TRAVAUX DE LA MAISON DE L'ORIENT ET DE LA MÉDITERRANÉE
N° 49

ARCHAEOZOOLOGY OF THE NEAR EAST VIII

Actes des huitièmes Rencontres internationales
d'Archéozoologie de l'Asie du Sud-Ouest et des régions adjacentes

Proceedings of the eighth international Symposium on the
Archaeozoology of southwestern Asia and adjacent areas

TOME II

edited by

Emmanuelle Vila, Lionel Gourichon,
Alice M. Choyke, Hijlke Buitenhuis

Aswa VIII
Lyon 28 juin-1er juillet 2006
Lyon, June 28th-July 1st, 2006

Ouvrage publié avec la participation de la Région Rhône-Alpes et de l'UMR 5133,
Archéorient, Maison de l'Orient et de la Méditerranée

Tome II

Archaeozoology of the Near East VIII
TMO 49, Maison de l'Orient et de la Méditerranée, Lyon, 2008

CAPRINE EXPLOITATION AT ERBABA HÖYÜK: A POTTERY NEOLITHIC VILLAGE IN CENTRAL ANATOLIA

Benjamin S. Arbuckle[1]

Abstract

In this paper, first results of the reanalysis of faunal remains from the Pottery Neolithic village site of Erbaba Höyük are described. In particular, questions concerning the exploitation of sheep and goats are addressed. These results show that both wild and domestic sheep and goats were exploited at Erbaba, and hunting may have replaced herding as the dominant form of caprine exploitation in the final phase of occupation of the site. In addition, survivorship data indicate that sheep and goats were managed with different production goals. These differences suggest that while sheep were likely managed for primary products and herd security, secondary products such as hair and milk may have played an important role in the management of goats.

Keywords: Animal management, hunting, sheep, goat, Pottery Neolithic, Anatolia, survivorship, metrical data.

Résumé

Les premiers résultats de la re-analyse des restes fauniques du village d'Erbaba Höyük, daté du Néolithique céramique, font l'objet de cet article. Les questions concernant l'exploitation des moutons et des chèvres y sont plus particulièrement explorées. Ces résultats montrent que les moutons et les chèvres aussi bien sauvages que domestiques étaient exploités à Erbaba, et que, dans la phase finale d'occupation du site, la chasse pourrait avoir remplacé l'élevage en tant que forme dominante de l'exploitation des caprinés. En outre, les données sur les structures démographiques indiquent que la gestion des moutons et celle des chèvres étaient orientées vers des objectifs différents. Ces différences suggèrent que tandis que les moutons étaient probablement gérés pour les produits primaires et la sécurité du cheptel, les produits secondaires tels que la toison et le lait pourraient avoir joué un rôle important dans l'exploitation des chèvres.

Mots-clés : *Élevage, chasse, mouton, chèvre, Néolithique céramique, Anatolie, courbes de survie, données métriques.*

1. Department of Anthropology, Forensic Science, and Archaeology, Baylor University, One Bear Place #97173, Waco, Texas 76798-7173 USA, e-mail: benjaminarbuckle@post.harvard.edu

INTRODUCTION

Although the subject of archaeological investigation for more than a half century (*e.g.* Mellaart 1964, 1967, 1970; Mellink 1973; Özgüç 1973; Todd 1973, 1980, 1998; Silistreli 1983; Omura 1990, 1996; Gülçur 1995, 1999; Özdoğan, Başgelen 1999; Gérard, Thissen 2002; Öztan 2003; Hodder 2005), the Pottery Neolithic period in Central Anatolia (*ca* 7000-6000 cal. BC), and particularly the economic foundations of the villages of this period, are poorly understood. With the exception of the site of Çatalhöyük, for which data from the Hodder excavations are detailed and abundant (*e.g.* Asouti, Hather 2001; Frame 2002; Hodder 1996, 2005; Hodder, Matthews 1998; Russell, Martin 1998, 2000; Russell *et al.* 2005), there are few sites in the region with well-described faunal and paleobotanical assemblages (although see Asouti 2003; Carruthers 2003, 2005; Martin *et al.* 2002 for Pınarbaşı A/B). As a result, while knowledge of subsistence organization at the unique "super-village" of Çatalhöyük is detailed, very little is known about how economic life was organized in the small village sites of this period (Baird 2002). This asymmetry makes it very difficult to place Çatalhöyük within its regional cultural context and to interpret the evolution of economic systems in this period following the emergence of agriculture and pastoralism.

The site of Erbaba Höyük represents the remains of a small Pottery Neolithic village in the Beyşehir region of Central Anatolia (*fig. 1*), and is partially contemporaneous with the upper levels of Çatalhöyük (Bordaz 1973; Bordaz, Alper-Bordaz 1979). Although recovered during excavations more than a quarter century ago, the important faunal assemblage from the site of Erbaba Höyük has never been described in any detail (see Perkins 1973; Bordaz, Alper-Bordaz 1979, 1982). This assemblage provides a unique opportunity to address the organization of the subsistence economy in a small Pottery Neolithic village during the 7th millennium BC (calibrated).

In this paper, the first results of the reanalysis of the faunal assemblage from this important Neolithic village site are described. In particular, this paper focuses on the nature of the exploitation of sheep and goats ("caprines"), the most abundant taxa in the assemblage, and addresses three specific issues, including: 1) the domestic status of the caprines at Erbaba, 2) the manner in which they were managed and whether differences in the exploitation of sheep and goats can be detected, and, finally, 3) if there are diachronic changes in the use of caprines through the stratigraphic sequence.

The caprine economy is addressed through examination of species frequencies, survivorship, and metrical data. Initial results indicate that although caprines were likely domesticated in the preceding Aceramic Neolithic (Peters *et al.* 1999; Zeder, Hesse 2000; Russell, Martin 2005), hunting played an important role in the Neolithic economy at Erbaba and in fact appears to have increased in importance over time. In addition, survivorship curves suggest that sheep and goats were exploited in different ways, suggesting that these taxa were subject to alternate management strategies as early as the Pottery Neolithic.

Erbaba Höyük

Erbaba Höyük is a small mound located on a band of alluvial deposits on the east side of Beyşehir Gölü, a large intermontaine lake on the northern edge of the Taurus range in the Lakes District of South Central Turkey (*fig. 1*). It was excavated by J. Bordaz as part of the Beyşehir-Suğla Project from 1969 to 1977 (Bordaz 1970a, b, 1973; Bordaz, Alper-Bordaz 1976, 1977a, b, 1978a, b, 1979, 1982). The mound was found to consist of four meters of deposits including three cultural layers assigned to the Late Pottery Neolithic. Radiocarbon determinations made on charcoal in the 1970s as well as four more recent determinations derived from bone collagen indicate an occupation dating to the 7th millennium BC (calibrated) (Bordaz 1973) (*table 1*). It should be noted that radiocarbon dates are not consistent within the stratigraphic sequence and the precise dating of basal level III and upper levels II and I remains problematic. Ceramic parallels link level III at Erbaba to the upper levels at Çatalhöyük (VIII-0), whereas levels II and I have close ceramic and figurine parallels with the Late Neolithic levels at Hacilar VI-IX (Bordaz 1973; Bordaz, Alper-Bordaz 1979). Best current estimates place the basal layer (III) between *ca* 6700-6400 cal. BC and the uppermost layer (I) between *ca* 6400-6000 cal. BC.

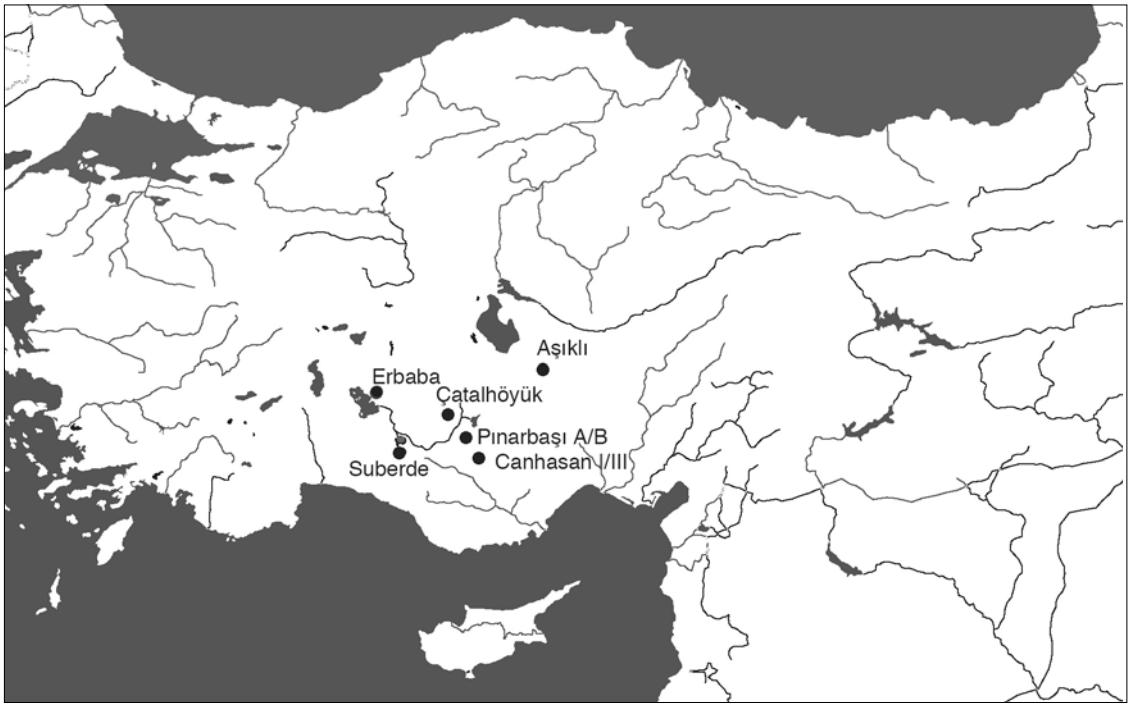

Fig.1—Map showing the location of Erbaba Höyük as well as other Neolithic sites mentioned in the text.

Sample #	Context	Material	14C Date BP	Date cal. BC
AA66741	level I	bone collagen	7677+/-86	6535 +/-70
GX-2543	level I-II	charcoal	7550+/-570	6546 +/-614
AA66738	level III	bone collagen	7275+/-42	6146 +/-53
AA66739	level III	bone collagen	7504+/-85	6354 +/-80
GX-2545	level III	charcoal	7530+/-430	6499 +/-471
GX-2544	level III	charcoal	6925+/-550	5831 +/-548
I-5151	level III	charcoal	7730+/-120	6618 +/-134

Table 1—Radiocarbon dates from Erbaba Höyük. Dates on charcoal are from Bordaz (1973).

Erbaba represents the remains of a small, agricultural village, approximately 0.5 hectares in area. Architecture, consisting of rough limestone blocks set in mud plaster, is cellular in plan with party walls and shared courtyards, and is typical of the Central Anatolian Neolithic as seen at sites such as Aşıklı Höyük, Çatalhöyük and Can Hasan III (Duru 2002) (*fig. 2*). Unlike the site of Çatalhöyük with its elaborate "shrines" and other symbolic architectural installations and decorations (see Mellaart 1967), there is little evidence for architectural or iconographic elaboration at Erbaba. Grinding stones and sickles characterize the lithic assemblage, while paleobotanical studies have revealed a floral assemblage dominated by crops typical of the Near Eastern agricultural package including domestic cereals (hulled emmer wheat, bread wheat, einkorn, and barley), and pulses including a large quantity of peas and bitter vetch (Van Zeist, Buitenhuis 1983). These finds, along with the location of the site on fertile alluvial deposits located between Lake Beyşehir and the northern margin of the Taurus mountains, support the interpretation of Erbaba as a small, and relatively simple, agricultural village of the 7th millennium BC (calibrated).

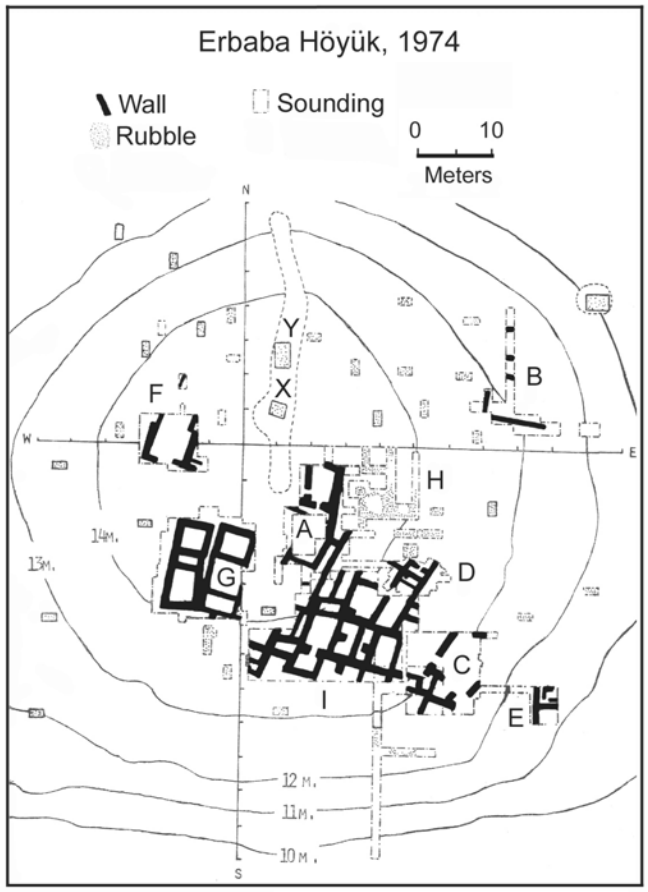

Fig. 2—Plan map of architectural remains at Erbaba Höyük (partially redrawn from Bordaz 1982, plate 33).

The faunal assemblage

One of the goals of the original research at Erbaba was to address questions of paleoeconomy during the transition to agriculture in Central Anatolia (Bordaz 1970a). As a result, a large collection of paleobiological remains was recovered from the site by means of dry sieving, using 1/4 inch screening, as well as flotation (Bordaz, Alper-Bordaz 1979). This collection included paleobotanical remains (analyzed and published by Van Zeist, Buitenhuis 1983) as well as a large faunal assemblage. Although the faunal assemblage was analyzed by D. Perkins in the 1970s, the results of this research were never published in any detail (for brief summaries see Bordaz, Alper-Bordaz 1979, 1982; Perkins 1973).

Following recovery, it appears that the faunal remains were "sorted" and many, but not all, shaft fragments and "unidentifiable" specimens were discarded before being transported to the US for more detailed analysis by Perkins at Columbia University. This "sorted" assemblage was reported to include more than 15,000 identified specimens (Bordaz, Alper-Bordaz 1979).

In the few short communications on his work at Erbaba, Perkins reports that the assemblage is dominated by domestic caprines and cattle and that cattle increase in frequency through the stratigraphic sequence. It is additionally reported that caprines survived to an older age in Level I, "suggesting an increase in their use of secondary products (*i.e.* wool and milk)" (Bordaz, Alpers-Bordaz 1979, p. 159).

Following the death of Perkins, the Erbaba faunal assemblage was moved to the Peabody Museum at Harvard University for storage. There the remains from level III were the subject of analysis by Makarewicz (1999) who found the assemblage to be dominated by domesticates including small-bodied sheep and goats. Following this, the author analyzed a sample of the assemblage including materials from all stratigraphic levels as part of his dissertation research in 2004.

Since an unknown number of fragments appear to have previously been removed from the assemblage through a process of "sorting" before the material was transported to the US, analysis of the assemblage was

limited to a standardized set of diagnostic skeletal parts including epiphyseal ends of long bones, astragalus, calcaneum, atlas, axis, innominate, petrosal, mandible and mandibular teeth. The data presented below, including quantification of the primary taxa, reflect only the analysis of these skeletal parts or portions.

CAPRINE EXPLOITATION

In order to address questions regarding the patterns of caprine exploitation at Erbaba and its change over time data reflecting species frequencies, survivorship, and biometrics are presented. The interpretation and significance of these data are further discussed in a following section.

Species frequencies

Caprines are by far the most abundant taxa in the Erbaba faunal assemblage in all levels. Sheep outnumber goats at a ratio of 4.6:1 for the entire assemblage (*table 2, 3, fig. 3*). The frequency of caprines is highest in level III, the oldest deposits in the mound, where they represent almost 84% of the assemblage based on specimen counts. Level III also exhibits the highest ratio of sheep to goat at 7.3:1. The frequency of caprines declines in levels II and I but is still high at *ca* 71% and 73%. In addition, the sheep to goat ratio decreases to 4.3:1 and 4:1 in these levels.

	I	I/II	II	II/III	III	All
Sheep	496	50	85	29	210	936
Goat	127	13	20	10	29	209
All caprines	1606	147	261	77	717	3012
Cattle	122	12	32	7	34	216
Pig	232	8	35	2	44	347
Deer	140	10	27	0	32	221
Equid	4	0	1	1	0	7
Other	87	8	8	0	27	130
Total	2191	185	364	87	854	3933

Table 2—Counts of mammal remains identified to genus from Erbaba. Deer includes Capreolus, Dama, *and* Cervus. *"Other" includes carnivores, hare, and rodents.*

	I	I/II	II	II/III	III	All
O:C ratio	4.0	3.8	4.3	2.8	7.3	4.6
Caprines	73.3	79.5	71.7	88.5	84.0	76.6
Cattle	5.6	6.5	8.8	8.1	4.0	5.5
Pig	10.6	4.3	9.6	2.3	5.2	8.8
Deer	6.4	5.4	7.4	0.0	3.8	5.6
Equid	0.2	0.0	0.3	1.2	0.0	0.2
Other	4.0	4.3	2.2	0.0	3.2	3.3
Total	100%	100%	100%	100%	100%	100%

Table 3—Frequency of mammal remains identified to genus from Erbaba based on specimen counts. Deer includes Capreolus, Dama*, and* Cervus*. "Other" includes carnivores, hare, and rodents.*

This overwhelming dominance of caprines, particularly sheep, is typical of the Central Anatolian Neolithic, and is a pattern that emerges in the earliest Neolithic in the region. Similarly high frequencies of caprines, particularly sheep, have been documented at the Aceramic sites of Suberde (85-90%) (Perkins, Daly 1968) and Aşıklı Höyük (85%) (Buitenhuis 1997), while sheep are also the dominant taxon in all levels at Çatalhöyük (61-75%) (Russell, Martin 2005).

In addition to caprines, pig, deer, particularly red deer (*Cervus elaphus*), and cattle comprise the bulk of the remainder of the assemblage. Pig remains represent 8.8% of the total assemblage and increase from 5% in level III to approximately 10% in levels II and I. In addition, deer, primarily red deer, make up 5.6% of the assemblage and increase from a low of 3.8% in level III to 7.4% and 6.4% in levels II and I. Cattle represent only 5.5% of the total assemblage based on specimen counts. Confirming Perkins' initial observations, the frequency of cattle increases slightly from level III, where it represents less than 4% of the assemblage, to levels II and I where cattle remains represent 8.8 and 5.6% of those assemblages.

The Erbaba assemblage is rich in terms of the number of taxa represented. In addition to the primary mammals described above other identified taxa include one species of equid (*Equus* sp.), hare (*Lepus*), a variety of carnivores including fox (*Vulpes*), dog/wolf (*Canis*), bear (*Ursus*), cat (*Felis*), and otter (*Lutra*), rodents, as well as birds. Despite this richness, however, sheep, and secondarily goats, were the dominant components of the animal economy.

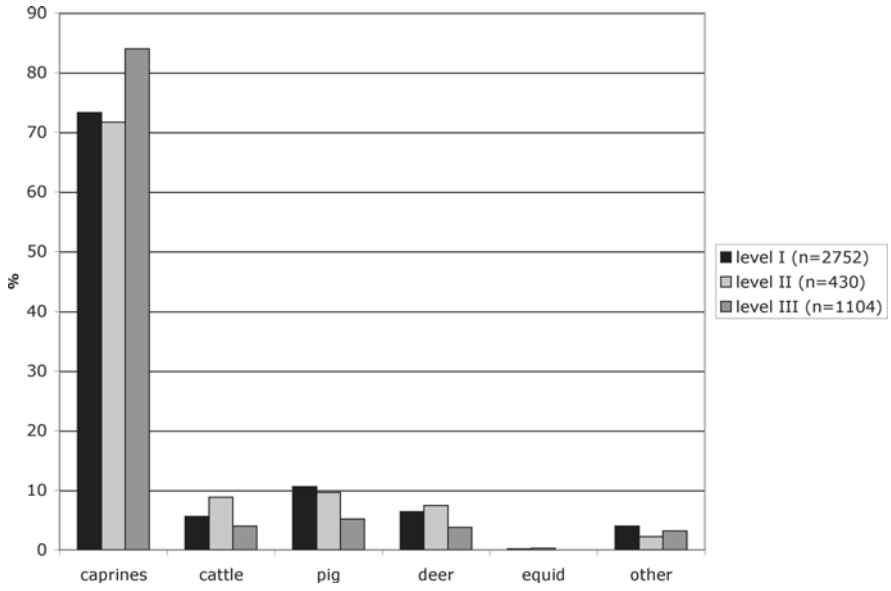

Fig. 3—Frequency of major mammalian taxa at Erbaba in levels III, II, and I.

Survivorship

Survivorship data based on mandibular tooth wear are presented in tables 4 and 5 and figure 4 (survivorship based on epiphyseal fusion is not discussed in this paper; see Arbuckle 2006, p. 259-266). Tooth wear was recorded following Payne (1973) although the calculation of survivorship curves differed from Payne's method in two ways. First, curves were calculated based on mandibles with teeth as well as loose dp/4s and M/3s. Second, Payne's (1973, p. 296) method of proportionally allocating specimens assigned to multiple wear stages was not used. Instead a system of allocation was used in which specimens assigned to multiple wear stages were distributed evenly among each individual wear stage (*e.g.* if 12 specimens were assigned to combined wear stages DEF, then 4 specimens were assigned to each wear stage D, E, and F; see Arbuckle 2006, p. 157-163).

Survivorship curves (*fig. 4, 5*) represent estimates of the percentages of those individuals slaughtered and/or deposited at a site, subsequently recovered by archaeologists, which survived each successive age category starting with 100% at age category 0. Survivorship values for each age category represent the percentage of individuals surviving at the beginning of each age category.

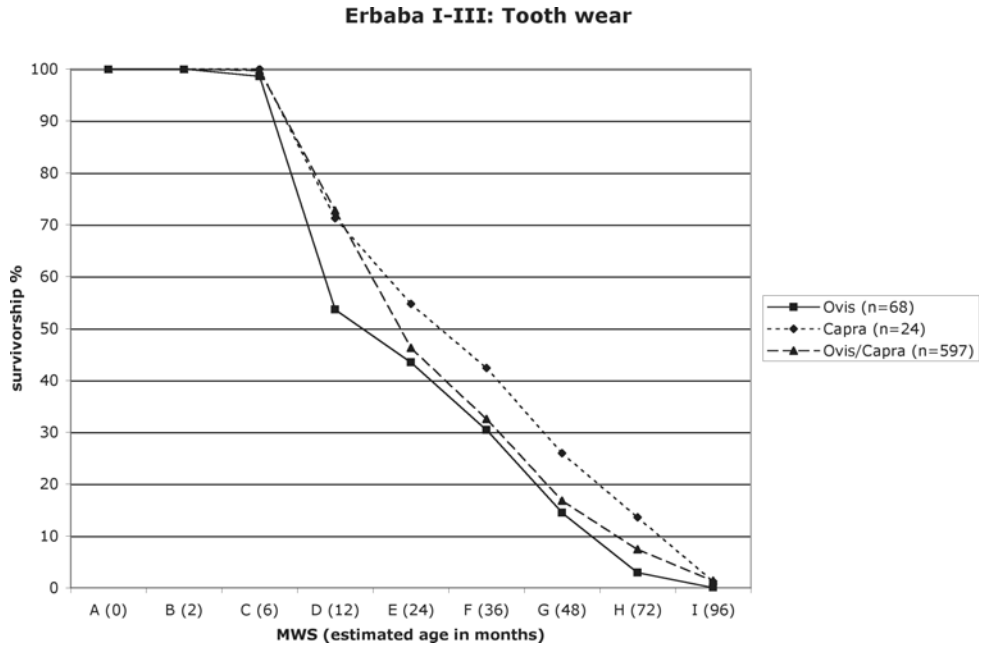

Fig. 4—Survivorship curves based on tooth wear for Ovis*,* Capra*, and combined* Ovis/Capra *categories for the entire assemblage.*

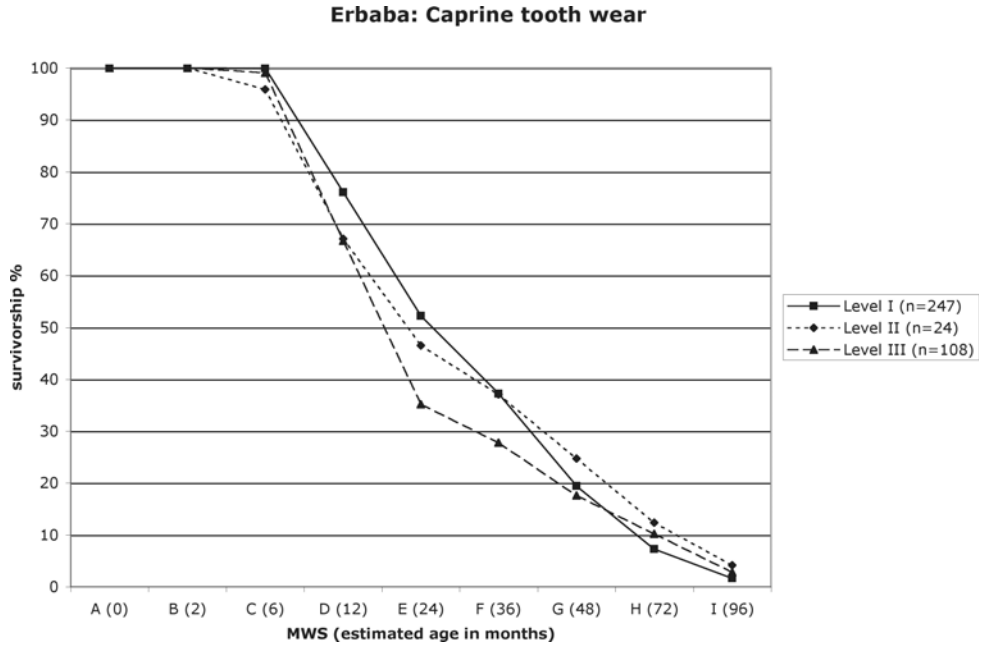

Fig. 5—Survivorship curves based on tooth wear for all caprines for levels III, II, and I.

Two patterns are evident in these data. First, the survivorship curve for sheep generated from the total assemblage exhibits a lower rate of survivorship than that for goats for most age categories (*table 4, fig. 4*). For sheep, survivorship at Payne's wear stage D, E, and F, representing animals at 12, 24 and 36 months, is 53.4%, 43.5%, and 30.4%. This indicates a concentrated kill-off among sheep in their first year and then continued heavy mortality in the second and third years as well. Goat survivorship is more than 10 points higher than that for sheep for each of these age categories indicating that goats were consistently slaughtered at older ages than sheep. The most striking difference in the kill-off between sheep and goats is in wear stage C, representing animals between 6-12 months. Almost 45% of sheep were slaughtered in this age category compared to only *ca* 29% of goats.

The second pattern indicates that survivorship for combined sheep and goats increases through the stratigraphic sequence (*fig. 5, table 5*). Survivorship is at its lowest in level III where only 35% survived past two years (wear stage E). Survivorship increases to its highest levels for subadult and adult caprines in level I, where 52% of caprines survived past two years. This pattern was first identified by Perkins who interpreted it as representing a change in management strategies related to an increase in the production of secondary products such as wool and milk (Bordaz, Alper-Bordaz 1979).

Specimen count (allocated)	*Ovis/Capra*	*Ovis*	*Capra*
A	0	0	0.0
B	8	1	0.0
C	161	31	7.0
D	158	7	4.0
E	82	9	3.0
F	94	11	4.0
G	56	8	3.0
H	36	2	3.0
I	8	0	0.3
Total	603	69	24.3
Mortality			
A	0.0	0.0	0.0
B	1.3	1.5	0.0
C	26.7	44.9	28.8
D	26.2	10.1	16.5
E	13.6	13.0	12.4
F	15.6	15.9	16.5
G	9.3	11.6	12.4
H	6.0	2.9	12.4
I	1.3	0.0	1.2
Total	100%	100%	100%
Survivorship			
A	100	100	100
B	100	100	100
C	98.7	98.6	100
D	72.0	53.6	71.2
E	45.8	43.5	54.7
F	32.2	30.4	42.4
G	16.6	14.5	25.9
H	7.3	2.9	13.6
I	1.3	0.0	1.2

Table 4—Mortality data including allocated specimen counts, mortality, and survivorship based on tooth wear for Ovis, Capra*, and combined* Ovis/Capra *for the total Erbaba assemblage.*

Specimen count (allocated)	Level I	Level II	Level III
A	0	0	0.0
B	0.3	1	1
C	59	7	35
D	59	5	34
E	37	2.3	8
F	44	3	11
G	30	3	8
H	14	2	8
I	4	1	3
Total	247.3	24.3	108
Mortality			
A	0.0	0.0	0.0
B	0.1	4.1	0.9
C	23.9	28.8	32.4
D	23.9	20.6	31.5
E	15.0	9.5	7.4
F	17.8	12.3	10.2
G	12.1	12.3	7.4
H	5.7	8.2	7.4
I	1.6	4.1	2.8
Total	100%	100%	100%
Survivorship			
A	100.0	100.0	100.0
B	100.0	100.0	100.0
C	99.9	95.9	99.1
D	76.0	67.1	66.7
E	52.2	46.5	35.2
F	37.2	37.0	27.8
G	19.4	24.7	17.6
H	7.3	12.3	10.2
I	1.6	4.1	2.8

Table 5—Mortality data including allocated specimen counts, mortality, and survivorship based on tooth wear for combined Ovis/Capra *for levels I, II, and III.*

METRICS

The caprines from Erbaba exhibit a wide range of variability in size. Measurements of the breadth and depth of epiphyseal ends of long bones, and breadth, depth and length measurements of astragalus, calcaneum, and phalanges indicate the presence of both large, robust individuals and smaller, more gracile individuals among both sheep and goats (Arbuckle 2006, p. 283-307). In figures 6 and 7, measurements of the length of the astragalus for Erbaba sheep and goats are compared to those from two well-known sites in Central Anatolia including Aceramic Aşıklı Höyük and Aceramic/Pottery Neolithic Çatalhöyük.

Although the domestic status of the Aşıklı caprines has been the subject of some debate, the caprines from Aşıklı clearly represent a large-sized, morphologically wild population (Buitenhuis 1997;

Martin *et al.* 2002). Furthermore, the distribution of measurements from Aşıklı is bimodal with peaks presumably representing males and females (*fig. 6, 7*). Caprines from Çatalhöyük are thought to represent a small-sized, morphologically domestic population from the earliest levels of the site (Martin *et al.* 2002; Russell, Martin 2005). The two sites exhibit clear differences in the metrical data, showing that both sheep and goats from Çatalhöyük are much smaller than those from Aşıklı and only overlap with the smallest sized specimens from that morphologically wild population. The paucity of large, morphologically wild caprines at Çatalhöyük—they are represented by only a few specimens—is no great surprise given the location of the site on the Konya Plain outside of the natural habitat zone of both caprine taxa. These two sites provide clear points of reference for the distinct metrical characteristics of morphologically wild and domestic caprines in Central Anatolia.

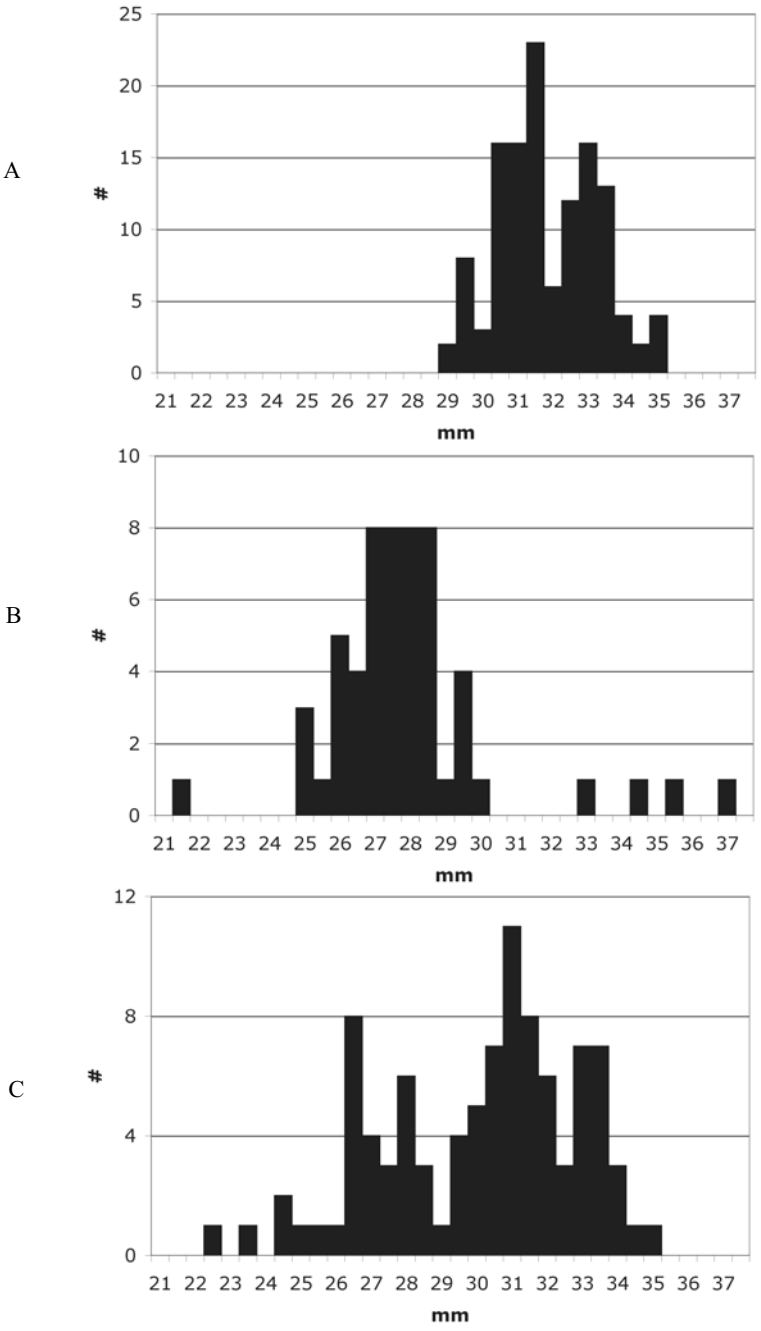

Fig. 6—Astragalus GLl measurements for Ovis *from A) Aşıklı Höyük (Buitenhuis personal communication). B) Çatalhöyük (Russell, Martin 2005). C) Erbaba Höyük.*

The distributions of astragalus measurements for sheep and goats from Erbaba clearly overlap those from both the Aşıklı and Çatalhöyük populations. The sheep measurements are particularly clear showing multiple peaks that mirror the bimodal distribution of morphologically wild specimens from Aşıklı as well as the small domestic specimens from Çatalhöyük. These metrical data provide clear evidence for the presence of both morphologically wild and domestic populations at Erbaba.

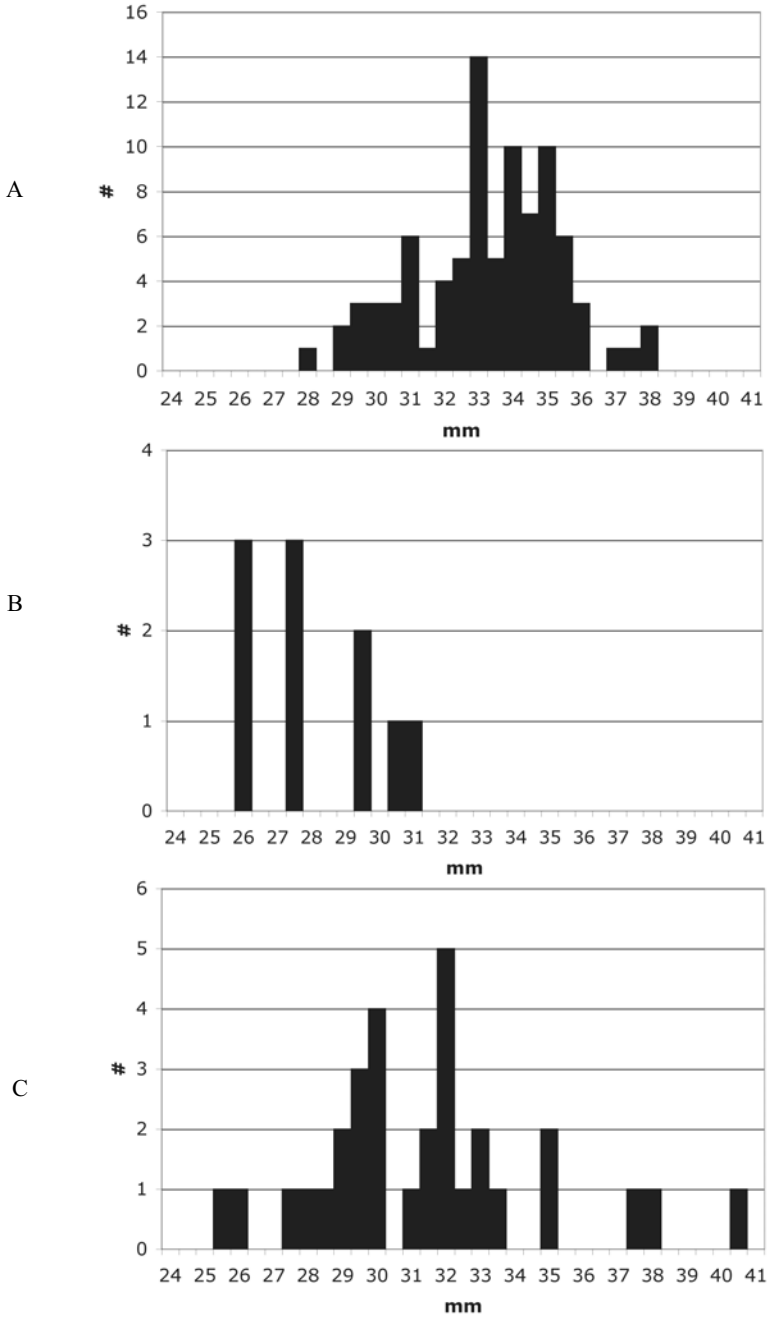

Fig. 7—Astragalus GLl measurements for Capra *from A) Aşıklı Höyük (Buitenhuis personal communication). B) Çatalhöyük (Russell, Martin 2005). C) Erbaba Höyük.*

There is clear evidence for changes in the mean size of both sheep and goats between levels III and I at Erbaba (*fig. 8, 9*). However, instead of indicating a decrease in size, which might be expected as a result of centuries of human selection on a domestic population, the opposite pattern is evident. In figures 8 and 9,

LSI values are presented for sheep and goats for levels III, II, and I (see Meadow 1999 for description of the LSI method). Using the LSI method, log transformed measurements are compared with those from a standard animal, in this case a female *Ovis orientalis* from Iran, and the averaged measurements of male and female *Capra aegagrus* from the Taurus mountains (following Uerpmann, Uerpmann 1994).

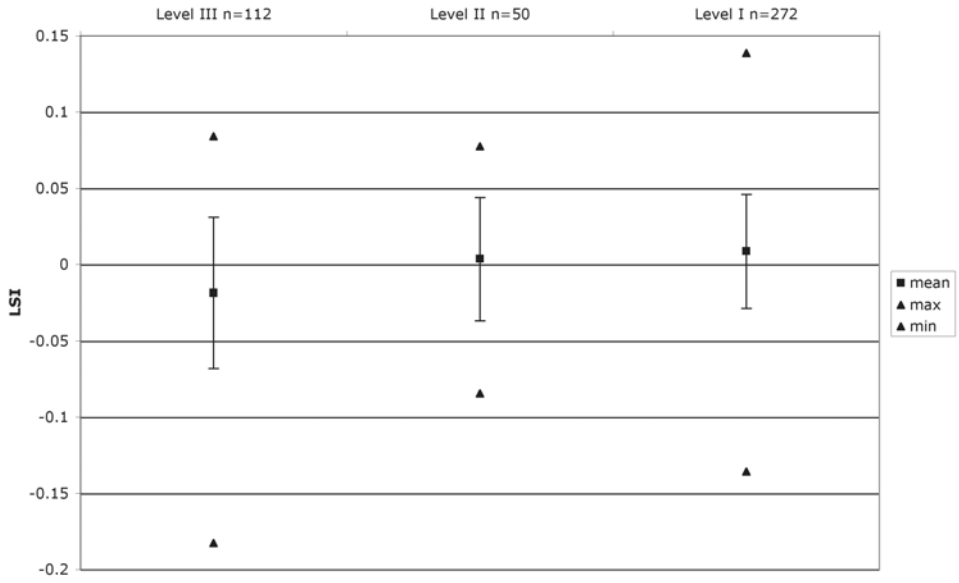

Fig. 8—Means, ranges, and one standard deviation ranges for LSI values for Ovis *for levels III, II, and I. Standard animal measurements from Uerpmann and Uerpmann (1994).*

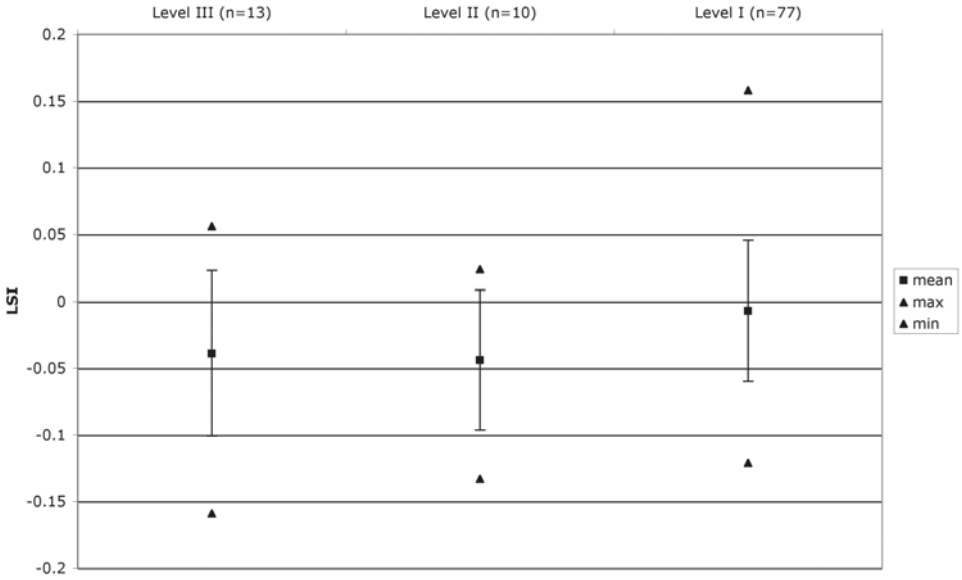

Fig. 9—Means, ranges, and one standard deviation ranges for LSI values for Capra *for levels III, II, and I. Standard animal measurements from Uerpmann and Uerpmann (1994).*

The mean LSI values for both sheep and goats increase from level III to level I indicating an increase in the frequency of larger bodied caprines in the latest phase of occupation. Examination of the distribution of astragalus length and breadth measurements for sheep from levels III and I further illustrates this trend (*fig. 10*). In level III, most specimens are located in the small end of the size range and most lie outside of the range of the Aşıklı population (indicated by the vertical line in *fig. 10*), while in level I the majority of specimens are in the large end of the size range, and are comparable in size to the Aşıklı population. Although some changes are evident in the maximum and minimum values represented in levels III and I, the most important difference between these levels is the shift in the distribution of measurements from one with a mean in the morphologically domestic size range in level III to one with a mean in the morphologically wild size range in level I (*table 6*).

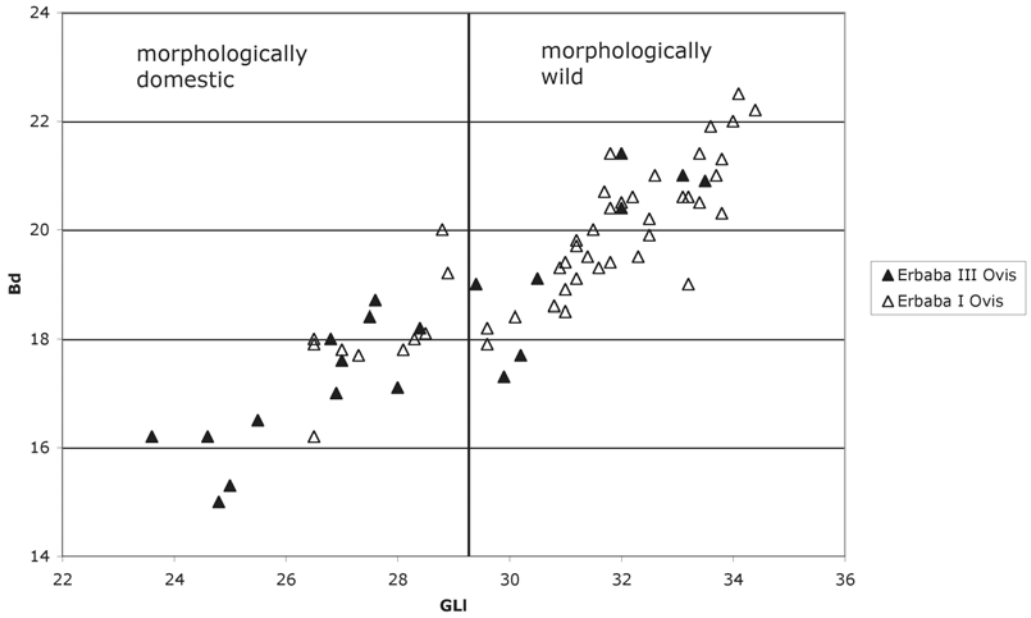

Fig. 10—Scatter plot showing the distribution of astragalus length and breadth measurements for Ovis *from levels III and I. The vertical line separating morphologically wild and domestic is based on the lower end of astragalus length measurements from Aşıklı Höyük (data from Buitenhuis personal communication).*

	Level III	Level I
Mean	28.4	31.1
Standard deviation	2.9	2.5
Maximum	33.5	35.0
Minimum	23.6	22.9
n	21	51

Table 6—Comparison of astragalus length measurements for sheep from levels III and I.

DISCUSSION

In his work as the zooarchaeologist for the Beyşehir-Suğla Project in the 1970s, Perkins concluded that the Aceramic site of Suberde was a hunter's village (Perkins, Daly 1968) and that the animal economy at nearby Erbaba was based on domesticates (Bordaz, Alper-Bordaz 1979, p. 159). Recent work has seriously questioned both of these conclusions. Martin and others (Payne 1972; Martin *et al.* 2002) have raised serious questions about the interpretation of caprine remains from Suberde as wild and reanalysis of fauna from Erbaba suggests that the characterization of the domestic status of the caprines is more complex than Perkins originally indicated. As a result, earlier interpretations of herd management practices and trends over time must be reevaluated.

Domestic status of caprines

Metrical data provide a productive way to address the domestic status of the caprines at Erbaba. Although it has been convincingly argued that metrical data alone cannot effectively be used to identify the earliest managed populations (Zeder, Hesse 2000; Zeder 2001, 2006), in cases following the initial emergence of pastoralism where good regional references are available, metrical data can effectively be used to identify morphologically wild and domestic populations. The presence of detailed metrical data from Aşıklı Höyük and Çatalhöyük representing examples of early morphologically wild and morphologically domestic populations provides just such a regional reference for interpreting the metrical data from Erbaba.

Astragalus measurements clearly show that both morphologically wild and domestic populations are present at Erbaba (*fig. 6, 7*). There are two ways to interpret this pattern, particularly regarding the interpretation of the morphologically wild specimens. The large, morphologically wild specimens at Erbaba may represent wild, hunted caprines, while smaller morphologically domestic animals represent a separate managed population. The presence of wild sheep and goats at Erbaba is not surprising given the location of the site in close proximity to the natural habitat of both taxa and also to a perennial water source. This interpretation suggests that hunting continued to play an important role in the economy well after the development of agriculture and pastoralism in the region, a trend also seen in other regions (*e.g.* Zeder 1994; Arbogast *et al.* 2001).

Alternately, it is possible that the presence of morphologically wild individuals represents a continual process of recruitment of caprines from local wild herds and the incorporation of these wild individuals into domestic herds. Wild sheep and goats may have been added to domestic herds in order to increase herd sizes or for a perceived "improvement" in the quality of the herds.

Although both interpretations are possible, it is argued that the morphologically wild specimens at Erbaba most likely represent wild hunted caprines. The fact that the distribution of astragalus measurements from Erbaba clearly parallels the bimodal distribution seen at Aşıklı as well as the distribution of small sheep at Çatalhöyük (*fig. 6*) provides convincing support for the interpretation of morphologically wild caprines as hunted wild animals. Rather than showing a continuous distribution of sizes from the very large to the very small, which would be expected if wild and domestic individuals were constantly inter-breeding, the metrical data instead suggest discrete populations of large and small sized, wild and domestic animals.

If morphologically wild specimens do represent wild individuals, then changes in the frequency of these individuals between levels III and I indicate that hunting assumed added importance in the later phase of occupation of the site in the latter half of the 7th millennium BC (calibrated). In fact, the distribution of astragalus measurements (*fig. 10*) suggests a major shift in caprine exploitation from the early phase of occupation to the latest phase at Erbaba. These data suggest that domestic sheep were the focus of the level III economy with a few wild sheep being taken as a supplementary activity. But in the level I occupation the importance of herding and hunting reversed and it appears that herding was largely replaced by hunting. In this period it appears that hunting wild sheep was the focus of the caprine economy while herding continued in a supplementary role.

This dramatic reorganization of the animal economy is difficult to explain. There are no indications of major changes in other lines of archaeological evidence suggesting a shift in the function of the site or in the identity of its inhabitants. In fact, with the exception of changes in pottery fabrics, there is a strong sense of continuity throughout the stratigraphic sequence at Erbaba (Bordaz, Alper-Bordaz 1979, 1982).

Both the relative and absolute dating of this economic shift remain open questions. It may have begun in level II, as seen in a shift towards larger LSI values for sheep (*fig. 8*), although sample sizes from this level are very small. In addition the absolute dating of the phases of occupation at Erbaba is still poorly understood. It is clear that the site dates to the 7th millennium (calibrated), and it can be suggested based on a combination of artifact cross-dating and radiocarbon dates that level I dates to the second half of the 7th millennium BC (calibrated).

This period is notable for a large-scale, but short-lived, climatic disturbance dated to between 6400-6000 BC (calibrated) (Alley *et al.* 1997; Grafenstein *et al.* 1998; Barber *et al.* 1999; Bar-Matthews *et al.* 1999; Kuzucuoğlu 2002). The effects of this "climatic crisis" have been identified across the northern hemisphere where it resulted in increased aridity and has been associated with the decline of the PPNB "civilization" in the southern Levant (*e.g.* Bar-Yosef 2001). Pollen cores from across Central Anatolia, including Beyşehir Gölü itself, exhibit declines in arboreal pollen levels at approximately this time, providing some indication that the region did experienced a notable increase in aridity during this climatic event (Bottema, Woldring 1984; Woldring, Bottema 2001/2002; Arbuckle 2006, p. 55).

It is, therefore, possible that the changes in caprine exploitation in level I reflect a cultural response to increased aridity in the Beyşehir region at the end of the 7th millennium BC (calibrated). The inhabitants of Erbaba may have increasingly turned to hunting in response to changes in vegetation and water availability in the surrounding uplands. These changes may have increased the availability of wild sheep and goats in the areas surrounding Lake Beyşehir and Erbaba Höyük itself and made these animals more vulnerable to human predation.

Since the dating of level I is still poorly documented, the strength of the correlation between economic and climatic change is currently difficult to evaluate. Work is currently underway to clarify the dating of the level I occupation in order to further address the impact of climatic change on animal exploitation at Erbaba.

Interpreting caprine exploitation strategies at Erbaba

In addition to identifying the domestic status of the caprines at Erbaba, a second goal of the reanalysis of the fauna was to address questions concerning how caprines were managed and whether differences are evident in the management of sheep and goats.

Management strategies are typically addressed through the analysis of survivorship curves, which are often interpreted using models of herd management derived by Payne (1973) and Redding (1981). These models draw parallels between the age and sex composition of the animals chosen for slaughter and the herders' production goals, whether focused on meat, milk, wool, or herd growth and security.

In his previous work on the Erbaba fauna, Perkins noted an increase in the age of slaughter between levels III and I and interpreted this change as representing an increase in the production of wool and milk among Erbaban herders (Bordaz, Alper-Bordaz 1979). Given the initial conclusion that the caprines at Erbaba were domestic, and the chronological placement of the site in the Pottery Neolithic, a time when more intensive herding practices were developing across the Near East, this conclusion fit the expectations of general models of economic evolution of the time (*e.g.* White 1949; Flannery 1973). However, in light of the observation that a proportion of the caprines at Erbaba were hunted, and a large proportion in level III, the conclusion of secondary products production in level I must be re-evaluated.

Since caprine exploitation at Erbaba involved a combination of exploitation strategies, most notably hunting and herding, it is difficult to apply models of herd management to these data. However, in level III, when herding was the dominant strategy, the survivorship curve for combined sheep and goats most closely resembles the predictions of Payne's (1973) model of meat production and Redding's (1981) of herd

security. These models predict that in order to maximize herd reproduction and the production of meat, herders will prefer to slaughter males in their first and second years, while females are slaughtered as reproductive potential declines after four or five years of age.

Although the Erbaba survivorship curve is somewhat higher than the curves predicted by these models, probably due to an influx of adult individuals as a result of hunting, it generally shows a pattern focused on the slaughter of individuals in their first and second years (*fig. 4, 5, table 4, 5*). In addition, although not discussed here in detail, metrical data suggest that males predominated among those individuals killed prior to reaching two years (Arbuckle 2006, p. 298-300). This suggests that, although herds were almost certainly used for a variety of products, the main goals of herd management were to maintain stable herds while at the same time providing a source of primary products including meat, fat, grease, leather, bone, and horn.

In level I, in contrast, survivorship for combined sheep and goats is considerably higher, indicating that more caprines were slaughtered at older ages. Instead of reflecting management decisions focused on exploiting older sheep and goats for wool and milk, this pattern is likely a reflection of the increase in hunting documented in level I. Hunting practices tend to target adult individuals and often result in survivorship curves that are considerably older than those typically produced by herding (Hole *et al.* 1969, p. 288; Hesse 1982, p. 403) (although this is not always the case; *e.g.* Collier, White 1976). This change in exploitation strategies, rather than the initiation of wool production, provides the best explanation for why more than half of the caprine remains recovered from level I represent adult animals greater than two years, compared to just 35% in level III.

Survivorship curves also suggest differences in the exploitation of sheep and goats. Based on data from all stratigraphic levels, the survivorship curve for sheep exhibits relatively low survivorship after 1 year, while that for goats indicates elevated survivorship in all age categories (*fig. 4, table 4*).

These differences are difficult to interpret given that each curve represents a combination of hunting and herding strategies. The differences may be the result of different sheep and goat hunting strategies. Survivorship for goats may be higher as a result of hunting strategies that targeted lone adult individuals, whereas sheep hunting may have involved the slaughter of entire herds including young and subadult individuals. However, if the demographic composition of hunted sheep and goats was similar, then this would suggest that the differences in sheep and goat survivorship were a result of divergent strategies of herd management.

As the primary focus of the animal economy, evidence suggests that sheep were managed for meat production and herd security. Goat management, on the other hand, took place on a much smaller scale, and may have been more focused on the household production of secondary products including milk and hair. This would explain why herders were willing to slaughter goats at an older age.

The identification of possible differences in the management of sheep and goats has important implications. First, it shows that the common zooarchaeological practice of combining sheep and goat into one category (*e.g.* sheep/goat, ovicaprines, or caprines) can result in misleading interpretations since these animals may have been subject to quite different management practices. Second, these data suggest that goats may have been used for small-scale secondary products production as early as the 7th millennium BC (calibrated), which suggests a very early and not-so-revolutionary start to the "secondary products revolution" (Sherrat 1979, 1983). However, it should be emphasized that, given the combination of herding and hunting strategies represented by the Erbaba faunal assemblage, other interpretations of the data are also possible.

CONCLUSIONS

In its initial stage, the reanalysis of the Erbaba fauna has made several contributions. First it has shown that in its intensive focus on caprines, the animal economy at Erbaba is typical of the Central Anatolian Neolithic. Second, it is now clear that both wild and domestic caprines are well represented in the Erbaba faunal assemblage. Research is increasingly showing that animal economies were diverse in the periods

following the initial domestication of plants and animals and that wild animals continued to play important roles in the economy in many regions (Zeder 1994; Vogler 1997; Arbogast *et al.* 2001; Arbuckle 2006). Moreover, the data from Erbaba suggest an even more interesting case in which hunting not only continued, but actually appears to have displaced herding as the dominant mode of caprine exploitation in the last phase of occupation at the site. This reversal from caprine herding to hunting may represent a unique example of subsistence change in a Neolithic village in the Near East.

Finally, it must be acknowledged that it is very difficult to interpret strategies of herd management at a site like Erbaba, where metrical and survivorship data represent palimpsests of herding and hunting strategies that are impossible to clearly differentiate. However, it is likely that sheep and goats were subject to different management strategies and it is further suggested that goats may have been managed on a small scale for secondary products while sheep appear to have been managed more intensively for meat and herd security. This conclusion has important implications for understanding the timing and nature of the production of secondary products in the Near East and suggests both an early start to, as well as a limited application of management strategies focused on secondary products.

Although the results presented in this paper are modest, they represent a gradual accumulation of data that is slowly bringing to light the nature of economic systems that supported and shaped the rich cultural traditions that developed in Central Anatolia. Through continued analysis of newly recovered materials at ongoing projects such as Çatalhöyük, as well as reanalysis of materials from past excavations such as Erbaba, our understanding of regional patterns of animal exploitation in Central Anatolia are becoming more detailed. With these advances our understanding of the dynamic nature of the foundation of cultural systems in Central Anatolia is slowly becoming more complete.

Acknowledgements

The research described in this paper was completed as part of the author's dissertation research, financial support for which was generously provided by an American Research Institute in Turkey—US Department of State Dissertation Fellowship, NSF Doctoral Dissertation Improvement Grant BCS-0530699, a Harvard University Dissertation Completion Grant, and research grants from the Department of Anthropology, Harvard University and the American School of Prehistoric Research. In addition, the support of the Zooarchaeology Laboratory of the Peabody Museum (especially Peter Burns and Tonya Largy) and of the Mammal Department of the Museum of Comparative Zoology, Harvard University (especially Judy Chupasko) is also gratefully acknowledged. I would like to thank Richard Meadow, Cheryl Makarewicz, Stine Rossel, and A. Levent Atıcı for their help during the analysis of the Erbaba fauna. Hijlke Buitenhuis generously shared metrical data from his work at Aşıklı Höyük. Special thanks to Hitomi Hongo for presenting my paper at the ASWA VIII meeting in Lyon in my absence. Despite all of the help received along the way, all errors in this work are the sole responsibility of the author.

BIBLIOGRAPHY

Alley R.B., Mayewski P.A., Sowers T., Stuiver M., Taylor K.C., Clark P.U. 1997, "Holocene climatic instability: a prominent, widespread event 8200 yr ago", *Geology* 25, p. 483-486.

Arbogast R.-M., Jeunesse C., Schibler J. 2001, *Rôle et statut de la chasse dans le Néolithique ancien danubien (5500-4900 av. J.-C.),* Actes des Premières rencontres danubiennes, Strasbourg, 20-21 novembre 1996, Verlag Marie Leidorf, Rahden.

Arbuckle B.S. 2006, *The Evolution of Sheep and Goat Pastoralism and Social Complexity in Central Anatolia*, Ph.D., Harvard University.

Asouti E. 2003, "Woodland vegetation and fuel exploitation at the prehistoric campsite of Pınarbaşı, south-central Anatolia, Turkey: the evidence from the wood charcoal macro-remains", *Journal of Archaeological Science* 30, p. 1185-1201.

Asouti E., Hather J. 2001, "Charcoal analysis and the reconstructions of ancient woodlands vegetation in the Konya Basin, south-central Anatolia, Turkey: results from the Neolithic site of Çatalhöyük East", *Vegetation History and Archaeobotany* 10, p. 23-32.

Baird D. 2002, "Early Holocene settlement in Central Anatolia: problems and prospects as seen from the Konya Plain", *in* F. Gérard, L. Thissen (eds), *The Neolithic of Central Anatolia: Internal Developments and External Relations during the 9th-6th Millennia cal. BC*, Ege Yayınları, Istanbul, p. 139-152.

Bar-Matthews M., Ayalon A., Kaufman A., Wasserburg G.J. 1999, "The Eastern Mediterranean paleoclimate as a reflection of regional events: soreq cave, Israel", *Earth and Planetary Science Letters* 166, p. 85-95.

Bar-Yosef O. 2001, "The world around Cyprus: from Epi-Paleolithic foragers to the collapse of the PPNB civilization", *in* C. Scurny (ed.), *Earliest Prehistory of Cyprus*, ASOR, Boston, p. 129-164.

Barber D.C., Dyke A., Hillaire-Marcel C., Jennings A.E., Andrews J.T., Kerwin M.W., Bilodeau G., McNeely R., Southon J., Morehead M.D., Gagnon J.-M. 1999, "Forcing of the cold event of 8,200 years ago by catastrophic drainage of Laurentide lakes", *Nature* 400, p. 344-348.

Bordaz J. 1970a, "A preliminary report of the 1969 excavations at Erbaba: a Neolithic site near Beyşhehir, Turkey", *Türk Arkeoloji Dergisi* 18, p. 59-64.

Bordaz J. 1970b, "Erbaba (Beyşehir), 1969", *Anatolian Studies* 20, p. 7-8.

Bordaz J. 1973, "Current research in the Neolithic of South Central Turkey: suberde, Erbaba and their chronological implications", *American Journal of Archaeology* 77, p. 282-288.

Bordaz J., Alper-Bordaz L. 1976, "Erbaba excavations: activities through the 1974 field season", *Türk Arkeoloji Dergisi* 23, p. 39-43.

Bordaz J., Alper-Bordaz L. 1977a, "Beyşehir-Suğla Basin Project", *American Journal of Archaeology* 81, p. 291.

Bordaz J., Alper-Bordaz L. 1977b, "Erbaba excavations, 1976", *Anatolian Studies* 27, p. 32-33.

Bordaz J., Alper-Bordaz L. 1978a, "Beyşehir-Erbaba", *American Journal of Archaeology* 82, p. 316.

Bordaz J., Alper-Bordaz L. 1978b, "Erbaba, 1977", *Anatolian Studies* 28, p. 20-21.

Bordaz J., Alper-Bordaz L. 1979, "The prehistory of the Beyşehir-Suğlu Basin Turkey: excavations at Erbaba", *National Geographic Research Reports,* p. 157-165.

Bordaz J., Alper-Bordaz L. 1982, "Erbaba: The 1977 and 1978 seasons in perspective", *Türk Arkeoloji Dergisi* 26, p. 85-93.

Bottema S., Woldring H. 1984, "Late Quaternary vegetation and climate of southwestern Turkey part II", *Palaeohistoria* 26, p. 123-149.

Buitenhuis H. 1997, "Aşıklı Höyük: a 'protodomestication' site", *Anthropozoologica* 25-26, p. 655-662.

CARRUTHERS D. 2003, *Hunting and Herding in Anatolian Prehistory: The 9th and 7th Millennium Site at Pınarbaşı*, Ph.D., University of Edinburgh.

CARRUTHERS D. 2005, "Synthesis of Pınarbaşı Site A and B Faunal Material", *http://www.liv.ac.uk/sace/research/projects/pinarbasi/Synthasis_Animal_Bones.html*. Accessed November 16, 2005.

COLLIER S., WHITE J.P. 1976. "Get them young? Age and sex inferences on animal domestication in archaeology", *American Antiquity* 41, p. 96-102.

DURU G. 2002, "Some architectural indications for the origins of the Central Anatolian Neolithic", *in* F. Gérard, L. Thissen (eds), *The Neolithic of Central Anatolia: Internal Developments and External Relations during the 9th-6th Millennia cal. BC*, Ege Yayınları, Istanbul, p. 171-180.

FLANNERY K. 1973, "The cultural evolution of civilizations", *Annual Review of Ecology and Systematics* 3, p. 399-426.

FRAME S. 2002, "Animal bone report", *http://catal.arch.cam.ac.uk/catal/Archive_rep02/a09.html*. Accessed November 16, 2005.

GÉRARD F., THISSEN L. 2002, *The Neolithic of Central Anatolia: Internal Developments and External Relations during the 9th-6th Millennia cal. BC*, Ege Yayınları, Istanbul.

GRAFENSTEIN U.V., ERLENKEUSER H., MÜLLER J., JOUZEL J., JOHNSEN S. 1998, "The cold event 8200 years ago documented in oxygen isotope records of precipitation in Europe and Greenland", *Climate Dynamics* 14, p. 73-81.

GÜLÇUR S. 1995, "Aksaray, Niğde, Nevşehir Illeri 1993 yüzey araştırması", *Araştırma Sonuçları Toplantısı II*, p. 191-213.

GÜLÇUR S. 1999, "Western Cappadocia. Distributions of mounds and flat-settlements", *in Çaglar boyunca Anadolu'da yerlesim ve konut uluslararası sempozyumu*, Ege Yayınları, Istanbul, p. 197-210.

HESSE B. 1982, "Slaughter patterns and domestication: the beginnings of pastoralism in western Iran", *Man* 17, p. 403-417.

HODDER I. 1996, *On the Surface Çatalhöyük 1993-1995*, McDonald Institute for Archaeological Research/British Institute for Archaeology at Ankara Monograph 22, London.

HODDER I. 2005, *Inhabiting Çatalhöyük: Reports from the 1995-1999 Seasons*, McDonald Institute for Archaeological Research/British Institute for Archaeology at Ankara Monograph 38, Cambridge and London.

HODDER I., MATTHEWS R. 1998, "Çatalhöyük: The 1990s seasons", *in* R. Matthews (ed.), *Ancient Anatolia: Fifty Years' Work by the British Institute of Archaeology at Ankara*, British Institute of Archaeology at Ankara, London, p. 44-51.

HOLE F., FLANNERY K.V., NEELY J.A. 1969, *Prehistory and human ecology on the Deh Luran Plain*, Memoirs of the Museum of Anthropology 1, University of Michigan, Ann Arbor.

KUZUCUOĞLU C. 2002, "The environmental frame in Central Anatolia from the 9th to the 6th millennia cal. BC", *in* F. Gérard, L. Thissen (eds), *The Neolithic of Central Anatolia: Internal Developments and External Relations during the 9th-6th Millennia cal. BC*, Ege Yayınları, Istanbul, p. 33-58.

MAKAREWICZ C. 1999, *The Faunal Remains of Neolithic Erbaba: Processes of Domestication and the Herding Economy*, BA Thesis, Brandeis University.

MARTIN L., RUSSELL N., CARRUTHERS D. 2002, "Animal remains from the Central Anatolian Neolithic", *in* F. Gérard, L. Thissen (eds), *The Neolithic of Central Anatolia: Internal Developments and External Relations during the 9th-6th Millennia cal. BC*, Ege Yayınları, Istanbul, p. 193-216.

MEADOW R.H. 1999, "The use of size index scaling techniques for research on archaeozoological collections from the Middle East", *in* C. Becker, H. Manhart, J. Peters, J. Schibler (eds), *Historia Animalium ex Ossibus. Beiträge zur Paläoanatomie, Archäologie, Ägyptologie, Ethnologie, and Geschichte der Tiermedizin*, Festschrift für Angela von den Driesch Zum 65. Geburstag, Verlag Marie Leidorf, Rahden/Westfalen, p. 285-300.

MELLAART J. 1964, "Anatolia before c. 4000 BC and 2300-1750 BC", *The Cambridge Ancient*

History 1 (7), Cambridge University Press, Cambridge, p. 3-52.

Mellaart J. 1967, *Çatal Hüyük: A Neolithic Town in Anatolia*, McGraw-Hill, New York.

Mellaart J. 1970, *Excavations at Hacılar*, Occasional Publications of the British Institute of Archaeology at Ankara 10, Edinburgh University Press.

Mellink M.J. 1973, "Archaeology in Asia Minor", *American Journal of Archaeology* 77, p. 169-193.

Omura S. 1990, "1989 yılı Kırşehir, Yozgat, Nevşehir, Aksaray Illeri sınırları içinde yürütülen yüzey araştırmaları", *Araştırma Sonuçları Toplantısı* 8, p. 69-88.

Omura S. 1996, "A preliminary report of the general survey in Central Anatolia (1994)", *in* H.I.H.P.T. Mikasa (ed.), *Essays on Ancient Anatolia and Syria in the Second and Third Millennium BC*, Harrassowitz Verlag, Wiesbaden, p. 135-192.

Özdoğan M., Başgelen N. 1999, *Neolithic in Turkey: The Cradle of Civilization*, Arkeoloji ve Sanat Yayınları, Istanbul.

Özgüç N. 1973, "Niğde Tepe Bağları Höyügü kazısı", *Belleten* 37, p. 442.

Öztan A. 2003, "A Neolithic and Chalcolithic settlement in Anatolia: Köşk Höyük", *Colloquium Anatolicum* 2, p. 69-86.

Payne S. 1972, "Can Hasan III, The Anatolian Aceramic and the Greek Neolithic", *in* E.S. Higgs (ed.), *Papers in Economic Prehistory*, Cambridge University Press, Cambridge, p. 191-194.

Payne S. 1973, "Kill-off patterns in sheep and goats: the Mandibles from Aşvan Kale", *Anatolian Studies* 23, p. 281-303.

Perkins D.P. 1973, "The beginnings of animal domestication in the Near East", *American Journal of Archaeology* 77, p. 279-282.

Perkins D.P., Daly P. 1968, "A hunter's village in Neolithic Turkey", *Scientific American* 219, p. 96-106.

Peters J., Helmer D., Driesch A. von den, Saña Seguí M. 1999, "Early animal husbandry in the northern Levant", *Paléorient* 25, p. 27-47.

Redding R. 1981, *Decision Making in Subsistence Herding of Sheep and Goats in the Middle East*, Ph.D., University Michigan.

Russell N., Martin L. 1998, "Çatalhöyük animal bone report", *http://catal.arch.cam.ac.ukcatal/Archive_rep98/martin98.html*. AccessedNovember 16, 2005.

Russell N., Martin L. 2000, "Neolithic Çatalhöyük: Preliminary zooarchaeological results from the renewed excavations", *in* M. Mashkour, A.M. Choyke, H. Buitenhuis, F. Poplin (eds), *Archaeozoology of the Near East IV*, ARC-Publicatie 32, Groningen, p. 164-170.

Russell N., Martin L. 2005, "The Çatalhöyük mammal remains", *in* I. Hodder (ed.), *Inhabiting Çatalhöyük: Reports from the 1995-1999 seasons*, McDonald Institute for Archaeological Research, Cambridge, p. 33-98.

Russell N., Martin L., Buitenhuis H. 2005, "Cattle domestication at Çatalhoyuk revisited", *Current Anthropology* 46 Supplement, p. S101-108.

Sherratt A. 1979, "Plough and pastoralism: aspects of the secondary products revolution", *in* I. Hodder, N. Hammond, G. Isaac (eds), *Patterns in the Past*, Cambridge University Press, Cambridge, p. 261-305.

Sherratt A. 1983, "The secondary exploitation of animals in the Old World", *World Archaeology* 15, p. 90-104.

Silistreli U. 1983, "Pınarbaşı ve Köşk Höyükleri", *Kazi Sonuçlari Toplantisi* 5, p. 81-85.

Todd I.A. 1973, "The Neolithic period in Central Anatolia", *Actes du VIII^{e} Congrès International des Sciences Préhistoriques et Protohistoriques II, Beograd* p. 214-225.

Todd I.A. 1980, *The Prehistory of Central Anatolia I: The Neolithic Period*, Paul Åströms Förlag, Göteborg.

Todd I.A. 1998, "Central Anatolian Survey", *in* R. Matthews (ed.), *Ancient Anatolia: Fifty Years'*

Work by the British Institute of Archaeology at Ankara, British Institute of Archaeology at Ankara, London, p. 17-26.

UERPMANN M., UERPMANN H.-P. 1994, "Animal bone finds from excavation 520 at Qala'at al-Bahrain", *in* F. Høljund, H.H. Anderson (eds), *Qala'at al-Bahrain. Vol. 1. The Northern City Wall and the Islamic Fortress*, Jutland Archaeological Society Publications 30 (1), Aarhus, p. 417-444.

VAN ZEIST W., BUITENHUIS H. 1983, "A Paleobotanical study of Neolithic Erbaba, Turkey", *Anatolica* 10, p. 47-89.

VOGLER U. 1997, *Faunenhistorische Untersuchungen am Sirkeli Höyük/Adana, Türkei (4.-1. Jahrtausend v. Chr.)*, Ph.D., Dissertation Institut für Paläoanatomie, Domesticakationsforschung und Geschichte der Tiermedizin der Tierärtzlichen Fakultät der Ludwig-Maximilians Universität München.

WHITE L. 1949, *The Science of Culture. A Study of Man and Civilization*, Farrar, Straus and Giroux, New York.

WOLDRING H., BOTTEMA S. 2001/2002, "The vegetation history of east-central Anatolia in relation to archaeology: the Eski Acıgöl pollen evidence compared with the Near Eastern environment", *Palaeohistoria* 43/44, p. 1-34.

ZEDER M. 1994, "After the revolution: Post-Neolithic subsistence in Northern Mesopotamia", *American Anthropologist* 96, p. 97-126.

ZEDER M. 2001, "A metrical analysis of a collection of modern goats (*Capra hircus aegagrus* and *C. h. hircus*) from Iran and Iraq: implications for the study of caprine domestication", *Journal of Archaeological Science* 28, p. 61-79.

ZEDER M. 2006, "Archaeological approaches to documenting animal domestication", *in* M. Zeder, D. Bradley, E. Emshwiller, B.D. Smith (eds), *Documenting Domestication: New Genetic and Archaeological Paradigms*, University of California Press, Berkeley, p. 171-180.

ZEDER M., HESSE B. 2000, "The initial domestication of goats (*Capra hircus*) in the Zagros mountains 10,000 years ago", *Science* 287, p. 2254-2257.