Hallan Çemi Tepesi: High-ranked Game Exploitation alongside Intensive Seed Processing at the Epipaleolithic-Neolithic Transition in Southeastern Turkey

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ABSTRACTS

Faunal evidence from Hallan Çemi Tepesi in southeastern Turkey reveals important similarities and differences in subsistence patterns when compared to the Levant at the time of the Epipaleolithic-Neolithic transition. Possible diet breadth expansion is examined at Hallan Çemi based on prey species and biomass composition, body part analysis, age profiles, and carcass processing patterns. The occupants of Hallan Çemi hunted a wide range of animals, including wild sheep and goats, pigs, red deer, and tortoises. Low-ranked, fast-moving small game animals such as hares and avian fauna are comparatively rare. Small game use at Hallan Çemi resembles patterns observed in some late Natufian sites, but there is focused exploitation of ungulates at Hallan Çemi. The site presents a seemingly contradictory pairing of a meat diet composed of high-ranked animal resources and intensive plant seed processing. Also supporting the overall picture of high-ranked animal exploitation are transport biases that favored the meatiest portions of ungulate carcasses, particularly the upper front limb region. Potential explanations for the contrasting meat and plant diet patterns must consider expanding diet breadth in response to demographic packing (expressed mainly in terms of plant exploitation) and display behaviors that emphasized large game but not other parts of the food supply.

RÉSUMÉ

Hallan Çemi Tepesi : mise en évidence d'une forte exploitation du gibier associée à une exploitation intensive des plantes à graines au cours de la transition Epipaléolithique/Néolithique dans le sud-est de la Turquie.
Les données fauniques du site d'Hallan Çemi Tepesi, dans le sud-est de la Turquie, révèlent à la fois d'importantes similitudes et d'importantes

différences dans les stratégies de subsistance par rapport à ce qui est observé au Levant au cours de la transition entre l'Épipaléolithique et le Néolithique. La possibilité d'une large expansion de l'alimentation à Hallan Çemi Tepesi est étudiée sous l'angle de la diversité taxonomique et de la composition de la biomasse, de l'analyse anatomique des fragments de squelettes, des profils d'âge et des processus de transformation des carcasses. Les habitants de Hallan Çemi Tepesi ont chassé une grande variété d'animaux, incluant des moutons et des chèvres sauvages, des cochons, le Cerf élaphe et des tortues. Les petites espèces à déplacement rapide tels que les lièvres et les oiseaux sont comparativement peu représentées. Les petites espèces chassées à Hallan Çemi Tepesi sont comparables à celles observées dans certains sites du Natoufiens final, mais c'est l'exploitation des ongulés qui a dominé à Hallan Cemi. Le site présente des indices apparemment contradictoires d'une alimentation carnée composée d'une exploitation extrêmement développée des ressources animales et d'une exploitation intensive des plantes à graines. Un autre aspect qui confirme également l'exploitation intense des ressources animales est le prélèvement préférentiel des parties à fort apport en viande, en particulier la partie supérieure des membres avant. Parmi les hypothèses susceptibles d'expliquer ce contraste entre l'exploitation alimentaire de la viande et des plantes, il faut considérer la possibilité d'un élargissement du régime alimentaire en réponse à une forte concentration démographique (particulièrement en ce qui concerne l'exploitation des végétaux) et des comportements qui valorisèrent largement le gibier mais pas les autres éléments de la chaîne alimentaire.

INTRODUCTION

Little is known about human foraging strategies during the Epipaleolithic-Neolithic transition in southeastern Anatolia, in contrast to the abundant research conducted in the adjacent Levant. Reconstructions of subsistence practices during this period are important to understanding the adoption of domesticated plants and animals in southwestern Asia. In this paper, we provide an in-depth analysis of the meat diet of the occupants of Hallan Çemi Tepesi (Fig. 1) in southeastern Turkey at about 11,500 years ago. We look for evidence of resource intensification based on prey species exploitation, paying attention to both large and small game resources, transport decisions, and ungulate age cohort analysis. The faunal evidence is then compared to plant exploitation patterns at the site (Rosenberg *et al.* 1998, Peasnall 2000, Savard *et al.* 2006) in order to fully appreciate the subsistence spectrum at this site.

The transition from foraging to farming in Eurasia set the stage for large-scale settlements, population growth and rapid technological change in the early Holocene. Understanding the nature of this transition has been a goal of archaeologists and other scientists for over a century, and myriad hypotheses have been proposed to explain the remarkable shifts in subsistence economies and social organization. Some models have stressed the impact of climatic change with the onset of the Younger Dryas in the evolution of agriculture and animal husbandry, others focus on dietary stress caused by increased populations (Childe 1951, Braidwood 1960, Binford 1968, Flannery 1969, Bar-Yosef & Belfer-Cohen 1989, Bar-Yosef & Meadow 1995, Bar-Yosef & Belfer-Cohen 2002). Scenarios for early farming are largely based on archaeological experience in the Levant, where evidence for true agriculture occurs in the late eleventh or early tenth millennium (Bar-Yosef & Meadow 1995). Much research also has been conducted on the pre-agricultural Natufian culture
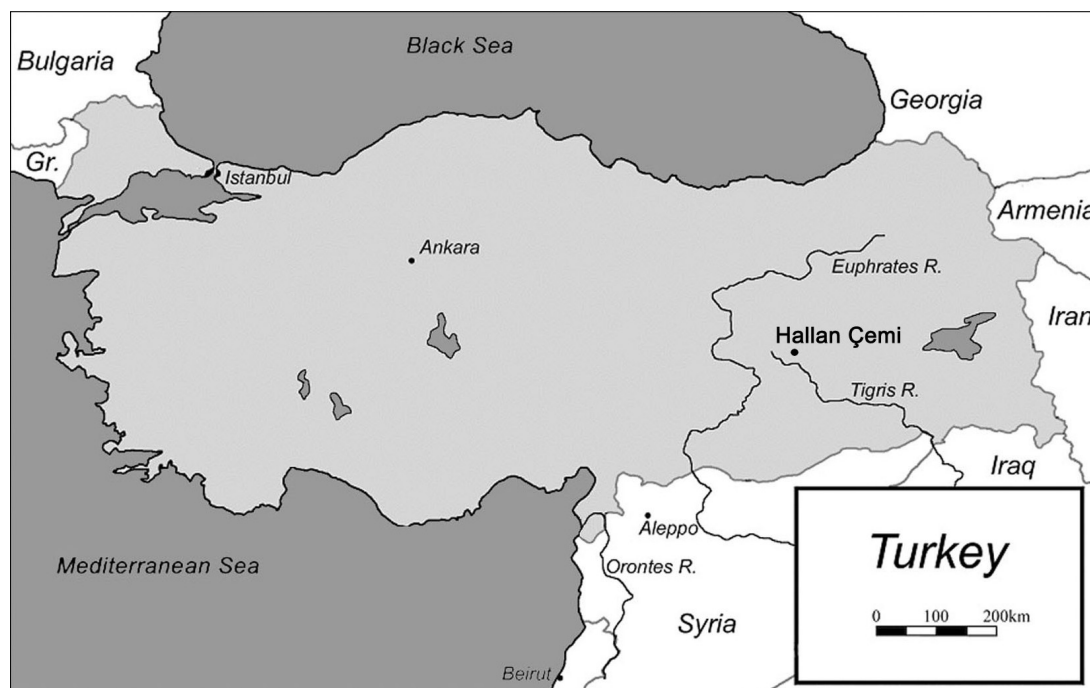
FIG. 1. — Map of southeastern Turkey showing the location of Hallan Çemi.

in this region, complex semi-sedentary foragers who existed from approximately 15,300/14,800 to 11,500 BP (Bar-Yosef 2002, Bar-Yosef & Belfer-Cohen 2002).

For historic and geographic reasons, the Natufian is an important comparator for this research program. The Natufian is divided into early and late phases. The Early Natufian is marked by increased sedentism and larger habitation sites and cereal grass cultivation, while the Late Natufian is characterized by more variable adaptations (Bar-Yosef & Belfer-Cohen 1989, 1992; Bar-Yosef & Meadow 1995, Bar-Yosef 2002, Bar-Yosef & Belfer-Cohen 2002). The Late Natufian is thought to coincide with the Younger Dryas at around 13,000 cal BP when there was a decrease in precipitation and harsher environmental conditions (Bar-Yosef 2002, Bar-Yosef & Belfer-Cohen 2002). Certain groups experienced a significant decrease in population size based evidence from on prey choice patterns (Munro 2004b). Mobility increased in the Late Natufian, not unlike the situation in the Kebaran (Epipaleolithic) before it (Henry 1989, Bar-Yosef 1998,

2002; Munro 2004b). Some scholars argue that Late Natufian groups intensified their use of wild cereal grasses through intentional cultivation and began settling in well-watered, alluvial areas along lake shores and rivers, which eventually led to full-scale agriculture (Bar-Yosef & Belfer-Cohen 1992; Bar-Yosef & Meadow 1995; Bar-Yosef 1996, 1998, 2002; Bar-Yosef & Belfer-Cohen 2002). The shift to farming is a matter for continued investigation, but it seems clear that cultivation and domestication of seed-bearing annuals was an important contribution of the Natufian.

Early emergence of herding economies is likely to have occurred elsewhere in the so-called "Fertile Crescent", probably centering in Anatolia in the case of sheep domestication (*e.g.* Meadow 1998) and the Zagros region in the case of goat domestication (Hesse 1978, Zeder & Hesse 2000). Some of these foragers also made extensive use of plant resources, some annual types of which may also have come under domestication (Harris 1998, Asoutie & Fairbairn 2002). Management of hoofed mammals seems to set the late Epipaleolithic of these regions

apart from the situation in the southern Levant (Hesse 1978, Bökönyi 1996, Meadow 1998).

A distinct picture is emerging for Southeastern Anatolia and the Zagros Mountains. Work in these regions is comparatively sparse, and historically interpretations have relied upon just a few sites such as Zawi Chemi Shanidar, M'lefaat and Karim Shahir (Rosenberg *et al.* 1998). In a comprehensive overview of sites along the Taurus-Zagros Arc, Peasnall (2000) defines the Southeastern Anatolian Epipaleolithic-Neolithic transitional period as the Taurus-Zagros Roundhouse Horizon. He notes that it can be divided into early and late phases, based on changes in material culture and settlement patterns. The Late Round House Horizon in Southeastern Anatolia begins at roughly the same time as the pre-pottery Neolithic A (PPNA) in the Levant (Henry 1989). The Early Round House Horizon dates from about 12,700 to 11,700 cal BP and is roughly contemporary with the Late Natufian and is the focus of this presentation. Sites in the Early Round House Horizon include Zawi Chemi Shanidar, Shanidar Cave, Hallan Çemi Tepesi, Karim Shahir, and possibly Gird Chai, all of which occur in the Kurdo-Zagrosian vegetation zone (Peasnall 2000). These sites are classified based on the presence of geometric microliths and a lack of well-formed points (Peasnall 2000). Significantly, there is little or no evidence for the exploitation of wild cereals at Round House Horizon sites, though more research is needed. Instead, plant exploitation focuses on nuts and pulses (Peasnall 2000, Savard *et al.* 2006).

Faunal data are available for Karim Shahir, Shanidar Cave, Zawi Chemi Shanidar, and Hallan Cemi Tepesi. Gird Chai is unpublished because excavations at the site revealed such extreme disturbance that the project had to be abandoned (Braidwood & Howe 1960). The data from Karim Shahir comes from two rough analyses that focused exclusively on the importance of sheep at the site (Howe 1983). Shanidar Cave and Zawi Chemi Shanidar historically have been treated as different sites at the same locality, thus data from the two sites are combined in Perkins' (1964) study, which also focused mainly on possible sheep and goat domestication from levels later than those relevant to this discussion. Munro's (2004a) more recent study of the consecutive faunal sequences from the final Epipaleolithic of Asiab (Bökönyi 1996) and the earliest Neolithic layers of Ganj Dareh (Hesse 1978) indicates a comparatively rapid transition from broad spectrum animal exploitation to animal husbandry.

Hallan Çemi, though a rapidly conducted salvage project, was excavated more recently, and selected samples of the faunal remains have been the focus of several preliminary analyses. The faunal remains occur in great numbers in association with round house structures, and the bones are very well preserved. Hallan Çemi therefore has the potential to fill a void in our understanding of this important period. A central question for this study concerns the full spectrum of the meat diet in relation to plant use and its implications for foraging ecology and demography of the late Epipaleolithic in the study area. Initial steps in addressing this question are taken here by examining the vertebrate portion of the diet in concert with the abundance of groundstone, which we argue is a suitable and durable proxy for plant use and intensification.

A second question concerns the extent to which southeastern Anatolia experienced population increase or deteriorating environmental conditions with the onset of the Younger Dryas. Does the faunal record register this global climate shift in the forms of broadening prey choice, processing intensification or both? People in the Levant adapted to demographic pressures by maintaining settlements nearer to stands of wild grasses, and they returned to a lower-density and more nomadic foraging lifestyle as the environment became more arid. A similar chronology in southeastern Turkey at this time might reflect parallel environmental and population pressures in the two regions. Cereal grasses are largely absent in the pollen record of Hallan Çemi and other Early Round House Horizon sites (Peasnall 2000, Savard *et al.* 2006), but other kinds of seeds were exploited in connection with greater sedentism. Cereal cultivation in the Levant was accompanied by increased pressure on animal resources in the Early Natufian (Munro 2004b, Munro & Bar-Oz 2005). As will be shown here, we see an entirely different strategy at Hallan Çemi, with a small, sedentary population that seemingly enjoyed a rich choice of high-ranked animals, yet also heavily exploited low-return plant resources.

It seems that the inhabitants of southeastern Anatolia experienced a different set of pressures and responded differently than did groups in the Levant, reinforcing the different cultural trajectories of the two regions.

THEORETICAL BACKGROUND

Following the influential papers by Lewis Binford (1968) and Kent Flannery (1969) on the forager-farmer transition and origins of agriculture, archaeologists have searched for data to support Flannery's Broad Spectrum Revolution (BSR) hypothesis. The BSR hypothesis predicts an increase in diet breadth among foragers immediately before the Neolithic revolution. This process was expected to be apparent from additions of new species, especially small animals and plant foods, to the diet in response to heightened short-cycle climatic variability and population crowding, particularly for groups expanding into less optimal areas for cereal cultivation (Flannery 1969).

Good evidence for the BSR was found in plant exploitation, mainly from the increasing abundance of groundstone technology in forager sites after the Late Glacial Maximum (Wright 1994), as well as the appearance of storage structures and preserved plant remains (Hillman *et al.* 1989, Miller 1992). Evidence for the BSR was not initially found in the faunal record of Southwest Asia (Edwards 1989, Neeley & Clark 1993, Horwitz 1996). Recent work, however, has considered prey species not in terms of Linnaean taxonomic affiliation or body size gradients as had been done previously, but in terms of flight response within the small prey fraction of archaeofaunal assemblages (Stiner *et al.* 2000, Stiner 2001, Stiner & Munro 2002, Munro 2004b, Stiner 2005). As preferred or high-ranked prey species become less abundant in the environment, human diets widen by including a more even mix of high-return and low-return prey types. Viewed in this capacity, it became apparent that not only was the BSR a real phenomenon in the Epipaleolithic, but that it began much earlier than Flannery predicted (Stiner *et al.* 2000). During the Middle Paleolithic in Eurasia, hominids were primarily big game hunters who also collected small, slow-moving species such as tortoises. Only in the Upper Paleolithic and Epipaleolithic periods did the meat diet expand to include significant proportions of quick-moving, lower-ranked small game species such as hares and partridges (Stiner 2001). The pattern is most intense, however, in the Epipaleolithic.

Ranking of prey is based on the handling costs and return rates of a given species (Stephens & Krebs 1986, Kelly 1995, Pianka 2000). Tortoises and large hoofed animals are high-ranked resources because they give a high return relative to their handling costs, unless they are exceptionally dangerous to capture. Small, fast-moving animals, such as hares and birds, are low-ranked because they are difficult to catch by hand and do not yield a high return rate without significant technological investment (Stiner *et al.* 2000). In the Mediterranean region, it has been shown that large-game use is not nearly as helpful in understanding changes in diet breadth as is the small game signature.

This prey choice model was applied to the Natufian culture of the Levant, where a complex picture of animal exploitation is apparent. Munro's (2004b) study showed a heavy reliance on large game hunting throughout the Natufian (Bar-Yosef & Tchernov 1967, Davis 1978, Rabinovich 1997, Bar-Oz 2004), but exploitation was intense, judging from the high incidence of juvenile gazelles and probable evidence for bone grease rendering (Munro 2004b, Munro & Bar-Oz 2005). Early Natufian foragers exploited low-ranked small prey in especially high proportions (Munro 2004b). There was a mild reversal of the trend during the Late Natufian in the Galilee area, coinciding with the dispersal of larger sedentary communities into smaller, more mobile groups (Stiner & Munro 2002). This shift in land use between the Early and Late Natufian in the Galilee was likely a response to deteriorating environmental conditions caused by the Younger Dryas, when Natufian populations could no longer be supported at high densities (Bar-Yosef & Meadow 1995, Bar-Yosef 1996, 1998, 2002; Bar-Yosef & Belfer-Cohen 2002).

For a time, archaeologists suspected that late Epipaleolithic and Neolithic groups in southeastern Anatolia received most aspects of their culture from the Levant by a process of diffusion (Bar-Yosef & Meadow 1995). Much new evidence has emerged

recently for southeastern Anatolia, indicating a unique regional cultural entity (Rosenberg 1999, Peasnall 2000). It seems that the "Neolithic Package" that eventually swept through Europe and elsewhere may actually represent a fusion of semi-autonomous cultural adaptations that developed in parallel in southeastern Anatolia and the Levant at the end of the Pleistocene (Rosenberg *et al.* 1998, Munro 2004b). Consequently, an understanding of the background of forager adaptations in Anatolia has become particularly urgent. We now turn to our discussion of Hallan Çemi Tepesi and its place within the transition from foraging to farming in the Near East.

HALLAN ÇEMI TEPESI

Hallan Çemi Tepesi, an Epipaleolithic-Neolithic transition site in southwestern Turkey (Fig. 1), was excavated in the mid-1990s by an international team from the University of Delaware (U.S.A.) and the Diyarbakır Museum of Turkey (Rosenberg & Davis 1992). The site is located in the foothills of the Sason Dağları, part of the Taurus Mountains, at an elevation of about 640 meters on the west bank of the Sason Çayı (Rosenberg & Davis 1992, Rosenberg *et al.* 1998, Peasnall 2000). The foothills support oak and pistachio forests, and to the south there is an open, hilly plain that is traversed by the floodplain of the Batman River and other, smaller drainages (Rosenberg, *et al.* 1998). Botanical remains from Hallan Çemi indicate that the mixed oak forest was also present during the occupation of the site, and gallery forests probably lined the watercourses to the south (Rosenberg *et al.* 1998, Peasnall 2000). Thus, the inhabitants of Hallan Çemi had ready access to plant and animal resources from nut-bearing trees in two kinds of forest.

Multiple radiocarbon dates place the occupation of Hallan Çemi between about 11,700 and 11,270 cal BP (Table 1), roughly contemporary with the end of the Natufian and beginning of the PPNA in the Levant, as well as with the end of the Younger Dryas (Rosenberg *et al.* 1998, Peasnall 2000). Artifactual evidence from Hallan Çemi indicates a unique cultural entity in southeast Anatolia at this time called the Taurus-Zagros Roundhouse Horizon. This cultural tradition seems to have its roots in the Epipaleolithic Zarzian of the region, and the material culture shares little with the Natufian or preceding Kebaran period of the Levant (Rosenberg 1999, Peasnall 2000).

At least four distinct building phases were identified at Hallan Çemi. Due to political turmoil in the region at the time of the excavation, the fourth phase (and below) remains largely unexplored (Rosenberg *et al.* 1998, Peasnall 2000). The architectural layout of the upper three levels is composed of circular structures surrounding a large, open central activity area about 15 meters in diameter (Fig. 2) (Rosenberg *et al.* 1998, Rosenberg 1999,

TABLE 1. — Radiocarbon dates from building levels 1-3 (Higham *et al.* 2007). Dates were calibrated with OxCal 4.0 using the IntCal 04 curve (Bronk Ramsey 1995; 2001, Reimer *et al.* 2004)

| Building Level	Sample Number	Date	Cal Years BP (2σ range)	Cal Years BC (2σ range)
1	OxA-12298	9980 +/- 60	11710-11247	9761-9298
1	OxA-12328	9960 +/- 45	11612-11248	9663-9299
1	OxA-12329	10085 +/- 45	11959-11399	10010-9450
2	OxA-12330	9980 +/- 45	11695-11259	9746-9310
2	OxA-12331	9975 +/- 45	11690-11254	9741-9305
2	OxA-12332	9935 +/- 45	11604-11237	9655-9288
2	OxA-12333	10050 +/- 45	11807-11329	9859-9380
3	OxA-12334	9970 +/- 45	11685-11251	9736-9302
3	OxA-12335	9995 +/- 40	11699-11270	9750-9321
3	OxA-12336	10020 +/- 40	11746-11317	9797-9368
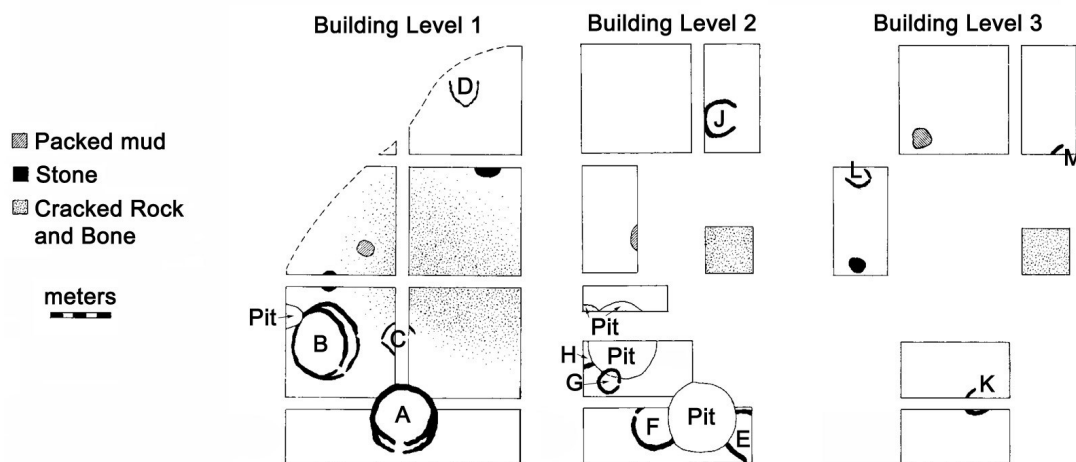
FIG. 2. — Map of the three main building levels excavated at Hallan Çemi (after Rosenberg *et al.* 1998).

Peasnall 2000). Two different kinds of structure were found: large semi-subterranean, plaster-paved houses and small surface structures with stone foundations and paved floors (Peasnall 2000); the latter type is more common. The central activity area is marked by a large quantity of faunal remains, including some still-articulated skeletal portions of carcasses as well as an arrangement of three sheep crania, and a high density of fire-cracked rock (Rosenberg *et al.* 1998, Rosenberg 1999). It has been argued that the abundance of fire-cracked rock and the surprising completeness of animal remains in this portion of the site, along with intricately carved groundstone objects, indicate feasting activities in an open or public space (Hayden 1995, Rosenberg & Redding 1998). The plant and animal species present and growth bands on fresh water clam (*Unio tigridus*) shells suggest that Hallan Çemi was occupied year-round (Rosenberg *et al.* 1998) or nearly year-round.

Groundstone and carved stone artifacts are abundant throughout the site—carved pendants and beads, polished stone bowls, ornately carved (as well as utilitarian) pestles, querns, mortars, and mullers (Peasnall 2000). The stone bowls are similar to those found in later levels of Çayönü, and the ornately carved pestles resemble specimens found at Nemrik 9, which post-dates the occupations

of Hallan Çemi (Rosenberg *et al.* 1998, Rosenberg 1999). The large quantity of utilitarian mortars, pestles, querns, and mullers is especially significant to our discussion of possible resource intensification (see below).

Many bone tools were found at Hallan Çemi and many of these were elaborately crafted. They include both utilitarian and non-utilitarian objects, and like some of the groundstone artifacts, many bone tools are extensively decorated (Goodarzi-Tabrizi 1999). Particularly noteworthy are similarities in form and manufacture technique to osseous artifacts from other sites in the Taurus-Zagros region. At Çayönü and Cafer Höyük in Turkey there are button-like pendants, and bone toggles at Çayönü may associate with weaving (Goodarzi-Tabrizi 1999). The bone tool assemblage at Hallan Çemi is most similar, however, to that at Zawi Chemi Shanidar and Shanidar Cave in Iraq (Rosenberg *et al.* 1998, Rosenberg 1999, Peasnall 2000). The manufacturing techniques (grinding as opposed to shaving) are the same at all of the sites listed above, as are many of the forms made, including awls, spatula-like tools, hafts, perforated tools, and beads (Goodarzi-Tabrizi 1999). Also notable is the lack of similarity between the bone tools at Hallan Çemi and those found at Natufian sites in the Levant (Goodarzi-Tabrizi 1999).

Chipped stone tools are abundant at Hallan Çemi and are made of both flint and obsidian, with obsidian dominating the assemblage (Rosenberg & Davis 1992, Peasnall 2000). The flint raw material was obtained locally, but the obsidian derives from three different sources near Lake Van and Bingöl, over 100 km north of Hallan Çemi (Rosenberg & Davis 1992; Rosenberg *et al.* 1998, Peasnall 2000). The chipped stone industry shares commonalities with many contemporary sites in the Taurus-Zagros Arc (Rosenberg *et al.* 1998, Rosenberg 1999). The small, highly variable scraper assemblage resembles that found at Qermez Dere. Sickle blades are absent at Hallan Çemi and burins are rare, similar to the situation at Qermez Dere and Nemrik 9 (Rosenberg & Davis 1992, Rosenberg *et al.* 1998). Oddly Hallan Çemi also lacks tanged and notched points as well as double-backed obsidian blades (Rosenberg & Davis 1992, Rosenberg *et al.* 1998, Rosenberg 1999). Convex pieces and scalene triangles link the Hallan Çemi stone tool industry stylistically to Zawi Chemi Shanidar and other Zarzian sites (Rosenberg *et al.* 1998, Rosenberg 1999). Chipped stone tool types characteristic of the Levantine Natufian are completely absent (Rosenberg *et al.* 1998, Rosenberg 1999), confirming the independence of these regional cultural entities.

Macro-botanical remains at Hallan Çemi include a variety of nuts, pulses, and legumes (Rosenberg *et al.* 1998, Rosenberg 1999, Peasnall 2000, Savard *et al.* 2006). Lentils and bitter vetch are present, as well as almond, pistachio and possibly acorn (Rosenberg *et al.* 1998, Rosenberg 1999, Peasnall 2000). Sea club-rush and dock/knotgrass are the most ubiquitous species in the site (Savard *et al.* 2006). *Gundelia tournefortii*, a perennial tumbleweed in the daisy family, is also common at Hallan Çemi, and though it is typically not found at other sites in the region, its oil-rich seeds are still eaten today in parts of Iraq (Rosenberg *et al.* 1998, Peasnall 2000). A few small-grained grasses are present in the floral assemblages, but none of these belongs to the cereal family (Rosenberg *et al.* 1998; Rosenberg 1999, Peasnall 2000, Savard *et al.* 2006) in marked contrast to the Epipaleolithic sites of the Levant. The lack of cereal remains at Hallan Çemi is significant to discussions of early agriculture, as it is often assumed that early sedentary complex foragers utilized wild cereal grasses as extensively as did later agricultural groups of the region (Savard *et al.* 2006).

Previous analyses of the faunal remains from the central activity area of Hallan Çemi identified *Ovis/ Capra* (sheep/goat, or ovicaprids), *Cervus elaphus* (red deer), and *Sus scrofa* (pig) as the dominant prey species (Rosenberg *et al.* 1998, Rosenberg 1999). Numerous carnivores, including *Vulpes* sp. (fox), *Felis silvestris* (wild cat), *Martes foina* (stone marten), and *Ursus arctos* (brown bear) were found (Rosenberg, *et al.* 1995). Some small mammals are also reported, along with notable quantities of Mediterranean tortoise (*Testudo graeca*) and turtle (*Mauremys* sp.) (Rosenberg *et al.* 1995, Rosenberg *et al.* 1998). The ovicaprid remains display a sex bias favoring two to three year old males, and this mortality pattern has been attributed to a combination of preferential selection of males and natural ranging patterns that may have been produced in a "male sink" near the site (Redding 2005, Rosenberg & Redding 1998). The idea is that, as prime-aged males were hunted-out near Hallan Çemi, young males may have expanded continuously into the vacated territories (Redding 2005).

An unusually high proportion of meat-bearing elements was noted for the ovicaprids and red deer at Hallan Çemi. These observations suggest preferential transport of the meatiest portions of prey animals, possibly because they were killed far from the site (Redding & Rosenberg 1998, Redding 2005). The proportion of meat-bearing to non-meat bearing bones for pigs posed a significant contrast to other large game animals. Body part representation for pigs indicates that meaty elements are only slightly more abundant than would be expected based on a complete carcass model (Redding & Rosenberg 1998, Redding 2005).

Finally, it was observed that the proportion of pig remains increases relative to ovicaprids and red deer from the oldest to the youngest layers in Hallan Çemi (Redding & Rosenberg 1998, Redding 2005). This trend, coupled with decreases in the sizes of the upper and lower third molars and an overrepresentation of males in the pigs, has been used to argue for incipient pig domestication, perhaps as the result of confining the females but allowing them to breed with wild males (Redding & Rosenberg 1998, Rosenberg & Redding 1998,

Redding 2005). The results described above were based on faunal material from the central activity area, a sample that is spatially and contextually separate from the sample that we studied. The excavators divided the faunal collection in terms of a central activity area and a series of structures surrounding the central activity area (Fig. 2), and our sample is confined to the latter. Re-evaluating the question of pig domestication therefore is not the focus of this presentation. Our goal is to consider the over-arching hunting activities at Hallan Çemi in relation to plant exploitation.

ZOOARCHAEOLOGICAL METHODS

The faunal assemblage from Hallan Çemi is very large, with possibly more than 100,000 identifiable bones from the entire site. This study employs a more manageable sample of 5,830 identifiable specimens from an estimated 30,000 identifiable bones recovered from the excavation units outside of the central activity area (Fig. 2), both within and outside of the structures described by Rosenberg *et al.* (1998). Although the site includes four discreet building levels (Rosenberg *et al.* 1998, Peasnall 2000), our analysis considers the remains as a cohesive unit. It is unclear where precisely the samples came from stratigraphically, and, in addition, the occupations span only a few hundred years (Higham *et al.* 2007).

The use of a time-averaged sample can be advantageous in enhancing sample-size, as well as by reducing the importance of single events when the goal is to establish a general subsistence picture. Certain important limitations prevail with time-averaged samples, so we use caution and do not attempt to glean too much detail from a coarse-grained analysis of the game spectrum. This analysis complements those done by Richard Redding at the University of Michigan, who focused mainly on fauna from the central activity area (Redding, pers. com.).

The faunal remains were identified using standard published zooarchaeological techniques. The skeletal reference collection in the Stanley J. Olsen Laboratory at the Arizona State Museum, University of Arizona and unpublished electronic faunal manuals created by the second author for Eurasian species were utilized for identifications. Due to the lack of appropriate comparative material at the time of study, birds were classified into four body sizes: small (<0.1 kg), medium (0.1 – 0.2 kg), large (0.2 – 2.0 kg), and very large (5.0 – 8.0) (Dunning 1993) (see Table 2 for taxonomic examples of each category). The counting units in this study follow Grayson (1984) and Lyman (1994). In addition to taxonomic or body class identifications, the remains were identified to skeletal element and portion of element, the latter following Stiner (2005). End and shaft features were used in the case of long bones. Other observations taken on each specimen included fusion state,

TABLE 2. — Average biomass values assigned to each species or body size group (Dunning 1993, Silva & Downing 1995).

	Mass (kg)	MNI	Biomass
Small birds (songbirds)	0.1	1	0.1
Medium birds (Galliformes, Columbiformes)	0.2	3	0.6
Large birds (small raptors, owls)	1	4	4
Very large birds (*Otis tarda* and large raptors)	7	2	14
Combined bird biomass			18.7
Testudo graeca	2	16	32
Lepus capensis	2.8	2	5.6
Vulpes vulpes	3.5	4	14
Ovis/Capra	80	22	1760
Cervus elaphus	170	9	1530
Sus scrofa	200	7	1400
Ursus arctos	170	2	340

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development and wear stages for mandibular teeth, burning stage, damage traces such as tool marks, fracture forms, gnawing or weathering damage, and maximum length of each fragment to control for the relation between fragmentation and prey body size differences. Although taking bone weights by excavation unit has been used effectively in other sites, it was not considered at Hallan Çemi because many of the remains are encrusted with solidified wood ash or wattle and daub so mass could not be compared reliably.

Most of the bones from Hallan Çemi are large and easily identified. Bones were processed for their marrow content, but the degree of fragmentation is considerably less than is typical of Paleolithic faunas (*e.g.* Stiner 1994, 2005). No carnivore damage was apparent in the study sample. Very few of the pieces were weathered, and fragile types of bone (such as from fetuses) are also common in the collection. While *in situ* weathering was not an issue, excavation damage is common. Modern breaks are easily distinguished from old breaks, however, and attention was paid to re-fitting bones broken recently.

COMPARISONS OF PREY SPECIES ABUNDANCE

The meat diet at Hallan Çemi was dominated by large game and supplemented by tortoises (Fig. 3, Table 3). Though certain species of small mammals and reptiles can easily burrow into an archaeological site and die naturally, there is little reason to believe that the tortoises in the Hallan Çemi assemblage were introduced in this manner. About four percent of the tortoise remains were burned, as compared to two percent burning for the entire assemblage. Additionally, cut marks were recorded on one tortoise tibia, impact fractures were observed on three shell fragments, and about a third of the shell fragments have green bone breaks on them. The bodies of the tortoises were cut and forcefully broken apart prior to being deposited in the site.

The proportion of *Ovis* sp. to *Capra aegagrus* is roughly 9:1, as compared to 18:1 found by Rosenberg *et al.* (1998), which may be a product of sample location.

TABLE 3. — NISP and MNI for each taxon and size class at Hallan Çemi.
MNI was not determined for mammalian size class categories. Two metapodials identified as *Ursus spelaeus*, if correct, would represent a particularly late occurrence of the species and need to be confirmed. *Ursus spelaeus* has been reported in other sites dating as late as 12,000 years ago (Guerin & Patou-Mathis 1996, Baryshnikov 1997).

|	NISP	MNI
REPTILES	3	1
Indeterminate lizard	369	16
Testudo graeca		
FISH		
Indeterminate fish	61	2
BIRDS		
Small birds	5	1
Medium birds	39	3
Large birds	43	4
Very large birds	31	2
SMALL MAMMALS		
Erinaceus sp.	6	1
Lepus capensis	46	2
Hystrix sp.	6	1
Castor fiber	2	1
CARNIVORES		
Martes foina	11	1
Vulpes vulpes	67	4
Felis silvestris	12	1
Meles meles	19	1
Small carnivore	25	
Lynx lynx	8	1
Panthera pardus	1	1
Ursus arctos	56	2
Ursus spelaeus	2	1
Large carnivore	5	
UNGULATES		
Capreolus capreolus	7	1
Small ungulate	1	
Ovis sp.	322	
Capra agaegrus	38	
Ovis/Capra	579	22
Dama dama	3	1
Medium ungulate	1262	
Cervus elaphus	514	9
Sus scrofa	549	7
Large ungulate	490	
Bos primigenius	3	1

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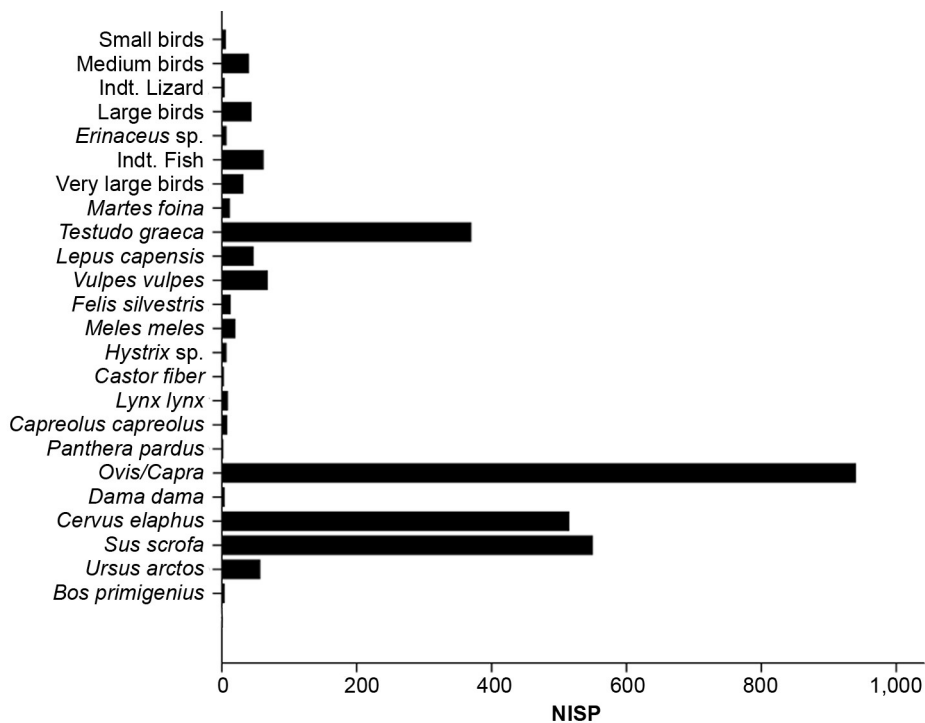
Fig. 3. — NISP for each taxon at Hallan Çemi. Note the dominance of medium to large ungulates such as *Ovis/Capra, Cervus elaphus, Sus scrofa*, as well as *Testudo graeca.*

Another view of the data is provided by the minimum number of individuals (MNI) and the minimum number of elements based on bones (bone MNE) (Fig. 4). MNI is calculated by dividing MNE by the number of times that a particular element appears in the body and using the highest value without taking side into account (preliminary analyses indicated that there is no reason to expect a side bias at Hallan Çemi). However, age as indicated by state of fusion was taken into account in our calculation of MNI. Problems with aggregation error and inconsistencies in calculation techniques between analysts are potential pitfalls of derived counting units such as MNE and MNI (Grayson 1984, Klein & Cruz-Uribe 1984). MNI is required, however, for calculations of prey biomass (below), and the sample size from Hallan Çemi is sufficiently large to warrant this approach. The relative dietary importance of prey types can also be considered from the perspective of meat biomass realized by hunters (Fig. 5, following Stiner 2005).

The MNI value for each species is multiplied by its estimated body mass (Dunning 1993, Silva & Downing 1995). To limit possible data aggregation effects, species represented by a MNI value of less than two are excluded from the comparison. Birds of all sizes were combined into one group in Figure 5, after multiplying the MNI for each size class by an average mass for each category and summing the averages. It is clear from this representation of the data that *Ovis/Capra* contributed only slightly more to the meat diet at Hallan Çemi than *Cervus elaphus* or *Sus scrofa*. The biomass comparison also reveals an importance of *Ursus arctos* (brown bear) that is not obvious from other treatments of the data, although the total NISP for this taxon is rather low. The faunal data indicate an overwhelming dependence on highly ranked prey types in the meat diet at Hallan Çemi.

Small game are expected to be more sensitive indicators of resource intensification among foragers, even

in situations where small game comprise a minor fraction of total prey biomass (Stiner 2001, Stiner & Munro 2002, Munro 2004b). Their importance for studies of diet breadth stems from their role as supplementary resources and the intensity with which they are sought by foragers (Stiner 2001).

Small game animals are divided into three categories: *Testudo graeca*, *Lepus capensis*, and birds, the latter of which includes birds of all size classes; though some birds (*e.g.* raptors) may not have been food sources at all. *Testudo graeca*, a slow moving species, makes up over half of the small game (Fig. 6). Of
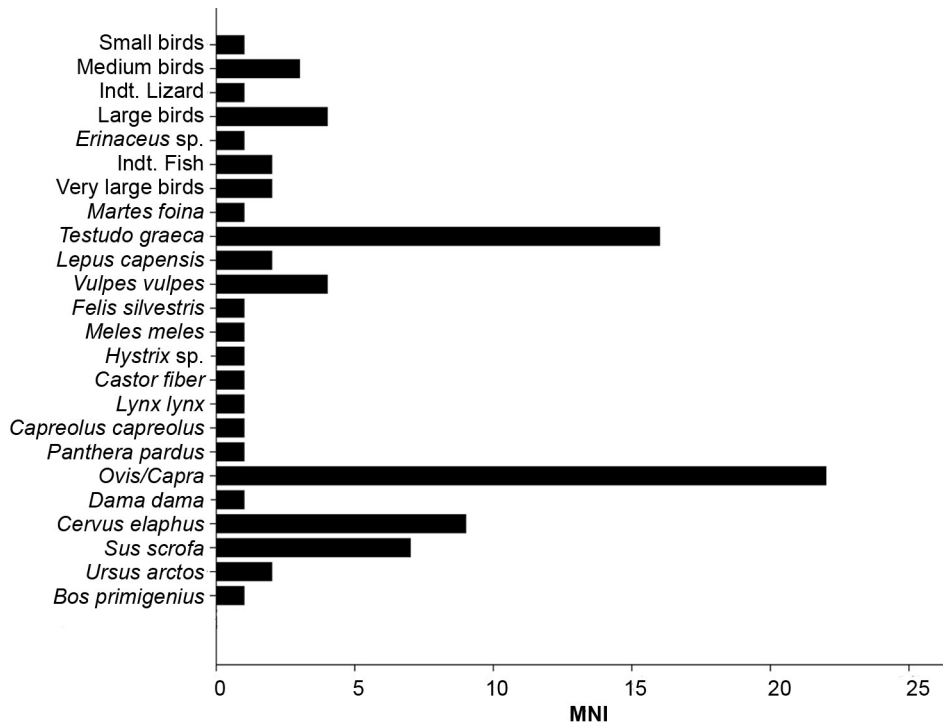
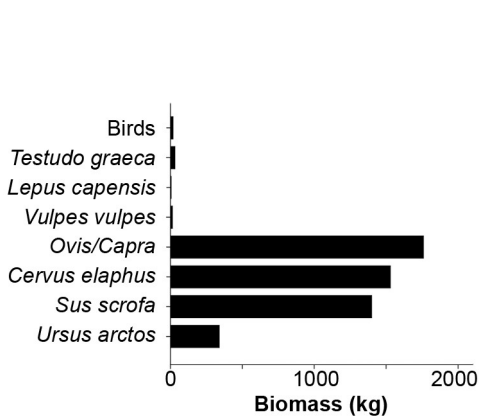Fɪɢ. 4. — MNI for each taxon at Hallan Çemi.

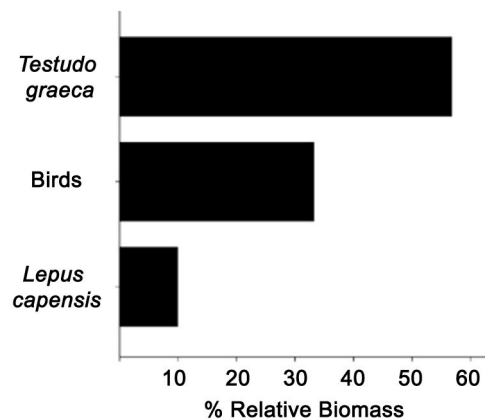Fɪɢ. 5. — Total biomass for each of the taxa represented by an MNI of two or more.

Fɪɢ. 6. — Relative biomass of three small game types at Hallan Çemi. The "bird" category is composed of birds of all sizes.

the small prey types, these are among the highest ranked because capture and processing costs are minimal, in contrast to the challenges that hunting hares or birds normally entail. The high proportion of tortoises means that these highly desirable small prey types were still available in appreciable numbers in the study area. Birds and hares were also exploited, but in lower proportions (*i.e.* an uneven distribution of the three prey types overall).

BONE SURVIVORSHIP

Density-mediated attrition is the loss of certain parts of the skeleton due to their lower structural density. Low density parts such as spongy epiphyses have a greater likelihood of being destroyed than do higher density portions such as long bone shafts (Lyman 1994). Such destruction can occur from mechanical processes such as carnivore ravaging, sediment compaction, and human butchering and marrow processing (Davis 1987, Lyman 1994). Since density-mediated processes have the potential to bias the anatomical content of an archaeofaunal assemblage, many authors have stressed the importance of understanding the role of density-mediated processes at a site before inferences about human behavior and transport decisions are made (Lyman 1985, 1994, Grayson 1989, Marean 1991). One solution has been to measure the structural density of selected portions of skeletal elements using photon-densitometry standards (Lyman 1984). Bone survivorship in archaeofaunas can be examined by comparison to these independent standards. Variation in the anatomical structure among species is an important caveat in the application of the bone density standards. Density parameters derived by different authors or even different scanning techniques such as photon densitometry or computed tomography yield fairly similar results, however, when examined in terms of anatomical regions as will be performed below (Stiner 2004).
Results of a Spearman's rank-order correlation test of bone density values against %survivorship for ovicaprids, *Sus scrofa*, and *Cervus elaphus,* respectively, refute the likelihood that non-human processes greatly biased body part representation at Hallan Çemi (Table 4). The analysis includes all postcranial

TABLE 4. — Spearman's rank-order correlation between bone density values and %survivorship. Asterisks indicate a significant, positive correlation (bone density values from Lyman 1994).

	N	r	r^2	P
Ovicaprids	56	0.268	0.071824	*0.047
Sus scrofa	37	0.342	0.116964	*0.038
Cervus elaphus	62	0.243	0.059049	0.067

scan sites for which density standards are available, with the exception of some pelvic portions. Density data applied to ovicaprids were taken from scans on domesticated sheep (noting that domestic variants are less robust skeletally), those applied to *Cervus elaphus* at Hallan Çemi were from *Odocoileus* deer (from Lyman 1982; 1984; in Lyman 1994), and density data applied to *Sus scrofa* from Hallan Çemi were taken from scans on domesticated pigs (Ioannidou 2003). A mildly positive correlation exists for both ovicaprids and *Sus scrofa* (Table 4), whereas no correlation is apparent for *Cervus elaphus*. Assuming that the reference sets are appropriate, we would expect to see a significant correlation for all three ungulate taxa. Additionally, the low r^2 values for ovicaprids and wild boar indicate that density-mediated attrition can at most explain only 7-12% of the variation in skeletal survivorship. It seems unlikely that non-human density mediated factors were significant at Hallan Çemi.

UNGULATE BODY PART REPRESENTATION

After an animal is killed, hunters normally must decide which parts of the animal to transport to the habitation site and which to leave behind. Various factors influence these decisions such as the size of the animal, the distance between kill site and residence, the size of the hunting party, and how badly the meat is needed (see Binford 1978, Bunn & Kroll 1988, O'Connell *et al.* 1988 for ethnographic examples). Skeletal completeness at a residential site may indicate that food was scarce, compelling people to utilize the entire carcass regardless of processing and transport costs (Binford 1978) and even to render grease from the bones. Skeletal completeness
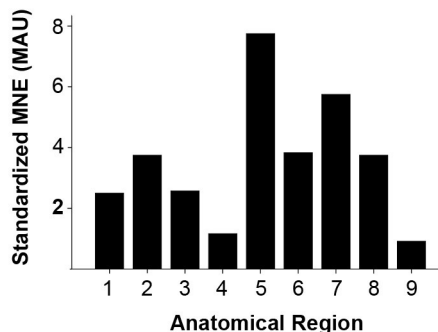
FIG. 7. — Body part representation of *Cervus elaphus*, showing an overrepresentation of the upper front and upper hind regions (1 = antler, 2 = head, 3 = neck, 4 = axial, 5 = upper front, 6 = lower front, 7 = upper hind, 8 = lower hind, 9 = feet).
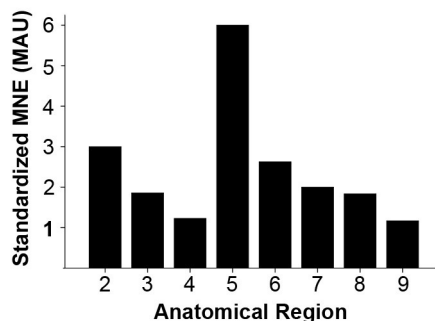

FIG. 8. — Body part representation for *Sus scrofa*. Note the overrepresentation of the upper front limb region relative to other regions of the body (anatomical regions as in Figure 7).
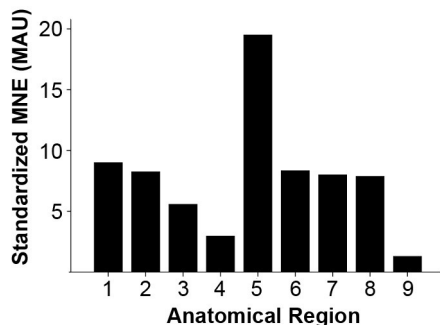

FIG. 9. — Body part representation for ovicaprids, with over-representation of the upper front limb area (anatomical regions as in Figure 7).

may also arise from the practice of killing animals at the residential site, if they were held captive there for any reason. Conversely, selected portions of animals at a site may be explained by preferential transport, with hunters focusing primarily on the highest yield parts of animals because food was abundant (Binford 1978).

Following Stiner (1991), the MNE for each of the three dominant ungulate taxa are collapsed into nine anatomical regions that correspond to element groups: horn or antler (if present in the species), head, neck, axial skeleton, upper front limb, lower front limb, upper hind limb, lower hind limb, and feet. A benefit of dividing the body in this way is that it circumvents problems of variable structural density within one element or group of elements, providing a buffer for possible non-human biases that may correlate to bone density (Stiner 2002, 2004). Figures 7 through 9 summarize body part representation for *Cervus elaphus, Sus scrofa* and *Ovis/ Capra*, respectively. Because axial elements such as vertebrae and ribs are less diagnostic of species than are other parts of the skeleton (Davis 1987), they were usually identified only to the level of medium or large ungulate body size groups. Ovicaprids comprise virtually all of the identifiable medium ungulate remains, so the axial category for this size group includes ovicaprid vertebra and rib portions as well as those from undetermined medium-sized ungulates. In the case of *Cervus* and *Sus,* rib and vertebral elements designated as large ungulate had to be divided between them. This is not an ideal solution but the approach nonetheless exposes some reliable, albeit general, patterns.

All three body part profiles are similar and display an under-representation of axial and foot elements and an extreme overrepresentation of upper front limbs. It has been shown elsewhere that axial elements are especially prone to under-representation in faunal assemblages due to their susceptibility to mechanical attritional processes and a tendency for these parts to be left at kill sites (Stiner 2005). At Hallan Çemi neck vertebrae are better represented than thoracic and lumbar vertebrae, and some relatively dense parts such as toe bones are under-represented. The possibility that axial elements were destroyed via bone grease rendering is not tenable since spongy long bone epiphyses were not being used similarly.

Also of interest is the ratio between tooth-based MNE and cranial bone-based MNE (Stiner 1994). Because of the high mineral content of teeth as compared to bone, teeth are less susceptible to many processes that can degrade bone (Lyman 1994; Stiner 1994). Oddly, at Hallan Çemi, cranial bone-based MNE values are actually higher than those for teeth (Table 5). This can probably be best explained by the high incidence of excavation damage on the assemblage; in this assemblage broken bone with modern damage could easily be refitted and was often still identifiable, whereas the teeth tended to be shattered.

The over-representation of front limb elements is significant in that this area of the skeleton associates with one of the larger meat masses on the ungulate body, hence the high utility index values documented ethnographically by Binford (1978). Over-representation of the anterior upper limbs in the Hallan Çemi faunas is not simply an artifact of the survival of the structurally dense distal humerus, since the more fragile glenoid fossa of the scapula is also over-represented. The body part profile for *Cervus elaphus* also indicates a high representation of upper hind limbs, which is the only area of an ungulate carcass with more meat than the upper front limbs (Binford 1978). The body part profiles therefore indicate a strong preference for the meatiest parts of ungulates. Clearly the inhabitants of Hallan Çemi were selective in their choices about which animal portions to transport. What is more, this highly selective pattern of bone transport is not consistent with the usual indicators of resource stress.

Redding (2005) and Rosenberg *et al.* (1998) remark on contrasts in the proportions of meat-bearing and non-meat bearing portions of pigs and those of the other ungulate taxa. Body part representation for pigs was found to be more complete, which they interpreted as pigs having been killed on site. The less complete body part representation for ovicaprids and red deer indicated that they were killed at more remote locations. Our findings on the faunal collection recovered from the middens do not set pigs apart from other large game. The upper front region is almost twice as abundant as the rest of the carcass for all three of the prey species. We note, however, that our faunal sample is spatially distinct

Table 5. — Cranial bone-based and tooth-based MNE for the three major ungulate taxa.
Note that in all cases the bone-based MNE exceeds that of the tooth-based value.

	Bone-based MNE	Tooth-based MNE
Ovicaprids	25	18
Sus scrofa	8	6
Cervus elaphus	8	5

from that used in the earlier study, and thus it is possible that the over-representation of the upper front limbs that we see in our sample is a product of differing space use by the inhabitants and area sampling by archaeologists. If this were the case, however, it would be expected that the data presented by Redding (2005) and Rosenberg *et al.* (1998) would display complementary biases toward non-meat bearing elements, which they do not.

MORTALITY PATTERNS

The Hallan Çemi faunal assemblage contains many fetal remains, which brings us to the discussion of ungulate age structures. Age structure analysis is important to research on sites of this time period for several reasons. First, it has been shown that exploiting higher proportions of juvenile animals can be a response to resource stress (Davis 1989, 1991; Munro 2004b). The proportions of juvenile gazelles in Levantine assemblages, for example, increased throughout the Paleolithic and Epipaleolithic, peaking during the Early Natufian, presumably in response to growing human populations, sedentism or both. It is possible that the situation was similar at contemporary sites in southeastern Anatolia. Second, higher proportions of juvenile animals, particularly males, may indicate culling practices relating to proto-domestication in some species (Hesse 1982). Hallan Çemi is an important case for comparing the age structures of wild ungulates (deer) and those species which eventually were domesticated in one world region or another (sheep, pigs, goats).

The identification of fetal bones from Hallan Çemi was based on comparisons with modern stillborn

TABLE 6. — Tooth-based MNI for the dominant ungulate taxa by age group.
All available teeth were selected from the 30,000+ identifiable bones from outside of the central activity area in order to expand the sample available for mortality analysis, thus the totals exceed those for the tooth-based MNE values presented in Table 3.

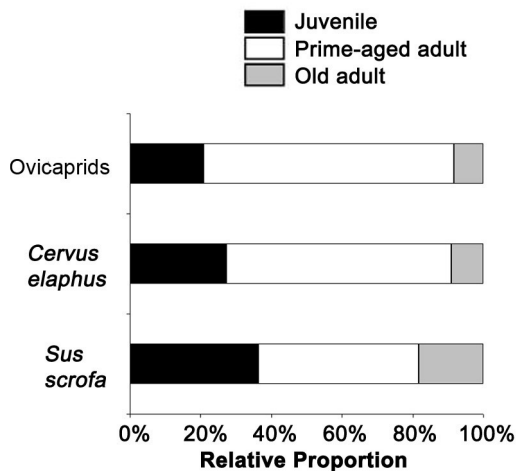|	Juvenile	Prime-aged adult	Old adult	Total
Ovicaprids	5	17	2	24
Sus scrofa	4	5	2	11
Cervus elaphus	3	7	1	11

FIG. 10. — Relative proportions of tooth-based MNI for each age group in each common ungulate taxon.

sheep, goats and pigs. In all cases, individuals identified as fetal in the archaeofaunal assemblages were considerably smaller (<75% in size) than the stillborn comparators. If there was any question about the natal status of the individual, fetal/neonate or juvenile labels were applied.

The age structures presented in Table 6 and Figure 10 are based on tooth eruption and wear schedules from Severinghaus (1949), Deniz and Payne (1982), and Grant (1982), and are constructed using the mandibular deciduous fourth premolar in conjunction with the mandibular third molar. Although use of the lower deciduous fourth premolar and adult fourth premolar is optimal because the deciduous tooth must shed before the adult tooth comes into use (Stiner 1994), the adult third molar is used in this study because the MNI based on this element was considerably higher, such that a larger sample was available for study. Side of the tooth was taken into account to avoid double counting. Following Stiner (1990), wear stages were collapsed into the broader categories of juvenile, prime aged adult, and old adult. The juvenile stage is composed of animals that died between the time of birth through the shedding of their deciduous fourth premolar. Prime-aged adults dominate for both the ovicaprids and *Cervus elaphus*, while *Sus scrofa* is represented by near-even proportions of juvenile and prime-aged adults, possibly relating to the large litter sizes of this species.

The MNI for fetal ovicaprids is one, whereas the MNI of fetal *Sus scrofa* is five. No fetal/neonate remains of *Cervus elaphus* were observed. Wild sheep and goats typically give birth to one to four young at once, whereas wild sows may have litters of up to twelve piglets (Burton 1991). With such a small sample, it is unclear if a pregnant animal was killed and transported to the site, or if a pregnant female died at the site.

Rosenberg *et al.* (1998) note similar differences in the age structures of pigs and ovicaprids, which they suggest is evidence of herd management in the case of pigs, a hypothesis that may require re-evaluation with a larger sample taken from all areas of the site. The proportion of juvenile animals at Hallan Çemi does not even approach the intensity of exploitation of gazelles in the Levant during this time period, where assemblages are made up of as much as 50% juvenile remains (Munro 2004b). In fact, the Hallan Çemi data are more consistent with earlier Paleolithic hunting patterns (Speth & Tchernov 1998, Stiner *et al.* 2000, Stiner & Munro 2002, Stiner 2005).

GROUNDSTONE
AND INTENSIFIED PROCESSING

Great quantities of utilitarian groundstone were found at Hallan Çemi, specifically mortars, pestles, querns, and mullers (Peasnall 2000). Table 7 gives the relative counts of just handstones and pestles to the ungulate NISP values for our sample area.

Although this comparison includes less than half of the full range of groundstone artifact types present in the site, it is useful for demonstrating the large amount of groundstone in comparison to bone. The quantity of groundstone is relevant to our discussion of game use for two reasons. First, heat-in-liquid grease rendering, an intensive method of grease extraction that involves pulverizing spongy bone and boiling the fragments to liberate nutrient rich oils (see Binford 1978: 157-163 for a description of the process), appears to have been one dimension of resource intensification in the Early Natufian (Munro 2004b, Munro & Bar-Oz 2005) and is accompanied by many groundstone artifacts. Second, if the groundstone tools were used only for processing plants, then we may conclude that intensification is *not* mirrored in the way that animal resources were prepared for consumption.

Typical indicators of grease rendering include extreme communition of fresh bones, large quantities of heat-fractured stone, and large pitted stone anvils (Stiner 2003). Bone grease rendering seems very unlikely at Hallan Çemi. The NISP:MNE ratios for long bone ends, which serve as an index of fragmentation (following Lyman 1994: 281-283), are quite low, indicating that long bone ends were largely intact (Table 8). The quantity of heat-fractured stone is not well understood for the site, although "dense concentrations" are mentioned by the excavators (Rosenberg *et al.* 1998) and suggest that stone boiling may have occurred. However, stone anvils do not seem to be part of the groundstone industry, and pitting from repeated impact is only noted on mullers that may have been used for cracking nuts (Peasnall 2000). The tests of density-mediated bone attrition likewise do not indicate severe smashing of spongy bone tissues, a hallmark of grease rendering.

The large amount of groundstone in Hallan Çemi can be attributed mainly or exclusively to the processing of non-animal materials, possibly pigments and certainly plant matter. Wright (1994) points out that groundstone technology is critical for semi-sedentary groups with growing populations. Even though intensive grinding may lower caloric return rates in terms of time spent working, grinding reduces plant food particle sizes and increases the overall surface area so that the food is more digestible and nutritious. Seed grinding results in greater return rates per

TABLE 7. — Counts of selected groundstone types and faunal remains from the same excavation units. Groundstone counts are from raw data provided by Rosenberg and Redding.

Handstones (mostly complete)	35
Pestles (mostly complete)	15
Total	50
NISP fauna	5830

TABLE 8. — Index of fragmentation based on NISP to MNE ratios for major long bones of large ungulates and ovicaprids (P = proximal, D = distal).

	NISP: MNE Ovicaprids	NISP: MNE large Ungulates
P humerus	2.20	1.75
D humerus	1.46	1.46
P radius	1.39	1.35
D radius	1.80	1.13
P femur	1.08	1.25
D femur	1.38	2.25
P tibia	3.00	1.40
D tibia	1.33	1.42

unit of land on which the edible plants grow rather than time spent, which is of critical importance to semi-sedentary groups (Wright 1994).

The groundstone evidence from Hallan Çemi is consistent with heavy utilization of plant seeds and nuts only. In the Early Natufian in the Levant, mortars and pestles were more abundant than grinding slabs and handstones. The latter are typically associated with the Late Natufian (Wright 1994). Early Natufian sites were typically at the edges of forested areas and contain more evidence of ground nuts and pulses as opposed to cereal grains (Wright 1994). Hallan Çemi was also situated at the edge of a forest, and the inhabitants exploited large quantities of nuts and pulses using a groundstone assemblage dominated by mortars and pestles, more similar to that described by Wright (1994) for the Early Natufian in the Levant.

CONCLUSIONS:
A PREY-PLANT USE PARADOX

At Hallan Çemi, large game made up the vast majority of animal resources in the diet, and there is no

evidence in our study sample for intensive carcass processing or unusually high proportions of juvenile animals killed. Additionally, body part profiles indicate that carcass transport focused on the meatiest portions of the ungulate species preferentially. A high degree of sedentism is indicated by large permanent structures and evidence from floral and faunal remains that the site was occupied year round (Rosenberg & Davis 1992, Rosenberg 1999, Peasnall 2000). The excavators estimate that there were never more than fifteen or twenty small structures in use at any time during its occupation (Rosenberg & Redding 1998), so it is likely that only a small group of people occupied the site.

It is possible that the abundance of high-quality animal resources at Hallan Çemi reflects its ready proximity to several productive hunting grounds in the pistachio-oak hilly forests and in gallery forests along the rivers (Peasnall 2000, Rosenberg *et al.* 1998). It is significant that many tortoises were collected by the inhabitants. Such a slow growing species can only be exploited sustainably by small human populations who have not depleted the supply of high-return resources (Stiner *et al.* 2000). The image of plenty that emerges from the faunal record is reminiscent of earlier Paleolithic conditions. Paradoxically, though increasing sedentism often results in reduced supplies of large game resources, the occupants of Hallan Çemi were a small group of semi-sedentary foragers who enjoyed the luxury of high-return animal species.

The co-occurrence of a continued focus on high-return game alongside intensive plant exploitation raises several questions about the nature of the occupations at Hallan Çemi. Intensive processing of plant foods lowers return rates with respect to calories gained per unit of time, while increasing return rates for each unit of plant patch that is harvested. This is the trade-off between high return rates and sedentism in the case of plant exploitation predicted by foraging models. The ways in which meat was exploited at Hallan Çemi are less well aligned with what would be expected by foraging theory at an occupation inhabited for the majority of the year. Temporal variation within the site has yet to be explored, and the transition to animal husbandry could have been rapid in the study area (as it appears to have been in the Zagros region,

Munro 2004a). It is possible that resources become progressively stressed through the four building levels, and our treatment of the remains in a single unit masks this effect.

Not for the first time these observations raise the question of whether feasting was an important activity at Hallan Çemi, as suggested previously by Hayden (1995) based on the presence of ornately carved groundstone objects, fully articulated portions of animal carcasses in the central activity area, and high-quality obsidian obtained from sources located far from the site (Rosenberg 1999). Perhaps intensively processed plants and low-level ungulate exploitation was the norm at Hallan Çemi, and the abundance of meaty portions of high-ranked game indicates periodic feasting. After all, it is in this region that some of the earliest evidence for elaborate ritual architecture is found at Göbekli Tepe (Schmidt 2000).

It is significant that this intense occupation at Hallan Çemi lasted only a few hundred years. Though the inhabitants maintained a meat diet consisting of high-return game alongside heavy seed and nut exploitation, a few centuries may have been all that the local environment could support of this, and the site was eventually abandoned.

Acknowledgments

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