Abstract

This paper studies the changes observed in wild ungulate game procurement strategies between the Epipalaeolithic and Neolithic periods in the southern Levant. It is proposed that the advent of agricultural societies in the Neolithic caused an increase in the frequency of encounters between human hunters and wild ungulate taxa drawn to agriculturally-modified habitats. This higher frequency of encounters is responsible for the observed shift from gazelle- and fallow deer-dominated assemblages in the Epipalaeolithic to the wild boar- and aurochs-dominated assemblages in the Neolithic. The intensification of hunting wild boar and aurochs during the Neolithic is argued to have given rise to a trajectory towards the cultural control of these taxa.

1 Introduction

The Pleistocene-Holocene boundary in the southern Levant saw the transition from hunting and gathering to agricultural economies, marking the end of an epoch in the prehistory of the old world. This dramatic shift engulfed all cultural domains. Production intensification and surplus accumulation entailed social, cultural and demographic changes which culminated in Neolithic civilisation. Large permanent settlements and economic systems marked by growing cultural control over plant and animal resources emerged for the first time.

Numerous socio-economic studies have focused on understanding the causes and timing of the process of animal domestication and its consequences for human societies and their environment (eg, Bökényi 1974; Clutton-Brock 1989, 1999; Diamond 2002; Davis 1987; Flannery 1969; Zeuner 1963). Such studies yielded important insights into the ecological, social and economic conditions which preceded, and may have played part in, the shift to agricultural societies. The earliest stages of animal domestication have been of special interest, as these may hold the key to understanding the process of domestication.

A key actor in the emergence of farming economies in the Levant is the Natufian complex hunter-gatherer culture. The Natufian hunter-gatherer societies in the Levantine core area show unequivocal evidence of increased complexity compared to their predecessors in the earlier Epipalaeolithic (Bar-Yosef 1981, 1998, 2001; Bar-Yosef & Belfer-Cohen 1989, 1991; Belfer-Cohen & Bar-Yosef 2000; Goring-Morris 1998). During the Natufian, and especially in its earlier phase (ca 14,500-12,500 cal BP; chronology follows Kuijt & Goring-Morris 2002 throughout this study), permanent settlements of relatively large size, with architecture, art and burials, make their first substantial appearance in the Levantine core-area. The intensification in the hunting and carcass processing of gazelles (Bar-Oz 2004; Bar-Oz et al 2004; Bar-Oz & Munro 2007; Munro & Bar-Oz 2005) and the overall trend towards more intensive utilisation of low-ranked...
prey resources (hare and partridge) (Munro 2001, 2004; Stiner & Munro 2002; Stiner et al 2000) and possibly fox (Yeshurun et al 2009), were invoked as evidence of increasing occupation intensity and over-exploitation of prey (Stutz et al 2009). Natufian sedentism and increasing impact on the landscape is evident, particularly in the vicinity of habitation sites (Tchernov 1991, 1993a).

The complex hunter-gatherer societies of the Late Epipalaeolithic did not rely on cultivars to any significant degree, nor did they posses domesticated livestock. These important innovations were acquired in the southern Levant by their Neolithic successors, who started to cultivate cereals, some fruit trees and possibly legumes, in the Pre-Pottery Neolithic A (PPNA), ca 11,700-10,500 BP (Kislev 1997; Kislev et al 2006; Weiss et al 2006). Sheep and goats were introduced from the northern and eastern parts of the Levant (Zeder & Hesse 2000; Peters et al 2005) during the Pre-Pottery Neolithic B (PPNB), ca 10,500-8250 BP (Bar-Yosef & Meadow 1995; Clutton-Brock 1999; Horwitz 1993; Horwitz et al 1999; Tchernov 1993b). Somewhat later, and certainly by the early Chalcolithic, domesticated cattle (Grigson 1989; Horwitz & Ducos 2005; Russell et al 2005) and pig (Davis in press; Haber & Dayan 2004) joined the suite of livestock taxa in the southern Levant.

The larger hamlets and village settlements of the Pre-Pottery Neolithic (PPN) were often founded in fertile lands suitable for intense agriculture (Kuijt & Goring-Morris 2002), and thus showed a clear tendency to occupy low-lying floodplains near perennial water sources (Bar-Yosef & Meadow 1995; Kuijt & Goring-Morris 2002). These settlement preferences, coupled with reduced mobility, larger population size, and agricultural activities, would have created special ecological conditions near large human occupations and adjacent fields, as increased human interference caused the degradation of the surrounding habitats (cf Tchernov 1991; Tchernov & Kolska-Horwitz 1990). The agriculturally-manipulated and modified floodplain landscapes are hypothesised to have drawn local wild ungulate taxa to forage on human crops and fallow – especially following the transformation of the natural habitat by human activities. Higher encounter rates of humans with foraging wild ungulates in such ‘man-made oases’ may have been reflected in game acquisition patterns during the Neolithic. If so, we should expect to witness a shift from extensive use of a variety of habitats, which characterise mobile hunters, to intensive use of habitats in the agricultural lands adjacent to sedentary Neolithic settlements.

The southern Levantine wild ungulate taxa most likely to have been encountered in agriculturally-modified floodplain habitats near permanent water-sources are wild boar (Sus scrofa) and aurochs (Bos primigenius). On the other hand, we expect that gazelle (Gazella gazella) and cervids (fallow deer [Dama mesopotamica], red deer [Cervus elaphus] and roe deer [Capreolus capreolus]) would be under-represented in animal assemblages which accumulated following frequent hunting episodes in agriculturally modified habitats. This is because cervids prefer Mediterranean forests, and gazelle prefer drier terrain. These are general habitat preferences, which are nevertheless expected to influence a time-averaged archaeofaunal collection.

Although boar favour forested habitats (Mendelssohn & Yom-Tov 1999), they were not affected directly by deforestation, as they were not obligate forest dwellers, and could forage in agricultural areas. Aurochs have been defined in a recent study as ‘floodplain specialists’ (Hall 2008). Thus, human reduction of the natural floodplain habitat in favour of agricultural activities, in conjunction with the opening of a new foraging niche around Neolithic villages, is suggested to have increased the encounter rate between boar, aurochs and Neolithic hunters. It is likely that this suggested high rate of encounters was a dominant factor in determining wild ungulate prey frequencies in Neolithic sites.

We suggest that large-game acquisition patterns changed significantly with the transition from hunting-gathering to farming economies. Less energy and time allocated to hunting would have made time-consuming, long-range hunting sorties rare. At the same time, hunters would have been more likely to encounter boar and aurochs foraging in the vicinity of agriculturally-modified habitats, especially in places where these species always abounded.

In this study, an analysis of the changes in large-game hunting patterns spanning the Epipalaeolithic to Neolithic divide is undertaken to substantiate this hypothesis. A diachronic upward shift in the frequencies of aurochs and boar is expected to appear in the Neolithic bone assemblages, concurrent with a reduced presence of gazelle and fallow deer, the large
game animals commonly hunted during the Epipalaeolithic. The faunas from Epipalaeolithic sites are expected to be distinguishable on these grounds from assemblages discovered in Neolithic sites.

If indeed Neolithic people hunted more aurochs and boar from nearby agriculturally-modified floodplain habitats, interesting consequences could ensue, as boar and aurochs are the wild progenitors of the prime animal domesticates of the later Neolithic. A mechanism showing greater human interaction with these taxa in ‘man-made oases’ in such chronologically propinquity to their domestication could portend cultural control of these animals (Redding 2005; Redding & Rosenberg 1998; Rosenberg & Redding 1998), and thereby may suggest a trajectory that led to incipient domestication.

2 Methods

The analysis of taxonomic patterns across the Epipalaeolithic/Neolithic cultural entities utilised 25 faunal assemblages from 20 sites located in the Mediterranean climatic zone of the southern Levant: 16 assemblages from 12 Epipalaeolithic sites, and 9 assemblages from 8 Neolithic (PPNB) sites in the southern Levant (figure 1). PPNA sites were omitted for two reasons, one practical and the other heuristic. First, there are nearly no published reports of faunal data from large habitation sites from the PPNA in the Mediterranean climatic zone. Second, it was thought that the pattern sought in the faunal data would best be demonstrated on a cultural phase which already practiced fully-fledged agriculture, with some element of animal husbandry. A comparison between two clear-cut cultural phases may yield results which are more easily interpretable, albeit at the cost of coarse-grained chronological division and an inability to chart the exact course the transition took.

After observing the changes in ungulate utilisation patterns in this sample, a further focus was made on the upper Jordan Valley, where three Epipalaeolithic and two Neolithic sites have been compared. The study of faunal assemblages from a single region is intended to elucidate the observations made on the larger dataset by testing them on a small area, where inter-site ecological differences are minimal, and changes in faunal composition patterns are more likely to be the result of a change in subsistence strategy.

The absolute frequencies of wild ungulates from each site are presented in table 1. Numbers of identified specimens (NISP) counts were used as a basic measure of taxonomic abundance (Grayson 1984; Grayson & Frey 2004; Lyman 2008). Equids (*Equus* spp.) and hartebeest (*Alcelaphus buselaphus*) counts were omitted, as their sporadic appearance across the sample did little to change the ensuing results. Goats were also excluded from the analysis, since it is difficult to differentiate the bones of bezoar goat (*Capra aegagrus*) from those of the domestic goat in many of the Neolithic sites where the goats may have already been fully domesticated, and thus they would not have reflected hunting behaviour. Aurochs and wild boar are treated here as game.

The morphological domestication of these taxa took place in the southern Levant at the very end of the Pre-Pottery Neolithic and the beginning of the Chalcolithic, respectively (see above), leaving open the question of management of these taxa in the PPNB. Possible intensification in the utilisation of these animals during the PPNB may thus clarify to a degree how this management could commence and proceed towards full morphological domestication.

Changes in the composition of the various faunal assemblages were explored using two statistical procedures. The first is cluster analysis (using a single-
<table>
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<th>Site</th>
<th>Abbreviation</th>
<th>Entity/Phase</th>
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<th>Bos primigenius</th>
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<th>Gazella gazella</th>
<th>Dama mesopotamica</th>
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Table 1 The list of the sites discussed in the text, the abbreviation of their names, the entity/phase to which they belong, references and the raw NISP counts of the wild ungulates found in them, excluding goats, hartebeest, and equids.
linkage algorithm with Euclidean distance as a measure of similarity) applied to the data after transforming absolute taxonomic frequencies in each assemblage to proportions. The data were bootstrapped 10,000 times to provide confidence intervals to each node in the hierarchical tree. The second procedure was correspondence analysis applied to the absolute frequencies listed in table 1. Diachronic changes in faunal composition were also displayed in a Relay plot. A relay plot is a composite diagram, where the frequencies of each column (taxon) in each row (site) of the data table are arranged in vertical bar graphs: the bars show the frequency of a taxon, and are chronologically ordered from the earliest to the latest site. The bar graphs themselves are arranged by their first axis scores, as determined by the correspondence analysis; thus the relay plot visually represents changes in the frequency of taxa through time. Statistics were performed using Palaeontological Statistics (PAST) version 1.80 (Hammer et al 2001).

3 Results

An examination of table 1 reveals a change towards higher frequencies of boar and aurochs hunting with the transition to the Neolithic. A correspondence analysis biplot was used to corroborate the observed similarities between the assemblages in terms of wild ungulate frequencies. The results show that a high percentage of the variation (65%; figure 2) in the faunal composition between the assemblages is explained by the first axis scores. These are interpreted as measuring the dominance of gazelle and fallow deer versus boar and aurochs in the faunal composition of each assemblage. Assemblages fall into two distinct clusters: Epipalaeolithic and Neolithic. The proximity of the row points (sites) to the column points (taxa) associated with the two clusters shows that the difference between the assemblages is due to the high frequencies of gazelle and fallow deer in the Epipalaeolithic cluster, as opposed to the high frequencies of wild boar and aurochs in the Neolithic cluster. Of these, the two PPNB faunal assemblages of Motza (Early PPNB and Middle PPNB) and those of Yiftahel (MPPNB) show the highest disparity from the mean first axis scores of the Neolithic assemblages, due to their high percentages of gazelle specimens.

A relay plot (figure 3), based on the first axis scores from the correspondence analysis and the taxonomic frequencies from table 1, shows a clear diachronic increase in the dominance of boar and aurochs
through time. Cluster analysis results (figure 4) show that the first node in the hierarchical tree (and the only one which is statistically significant within a 0.05 confidence interval) segregates Neolithic assemblages from Epipalaeolithic ones. This is not a clear pattern, and here again the same three Neolithic outliers appear in the Epipalaeolithic cluster. Furthermore, the Epipalaeolithic site of Eynan appears inside the Neolithic cluster. It may be said that, excepting three outliers, a persistent pattern emerges using both methods of analysis: Epipalaeolithic assemblages have a distinct faunal composition, dominated by ga-
zelles and fallow deer, while Neolithic sites are distinguished by dominance of wild boar and aurochs.

If we narrow our focus to the five sites in the upper Jordan Valley (Ohalo II, Ein Gev I, Eynan, Munhata and Tel Teo), where the ecological setting is very similar, the pattern becomes more obvious. In figure 5, correspondence analysis shows that the Epipalaeolithic sites are distinct from the Neolithic ones along the first axis, which explains 74% of the variation between the assemblages. Again, the Epipalaeolithic assemblages are strongly associated with gazelle and fallow deer, while Neolithic ones are associated with wild boar and aurochs. We note that the assemblage of Eynan is the closest to the Neolithic row points, and to the column points denoting wild boar and aurochs. Cluster analysis results (figure 6) corroborate this observation. While the greatest dissimilarity is between Epipalaeolithic and Neolithic sites ($p < 0.0001$), Eynan is significantly different from its Epipalaeolithic peers ($p = 0.02$).

4 Discussion

The Epipalaeolithic and Neolithic faunal sequences from the southern Levant are important for understanding the cultural, economic and palaeoecological processes that led to cultural control of boar and aurochs and eventually domestication. The analyses undertaken in this study point to an overall trend of increase in hunting aurochs and wild boar relative to other wild ungulates with the transition to the Neolithic. This may be taken as support for the hypothesis that changes in the settlement pattern and intensity of early agricultural societies narrowed the range of hunting episodes into familiar habitats along the agriculturally-modified floodplains in the vicinity of sites. As a result, the frequency of encounters with boar and aurochs rose; this pattern distinguishes and characterises Neolithic hunting patterns from Epipalaeolithic ones.

Four assemblages from three sites in the analysis seem not to obey the Epipalaeolithic/Neolithic dichotomy outlined above. The Early Natufian site of Eynan shows rather high frequencies of wild boar and aurochs compared to the Neolithic groups. However, within the context of the upper Jordan Valley, it resembles the early Epipalaeolithic sites of Ohalo II and Ein Gev I more closely than those of the Neolithic Munhata and Tel Teo. We take the composition of the assemblage from Eynan to indicate a transitory state of a permanent settlement which was not yet agricultural. The inhabitants of Eynan exploited the nearby habitats more intensively than earlier Epipalaeolithic sites, but still engaged in frequent hunting sorties away from the Hula valley. The assemblages from Early PPNB Motza and from Middle PPNB Motza and Yiftahel tend to cluster more closely with Epipalaeolithic than with other Neolithic assemblages. These assemblages do not form the extreme end of a continuous distribution of the first axis scores for Neolithic assemblages, but are complete outliers to their group. This can probably be linked with the
absence of domesticated sheep and goats from these assemblages. Since all the meat supply in PPNB Yiftahel and Motza had to be hunted, extensive use of habitats for this purpose had to be made, producing a signal very similar to that observed in Epipalaeolithic sites. In effect, the inhabitants of Motza and Yiftahel seem to have retained their traditional way of hunting well into the PPNB. Therefore, it seems that the pattern detected in the data analysed above falls within the dichotomy of hunter-gatherers versus hunter-farmers with domesticated stock. Cases which confound these ‘pure’ types, namely settled hunter-gatherers (Eynan) and settled hunter-farmers (Yiftahel and Motza), do not fall cleanly into the frame presented here.

The evolution of Neolithic hunting behaviours may be detected in additional aspects of the material culture. With the transition to the Neolithic, the use of microliths as arrowheads declined in favour of more robust forms (eg, Jericho and Byblos points; Gopher 1994), which were necessarily propelled by more powerful bows and mounted on longer shafts. This change suits well with the increase in frequencies of massive, ferocious and dangerous game animals like aurochs and boar; and also fits shorter, near-home hunting episodes, where prey needs to be...
brought down quickly by inflicting massive damage instead of being followed for many miles until it expires (possibly in someone else’s territory).

Also remarkable in this respect is the appearance of bull symbolism, so dominant in the Neolithic world of the Near East (Cauvin 2000; Goring-Morris & Kolska-Horwitz 2007; Hodder 2006; Verhoeven 2002, 2004). The preoccupation of PPNB Neolithic groups with aurochs is archaeozoologically evident in buccrania and feasting deposits (eg, Goring-Morris & Kolska-Horwitz 2007; Martin & Russell 2000; Sapir-Hen et al 2009). Given that the aurochs was laden with symbolic meaning, an ecological explanation for the increase in the frequencies of this taxon during the PPNB may seem simplistic. However, the fact that the frequency of wild boar also increases seems to support a mechanism other than intense hunting of aurochs for use in ritual to account for the shift observed in the frequency of large game.

The increase in the frequency of boar and aurochs in the large game assemblages from the PPNB naturally brings to mind the matter of the appearance of domestic forms of these two taxa in the following cultural phases in the southern Levant. Cattle were fully domesticated by the Late Neolithic (Grigson 1989; Horwitz & Ducos 2005), and morphologically-domesticated suids appear by the later Late Neolithic or the Early Chalcolithic (Wadi Raba Culture) in the southern Levant (Davis in press; Haber & Dayan 2004; Haber et al 2005). It is therefore remarkable that intensification in the use of these taxa as game preceeds domestication. If the hypothesis presented in this paper is correct, then a causal link between the intensification of aurochs and boar hunting and their following domestication may be drawn. It may be suggested that the interaction bringing about incipient domestication of aurochs and boar was the intensification of hunting caused by ‘huddling together’ of humans and beasts in limited habitats optimal for the way of life of all three taxa, once humans started practising agriculture.

This may sound similar to some extent to the ‘oasis theory’ proposed by V Gordon Childe (1961). Childe, however, thought that the occupation of oases by both man and beast was a result of severe drought; here we propose that it has been the introduction of farming, with the need for fertile alluvium and permanent water sources, which drove humans into the natural floodplain habitat of aurochs and boar. The stress on these game populations was not the result of climatic deterioration, but of more intense human hunting in these environments. Oases were not natural refuges where water and vegetation could be found, but the new foraging opportunities offered near human fields and settlements when the natural habitat rapidly deteriorated and gave way to fields.

Under these conditions of physical proximity, humans could learn the habits and ethology of aurochs and boar. As the exploitation of aurochs for feasting waxed and the supply of these animals near home waned, means were devised to draw the animals, tame them, and avoid the depletion of their populations. These activities initialise the process of domestication. Such conscious decisions to intervene in the population dynamics of boars and aurochs can be conceived as the necessary and well-rewarded choice to be made by hunter-farmers when their main prey taxa, bearing an economical and social meaning, were on the verge of disappearing from available hunting grounds.

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