Implications of Age Structures for Epipaleolithic Hunting Strategies in the Western Taurus Mountains, Southwest Turkey

Levent ATICI

Department of Anthropology
Mail Stop 455003
University of Nevada, Las Vegas
Las Vegas, NV 89154-5003 (U.S.A.)
Levent.Atici@unlv.edu

ABSTRACT

This paper investigates hunter-gatherer behavioral strategies during the Epipaleolithic period in the western Taurus Mountains of Mediterranean Turkey. Seven archaeofaunal assemblages excavated from Karain B and Öküzini caves were analyzed and interpreted with a special emphasis on age structures and their implications for general hunting strategies, site function and use, and seasonality. A detailed analysis of age structures based on dental wear and epiphyseal fusion data combined with other zooarchaeological evidence has revealed that hunter-gatherers in the Western Taurus Mountains intensively hunted wild sheep and goat, mostly targeted prime-age animals, shifted from seasonally restricted site use and hunting to unrestricted multiseasonal site use and hunting pattern, and progressively hunted larger number of juvenile caprines throughout the Epipaleolithic.

KEY WORDS
Karain,
Öküzini,
Turkey,
Epipaleolithic,
Seasonality,
Mortality Profiles,
Discrete Age Cohorts,
Synchronized Killing.

RÉSUMÉ
Incidence des répartitions par âge dans les stratégies de chasse durant l'Épipaléolithique dans la chaîne du Taurus, sud-ouest de la Turquie.
Cet article aborde les stratégies comportementales des chasseurs-cueilleurs durant l'Épipaléolithique dans la chaîne du Taurus occidental de la Turquie méditerranéenne. Sept ensembles fauniques provenant des sites de Karaïn B et d'Öküzini ont été analysés et interprétés, mettant l'accent sur les répartitions par âge et leurs implications sur les stratégies cynégétiques générales, la fonction et l'utilisation du site, et la saisonnalité. L'analyse détaillée des répartitions par âge, d'après l'analyse de l'usure dentaire et les données de

MOTS CLÉS
Karain,
Öküzini,
Turquie,
Epipaléolithique,
saisonnalité,
profils de mortalité,
familles d'âge distinctes,
abattage synchronisé.

la fusion épiphysaire, combinée à d'autres données archéozoologiques, montre que les chasseurs-cueilleurs des montagnes du Taurus occidental ont chassé intensivement des moutons et des chèvres sauvages, que la chasse visait principalement des animaux jeunes, qu'ils se sont déplacés de sites saisonniers, strictement réservés à la chasse vers des sites multisaisonniers, non-dédiés spécifiquement à la chasse, et qu'ils ont abattu progressivement et majoritairement de jeunes caprinés durant l'Épipaléolithique.

INTRODUCTION

The Epipaleolithic period marked a period of intensive changes in hunter-gatherer behavioral strategies that led to the emergence of agricultural economies during the Terminal Pleistocene and Early Holocene in the Near East. The changes from Upper Paleolithic subsistence strategies as reflected in the faunal record of the Epipaleolithic of the eastern Mediterranean and of the Levant generally were:

(1) intensified hunting of ungulates such as gazelles (e.g., Davis 1983; Bar-Yosef 2002; Bar-Oz 2004; Bar-Oz *et al.* 2004; Munro 2004; Munro & Bar-Oz 2005);

(2) increased dietary breadth, which is often referred to as the "broad-spectrum revolution" (originally coined by Flannery 1969) and which involved intensified exploitation of small game such as hare, tortoise, and birds (e.g., Dobney et al., 1999; Munro 1999, 2004; Stiner 2001, 2005; Stiner et al. 2000; Surovell 1999; Weiss et al., 2004);

(3) increased selective hunting of juvenile animals (e.g., Bar-Yosef and Meadow 1995; Davis 1983; Legge and Rowley-Conwy 1987; Liebermann 1993a; Munro 2004); and

(4) increased duration of the occupation at same sites or a shift toward more sedentary life ways (e.g., Bar-Yosef and Belfer-Cohen 1989; Davis 1983; Lieberman 1993b, 1998; Moore 1985; Moore and Hillman 1992; Nadel et al. 2004; Rocek 1998; Tchernov 1982, 1984; Valla 1998, 1999).

These adaptive strategies have been thought to have laid the foundation for the emergence of animal domestication and pastoral economies in the Near East. As such, it is essential to establish individual chronological and cultural frameworks for each sub-region of the Near East, and to test the validity of archaeologically observed Epipaleolithic Levantine forager adaptations (The Levantine model) and their applicability to other sub-regions of the Near East. The scarcity of research on Anatolian Epipaleolithic in general and lack of comprehensive faunal analysis from Anatolian Epipaleolithic sites in particular leave this crucial sub-region of the Near East largely unknown. The corpus of data accumulated through extensive research on the faunal assemblages from well-dated stratigraphic contexts of Karain B and Öküzini makes these sites the only currently available candidates for investigating animal exploitation patterns during the Epipaleolithic in Anatolia, and for comparing these patterns with those in other sub-regions of the Near East.

Besides investigating general hunting strategies, this paper seeks to test whether there was a trajectory toward progressively younger age structures and a shift toward more sedentary life ways during the investigated part of the Epipaleolithic period (from ca. 20,000 to 14,000 calibrated years BP) in the western Taurus Mountains of Mediterranean Turkey as observed in Epipaleolithic Levantine faunal assemblages. A detailed analysis of age structures based on dental wear and epiphyseal fusion data has been primarily used to determine whether proportions of young animals in the faunal assemblages remained constant or progressively increased over time. A focus on the juvenile caprine teeth from the Epipaleolithic "bonebed" at Karain B Cave and from contemporaneous strata from Öküzini Cave has been used to identify discrete age cohorts and synchronized killing of caprines, and to determine whether Öküzini and Karain B caves had multiseasonal site use patterns and a shift toward more sedentary life ways during the Epipaleolithic.

Age Structures and Hunting Strategies

Data derived from the analyses of tooth eruption and wear and of epiphyseal fusion of ungulates represented in archaeofaunal assemblages have commonly been used to demonstrate the demography of mortality and to interpret general hunting strategies (Kurten 1953; Voorhies 1969; Klein 1982; Koike & Ohtaishi 1987; Stiner 1990, 1991; Lubinski 2001a, b; Lubinski & O'Brien 2001; Pike-Tay & Cosgrove 2002). Mammalian age structures have been used to infer mobility patterns and site function as well as to interpret hunting strategies.

Overrepresentation of prime-age, adult animals compared to very young or very old animals points to 'selective hunting' (Stiner 1990). Enloe (1997: 101) notes that prime dominated hunting probably involved selection by sex and age. The prime-age dominated pattern may reflect selection for largest size or the meatiest game after a drive, selection when scavenging from a catastrophic kill event, or skilled hunters selecting prime animals (Pike-Tay & Cosgrove 2002: 106). Based on their studies of the Sika deer game populations at the Hokkaido Reserve in Japan, Koike and Ohtaishi (1987) report that hunting with bows and arrows and targeting animals one by one produce a stronger selection among the game animals, creating a bias against fawns and yearlings. 'Fawn-abundant' patterns, in contrast, suggest a different hunting technique, most probably trapping, and produce a catastrophic age profile (Koike & Ohtaishi 1987: 265).

Seasonality of Hunting and Site Use

The study of past hunter-gatherer adaptations and their resource procurement strategies usually begins with an effort to type an archaeological site using the conventional taxonomy of mobility patterns conceptualized by Binford (1980). Two models of prehistoric mobility patterns that have been recognized for hunter-gatherers are:

1) *circulating* or *residential* mobility of foragers, who 'move people to resources';

2) *radiating* or *logistical* mobility of collectors, who 'move resources to people' (Binford 1980; Barton *et al.* 1995; Kelly 1995, 1998; Sutton 2000: 222).

Site function models postulate that specialized collector sites reflecting logistical organization show a specialized response and heavy reliance on a single resource; a low richness and diversity of ecofactual and artifactual assemblages suggesting brief occupations by smaller numbers of people performing restricted and/or specialized activities; a prime-dominated or catastrophic mortality profile (e.g. mass kills); and restricted, seasonal hunting consistent with prey behavior associated with large numbers of animals and discrete cohorts. In contrast, residential mobility or foragers produce a more generalized and opportunistic response to local resources; deposits containing a high richness or diversity of ecofactual and artifactual remains reflecting a more complete set of activities performed by a larger number of people; a combined mortality profile of attrition and prime-age targeting of smaller number of animals (e.g., single kills); and unrestricted, multi-seasonal, small hunting episodes with small numbers of animals (Binford 1980; Sutton 2000; Pike-Tay & Cosgrove 2002; Burke 2006).

Seasonality may be defined as temporal periodicity in resource use as well as in site use. Seasonality and function and use of sites are all interrelated aspects of mobility patterns and settlement systems, informing us about patterns of social organization (Rocek & Bar-Yosef 1998). Thus, it is essential that site use and function, and seasonality of resource procurement be included in any discussion of hunting strategies. One should expect to detect variations in taxonomic composition depending upon whether a site has restricted seasonal use or unrestricted multiseasonal use. In the former case, a collector site type focusing on one or two taxa will create faunal spectra dominated by targeted prey due to its seasonal abundance. In the latter case, a more opportunistic and generalized hunting strategy will include almost every prey form encountered.

REGIONAL SETTING OF THE SITES

Karain (Black Cave) and Öküzini (Oxen Cave) caves are located 1 km apart in the foothills of the Taurus Mountains, near the village of Yağca, some 30 km northwest of Antalya and of Mediterranean coast in southwest Turkey (Fig. 1).

Karain Cave, located 450 m above the sea level and 150 m above the travertine plain that it overlooks,
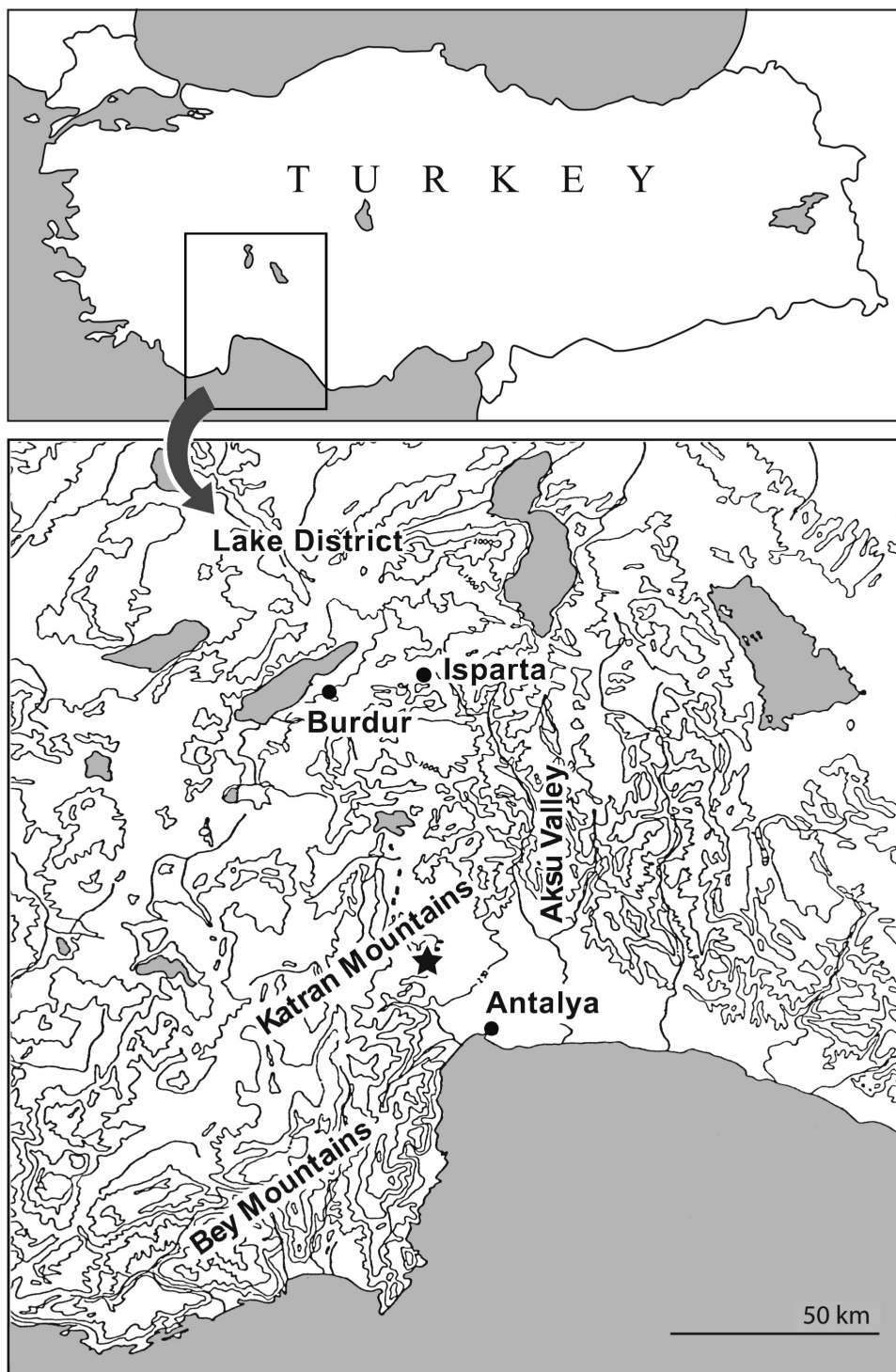
FIG. 1. — Location of Karain B and Öküzini caves.

is a complex of several interconnected chambers (A-G currently known). In contrast, Öküzini Cave is located at the contact of the base of the Katran Mountains with the travertine plain, approximately 300 m above the seal level. The sites are situated in an ecotonal zone having access to a wide range of microenvironments including steep mountains cut by short valleys; broad, flat travertine plain and open grassland with shrubs, marshes, and gallery forests; and pine forests limited to high altitudes.

EXCAVATIONS AND STRATIGRAPHY

Both Karain and Öküzini caves were first discovered and intermittently excavated by Kökten in 1950s. After Kökten, his successor Işın Yalçınkaya of Ankara University excavated Öküzini between 1989 and 1999 in collaboration with a large interdisciplinary team (Albrecht 1988, 1992; Yalçınkaya *et al.* 2002a). Yalçınkaya also restarted excavations at Karain B in 1996 (Yalçınkaya *et al.* 2000, 2001). The stratigraphic column at Karain B comprises mixed deposits from the Neolithic through Middle Ages, with underlying Pleistocene components divided into three geological horizons (GH): Epipaleolithic (P.I.1 and P.I.2), Upper Paleolithic (P.II), and Middle Paleolithic (P.III) (Yalçınkaya 2002b). At

Öküzini excavations revealed 13 discrete geological horizons (GH 0 through XII) within a 3.5-meter Epipaleolithic sequence including a mixed protohistoric level preceded by Epipaleolithic layers that have been subdivided into four cultural phases or archaeological units (AUs 1, 2, 3, 4) based on characteristics of the lithic assemblages (Yalçınkaya *et al.* 1996, 1998).

CHRONOLOGICAL FRAMEWORK

Calibrated radiocarbon dates listed in Table 1 represent geological horizons (GH), units, and assemblages. For the sake of consistency and ease of use, the sites and their strata have been assigned codes. The elimination of bone and aberrant charcoal dates and outliers from the large corpus of radiocarbon dates, while reducing the sample size, has enabled us to establish a more consistent and presumably reliable chronological framework for the Epipaleolithic at Karain B and Öküzini. Thus, hereafter the site and faunal assemblage codes listed in Table 2 are used. Seven assemblages from Karain B and Öküzini caves, covering a period from approximately 19,800 to 13,700 cal BP, provide the faunal material employed in the remainder of this paper. With its longer sequence, Öküzini covers the entire

TABLE 1. — Radiocarbon date ranges for faunal assemblages from Karain B (KB) and Öküzini (OK) (as defined and used by Otte *et al.* 2003; Yalçınkaya *et al.* 2002a).
GH = Geological Horizon, AU = Archaeological Unit, and FA = Faunal Assemblage.

| Calibrated with OxCAL Version Beta 4.0* *Ramsey 2006 | | | BP Calibration limits | | | | | | |
| | | | 68% | | 95% | | | | |
Stratum	uncal BP	Error ±	From	To	From	To	AU	FA	Phase
Öküzini Cave GH Ia	10,922	55	12,910	12,850	12,952	12,824	VI	OK6	NA
Öküzini Cave GH II	12,002	81	13,949	13,778	14,040	13,710	V	OK5	5
Öküzini Cave GH III	12,059	63	13,983	13,833	14,056	13,775	V	OK5	5
Öküzini Cave GH IV	12,350	59	14,457	14,119	14,722	14,053	IV	OK4	4
Öküzini Cave GH VI	13,027	39	15,520	15,230	15,706	15,118	III	OK3	3
Öküzini Cave GH VII	14,575	98	17,886	17,385	17,992	17,069	II	OK2	2
Öküzini Cave GH VIII	14,624	88	17,948	17,509	18,015	17,151	II	OK2	2
Öküzini Cave GH IX-X	16,037	107	19,342	19,080	19,440	19,002	I	OK1	1
Öküzini Cave GH XI	16,460	95	19,791	19,491	19,842	19,459	I	OK1	1
Karain B Cave GH PI.1	15,925	47	19,165	19,005	19,275	18,965	PI.1	KB2	1
Karain B Cave GH PI.2	16,197	46	19,457	19,325	19,478	19,203	PI.2	KB1	1

TABLE 2. — Site and Faunal Assemblage codes (as defined and used by Atici 2007).

Assemblage	BP cal. from	BP cal. to	Phase
OK5	13,900	13,700	5
OK4	14,500	14,100	4
OK3	15,500	15,200	3
OK2	18,000	17,300	2
OK1	19,800	19,000	1
KB2	19,800	19,000	1
KB1	19,800	19,000	1

length of the Epipaleolithic, whereas Karain B has a shorter sequence dating to only the earlier phase of the Late Glacial. Radiocarbon determinations clearly show that the strata PI.2 and PI.1 at Karain B (KB1 and KB2) are contemporaneous with Öküzini GHs XII through IX (OK1).

METHODOLOGY

RECOVERY OF FAUNAL ASSEMBLAGES
All deposits from both caves were systematically processed using bucket flotation during the excavation for the recovery of wood charcoal and other plant remains. All the excavated sediments, from both Karain B and Öküzini, were wet-screened using a set of nested sieves consisting of three different mesh sizes: 4, 2, and 1 mm. Thus, there is no or minimal bias involved in the recovery of these assemblages. Recording of the faunal material from the sites was carried out at the excavation facility of the Karain Cave project near the village of Yağca in Antalya, at the Prehistory Laboratory of Prehistory Department at Ankara University in Ankara, and at the Zooarchaeology Laboratory of Harvard's Peabody Museum in Cambridge, Massachusetts, USA.

SAMPLING
The excavation units — Archaeological Horizons (AH) — form the basis for sampling for both caves (Gamble 1978). AHs were combined into Geological Horizons (GH) to generate larger and comparable analytical units. Sampled and analyzed assemblages from Öküzini and Karain B cover 43.3

and 21 percent of all excavated units respectively, adequate to generate statistically viable and robust age profiles (see Table 8).

DEMOGRAPHY OF MORTALITY:
EPIPHYSEAL FUSION
At the most fundamental level, epiphyseal fusion data are very coarse grained and not robust; age profiles based on long bone epiphyseal fusion thus serve to show only general trends in age structures in the first 2.5 years of life, which is the way that they are used here.
The state of epiphyseal fusion for caprine bones was recorded to document age structures following the fusion sequence and corresponding age brackets that Zeder (2006) has documented for modern wild caprine (*Ovis orientalis* and *Capra aegagrus*) specimens from Iran (Table 3). The age stage assignments and corresponding sequence of fusion were modified to accommodate taphonomic bone loss. Zeder (2006) separates proximal humerus as an independent fusion stage to represent specimens older than 48 months (>48 months). Yet, as one of the least dense elements, proximal humeri are usually significantly underrepresented in archaeofaunal assemblages. Thus, I lumped proximal humerus into an "older than 30 months" category (>30 months) to avoid sample bias-related problems (see Table 3).
Based on the assumption that wild caprines will display similar developmental patterns in similar environments, i.e., in Zagros and Taurus Mountains, we expect to reconstruct age profiles accurately. In order to avoid double counting, MNE values were used rather than NISP for generating age profiles. For the estimation of MNE values, a combination of Morlan's (1994) definition of discrete features or landmarks (e.g., nutrient foramina) approach and Bunn and Kroll's (1986) "manual overlap" approach were employed. This approach involves laying out all the bones on the bench and recording MNEs while 'eyeballing' the overlap for each skeletal element and portion. It is essential to note that efforts to refit fragmented specimens were made for every element category before final recording. Besides 'eyeballing' overlap, degree of fragmentation for all the specimens was recorded. By so doing, a certain degree of standardization

TABLE 3. — Fusion stages and corresponding age classes for caprines
(modified after Zeder 2006; P = proximal, D = distal).

Stage	Age class	Element portion
I	> 2 months	Proximal radius
II	> 6 months	Distal humerus, distal scapula
III	> 12 months	Proximal second phalanx, proximal first phalanx
IV	> 18 months	Distal tibia, distal metapodia
V	> 30 months	P calcaneus, P femur, D femur, P ulna, D radius, P tibia, P humerus

has been reached in estimating the MNE values and in avoiding double counting and inflating the element numbers.

DEMOGRAPHY OF MORTALITY:
TOOTH ERUPTION AND WEAR

Recording tooth eruption and wear stages helps to discriminate different age classes and to infer age-related selection decisions made by Epipaleolithic hunters. Age classes were recorded for wild sheep, wild goat, and fallow deer following procedures described by Deniz and Payne (1982). Eruption and wear of mandibular deciduous fourth premolars (dP4) and mandibular permanent fourth premolars (P4), first (M1), second (M2), and third (M3) molars were recorded for all taxa to investigate the demography of mortality and general hunting patterns. In order to avoid double counting, MNE values were used rather than NISP. Particular emphasis was placed on documentation of eruption and wear of mandibular deciduous fourth premolars (dP4), which in turn helps to determine same age cohorts and to identify peaks indicating discrete cohorts, providing insights into the seasonality of hunting and of site use.

Eruption and wear of mandibular deciduous fourth premolars (dP4), mandibular fourth premolars (P4), and mandibular third molars (M3) were also analyzed for loose teeth and for teeth still embedded in mandibles for all taxa following Stiner's (1990, 1991, 1994, 2005) prey age structures (the three-cohort system). Wear stage and symmetry were considered, and teeth that may have come from the same mandible were eliminated to avoid double counting and inflating MNE counts. Hence, corrected MNE counts were used.

The three-cohort system involves juvenile, prime-adult, and old adult cohorts, covering the principal life stages of long-living species. Although this is a coarse and low-resolution method to construct averaged age structures (see Steele & Weaver 2002), the method provides the advantage of using conventional tooth wear data (i.e., Payne 1973) not only for teeth in mandibles but for loose teeth as well. Thus, when large series of mandibles are not available due to high degrees of fragmentation, the analyst can use dP4-P4 or dP4-M3 pairs to cover the potential life span of an ungulate (Stiner 2005: 200). Table 4 shows three age cohorts/life stages and corresponding wear stages for caprines following Payne (1973). Numbers in Table 4 (e.g., dP4 1-12) refer to sequential drawing conventions developed by Payne (1973). For my tabulations, I constructed age structures using both pairs and picked the one with the larger number of specimens. Both dP4 + P4 and dP4 + M3 pairs yielded viable sample sizes (N = 307 and 300 specimens, respectively). Thus, I only used dP4 + P4 pair as it had a slightly higher sample size and very slim chance of overlap between the two teeth.

TABLE 4. — Three age cohorts and corresponding Payne (1973) wear stages.

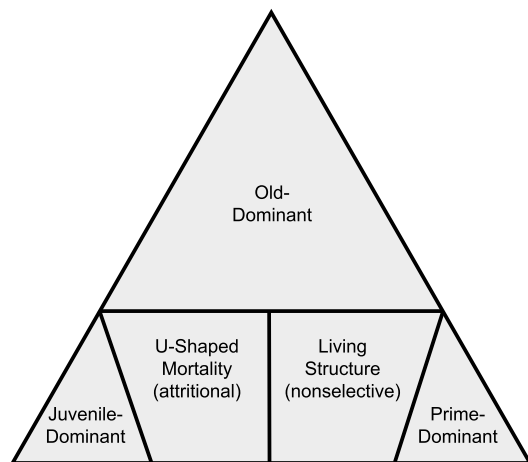| Payne Stage	Life Stage
dP4 — 1-12	Juvenile
P4 — 1-8	Prime
P4 — 9	Old

Fig. 2. — Common mortality models found in nature presented in tripolar format.

TABLE 5. — Wear stages for individual teeth and their correspondent life stages. Median age data after Atici & Stutz (2002).

Payne Stage	Life Stage	Median Age
dP4 — 1	Juvenile	0 m
dP4 — 2-4	Juvenile	0-2 m
dP4 — 5	Juvenile	2.5 m
dP4 — 6-7	Juvenile	4.5 m
dP4 — 8	Juvenile	15 m
dP4 — 9-12	Older Juvenile	16.5 m
P4 — 1-5	Young Adult/ Prime	24 m
P4 — 6-7	Prime	30 m
P4 — 8	Prime	48 m
P4 — 9	Old	69 m

The number of individuals in each age category is presented as proportional values and plotted on tripolar/ternary graphs. The two lower panels on the graph show attritional and nonselective/ living models, two of the most common mortality patterns seen in nature (Fig. 2) (Stiner 1991, 2005: 202-203). The attritional model predicts higher numbers of young and old individuals, whereas the living structure model mirrors the proportions of age classes existing in nature. The three corners of the graph correspond to representations heavily dominated by a single kill-off strategy. Based on her analysis of Mediterranean Middle and Upper Paleolithic, and Epipaleolithic sites, Stiner (2005: 203-204) reports a common pattern suggesting prime-dominated nonselective living structure across time and space. Natufian gazelle assemblages, however, show a strong bias toward hunting juveniles. Stiner (2005) suggests that prime-dominated patterns are indicators of "cursorial" or "ambush" hunting. This methodology is applied to Karain B and Öküzini archaeofaunas to infer hunting strategies from mortality patterns.

PROPORTION OF YOUNG CAPRINES
Besides detecting overall trends, the mortality data generated in this research have been primarily used to determine whether proportions of young animals hunted remained constant or progressively increased over time as observed in Epipaleolithic Levantine faunal assemblages (e.g., Bar-Oz 2004; Munro 2004). In addition, having two lines of evidence, epiphyseal fusion and tooth eruption/wear, to address the same questions provides a means to independently examine age structures and to detect the hunting of young animals. A progressively increasing proportion of young individuals would be an indicator of the transition from intensive hunting to wild herd management, and from (un)conscious selection to livestock husbandry (Peters *et al.* 2005; Vigne *et al.* 2005). An increase in hunting more juveniles may also be associated with resource depression or depletion as a result of population increase (Munro 2004). In calculating proportions of young animals based on epiphyseal fusion, I used unfused proximal radius, distal humerus, distal scapula, proximal first phalanx, and proximal second phalanx (Table 3).

In order to calculate the proportions of young animals represented in the assemblages based on tooth eruption and wear, I used the wear stages (dP4 1-12) of the mandibular deciduous fourth premolar (dP4) following Payne (1973) as suggested by Stiner (1990, 2005). Table 5 lists the wear stages, life stages, and median age stages, whereas Table 6 lists the letter codes that were used to document age cohorts and seasonality in the Taurus assemblages.

TABLE 6. — Wear stages for dP4 and correspondent letter codes and seasons.

Payne Stage	Letter Code	Median Age	Season
dP4 — 1	A	0 m	Late Spring
dP4 — 2	B	0-2 m	Late Spring/Early Summer
dP4 — 3	C	0-2 m	Late Spring/Early Summer
dP4 — 4	BC	0-2 m	Late Spring/Early Summer
dP4 — 5	BC	2.5 m	Summer
dP4 — 6	C	4.5 m	Fall
dP4 — 7	C	4.5 m	Fall
dP4 — 8	CD	15 m	Summer
dP4 — 9	D	16.5 m	Late Summer/Early Fall
dP4 — 10	D	16.5 m	Late Summer/Early Fall
dP4 — 11	D	16.5 m	Late Summer/Early Fall
dP4 — 12	D	16.5 m	Late Summer/Early Fall

SEASONALITY OF HUNTING AND SITE USE

Because the eruption sequence of teeth in ungulates is reasonably standardized, tooth eruption/wear data from very young animals have been used to interpret seasonality of hunting (*e.g.*, Frison 1991; Pike-Tay & Cosgrove 2002; Lubinski & O'Brien 2001; Pokins 2001). Spiess (1979: 78) notes that 'deciduous molar wear patterns will only appear discrete in sites of limited seasonal hunting.' Frequency distributions or histograms of deciduous mandibular fourth premolar (dP4) wear patterns can document peaks of wear corresponding to discrete age cohorts, signaling the existence of restricted killing events. Using such information in conjunction with eruption and wear data from permanent mandibular molar teeth (M1, M2, and M3) can help demonstrate 'synchronized mortality,' which in turn can help determine season of hunting and of site use (Enloe 1997: 98).

RESULTS

ASSEMBLAGE CHARACTERIZATION AND ITS IMPLICATIONS FOR SITE FORMATION PROCESSES

Before focusing on hunting strategies and seasonality, I briefly characterize the assemblages and

TABLE 7. — Correlation coefficients and significance levels for bone density vs. %MAU. Highlighted values show a significant positive correlation.

%MAU	Spearman's rho	Density**
OK5	Correlation Coefficient	**.723***
	Significance (2-tailed)	0.000
	N	24
OK4	Correlation Coefficient	0.249
	Significance (2-tailed)	0.241
	N	24
OK3	Correlation Coefficient	0.376
	Significance (2-tailed)	0.070
	N	24
OK2	Correlation Coefficient	**.588***
	Significance (2-tailed)	0.003
	N	24
OK1	Correlation Coefficient	0.398
	Significance (2-tailed)	0.054
	N	24
KB2	Correlation Coefficient	**.712***
	Significance (2-tailed)	0.000
	N	24
KB1	Correlation Coefficient	0.080
	Significance (2-tailed)	0.711
	N	24

* Correlation is significant at the 0.01 level (2-tailed).
** Lyman 1994.

isolate human behavior as the responsible agent for accumulation, modification, and destruction of bones at Karain and Öküzini caves. At both of the sites, degree of fragmentation is high and long bone shaft fragments dominate the archaeofaunal assemblages.

First, the marked inter-assemblage variations in the representation of articular ends and in bone loss suggest a set of complex behaviors and different taphonomic histories for individual assemblages. A detailed examination of the survivorship patterns with respect to bone density reveals that there are not significant correlations between bone density and skeletal part survival rates for each assemblage and that pre-burial bone destruction must have occurred in addition to, or instead of, post-depositional bone loss (Fig. 3; Table 7; Atici 2007).
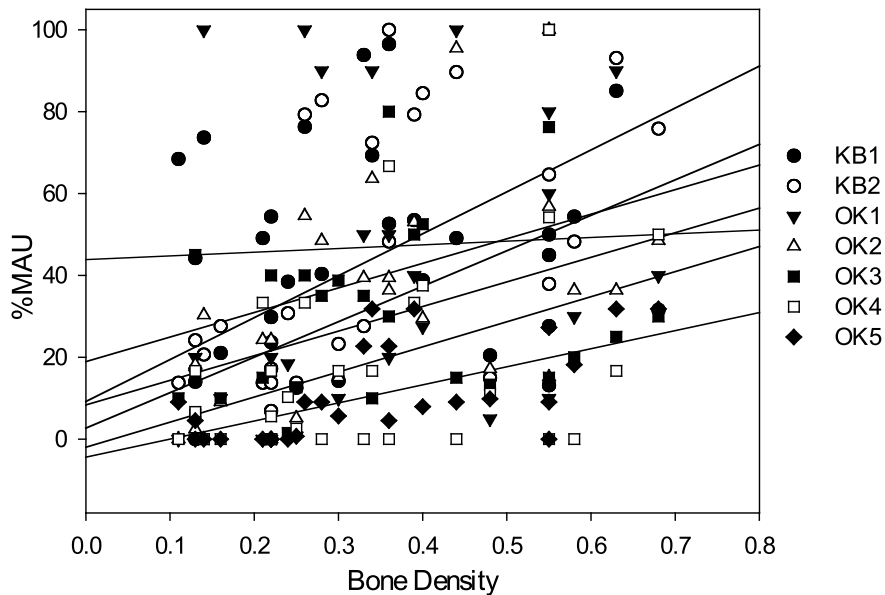
F<small>IG</small>. 3. — Multiple scatterplot diagram showing the relationships between bone density and %MAU for each of the assemblages.

Traces left by carnivores in the form of gnawing, biting, or swallowing and regurgitating bones are extremely rare or completely missing from all of the assemblages. The lack of impacts by non-human biotic agents on the faunal remains is complemented by the lack of impacts by abiotic agents such as fluvial transport, weathering, root etching, and erosion. These all suggest that each assemblage at Karain B and Öküzini was deposited and buried rather rapidly with minimal exposure to the attritional and destructive physical and chemical effects of the weather. The results of geoarchaeological and archaeometrical research also point to rapid sediment accumulation and stratification at Öküzini (Pawlikowski 2002).

The second step of the taphonomic analyses, thus, excludes carnivore ravaging, other biotic agents, and abiotic agents as major bone accumulators/collectors, modifiers, and destroyers, isolating cultural factors as the primary and major taphonomic filter. The taphonomic analyses also point to prey procurement intensification being reflected in faunal assemblages. This intensification involved dismemberment of carcasses, removal of meat, fragmentation of long bones and even phalanges for marrow extraction,

and smashing of axial elements and articular ends for grease rendering (Atici 2007).

These patterns suggest that the duration of occupation over time at Karain and Öküzini was rather constant and that the sites were often frequented by humans, indeed so much so that carnivores and other non-human biotic agents did not have access to bones even after human consumption and disposal.

TAXONOMIC COMPOSITION
AND HUNTING STRATEGIES
Table 8 shows the NISP values for the principal taxa identified in Karain B and Öküzini assemblages. For Karain B, wild sheep (*Ovis orientalis*) and wild goat (*Capra aegagrus*) exclusively dominate the Epipaleolithic menu of foragers; while for Öküzini fallow deer (*Dama dama*) contributed to diet as a secondary food animal.

The contribution of the tertiary taxa such as roe deer (*Capreolus capreolus*) and wild boar (*Sus scrofa*) is marginal for each of the assemblages. Also present are the remains of red deer (*Cervus elaphus*) and aurochs (*Bos primigenius*) in extremely small numbers. Carnivores, too, are extremely underrepre-

TABLE 8. — NISP values for principal taxa before the proportional allocation of sheep/goat NISP.

Taxa	KB1	KB2	OK1	OK2	OK3	OK4	OK5	Total NISP	%NISP
Avifauna (Birds)	160	28	12	109	9	46	24	388	0.60
Testudo graeca (Tortoise)	0	0	0	0	3	5	65	73	0.11
Lepus europaeus (Hare)	71	10	13	3	2	3	2	104	0.16
Small mammals (Rabbit size)	0	1	1	8	21	23	57	111	0.17
Medium mammals (Dog size)	16	1	3	5	5	1	8	39	0.06
Bos primigenius (Aurochs)	7	0	0	0	0	0	0	7	0.01
Cervus elaphus (Red deer)	0	0	5	0	0	0	1	6	0.01
Sus scrofa (Wild boar)	7	2	22	0	94	0	41	166	0.25
Capreolus capreolus (Roe deer)	0	1	0	15	15	29	30	90	0.14
Dama dama (Fallow deer)	10	0	1191	297	1015	222	363	3098	4.76
Capra aegagrus (Wild goat)	280	57	199	358	250	97	92	1333	2.05
Ovis orientalis (Wild sheep)	621	201	397	1401	1077	193	71	3961	6.08
Sheep/Goat	17744	6931	2426	14224	12241	1518	613	55697	85.51
Other	0	0	0	12	5	24	22	63	0.10
TOTAL NISP	**18916**	**7232**	**4269**	**16432**	**14737**	**2161**	**1389**	**65136**	**100.00**

sented (< % 0.1) in each KB and OK assemblage. Wolf (*Canis lupus*), red fox (*Vulpes vulpes*), Eurasian lynx (*Lynx lynx*), brown bear (*Ursus arctos*), stone marten (*Martes foina*), and wild cat (*Felis silvestris*) are among the carnivores represented in Karain B and Öküzini assemblages.

TRENDS IN TAXONOMIC REPRESENTATION
The NISP for the general sheep/goat (O/C or *Ovis/Capra*) category was proportionally allocated to the sheep and goat categories to specifically examine the patterns in the exploitation of these two caprine species as well as between caprines and fallow deer. Fig. 4 shows that caprines dominate the Karain B assemblages. In KB1, caprines are represented with a proportion of 99.9 percent, while in KB2 their remains make up 100 percent of the entire assemblage. In KB1, the remaining 0.1 percent (n = 10) of the remains are 9 antler fragments and 1 loose maxillary tooth identified as from a fallow deer. This suggests that male fallow deer skull(s) or antlers were collected and brought to the cave for manufacturing antler tools, perhaps hammers used in flint knapping. Thus, it is unlikely that fallow deer contributed to the diet of Karain B Epipaleolithic foragers. This makes

caprines the exclusively targeted taxa of the inhabitants of Karain B.
For Öküzini, the picture is rather different with the appearance of secondary fallow deer hunting by OK1 and the apparent inclusion of tertiary roe deer and wild boar by OK3. For OK1, which was occupied contemporaneously with KB1 and KB2, the representation of fallow deer is notable with a proportion of 28.3 percent. In OK2, the proportion of fallow deer drops back to 1.8, and then rebounds, increasing up to 6.9 percent in OK3, 10.8 percent in OK4, and 30 percent in OK5. The rise in fallow deer proportions occurs at the expense of wild sheep proportions, which display the opposite trend. As to roe deer and wild boar, a similar trend toward a progressive increase in representation over time is evident as well. Yet, because their remains make up far under 1 percent of the total NISP (wild boar 0.25 percent; roe deer 0.14 percent), it is unlikely that this trend was economically a significant one.
The most interesting aspect of the trends described above is the absence of fallow deer remains and the focus on caprines in Karain B assemblages. Because KB1, KB2, and OK1 have a significant temporal overlap, occurrence of the one taxon at one of the
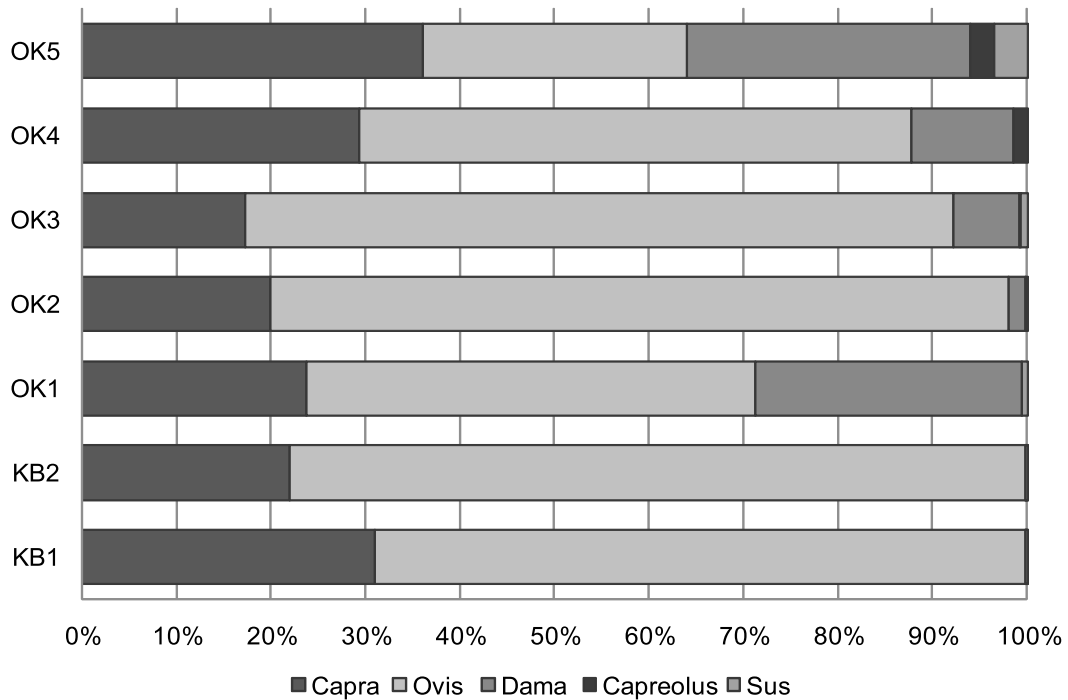
Fɪɢ. 4. — Trends seen in the distribution of ungulate taxa.

sites, buts its complete absence from the other may have significant implications with respect to hunting tactics and strategies, site use and function, and seasonal procurement of animal foods.

As far as the trend for sheep and goat hunting, with the exception of OK5, wild sheep outnumber wild goat in each of the assemblages albeit in varying ratios. The ratio of sheep to goat MNE shows a trend of steady increase in favor of sheep from 2.6:1 in KB1 to 3.3:1 in KB2; from 2.8:1 in OK1 to 4.2:1 in OK2 and to 5.3:1 in OK3. In OK4, a decline brings the sheep/goat ratio back to 1.3:1. In OK5, however, the sheep to goat ratio of 0.7:1 reflects a bias against sheep for the first time (Fig. 5).

AGE STRUCTURES AND HUNTING STRATEGIES: EPIPHYSEAL FUSION

Kill-off patterns or survivorship curves for the Karain B and Öküzini assemblages were generated using age at death estimations based on long bone epiphyseal fusion states. The proportions of animals surviving beyond a given age category were obtained only

for wild sheep and goats since the sample size for fallow deer, roe deer, and wild boar do not allow us to generate dependable and conclusive data.

The epiphyseal union data were primarily used to determine proportions of young animals hunted as an independent check of age profiles constructed using tooth eruption and wear data. Table 9 reports percentage MNE of animals by age class and fusion stage recorded for each of the assemblages.

Fig. 6 suggests that overall kill-off patterns for the Karain B and Öküzini assemblages were similar: nearly all the animals survived 2 months of age, 85.5 to 96.3 percent of animals survived 6 months of age, 77.5 to 88.2 percent of animals survived 12 months of age, 72 to 79.7 percent of the animals survived 18 months of age, and 42.6 to 68.2 percent of the animals survived 30 months of age (Table 9).

AGE STRUCTURES AND HUNTING STRATEGIES: TOOTH ERUPTION AND WEAR

Table 10 details the combined dP4 + P4 wear stage data utilized in constructing caprine age at death
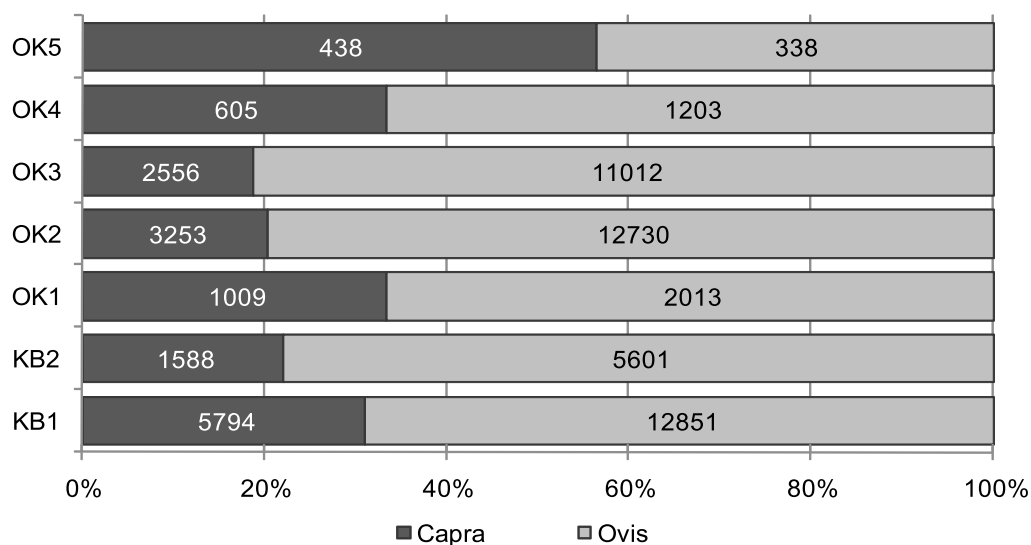
Fig. 5. — Patterns observed in wild sheep and goat distribution.

TABLE 9. — Epiphyseal fusion data for caprine long bones (figures represent %fused based on the elements listed in Table 3).

Stage	Age class	%SURVIVORSHIP (%FUSED)						
		KB1	KB2	OK1	OK2	OK3	OK4	OK5
0	> 0 months	100.0	100.0	100.0	100.0	100.0	100.0	100.0
I	> 2 months	100.0	96.0	100.0	100.0	100.0	100.0	100.0
II	> 6 months	96.3	87.5	86.7	85.5	93.1	100.0	100.0
III	> 12 months	88.2	77.5	78.0	81.7	85.4	80.7	84.6
IV	> 18 months	79.7	72.0	75.0	74.3	74.4	72.2	78.3
V	> 30 months	52.8	42.6	54.5	48.2	47.5	63.2	68.2
	MNE	1229	543	110	611	354	120	124

or mortality profiles for Karain B and Öküzini assemblages. Fig. 7 shows caprine age at death or mortality profiles for Karain B and Öküzini assemblages.

KB1 and KB2 age structures are very similar with a bimodal distribution of age-at-death. The main focus of hunting appears to have been the prime adults between the ages of 2 and 4 years, with a first mode peak in the 4 year old age group and a second peak in the 2.5 to 6 month old group. It is worth noting that almost all caprine age groups are represented, save for the newborns, in both KB1 and KB2. Unlike KB1 and KB2, the contemporaneous assemblage of OK1 does not have all the age groups represented. The age-at-death data are sparse and discontinuous. This may be the result of the much smaller sample size. Despite these differences, the small number of teeth creates a pattern that is identical to KB1 and KB2 in that the two peaks for OK1 overlap with the ones for the KB assemblages. The first cluster is in the 2.5 months old group and the second one is in the 2 to 4 years old group. The very youngest age group is completely missing in OK1 as they were in the KB1 and KB2 assemblages.
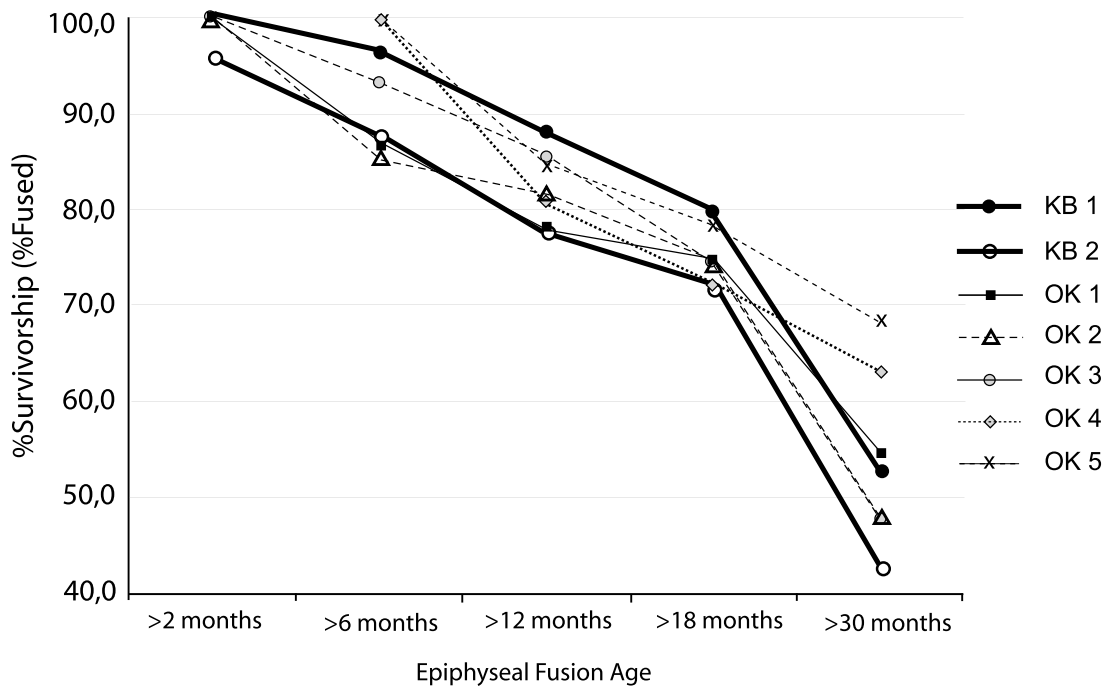
FIG. 6. — Kill-off patterns or %Survivorship curves for the assemblages based on the caprine long bone epiphyseal fusion data.

TABLE 10. — Caprine age structures based on the dental wear data for dP4 +P4 pair. Median age is after Atici & Stutz (2002) following Deniz & Payne (1982).

| Payne Stage	Life Stage	Median Age	KB1	KB2	OK1	OK2	OK3	OK4	OK5
dP4 — 1	Juvenile	0 m	0	0	0	1	2	0	0
dP4 — 2-4	Juvenile	0-2 m	1	1	0	7	6	1	0
dP4 — 5	Juvenile	2.5 m	15	3	3	3	3	4	1
dP4 — 6-7	Juvenile	4.5 m	8	8	1	11	6	2	2
dP4 — 8	Juvenile	15 m	3	3	1	6	2	1	0
dP4 — 9-12	Older Juvenile	16.5 m	11	4	0	2	0	0	0
P4 — 1-5	Young Adult/ Prime	24 m	14	7	2	16	6	1	0
P4 — 6-7	Prime	30 m	14	8	7	16	4	2	5
P4 — 8	Prime	48 m	25	11	4	20	10	2	3
P4 — 9	Old	69 m	2	1	0	3	1	1	0
Corrected MNE Total			93	46	18	85	40	14	11
%JUVENILE (dP4 stages 1-12)			40.9%	41.3%	27.8%	35.3%	47.5%	57.1%	27.3%
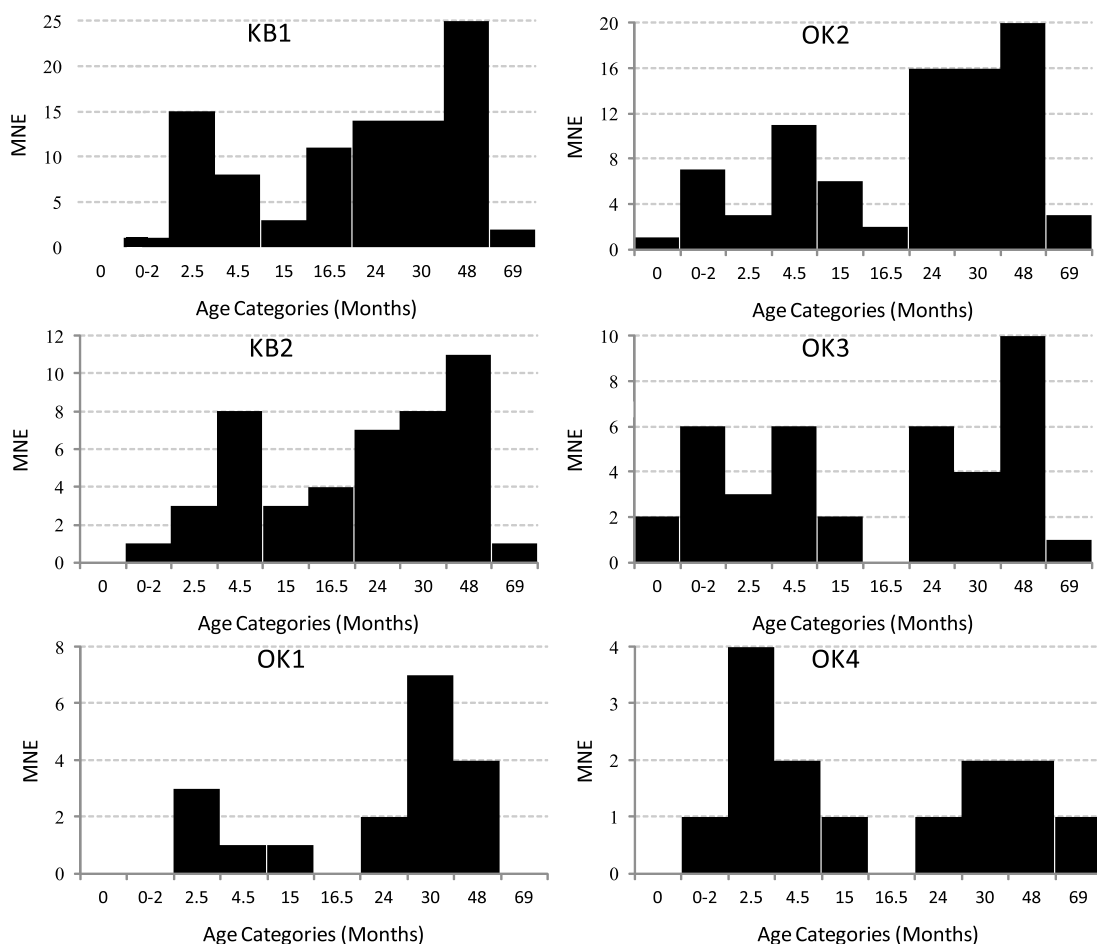
Fig. 7. — Caprine age structure histogram based on tooth eruption and wear data.

With a large sample, the OK2 assemblage has a similar mortality pattern to KB1 and KB2, showing a bimodal distribution. The main targets of hunting appear to have been prime age caprines with a cluster at 2 to 4 years. A secondary focus is on the younger age groups including newborns and 4.5 months old. Unlike, KB1, KB2, and OK1, newborns and very old animals are represented, albeit sparsely, in the OK2 assemblage. OK3 also fits the pattern just described for OK2. It, too, has a bimodal pattern with the same central tendencies around the 2 to 4 month and 2 to 4 year age groups. Newborn and very old individuals are represented again in very small numbers.

OK4 departs from the patterns described above for the KB1, KB2, and OK1-3 assemblages in that the central tendency around the 2.5 months old age group suggests that the focus of hunting shifted from prime age caprines to juveniles, a pattern consistent with the juvenile proportion data. This pattern may be a product of small sample size, but it does not relate to natural taphonomic loss as bones and teeth of younger animals are more susceptible to attrition.

The pattern that OK5 displays is very similar to the pattern that is observed and noted above for all of the assemblages, except for OK4. But, the small sample size (N = 11) makes it difficult to be

sure of the interpretation. This smaller assemblage size can indicate lower occupation duration and frequency at Öküzini Cave during the latest part of the Epipaleolithic, or it could reflect marked seasonality in hunting activities, or it could be due to taphonomic factors.

To summarize, there is a common pattern in almost all of the assemblages with the exception of OK4. The primary targets of caprine hunting appear to have been animals within the 2 to 4 years old age interval. These animals represent the largest and the fittest individuals and thus the most suitable targets for maximum nutritional and energetic return. The younger caprines aging 2.5 to 15 months old were the secondary focus of the Epipaleolithic hunters. Newborn and very old animals were probably avoided for economic reasons; even so they were occasionally hunted as well.

THREE-AGE-COHORT SYSTEM

Based on Table 10, tooth wear data for dP4 + P4 pair were converted into proportions to represent three age-cohorts: juvenile, prime, and old. These three age-cohorts were then plotted as a tripolar graph to examine whether there is a bias against any of the categories. Table 11 details the three age-cohorts and their proportions for each of the assemblages; Fig. 8 illustrates these results.

Actualistic studies on the prey-predator relationships patterns provide zooarchaeologists with a framework to examine archaeologically observed mortality profiles. As Fig. 8 illustrates, all of the Karain B and Öküzini assemblages fall into the lower right hand side panel of the ternary graph. This area reflects a
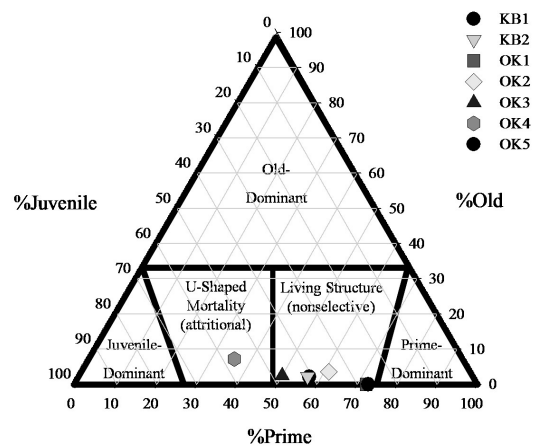

FIG. 8. — Observed ungulate mortality models shown in tripolar format for Karain B and Öküzini assemblages.

"living structure" or "nonselective mortality" model, which indicates representation of each of the three age cohorts in proportions found naturally in the wild. This part of the graph is also characterized by the dominance of prime age individuals. Stiner (1990, 1991, 1993, 1994, and 2005) associates this pattern with individual cursorial or ambush hunting, a characteristic hunting method of human predators. Thus, we can picture Epipaleolithic hunters of the Western Taurus Mountains as skilled hunters organizing small hunting parties and targeting the best and largest caprines for maximum meat return. The ternary graph also shows that there is a trajectory at Karain and Öküzini toward progressively increasing juvenile caprine hunting, although overall trend with fluctuating proportions

TABLE 11. — Caprine dental wear data converted into three-age cohorts.

Assemblage	Juvenile	Prime	Old	% Total
OK5	27.3	72.7	0.0	100.0
OK4	57.1	35.7	7.1	100.0
OK3	47.5	50.0	2.5	100.0
OK2	35.3	61.2	3.5	100.0
OK1	27.8	72.2	0.0	100.0
KB2	41.3	56.5	2.2	100.0
KB1	40.9	57.0	2.2	100.0

of juvenile caprines masks this pattern at first glance. The progressively increasing proportions of juvenile caprines observed in OK1 through OK4, however, might signal a change in the hunting techniques and an intensified exploitation of caprines.

PROPORTIONS OF YOUNG CAPRINES
The proportions of young individuals in each of the assemblages estimated from fusion data point to a prime dominated pattern at Karain B and Öküzini throughout the Epipaleolithic sequence. The proportion of juvenile animals is 12.8 percent for KB1, 22.5 percent for KB2, 13.3 percent for OK1, 18.3 percent in OK2, 14.6 percent for OK3, 19.3 percent for OK4, and 15.4 percent for OK5. These values do not fit a progressively increasing juvenile hunting scenario of a kind that has been observed in Levantine Epipaleolithic gazelle assemblages (e.g., Bar-Oz 2004; Bar-Oz *et al.* 2004; Munro 2004; Stiner 2005). Munro (2004) reports a trend toward increasing juvenile gazelle hunting in Levantine Epipaleolithic assemblages and documents 26.6 percent juvenile gazelles in the Kebaran, 28 percent in the Geometric Kebaran, and 34.5 percent in the Natufian. In contrast, Bar-Oz (2004: 69) reports that the proportions of juvenile fallow deer are 23.3 in the Nahal Hadera V assemblages, 17 percent in the Hefzibah 7-18 assemblages, and 17.8 percent in the Neve-David assemblages. Thus, like the Mediterranean Levantine fallow deer assemblages, the Western Taurus caprine assemblages do not show a progressively increasing juvenile hunting pattern based on epiphyseal fusion data.

When using caprine tooth eruption and wear data in the Karain and Öküzini assemblages to estimate young animal proportions, however, a significantly different picture arises. Based on the recording of the first 12 wear stages of caprine deciduous mandibular fourth premolars (dP4), the proportion of young individuals is 40.9 percent for KB1, 41.3 percent for KB2, 27.8 percent for OK1, 35.3 percent for OK2, 47.5 percent for OK3, 57.1 percent for OK4, and 27.3 percent for OK5. In these cases, the leap from 35.3 percent in OK2 to 57.1 percent in OK3 is noteworthy, marking a significant change toward intensification in caprine hunting. Yet, the proportions of juvenile caprines in the earliest levels at Karain B (40.9 and 41.3 for KB1

and KB2, respectively) even exceed those reported by Munro (2004) for Levantine Natufian gazelle assemblages (34.5 percent), complicating the matter. Bar-Oz (2004) and Munro (2004) point to a similar conflict in the Natufian gazelle assemblages at El-Wad Terrace, Hayonim Cave, and Hayonim Terrace in Israel. They state that the percentage of young individuals based on long bone epiphyseal fusion and tooth eruption and wear data generate different mortality patterns (Bar-Oz 2004: 69; Munro 2004: 15).

Obtaining different mortality patterns based on bone fusion and tooth eruption/wear data appears to be a general pattern in the zooarchaeological record across time and space due to the coarse grained fusion data and the stronger effects of taphonomic bone loss on epiphyseal aging (Atici 2006), or to 'difference in the age boundaries separating juveniles from adults in two methods' as suggested by Munro (2004). Despite the discrepancies between the two methods of constructing age structures, however, it is clear that juvenile caprines, besides prime animals, are significantly represented in almost all of the Karain B and Öküzini assemblages as revealed by tooth wear data.

SEASONALITY OF HUNTING
AND SITE USE

Determination of age at death and season of killing based on tooth eruption and wear data can be accurate and precise only with a sample size of more than 30 to 40 (Klein & Cruz-Uribe 1984; Shipman 1991) and only when using the short-lasting early stages of wear (Spiess 1979; Frison 1991; Lubinski & O'Brien 2001; Pokins 2001; Pike-Tay & Cosgrove 2002).

Deniz and Payne (1982) postulate that teeth progress through the first five stages very rapidly, permitting analysts to "time" or "age" them with more precision, whereas tooth wear stage 6 (C), the so-called "mature wear stage," lasts a much longer time, limiting precision. The pattern observed in KB1, thus, is reliable with respect to sample size and robustness (MNE = 58; MNI = 38) (See Table 12).

The analyses of caprine dP4 wear patterns from KB1 and KB2 in comparison with caprine and

TABLE 12 — Frequency of deciduous mandibular fourth premolar (dP4) wear stages.

dP4Wear Stage	KB1	KB2	OK1	OK2	OK3	OK4	OK5
A-1	0	0	0	1	2	0	0
B-2	0	0	0	0	2	1	0
C-3	0	0	0	5	6	0	0
BC-4	1	1	0	7	1	0	0
BC-5	20	4	5	6	5	4	1
C-6	7	8	1	6	3	2	1
C-7	6	4	0	11	7	1	1
CD-8	4	5	2	7	3	2	0
D-9	12	3	0	2	0	0	0
D-10	3	0	0	0	0	0	0
D-11	5	1	0	0	0	0	0
D-12	0	0	0	0	0	0	0
Total MNE	58	26	8	45	29	10	3

fallow deer data from OK1 provide us with a unique opportunity to explore temporal and functional relationships between the overlapping strata at the sites. The frequency distributions or histograms of dP4 wear patterns can document different peaks of wear or multi-modal distributions corresponding to discrete age cohorts, signaling very restricted killing events. A glance at Fig. 9 illustrates the presence of such discrete age cohorts and thus suggests synchronized killing events in most Karain B and Öküzini assemblages.

The bimodal distribution of wear stages detected helps us time the seasons of these hunting episodes. The first and strongest peak is in the wear stage BC-5 area, the cohort between 2.5 and 4.5 months old. This corresponds to a range between July and October, as modern Anatolian mouflon and bezoar goat have a modal and standardized birth taking place in May (Kaya & Aksoylar 1992). The second clustering is in the area of tooth wear stage D-9, the second year cohort aged to 16.5 months old, again corresponding to a late-Summer-Fall hunting. Thus, a strong signal pointing to a repeated and seasonally restricted hunting strategy can be detected. Also notable is the underrepresentation of first three age stages, corresponding to newborns and 2-3 month old caprines.

Fig. 9 also captures the age cohort discreteness phenomenon for the OK1 caprine assemblage. The pattern observed here is identical to that of KB1, with marked seasonality able to be inferred from the disproportional and discontinuous distribution of cases across wear categories. Indeed, the OK1 data appear even more seasonally restricted than does the KB1, with the bimodal distribution centered on wear stages BC-5 and CD-8 pointing to first and second year cohorts and mid-summer to fall hunting. The underrepresentation of the first three wear stages is observed here as well.

Because the Karain B assemblages are made up almost exclusively of caprine remains, only the OK1 assemblage could be examined for contemporary fallow deer tooth wear data as an independent check for seasonality. One unworn and one very slightly worn fallow deer mandibular fourth premolar (dP4) could be assigned to the first and second stages, respectively, denoting newborn fawns. Based on a restricted birth schedule in May (Chapman & Chapman 1975), these would be aged to 0 to 2 months, May-July, suggesting a late spring to early summer kill-off.

Even though two specimens are not enough to generate reliable data for constructing season of hunting and site use, they still form a highly valuable piece of direct evidence for multiseasonal site use. Thus, these two specimens expand site seasonality from May to October, or late spring and fall. A rather important question arises, however,
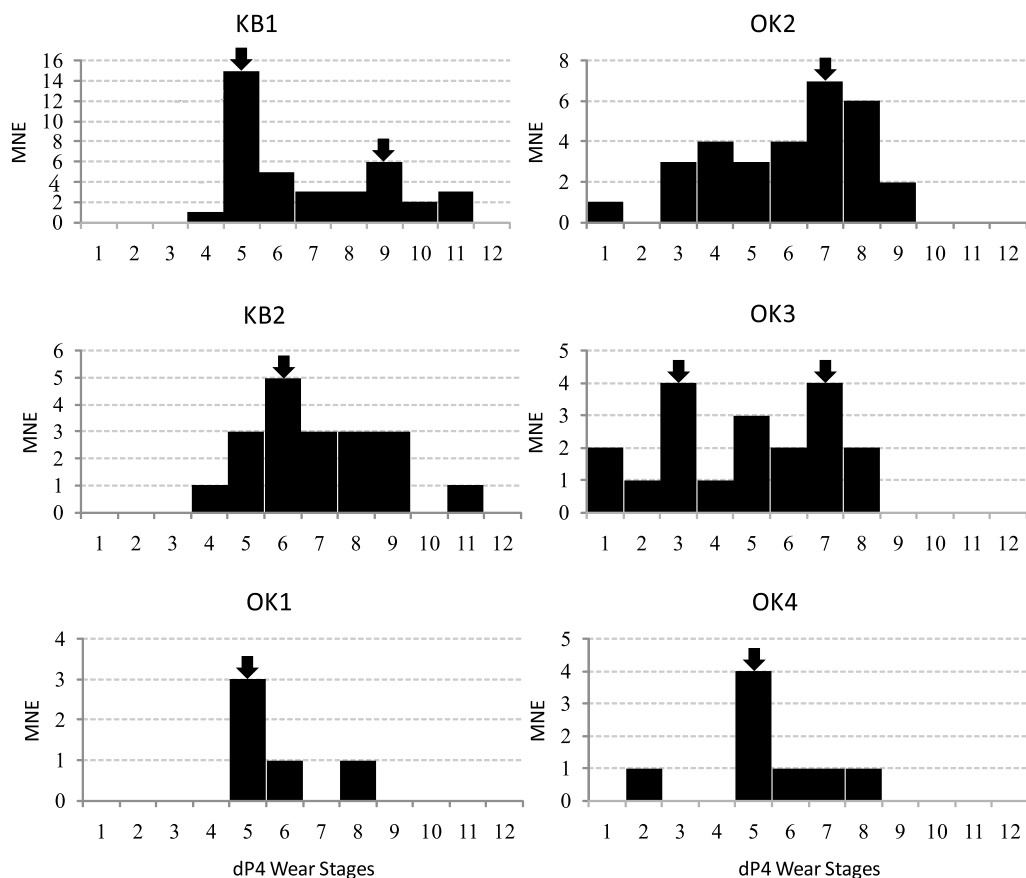
Fig. 9. — Caprine age cohort discreteness in Karain B and Öküzini assemblages.

as to what explains the lack of newborn caprines at both sites. Using only the caprine data, one could have hypothesized that the Epipaleolithic foragers did not occupy Öküzini and Karain B during the spring. The fallow deer data, however, require rejection of this hypothesis. Had the Epipaleolithic hunters at Karain B and Öküzini avoided newborns due to an optimal foraging strategy (i.e., maximum meat return), they should have done the same for fallow deer newborns. Thus, the lack of newborn caprines does not appear to be due to season of occupation or hunting strategy targeting *only* prime animals. An answer to the lack of newborn caprines in the KB1 and OK1 should be sought in prey behavior.

Wild sheep and goat are known to move between high and low elevations seasonally, and also gene-rate patterns of seasonal prey abundance through specific social behaviors (Dean 1997; Kaya 1990). Thus, a relatively higher degree of mobility and more restricted seasonal site use may have been dependant on prey availability and predictability during the Epipaleolithic in the Taurus Moun-tains. Thus, prey behavior may well account for the lack of newborn caprines in KB1 and OK1. Kaya (1990) reports very high mortality rates for Anatolian Mouflon in Konya, Turkey (72 death of 85 births, 85%). Coupled with high infant morta-lity rates, inaccessibility or unavailability appears to be the reason why remains of caprine newborns

are absent from the KB1 and OK1 assemblages. By the time caprines were 4 months old or older, i.e., during the late summer and early fall, however, Epipaleolithic hunters started regularly hunting them as tooth wear data attest. At the same time, second year cohorts (ca. 16.5 months old; wear stage D-9) were also hunted as were older animals the season of death of which cannot be accurately determined using macroscopic methods.

The frequency of caprine dP4 wear stages reveals a similar, yet somewhat different pattern of hunting and seasonality for KB2, with a central tendency in the area of the "mature" or "long lasting" C-6 wear stage. This pattern hampers determination of age at and season of death and suggests that seasonality of kill-off was not as restricted as it was for OK1. There are still a number of BC-5 wear stage specimens (MNE = 3), indicating late summer to fall hunting and site occupation, but the mode in the area of the C-6 wear stage would suggest a less restricted multi-seasonal hunt. What remains constant, however, is the underrepresentation of newborn caprines.

Having looked at seasonality and site use patterns synchronically, I now probe long term trends in seasonality and site use using the longer sequence of Öküzini. For OK2, age cohort discreteness is not as marked as it is for KB1 and OK1 (see Fig. 9). A pattern of continuous and proportionally distributed cases across wear stages suggests less restricted seasonality, increased duration of occupation, and a trend toward multi-seasonality. Besides caprine teeth, only one unworn fallow deer specimen that was assigned to the stage A-1 (newborn) was observed. Thus, combined caprine and fallow deer tooth wear data indicate late spring, summer, and fall occupation and hunting, and a trend toward less marked seasonality and increased sedentism or longer term use of a specialized hunting camp.

Fig. 9 suggests that the pattern seen in OK3 also indicates multi-seasonal hunting, which in turn hints at an increased duration of occupation. The first three wear stages point to late spring and early summer, and BC-5 points to mid-summer and fall. In addition, a single unworn fallow deer dP4 (stage A-1) confirms late spring hunting. As with OK2, combined fallow deer and caprine data expand the season of occupation at OK3 from late

spring through fall and suggest a multiseasonal site use pattern.

In OK4, a shift to a seasonally more restricted hunting and possibly occupation is evident. A central tendency in the area of the BC-5 wear stage and a disproportional distribution of specimens across wear stages suggest discrete age cohorts and synchronized killing in mid-summer and fall. This pattern may be a result of either small sample size (N = 8) or a real phenomenon. Yet, as I mentioned above, a sample size of 30 to 40 is considered necessary for statistical viability and meaningful results. Still, this pattern could be real, as it is observed for KB1, KB2, and OK1 with much larger sample sizes. The presence of newborns represented by the first two wear stages, however, makes the situation complicated again, as it expands the season of hunting to include the late spring. Five unworn fallow deer dP4s (stage A-1) provide another line of evidence to suggest spring kill off. The OK5 assemblage did not yield samples large enough to draw any meaningful conclusions. Yet, three caprine specimens represent wear stages 5 through 7 showing, again, mid-summer and fall hunting. In addition, two unworn fallow deer deciduous mandibular fourth premolars (wear stage A-1) add spring hunting to expand, again, the duration of occupation to multiple seasons.

DISCUSSION

The Karain B faunal assemblages are characterized by the exclusive representation of caprines with proportions over 99 percent and the absence of fallow deer. As such, one could argue that Karain B was a specialized collector site with a logistical mobility pattern. The lack of conspicuous features and of evidence for distinct organization of space within the deposits could support this argument and further suggest that a narrower range of activities took place at Karain B. Yet, techno-typological analyses of the lithic assemblages show that a wide range of activities probably took place at the site due to the non-specialized tool kits recovered. The presence of all stages of core reduction and tool making, including debitage and splinters along with broken, unfinished, or exhausted/discarded pieces, indicates that flint-knapping took place in

the cave (Özçelik 2001). This, in turn, indicates that Karain B was used as a residential base camp and reflects a more general site use. As for Öküzini, the thickness and broad horizontal extent of the Epipaleolithic deposits, the diversity and richness of the lithic tool kits found there (see Kartal 2002, 2003), the presence of features such as hearths, and faunal assemblages characterized by the bones of a diverse range of animals including birds and by the representation of all caprine age groups attest to the cave being a more generalized forager site than Karain B, but also reflecting residential mobility. Thus, settlement and mobility patterns at Karain B and Öküzini reflect complex behavior and a continuum from logistically organized, seasonally restricted, and collector type specialized settlements to residentially organized, forager type generalized settlements. This continuum is reflected in the faunal, floral, and lithic technology records (Atici 2007).

Besides the synchronic examination of function and use of Karain B and Öküzini caves, the nature of the relationships between the sites and their surrounding landscape is another significant aspect of site use and function during the Epipaleolithic. Strauss (1993) suggested that the 'tactical use of topographic features in hunting' was a significant factor affecting the location and function of sites during the Upper Paleolithic in Western Europe. In particular, a site's location close to abundant resources has been considered a key characteristic of specialized sites and logistically organized collectors as formulated by Binford (1978, 1980). This concept was often applied to European Upper Paleolithic sites and was linked to specialized ibex (*Capra ibex*) hunting (*e.g.*, Strauss 1987, 1993, 1997, 1999, 2006; Phoca-Cosmetatou 2004). Phoca-Cosmetatou (2004), however, describes a discrepancy for the European Upper Paleolithic assemblages regarding specialized 'Ibex-site Phenomenon.' According to Phoca-Cosmetatou (2004: 218), ibex sites display a number of shared features including location of the sites at higher elevations near ecotonal zones, intensified resource exploitation, and a narrower set of cultural activities attested by specialized tool-kits, and opportunistic and shorter duration of occupation. Yet, Phoca-Cosmetatou also acknowledges the fact that there is not a standard

specialized site, as neither examination of 16 ibex sites from Cantabrian Spain and French Pyrenees nor comparison of ibex sites in Greece and Iberian peninsula generated a template to account for the variety of human activities, hunting techniques, lithic industries, taxonomic composition, and even prey body parts represented in faunal assemblages (Straus 1987 and Gamble 1997 cited in Phoca-Cosmetatou 2004: 218-219).). A dichotomized approach to characterizing forager subsistence does not work with the Karain B and Öküzini data, and the conventional framework that seeks to type sites using binary oppositions or dichotomies usually fails to deal adequately with a series of contingent complex behaviors.

In the context of the current discussion, the location of the sites within the same microenvironment should be considered in relation to their use and function. The location of Karain B Cave makes it an excellent spot to hunt wild goat moving nearby on the steep slopes of sharp mountains and around the deep and narrow valleys, and to monitor wild sheep on the broad Antalya Travertine Plain that stretches all the way to the Mediterranean Sea. In contrast, Öküzini Cave is situated just a few meters above the travertine plain. The different topographic positions of the two sites so close to one another within a single ecotonal zone in which a variety of resources could be exploited with ease might have led to specialization in certain exploitation strategies and to preferential focus on different animal taxa due to differential seasonal use of the sites. A specialized hunting strategy targeting exclusively caprines at Karain B (99.9 percent) and caprines and fallow deer at Öküzini (99 percent) is evident from the faunal spectra observed at the sites. The apparent absence of evidence for fallow deer at Karain B is most likely a result of cultural and behavioral choices such as seasonal hunting and specific mobility patterns. It should be reiterated that wild sheep outnumber wild goat in both Öküzini and Karain B assemblages, despite Karain B's location where wild goats are at home at an elevation of 450 m above the sea level and 150 m above the travertine plain that it overlooks. This pattern, too, most likely stems from hunting locality preference in favor of the broad and flat travertine plain and open grassland with shrubs, marshes, and gallery

forests in the foothills of the Taurus Mountains. In this sense, the pattern observed for Karain B differs from specialized ibex sites from Upper Paleolithic Europe (Straus 1987; Phoca-Cosmetatou 2004). Mortality data from each of the Karain B and Öküzini assemblages also point to a more generalized forager type of site use with repeated small-scale hunting targeting mostly prime-aged animals. Such a hunting strategy would have involved ambush or cursorial hunting tactics, which result in non-selective or living structure mortality profiles, including all age groups in the proportions naturally found in ungulate herds. This is what was observed for the Karain and Öküzini faunal assemblages. Besides the mortality patterns, an analysis of age structures also clearly shows that hunting of a kind that involved taking increasing numbers of juvenile animals through time, the trend observed for the Levantine archaeofaunal assemblages, did also exist in the Western Taurus Epipaleolithic. There is, however, little basis to associate this pattern with human induced resource depletion due to environmental deterioration or population increase. The observed trend toward a more intensified use of caprines, as reflected in progressively younger age structures at Karain B and Öküzini, is accompanied by a trend toward relatively broader dietary breadth by 13,900 with the addition of high-yield tertiary taxa such as roe deer and wild boar, small- and fast-moving taxa such as hare and partridge, and small- and slow-moving taxa such as tortoise (Atici 2007). These trends became more conspicuous during the environmentally more favorable Bölling/Allerød climate optimum. Because this is so, the dietary intensification can be seen as a result of the availability, accessibility, predictability, and abundance of caprines of all age groups.

The combined use of data obtained from caprine and fallow deer dental aging in the assemblages reveals that Öküzini and Karain B caves had multiseasonal site use patterns throughout the Epipaleolithic. The caprine dental data from both caves clearly point to the existence of discrete age cohorts and thus to synchronized killing and restricted seasonal hunting during the mid-summer and fall for the earliest Epipaleolithic (Phase 1, 19,800-19,000 years ago). Fallow deer tooth wear data from Öküzini expand the seasonality of hunting for Phase 1 at that site

to include late spring and early summer. Thus, faunal data suggest a mid-summer through fall occupation at Karain B, and a late spring through fall occupation at Öküzini Cave for the first part of the Epipaleolithic at those sites. It is interesting that the use of the sites overlaps during the mid-summer and fall, but only Öküzini yields a spring signal. For the rest of the Epipaleolithic period (Phases 2-5), the longer sequence of Öküzini indicates multiseasonal site use with much weaker age cohort discreteness patterns signaling less restricted and less synchronized killing events.

CONCLUSIONS

This paper sheds new light on the exploitation of wild animal resources during the Epipaleolithic period in the western Taurus Mountains of Mediterranean Turkey. Seven archaeofaunal assemblages excavated from Karain B and Öküzini caves were analyzed and interpreted with an emphasis on age structures and their implications for general hunting strategies, site function and use, and seasonality. The present work has sought answers to the following questions: Did Epipaleolithic hunter-gatherers of the Western Taurus adopt new strategies, such as intensified hunting of ungulates, increased selective hunting of juvenile animals, and increased duration of the occupation at same sites or a shift toward more sedentary life ways, as observed for Levantine hunter-gatherers, or did they follow a completely different and/or independent developmental trajectory? A detailed analysis of age structures combined with other zooarchaeological data has yielded ample evidence for the following forager adaptations during the final part of the Pleistocene in the Western Taurus Mountains:
1) specialization and intensification in wild sheep and goat exploitation;
2) a stable hunting strategy primarily targeting prime-age caprines throughout the Epipaleolithic;
3) a shift from seasonally restricted site use and hunting pattern to unrestricted multiseasonal site use and hunting pattern, and
4) a trend toward progressively younger age structures or increased hunting of juvenile caprines.

Thus, the behavioral patterns of the Epipaleolithic foragers and their paleoeconomies in the Western Taurus Mountains were similar to those of the foragers in the Levant. Studying the nature of animal exploitation patterns that existed during the end of the Pleistocene in western Asia is likely to have significant implications for our understanding of the origins of agricultural life ways in general and of pastoralism in particular. Heavy reliance on high-yield ungulates such as gazelles in the Levant and caprines in the Taurus arc has broad implications. It is now clear that the Levant had a long-standing tradition that involved the specialized hunting of an ungulate species that was never domesticated, namely, the gazelle. The Western Taurus Mountains, on the other hand, had a long tradition of exploitation of wild sheep and goat, both of which in their domestic forms, became part of the backbone of later pastoral economies. Because Karain B and Öküzini caves were not occupied during both the Epipaleolithic and Neolithic, it is not possible to directly investigate the transition from hunting to herding or to argue for a direct causal relationship between local forager adaptations and the domestication of animals. Yet, the existence of a long-lasting specialized caprine hunting tradition throughout the Epipaleolithic implies that Western Taurus Mountains foragers developed the kinds of behavioral ecological knowledge of wild sheep and wild goat that would have served as a foundation for the later domestication of these animals. Thus, areas where there is a long tradition and history of sheep and/or goat exploitation would provide useful insights into our understanding of caprine domestication. As such, Karain and Öküzini caves make a strong case to add the western Taurus Mountains onto the map of caprine domestication.

REFERENCES

ALBRECHT, G. 1988. — An Upper paleolithic sequence from Antalya in Southern Turkey. Results of the 1985 cave excavations in Karain B. *L'Homme de Néandertal* 8: 23-35.

ALBRECHT G., ALBRECHT B., BERKE H., BURGER D., MOSER J., RAHLE W., SCHOCH W., STORCH G., UERPMANN H.-P. & URBAN B. 1992. — Late Pleistocene and Early Holocene finds from Okuzini: a contribution to the settlement history of the Bay of Antalya, Turkey. *Paleorient* 18(2):123-141.

ATICI L. 2006. — Who let the dogs out? Bone destruction and its broader implications in interpreting the Bronze Age pastoral economies at Kaman Kalehoyuk. *Anatolian Archaeological Studies* XV: 121-131.

ATICI L. 2007. — *Before the Revolution: A Comprehensive Zooarchaeological Approach to Terminal Pleistocene Forager Adaptations in the Western Taurus Mountains, Turkey*. Unpublished Ph.D. Dissertation. Harvard University, Cambridge.

ATICI L. & STUTZ A. J. 2002. — Mortality Profile Analysis of the Ungulate Fauna from Okuzini: A Preliminary Reconstruction of Site Use, Seasonality, and Mobility Patterns, in YALÇINKAYA I., OTTE M., KOZLOWSKI J. & BAR-YOSEF O (eds), *La Grotte d'Okuzini : Evolution du Paleolithique Final du Sud-Ouest de l'Anatolie.* ERAUL 96. Universite de Liège, Liège: 101-108.

BAR-OZ G. 2004. — *Epipaleolithic Subsistence Strategies in the Levant: A Zooarchaeological Perspective*. Brill Academic Publisher, Boston.

Bar-Oz G., Dayan T., Kaufman D. & Weinstein-Evron J. 2004. — The Natufian economy at el-Wad Terrace with special reference to gazelle exploitation patterns. *Journal of Archaeological Science* 31: 217-231.

Barton R.N.E., Berridge P.J., Walker M.J.C. & Bevins R.E. 1995. — Persistent places in Mesolithic landscape: an example from the Black Mountain uplands of Southern Wales. *Proceedings of the Prehistoric Society* 61: 81-116.

Bar-Yosef O. 2002. — Natufian: a complex society of foragers, in *Beyond foraging and collecting: evolutionary change in hunter-gatherer settlement systems*. Kluwier; Plenum, New York: 91-149.

Bar-Yosef O. & Belfer-Cohen A. 1989. — Origins of sedentism and farming communities in the Levant. *Journal of World Prehistory* 3(4).

Bar-Yosef O. & Meadow R.H. 1995. — The origins of agriculture in the Near East, in Price T.D. & Gebauer A.B. (eds), *Last Hunters, First Farmers: New Perspectives on the Prehistoric Transition to Agriculture*. School of American Research Press, Santa Fe: 39-94.

Binford L.R. 1980. — Willow smoke and dogs' tails: hunter-gatherer settlement systems and archaeological site formation. *American Antiquity* 45: 4-20.

Bunn H.T. & Kroll E.M., 1986. — Systematic butchery by Plio-Pleistocene hominids at Olduvai Gorge, Tanzania. *Current Anthropology* 27(5): 431.442.

Burke A. 2006. — Introduction to the special issue: Multidisciplinary approaches to the study of site function and settlement dynamics in prehistory. *Journal of Anthropological Archaeology* 25(4): 403-407.

Chapman D.I. & Chapman N.G. 1975. — *Fallow Deer*. Terence Dalton, Lavenham (Suffolk).

Davis S.J.M. 1983. — The age profiles of gazelles predated by ancient man in Israel: possible evidence for a shift from seasonality to sedentism in the Natufian. *Paleorient* 9: 55-62.

Dean R.M. 1997. — *Ungulate Ethoarchaeology: Interpreting Late Pleistocene and Early Holocene Archaeological Ungulate Assemblages from Southwest Asia*. Master of Arts Thesis. University of Arizona, Tucson.

Deniz E. & Payne S. 1982. — Eruption and wear in the mandibular dentition as a guide to ageing Turkish Angora goats, in Wilson B., Grigson C. & Payne S. (eds), *Ageing and Sexing Animal Bones from Archaeological Sites*. BAR International Series 109. Archaeopress, Oxford: 155-205.

Dobney K., Beech M. & Jaques D. 1999. — Hunting the broad spectrum revolution: the characterization of Early Neolithic animal exploitation at Qermez Dere, Northern Mesopotamia, in Driver J.C. (ed.), *Zooarchaeology of the Pleistocene/Holocene Boundary*. BAR International Series 800. Archaeopress, Oxford: 47-58.

Enloe J.G. 1997. — Seasonality and age structure in remains of *Rangifer tarantus*: Magdalenian hunting strategy at Verberie. Actes du 7e Colloque de l'International Council for Archaeozoology. Constance, septembre 1994. *Anthropozoologica* 25-26: 95-102.

Flannery K.V. 1969. — Origins and ecological effects of early domestication in Iran and the Near East, in Ucko P.J. & Dimbleby G.W. (eds), *The Domestication and Exploitation of Plants and Animals*. Aldine, Chicago: 73-100.

Frison G.C. 1991. — Hunting strategies, prey behavior and mortality data., in Stiner M.C. (ed.), *Human Predators and Prey Mortality*. West View Press, Boulder: 15-30.

Gamble C. 1978. — Optimising information from studies of faunal remains, in Cherry J.F., Gamble C. & Shennan S. (eds), *Sampling in Contemporary British Archaeology*. BAR International Series 50. Archaeopress, Oxford: 321-353.

Kartal M. 2002. — The microliths of Öküzini, in Yalçinkaya I., Otte M., Kozlowski J. & Bar-Yosef O (eds), *La Grotte d'Okuzini : Évolution du Paleolithique Final du Sud-Ouest de l'Anatolie*. ERAUL 96. Universite de Liège, Liège: 235-252.

Kartal M. 2003. — Anatolian Epi-Paleolithic assemblages: problems, suggestions, evaluations and various approaches. *Anatolia* 24: 45-61.

Kaya M.A. 1990. — Anadolu yaban koyunu, *Ovis orientalis anatolica* Valenciennes 1856'nin yasama alani ve populasyon yogunlugu. *X. Ulusal Biyoloji Kongresi*. Ataturk Universitesi Fen-Edebiyat Fakultesi, Erzurum, Turkiye: 373-382.

Kaya M.A. & Aksoylar M.Y. 1992. — Bozdag (Konya)'da yasayan Anadolu yaban koyunu, *Ovis orientalis anatolica* Valenciennes 1856'nin davranislari. *Tubitak Doga Zooloji Dergisi* 16(2): 229-241.

Kelly R.L. 1995. — *The Foraging Spectrum: Diversity in Hunter-Gatherer Lifeways*. Smithsonian Institute, Washington D.C.

Kelly R.L. 1998. — Individual foraging and group movement, in Rocek T.R. & Bar-Yosef O. (eds), *Seasonality and Sedentism: Archaeological Perspectives from Old and New World Sites*. Peabody Museum Bulletin 6. Harvard University, Cambridge: 9-23.

Klein R.G. 1982. — Age (mortality) profiles as a means of distinguishing hunted species from scavenged ones in Stone Age archaeological sites. *Paleobiology* 8(2): 151-158.

Klein R.G. & Cruz-Uribe K. 1984. — *The Analysis of Animal Bones from Archaeological Sites*. University of Chicago Press, Chicago.

Koike H. & Ohtaishi N. 1987. — Estimation of prehsitoric hunting rates based on the age composition of sika deer (*Cervus nippon*). *Journal of Archaeological Science* 14(3): 251-269.

Kurten B. 1953. — On the variation and population dynamics of fossil and recent mammal populations. *Acta Zoologica Fennica* 76: 1-222.

Legge A. J. & Rowley-Conwy P. 1987. — Gazelle killing in Stone Age Syria. *Scientific American* 257: 88-95.

Lieberman D.E. 1993a. — Variability in hunter-gatherer seasonal mobility in the southern Levant: from the Mousterian to the Natufian, in Peterkin G.L., Bricker H.M. & Mellars P. (eds), *Hunting and Animal Exploitation in the Later Palaeolithic and Mesolithic of Eurasia*. American Anthropological Association, Washington D.C.: 207-219.

Lieberman D.E. 1993b. — The rise and fall of seasonal mobility among hunter-gatherers: the case of the Southern Levant. *Current Anthropology* 34(5): 599-631.

Lieberman D.E. 1998. — Natufian "sedentism" and the importance of biological data for estimating reduced mobility, in Rocek T.R. & Bar-Yosef O. (eds), *Seasonality and Sedentism: Archaeological Perspectives from Old and New World Sites*. Harvard University, Cambridge: 75-92.

Lubinski P.M. 2001a. — Estimating age and season of death of pronghorn antelope (*Antilocapra americana* Ord) by means of tooth eruption and wear. *International Journal of Osteoarchaeology* 11: 218-230.

Lubinski P.M. 2001b. — A comparison of methods for evaluating ungulated mortality distributions, in Pike-Tay A. (ed.), *Assessing Season of Capture, Age, and Sex of Archaeofaunas*. Bibliotheque d'Archeozoologie 11. La Pensée Sauvage, Paris: 121-134.

Lubinski P.M. & O'Brien C. J. 2001. — Observations on seasonality and mortality from a recent catastrophic death assemblage. *Journal of Archaeological Science* 28: 833-842.

Lyman R.L. 1994. — *Vertebrate Taphonomy*. Cambridge University Press, Cambridge.

Moore A.M.T. 1985. — The development of Neolithic societies in the Near East. *Advances in World Archaeology* 4: 1-69.

Moore A.M.T. & Hillman G.C. 1992. — The Pleistocene to Holocene transition and human economy in Southwest Asia: the impact of the Younger Dryas. *American Antiquity* 57(3): 482-494.

Morlan R. E. 1994. — Bison bone fragmentation and survivorship: a comparative method. *Journal of Archaeological Science* 21: 797-807.

Munro N. 1999. — Small game as indicators of sedentarization during the Natufian Period at Hayonim Cave in Israel, in Driver J.C. (ed.), *Zooarchaeology of the Pleistocene/Holocene Boundary*. BAR International Series 800. Archaeopress, Oxford: 37-45.

Munro N. 2004. — Zooarchaeological measures of hunting pressure and occupation intensity in the Natufian. *Current Anthropology* 45: 5-33.

Munro N. & Bar-Oz G. 2005. — Gazelle bone fat processing in the Levantine Epipaleolithic. *Journal of Archaeological Science* 32: 223-239.

Nadel D. (ed.) 2002. — *Ohalo II: A 23,000 Year-Old Fisher-Hunter-Gatherer's Camp on the Shore of the Sea of Galilee*. University of Haifa, Haifa.

Otte M., Bayon I.L., Noiret P., Bar-Yosef O., Yalcinkaya O., Kartal M., Leotard J.-M. & Pettitt P. 2003. — Sedimentary deposition rates and carbon-14: the Epipaleolithic sequence of Öküzini Cave (Southwest Turkey). *Journal of Archaeological Science* 30: 325-341.

Özcelik K. 2001. — *Karain Magarasi B Gozu Pleistosen Donem Yontmatas Endustrisinin Tekno-Tipolojisi*. Unpublished Ph.D. Dissertation, Ankara University.

Payne S. 1973. — Kill-off patterns in sheep and goats: mandibles from Avsankale. *Anatolian Studies* 23: 281-303.

Pawlikowski M. 2002. — Mineralogical investigations at Okuzini Cave, in Yalçinkaya I., Otte M., Kozlowski J. & Bar-Yosef O (eds), *La Grotte d'Okuzini: Évolution du Paléolithique final du Sud-Ouest de l'Anatolie*. ERAUL 96. Université de Liège, Liège: 19-25.

Peters J., Von Den Driesch A. & Helmer D. 2005. — The Upper Euphrates-Tigris Basin: Cradle of Agro-Pastoralism, in Vigne J.-D., Peters J. & Helmer D. (eds), *First Steps of Animal Domestication: New Archaeological Approaches*. Oxbow Books, Oxford: 96-124.

Phoca-Cosmetatou N. 2004. — Site function and the 'ibex-site phenomenon': myth or reality? *Oxford Journal of Archaeology* 23(3): 217-242.

Pike-Tay A. & Cosgrove R. 2002. — From reindeer to wallaby: recovering patterns of seasonality, mobility and prey selection in the Palaeolithic Old World. *Journal of Archaeological Method and Theory* 9(2): 101-146.

Pokins J.T. 2001. — When the cats away, in Pike-Tay A. (ed.), *Innovations in assessing season of capture, age and sex of archaeofaunas*. Bibliotheque d'Archeozoologie 11. La Pensée Sauvage, Paris.

Ramsey C.B, Buck C.E., Manning S.W., Reimer P., Van Der Plicht H. 2006. — Developments in radiocarbon calibration for archaeology. *Antiquity* 80 (310): 783-798.

Rocek T.R. 1998. — Pithouses and Pueblos on two continents: interpretations of sedentism and mobility in the Southwestern United States and Southwest Asia, in Rocek T.R. & Bar-Yosef O. (eds), *Seasonality and Sedentism: Archaeological Perspectives from Old and New World Sites*. Harvard University, Cambridge: 199-216.

Rocek T.R. & Bar-Yosef O. (eds) 1998. — *Seasonality and Sedentism: Archaeological Perspectives from Old and New World Sites*. Harvard University, Cambridge.

Shipman P. 1981. — *Life History of a Fossil: An Introduction to Taphonomy and Paleoecology*. Harvard University Press, Cambridge.

Spiess A.E. 1979. — *Reindeer and Caribou Hunters: An Archaeological Study*. Academic press, New York.

Steele T.E. & Weaver T.D. 2002. — The modified triangular graph: a refined method for comparing

mortality profiles in archaeological samples. *Journal of Archaeological Science* 29: 317-322.

Stiner M.C. 1990. — The use of mortality patterns in archaeological studies of hominid predatory adaptations. *Journal of Anthropological Archaeology* 9: 305-351.

Stiner M.C. (ed.) 1991. — *Human Predators and Prey Mortality*. Westview Press, Boulder.

Stiner M.C. 1993. — Modern human origins-faunal perspectives. *Annual Review of Anthropology* 22: 55-82.

Stiner M.C. 1994. — *Honor Among Thieves: A Zooarchaeological Study of Neanderthal Ecology*. Princeton University Press, Princeton.

Stiner M.C. 2001. — Thirty years on the "Broad Spectrum Revolution" and paleolithic demography. *PNAS* 98(13): 6993-6996.

Stiner M.C. 2005. — *The Faunas of Hayonim Cave, Israel: A 200,000 Years Record of Paleolithic Diet, Demography, and Society*. Harvard University, Cambridge.

Stiner M.C., Munro N.D. & Surovell T.A. 2000. — The tortoise and the hare. *Current Anthropology* 41(1): 39-73.

Straus L.G. 1987. — Upper Paleolithic ibex hunting in Southwest Europe. *Journal of Archaeological Science* 14(2): 163-178.

Straus L.G. 1993. — Upper Paleolithic Hunting Tactics and Weapons in Western Europe, in Peterkin G.L., Bricker H.M. & Mellars P. (eds), *Hunting and Animal Exploitation in the Later Palaeolithic and Mesolithic of Eurasia*. American Anthropological Association, Washington D.C.: 83-93.

Straus L.G. 1997. — Convenient cavities: some human use of caves and rockshelters, in Bonsall C. & Tolan-Smith C. (eds), *The Human Use of Caves*. BAR International Series 667. Archaeopress, Oxford: 1-8.

Straus L.G. 1999. — High resolution archaeofaunal records across the Pleistocene Holocene transition on a transect between 43 and 51 degrees north latitude in western Europe, in Driver J.C. (ed.), *Zooarchaeology of the Pleistocene/Holocene Boundary*. BAR International Series 800. Archaeopress, Oxford: 21-29.

Straus L.G. 2006. — Of stones and bones: interpreting site function in the Upper Paleolithic and Mesolithic of Western Europe. *Journal of Anthropological Archaeology* 25(4):500-509.

Surovell T.A. 1999. — Modeling occupation intensity and small game use in Levant, in Driver J.C. (ed.), *Zooarchaeology of the Pleistocene/Holocene Boundary*. BAR International Series 800. Archaeopress, Oxford: 31-36.

Sutton M. Q. 2000. — Strategy and tactic in the analysis of archaeological hunter-gatherer systems. *North American Archaeologist* 21(3): 217-231.

Tchernov E. 1982. — Faunal responses to environmental changes in the eastern Mediterranean during the last 20,000 years, in Bintliff J.L. & Van Zeist W. (eds)., *Paleoclimates, Paleoenvironments and Human Communities in the Eastern Mediterranean Region in the Later Prehistory*. BAR International Series 133. Archaeopress, Oxford: 105-127.

Tchernov E. 1984. — Commensal animals and human sedentism in the Middle East, in Clutton-Brock J. & Grigson C. (eds), *Animals and Archaeology: 3. Early Herders and their Flocks*. BAR International Series 202. Archaeopress, Oxford: 91-115.

Valla F.R. 1998. — Natufian seasonality: a guess. in Rocek T.R. & Bar-Yosef O. (eds), *Seasonality and Sedentism: Archaeological Perspectives from Old and New World Sites*. Harvard University, Cambridge: 92-108.

Valla F.R. 1999. — The Natufian Culture: A coherent thought? in Davies W. & Charles R. (eds), *Dorothy Garrod and the progress of the Palaeolithic: studies in the prehistoric archaeology of the Near East and Europe*. Oxbow Books, Oxford: 225-241.

Vigne J.-D., Helmer D. & Peters J. 2005. — New archaeozoological approaches to trace the first steps of animal domestication: general presentation, reflections and proposals, in Vigne J.-D., Peters J. & Helmer D. (eds), *First Steps of Animal Domestication: New Archaeological Approaches*. Oxbow Books, Oxford: 1-16.

Voorhies M. R. 1969. — Taphonomy and population dynamics of an early Pliocene vertebrate fauna, Knox County, Nebraska. *University of Wyoming Spcial Contributions to Geology Special Paper* 1: 1-69.

Weiss E., Wetterstrom W., Nadel D. & Bar-Yosef O. 2004. — The broad spectrum revisited: Evidence from plant remains. *PNAS* 101(26): 9551-9555.

Yalçinkaya I., Leotard J.-M., Kartal M., Otte M., Erek C.M., Atici L. & Lopez I. 1996. — 1990-1995 Öküzini kazilari (Tardiglasiyer yerlesimleri). *XVIII. Kazi Sonuclari Toplantisi I*, T.C. Kultur Bakanligi Anitlar ve Muzeler Genel Mudurlugu, Ankara: 11-16.

Yalçinkaya I., Kartal M., Erek C.M., Atici L., Kosem M.B., Ceylan K., Leotard J.-M. & Otte M. 1998. — *1995 ve 1996 yillari Öküzini kazilari. XIX. Kazi Sonuclari Toplantisi I*. T.C. Kultur Bakanligi Anitlar ve Muzeler Genel Mudurlugu, Ankara: 47-71.

Yalçinkaya I., Otte M., Taskiran H., Ozcelik K., Atici L., Kosem M.B., Erek C.M. & Kartal M. 2000. — *1998 yili Karain kazisi. 21. Kazi Sonuclari Toplantisi I*. T.C. Kultur ve Turizm Bakanligi Eski Eserler ve Muzeler Genel Mudurlugu, Ankara: 15-28.

Yalçinkaya I., Taskiran H., Atici L., Kosem M.B., Ozcelik K., Kartal M. & Erek C.M. 2001. — *1999 yili Karain kazisi. XXII. Kazi Sonuclari Toplan-*

tisi I. T.C. Kultur ve Turizm Bakanligi Eski Eserler ve Muzeler Genel Mudurlugu, Ankara: 9-20.

Yalçinkaya I., Otte M., Kozlowski J. & Bar-Yosef O. (eds) 2002a. — *La grotte d'Okuzini : Évolution du Paléolithique final du Sud-Ouest de l'Anatolie.* ERAUL 96. Les Éditions de l'Université de Liège, Liège.

Yalçinkaya I., Taskiran H., Kosem M.B., Ozcelik K. & Atici L. 2002b. — *2000 yili Karain kazisi. XXIII. Kazi Sonuclari Toplantisi I.* T.C. Kultur ve Turizm Bakanligi Eski Eserler ve Muzeler Genel Mudurlugu, Ankara: 163-170.

Zeder M.A. 2006. — Reconciling Rates of Long Bone Fusion and Tooth Eruption and Wear in Sheep (*Ovis*) and Goat (*Capra*), in Ruscillo D. (ed.), *Ageing and Sexing Animals from Archaeological Sites.* Oxbow Press, Oxford: 87-118.