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A Zooarchaeological Metadata Analysis of Animal Domestication in the Neolithic Northern Levant

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Introduction

The forager-farmer transition is one of humanity's most critical turning points. This transition coincided with the shift to sedentary societies, ultimately opening the door for rapid innovation and the rise of state-level civilizations within a few thousand years. Due to the relatively immediate consequences of this transition, much work has been directed at studying its multi-faceted components. One important facet of the transition to agriculture is the domestication of animals. Between 8,500 to 7,000 calibrated BCE in Southwest Asia, local populations shifted from a subsistence economy focused on acquiring wild animals to one focused on the management and ultimately the intentional reproductive control of full-fledged domestic animals (Vigne et al. 2005). Ultimately, the domestication of animals was crucial for providing stable primary and secondary animal products to local populations and ensuring stable access to animal resources (Sherratt 1981; Coppinger and Smith 1983; Zeder 2006). The success of sustenance acquisition had profound impacts on every aspect of the human experience including human fertility, settlement, and physical condition (Zeder 2012; Bouquet-Appel and Bar-Yosef 2008; Armelagos and Cohen 1984).

The northern Levant is of particular interest in the study of the forager-farmer transition as it is suspected to be home to the earliest dates for this shift. As a result, the core area model emerged to explain the origins of agriculture in Southwest Asia. This model proposes that the coalescence of all wild progenitors of domestic Southwest Asian crops in this region and their early date implies a single location for the domestication of these species. From this event, agriculture is theorized to have gradually radiated outwards to the rest of Southwest Asia (Lev-Yadun et al. 2000; Peters et al. 2005). Since this model was proposed, however, new evidence has emerged across Southwest Asia suggesting this account is not as accurate as once thought. In recent years, the ability of MtDNA to trace and date maternal lineages of domestic animals, as well as new guidelines for what is considered wild versus domestic and more focus on local variability rather than region-scale similarities has drastically changed the picture of domestication in the region (Bruford et al. 2003; Zeder 2006; Arbuckle 2014). The new data sets have given rise to a multiregional model of animal domestication, which theorizes that wild progenitors were domesticated in multiple regions independently (Fuller et al. 2011; Zeder 2011).

As researchers gradually shift from a core to multiregional interpretive framework, the focus is increasingly on exposing variation among archaeological sites on the local scale (cf. Connolly et al. 2011; Munro et al. 2018; Stiner et al. 2014). Site-level analyses provide excellent insight into local patterns, events, and trajectories of development that are lost when the resolution is lowered as required from a larger regional study. Nevertheless, it is important not to lose track of the importance of stepping back to examine larger patterns on a regional scale. Larger scale analyses allow us to investigate the timing of the shift to animal management across the northern Levant and to compare it to other regions to provide a fuller picture of the transition to agriculture across Southwest Asia. As more data continues to be compiled, the picture of the origin and spread of domesticates evolves from year to year, as more in-depth questions are answered, and interpretative frameworks gain and lose ground. With this in mind, this study aims to provide a larger updated examination of the existing data in the northern Levant through the comparison and synthesis of numerous archaeological sites.

This thesis is a metastudy—it examines a compilation of published NISP (number of identified specimens) data for animals hunted or managed by humans and discarded in archaeological sites spanning the Epipaleolithic through the Pottery Neolithic periods (See

Figure 1) in the northern Levant. The goal is to investigate the relative sequence of events that led to the domestication of animals in this region and to deduce the timing of the shift from hunting to animal management. To do so, this study adopts a behavioral ecological approach to guide the interpretation of this dataset. Human behavioral ecology provides the necessary tools to explain not only when humans made this transition, but to interpret the changes in the types of animals that they consumed (Smith et al. 1983; Stephens and Krebs 1986). Understanding the tradeoff between the cost/benefits needed to search for, procure and prepare wild animal prey versus the cost/benefits of managing and raising domestic animals helps to understand why humans made this transition when they did. The analysis features indices of high- versus low-ranked animal taxa that track changes in human foraging efficiency as well as the tradeoff between wild and managed populations in human diets (Stephens and Krebs 1986; MacArthur and Pianka 1966).

Background

The earliest evidence for the domestication process is particularly difficult to detect in the archaeological record since no immediate morphological changes are expected to differentiate managed from wild populations when people first began to experiment with animals (Zeder 2011). This challenge is only amplified by the gradual nature of domestication (Arbuckle 2014). To examine how people first began this process, a number of markers can indicate different degrees of human control and management. These include age and sex profiles, bone pathologies and morphological changes, as well as secondary archaeological evidence such as dung deposits. (Payne 1973; Stiner 2014; Zimmermann et al. 2018; Zeder 2012; Clutton-Brock 1992; Meadow 1984). Nevertheless, revealing the stages of domestication in practice is very difficult, especially in the early stages. Some localities within the northern Levant in particular pose a unique challenge, as many wild progenitors of domestic animals are found in the region, and as seen through this study, were intensively hunted prior to the shift toward animal management practices (Peters et al 2005). As a result, it is important to harness a variety of methods to detect the various stages in this process.

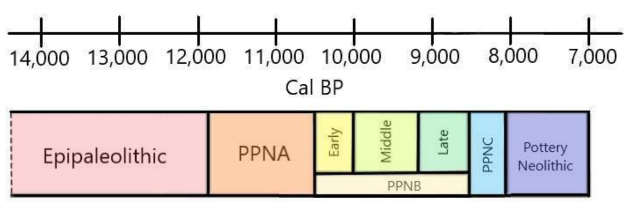
The first critical shift is from hunting to human control over the movement of animal taxa with appropriate characteristics for human management. To detect this stage, the relative abundance of ungulates that were ultimately domesticated by humans is particularly useful. Certain species such as sheep, goat, cattle, and pig have characteristics that are more amenable to human management than others and they are expected to grow in frequency in comparison to typically hunted ungulate species when humans first start to control and ultimately manage these populations (Zeder 2012, Connoly et al. 2010, Munro et al. 2018). In a similar manner, age and sex profiles are useful to examine later shifts from wild to managed populations, as humans use unique culling patterns to maximize the cost/benefits of desired animal products when they first begin maintaining wild populations (Payne 1973, Hesse 1982). Finally, once animals are fully domesticated, distinct morphological characteristics (such as twisted horn cores and body-size diminution) can be used to distinguish wild and domestic populations (Clutton Brock 1992, Zeder 2011).

The very beginning of the domestication process was likely characterized by a shift to the capture of animals with characteristics that are amenable to management and domestication (Arbuckle 2014, Zeder 2012). Therefore, an increase in the relative taxonomic abundance of these animals is a good way to capture this trade-off from wild to managed animals. This analysis aims to understand the pace and timing of domestication. In addition, models from behavioral ecology are useful to show the background conditions for this change—i.e., how intensively humans were hunting animals when they were first domesticated. The prey choice model assumes that humans will maximize the net benefits when foraging. The cost/benefits of hunting are measured by ranking prey based on their return rates (often measured in calories per unit time) after the costs of acquisition and processing are accounted for. This equation considers prey body size as a proxy for caloric returns, and the costs required to track, catch, kill, and prepare the item. For example, slow animals cost less to hunt and capture than fast animals and therefore are higher ranked than animals of similar body size with higher rates of capture. Larger animals are also often higher ranked than smaller animals based on their higher caloric return for the energy invested in hunting. Therefore, narrower diets focused on high-ranked prey are most cost-effective (high foraging efficiency) and reflect lower hunting intensity when compared to a broad diet that incorporates more low-ranked prey (Smith et al. 1983; Macarthur and Pianka 1966; Stephens and Krebs 1986; Winterhalder 1981). Indices tracking the cost-benefits of the diet are useful for examining the hunting intensity of humans living in the region immediately preceding and during the early stages of the domestication process. By comparing indices that plot the proportion of high-ranked prey types to lower-ranked prey types, it is possible to detect changes in hunting intensity over time to determine the conditions from which animal domestication emerged (cf. Stiner and Munro 2002; Munro 2004)

Through the examination of these indices, several measures can be investigated to support or reject the hypotheses that animal domestication occurred slowly, locally, and with many trials and errors: the main goal being the analysis of the trends in hunting intensity, and prey and ultimately livestock relative abundance in the existing northern Levantine data. First, relative abundance and diversity indices are analyzed. Then, the pace and characteristics of animal management in the northern Levant are considered based on these trends. Finally, these trends are compared to similar results from adjacent regions.

Methodology and Sample Selection

Over the past five decades, numerous in-depth zooarchaeological analyses have been conducted at archaeological sites, providing detailed NISP data sets to examine. Since these analyses are intensive and time-consuming, it is only recently that metadata studies to analyze local and regional trends have been possible (cf. Connoly 2011; Martin and Edwards 2013, Munro et al. 2018). A comprehensive inquiry into the published literature revealed 17 sites in the northern Levant with sufficient samples of identified faunal remains (NISP total >100) within the time frame that encapsulates the transition to agriculture and the beginning of animal domestication (Epipaleolithic to Pottery Neolithic). Of these 17 sites, several spanned multiple time periods based on chronological information in the original published reports. In this study the time periods were defined following data from published material used in the creation of the database, as well as the following figure (adapted from Zeder 2009) (Fig. 1)



PPNA: Pre-Pottery Neolithic A; PPNB: Pre-Pottery Neolithic B; PPNC: Pre-Pottery Neolithic C

Fig. 1 Timeline of periods examined and their corresponding dates (cal BP)

To track change over time, each assemblage was divided into the time periods represented at that site. This produced 23 discrete faunal assemblages each representing one site and one time period.

Taxonomic categories used by zooarchaeologists who wrote the reports were also highly variable making it difficult to combine these into groups, and then into a single database. Comparing data collected by different researchers is complicated by inter-analyst variation in how taxonomic categories are recorded. Before indices could be created from these data sets to track changes in hunting intensity, several decisions had to be made regarding the best method to combine the taxonomic groups used by the zooarchaeologists who wrote the original reports. The first problem concerned how to distinguish the animals in the assemblage that were ultimately domesticated, since it is often impossible to determine whether they are wild or domestic, especially in the initial stages of animal management. Because of this, the goat (*Capra sp*), sheep (*Ovis sp*), cattle (*Bos sp*), and pig (*Sus scrofa*) categories combine animals that may be wild, managed, or fully domesticated. For the sake of simplicity, the term "domesticates and their progenitors" will be used in this paper when addressing these groups of ungulates since it is unclear whether the populations are wild, managed, or domesticated.

To resolve inconsistencies, it was necessary to broaden taxonomic categories so that similar taxa could be combined when researchers had assigned them to different levels of taxonomic specificity. For example, while some publications identified remains from the family Testudinidae to the species level, most did not, thus these were collapsed into the broader Testudinidae category. The final major act of data compression was aimed at reducing the amount of noise in the data set. Many faunal categories contained only a few specimens. Therefore, taxa within the same genus were combined if they were rare in the assemblage (i.e. *Erinaceus europaeus, Erinaceus concolor*, and *Erinaceus sp.* were combined into *Erinaceus sp.*)

Seven indices were created to track the tradeoff between wild and domestic animals and hunting intensity over time. Hunting intensity was analyzed by considering the proportion of the lowest-ranked taxon in a group, since low-ranked taxa are less cost-effective than high-ranked taxa, hunting intensity increases with the proportion of low-ranked taxa (Stephens and Krebs 1986; MacArthur and Prianka 1966; Munro 2004; Davis 2005). One index focuses on the abundance of gazelle out of all ungulates. The gazelle is the smallest-bodied animal in the assemblage and is thus the lowest-ranked of the ungulate resources. This index, therefore, provides a measure of hunting intensity: a higher index value will represent higher hunting intensity. The abundance of small game in the assemblage provides an independent marker of hunting intensity. These animals have small body sizes and are thus lower ranked than their ungulate counterparts. Therefore, like with gazelles, higher proportions of small game indicate higher hunting intensity. The next group of indices examined taxonomic tradeoffs, including the proportion of domestic ungulates and their progenitors out of total ungulates, carnivores out of the total assemblage, and once again, small game out of the total assemblage. In comparison to one another, these indices show the decline in wild taxa in favor of ungulates, and specifically domestic ungulates and their progenitors. Graphs showing the relative abundance of the primary ungulate taxa in the ungulate fraction (cattle, pigs, caprines, gazelle, and cervids) were also created to track the relative importance of the species that were ultimately domesticated (goat, sheep, cattle, and pigs) in the diet, since increased dependence on these animals may suggest growing control and ultimately management. Finally, the reciprocal of Simpson's Diversity Index: $\frac{1}{\Sigma[\left(\frac{Species\ NISP}{Total\ NISP}\right)^2]}$, a measure of species evenness and richness (Simpson 1949), was calculated for ungulates and small game. It is expected that diversity in both categories will narrow with domestication, as people begin to rely more heavily on the very specific taxa that will become domesticated and ultimately on ungulate domesticates. A decrease in small game and ungulate diversity emphasizes the decreased reliance on wild game species.

Results

Gazelle/ Ungulates

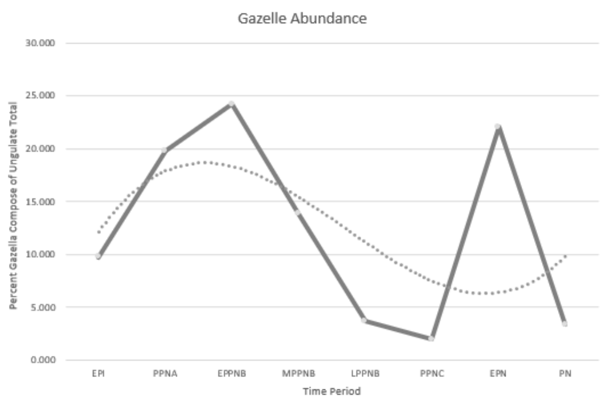


Fig. 2 Average proportion of gazelle to total ungulate NISP in each time period

The Gazelle abundance data provides an index of hunting intensity. Gazelle are more intensively hunted from the Epipaleolithic to the onset of the Early Pre-Pottery Neolithic B, indicated by a rise in their numbers from roughly 9% to 25% of the total assemblage. This early increase may be disproportionately driven by the results from PPNA Gobeklitepe, reporting around 56% gazelle of the total ungulates (Peters and Schmidt 2004), and Tell Aswad in the EPPNB reporting around 38% (Helmer and Gourichon 2017), while the rest of the sites report less than 10% at this time. Regardless, after the EPPNB, gazelle abundance rapidly drops off to a level lower than in the Epipaleolithic. By the Late Pre-Pottery Neolithic B, gazelle decreased to just below 5% of the total ungulate assemblage, and declined even further by the Pre-Pottery Neolithic C, to about 2%. Interestingly, this decline is interrupted briefly in the Early Pottery Neolithic when gazelle abundance rises sharply to above 20%. By the Pottery Neolithic, the proportion has returned to its previous level below 5%.

Small Game (excluding Aves)/ Total Game

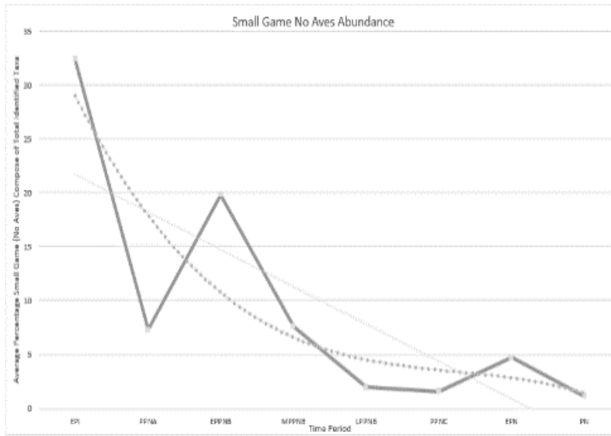


Fig. 3 Average proportion of small game (excluding aves) to total assemblage NISP for each time period

The small game follows a unique trend, although the overall pattern is one of long-term decline. Small game abundance is very high in the Epipaleolithic but declines substantially from about 32.5% to about 7.5% in the following period (PPNA). However, unlike other taxonomic groups, it immediately rises steeply again to roughly 20% in the EPPNB. There is a very large fluctuation in the data in the first three time periods, and there does not appear to be any outliers in the data that would cause this. After the EPPNB, small game abundance decreases over time until it reaches an all-time low in the PPNC, at about 2%. A number of species drive this decline, including beaver and hedgehog which fully disappear from the record at this time, as well as hare, birds, and reptiles which together decrease across all of the sites and time periods examined. Following another slight increase to 5% in the EPN, the small game returns to its previous low.

Carnivores/ Total NISP

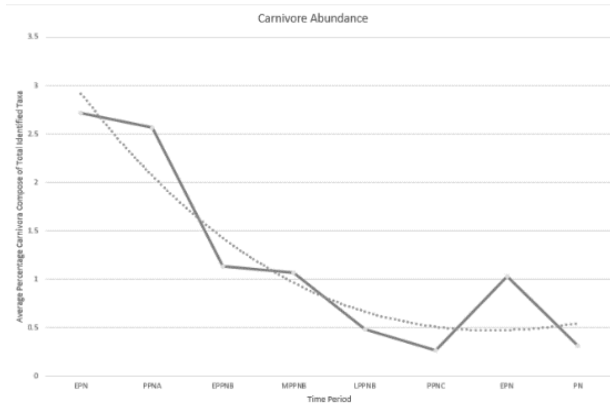


Fig. 4 Average proportion of carnivore taxa to total assemblage NISP for each time period

Carnivores never comprise a large proportion of the total assemblage. Even so, there is a relatively steady decline in the proportion of carnivores in the assemblage. While some taxa such as fox decline rapidly through time, other species such as bear disappear from the record altogether. Falling from above 2.5% in the Epipaleolithic to under 0.5% in the PPNC, there is clearly a decrease in the interest in hunting this group of wild taxa. However, in the EPN, the proportion of carnivores almost doubles—a surprising increase like that seen in gazelle. Rising from less than 0.5% in the PPNC to roughly 1% in the EPN, there is an evident increase in carnivore hunting for a period of time before it declined once again to below 0.5% in the Pottery Neolithic.

Domestic Ungulates and their Progenitors/ Ungulates

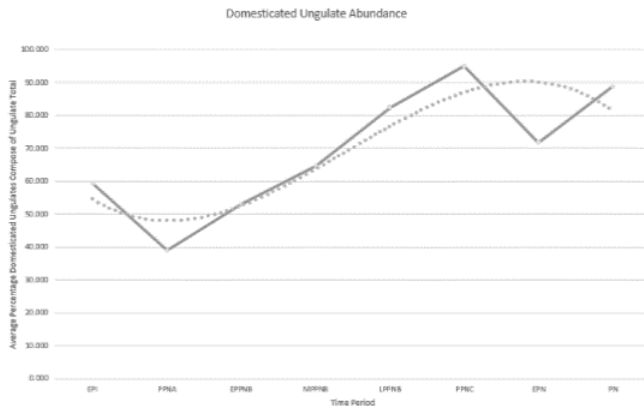


Fig. 5 Average proportion of domesticated ungulates to total ungulate NISP for each time period

The animals that were ultimately domesticated decreased from the Epipaleolithic through the Pre-Pottery Neolithic A. From this low, the proportion of these ungulates increases steadily from the PPNA to the PPNC. The proportion of domesticated ungulates out of total ungulate abundance in this time span rises 55%, from 40% in the PPNA to 95% in the PPNC. All four core domesticates (cattle, pig, goat, sheep) increase dramatically in this time frame, with cattle and pig occurring consistently at every site beginning in the EPPNB. There is another decrease in the domesticated ungulate proportion, falling to around 70% in the Early Pottery Neolithic, but this returns to near PPNC proportions by the Pottery Neolithic.

Wild Game Diversity

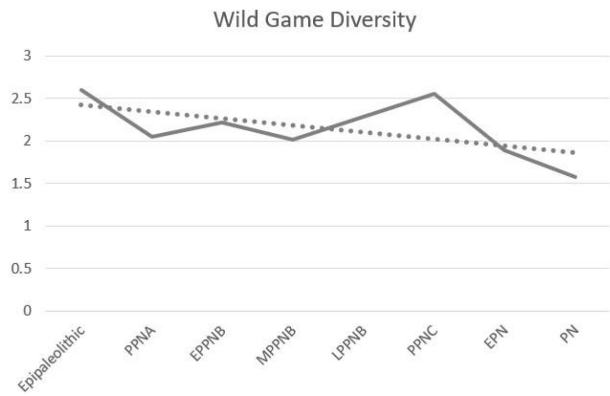


Fig. 6 Simpson's Index calculated for small game (excluding aves) and averaged for each time period

Small game diversity, a combined measure of the richness (number of taxa) and evenness (distribution of taxa) of taxa in each time period (Simpson 1949), steadily declines throughout the sequence. Beginning with a reciprocal of Simpson’s Index of 2.5 in the Epipaleolithic, there is a clear decline in the index to 1.5 by the end of the sequence to 1.5 in the PN. While this trend declines fairly steadily, there is a discrepancy around the LPPNB/PPNC, with a sharp jump in the proportion of wild game reaching back up to the original levels of 2.5. This may be driven by the data from Gritille in the LPPNB (Monahan 2000), which reports a significant proportion of fish and mollusks in the LPPNB, among a variety of other taxa not reported in other sites in the EPPNB and MPPNB. It is unclear what is driving the increase in the PPNC; however, this data point is represented by only one site, Mezraa Teleilat (Ilgezdi 2008), and may result from sampling constraints. Regardless, this index shows a steady restriction in diversity throughout the sequence, as people rely less and less on wild game.

Ungulate Proportions

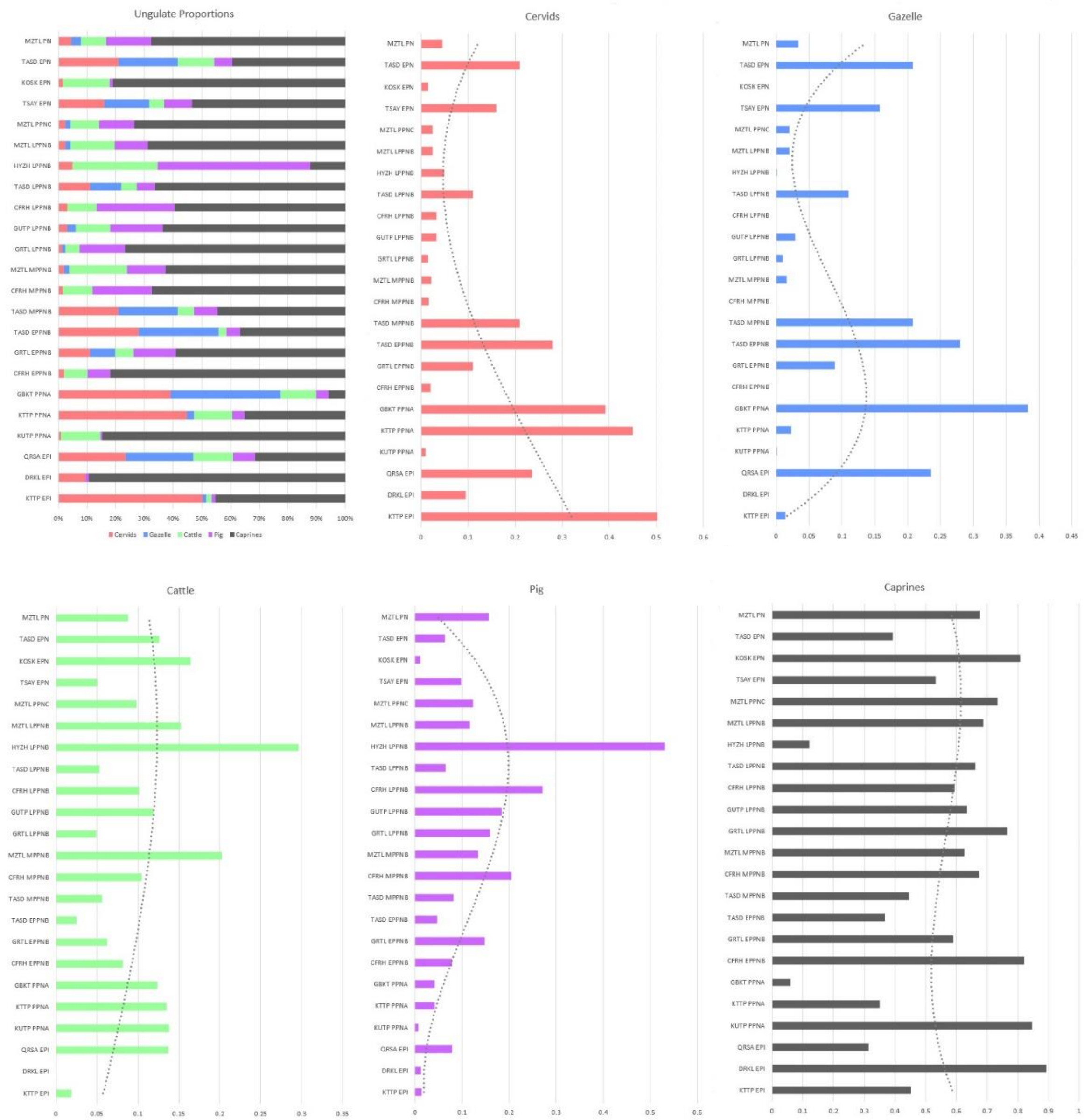


Fig. 7 Proportion of each ungulate taxa to total ungulate NISP for each site and time period

Figure 7 provides a breakdown of the most common ungulate taxa and time period arranged in temporal order from oldest to youngest from bottom to top. Caprines were a favorite across the entire span of time with the exception of a few select sites. However, there is a clear drop in the most common wild ungulate taxa, the cervids and gazelle, over time, while the taxa that were ultimately domesticated, cattle and pigs, increase over time though not as much as caprines. Cervids are very prevalent in the earlier time periods, comprising up to 50% of the assemblage in the Epipaleolithic. The broad downward trend in this taxon is interrupted by a slight increase in the Early Pottery Neolithic. Gazelle do not follow the same exact trend, as they decline during the PPNB and then increase significantly at a number of later sites. Cattle remain fairly stable over time, only increasing slightly on average through the temporal span. Pigs are nearly absent from earlier assemblages but gradually increase in abundance through the Neolithic. There is no clear trend in the caprines, as they make up a majority of the assemblage in each time period whether they are wild or domestic. In some time periods, there is extensive variation in the relative abundance of taxa from site to site, likely due to geographic differences in taxonomic representation, or issues in preservation or reporting.

Discussion

In the northern Levant, the emergence of new relationships between humans and animals can be investigated by considering changes in human hunting intensity and determining the timing and nature of the tradeoff between wild and domesticated animals. Detecting the early stages of animal management is quite difficult in this region because there is considerable overlap in the taxonomic composition of the wild and domesticated economies. Notably, the wild progenitors of the primary domesticates (wild sheep, wild goat, wild cattle, and wild boar) are native to the northern Levant and were hunted extensively during the Epipaleolithic before the initial shift towards animal management began (Peters et al. 2005, Arbuckle 2014). These animals were ultimately domesticated, but determining the point at which hunting ended and management began is very difficult since the earliest stages of the management status of ungulates cannot be easily established through direct osteological evidence (Zeder 2001).

Therefore, analyzing the hunting intensity and changes in the relative abundance of animals used by humans provides the best insight into this early phase. Data concerning both the animals that were domesticated and those that were not such as small game, gazelle, and carnivores are equally important, and provide different sides of the same story, adding more nuance to the overall picture.

Changes in Hunting Intensity

The human-environmental relationship surrounding the onset of animal management practices is critical for not only investigating how animal domestication emerges, but why. Specifically, measurements of hunting intensity are important for analyzing the shift in animal management practices as they provide information regarding the background conditions from which these practices emerged. Some have proposed that animal domestication emerged out of rich resource availability and competitive feasting (Hayden 2003). Recent studies in neighboring regions, however, have cited imbalances between the availability of wild resources and human population as a driving force behind increased hunting intensity and the emergence of animal management practices (cf. Davis 2005; Munro et al 2018; Stiner et al 2014). To examine this phenomenon in the context of the northern Levant, indices tracking low and high-ranked prey are analyzed following a behavioral ecological approach to reconstruct trends in hunting intensity, and therefore the conditions from which animal management emerged, i.e. a time of resource limitation or abundance.

In this study, gazelle and small game abundance indices provide suitable measures of hunting intensity across the time periods examined. In relation to other ungulates and larger game, gazelle and small game comprise the low-ranked taxa prominent at the sites included in this study. In examining these indices, there is evidence that the proportion of the lower-ranked taxa are most prevalent in the earliest time periods in the sequence, but then decrease in abundance over time, in other words, hunting intensity declines. Notably, gazelle proportions are high in the earliest part of the sequence, even rapidly increasing from the Epipaleolithic to the EPPNB, before beginning to decline, while the small game start relatively high and decrease through the sequence apart from an uncharacteristically rapid drop in the PPNA. The extreme nature of this drop in the PPNA is surprising and may result from anomalies in the data. Even so, at the beginning of the sequence, the proportion of low-ranked taxa in the total assemblage in relation to later periods suggests there are more intensive hunting practices than later on. Given the small body size and low rank of these prey, this implies an imbalance between humans and resource availability in the early periods, which may be related to the adoption of higher-ranked prey animals through animal management (Stephens and Krebs 1986; Macarthur and Pianka 1966). After the EPPNB, there is a clear and consistent decrease in both of these indices. The correspondence between this shift and the increase in animals that were ultimately domesticated may suggest that the onset of animal management relieved hunting pressure (Stephens and Krebs 1986). This release implies a fundamental shift in subsistence acquisition strategies occurring by the EPPNB.

To more closely examine what this means in terms of the emergence of animal management practices, it is helpful to examine the trends within the higher-ranked ungulate group, specifically the proportions of domesticated ungulates and their progenitors in relation to animals that were never domesticated. As seen in Figure 5, the PPNA/EPPNB shift coincides with a dramatic increase in such taxa. When hunting is more intensive around the PPNA/EPPNB boundary, domestic progenitors are less common. This line of evidence provides further support for the hypotheses that hunting intensity releases around this time, and that this coincides with the onset of animal management practices, specifically an increased focus on ungulates that were ultimately domesticated. Based on these indices, it is possible to conclude that in the northern Levant, animal management practices emerged from an extensive background of hunting intensity and that intensive hunting was released with the uptake of animal management.

Taxonomic Tradeoffs

To better understand this shift, it is important to examine the specific taxonomic tradeoffs driving these trends before, during, and after the clear release in hunting intensity. Overall, the data shows a continual increase in the proportion of domesticates and their progenitors at the clear expense of wild taxa across the sequence. The progenitor taxa of the core domesticates (cattle, pig, goat, sheep) are native to the region (Peters et al. 2005), and as seen above, they are prominent aspects of the subsistence economies during pre-domestic periods as well (Epipaleolithic, PPNA). Because these taxa are abundant from early on, it is especially difficult to determine whether this pattern is a shift in hunting strategies or management practices (Zeder 2011).

Despite their early prevalence, these taxa still increase throughout the sequence. This is especially clear in the proportions of pig and to a lesser extent, cattle, which are more minor aspects of the earlier wild diet but gradually increase in abundance during the domestication process. Caprines remain important taxa through the entirety of the sequence with no clear increase or decrease overall. This reflects their early importance in hunting as well as their significance in the domestic economies of the later Neolithic. As it is somewhat difficult to detect an increase in the proportion of individual domestic taxa besides pig, the decline in gazelle

(Figure 2, 7) and cervids (Figure 7) is especially useful to further illustrate the increase in reliance on domesticates and their progenitors. As gazelle and cervids were never domesticated, their notable absence in later periods is a clear indication of the abandonment of wild taxa through time. People begin to move away from wild taxa in favor of the animals that would become domesticated.

To further ensure that this tradeoff between wild and domestic taxa represents the beginnings of animal management, it is important to also examine the patterns within the non-ungulate portions of the data. The wild game indices depicting trends in small game and carnivore abundance (Figures 3 and 4), show a clear inverse relationship with the patterns shown in the ungulate data. Wild small game and carnivore taxa decline through the sequence while domesticated ungulates and their progenitors rise within the ungulate fraction. More specifically, domesticated ungulates show a brief decrease in the PPNA, before rapidly increasing through the rest of the sequence. In comparison, abundance data from the carnivores shows somewhat of a plateau before the PPNA, before rapidly declining after this time period. The small game abundance data rapidly decreases in the PPNA before unexpectedly rising in the EPPNB and once again rapidly declining through the rest of the sequence. In the ungulate index domestic ungulates and their progenitors are measured only in terms of the total ungulate assemblage. The other two wild indices are compared against the total NISP of all taxa in the assemblage making this an independent measure. It is especially important, therefore, that a clear inverse relationship occurs. This suggests that there is not only a reduction in the use of wild gazelles and cervids, but also in the overall abundance of the wild small game and carnivore components of the assemblages. This supports a scenario of animal management practices rather than a change in hunting strategies as wild game nearly disappears.

The trends in the wild game diversity data also support this interpretation. The results from the reciprocal of Simpson's Index for wild game diversity show an overall decrease in the diversity of wild taxa through the sequence. While there are some discrepancies as summarized above, this overall decline in wild game diversity suggests that people are narrowing their diets to focus on domesticated taxa. This is not a complete shift, as people tended to keep some aspects of a wild diet as supplements in an economy mostly focused on domesticates. However, the overall narrowing of diversity through time shows the shift away from these taxa, which, as seen above, were replaced with domesticated ungulate taxa.

Despite these broad trends, there are some anomalies in the results. The clearest example is the interruption of the trends in many of the indices in the EPN. These anomalies may be related to the smaller sample sizes of the EPN site on average (<1000 NISP). Therefore, any slight increase or decrease in the NISP of specific taxa will have a more profound impact on the final results than the other sites with larger samples. It is also possible that the sites selected for this time period have unique trends specific to the local context that have created discrepancies in the overall pattern. Two of the three sites, Köşk Höyük and Tell Aswad, are on the northwestern and southern edges of the range examined, which may have resulted in unique geographic conditions that emerged in the data, such as the variation in proportions of gazelle or small game. Regardless of these anomalies, there is clear overall evidence that the taxonomic tradeoffs reflect a shift in the economic focus toward animals with the right characteristics for domestication and that a corresponding release in the intensity of hunting, occurring between the Epipaleolithic and the EPPNB. Along with the evident decrease in wild game such as certain ungulate taxa and carnivores, and the increase in domesticates and their progenitors, the timing of this tradeoff solidifies the hypothesis that animal management emerged around the PPNA/EPPNB transition.

Inter-regional Comparisons

This study shows some similarities in human hunting intensity and the onset of animal management in the northern and southern Levant. As seen in the northern Levant through the indices examined above, there is a tradeoff between wild and domestic game, as well as a release in hunting intensity beginning around the PPNA/EPPNB boundary. While this is slightly earlier than in surrounding regions (Munro et al. 2018, Stiner et al. 2022), relative abundance data shows that the timing is more similar than was once understood (Lev-Yadun et al. 2000, Peters et al. 2005). In the northern Levant, small, low-ranked, wild taxa experience a sudden decline in prevalence as they are replaced by larger-bodied ungulate taxa that ultimately become domesticated around the transition between the PPNA and EPPNB. This same pattern occurs in the southern Levant, as small game similarly declines and is replaced by large-bodied ungulates around the EPPNB. As described by Munro et al. (2018) in the southern Levant, this shift is significant as it disrupts nearly 1,000 years of intensive hunting practices. The data presented above supports the notion that this shift in management practices emerged out of a period of intensive hunting as well. It is clear that a region-wide shift occurs by the EPPNB, yet in the northern Levant it is unclear whether this shift happens slightly earlier, in the PPNA, as the small game drops rapidly at this time but there are too many early discrepancies among the other indices to be certain.

While a large-scale metadata analysis has not been conducted in central Anatolia, to the northwest of the northern Levant, since there are few Epipaleolithic and Neolithic sites in this region, comparative data has been examined from a handful of sites in the period of interest. In central Anatolia, strong evidence from compacted animal dung, relative taxonomic abundance, caprine age and sex distribution patterns and pathological features on the ankle joints indicates that sheep and likely goat were being confined at least at the site of Asikli Hoyuk by the MPPNB (Stiner et al. 2022; Zimmerman et al. 2018; Payne 1973; Stiner 2014; Zeder 2012; Clutton-Brock 1992; Meadow 1984). Therefore, the first shifts in animal management practices had to have come just before or around this time period. In addition, evidence suggests new culling patterns from the MPPNB onward. The presence of an abundance of juveniles in the earlier periods followed by a shift to more prime-aged adults in the later periods shows a fundamental change in animal management strategies. It appears that domestication has taken place by the MPPNB, meaning that there must have been earlier, experimental animal management practices, perhaps on the scale of the Levantine data, before this, in the EPPNB (Stiner et al. 2022). Due to the nature of the data, no further conclusions can be drawn.

The northern Levant, the southern Levant, and central Anatolia compose a large portion of Southwest Asia. This region is notable for being the location outlined in the Core Area Model, hypothesized to contain the earliest dates for domestication (Lev-Yadun 2000, Peters et al. 2005). As seen through the analysis of the indices created in this project, as well as the comparison between the other regions, the very beginning of animal management may have emerged slightly earlier in this region, but not as early as had previously been suggested when only later stages of the animal management process were considered. Given the challenges of determining the exact timing of the onset of domestication or even exactly when an animal can be considered domesticated, this picture may continue to change. It is possible that the dates for central Anatolia may be even earlier than the Levantine data, however, the published sequence does not extend far enough back to observe this. In all three regions, it is possible that animal management emerged at roughly the same time, in the Early Pre-Pottery Neolithic B.

Conclusion

Through the examination of a variety of indices tracking the pace, timing, and characteristics of taxonomic abundance data across the northern Levant, it is possible to deduce the approximate timing of the beginning of the shift from an economy focused on wild hunting to one focused on animal management. Using a combination of indices representing proportions of low and high-ranked prey, wild versus domestic game, and taxonomic diversity, there is evidence to support a shift in subsistence acquisition strategies emerging around the PPNA/EPPNB in the northern Levant. When compared to similar studies in the southern Levant (Munro et al. 2018) and central Anatolia (Stiner et al. 2022) a region wide pattern emerges. It appears as though across the region animal management begins to emerge around the EPPNB. While evidence suggests this transition may have emerged slightly earlier in the northern Levant, it is not as significant of a difference as previously hypothesized by the core area model (Lev-Yadun et al. 2000, Peters et al 2005).

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