		11	29		**40**	1	8	38	2	**49**			14		**14**		2	8		**10**			1		**1**			6		**6**			4		**4**
Humerus	Unknown					**0**					**0**					**0**					**0**					**0**	2				**2**				1	**1**					**0**
Radius	Left	1		3		**4**	6		8		**14**	3		1		**4**			3		**3**	1				**1**					**0**	1				**1**	1		1		**2**
Radius	Right	3	1	5		**9**	9		7		**16**					**0**			1		**1**					**0**	1				**1**	1				**1**	2		2		**4**
Radius	Unknown					**0**					**0**					**0**					**0**					**0**					**0**					**0**					**0**
Pubis	Left			2	6	**8**	1		2	2	**5**	4		1	4	**9**			4	5	**9**	3		4	3	**10**	1			1	**2**	1		2	7	**10**			1		**1**
Pubis	Right	1		2	6	**9**	2		5	6	**13**			2	2	**4**			5	2	**7**			5	4	**9**	1			2	**3**	2		4	10	**16**			1	1	**2**
Pubis	Unknown					**0**					**0**					**0**					**0**					**0**					**0**					**0**					**0**
Femur	Left	1				**1**					**0**	5		6		**11**		1	1		**2**	4		2		**6**	1				**1**				1	**1**	1		1		**2**
Femur	Right					**0**			1		**1**	7	1	4		**12**	2		1		**3**	2		1		**3**			2		**2**	1				**1**			1	1	**2**
Femur	Unknown					**0**					**0**					**0**					**0**					**0**	1				**1**	1				**1**					**0**
Tibia	Left			7		**7**	3		19		**22**	5	2	12	1	**20**			7		**7**			2		**2**					**0**	4		3		**7**			2		**2**
Tibia	Right	1	1	4		**6**	4		15		**19**	4	2	24		**30**			3		**3**	1	1	3		**5**			1		**1**	2	2	3		**7**			2		**2**
Tibia	Unknown					**0**					**0**					**0**					**0**					**0**					**0**					**0**					**0**
Metacarpal	Left			9		**9**	1		12		**13**					**0**			3		**3**					**0**					**0**					**0**					**0**
Metacarpal	Right			3		**3**	1		13		**14**					**0**			1		**1**					**0**	1			1	**2**					**0**					**0**
Metacarpal	Unknown					**0**					**0**					**0**			1		**1**					**0**					**0**					**0**				1	**1**
Metacarpal 1/2	L.Med/R.Lat	5		2		**7**	13		11	1	**25**					**0**		1	4	1	**6**				1	**1**					**0**			1		**1**					**0**
Metacarpal 1/2	R.Med/L.Lat	5	2	6		**13**	9	1	9		**19**					**0**		2	6		**8**			1		**1**					**0**					**0**					**0**
Metacarpal 1/2	Unknown					**0**					**0**					**0**					**0**					**0**					**0**					**0**					**0**
Metatarsal	Left			7		**7**	3		8		**11**					**0**			1		**1**			1		**1**	1				**1**					**0**			1		**1**
Metatarsal	Right	2	1	6		**9**	3		13		**16**					**0**			2		**2**					**0**			1		**1**					**0**					**0**
Metatarsal	Unknown					**0**					**0**			1		**1**			1		**1**					**0**					**0**					**0**					**0**
Metatarsal 1/2	L.Med/R.Lat		1	1		**2**	12		3		**15**	1				**1**			2	1	**3**					**0**					**0**					**0**					**0**
Metatarsal 1/2	R.Med/L.Lat	4	1	4		**9**	7		5		**12**					**0**	2		2	2	**6**					**0**					**0**					**0**					**0**
Metatarsal 1/2	Unknown					**0**					**0**					**0**					**0**					**0**					**0**					**0**					**0**
Metapodial	Left					**0**					**0**					**0**					**0**					**0**					**0**					**0**					**0**
Metapodial	Right					**0**					**0**					**0**					**0**					**0**					**0**					**0**					**0**
Metapodial	Unknown					**0**					**0**					**0**					**0**					**0**	1		1	1	**3**					**0**			4	3	**7**
Metapodial 1/2	L.Med/R.Lat	1				**1**	3				**3**					**0**	1				**1**	2				**2**	2		3	1	**6**	5	1	4		**10**					**0**
Metapodial 1/2	R.Med/L.Lat					**0**	4		5	1	**10**	2				**2**	1		2	1	**4**					**0**	1		6		**7**	2		5		**7**					**0**
Metapodial 1/2	Unknown					**0**				1	**1**				1	**1**					**0**					**0**				3	**3**		1		1	**2**					**0**
First Phalanx	L.Med/R.Lat			12		**12**	2	2	19		**23**	3		21		**24**			16		**16**			1		**1**	2		8		**10**	2	1	10		**13**					**0**
First Phalanx	R.Med/L.Lat			12		**12**	1	1	21		**23**	1	2	33		**36**			24		**24**	1		4		**5**			9		**9**	3		12		**15**					**0**
First Phalanx	Unknown					**0**					**0**					**0**					**0**					**0**					**0**			2		**2**			3		**3**
Third Phalanx	L.Med/R.Lat				13	**13**				10	**10**				24	**24**				9	**9**				5	**5**				4	**4**				10	**10**					**0**
Third Phalanx	R.Med/L.Lat				5	**5**				12	**12**				16	**16**				7	**7**				1	**1**				4	**4**				8	**8**					**0**
Third Phalanx	Unknown					**0**					**0**					**0**					**0**					**0**					**0**					**0**				4	**4**
Astragalus	Left				15	**15**				33	**33**				28	**28**				12	**12**				7	**7**				4	**4**				8	**8**					**0**
Astragalus	Right				18	**18**				41	**41**				19	**19**				8	**8**				7	**7**				5	**5**				9	**9**				6	**6**
Astragalus	Unknown					**0**					**0**					**0**					**0**					**0**					**0**					**0**					**0**
Calcaneum	Left	2		4	5	**11**	7		5	2	**14**	10		3	9	**22**	3		3	1	**7**	2				**2**				1	**1**	5			4	**9**	1				**1**
Calcaneum	Right	4		4	2	**10**	4		8	6	**18**	9		4	5	**18**	3		6		**9**	8			1	**9**				1	**1**	7		1	7	**15**			2		**2**
Calcaneum	Unknown					**0**					**0**					**0**					**0**					**0**					**0**					**0**					**0**
Mandible with teet	Left				1	**1**					**0**				29	**29**				2	**2**				2	**2**				1	**1**				7	**7**					**0**
Mandible with teet	Right				3	**3**					**0**				42	**42**					**0**				1	**1**				1	**1**				3	**3**					**0**
Mandible with teet	Unknown					**0**					**0**					**0**					**0**					**0**					**0**				7	**7**					**0**
	TOTAL					**236**					**526**					**515**					**208**					**121**					**80**					**215**					**50**

		Gt	Gt	Gt	Gt	Gt	Sp	Sp	Sp	Sp	Sp	Gt/Sp	Gt/Sp	Gt/Sp	Gt/Sp	Gt/Sp	Gz	Gz	Gz	Gz	Gz	SR	SR	SR	SR	SR	Ct	Ct	Ct	Ct	Ct	Pg	Pg	Pg	Pg	Pg	Eq	Eq	Eq	Eq	Eq
Non POSAC	**Side**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**
Mandibular tooth	Left				2	**2**					**0**				59	**59**					**0**					**0**				3	**3**				1	**1**				1	**1**
Mandibular tooth	Right				1	**1**				1	**1**				65	**65**				1	**1**					**0**				7	**7**				28	**28**				1	**1**
Mandibular tooth	Unknown					**0**					**0**					**0**					**0**					**0**				1	**1**					**0**				8	**8**
Horncore	Left				6	**6**				1	**1**				1	**1**				4	**4**					**0**				1	**1**					**0**					**0**
Horncore	Right				5	**5**				3	**3**				1	**1**				3	**3**					**0**				1	**1**					**0**					**0**
Horncore	Unknown				3	**3**					**0**				2	**2**				5	**5**					**0**				1	**1**					**0**					**0**
	TOTAL					17					5					**128**					**13**					**0**					**14**					**29**					**10**

Species	**NISP**	**%**
Goat	236	12.1
Sheep	526	27.0
Goat/Sheep	515	26.4
Gazelle	208	10.7
Small Ruminant	121	6.2
Cattle	80	4.1
Pig	215	11.0
Equid	50	2.6
TOTAL	**1951**	**100.0**

Table C.7: 'Ain Ghazal PPNC Bone Counts (NISP)

POSAC	Side	Gt uf	Gt fg	Gt F	Gt ?	Gt Total	Sp uf	Sp fg	Sp F	Sp ?	Sp Total	Gt/Sp uf	Gt/Sp fg	Gt/Sp F	Gt/Sp ?	Gt/Sp Total	Gz uf	Gz fg	Gz F	Gz ?	Gz Total	SR uf	SR fg	SR F	SR ?	SR Total	Ct uf	Ct fg	Ct F	Ct ?	Ct Total	Pg uf	Pg fg	Pg F	Pg ?	Pg Total	Eq uf	Eq fg	Eq F	Eq ?	Eq Total
Scapula	Left	1		7		**8**		2	22	1	**25**	8		17	13	**38**			8		**8**	4	1		2	**7**			1		**1**	4	1	6		**11**					**0**
Scapula	Right			5	1	**6**	2		19	1	**22**	9		19	12	**40**			6	3	**9**	1		1	1	**3**					**0**	2		6	7	**15**	1		1		**2**
Scapula	Unknown					**0**					**0**					**0**					**0**					**0**					**0**					**0**					**0**
Humerus	Left		1	8		**9**		1	35		**36**	1	8	26		**35**			11		**11**	1	4	15		**20**			2		**2**	1	2	8		**11**			2		**2**
Humerus	Right			9		**9**		11	29		**40**	1	8	38	2	**49**			14		**14**		2	8		**10**			1		**1**			6		**6**			4		**4**
Humerus	Unknown					**0**					**0**					**0**					**0**					**0**	2				**2**				1	**1**					**0**
Radius	Left	1		3		**4**	6		8		**14**	3		1		**4**			3		**3**	1				**1**					**0**	1				**1**	1		1		**2**
Radius	Right	3	1	5		**9**	9		7		**16**					**0**			1		**1**					**0**	1				**1**	1				**1**	2		2		**4**
Radius	Unknown					**0**					**0**					**0**					**0**					**0**					**0**					**0**					**0**
Pubis	Left			2	6	**8**	1		2	2	**5**	4		1	4	**9**			4	5	**9**	3		4	3	**10**	1			1	**2**	1		2	7	**10**			1		**1**
Pubis	Right	1		2	6	**9**	2		5	6	**13**			2	2	**4**			5	2	**7**			5	4	**9**	1			2	**3**	2		4	10	**16**			1	1	**2**
Pubis	Unknown					**0**					**0**					**0**					**0**					**0**					**0**					**0**					**0**
Femur	Left	1				**1**					**0**	5		6		**11**		1	1		**2**	4		2		**6**	1				**1**				1	**1**	1		1		**2**
Femur	Right					**0**			1		**1**	7	1	4		**12**	2		1		**3**	2		1		**3**			2		**2**	1				**1**			1	1	**2**
Femur	Unknown					**0**					**0**					**0**					**0**					**0**	1				**1**	1				**1**					**0**
Tibia	Left			7		**7**	3		19		**22**	5	2	12	1	**20**			7		**7**			2		**2**					**0**	4		3		**7**			2		**2**
Tibia	Right	1	1	4		**6**	4		15		**19**	4	2	24		**30**			3		**3**	1	1	3		**5**			1		**1**	2	2	3		**7**			2		**2**
Tibia	Unknown					**0**					**0**					**0**					**0**					**0**					**0**					**0**					**0**
Metacarpal	Left			9		**9**	1		12		**13**					**0**			3		**3**					**0**					**0**					**0**					**0**
Metacarpal	Right			3		**3**	1		13		**14**					**0**			1		**1**					**0**	1			1	**2**					**0**					**0**
Metacarpal	Unknown					**0**					**0**					**0**			1		**1**					**0**					**0**					**0**				1	**1**
Metacarpal 1/2	L.Med/R.Lat	5		2		**3.5**	13		11	1	**12.5**					**0**		1	4	1	**3**				1	**0.5**					**0**			1		**0.5**					**0**
Metacarpal 1/2	R.Med/L.Lat	5	2	6		**6.5**	9	1	9		**9.5**					**0**		2	6		**4**			1		**0.5**					**0**					**0**					**0**
Metacarpal 1/2	Unknown					**0**					**0**					**0**					**0**					**0**					**0**					**0**					**0**
Metatarsal	Left			7		**7**	3		8		**11**					**0**			1		**1**			1		**1**	1				**1**					**0**			1		**1**
Metatarsal	Right	2	1	6		**9**	3		13		**16**					**0**			2		**2**					**0**			1		**1**					**0**					**0**
Metatarsal	Unknown					**0**					**0**			1		**1**			1		**1**					**0**					**0**					**0**					**0**
Metatarsal 1/2	L.Med/R.Lat		1	1		**1**	12		3		**7.5**	1				**0.5**			2	1	**1.5**					**0**					**0**					**0**					**0**
Metatarsal 1/2	R.Med/L.Lat	4	1	4		**4.5**	7		5		**6**					**0**	2		2	2	**3**					**0**					**0**					**0**					**0**
Metatarsal 1/2	Unknown					**0**					**0**					**0**					**0**					**0**					**0**					**0**					**0**
Metapodial	Left					**0**					**0**					**0**					**0**					**0**					**0**					**0**					**0**
Metapodial	Right					**0**					**0**					**0**					**0**					**0**					**0**					**0**					**0**
Metapodial	Unknown					**0**					**0**					**0**					**0**					**0**	1		1	1	**3**					**0**			4	3	**7**
Metapodial 1/2	L.Med/R.Lat	1				**0.5**	3				**1.5**					**0**	1				**0.5**	2				**1**	2		3	1	**3**	5	1	4		**5**					**0**
Metapodial 1/2	R.Med/L.Lat					**0**	4		5	1	**5**	2				**1**	1		2	1	**2**					**0**	1		6		**3.5**	2		5		**3.5**					**0**
Metapodial 1/2	Unknown					**0**				1	**0.5**				1	**0.5**					**0**					**0**				3	**1.5**		1		1	**1**					**0**
First Phalanx	L.Med/R.Lat			12		**12**	2	2	19		**23**	3		21		**24**			16		**16**			1		**1**	2		8		**10**	2	1	10		**13**					**0**
First Phalanx	R.Med/L.Lat			12		**12**	1	1	21		**23**	1	2	33		**36**			24		**24**	1		4		**5**			9		**9**	3		12		**15**					**0**
First Phalanx	Unknown					**0**					**0**					**0**					**0**					**0**					**0**			2		**2**			3		**6**
Third Phalanx	L.Med/R.Lat				13	**13**				10	**10**				24	**24**				9	**9**				5	**5**				4	**4**				10	**10**					**0**
Third Phalanx	R.Med/L.Lat				5	**5**				12	**12**				16	**16**				7	**7**				1	**1**				4	**4**				8	**8**					**0**
Third Phalanx	Unknown					**0**					**0**					**0**					**0**					**0**					**0**					**0**				4	**8**
Astragalus	Left				15	**15**				33	**33**				28	**28**				12	**12**				7	**7**				4	**4**				8	**8**					**0**
Astragalus	Right				18	**18**				41	**41**				19	**19**				8	**8**				7	**7**				5	**5**				9	**9**				6	**6**
Astragalus	Unknown					**0**					**0**					**0**					**0**					**0**					**0**					**0**					**0**
Calcaneum	Left	2		4	5	**11**	7		5	2	**14**	10		3	9	**22**	3		3	1	**7**	2				**2**				1	**1**	5			4	**9**	1				**1**
Calcaneum	Right	4		4	2	**10**	4		8	6	**18**	9		4	5	**18**	3		6		**9**	8			1	**9**				1	**1**	7		1	7	**15**			2		**2**
Calcaneum	Unknown					**0**					**0**					**0**					**0**					**0**					**0**					**0**					**0**
Mandible with teet	Left				1	**1**					**0**				29	**29**				2	**2**				2	**2**				1	**1**				7	**7**					**0**
Mandible with teet	Right				3	**3**					**0**				42	**42**					**0**				1	**1**				1	**1**				3	**3**					**0**
Mandible with teet	Unknown					**0**					**0**					**0**					**0**					**0**					**0**				7	**7**					**0**
	TOTAL					**220**					**483.5**					**513**					**194**					**119**					**72**					**205**					**57**

POSAC	Side	Gt uf	Gt fg	Gt F	Gt ?	Gt Total	Sp uf	Sp fg	Sp F	Sp ?	Sp Total	Gt/Sp uf	Gt/Sp fg	Gt/Sp F	Gt/Sp ?	Gt/Sp Total	Gz uf	Gz fg	Gz F	Gz ?	Gz Total	SR uf	SR fg	SR F	SR ?	SR Total	Ct uf	Ct fg	Ct F	Ct ?	Ct Total	Pg uf	Pg fg	Pg F	Pg ?	Pg Total	Eq uf	Eq fg	Eq F	Eq ?	Eq Total
Mandibular tooth	Left				2	**2**					**0**				59	**59**					**0**					**0**				3	**3**				1	**1**				1	**1**
Mandibular tooth	Right				1	**1**				1	**1**				65	**65**				1	**1**					**0**				7	**7**				28	**28**				1	**1**
Mandibular tooth	Unknown					**0**					**0**					**0**					**0**					**0**				1	**1**					**0**				8	**8**
Horncore	Left				6	**6**				1	**1**				1	**1**				4	**4**					**0**				1	**1**					**0**					**0**
Horncore	Right				5	**5**				3	**3**				1	**1**				3	**3**					**0**				1	**1**					**0**					**0**
Horncore	Unknown				3	**3**					**0**				2	**2**				5	**5**					**0**				1	**1**					**0**					**0**
	TOTAL					**17**					**5**					**128**					**13**					**0**					**14**					**29**					**10**

Species	**adj NISP**	**%**
Goat	220	11.8
Sheep	483.5	25.9
Goat/Sheep	513	27.5
Gazelle	194	10.4
Small Ruminant	119	6.4
Cattle	72	3.9
Pig	205	11.0
Equid	57	3.1
TOTAL	**1863.5**	**100.0**

Table C.8: 'Ain Ghazal PPNC Bone Counts (adjusted NISP)

		Gt	Gt	Gt	Gt	Gt	Sp	Sp	Sp	Sp	Sp	Gt/Sp	Gt/Sp	Gt/Sp	Gt/Sp	Gt/Sp	Gz	Gz	Gz	Gz	Gz	SR	SR	SR	SR	SR	Ct	Ct	Ct	Ct	Ct	Pg	Pg	Pg	Pg	Pg	Eq	Eq	Eq	Eq	Eq
POSAC	**Side**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**
Scapula	Left	1		7	2	**10**	1	1	12	1	**15**	9		12	17	**38**			6	2	**8**	2		3		**5**			1		**1**	3		2		**5**			2	1	**3**
Scapula	Right			9		**9**		1	13	1	**15**	13		13	5	**31**			7	1	**8**	2				**2**			1		**1**	2		3	4	**9**			2	2	**4**
Scapula	Unknown					**0**					**0**					**0**					**0**					**0**					**0**					**0**					**0**
Humerus	Left		1	7		**8**			21		**21**	1	4	28	1	**34**			6		**6**			2		**2**					**0**	1		1		**2**	1		10		**11**
Humerus	Right			18		**18**		2	17		**19**	1	5	14	2	**22**		1	6		**7**	1	2	7	1	**11**			2	1	**3**	1	1	2		**4**		1	7		**8**
Humerus	Unknown					**0**					**0**					**0**					**0**					**0**					**0**					**0**					**0**
Radius	Left			1		**1**	2		7		**9**		1	1		**2**			1		**1**					**0**					**0**					**0**					**0**
Radius	Right	2	1			**3**	4		3		**7**					**0**					**0**	1				**1**					**0**	1				**1**			1		**1**
Radius	Unknown					**0**					**0**					**0**			4	3	**7**					**0**					**0**					**0**					**0**
Pubis	Left			1	1	**2**	1		5	4	**10**			3		**3**			2	2	**4**			2	3	**5**			1	2	**3**			2	3	**5**			6	2	**8**
Pubis	Right	1		1	2	**4**			6	5	**11**			2	8	**10**					**0**			4	3	**7**	1		1	1	**3**	1		1	3	**5**	1		4	1	**6**
Pubis	Unknown					**0**					**0**					**0**	1		2		**3**					**0**					**0**					**0**					**0**
Femur	Left					**0**					**0**	3	1	2		**6**	2		1		**3**			1		**1**					**0**	1				**1**					**0**
Femur	Right					**0**			1		**1**	2	1	3		**6**					**0**	1			1	**2**			1		**1**					**0**			2		**2**
Femur	Unknown					**0**					**0**					**0**			1		**1**					**0**					**0**					**0**					**0**
Tibia	Left			5		**5**			15		**15**	3	1	26		**30**					**0**			3		**3**	1		1		**2**			1		**1**	1		2		**3**
Tibia	Right			1		**1**	1		10		**11**	3		23		**26**			1		**1**			5		**5**			2		**2**	1				**1**			4		**4**
Tibia	Unknown					**0**					**0**					**0**					**0**					**0**					**0**					**0**					**0**
Metacarpal	Left	1	1	4		**6**			7		**7**					**0**			1		**1**					**0**					**0**					**0**					**0**
Metacarpal	Right	1		1		**2**			11		**11**				1	**1**			1		**1**					**0**		1	1		**2**					**0**					**0**
Metacarpal	Unknown					**0**			1		**1**					**0**			1		**1**					**0**					**0**					**0**					**0**
Metacarpal 1/2	L.Med/R.Lat	2	1	3		**6**	2		1		**3**	1				**1**					**0**			1		**1**					**0**					**0**					**0**
Metacarpal 1/2	R.Med/L.Lat	2	1	6		**9**	3		4	1	**8**					**0**			3		**3**					**0**					**0**	1				**1**					**0**
Metacarpal 1/2	Unknown					**0**			1		**1**					**0**			2		**2**					**0**					**0**					**0**					**0**
Metatarsal	Left			9		**9**			6		**6**					**0**					**0**				1	**1**					**0**					**0**					**0**
Metatarsal	Right	1		4		**5**	1		13		**14**					**0**	1		2		**3**					**0**					**0**					**0**					**0**
Metatarsal	Unknown					**0**					**0**					**0**	1		1		**2**					**0**					**0**					**0**					**0**
Metatarsal 1/2	L.Med/R.Lat	1		1		**2**	5		5	1	**11**	1				**1**					**0**					**0**					**0**					**0**					**0**
Metatarsal 1/2	R.Med/L.Lat	3		3		**6**	2		6		**8**	1				**1**					**0**					**0**					**0**	1				**1**					**0**
Metatarsal 1/2	Unknown					**0**					**0**					**0**					**0**					**0**					**0**					**0**					**0**
Metapodial	Left					**0**					**0**					**0**					**0**					**0**					**0**					**0**					**0**
Metapodial	Right					**0**	1				**1**					**0**					**0**					**0**			1		**1**					**0**					**0**
Metapodial	Unknown					**0**					**0**					**0**					**0**					**0**	1		4		**5**					**0**			9	1	**10**
Metapodial 1/2	L.Med/R.Lat					**0**	1		2		**3**	2				**2**					**0**					**0**	1				**1**	1		1		**2**					**0**
Metapodial 1/2	R.Med/L.Lat	1				**1**	1		2	1	**4**	1				**1**	1				**1**	1				**1**					**0**	3		3		**6**					**0**
Metapodial 1/2	Unknown					**0**					**0**					**0**					**0**					**0**	1				**1**					**0**					**0**
First Phalanx	L.Med/R.Lat			13		**13**		1	18		**19**	1		18		**19**			16		**16**			2		**2**			5		**5**	1		1		**2**					**0**
First Phalanx	R.Med/L.Lat			9		**9**		2	18		**20**	2	1	23		**26**			12		**12**			4		**4**			7		**7**	2	1	3		**6**					**0**
First Phalanx	Unknown					**0**					**0**					**0**					**0**					**0**					**0**			3		**3**			12		**12**
Third Phalanx	L.Med/R.Lat					**0**				4	**4**				11	**11**				4	**4**				2	**2**				2	**2**					**0**					**0**
Third Phalanx	R.Med/L.Lat				2	**2**				4	**4**				7	**7**				7	**7**				3	**3**				3	**3**				1	**1**					**0**
Third Phalanx	Unknown					**0**					**0**					**0**					**0**					**0**					**0**					**0**				6	**6**
Astragalus	Left				9	**9**				29	**29**				7	**7**				2	**2**				4	**4**				3	**3**				3	**3**				2	**2**
Astragalus	Right				10	**10**				25	**25**				9	**9**				5	**5**				7	**7**				3	**3**				3	**3**				3	**3**
Astragalus	Unknown					**0**					**0**					**0**					**0**					**0**				1	**1**					**0**					**0**
Calcaneum	Left	1		1		**2**	2	1	9		**12**	9		2	5	**16**	1	1	3		**5**	3			2	**5**					**0**	4			3	**7**					**0**
Calcaneum	Right	1		5	2	**8**	4		6	1	**11**	7		4	5	**16**	3		1	1	**5**	2			1	**3**	1		1		**2**	3		1	1	**5**			2		**2**
Calcaneum	Unknown					**0**					**0**					**0**					**0**					**0**					**0**					**0**					**0**
Mandible with teet	Left				3	**3**				2	**2**				89	**89**				9	**9**				3	**3**				1	**1**				1	**1**					**0**
Mandible with teet	Right				2	**2**				2	**2**				76	**76**				10	**10**				2	**2**					**0**				7	**7**					**0**
Mandible with teet	Unknown					**0**					**0**					**0**					**0**					**0**					**0**				4	**4**					**0**
	TOTAL					**165**					**340**					**491**					**138**					**82**					**53**					**86**					**85**
		Gt	**Gt**	**Gt**	**Gt**	**Gt**	**Sp**	**Sp**	**Sp**	**Sp**	**Sp**	**Gt/Sp**	**Gt/Sp**	**Gt/Sp**	**Gt/Sp**	**Gt/Sp**	**Gz**	**Gz**	**Gz**	**Gz**	**Gz**	**SR**	**SR**	**SR**	**SR**	**SR**	**Ct**	**Ct**	**Ct**	**Ct**	**Ct**	**Pg**	**Pg**	**Pg**	**Pg**	**Pg**	**Eq**	**Eq**	**Eq**	**Eq**	**Eq**
Non POSAC	**Side**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**	**uf**	**fg**	**F**	**?**	**Total**
Mandibular tooth	Left					**0**					**0**				49	**49**					**0**					**0**				2	**2**					**0**				2	**2**
Mandibular tooth	Right					**0**				1	**1**				57	**57**					**0**					**0**				4	**4**				2	**2**				10	**10**
Mandibular tooth	Unknown					**0**					**0**					**0**					**0**					**0**				11	**11**				2	**2**					**0**
Horncore	Left				18	**18**				1	**1**				4	**4**				12	**12**					**0**					**0**					**0**					**0**
Horncore	Right				19	**19**				3	**3**				3	**3**				10	**10**					**0**					**0**					**0**					**0**
Horncore	Unknown				1	**1**				2	**2**				1	**1**				8	**8**				5	**5**					**0**					**0**					**0**
	TOTAL					**38**					**7**					**114**					**30**					**5**					**17**					**4**					**12**

Species	**NISP**	**%**
Goat	165	11.5
Sheep	340	23.6
Goat/Sheep	491	34.1
Gazelle	138	9.6
Small Ruminant	82	5.7
Cattle	53	3.7
Pig	86	6.0
Equid	85	5.9
TOTAL	**1440**	**100.0**

Table C.9: 'Ain Ghazal Yarmoukian Bone Counts (NISP)

POSAC	Side	Gt uf	Gt fg	Gt F	Gt ?	Gt Total	Sp uf	Sp fg	Sp F	Sp ?	Sp Total	Gt/Sp uf	Gt/Sp fg	Gt/Sp F	Gt/Sp ?	Gt/Sp Total	Gz uf	Gz fg	Gz F	Gz ?	Gz Total	SR uf	SR fg	SR F	SR ?	SR Total	Ct uf	Ct fg	Ct F	Ct ?	Ct Total	Pg uf	Pg fg	Pg F	Pg ?	Pg Total	Eq uf	Eq fg	Eq F	Eq ?	Eq Total
Scapula	Left	1		7	2	**10**	1	1	12	1	**15**	9		12	17	**38**			6	2	**8**	2		3		**5**			1		**1**	3		2		**5**			2	1	**3**
Scapula	Right			9		**9**		1	13	1	**15**	13		13	5	**31**			7	1	**8**	2				**2**			1		**1**	2		3	4	**9**			2	2	**4**
Scapula	Unknown					**0**					**0**					**0**					**0**					**0**					**0**					**0**					**0**
Humerus	Left		1	7		**8**			21		**21**	1	4	28	1	**34**			6		**6**			2		**2**					**0**	1		1		**2**	1		10		**11**
Humerus	Right			18		**18**		2	17		**19**	1	5	14	2	**22**		1	6		**7**	1	2	7	1	**11**			2	1	**3**	1	1	2		**4**		1	7		**8**
Humerus	Unknown					**0**					**0**					**0**					**0**					**0**					**0**					**0**					**0**
Radius	Left			1		**1**	2		7		**9**		1	1		**2**			1		**1**					**0**					**0**					**0**					**0**
Radius	Right	2	1			**3**	4		3		**7**					**0**					**0**	1				**1**					**0**	1				**1**			1		**1**
Radius	Unknown					**0**					**0**					**0**			4	3	**7**					**0**					**0**					**0**					**0**
Pubis	Left			1	1	**2**	1		5	4	**10**			3		**3**			2	2	**4**			2	3	**5**			1	2	**3**			2	3	**5**			6	2	**8**
Pubis	Right	1		1	2	**4**			6	5	**11**			2	8	**10**					**0**			4	3	**7**	1		1	1	**3**	1		1	3	**5**	1		4	1	**6**
Pubis	Unknown					**0**					**0**					**0**	1		2		**3**					**0**					**0**					**0**					**0**
Femur	Left					**0**					**0**	3	1	2		**6**	2		1		**3**			1		**1**					**0**	1				**1**					**0**
Femur	Right					**0**			1		**1**	2	1	3		**6**					**0**	1			1	**2**			1		**1**					**0**			2		**2**
Femur	Unknown					**0**					**0**					**0**			1		**1**					**0**					**0**					**0**					**0**
Tibia	Left			5		**5**			15		**15**	3	1	26		**30**					**0**			3		**3**	1		1		**2**			1		**1**	1		2		**3**
Tibia	Right			1		**1**	1		10		**11**	3		23		**26**			1		**1**			5		**5**			2		**2**	1				**1**			4		**4**
Tibia	Unknown					**0**					**0**					**0**					**0**					**0**					**0**					**0**					**0**
Metacarpal	Left	1	1	4		**6**			7		**7**					**0**			1		**1**					**0**					**0**					**0**					**0**
Metacarpal	Right	1		1		**2**			11		**11**				1	**1**			1		**1**					**0**		1	1		**2**					**0**					**0**
Metacarpal	Unknown					**0**			1		**1**					**0**			1		**1**					**0**					**0**					**0**					**0**
Metacarpal 1/2	L.Med/R.Lat	2	1	3		**3**	2		1		**1.5**	1				**0.5**					**0**			1		**0.5**					**0**					**0**					**0**
Metacarpal 1/2	R.Med/L.Lat	2	1	6		**4.5**	3		4	1	**4**					**0**			3		**1.5**					**0**					**0**	1				**0.5**					**0**
Metacarpal 1/2	Unknown					**0**			1		**0.5**					**0**			2		**1**					**0**					**0**					**0**					**0**
Metatarsal	Left			9		**9**			6		**6**					**0**					**0**				1	**1**					**0**					**0**					**0**
Metatarsal	Right	1		4		**5**	1		13		**14**					**0**	1		2		**3**					**0**					**0**					**0**					**0**
Metatarsal	Unknown					**0**					**0**					**0**	1		1		**2**					**0**					**0**					**0**					**0**
Metatarsal 1/2	L.Med/R.Lat	1		1		**1**	5		5	1	**5.5**	1				**0.5**					**0**					**0**					**0**					**0**					**0**
Metatarsal 1/2	R.Med/L.Lat	3		3		**3**	2		6		**4**	1				**0.5**					**0**					**0**					**0**	1				**0.5**					**0**
Metatarsal 1/2	Unknown					**0**					**0**					**0**					**0**					**0**					**0**					**0**					**0**
Metapodial	Left					**0**					**0**					**0**					**0**					**0**					**0**					**0**					**0**
Metapodial	Right					**0**	1				**1**					**0**					**0**					**0**			1		**1**					**0**					**0**
Metapodial	Unknown					**0**					**0**					**0**					**0**					**0**	1		4		**5**					**0**			9	1	**10**
Metapodial 1/2	L.Med/R.Lat					**0**	1		2		**1.5**	2				**1**					**0**					**0**	1				**0.5**	1		1		**1**					**0**
Metapodial 1/2	R.Med/L.Lat	1				**0.5**	1		2	1	**2**	1				**0.5**	1				**0.5**	1				**0.5**					**0**	3		3		**3**					**0**
Metapodial 1/2	Unknown					**0**					**0**					**0**					**0**					**0**	1				**0.5**					**0**					**0**
First Phalanx	L.Med/R.Lat			13		**13**		1	18		**19**	1		18		**19**			16		**16**			2		**2**			5		**5**	1		1		**2**					**0**
First Phalanx	R.Med/L.Lat			9		**9**		2	18		**20**	2	1	23		**26**			12		**12**			4		**4**			7		**7**	2	1	3		**6**					**0**
First Phalanx	Unknown					**0**					**0**					**0**					**0**					**0**					**0**			3		**3**			12		**24**
Third Phalanx	L.Med/R.Lat					**0**				4	**4**				11	**11**				4	**4**				2	**2**				2	**2**					**0**					**0**
Third Phalanx	R.Med/L.Lat				2	**2**				4	**4**				7	**7**				7	**7**				3	**3**				3	**3**				1	**1**					**0**
Third Phalanx	Unknown					**0**					**0**					**0**					**0**					**0**					**0**					**0**				6	**12**
Astragalus	Left				9	**9**				29	**29**				7	**7**				2	**2**				4	**4**				3	**3**				3	**3**				2	**2**
Astragalus	Right				10	**10**				25	**25**				9	**9**				5	**5**				7	**7**				3	**3**				3	**3**				3	**3**
Astragalus	Unknown					**0**					**0**					**0**					**0**					**0**				1	**1**					**0**					**0**
Calcaneum	Left	1		1		**2**	2	1	9		**12**	9		2	5	**16**	1	1	3		**5**	3			2	**5**					**0**	4			3	**7**					**0**
Calcaneum	Right	1		5	2	**8**	4		6	1	**11**	7		4	5	**16**	3		1	1	**5**	2			1	**3**	1		1		**2**	3		1	1	**5**			2		**2**
Calcaneum	Unknown					**0**					**0**					**0**					**0**					**0**					**0**					**0**					**0**
Mandible with teet	Left				3	**3**				2	**2**				89	**89**				9	**9**				3	**3**				1	**1**				1	**1**					**0**
Mandible with teet	Right				2	**2**				2	**2**				76	**76**				10	**10**				2	**2**					**0**				7	**7**					**0**
Mandible with teet	Unknown					**0**					**0**					**0**					**0**					**0**					**0**				4	**4**					**0**
	TOTAL					**153**					**321**					**488**					**135**					**81**					**52**					**81**					**103**

Non POSAC	Side	Gt uf	Gt fg	Gt F	Gt ?	Gt Total	Sp uf	Sp fg	Sp F	Sp ?	Sp Total	Gt/Sp uf	Gt/Sp fg	Gt/Sp F	Gt/Sp ?	Gt/Sp Total	Gz uf	Gz fg	Gz F	Gz ?	Gz Total	SR uf	SR fg	SR F	SR ?	SR Total	Ct uf	Ct fg	Ct F	Ct ?	Ct Total	Pg uf	Pg fg	Pg F	Pg ?	Pg Total	Eq uf	Eq fg	Eq F	Eq ?	Eq Total
Mandibular tooth	Left					**0**					**0**				49	**49**					**0**					**0**				2	**2**					**0**				2	**2**
Mandibular tooth	Right					**0**				1	**1**				57	**57**					**0**					**0**				4	**4**				2	**2**				10	**10**
Mandibular tooth	Unknown					**0**					**0**					**0**					**0**					**0**				11	**11**				2	**2**					**0**
Horncore	Left				18	**18**				1	**1**				4	**4**				12	**12**					**0**					**0**					**0**					**0**
Horncore	Right				19	**19**				3	**3**				3	**3**				10	**10**					**0**					**0**					**0**					**0**
Horncore	Unknown				1	**1**				2	**2**				1	**1**				8	**8**				5	**5**					**0**					**0**					**0**
	TOTAL					**38**					**7**					**114**					**30**					**5**					**17**					**4**					**12**

Species	**adj NISP**	**%**
Goat	153	10.8
Sheep	321	22.7
Goat/Sheep	488	34.5
Gazelle	135	9.5
Small Ruminant	81	5.7
Cattle	52	3.7
Pig	81	5.7
Equid	103	7.3
TOTAL	**1414**	**100.0**

Table C.10: 'Ain Ghazal Yarmoukian Bone Counts (adjusted NISP)