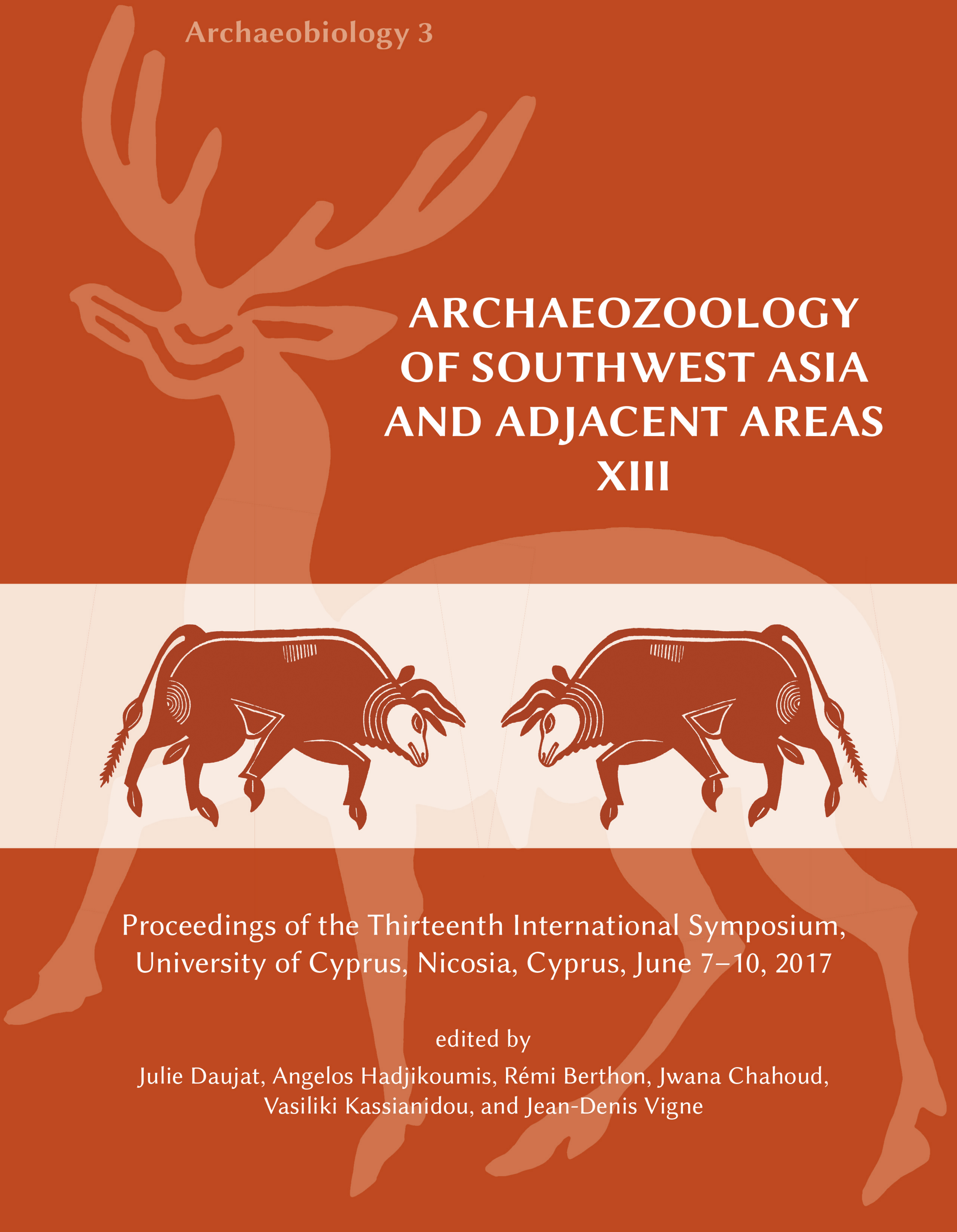

Archaeobiology 3

# ARCHAEOZOOLOGY OF SOUTHWEST ASIA AND ADJACENT AREAS
## XIII

Proceedings of the Thirteenth International Symposium,
University of Cyprus, Nicosia, Cyprus, June 7–10, 2017

edited by
Julie Daujat, Angelos Hadjikoumis, Rémi Berthon, Jwana Chahoud,
Vasiliki Kassianidou, and Jean-Denis Vigne

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# Archaeobiology

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Number 3

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# FOREWORD

The 13th ASWA conference was hosted by the University of Cyprus, one of the youngest of Europe's universities. In 2019, it was only thirty years since its foundation. Nevertheless, this is a thriving academic institution, which currently consists of eight faculties, twenty-two departments, and eleven research units.

In 1991, and just two years after the university's foundation, the Archaeological Research Unit (ARU) was founded by decree from the Government of the Republic of Cyprus, following the issuance of the dependent legislation by the House of Representatives. The decision to establish the ARU was based on the recommendation of the Interim Steering Committee of the University of Cyprus, which stated the following:

1. Cyprus is offered for primary research in the field of archaeology thanks to its distinctive cultural signature and history, as well as due to the fact that Cypriot archaeology and archaeological research on the island already has a distinguished tradition and international reputation;

2. The subsequent international recognition of the importance of archaeological research in Cyprus should comprise one of the first incentives for choosing the University of Cyprus as a center for postgraduate studies, and will pave the way for the exchange of students and academics between the University of Cyprus and academic institutions overseas.

The faculty members of the ARU, who are also part of the Department of History and Archaeology academic staff, have contributed immensely over the past 28 years to the achievement of the aforementioned objectives for the study and promotion of Cypriot cultural heritage through their research, their teaching, and the practical training they have been providing to students at undergraduate and postgraduate levels. The active study of other regions of the Mediterranean world have not been overlooked either, as members of the ARU academic staff have been carrying out excavations and research projects in Greece, Turkey, and France.

The members of the ARU are actively carrying out research in Pre- and Protohistoric Archaeology, Classical and Byzantine Archaeology but also Archaeometry and Environmental Archaeology, Maritime Archaeology, and Western Art. In the course of the past 28 years, the ARU has laid very stable foundations in all aforementioned specialisations of the archaeological discipline, none of which existed at academic level in Cyprus before the unit's establishment. Through their teaching at undergraduate and postgraduate levels, all members of the ARU academic staff have been contributing to the formation of a new generation of Cypriot archaeologists, equipped with all the necessary knowledge and practical experience needed to excel in this scientific field.

Over the years, the ARU has been very active in organizing international conferences and workshops. The ARU has organized over 50 international conferences, while members of the academic staff have published the proceedings of over 20 scientific meetings held at the ARU.

Thus, when Jean-Denis Vigne came to my office several years ago with the suggestion to co-organize the 13th Archaeozoology of Southwest Asia and Adjacent Areas conference I gladly accepted. The meeting in Nicosia brought together colleagues from all over the world and offered a venue where new results from the field or the laboratory could be presented and discussed. The publication of the conference proceedings enables colleagues who were unable to attend the conference to read about the latest developments in the archaeozoology of this culturally important region.

I would like to close by thanking all the members of the 13th ASWA organizing committee for all the work they have put into bringing so many scholars to Cyprus, many of them for the first time. I would also like to thank the co-editors of this volume for all the work they have put into the publication of the proceedings.

Professor Vasiliki Kassianidou
Director of the Archaeological Research Unit,
University of Cyprus
Nicosia, August 2019

# EDITORS' PREFACE

Due to their location at the meeting point of the three Old World's continents—Africa, Asia, and Europe—Southwest Asia and its adjacent areas played a pivotal role in the history of humanity. They received successive waves of our species—*Homo sapiens*—out of Africa. Different processes in several areas of this large region brought about the transition to the Neolithic, and later on the urban revolution, the emergence of empires bringing with them important subsequent religious, cultural, social, and political consequences. Southwest Asia also played a major role in the interactions between East (Asia) and West (Europe) during the last two millennia. The unique importance of Southwest Asia in the history of humanity is strengthened by the, also related to its location, fact that this area is a hotspot of biodiversity, especially in mammals, which were—as everywhere in the world—tightly associated to the history of civilizations in a diversity of roles: game, providers of meat and milk, traded raw material, symbol of prestige and wealth, pets, etc.

Everywhere in the world, the biological and cultural interactions between humans and animals often remain under-evaluated in their heuristic value for understanding complex social and biological interactions and trajectories. This is why, almost half a century ago, archaeologists who were carrying out research and reflecting on such themes founded a very active nonprofit world organization named the International Council for Archaeozoology (ICAZ). This is also why the ICAZ working group "Archaeozoology of Southwest Asia and Adjacent Areas" (ASWA[AA]) was one of the first ones created within ICAZ, constituting one of the largest and most active of ICAZ's working groups.

The ASWA[AA] was formed during the 1990 ICAZ International Conference in Washington, D.C. Its purpose is to promote communication between researchers working on archaeological faunal remains from sites in western Asia and adjacent areas (e.g., Northeast Africa, Eastern Europe, Central Asia, and South Asia). It carries out its mandate mainly through the sponsoring of biennial international conferences. Since 1998, these meetings have alternated in being hosted in Europe or in Southwest Asia: Paris (1998), Amman (2000), London (2002), Ankara (2004), Lyon (2006), Al Ain (2008), Brussels (2011), Haifa (2013), Groningen (2015).

Ongoing armed conflicts and political tensions in several countries of Southwest Asia made it difficult to locate a safe and convenient place that would enable the organizing the 13th ASWA[AA] meeting in within that region. Although Cyprus is currently a member of the European Union, in (pre-)history Cyprus was embedded in the eastern Mediterranean "world." Because of its location, Cyprus was indeed at the confluence of African, Levantine, Anatolian, and Greek cultural streams and, as is common for islands, recombined them in different but always original ways all along its history. Archaeozoology recently provided one of the most convincing illustrations of the tight connection between Cyprus and Southwest Asia, demonstrating that the earliest domesticated mammals, especially cats, pigs, cattle, sheep, and goats, were introduced to the island very shortly after their first incipient domestication on the near continent, that is, during the ninth millennium BC. For all these reasons, Cyprus represented an ideal place to host the 13th ASWA[AA] conference.

Despite the illegal military occupation of part of its territory by a foreign country, the option of hosting the meeting in Cyprus was enthusiastically embraced by all members of the working group, especially because it is open to all nationalities and maintains good diplomatic relationships with a large majority of countries in Southwest Asia. These facts contributed towards the 13th ASWA[AA] meeting in Cyprus (June 7–9, 2017) becoming one of the best-attended ASWA[AA] meetings. It brought together 80 scientists coming from 25 different countries: from Southwest Asia (6 countries), Europe (14 countries), North America (2 countries), and Japan.

They presented their results in 36 oral and 32 poster presentations. They debated the long-term interactions between humans and biodiversity, about the beginning of animal domestication and husbandry, the strategies of animal exploitation from the Paleolithic to modern times, and the symbolic and funeral use of animals through time. They also greatly enjoyed the numerous social events organized, including a fantastic Cypriot mezze dinner, enhanced by a local folk-music band, and a nice excursion to the archaeological sites of Amathous, Kourion, and Khirokitia, and to the museums of Nicosia and Larnaca, which provided ample opportunities for scientific exchanges in a friendly atmosphere.

The hosting of the conference at the new campus of the University of Cyprus was another major reason to the meeting's success. This campus was a convenient and pleasant venue for such a conference, and the strong support of the University of Cyprus, as well as its valuable experience for the organization of such meetings were deeply appreciated by both the scientific organizers and the delegates. Several other partners contributed to the organization: the French archaeological mission "Neolithisation—Klimonas," which is itself strongly supported by the French School at Athens, the Cyprus Department of Antiquities, the French Institute of Cyprus, the French National Center for Scientific Research (Centre National de la Recherche Scientifique [CNRS]), and the French National Museum of Natural History (Muséum national d'Histoire naturelle [MNHN]).

The present volume brings together the texts of 18 of the 68 presentations of the meeting in Nicosia. The editorial board collected the papers and organized their review and editing. We are very grateful to Sarah Kansa (and Open Context), Justin Lev Tov, and Lockwood Press for their constant support in bringing this volume to fruition.

Julie Daujat
Angelos Hadjikoumis
Rémi Berthon, Jwana Chahoud
Vasiliki Kassianidou
Jean-Denis Vigne

# Part 1

## Methodological Approaches to Faunal Analysis in the Archaeozoology of Southwest Asia and Adjacent Areas

# 1.1 | Assessing Changes in Animal Mobility and Activity Patterns During Early Stages of Domestication and Husbandry of *Capra*

## Tell Halula as a Case Study (Euphrates Valley, Syria)

Roger Alcàntara Fors,* Josep Fortuny,† Miquel Molist Montaña,* Carlos Tornero,‡
and Maria Saña Seguí*

### Abstract

Domestication implies a certain degree of human control over all aspects of animals' life, including their ability to move freely. Consequently, domestic animals should experiment a significant reduction of their mobility regimes, such as range, duration, and intensity. Bone tissue is a plastic and alive material with the ability to remodel in response to mechanical loading. In Tell Halula (7800–5200 cal BC) exploitation of *Capra aegagrus* and *Capra hircus* played a significant role from its earliest occupations. This study attempts to detect potential variations in cortical bone development using Computed Tomography scanning and cross-section analysis of *Capra* humeri in response to changes in their mobility regimes. Results support domestic specimens with loading patterns matching those of wild specimens together with loading patterns among the domestic group changing through the periods analyzed. Moments of inertia show antero-posterior and mediolateral loading differences between domestic and wild populations that may be indicative of mobility differences. Activity levels, evidenced by the relative amount of cortical bone and the polar moment of inertia, also seem to constitute a distinguishing marker of goat management strategies in the course of the archaeological sequence. The circularity index and the three different cross-sections documented also reinforce this hypothesis.

### Keywords

*Tell Halula, goat, humerus, early husbandry, management strategies, biomechanics, bone adaptation, mechanical properties, physical stress*

## Introduction

Domestication is a widely discussed concept that implies several interactions between social, physiological, and ecological domains. Even though animal domestication processes are currently ongoing, the first husbandry practices are documented during the early Holocene and constitute one of the most relevant turning points in human history. In Southwest Asia, the direct control of the productive and reproductive cycles of some animal species resulted in important changes in the economy and social organization of human societies, paired with the development of new work processes and an increasingly sedentary lifestyle. From a biological point of view, it also had an important impact. The adaptation of the animals to the anthropic environment caused physiological, behavioral, and anatomical changes (Helmer 1992). The feeding, reproduction, and mobility patterns of herds were affected in dif-

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ferent ways, under different timings, depending on the species but also on the degree of artificial manipulation to which the species were subjected. Unfortunately, these changes are poorly detected in the archaeological record and zooarchaeology, and the study of the faunal remains is the best direct way to investigate these processes. Nevertheless, different publications have shown that different ways can be used to obtain valuable data on early domestication, revealing that some of the traditional zooarchaeological limitations can be solved with different and complementary analytical approaches. Most of these approaches are based on biogeochemistry, of which stable isotopes and genomic analyses are the most common ones (e.g., Balasse et al. 2015; Bar-Gal et al. 2003; Blaise and Balasse 2011; Makarewicz and Turos 2012; Tornero 2011).

Here, we present and discuss an analytical approach that could be useful to recognize animals subjected to control conditions, causing changes in activity patterns, and physiological stress under different situations from the ones occurring in wild populations. This approach is based on the analysis of structural changes in bone tissue. Although pioneering works based on this approach were published during the 1970s (Daly et al. 1973; Drew et al. 1971; Museum Applied Science Center for Archaeology [MASCA] 1970, 1973), few studies have so far considered inner bone tissue architecture as a potential domestication indicator.

In these early studies (e.g., Drew et al. 1971), the authors compared different structural components of bone tissue in domestic and wild populations through the analysis of spongy and compact bone and articular surfaces. Their results supported that differences in trabecular thickness, the trabeculae, and subchondral plate joint and birefringence in the circumferential layers of transversal sections effectively distinguished between wild and domestic animals. Zeder (1978) considered the methodological approach of these early works valid but noted the importance of assessing whether the results could be biased by other factors, such as the levels of stress that animals were subjected to, mobility patterns, age, or health state of the specimens. Later, Gilbert (1989) also pointed out the importance of determining if the analyzed remains presented taphonomic alterations that could affect their inner structure.

The most important point of these approaches is that they test the correlation between density and bone structure, and the degree of activity of the animals, as it may be affected by the domestication process. The plasticity of bone tissue and its capacity to adapt to the mechanical environment has long been a guiding principle in biological studies (Ruff et al. 2006; Wolff 2012 [1892]). It is known that bone reacts when biomechanical movement generates strains caused by ground impact and skeletal muscle forces (Shaw and Stock 2009).

Based on this principle, some recent studies performed on modern animal populations provide interesting data that can be used as a reference to evaluate animal activity patterns in archaeological fauna remains (Jepsen et al. 2015; O'Regan and Kitchener 2005; Ruff et al. 1993; Stock and Macintosh 2016). It is common in biological and veterinary studies to correlate the growth and differential development of bones with the capability to adapt to mechanical stress. One of these parameters that can be tested in an archaeological study is the cortical width of long bones (Nazem et al. 2015). Hiney and colleagues (2004) evaluated the correlation between density and morphology of the cortical bone in the metapodial diaphysis in three groups of bull calves with three differentiated activity patterns: one with punctual high intensity activity, a free ranging group, and a completely static third group. The results obtained show that mobility is reflected in the percentage of the bone's cortical area and its geometry, with the mineral density of the bone in static populations relatively more reduced. In a similar way, Main and Biewener (2004) analyzed limb loading patterns of young goats in an attempt to relate them to *in vivo* bone strains in the radius of domestic goat, showing that the radius was primarily loaded with bending strains through ontogeny. Later, Niinimäki and Salmi (2016) analyzed populations of reindeer and showed that different points of muscular insertion of the elbow articulation are more developed in wild reindeer populations than in captive populations in zoos. One of the most important and recent publications on this topic was published by Shackelford and colleagues (2013), who focused on testing the changes in bone structure related to mobility reduction—due to domestication—in wild asses.

Analyses of changes in the inner bone structure could represent a useful way to shed light on early husbandry practices and provide an opportunity to identify variations in the mobility and activity patterns of animal populations derived from domestication processes. We therefore propose the hypothesis that animal domestication may involve a greater control of human communities over animals than previously thought. This control could lead in some cases to their breeding and maintenance in the settlements or nearby, thus decreasing the degree of physical activity. In order to examine this possibility, Computed Tomography (CT) techniques represent a noninvasive methodology for fossil remains as its capacity to record external and internal features of bones has been attested (Stock 2002). It is able to identify variations in inner-bone microstructure derived from potential selective pressures and interpret its patterns and intensity. To date, no investigation has been performed on archaeological goat populations, the main focus of the present study.

This paper presents the preliminary results of the application of this approach and methodology to the study of early goat husbandry at the Neolithic settlement of Tell Halula (Middle Euphrates Valley, Syria). The site of Tell Halula, with more than 2,000 years of continuous occupation, allows following in detail the main changes that occurred in early domestic goat-management strategies between 7800 and 5700 cal BC. The main objective is to evaluate if there are variations in the activity levels of the analyzed specimens based on the analysis of the bone structure and, if so, to correlate these variations with the management strategies for this species and the size changes in the animals, data already available from recent studies (Saña Seguí 1999, 2000; Saña Seguí and Tornero 2008, 2013; Tornero 2011).

## Materials

Tell Halula is an archaeological site located in the Middle Euphrates Valley in Syria. The archaeological work carried out at Tell Halula during the last twenty-five years has revealed a long sequence of occupation in its more than 11 m stratigraphic sequence. An area of about 4,200 $m^2$ has been excavated. The sequence of occupation covers a period between 7800 to 5700 cal BC, which is subdivided into thirty-seven Occupation Phases (OP) corresponding to middle Pre-Pottery Neolithic B (MPPNB), Late Pre-Pottery Neolithic B (LPPNB), Pre-Halaf, and Halaf periods (Molist Montaña 2013).

During the oldest occupation phases, dating back to around 7800–7600 cal BC, most of the domestic structures—mainly cooking and storage structures—are distributed in large open areas, approximately between OP 1 to OP 9. At the end of the MPPNB and during LPPNB the excavation of a wide area made it possible to document a living area with an alignment of seven synchronically occupied houses that share some formal features, such as building techniques or spatial distribution. All the houses are rectangular and are identically organized in three or four rooms, with a large open area in front where most of the production activities were carried out. Starting in the Pottery Neolithic, dated around 6900–6800 cal. BC—OP20 to OP32—different levels with low investment in architectural constructions were documented dispersed over large open areas. Circular buildings start to appear, although some houses keep the rectangular and pluricellular organization. During the last occupation phases—OP36 and OP37, dated between around 6000 and 5500 cal BC—rectangular and circular floor plans in combination define the architecture of the site with a preferential use of stone foundations and beaten floors.

To date, a sample of about 35,000 faunal remains has been analyzed (Saña Seguí 1999, 2000; Saña Seguí and Tornero 2008, 2013; Tornero 2011). During the oldest occupations around 7800–7600 cal BC (MPPNB), wild species played a major role in the supply of food while goats were the main domestic livestock. The beginning of sheep husbandry is attested for the first time in OP 8 (7590–7520 BC), and a strategy mainly focused on the consumption of domestic sheep and goats has been documented during the intermediate occupation phases, OP13 to OP19. Cattle are documented from the beginning of the archaeological sequence with low representation values and as a source of meat (Helmer et al. 2005). Pigs are well represented throughout the whole sequence with fluctuating representation percentages, and their domestic form has been identified starting with the first occupation (Alcàntara Fors 2014).

The *Capra* assemblage consists of a total of 1,386 remains (4% of the Number of Identified Specimens = NISP). Due to the characteristics of the archaeological bone remains, the selected fraction was from the medial diaphysis to the distal epiphysis where the remains that could be measured were selected. Sampling was also carried out on the available remains at the Archaeozoology Laboratory of the Autonomous University of Barcelona. In this way, a total of 35 goat humeri were selected for CT scanning. According to the archaeological and historical dynamics represented at the site and the different turning points documented in animal management strategies (Saña Seguí 1999, 2000), samples were grouped in three periods following a chronological order. Thus, 9 samples correspond to Period 1 (OP1 to OP10), 8 samples to Period 2 (OP11 to OP21), and lastly 15 samples correspond to Period 3 (OP22 to OP37). Based on biometrical criteria, 32 remains were classified as *Capra hircus* and three as *Capra aegagrus*. All the analyzed samples are from adult specimens. The wild goat specimens belong to Period 1 (Samples No. 2 and 3) and Period 2 (Sample No. 6) and are represented in an individualized group as a reference for this population.

## Methodology

The biometric features of the selected humeri from Tell Halula were recorded following the criteria defined by von den Driesch (1976) and Helmer and Rocheteau (1994). The measurements recorded correspond to the maximum width of the epiphysis (Bd), maximum width of the distal trochlea (Bt), and maximum (H) and minimum height (h) of the trochlea. Measurements of goat humeri from the sites of Abu Gosh (Ducos 1978), Munhatta (Ducos 1968), and Cafer Höyük (Helmer 1985, 1988, 1991) were also included as reference datasets.

The remains were CT scanned using a medical CT scanner Sensations 16 (Siemens) at the Hospital Universitari Mútua de Terrassa (Terrassa, Catalonia) at 120 kV, 59 mA, with an output of 512 × 512 pixels per slice and obtaining a physical resolution of 0.75 mm. The raw data obtained were processed using the software Avizo 7.0 (FEI Company). This software allowed the generation of 3D models for each bone. Then, a slice from the distal diaphysis at the outermost proximal limit of the olecranon fossa was obtained for each bone. This point represents a homologous locus for all the humeri. It is on the bone diaphysis and easy to locate, which permits reliable replication of cross-sectioning procedures. ImageJ software (Schneider et al. 2012) was used to take such measurements at the cortex width in the mediolateral plane, anteroposterior and mediolateral diameters of the subperiosteal section, and of the medullary cavity as well as the total, cortical, and medullary area of the section (Figure 1.1.1).

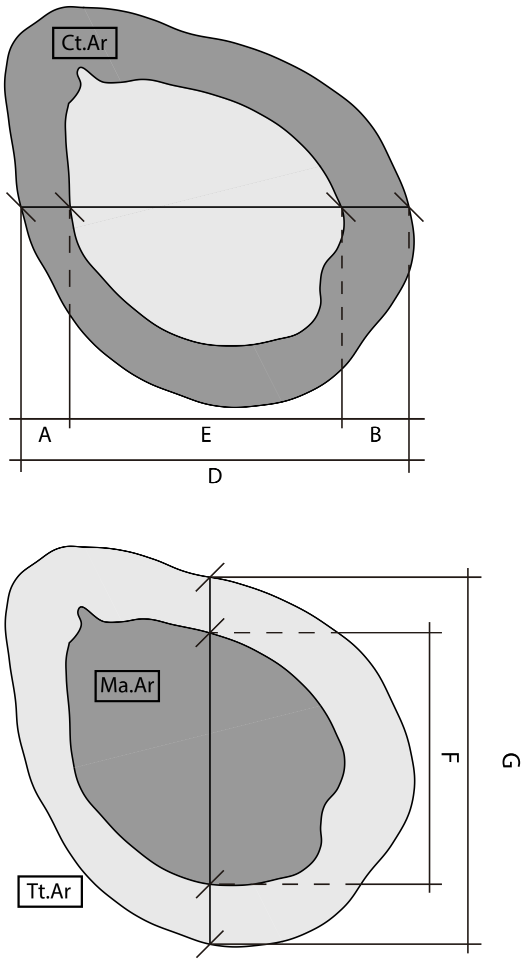

Figure 1.1.1. Measurements on humerus cross section. A + B = Cortical thickness (Ct.Th); D = Mediolateral breadth of the section (ML); E = Mediolateral breadth of the marrow (ml); G = Anteroposterior breadth of the section (AP); F = Anteroposterior breadth of the marrow (ap); Ct.Ar = Cortical area; Ma.Ar = Marrow area; Tt.Ar = Subperiosteal area.

These measures were used to calculate the physical parameters defined with the C/D ratio (C = cortical thickness; D = diameter of bone), Ct.Ar/Tt.Ar ratio (Ct.Ar = cortical area; Tt.Ar = total area), the second moment of area or moment of inertia (I), and the polar moment of area or polar moment of inertia (J). Values obtained with the calculation of these parameters are representative of the modifications that bone tissue may undergo as a result of its adaptation or response to different loads received during the animal's life, being a reflection of their intensity, recurrence, duration, and direction.

The C/D ratio expresses the amount of cortical bone (sum of medial and lateral thickness) related to the diameter of the bone (mediolateral diameter). The C/D ratio is widely used in veterinary science as a diagnostic tool for the identification of bone growth anomalies and is not affected by age, sex, weight or height (Nazem et al. 2015). The Ct.Ar/Tt.Ar ratio equally expresses the relative amount of cortical bone in the section. Cortical area is related to the compression and traction loadings the bone had to bear (Nordin and Frankel 2001). The moment of inertia (I) reflects the adaptation of the bone to bending and torsional loadings and was calculated in relation to the animal's anatomical axes using the formula for the moment of inertia of a hollow ellipse (Mediolateral moment of inertia: $I_{ML} = 0.0491[AP^3*ML - ap^3*ml]$ and Anteroposterior moment of inertia: $I_{AP} = 0.0491[ML^3*AP - ml^3*ap]$; American Society of Agricultural Engineers [ASAE] 2003; Ruff and Hayes 1983). These two values express the distribution of the cortical mass in response to the analyzed loadings. Consequently, it is expected that the bones of an animal with greater mobility, performing intense runs and changes of direction, should present a more evenly distributed cortical mass, given that their bones must adapt to a great variety of loadings. On the contrary, the bones of an animal with more limited movements, constrained to motions in a straight line, will adapt to compensate for this single recurrent effort (Carlson and Judex 2007). Following the same reasoning, low activity of the animal should be reflected in lower values for this parameter. The relation of this parameter in its two perpendicular axes generates therefore an index of circularity that expresses the previous scenarios. The polar moment of inertia, in other words the result of the sum of any pair of perpendicular moments of inertia, represents the adaptation of the bone to torsional loadings (Daegling 2002; Ruff 2000). The last considerations take into account the morphology of the cross sections given the effects of multidirectional stress to bone growth.

In order to reduce the influence of animal size, the values obtained with the moment of inertia and the polar moment of inertia calculations were standardized using the geometric mean of the four linear measurements Bd, Bt, H, and h. Since the values returned by the formula used to calculate these parameters are expressed in $mm^4$, the value of the geometric mean was raised to the fourth power. Usual procedures to standardize this data involve using bone length and body mass to compensate for any weight or size difference that may affect the sample (Hiney et al. 2004; Ruff 2000; Ruff and Hayes 1983; Ruff et al. 1993; Ruff et al. 2006; Shackelford et al. 2013). Given the extreme difficulty in accessing these values due to preservation issues in archaeological contexts, Bd, Bt, H, and h are taken here as markers of size and body mass factors, taking into account that breadth and width measurements are substantially a function of weight (Currey 2013).

Measurements' distribution and obtained values in standard error and box plot diagrams enable the assessment of continuity and discontinuity between wild and domestic populations as well as between periods. In order to compare the data according to chronology, the Kruskal-Wallis test was used, with a statistical significance probability threshold of $\alpha = 0.05$ (Hammer et al. 2001).

## Results

The different measurements and parameters calculated refer to characteristics and properties of the bone epiphyses and bone section. Firstly, goat size evolution throughout the archaeological sequence was characterized. Then, the values and tendencies obtained with the measurements directly taken from the cross section—bone area, cortical area, and marrow area—are checked. These data are complemented by parameters from the cross sections calculated with the linear and area measurements as previously described. These parameters are related to the bone strength and its capacity to resist different levels and kinds of physical stress.

A reduction in size of goat specimens, in the course of the chronological sequence at Tell Halula, has been previously documented (Saña Seguí 1999, 2000; Saña Seguí and Tornero 2008, 2013; Tornero 2011). The results obtained with Bd and h measurements of distal epiphysis of the analyzed humeri are grouped according to the three periods established as a temporal reference and are presented here by means of standard error diagrams. As can be seen in Figure 1.1.2, the samples selected for this study follow the general trend with a clear difference in these measurements between wild and domestic populations. Kruskal-Wallis *p* values (Table 1.1.1) corroborate this trend, with the only similarities being between wild goat reference samples taken from the eastern Levant and Tell Halula P1 samples.

Next, values for the area of the cortical mass (Ct. Ar) were correlated with values of the total area (Tt. Ar) in order to evaluate whether the dynamics of

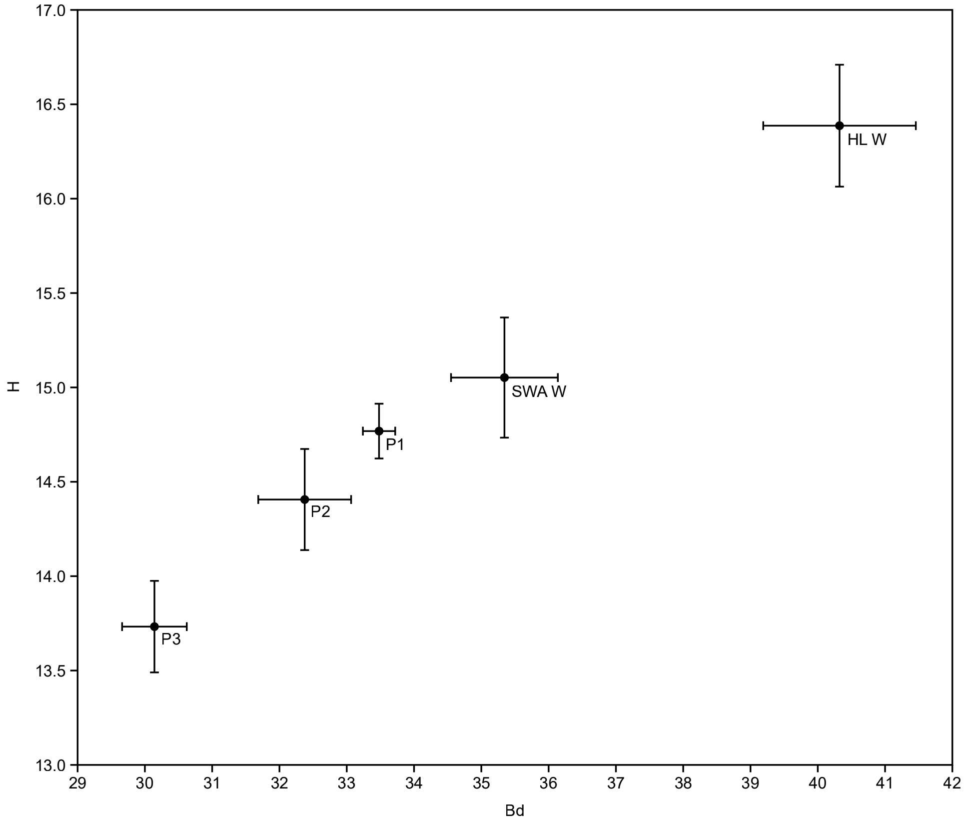

Figure 1.1.2. Standard error diagram of distal breadth (Bd) and minimum height of the trochlea (h). Tell Halula wild goats (HL W, N = 3); Tell Halula domestic goats (P1, N = 9; P2, N = 8; P3, N = 15); Southwest Asia wild goats (SWA W, includes samples from Abu Gosh [N = 20, Ducos 1978], Munhatta [N = 1, Ducos 1968], and Cafer Höyük [N = 1, Helmer 1985, 1988, 1991]). P1 (Period 1), P2 (Period 2), and P3 (Period 3).

Ct.Ar in Tell Halula sequence are similar or not to those obtained for the size. Values of *Capra aegagrus* specimens were also individualized (Figure 1.1.3). The results show a positive correlation between the two areas (*r* = 0.93476; see Table 1.1.2 for further details), clearly separating the wild population from the rest. Values (P1 Ct.Ar-SD=17.01; P1 Tt.Ar-SD=24.27; see Table 1.1.3) obtained for P1 are grouped and have a lower variability than for the next two periods, especially with the most recent occupation phase (P3). Those specimens that do not follow this trend were marked in the distribution. The progressive decrease documented in these values would be equivalent to the one recorded for size, although between Periods 2 and 3, a sharp reduction in the size of the cortical area is detected whereas Tt.Ar maintains a steady decrease. The correlation of C/D ratio with Bd measurement was used to evaluate the relationship between size reduction of the represented specimens and changes in the cortical bone (Figure 1.1.4). The scatter plot shows the lack of linear correlation between these two values (*r* = 0.44696, see Table 1.1.2 for further details). P1 specimens have a relatively higher cortical mass than specimens from the other two periods, whereas P3 specimens show greater variability. In the latter case, two groups with different tendencies can be isolated (Group 1 with Samples 8, 9, 13, 14, 29, 38, and 46; Group 2 with Samples 10, 19, 20, 21, 22, 23, 27, and 28). Wild specimens, whose size is greater than the rest of individuals, present intermediate values of relative quantity of the cortical mass, less than what would be expected for domestic goats with same Bd. Likewise, we observe an isolated case that stands out due to an especially low C/D ratio value given its size (Sample 34).

Observed dynamics in the moments of inertia and circularity index show a slightly different path. The distribution obtained from the measurements $I_{AP}$ and $I_{ML}$ (Figure 1.1.5) defines a group of individuals whose values for bending resistance are higher than

Table 1.1.1. Kruskal-Wallis test results of Bd values between Southwest Asia wild goats (SWA W, N=23; Abou Gosh, N=20; Munhatta, N=1; Cafer Höyük, N=1), Tell Halula wild goats (HL W, N = 3) and domestic goats Period 1 (P1, N = 9), Period 2 (P2, N = 8) and Period 3 (P3, N = 15) with a statistical significance probability threshold of α = 0.05 (* represents significant difference).

| | **WSWA** | **HL W** | **P1** | **P2** | **P3** |
|---|---|---|---|---|---|
| **SWA W** | | 0,0595 | 0,6165 | 0,003892* | 3.60E-02* |
| **HL W** | 0,0595 | | 0,01623* | 0,0189* | 0,009116* |
| **P1** | 0,6165 | 0,01623* | | 0,01077* | 0,0003861* |
| **P2** | 0,003892* | 0,0189* | 0,01077* | | 0,05682 |
| **P3** | 3.60E-02* | 0,009116* | 0,0003861* | 0,05682 | |

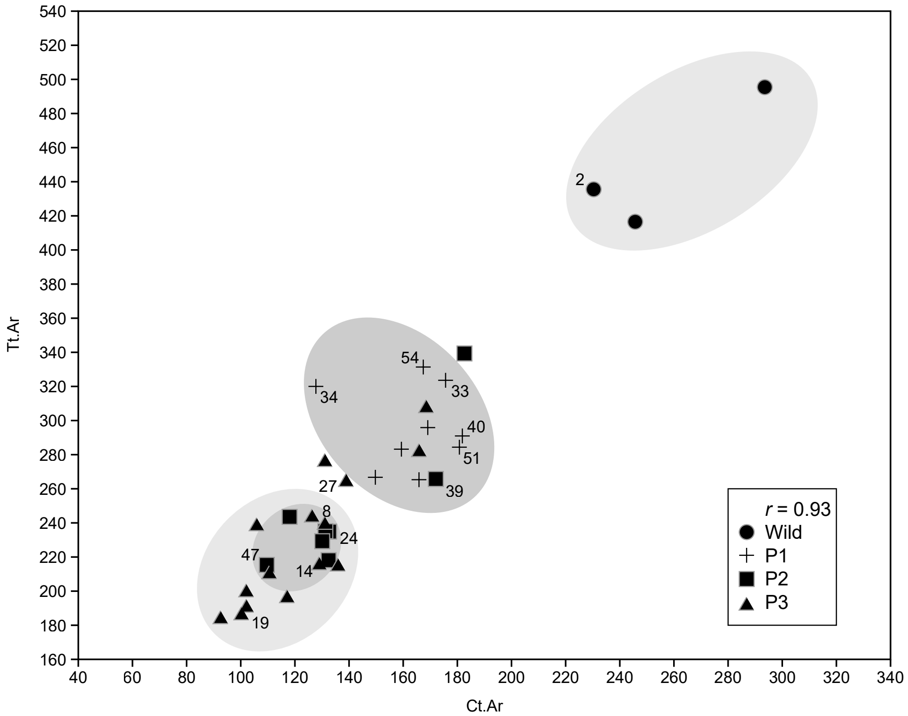

Figure 1.1.3. Bivariate graph of the Cortical Area (Ct.Ar) and the Total Area (Tt.Ar) of the 35 analyzed cross sections within their corresponding group of analysis. Ellipses mark the main concentrations of values for each group.

for the rest of individuals. This group is formed by the three samples of *Capra aegagrus*, two specimens from P1 (Samples 33 and 54) and a specimen from P3 (Sample 20). The greatest variability in this group is observed in the values of $I_{AP}$, while the values of $I_{ML}$ remain stable. The remaining specimens in the sequence are divided into two main groups. The first one is mainly composed of samples from P3, together with two from P2. The second group, with lower $I_{AP}$ values, is made up of specimens from P2 and P3 equally. Samples corresponding to P1, with the exception of the aforementioned specimens, show intermediate values between these two groups partially overlapping with them. The circularity index, whose paradigmatic case of reference should present a relation of 1:1 (Stock 2006; Stock and Pfeiffer 2004), displays a clear tendency toward lower circularity in the course of the archaeological sequence (Table 1.1.4).

In the same way, the average of the values for the circularity index in wild specimens is the closest

Table 1.1.2. Reduced Major Axis (RMA) Regression results between Cortical area and Total area of the cross section (Ct.Ar–Tt.Ar) and between distal breadth and C/D ratio (Bd–C/D Ratio).

| **RMA regression** | | **Ct.Ar–Tt.Ar** | **Bd–C/D ratio** |
|---|---|---|---|
| | Slope *a* | 1.6352 | 1.193 |
| | Std. error *a* | 0.10113 | 0.18578 |
| | *t* | 16.169 | 6.4217 |
| | *p* (slope) | 3.0276E−17 | 2.8037E−07 |
| | Intercept *b* | 26.485 | -9.991 |
| | Std. error *b* | 245.48 | 36.55 |
| 95% bootstrapped confidence intervals (N = 199) | | | |
| | Slope *a* | (1.4542, 1.7674) | (0.5315, 1.5481) |
| | Intercept *b* | (6.8177, 51.942) | (-21.16, 10.12) |
| Correlation | | | |
| | *r* | 0.93476 | 0.44696 |
| | *r2* | 0.87377 | 0.19977 |
| | *t* | 15.114 | 2.8703 |
| | *p* (uncorr.) | 2.1688E−16 | 0.0071063 |
| | Permutation *p* | 0.0001 | 0.0073 |

to those for Period 1. The variability of this index increases over time, reaching values higher than a 2:1 ratio.

The area polar moment represents the resistance to torsional loadings. In this case, results show a population of six individuals (the three wild individuals, Samples 33 and 54 from P2, and Sample 20 from P3) especially resistant to torsional loadings despite having clearly different sizes. P2, with larger specimens than those in P3, records a lower average value of torsional strength equivalent to the lowest resistance values in P3. Although the specimens from P3 are generally of smaller size than the rest of the analyzed sample, their range of resistance to torsional forces reaches the full scope of possible results, with two apparent separate groups according to their greater or lesser resistance to torsion. Larger specimens from P1 (Samples 34, 40, 45, and 55) have high torsional strength values equivalent to the highest resistance group in P3. These tendencies are well reflected in the box plot diagram (Figure 1.1.6), where the existence of a turning point in this parameter can be clearly seen between Periods 2 and 3.

Finally, the morphological analysis of the obtained shaft diaphysis's cross sections was performed. This analysis differentiated morphologies that can be grouped into three main types (Figure 1.1.7). The first type (T1) has a round outline with a protuberance due to the lateral condyle. In the second type (T2), the protuberance of the condyle is maintained, but the rest of the outline acquires a more angular aspect. In the third type (T3), both condyles maintain similar sizes, which gives the section a rectangular profile. This morphological ascription is relevant if one takes into account its temporal distribution, since T1 is documented mainly during Period 1 and is also associated with wild specimens. In the same line, T3 is most frequent during P3. Nonetheless, T2 seems equally distributed between Periods 2 and 3 (Table 1.1.5).

## Discussion

Animal domestication—here goat domestication processes—has traditionally been studied through morphometric analysis in combination with mortality profile patterns (Peters et al. 1999). One of the prom-

Table 1.1.3. Summary statistics of Cortical area (Ct.Ar.) and Total area (Tt.Ar) values for each of the analyzed groups of Tell Halula.

| | **HL W Ct.Ar** | **HL W Tt.Ar** | **P1 Ct.Ar** | **P1 Tt.Ar** | **P2 Ct.Ar** | **P2 Tt.Ar** | **P3 Ct.Ar** | **P3 Tt.Ar** |
|---|---|---|---|---|---|---|---|---|
| N | 3 | 3 | 9 | 9 | 8 | 8 | 15 | 15 |
| Min | 230.353 | 416.517 | 127.756 | 265.326 | 109.624 | 215.383 | 92.545 | 184.738 |
| Max | 293.551 | 495.434 | 181.84 | 331.378 | 182.631 | 339.324 | 168.483 | 308.43 |
| Sum | 769.605 | 1347.502 | 1477.371 | 2661.483 | 1108.8 | 1981.415 | 1856.962 | 3460.418 |
| Mean | 256.535 | 449.1673 | 164.1523 | 295.7203 | 138.6 | 247.6769 | 123.7975 | 230.6945 |
| Std. error | 19.03093 | 23.77693 | 5.670556 | 8.088889 | 8.983698 | 14.21732 | 5.894883 | 9.95999 |
| Variance | 1086.528 | 1696.027 | 289.3968 | 588.8712 | 645.6546 | 1617.057 | 521.2447 | 1488.021 |
| Stand. dev | 32.96253 | 41.18284 | 17.01167 | 24.26667 | 25.40973 | 40.21265 | 22.83078 | 38.57488 |
| Median | 245.701 | 435.551 | 167.412 | 290.969 | 131.8515 | 235.0095 | 126.304 | 216.333 |
| 25 prcntil | 230.353 | 416.517 | 154.519 | 274.9705 | 121.0637 | 220.907 | 102.079 | 197.055 |
| 75 prcntil | 293.551 | 495.434 | 178.2065 | 321.8085 | 162.2007 | 260.2022 | 135.904 | 265.152 |
| Skewness | 1.319265 | 1.325194 | -1.29104 | 0.285472 | 1.025814 | 2.067436 | 0.673668 | 0.621632 |
| Kurtosis | -2.33333 | -2.33333 | 1.79622 | -1.34988 | -0.0428 | 4.628463 | -0.11251 | -0.66028 |
| Geom. mean | 255.1691 | 447.9393 | 163.3018 | 294.843 | 136.7066 | 245.1954 | 121.9189 | 227.8085 |
| Coeff. var | 12.84914 | 9.168709 | 10.36334 | 8.205952 | 18.33314 | 16.23593 | 18.44204 | 16.72119 |

inent agents in this matter has been the inclusion of biogeochemical studies (Tornero 2011; Tornero and Saña Seguí 2008; Wiener and Wilkinson 2011). Isotopic analyses carried out on samples recovered at Neolithic archaeological sites in the northern and southern Levant (Lösch et al. 2006; Makarewicz et al. 2016; Tornero, Molist Montaña, and Saña Seguí 2016) suggested a wide variety of synchronic caprine culling practices, reflecting geographic as well as temporal differences in the adoption of goat husbandry. Early evidence of domestic goats in this region is hypothesized for Nevalı Çori (Peters et al. 2005), dating back to around 8500 cal BC and is supported by a slight reduction in size—which does not occur for gazelles and bovids, a large majority of female and immature individuals, and an overrepresentation of caprines in the following levels of the site.

Although a higher number of samples would be desirable, the present application studying humeri cross sections was able to measure several strength-related bone parameters and observe their evolution and variations through a sequence of 2,000 years. Among the results obtained, the first question to be taken into account is the progressive decrease in the observed size during the chronological sequence at Tell Halula. The reduction in size is one of the factors generally accepted as a marker, not necessarily unambiguous, of domestication processes (Helmer 1992; Peters et al. 2005; Vigne 2011; Zeder 1999; Zeder and Hesse 2000). Causes for this reduction in size have to be considered, among other factors, within the human selective pressures applied to the species. The detection of biannual reproduction patterns in goats during the MPPNB (Tornero 2011), the prior killing of specimens in their growth stage (Saña Seguí 1999), and a markedly decreased size in relation to its wild agriotype (Saña Seguí 1999) suggest the presence of domestic goat, *Capra hircus*, from the oldest occupations of the settlement. It is interesting to note that sheep was not introduced in this site until Occupation Phase 8 (7590–7520 cal BC) and in parallel an increase in the importance of goat herding can be seen. It is not until the end of the MPPNB that sheep replaced and overtook the economic importance of goats (Saña Seguí and Tornero 2012; Tornero, Balasse, Molist Montaña, and Saña Seguí 2016). The economic

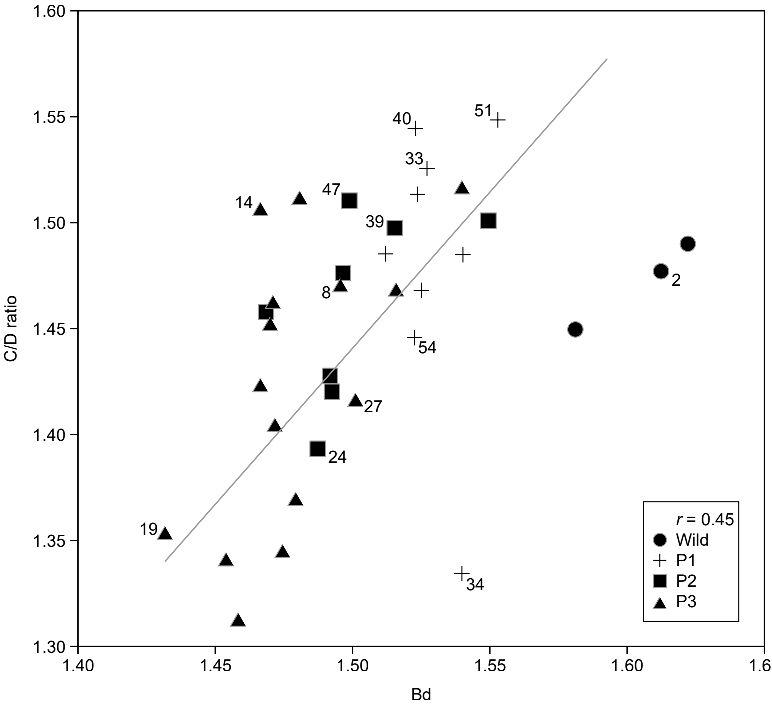

Figure 1.1.4. Bivariate graph of distal breadth of humerus (Bd) and C/D ratio log values of the 35 analyzed samples within their corresponding group of analysis.

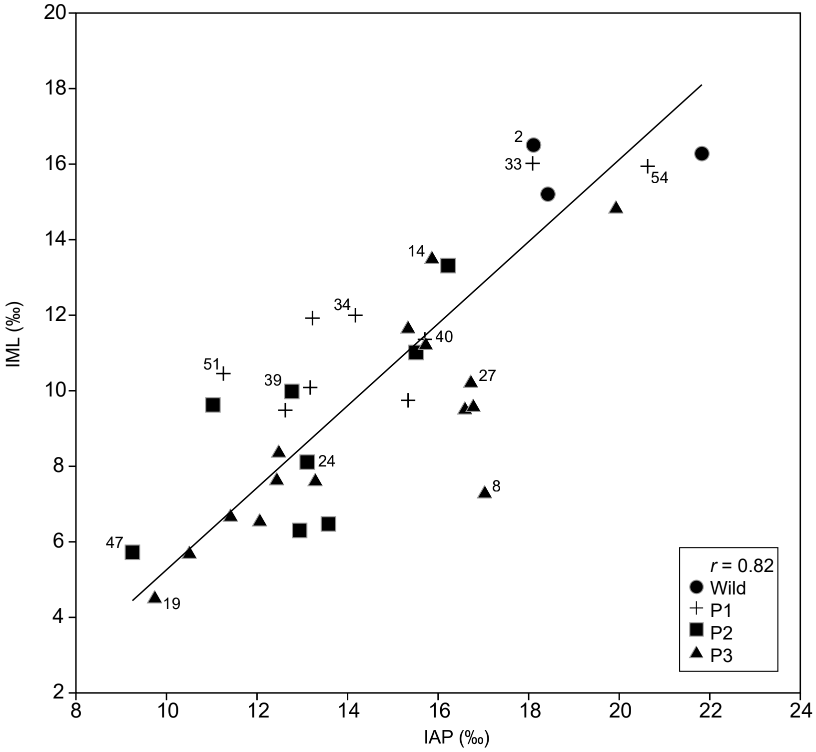

Figure 1.1.5. Bivariate plot of the anteroposterior moment of inertia ($I_{AP}$, in ‰) and the mediolateral moment of inertia ($I_{ML}$, in ‰). Values were standardized by the geometric average of Bd, Bt, H, and h rose to the fourth power.

Table 1.1.4. Cross-sectional geometric properties (mean and standard error values) for *Capra aegagrus* (wild) and *Capra* during Period 1, Period 2, and Period 3. Relative amount of cortical bone (C/D ratio; Ct.Ar/Tt.Ar); anteroposterior moment of inertia, anteroposterior bending strength ($I_{AP}$, in ‰), mediolateral moment of inertia, mediolateral bending strength ($I_{ML}$, in ‰), polar moment of inertia, torsional strength (J, in ‰) and circularity index ($I_{AP}/I_{ML}$).

| | | **Wild** | **Period 1** | **Period 2** | **Period 3** |
|---|---|---|---|---|---|
| **C/D ratio (%)** | Mean | 29.686 | 30.726 | 28.997 | 26.823 |
| | SE | 0.808 | 1.417 | 1.000 | 1.059 |
| | N | 3 | 9 | 8 | 15 |
| **Ct.Ar/Tt.Ar (%)** | Mean | 57.043 | 55.868 | 55.961 | 53.730 |
| | SE | 2.079 | 2.456 | 1.827 | 1.271 |
| | N | 3 | 9 | 8 | 15 |
| **$I_{AP}$ (‰)** | Mean | 19.453 | 15.370 | 12.985 | 14.156 |
| | SE | 1.190 | 0.978 | 0.649 | 0.730 |
| | N | 3 | 9 | 8 | 15 |
| **$I_{ML}$ (‰)** | Mean | 15.995 | 12.070 | 9.180 | 8.950 |
| | SE | 0.401 | 0.918 | 0.930 | 0.698 |
| | N | 3 | 9 | 8 | 15 |
| **J (‰)** | Mean | 35.448 | 27.440 | 22.166 | 23.107 |
| | SE | 1.358 | 1.824 | 1.300 | 1.369 |
| | N | 3 | 9 | 8 | 15 |
| **$I_{AP}$ / $I_{ML}$** | Mean | 1.217 | 1.265 | 1.554 | 1.667 |
| | SE | 0.070 | 0.053 | 0.129 | 0.079 |
| | N | 3 | 9 | 8 | 15 |

importance of goat herding could favor, as pointed out by some of the obtained results, changes in living conditions of these animals, which would affect their mobility and physical activity patterns.

Results show how the relative amount of cortical mass (C/D ratio and Ct.Ar/Tt.Ar) generally tends to decrease progressively over time, although the rate of decrease in cortical mass is not directly related to a size reduction. Both ratios show different values for individuals of similar size. In the case of *Capra aegagrus*, for example, the three analyzed specimens have a relative amount of cortical mass (Ct.Ar/Tt.Ar = 59.25 [Sample 3], 58.99 [Sample 6], 52.89 [Sample 2], and C/D ratio = 30.90 [Sample 3], 28.16 [Sample 6], 30 [Sample 2]) lower than a good number of smaller specimens, such as Sample 40 (62.49, 35.03), Sample 39 (64.74, 31.43), and Sample 14 (59.61, 32.10).

As Ct.Ar is an indicator of the tension and compression loads that the bone has supported (Nordin and Frankel 2001), it is possible to interpret these results as a reflection of the volume of activity that the bone had to cope with and, therefore, of the animal, in the sense of the animal's weight that the bone had to carry. On the other hand, it is necessary to take into account that Ct.Ar varies according to Tt.Ar, that is to say to the bone size, meaning that wide bones have expectedly higher absolute Ct.Ar but lower relative cortical area (Ct.Ar/Tt.Ar or C/D) than narrow bones (Jepsen et al. 2007; Jepsen et al. 2015). This explains why, when C/D ratio is related to size, domestic specimens appear more robust than wild ones. The most significant cases are documented, however, during P3, when two inverse dynamics are differentiated. None of these dynamics is

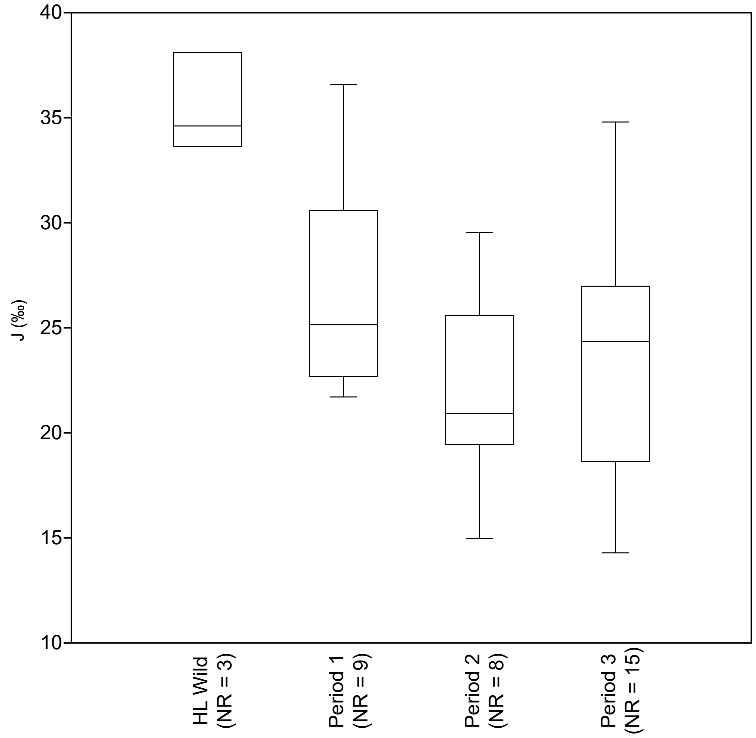

Figure 1.1.6. Boxplot representation of the Polar moment of inertia (J, in ‰) values in each period showing differences in torsional resistance values.

limited to specific phases of occupation. In contrast, from OP 1 to OP 10 the registered dynamics are significantly homogeneous. During the pre-Halaf occupations, a change in goat-herding management strategies would be developing, which would imply an apparent lower volume of activity for part of the flock. There is no direct correlation of this fact with the body size of specimens, which prevents, in all cases, these differences being attributed to sexual dimorphism. In this sense, although sexual dimorphism should not be an accountable variable, a differential management of males and females might result in an interesting point to interpret with our data.

Results obtained for the calculation of the moments of inertia raise several interesting questions regarding changes in goat activity patterns during the occupation of Tell Halula. It can be considered that the greater the loads received—more intense, more recurrent, and more durable—the higher the values of the moment of inertia. Moreover, we should expect higher values in $I_{AP}$ than in $I_{ML}$, as it relates to the main displacement direction of goats and is thus more constantly exposed to bending loads, which refers to bone growth reacting to loading intensity, movement iteration, or time of exposition (Main and Biewener 2004). This approach individualizes a group of specimens clearly differentiated from the rest because of their high *I* values, which we can relate to a higher mobility regime. This group includes the three specimens of *Capra aegagrus* and samples number 20, 33, and 54, the first two associated with P1 and the latter with P3. These samples correspond to individuals of undoubtedly smaller size than *Capra aegagrus* but which, despite this, show similar bending strength values. In this sense, it is important to highlight that, in addition to their high values, both moments of inertia present similar values and, therefore, a high index of circularity. These values could be indicative of a varied mobility, with frontal and lateral displacements alike that cause loads on the bone from multiple directions (Main and Biewener 2004; Shackelford et al. 2013). For the rest of samples from P1, the values of the moments of inertia decrease in comparison with the maximum activity reference group, although they maintain circularity index values close to 1. This suggests that these individuals may be incurring in loading patterns similar to those of the *Capra aegagrus* group, even if coupled with a lower intensity or recurrence.

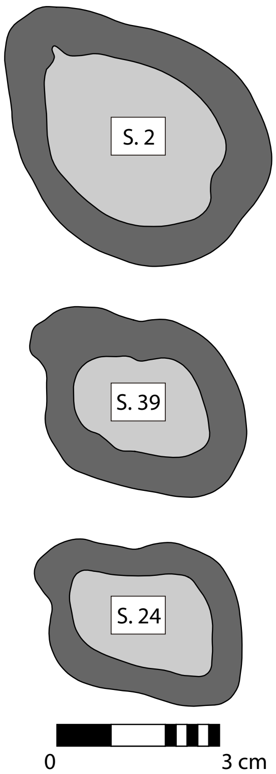

Figure 1.1.7. Examples of the three outline shape types documented for the cross sections. From top to bottom, T1 (Sample 2), T2 (Sample 39), T3 (Sample 24).

Table 1.1.5. Section outline morphotype (T1, T2, and T3) abundance for each of the defined groups: Wild, Period 1 (P1), Period 2 (P2), and Period 3 (P3). Underlined values represent where the highest number of remains for each shape type can be found.

| | T1 | T2 | T2 | N |
|---|---|---|---|---|
| **Wild** | 3 | 0 | 0 | 3 |
| **P1** | 7 | 0 | 2 | 9 |
| **P2** | 1 | 3 | 4 | 8 |
| **P3** | 2 | 4 | 9 | 15 |
| **N** | 13 | 12 | 10 | |

The dynamics documented for P2 and P3 are more complex, as they show a wider range of variability in *I* values and a fluctuating imbalance between both parameter values.

Both Periods 2 and 3 show two clear and matching differentiated groups polarizing around higher (N = 13, $I_{AP} = 15.71$, $\sigma^2 = 1.15$, $I_{ML} = 10.97$, $\sigma^2 = 2.83$) or lower *I* values (N = 16, $I_{AP} = 11.98$, $\sigma^2 = 1.72$, $I_{ML} = 7.72$, $\sigma^2 = 3.30$) that could be interpreted as indicative of higher or lower activity patterns. However, samples corresponding to P2 seem to belong more to the group with low *I* values, meaning lower activity, while samples from P3 are distributed more homogeneously between both groups. It should also be said that the samples from Period 1 are not associated with the wild specimens, which also show a similar grouping.

Additionally, the variability in the values of $I_{ML}$, that is, the variability in the levels of bending loadings received laterally, is worth noticing. This variability clearly influences the circularity index values, where individuals with high circularity values—close to 1—are perceived along with specimens whose circularity index exceeds the ratio of 2:1. This situation can be related to the reduction of lateral movements in these individuals, thus indicating different loading regimes that may be related to a different mobility, probably focused on a forward movement. Therefore, different groups seem to be defined based on the volume of activity and the type of displacement—or perhaps degree of freedom. If we look into the polar moment of inertia, the torsional resistance values define similar dynamics, identifying the same groups. On one hand, the maximum torsional loading group is maintained with the three specimens of *Capra aegagrus* and Samples 20, 33, and 54. If we take a look at the size of these three samples, Samples 33 and 54 are similar in size, while Sample 20 is consistently smaller. Coincidentally, when taking Bd and h values from Tell Halula *Capra* humeri against a reference sample of male and female wild goat specimens from Abu Gosh (Ducos 1978), these three samples, especially Samples 33 and 54, fall in the same size range as Abu Gosh female goats. Although we must note that most of Halula's domestic specimens fall within that range, just these three samples show similar patterns to those of the previously identified wild specimens, which, in this sense, match Abu Gosh male wild samples. Additionally, the classification of samples according to the three established representative types of cross-section morphology can also be ordered at a temporal level in consonance with these results. More concretely, a certain correspondence can be established between individuals with circularity indexes close to 1 and Period 1. At the same time, T2 only appears during P2 and P3, and T3 is mostly represented during P3 when the most extreme values of all the analyzed samples are recorded.

The results allow us to consider the coexistence of diverse goat management strategies in the course of the occupation sequence at Tell Halula. The data from P1 suggest a relatively homogeneous level of activity for the goat population with an unrestricted freedom of movement that is reflected in bone development similar to that of wild goats. For P2 and P3 greater variability is evidenced: individuals with, possibly, different levels of activity and different degrees of freedom of movement are present. Given that the analyzed samples actually belong to different occupation phases and, consequently, to different flocks, it is difficult to consider the coexistence of different practices, although it is interesting that the evaluated parameters show different dynamics throughout the analyzed sequence and that these dynamics are not directly correlated with the documented decrease in size. The detection of individuals of relatively smaller size with loading patterns similar to, or even associated with, those of *Capra aegagrus* is also highly significant, as it offers evidence for differential treatment among the specimens comprising the domestic sample. This reveals, at least, one practice that mainly generates anteroposterior strains, reducing lateral displacement, and one that maintains a multidirectional strain, therefore indicating a probable varied mobility. Accordingly, there is a wide range of management strategies that should be taken into consideration. Some possible explanations for these differences among domestic specimens might relate to differential management of individuals according to their exploitation and thus, in some sense, also their sex. While sexual dimorphism should not be an issue directly affecting our data, we must take into account that a major product such as milk can only be obtained from females, and this could certainly be the cause of differential management. In this sense, we should consider all possible approaches to herding and their consequences mobility-wise. A full enclosure and confinement of animals would reflect low torsional values and probably a situation close to brittle bones. Enclosure in wide spaces would give a better chance for movement, yet still reduced, thus reflecting low mobility patterns. Higher mobility strategies would probably reflect seasonal movement of herds or some kind of nomadic pastoralism, which include recurrent displacement and interaction with different kinds of landscapes and ground underfoot. Also, as previously stated, the three small specimens grouping with *Capra aegagrus* specimens might indicate that those specimens were female wild goats. In a similar sense, trapping wild specimens and breeding them with the herd or recapturing domestic escapees might result in distinct mobility options.

Similar hypotheses have also been considered in previous studies regarding different species and methodological approaches (Evin et al. 2014; Price and Evin 2019). A straight line of domestication is no longer imaginable. Capturing young wild specimens and raising them as domestics or capturing adults are both plausible options. Bearing in mind the nature of goats, it is also feasible to propose that domesticated specimens might escape to live in the wild.

Taking into consideration the criteria used up to this point, raising young wild specimens as domestic resources will most probably result in bones showing an adaptation to domestic movement “limitations.” In a similar way, domestic escapees’ bones might readapt, given enough time, to their new wild life. At the same time, the descendants of these escapees living in the wild, while domestic, will show adaptation to wild mobility. What should define the specimens we are analyzing is not their degree of domestication as much as how long and in which manner they moved during their lives as wild or captive individuals.

## Concluding Remarks

Computed Tomography (CT) enables us to reveal changes in the morphology and the development of the distal diaphysis of *Capra* humeri throughout the occupation of Tell Halula. Calculation of the amount of cortical mass, either through C/D ratio or through the cortex area, allows us to observe differential developments of the cortical mass that do not necessarily depend on the size of individuals, so that the activity carried out by the animal in life becomes an extremely important factor in the conformation and growth of the bone.

Physical parameters of humeri section allowed an assessment of the directionality and the intensity of loads received, evidencing the existence of different mobility or activity regimes throughout the sequence that could be related to the implementation of various livestock maintenance strategies.

Additionally, we were able to observe how the geometry of humeri sections also reflects some shape variations that could be linked to these same changes suggested by the physical parameters addressed in this paper. Shape variations between wild and domestic animal populations is a widely addressed topic that has received particular attention in the last decade with remarkable results for the identification of human selective pressures and the inference of domestication statuses (Cucchi 2008; Cucchi et al. 2011; Evin et al. 2013). Geometric morphometrics could be implemented to analyze the shape of cross section and study these bone changes through time, thus contributing to our understanding of human selective pressures resulting from different management strategies implemented.

Future and further development of cross-section analysis requires the integration in the analysis, as far as possible, of other long bones—tibia, femur, radius—that enable a broader vision of bone development in response to received loadings. At the same time, we suggest that it is necessary for a correct interpretation of the results to create a broad reference database (such as with specimens from Zeder 2001) to associate with a certain degree of reliability the different patterns of mobility detected in specific livestock practices. Correctly assessing the probable real practices behind different loading patterns is essential if we aim to understand the shifts in animal management strategies linked to Neolithization. Studying modern reference datasets with monitored-controlled factors affecting mobility regimes would help in the interpretation of our archaeological data.

As a matter of fact, we must underscore the need to continuously and actively search for, explore, and improve alternative techniques and methods of analysis in archaeozoology in order to complement, correct, or increase our knowledge of animal domestication. However much we already know, it is still just the tip of the hoof.

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# 1.2 | Pigs in Between

## Pig Husbandry in the Late Neolithic in Northern Mesopotamia

Max Price*

### Abstract

Stuck between the agricultural and urban revolutions, the Late Neolithic (LN; seventh and sixth millennia BC) often receives less attention from zooarchaeologists than other periods. However, recent data suggest that this period was defined by agricultural intensification and new forms of livestock management. Data from pigs and wild boar—both referred to in this paper as *Sus scrofa*—add to the developing picture of dynamic agricultural systems in northern Mesopotamia and southern Anatolia. Survivorship data indicate a diversity of pig slaughter strategies. Meanwhile, increasing rates of linear enamel hypoplasia (LEH) and the continued reduction in dental size, which follows a different pattern than postcranial metrics, are argued to be evidence of pig husbandry becoming more intensive in the LN. That is, pigs were increasingly penned, foddered, and kept away from wild boar, although wild boars were still used as a stocking resource. These patterns represent a shift from the more extensive "free-range" pig husbandry systems that likely dominated the region in the Pre-Pottery Neolithic. Alongside other forms of agricultural changes, the shifts in pig husbandry in the LN may have been connected to evolving foodways, agricultural expansion, and incipient forms of social complexity in the LN period.

### Keywords

*pigs,* Sus scrofa, *Late Neolithic, animal husbandry, linear enamel hypoplasia, biometrics, northern Mesopotamia, domestication, intensification, feasting*

## Introduction

One of the most exciting features of archaeological research in today's age of expanded scientific methods is the prospect of detecting subtle revolutions in economics and human behavior that had previously flown under the radar. Perhaps no period in Southwest Asian prehistory has been as understudied as the Late Neolithic (LN; seventh–sixth millennia BC). Perhaps no major form of animal husbandry has been as passed over as that of the domestic pig—*Sus scrofa.*

This chapter will focus on pig husbandry in northern Mesopotamia, the region where pigs were first domesticated in the eighth millennium BC (Ervynck et al. 2001; Helmer 2008; Zeder 2011). This paper explores how pig husbandry evolved in the millennia after initial domestication. I present evidence that LN communities initiated a process of husbandry intensification that represented a key turning point in the long-term history of the pig, a transition from the loose, extensive types of management that characterized the earlier part of the Neolithic toward a form of pig production more attuned to intensive garden and cereal agriculture.

## Unique Aspects of Pig Husbandry and Domestication

Physiologically and behaviorally, pigs are unique among the Old World mammalian domesticates. Omnivores capable of converting feed to meat calories more efficiently than sheep, goats, or cattle (Redding 2015:Table 3), pigs exhibit considerable

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dietary breadth. Dissections of wild boar stomach have revealed a variety of plants, animals, and fungi species, with a focus on high-calorie foods like nuts, mushrooms, insects, and seeds (Gimenez-Anaya et al. 2008). Pigs also mature and reproduce rapidly. Domestic sows can reach sexual maturity by around one year of age and produce two litters per year of ten or more piglets each (Bazer et al. 2001), while feral and wild sows usually produce one litter of four to six piglets per year beginning in their second year of life (Bazer et al. 2001; Bywater et al. 2010; Focardi et al. 2008; Mount 1968:35).

In terms of social behavior, wild and feral males tend to leave their natal herds at around one year old, remaining solitary or forming small bachelor herds (Spinka 2009). However, as pigs are only weakly territorial, males can wander into and out of sow groups—sounders—within relatively restricted home ranges of around 100–200 ha (Nowak 1999:1055). Sounders themselves are typically small, averaging around 2–5 sows and their offspring, usually about 20 pigs (Taylor et al. 1998).

Pigs can be managed in a number of ways. Under "intensive management," pigs are kept bound in sties for much or all of their lives. Such practices are ideal when land is scarce or when there is a desire to grow fat-rich meat quickly—such as for annual feasts or sale on the market (e.g., see Boyd 1985). "Extensive management" strategies describe those in which pigs are allowed to forage their own food, wandering into and out of villages and their neighboring catchment areas for much of their lives. Nevertheless, the bond with humans remains; extensively managed pigs typically return regularly to pens or human-provided food sources.

Several years ago, Redding and Rosenberg (1998) proposed that extensive pig husbandry best described the earliest domestic pigs in northern Mesopotamia, referring to a "New Guinea model" after the numerous cases of extensive husbandry in Papua New Guinea (for a full review, see Hide 2003). But modern examples of extensive pig husbandry derive from around the globe, including the Mediterranean region (Albarella et al. 2011; Hadjikoumis 2012; Halstead and Isaakidou 2011).

Zooarchaeological data corroborate Redding's hypothesis. The transportation of wild boar to Cyprus in the tenth millennium BC or earlier (Vigne 2015; Vigne et al. 2009) and the targeted hunting of juvenile males at Hallan Çemi (Peasnall et al. 1998; Rosenberg and Redding 1998) are indications of evolving relationships with *Sus scrofa* prior to morphological domestication. But the best data for pig domestication, occurring slowly in accordance with Redding's hypothesis, comes from the Pre-Pottery and Pottery Neolithic site Çayönü Tepesi. At Çayönü, Ervynck and others (2001) documented changes in suid biometrics, survivorship, and frequency of enamel hypoplasias. The authors showed three changes: a gradual reduction in body and dental size over the eighth through mid-seventh millennium BC, with a steady decrease in the smallest specimens at the site, likely domestic females; a trend toward younger kill-off, with most animals slaughtered between one and two years; and decreased rates of hypoplasias in the Pre-Pottery Neolithic—followed by an increase in the Pottery Neolithic. Ervynck et al. (2001) interpreted the slow rate of change and low rates of hypoplasias as indicative of extensive husbandry transitioning rather seamlessly from intensive hunting.

## The Pottery Neolithic

The LN in northern Mesopotamia (Figure 1.2.1) is defined here as beginning with the first use of pottery, around 7000 BC, and ending with the termination of the Halaf tradition at 5200 BC (Table 1.2.1). This period, while frequently depicted only as a chronological bridge between the agricultural and urban revolutions, in fact saw major developments in village life that set the stage for the development of socioeconomic inequality in later periods (Wengrow 2010:54).

The onset of the Pottery Neolithic coincided with the disappearance at around 7000 BC of the "PPNB interaction sphere," a tradition defined by interregional commonalities in ritual and technology (Bar-Yosef and Belfer-Cohen 1989; Bar-Yosef and Meadow 1995). The seventh millennium saw the regionalization of ritual and technological traditions as well as increased separation between sedentary and mobile components of societies (Akkermans and Duistermaat 1996; Verhoeven 2002). Pottery was coincidental to these changes; evidence from Jarmo and Sabi Abyad indicate that ceramic technology was added gradually and without any interruption in settlement and architectural patterns (Adams 1983; Nieuwenhuyse et al. 2010).

While the introduction of pottery did not represent a major cultural upheaval, it did have major sociopolitical ramifications by allowing for new

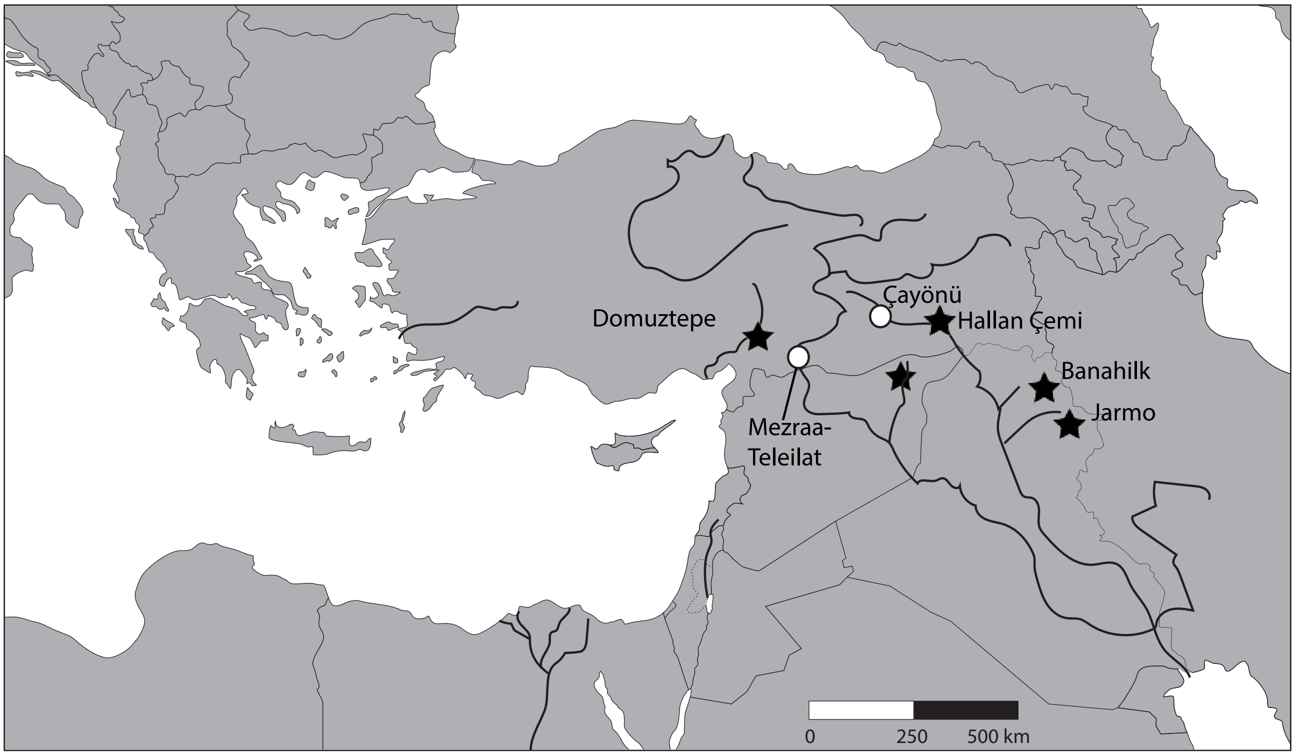

Figure 1.2.1. Map of northern Mesopotamia with sites used in this study.

Table 1.2.1. Chronology of the Late Neolithic in northern Mesopotamia, following summaries by Zeder (2011:S223), Aurenche et al. (2001), Campbell (2007), Hole (2001), Nieuwenhuyse et al. (2010), van der Plicht et al. (2011), Nishiaki and Le Mière (2005), Özdoğan et al. (2011).

| Date (approx. BC) | Major ceramic traditions in northern Mesopotamia | Sites discussed in this paper |
|---|---|---|
| 8000–7500? | Middle PPNB | Çayönü (Grill, Channel, Cobble),<br>Mezraa–Teleilat (Phase V) |
| 7500?–7000 | Late PPNB | Çayönü Tepesi (Cell),<br>Mezraa–Teleilat (Phase IV) |
| 7000–6500? | Pottery Neolithic, Jarmo Ware, Pre-Proto–Hassuna, Amuq A–B, Final PPNB | Jarmo,<br>Mezraa–Teleilat (Phases III and IIC),<br>Çayönü Tepesi (Large Room and PN) |
| 6500?–5900 | Proto-Hassuna, Hassuna, Samarra, Amuq B | Mezraa–Teleilat IIB–A |
| 5900–5200 | Halaf, Amuq C | Umm Qseir, Domuztepe, Banahilk |

methods of food storage, cooking, and presentation. Indeed, the use of pottery in the "commensal politics" of societies around the globe is well established (Bray 2003; Dietler 2001) and its introduction to northern Mesopotamia had major impacts on the social and political significance of food. Some of the earliest pottery in the region, for example, bears evidence of soot indicating cooking in clay pots (Nieuwenhuyse et al. 2010). New cooking methods, including stewing, boiling, and fermentation, would have been facilitated by pottery, altering what Wengrow (2010:44–49) has characterized as the roasting/bread-baking culinary culture of the Pre-Pottery Neolithic. Meanwhile, the elaboration of painted ceramics, especially during the Halaf (5900–5200 BC), suggests that this pottery facilitated new sociopolitical meanings of food presentation and consumption (Cruells and Nieuwenhuyse 2004; Nieuwenhuyse 2007; Nieuwenhuyse et al. 2010). In particular, feasting likely played an important social role throughout the Pottery Neolithic, serving to alleviate the risks of agricultural production and, perhaps, as a social-leveling mechanism through food sharing and reciprocity (Mottram 2016:46). This political use of food fits with our understanding of Pottery Neolithic societies' strong institutions of egalitarianism (Bernbeck 1995; Frangipane 2007).

In addition to new social uses of food, the LN was a period of expansion and crystallization of the "Neolithic Package" that cemented animal husbandry and intensive plant agriculture into the rhythms of daily life in northern Mesopotamia and neighboring regions (see Düring 2011:122). Beginning in the seventh millennium BC, domesticated crops and animals began appearing in southeastern Europe, Egypt, and South Asia (Arbuckle 2013; Zeder 2008). Within the core region of the Fertile Crescent, domestic animal and plant production took on a greater economic significance, although a few communities continued to rely heavily on hunting equids and gazelles—for example, Tell Zeidan (Grossman and Hinman 2013), Umm Qseir (Zeder 1994), and Umm Dabaghiyah (Bökönyi 1973). The LN also provides the first clear evidence for secondary product exploitation, including milk residues in ceramics (Evershed et al. 2008; Nieuwenhuyse et al. 2015), delayed kill-off of sheep and goats (Russell 2010), and the appearance of spindle whorls for spinning animal fibers (Rooijakkers 2012). Cattle husbandry, too, expanded dramatically in the sixth millennium BC (Arbuckle et al. 2016). Meanwhile, agricultural intensification is indicated by enrichment in $\delta^{15}N$ in plant seeds and animal bones recovered from LN sites, indicative of manuring (Bogaard 2005; Bogaard et al. 2007; Styring et al. 2017).

The communities that relied most on hunting were concentrated in or on the margins of the more arid grassland parts of northern Mesopotamia. These areas, receiving less average yearly rainfall than the hilly regions to the north and east, would have been particularly sensitive to climate change. The aridification at around 6200 BC—the "8.2 ka event"—represented a major challenge to village life in these areas, and communities may have adapted to the changes by relying more heavily on hunting grassland species. Climatic downturn probably also affected agricultural practices, including pig husbandry. At Tell Sabi Abyad, for example, Russell (2010) has argued that aridification led to the near abandonment of pig husbandry. But it is also possible that, at other sites, climate change and perhaps the retreat of forests (see Willett et al. 2016) pushed people to adopt more intensive forms of pig husbandry as ecosystems that supported the traditional extensive husbandry disappeared.

## Pigs in the Late Neolithic

Pigs were typically a secondary or even tertiary component of the animal economy in LN northern Mesopotamia, making up 1–30% of the recovered mammalian fauna (Table 1.2.2). Domestic sheep and goats predominated, and cattle made significant contributions as well. Wild taxa, especially gazelle and onagers, were also exploited.

## Methods Employed in the Documentation of Pig Husbandry

Globally, in most husbandry systems, the majority of pigs are culled between the ages of six months and two years. However, because pig populations grow rapidly, livestock owners do not need to manage their demographics as tightly as ungulates. As a result, slaughter patterns are often dictated by culturally contextual consumption goals, such as taste preference—for example, bacon hogs *versus* sucklings—or the scheduling of feasts/markets, rather than resource-maximizing production goals, strictly speaking, such as herd growth or efficiently achieving optimal slaughter weight. In other words, because pigs breed quickly and produce many offspring, humans can schedule their slaughter in a flexible manner. They need not follow economically "rational" models such as those that have proven so useful for modeling the management of ungulate species. Thus, while the most commonly employed zooarchaeological technique for understanding ancient husbandry practices is survivorship or kill-off analysis, this method tells us less about pig production strategies than it does for other animals.

An expanded zooarchaeological toolkit can shed significant light on pig husbandry. Biometrics and Geometric Morphometric Methods (GMM), especially of post-canine teeth, allow assessment of the

Table 1.2.2. Late Neolithic sites in northern Mesopotamia showing the NISP (Number of Identified Specimens) of *Sus* specimens and the relative abundance of pigs among the four domesticate species only—sheep, goat, cattle, pigs. Note that some sites, especially Umm Dabaghiyah and Umm Qseir, are dominated by wild taxa. Bold site names are those included in this study.

| Site | Dates (BC) | NISPSus | %Sus | Reference |
|---|---|---|---|---|
| Feyda | Early 7th mil. | 2 | 1% | Zeder 1998 |
| **Jarmo, JI levels 1–3; JII lev. 1–5** | **7000–6500** | **241** | **8%** | **Stampfli 1983** |
| Umm Dabaghiyah | Early 7th mil.? | 66 | 10% | Bökönyi 1973 |
| Damishliyah | 6600–6400 | 52 | 15% | Russell and Buitenhuis 2008 |
| Matarrah | Late 7th mil. | 37 | 30% | Stampfli 1983 |
| Sabi Abyad | 7th–6th mil. | | 4–16% | |
| Sabi Abyad I, Op. III A levels | 6900–6200 | 1,181 | 9% | Russell 2010 |
| Sabi Abyad I, Op. I levels 7–11 | 6500–6000 | 92 | 5% | Cavallo 2000 |
| Sabi Abyad I, Op. III B levels | 6200–5900 | 128 | 4% | Russell 2010 |
| Sabi Abyad I, Op. I levels 4–6 | 6000–5900 | 164 | 8% | Cavallo 2000 |
| Sabi Abyad I, Op. I levels 1–3 | 5900–5800 | 380 | 16% | Cavallo 2000 |
| Sabi Abyad I, Op. III C levels | 5900–5700 | 41 | 8% | Russell 2010 |
| Kashkashok I | 5800–5500 | 30 | 10% | Zeder 1998 |
| **Banahilk** | **5700–5200** | **163** | **16%** | **Laffer 1983** |
| Hajji Firuz, A1–D | Early 6th mil.? | 71 | 29% | Meadow 1975 |
| Zeidan, Halaf phases | 5900–5200 | 7 | 6% | Grossman and Hinman 2013 |
| **Umm Qseir, Halaf phases** | **5900–5700** | **318** | **30%** | **Zeder 1994** |
| Kurdu, Trench 12&16, Amuq C | 5500–5200 | 544 | 9% | Özbal et al. 2004 |
| Shams ed-Din | 6th mil. | 11 | 2% | Uerpmann 1982 |
| **Domuztepe** | **5900–5400** | **1,529** | **28%** | **Kansa et al. 2009** |

dynamics of suid physiology, the effects of domestication, and, potentially, cases of hybridization and feralization (Albarella and Payne 2005; Balasse et al. 2016; Cucchi et al. 2009; Evin et al. 2013, 2014; Payne and Bull 1988; Rowley-Conwy et al. 2012).

Linear enamel hypoplasia (LEH) can provide insight into pig health, diet, and management (Dobney and Ervynck 2000; Dobney et al. 2002, 2004; Ervynck and Dobney 1999; Ervynck et al. 2001). LEH reflects the disruption of amelogenesis due to a number of possible stressors—such as incidence of disease, localized trauma, and heritable anomalies—but it is frequently associated with metabolic stress due to dietary deficiency (see Goodman and Rose 1990:64). Moreover, the location of LEH on teeth can indicate the timing of stressors in an animal's development (Dobney et al. 2004). Because stressors must be survived to be recorded on teeth, LEH is subject to the "osteological paradox" (Wood et al. 1992), whereby the observation of higher rates of pathologies can indicate one of two seemingly contradictory scenarios: (1) a population was under more stress, or (2) it was subjected to fewer incidents of lethal stress. In fact, both higher rates of stress and higher survivorship of stressor are expected to increase in a managed population, leading to a higher incidence of LEH.

## Materials and Methods

In order to address more directly the problem of pig husbandry in the LN, I collected biometrical, survivorship, and LEH data from four sites:

Table 1.2.3. Collections analyzed in this study, their principal analysts, and their current location.

| **Site** | **Principal zooarchaeologist(s)** | ***Analysis ongoing?*** | **Location of collection** |
|---|---|---|---|
| Jarmo | Hans Stampfli | No | Field Museum |
| Banahilk | Joanne Laffer | No | Field Museum |
| Domuztepe | Sarah Kansa and Hannah Lau | Yes | Kahramanmaraş Archaeological Museum |
| Umm Qseir | Melinda Zeder | No | Smithsonian Institution |
| Hallan Çemi | Richard Redding and Melinda Zeder | Yes | Smithsonian Institution |

(1) Qalat Jarmo, a Final PPNB to Pottery Neolithic village (ca. 7000–6500 BC) located in the Zagros foothills (Braidwood 1983; Price and Arbuckle 2015; Stampfli 1983).
(2) Umm Qseir, a small Halaf pioneer settlement (ca. 5900–5700 BC) located on the banks of the Khabur River and adjacent to the grassland steppe of the Syrian Jezireh (Hole 2001; Zeder 1994).
(3) Gird Banahilk, a Halaf village (ca. 5700–5200 BC) located in the Zagros foothills (Laffer 1983; Lawn 1973; Watson 1983).
(4) Domuztepe, a large (20 ha) Halaf site (ca. 5900–5400 BC) located in a marshy area in the Kahramanmaraş Valley (Campbell 2007; Kansa et al. 2009; Lau and Kansa 2018).

For a comparative assemblage, data were also collected from a fifth site, Epipaleolithic Hallan Çemi, which is located in the foothills of southern Anatolia (Peasnall et al. 1998; Rosenberg 1994). When available, I used published data from the PPN and PN sites of Çayönü Tepesi (Ervynck et al. 2001; Hongo and Meadow 1998) and Mezraa–Teleilat (İlgezdi 2008), both located in southern Anatolia (Figure 1.2.1).

The four LN sites and Hallan Çemi were chosen on the basis of:

(1) their high numbers of pig bones and teeth;
(2) accessibility, especially in light of the ongoing political turmoil in Syria and southern Turkey;
(3) their geographic spread, which includes sites in the foothills of the oak–pistachio belt of the Zagros (Jarmo, Banahilk) and Taurus Mountains (Hallan Çemi), the environments where pigs were first domesticated.

It should also be noted that I did not conduct preliminary analysis on the faunal assemblages, nor did I analyze nonsuid material. More thorough and standard zooarchaeological analyses of these assemblages have been conducted by other researchers and in some cases are ongoing (Table 1.2.3). Permission to analyze the material for this study was granted by the respective institutions in coordination with the principal zooarchaeologist, when possible.

A comparative study such as this can run into several analytical challenges. The first is the well-known palimpsest problem: archaeological data, especially those deriving from predominantly secondary contexts such as animal bones, represent the accumulation of discard activities taking place over the span of years or even decades (Bailey 2007; Lyman 2007). Drawing inferences from time-averaged deposits as if they were moments in time is problematic. The results presented here should be taken not as a concrete statement of the exact type of pig husbandry practiced at each site, which may have varied considerably, but rather a time-averaged estimate of pig-management strategies. Second, and related, is the analytical lumping of contexts potentially created by diverse activities. Indeed, two sites sampled here contain evidence for a mix of feasting and more mundane household refuse. The first is Hallan Çemi, where a large pit at the center of the site—located within excavation Square 6F—supplied over half the remains used in this study. The second is Domuztepe, where around 20% of the sampled remains derive from a deposit thought to be associated with feasting activity—the Ditch in Operation 1 (Lau 2016). Comparing these contexts to those containing everyday household waste is important, especially for understanding socioeconomic dynamics. However, for this study, I will only consider the data in aggregate.

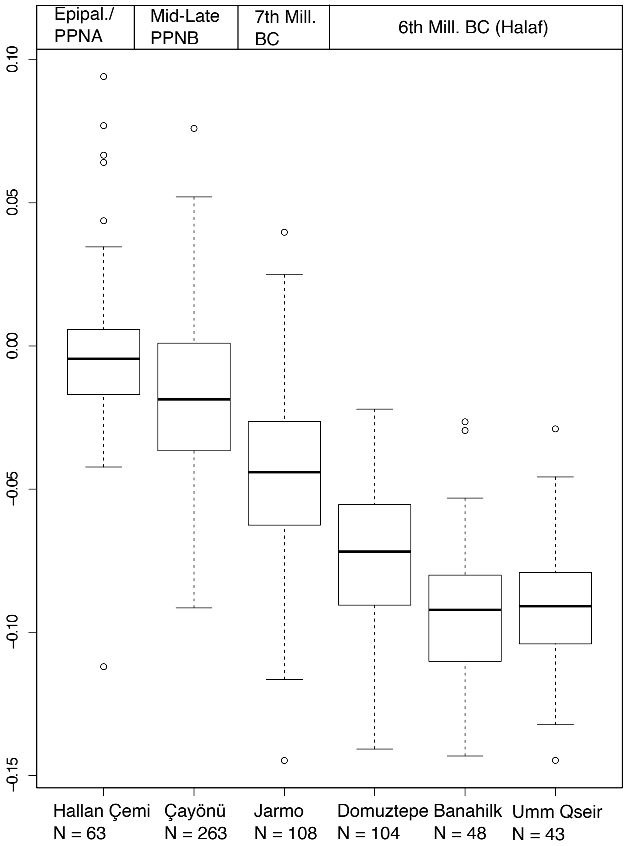

Figure 1.2.2. Log-Size Index (LSI) values for dental breadths (M1–M3 WA and WP) based on the standard values derived from wild boar from Kizilcahamam, Turkey, published by Payne and Bull (1988). Data from Çayönü published by Kusatman (1991).

Biometrics included postcranial and dental measurements published by Payne and Bull (1988) and later examined by Albarella and Payne (2005). Following these studies, dental breadths were used to estimate the proportions of wild and domestic pigs. To combine measurements, the Log-Size Index (LSI) method was used (Meadow 1999). Raw metrical and other data are available on Open Context (Price 2015).

For survivorship, I used Lemoine and colleagues' (2014) ageing classification system and their simplified–A age class assignment protocol. Most teeth were loose or in fragmented jaws. To maintain independence of specimens, I only considered jaws with either dP4s or M3s and took a maximum of right or left specimens assigned to each age class.

LEH was examined following the protocols set forth by Dobney and Ervynck (1998). LEH lines were recorded and measured from the cementum-enamel junction on first through third molars. Translating LEH features into meaningful statistics is complicated. The original calculation by Dobney and Ervynck (2000) that employs only mandibular teeth is cumbersome, but it takes into consideration variation in the numbers of different tooth types between teeth. A simpler metric of % teeth affected was also calculated using both mandibular and maxillary teeth.

## Results

### *Biometrical Data*

Size reduction in teeth and postcranial bones over the course of the LN indicates continued morphological change in pigs in the millennia after their initial domestication. Mean dental LSI declined from -0.043 at Jarmo, occupied in the early seventh millennium BC, to -0.082 for the combination of sixth-millennium Halaf-associated sites of Domuztepe, Umm Qseir, and Banahilk (Figure 1.2.2). This translates to a size decrease of about 9%, similar to that between Jarmo and the morphologically wild boar from Hallan Çemi (mean LSI = -0.002). Similarly, examination of the lower fences, which tracks size change in the smallest pigs in each assemblage (Ervynck et al. 2001), showed a steady reduction over time, with the smallest size achieved at LSI = -0.14 in the sixth-millennium assemblages (Price and Evin 2019).

There is, however some inter-site variability; mean dental size is smaller at Umm Qseir and Banahilk (mean LSI = -0.092) than at Domuztepe (mean LSI = -0.073). But on the whole, by the end of the LN, average pig dental size was about 20% smaller than the wild boar from Hallan Çemi. However, wild boar remained present in the assemblages. Domuztepe and, especially, Jarmo show a high degree of overlap with the dental size range of wild boar. In another paper, mixture modeling and linear discriminant analysis of geometric morphometric shape data were employed to estimate that wild boar—and probably hybrids—composed around 22–30% of the Domuztepe assemblage and 53–52% of the Jarmo assemblage (Price and Evin 2019).

Like teeth, the average size of the postcranial skeleton (Figure 1.2.3 and Figure 1.2.4) decreased about 20% from a mean LSI of 0.016 at Hallan Çemi to -0.072 at the sixth-millennium sites. However, unlike in the situation with teeth, there was only a

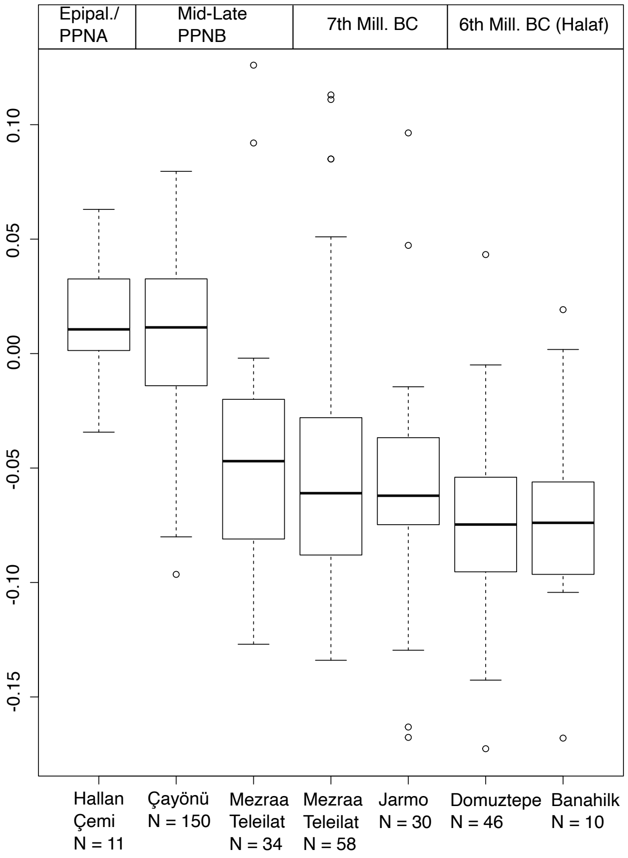

Figure 1.2.3. Log-Size Index (LSI) values for postcranial breadth and depth measurements. Çayönü data from Kusatman (1991), Mezraa–Teleilat data from İlgezdi (2008). LSI based on the standard values published by Payne and Bull (1988).

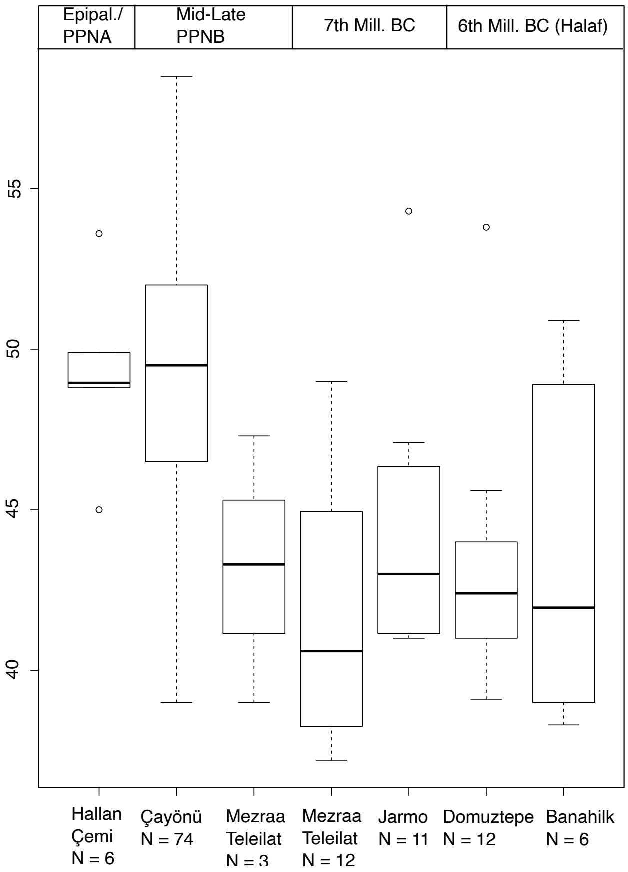

Figure 1.2.4. Astragalus GLl measurements (in mm). Çayönü data from Kusatman (1991), Mezraa–Teleilat data from İlgezdi (2008).

minor reduction in the postcranial skeleton between seventh-millennium Jarmo (mean LSI = -0.062) and the sixth-millennium sites (mean LSI = -0.072). Thus, while dental metrics suggest continued and gradual craniofacial shortening throughout the seventh and sixth millennia BC, postcranial metrics indicate that mean body size diminished rapidly in the earliest phases of domestication and then remained relatively stable during the succeeding millennia.

### *Survivorship*

Table 1.2.4 presents survivorship data. In general, the majority of pigs at Jarmo and Banahilk were killed prior to one year of age, with a third or more slaughtered in the first sixth months of life. Very few (ca. 10–15%) pigs at these two sites survived their second birthday. The situation is much different at Domuztepe, where half to two-thirds of pigs survived their first birthday, a pattern consistent with the wild boar at Epipaleolithic Hallan Çemi and also similar to the slaughter pattern at PPN levels at Çayönü, where around 50% survived their first birthday (Ervynck et al. 2001:54).

The data thus indicate diversity in slaughter timing in the LN. Some sites, like Domuztepe, contained higher numbers of older animals. To some extent, this might be due to the contribution of wild boar or hybrids noted in that assemblage by Price and Evin (2019). Combining the metrical data with the survivorship data, there is some evidence to suggest that wild/feral/hybrid *Sus* survived to older ages: of 15 lower M3s, those with wear stages a–b (7–8 in Lemoine et al. 2014)—indicating slaughter prior to about 30 months old—displayed a mean WA of 15.1 mm (N = 6), while those with wear stages c or older displayed a mean WA of 15.7 mm (N = 9). However, at Jarmo, which had a higher proportion of morpho-

Table 1.2.4. Survivorship data from four sites arranged in chronological order from Hallan Çemi (eleventh millennium BC) to Banahilk (sixth millennium BC). Percent indicates the proportion of animals that survived past each age class. Error ranges indicate 95% confidence interval limits. Number parentheses indicate number of mandibles assigned to each age class. Umm Qseir (sixth millennium BC) excluded due to small sample size.

| **Age class** | **Hallan Cemi (Epipal.)** | **Jarmo (PN)** | **Domuztepe (PN)** | **Banahilk (PN)** |
|---|---|---|---|---|
| A (< 1 month) | 95% ± 8 (2) | 95% ± 7 (2) | 96% ± 8 (1) | 100% (0) |
| B (3–5 mos.) | 80% ± 12 (6) | 63% ± 14 (13) | 83% ± 16 (4) | 71% ± 22 (4) |
| C (6–12 mos.) | 66% ± 14 (6) | 30% ± 15 (10) | 58% ± 21 (7) | 43% ± 22 (4) |
| D (12–16 mos.) | 59% ± 14 (3) | 32% ± 15 (3) | 46% ± 21 (3) | 29% ± 22 (2) |
| E (16–30 mos.) | 32% ± 14 (11) | 12% ± 10 (8) | 21% ± 13 (6) | 14% ± 21 (2) |
| F (30–72 mos.) | 15% ± 10 (7) | 2% ± 5 (4) | 4% ± 12 (4) | 0 (2) |
| G (> 72 mos.) | 0 (6) | 0 (1) | 0 (1) | 0 (0) |
| **Mandibles** | **41** | **41** | **26** | **14** |

logically wild boar, younger kill-off was not skewed toward smaller animals (see raw data in Price 2015). While differences in husbandry practices or the inclusion of hunted wild boar in the assemblages might explain these patterns, I suggest that taste or seasonal slaughter schedules likely had the largest impact.

### *Linear Enamel Hypoplasia (LEH)*

The incidence of hypoplastic defects on domestic pigs is expected to be higher than in wild animals because (1) domestic animals are exposed to novel sources of stress compared to the wild and/or (2) under human care, higher proportions of animals are expected to have survived episodes of stress. Empirically, higher rates of LEH are seen on domestic pigs than wild boar: of 48 teeth dating to the eleventh–third millennium BC determined by GMM to wild or domestic status, 58% (18/34) of domestic specimens were affected by LEH and only 29% (4/14) of wild ones (Price 2016). One would also expect higher levels of LEH in pigs raised under more intensive conditions—they would be exposed to potentially more stressful environments, but also less vulnerable to extreme temperatures and predation.

Figure 1.2.5 shows the incidence of LEH, using two different quantification methods. The first is the index value described by Ervynck and Dobney (1999), which includes only lingual cusps of lower molars and accounts for the differing numbers of tooth types present. The second is a more straightforward ratio of molar teeth—upper and lower—with visible hypoplastic defects, which can be compared to the data published from Çayönü by Ervynck and others (2001).

Among the datasets studied here, the data show low levels of LEH at Epipaleolithic Hallan Çemi and seventh-millennium Jarmo, with roughly 20% of teeth affected by defects. Incidence of LEH increased in the sixth millennium BC (Halaf period), with the highest levels reached at Banahilk and Domuztepe. The ratio is much higher at Çayönü (reported in Ervynck et al. 2001) in both the PPN and the PN, with a large increase in the PN. In fact, the ratios at Çayönü are higher than any of the sites in this study. The difference is possibly an artifact of interanalyst variability in detecting LEH marks or, perhaps, the insecure dating of the PN levels at this site; there is at least one Halaf sherd in the ceramic assemblage (see Özdoğan and Özdoğan 1989:66). On the other hand, the pattern of LEH increase at PN Çayönü is generally consistent with the overall pattern of increasing proportions of teeth affected by hypoplasias.

Table 1.2.5 indicates that the higher rates of LEH disproportionately affected second and third molars. The pattern is clearer in the lower teeth than the upper teeth. In lower M1s (formed *in utero*–1 month), rates of LEH were consistently around 25%, indicating that peripartum levels of stresses/survivability remained consistent over time. LEH rates on the M2 (1–7 months) and M3 (3–13 months), however, in-

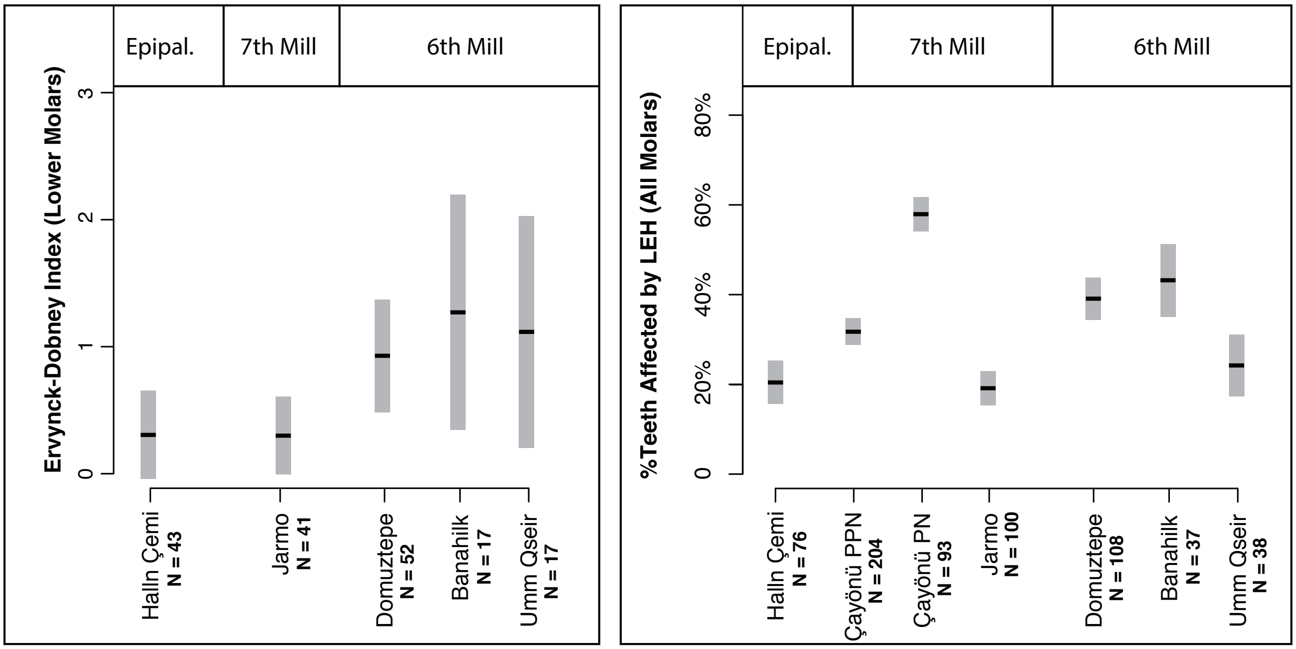

Figure 1.2.5. Rates of linear enamel hypoplasia (LEH) using the quantification method described by Ervynck and Dobney (1999; left) and the proportion of affected teeth in each assemblage (right). Çayönü data from Ervynck et al. (2001).

creased markedly from around 20–30% in the Hallan Çemi and Jarmo assemblages to 40–60% in the sixth millennium, with the exception of the Halaf pioneer settlement of Umm Qseir. This increase likely reflects greater survivability of stresses during weaning, perhaps provisioning of weaning foods by humans and their protection of weaker piglets from predation and hypothermia (cf. Ervynck and Dobney 1999), and/or greater stresses—for example, increased pathogen load—caused by confinement of growing pigs.

## Discussion and Conclusions

The data indicate considerable dynamism in pig husbandry in northern Mesopotamia during the seventh and sixth millennia BC. I argue that these changes reflect a process of husbandry "intensification" in which pigs were increasingly confined to pens for longer periods of time. This shift was probably gradual, piecemeal, and intimately connected to other changes in LN agriculture and society.

The gradual and continual reduction in dental biometrics over time likely relates to two—probably interconnected—processes facilitated by increased use of penning. The first is the evolution in craniofacial morphologies toward shorter snouts, a trend consistent with the neoteny of domestic animals and perhaps a reflection of increased selection pressure for tameness (Price 1999). The second is the declining rate of wild boar admixture, which was inevitable once domestic pigs were confined to pens. Interestingly, the reduction in dental size followed a somewhat different pattern than that of postcranial size, which dropped rapidly in the earliest phases of the domestication process but only marginally afterwards. Postcranial growth, perhaps more plastic than dental size and shape, appears to have been under greater selection pressure early on but less in later periods. These divergent patterns highlight the need for zooarchaeologists and biologists to better understand the unique selective pressures involved in domestication.

The LEH data are another indication of husbandry intensification. The increase in hypoplasias, especially on the second and third molars indicates either heightened levels of stress or increased rates of stress survival—or both. Intensification can explain both patterns. As pigs were moved to pens, they would have become more heavily reliant on humans to supply their food. This could result in shortages, especially in periods of drought, harvest failure, or simply seasonal shortages. In these cases, the reversion to more extensive husbandry may

Table 1.2.5. Rates of teeth affected by LEH (Linear Enamel Hypoplasia) by type with sites arranged in chronological order. Numbers in parentheses indicate number of specimens.

| Site | $M_1$ | $M_2$ | $M_3$ | $M^1$ | $M^2$ | $M^3$ |
|---|---|---|---|---|---|---|
| Hallan Çemi | 23% (13) | 36% (14) | 19% (16) | 7% (15) | 25% (8) | 40% (10) |
| Jarmo | 26% (23) | 23% (13) | 20% (5) | 13% (31) | 17% (18) | 20% (15) |
| Domuztepe | 26% (20) | 50% (12) | 55% (20) | 20% (25) | 47% (19) | 42% (12) |
| Banahilk | 28% (7) | 60% (5) | 60% (5) | 36% (11) | 57% (7) | 0% (2) |
| Umm Qseir | 25% (12) | 40% (5) | (0) | 0% (8) | 0% (8) | 80% (5) |

have been attractive, but the dangers posed by roaming pigs to crops and other livestock, not to mention the risk of losing pigs to poachers, may have led pig owners to keep their pigs penned even if doing so risked weight loss. Additionally, under greater protection from predators and the elements, vulnerable pigs were probably better able to survive episodes of stress within their pens. Both the increased vulnerability to food shortages and the increased ability to survive them explain the rise in LEH.

It remains unclear how new husbandry regimes impacted slaughter schedules. At first glance, there appears to be little impact; there was late slaughter of intensively raised pigs at Domuztepe, early slaughter of extensively managed pigs at Jarmo, and early slaughter of intensively managed pigs at Banahilk. I have suggested that other factors—taste or seasonality—may have been more determinative of slaughter practices. Still, the intertangled relationship between production and consumption would suggest that, in the long run, the movement to more intensive husbandry practices may have provided new opportunities and imposed new limitations on slaughter schedules. Future research should explore this question in greater depth.

Other studies, too, suggest pig husbandry intensification in the seventh–sixth millennia BC. Weber and Price (2016) identified gelatinized starch granules on teeth of morphologically domestic pigs from Domuztepe, suggesting the consumption of cooked food or food waste. Six others suid teeth from Domuztepe, including two from morphologically wild specimens, contained starch granules of oat (*Avena* sp.) and barley (*Hordeum* sp.) that had been damaged in a manner consistent with grinding/processing. Potentially, this suggests feeding household refuse to pigs and perhaps captured wild boar or hybrids. An alternative scenario is that wild boar scavenged village refuse.

More direct evidence for penning is the burnt pig skeletons found at Mezraa-Teleilat. These were found within the walls of a house: Building AY Phase IIB2, which dates to the mid–late seventh millennium BC (İlgezdi 2008; Özdoğan et al. 2011). These pigs included one animal aged two years, two one-year-olds, and two one-month-old piglets (İlgezdi 2008:161, Plates 195–101). Although it is possible that these represent ritual offerings, İlgezdi (2008) argues that they represent the remains of pigs raised within the house that were trapped in an accidental fire.

The question remains as to why people were intensifying pig husbandry in the LN. Deforestation may have limited the capacity of local environments to support extensive husbandry systems. Alternatively or at time same time, intensive pig husbandry might have been a response to the intensification of cereal production. Keeping pigs away from agricultural fields would be necessary to prevent both damage to crops and conflicts between pig owners and crop growers. The expansion of domestic cattle husbandry might also have reduced the space within a settlement's catchment area available for raising free-ranging pigs. Penned pigs, on the other hand, offer two advantages to an increasingly intensive agricultural regime. Not only does penning keep pigs out of fields, it also enables farmers to collect pig manure more easily and use it for intensive garden agriculture. Indeed, pigs' omnivorous diets make their feces particularly rich in nitrogen (e.g., Pratt and Castellanos 1981).

Intensive pig husbandry is also more productive than extensive forms. It is possible that the intensification of pig husbandry related to social demands for feasts of pork. In Papua New Guinea, the intensification of pig husbandry has been linked to feasting (Blanton and Taylor 1995; Boyd 1985). In one case, the entire village of Irakia Awa decided to shift to intensive pig husbandry in order to better supply feasts and enrich themselves through exchange—which they were able to achieve through an increase in pig herd size of around 30% following the adoption of intensive management strategies (Boyd 1985). The identification of discrete feasting deposits in the LN remains sparse, but feasting has been discussed at the Ditch feature at Domuztepe where pigs represented about 23% of the animal bones (Campbell et al. 2014:46).

The data presented here suggest that pig husbandry intensification occurred in the late seventh–sixth millennium BC. However, the hypothetical scenarios discussed above remain to be tested. More and different types of data are needed to understand the timing, spread, and impact of changing pig husbandry practices in the LN. Important will be more in-depth analyses of pig husbandry at other LN sites, especially those with large numbers of pig remains like Tell Sabi Abyad and Tell Kurdu. Was pig husbandry intensification a pan-regional phenomenon closely linked to the intensification of other forms of agriculture? How did the process of intensification unfold at each site? The expansion of new scientific methods in zooarchaeology, which open up new avenues for reconstructing ancient animal husbandry, are promising tools for answering these and other questions.

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# 1.3 | Stable Isotope Evidence for Animal Husbandry Practices at Prehistoric Monjukli Depe, Southern Turkmenistan

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## Abstract

Using stable carbon ($\delta^{13}C$) and oxygen ($\delta^{18}O$) isotope ratios of caprine tooth enamel from the Aeneolithic site of Monjukli Depe in southern Turkmenistan, this study investigates diet and seasonal movement of livestock. The carbon isotope profiles of some of the sequentially sampled third molars indicate a supply of $C_3$-plant-based forage year round, while the data from other teeth point to a seasonal contribution of $C_4$ plants. Considered in combination with archaeobotanical data, the first pattern likely relates to permanent use of pasture grounds in the closer vicinity of the site. In cases of varying carbon isotope ratios along the teeth, the highest $\delta^{13}C$ values co-occurred with the lowest $\delta^{18}O$ values. Contradicting expectations of enhanced availability of $C_4$ plants in summer, this finding indicates larger shares of this forage in winter and a prevalence of $C_3$ plants in summer. Among the possible explanations, stockpiling of winter forage containing $C_4$ plants and movement into the desert fringes during winter seem more likely than the use of upland pastures in summer. The study indicates diverse feeding practices and herding into a range of consciously selected habitats and illustrates intimate knowledge of the local ecology by those who tended the animal herds.

## Keywords

*Aeneolithic/Chalcolithic, oxygen and carbon isotopes, tooth enamel, sheep and goat, diet, mobility, seasonality, upland herding, steppe, desert, stockpiling*

## Introduction

Early forms of vertical seasonal mobility, where pastoralists and their herds moved between summer pastures in mountain regions and winter camps in the lowlands, are increasingly discussed in the archaeological literature of western Asia (e.g., Abdi 2003, 2015; Alizadeh 2010; Hole 2009; Potts 2014; Sumner 1994). Such kinds of pastoral nomadism are hypothesized for many places during the fifth millennium BC but most insistently for the area of the Aeneolithic Bakun tradition in southwestern Iran. In support of such scenarios of early pastoral lifeways, similarities with mobility patterns of today's pastoral nomadic societies in the same regions are assumed. Groups such as the Qashqai and Bakhtiari nomads serve as a basis for these reconstructions (Alizadeh 1988, 2003, 2010). This approach has also, however, been sharply criticized, particularly by Potts (2010, 2013), who insisted that there is no hard-and-fast empirical evidence for widespread mobile herding practices in prehistoric Iran.

We use data from a similar period and a region adjacent to the Iranian highlands (southeastern Turkmenistan) to test both the mobility scenario and its opposite, namely, the idea of sedentary village occupations. The point is not to refute one of these two scenarios and thus confirm the other but rather to investigate "degrees" and "variants" of mobility in fifth-millennium BC southern Turkmenistan. More specifically, this will be attempted based on data from the late Neolithic and early Aeneolithic levels (ca. 6000–4300 BC) of Monjukli Depe (Heit 2019). Archaeozoological and archaeobotanical studies have

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documented a subsistence economy based heavily on sheep- and secondarily goat-herding as well as crop cultivation on the fertile loess sediments that characterize the region. Hunting played only a minor role. Data on caprine age-at-death distribution and sex ratios suggest the exploitation of meat and milk products and do not indicate seasonal absence of animals (Benecke 2011, 2018; Eger 2018; Miller 2011; Ryan 2011). Nonetheless, seasonal mobility may have been important in buffering seasonal fodder shortages and water scarcity. Herders may have moved their herds to seek different types of grass from a variety of pastures and to access periodically fresh high-quality grazing areas in order to ensure herd survival and avoid overgrazing. It has also been proposed that agriculture and herding do not integrate harmoniously because goats in particular eat the growing crops. Herders might have solved this problem by moving the herds far from cultivations during the growing season (Bernbeck 1992:85; Köhler-Rollefson 1988:90). Better pastures might have prevailed seasonally in the Kopet Dag Mountains, so that vertical moves with herds could have been an attractive option. However, it has also been observed that the vegetation in the lowland Karakum Desert and on the piedmont strip can be used as high quality, permanent or seasonal pastures (Dolukhanov 1981:369–371). Therefore, horizontal shifts entailing movement out of a settlement's direct environment or possibly further away into the edges of the desert might have been practiced.

Analyses of stable oxygen ($\delta^{18}O$) and stable carbon ($\delta^{13}C$) isotopes were conducted on caprine—sheep (*Ovis aries*) and goat (*Capra hircus*)—teeth from the Monjukli Depe faunal assemblage. Stable oxygen isotope values of tooth enamel can provide information on seasonal temperature changes: higher values being correlated with warmer temperatures in summer and lower values being associated with colder temperatures in winter. Moreover, oxygen isotopes reflect hydrological and climatic conditions that can vary spatially with altitude, latitude, and distance from the sea (Delgado Huertas et al. 1995; Fricke and O'Neil 1996; Tütken 2010). Carbon isotope ratios reflect forage composition with regard to $C_3$ and $C_4$ plants (Cerling and Harris 1999; Tieszen 1991; Zazzo et al. 2000). In combination, they can offer important insights into animal husbandry strategies.

We applied stable carbon and oxygen isotope analyses in order to examine whether seasonal herd movements played any role in this prehistoric society and to characterize the feeding practices of domestic herbivores. More specifically, the analysis aimed at identifying whether the composition of the diet of domesticated animals varied seasonally. If so, which dietary components prevailed in warmer periods and which in colder ones? Do sampled teeth show similar patterns, or are there differences that imply variation in feeding? Moreover, do the observed patterns relate to vertical or other types of horizontal herd movements, or might they imply a complex combination of both? This study is part of an ongoing multi-isotope investigation that examines food resources, animal husbandry, and mobility patterns of the dominant animal taxa—sheep/goat—at the site. The aim is to gain a better understanding of the codevelopment of humans and caprines as well as their interactions over the time of the settlement's occupation.

## Archaeological Context

The site of Monjukli Depe is a small settlement located in the piedmont zone of the Kopet Dag on the eastern edges of the gravel fan of the Wadi Meana, close to the present-day Turkmen–Iranian border and just south of the Karakum Desert (Figure 1.3.1).

The ancient village lies approximately 8 km to the east of the Kopet Dag's foothills and is situated between two streams, Meana and Chacha. They emerge from the mountains and flow south–north. Today, both streams carry water only seasonally. However, palaeoenvironmental investigations that examined landscape changes from the Pleistocene until modern times suggest a denser and more diverse flora and fauna than that observed today (Berking et al. 2017; Berking and Beckers 2018). Archaeological research was undertaken by a team from the Free University of Berlin under the direction of S. Pollock and R. Bernbeck from 2010 to 2014 (Bernbeck et al. 2012; Bernbeck and Pollock 2016; Pollock and Bernbeck 2011; Pollock et al. 2013, 2018, 2019). This work was preceded by a stratigraphic sounding excavated by A. Marushchenko in 1959 and an exposure of the site's uppermost levels by Marushchenko and O. Berdiev in the early 1960s (Berdiev 1972, 1974). The goals of the ongoing research project include an examination of the site's stratigraphy and chronology, of technological changes within the further mentioned prehistoric periods in the

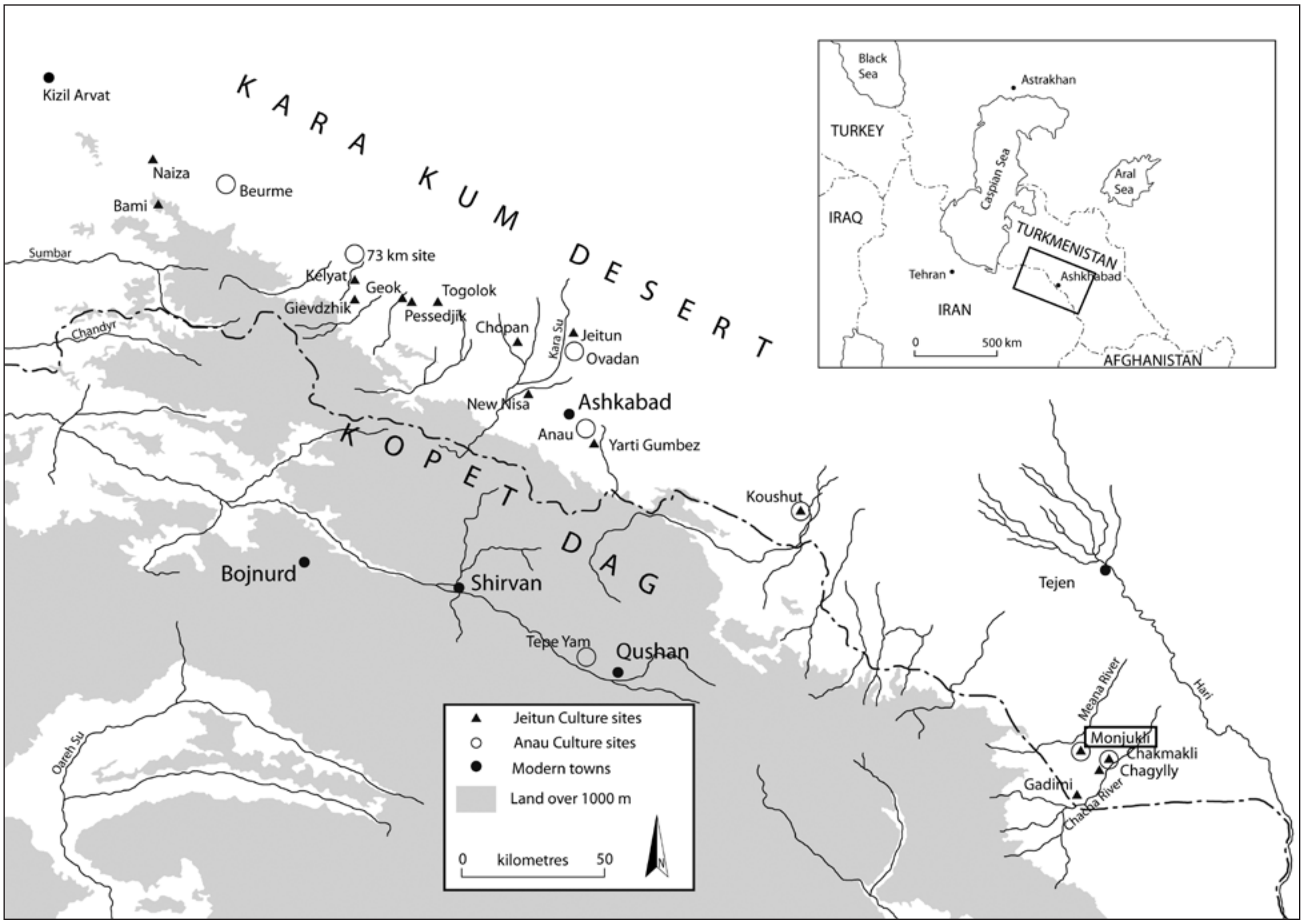

Figure 1.3.1. Monjukli Depe between the two rivers, Meana and Chacha, as well as other sites with Neolithic—Jeitun Culture—and Aeneolithic—Anau IA Culture—material. (Modified from Pollock and Bernbeck 2011:Figure 1.)

northeastern part of the Kopet Dag foothills, and of intrasettlement variability within the Aeneolithic village. Excavated levels date to the late Neolithic (ca. 6000–5650 BC) and early Aeneolithic period (ca. 4800–4350 BC). Contrary to the conclusions of the early research, the recent project has demonstrated that there was a lengthy hiatus of about 850 years between the Neolithic and earliest Aeneolithic levels at the site (Bernbeck and Pollock 2016; Heit 2019). The Aeneolithic levels are subdivided into four strata with Stratum I being the youngest and Stratum IV the oldest building level. The Aeneolithic occupation is characterized by well-preserved mud-brick architecture with walls still standing up to 1.5 m high (Bernbeck et al. 2012:15–16). The renewed excavations have produced a large sample of animal bones from undisturbed and well-stratified contexts. Most of the bones are in good condition. All primary and secondary contexts were dry-screened using 5 mm mesh. Samples from a large number of these contexts were also wet-screened, providing a reliable basis for quantitative evaluation (Pollock and Bernbeck 2011:175–176).

The study presented here is based on the zooarchaeological data recovered from the seasons 2010 to 2012 at Monjukli Depe; the bones were identified at the Department of Natural Sciences of the German Archaeological Institute in Berlin (Benecke 2011, 2018).

Domestic taxa are overwhelmingly predominant in the faunal remains collected at the site, pointing to animal husbandry as an important subsistence strategy in addition to the cultivation of plants (Miller 2011:219–221). This is the case both in Neolithic and Aeneolithic levels (Benecke 2011:209, Table 13). Nearly 96% of the identified Aeneolithic bones derive from domesticated animals (Table 1.3.1). Domestic caprines are the dominant taxa. Among the bones that could be attributed to genus, sheep outnumber goats based on criteria for postcranial skeletal elements (e.g., Zeder and Lapham 2010). Cattle is the second most common taxon with about 5.5% of the total bones. This is followed by dogs, which occur in very small proportions. Wild animals comprise only four percent of the bone collection, with onager and gazelle representing the most common hunted animals, closely followed by wild sheep. Fox is also attested, while other wild taxa occur only occasionally. The quantities of small animals are unexpectedly low, considering the extensive screening conducted.

The location of the site, the specific composition of the faunal assemblage, and an intensive discussion of the early importance of vertical seasonal movements by pastoral nomads in neighboring Iran contributed to the research questions formulated for this study.

## Methods and Materials

### *Oxygen and Carbon Stable Isotopes*

Oxygen and carbon are incorporated into the enamel during tooth development and can record seasonal fluctuations of the isotopic composition of these elements. Because enamel does not remodel after tooth formation and is rather resistant to diagenetic alteration, the isotopic information reflects the water and food consumption during the first years of an individual's life. This information differs in time, depending on which tooth is sampled and the range of its formation (Balasse et al. 2003; Cerling and Harris 1999; Makarewicz and Pederzani 2017; Zazzo et al. 2010). Sequential sampling—the extraction of enamel in multiple horizontal bands along the crown—is the standard method for obtaining the isotopic signals from high-crowned herbivore teeth (Balasse et al. 2002; Knipper 2011; Makarewicz 2017; Makarewicz and Pederzani 2017; Tornero et al. 2016). Plotting the resulting $\delta^{18}O$ and $\delta^{13}C$ values against the distance of each sample from the Enamel–Root Junction (ERJ) reveals relationships between the isotopic signals of both elements. The oxygen isotope composition in enamel bioapatite is linked to the water and food ingested throughout the time of tooth formation. During enamel mineralization, seasonal differences in rainwater/drinking water are transferred to the animal's tooth. They record temperature changes over the year, with the highest values occurring in the warmest and the lowest in the coldest season (Balasse et al. 2006; Fricke and O'Neil 1996; Henton et al. 2014; Knipper 2011; Sharp and Cerling 1998). Oxygen is incorporated into both the phosphate and the structural carbonate of teeth and bones' hydroxyapatite. Due to isotope fractionation in the body, $\delta^{18}O$ values in tooth enamel differ from those in water. However, since the fractionation of oxygen in body fluid takes place under constant temperature conditions in homeothermic animals, there is a direct correlation between isotopic ratios of drinking water and food and oxygen in the hydroxyapatite (Bryant et al. 1996; Knipper 2011:148–149).

Monthly average $\delta^{18}O$ values of precipitation in the region around Monjukli Depe can help to estimate expected oxygen isotope ratios in the animals' teeth; however, such data are generally scarce. Geographical work at Monjukli Depe and other prehistoric sites in southern Turkmenistan provides information on climatic conditions and annual rainfall (Berking et al. 2017; Berking and Becker 2018; Dolukhanov 1981). Accordingly, annual precipitation is around 230 mm and falls mostly in March and April. There is almost no rainfall in summer (Berking and Becker 2018:Table 1). The International Atomic Energy Agency (IAEA) holds a database of $\delta^{18}O$ values of precipitation at worldwide climate stations. However, none of them are located in Turk-

Table 1.3.1. Faunal remains from Aeneolithic levels at Monjukli Depe as percentages of Number of Identified Specimens (NISP).

| **Taxa** | **NISP** | **(%)** |
|---|---:|---:|
| Sheep/goat | 11,009 | 87.7 |
| Sheep (*Ovis aries*) | 205 | 1.6 |
| Goat (*Capra hircus*) | 75 | 0.6 |
| Cattle (*Bos taurus*) | 688 | 5.5 |
| Dog (*Canis familiaris*) | 36 | 0.3 |
| **Total domestic animals** | **12,013** | **95.6** |
| | | |
| Onager (*Equus hemionus*) | 109 | 0.9 |
| Gazelle (*Gazella subgutturosa*) | 72 | 0.6 |
| Wild sheep (*Ovis orientalis*) | 51 | 0.4 |
| Fox (*Vulpes corsac*) | 47 | 0.4 |
| Other wild taxa | 268 | 2.1 |
| **Total wild animals** | **547** | **4.4** |

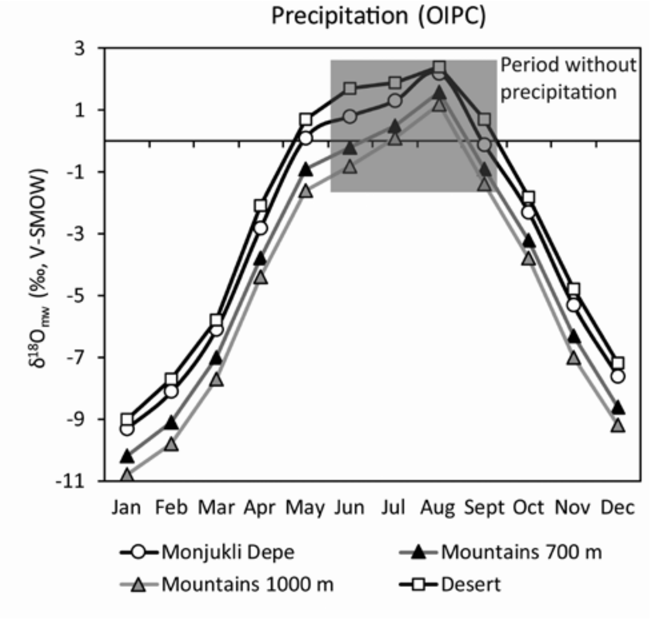

Figure 1.3.2. Modeled monthly average $\delta^{18}O$ values of precipitation at Monjukli Depe in comparison to the Kopet Dag (700 m and 1,000 m asl) and in the desert based on the Online Isotopes in Precipitation Calculator (OIPC).

menistan, and only few stations with available data, including those in Tehran (Iran), Astrakhan (Russia), Kabul (Afghanistan), and Tashkent (Uzbekistan), are found in the wider area (modern precipitation and hydrological data are accessible on the WISER portal of the IAEA homepage; see GNIP at https://www.iaea.org/services/networks/gnip and GNIR at https://www.iaea.org/services/networks/gnir). The Online Isotopes in Precipitation Calculator (OIPC) uses the IAEA data and general principles of spatial variation of oxygen isotope compositions to model yearly and monthly average $\delta^{18}O$ values at any place worldwide (Bowen and Revenaugh 2003; Bowen et al. 2005; Bowen 2018). Figure 1.3.2 illustrates the modeled seasonal variation of the oxygen isotope composition in precipitation at Monjukli Depe, in the Kopet Dag mountain range, and further into the Karakum Desert. These data provide an estimate of isotopic differences between winter and summer, and between Monjukli Depe, possible grazing areas in the uplands—arbitrary locations at 700 and 1,000 m asl, and others in the desert—Gulanly, a town in Oguzhan district in the Mary Region of Turkmenistan, was chosen as an example.

For all four locations, the model predicts seasonal variation of about 11–12‰ of $\delta^{18}O$ in meteoric water, with the lowest values in January and the highest in August. Practically, however, the area does not receive any precipitation between June and October. This suggests that the oxygen with highest $\delta^{18}O$ values returned by the model will most likely not have contributed to the oxygen isotope values recorded in the teeth. Instead, tooth data probably represent water present in food and in the drinking water that is attributable to precipitation that fell between autumn and spring, in addition to river and ground water.

Oxygen isotope ratios of precipitation are negatively correlated with elevation. Therefore, one would expect lower $\delta^{18}O$ values in the uplands compared to higher values around a lowland site such as Monjukli Depe. For our research area, we do not have any direct data to estimate whether $\delta^{18}O$ values in teeth could distinguish upland and lowland herding. The modeled seasonal curves of the isotopic composition of rainwater suggest that spatial variation is small in comparison to seasonal variation (see Figure 1.3.2). Moreover, rivers and shallow groundwater originating in the mountains are important water sources to supply animal herds in the lowlands (Berking et al. 2017:12). Taking into account the scarcity of data, inter-annual variation, and uncertainty about climate shifts between the Aeneolithic and today, we would expect relatively lower $\delta^{18}O$ values in the mountains than in the lowlands, but we do not have good enough background data to specify the expected differences reliably.

Carbon isotope ratios ($\delta^{13}C$) are determined in the same measurement as the $\delta^{18}O$ values. The isotopic composition of carbon in enamel carbonate depends on the plants consumed (Ambrose and Norr 1993; Balasse et al. 2002). Due to different fractionation rates in the photosynthetic pathway, $C_3$ and $C_4$ plants demonstrate differences in carbon isotope ratios. Modern $C_3$ plants have $\delta^{13}C$ values between about -35‰ and -22‰ (Cerling et al. 1997). Due to the fossil fuel effect in modern plants, $\delta^{13}C$ values of plants that grew during preindustrial times were about 1.4‰ higher and average around -25.6‰ (Balasse et al. 2006; Cerling and Harris 1999). In contrast, the mean carbon isotope ratio of $C_4$ plants is higher, with $\delta^{13}C$ values around -13.1 ± 1.2‰ (Bocherens et al. 2006). Originating from diet, carbon is incorporated into animals' teeth during enamel mineralization. Its isotopic composition provides information on the proportions of the consumed $C_3$ and $C_4$ plants. Due to isotope fractionation, $\delta^{13}C$ values in enamel apatite are 14.1‰ higher than those in the diet (Ambrose and Norr 1993; Cerling and Harris 1999). Thus, pure $C_3$ plant consumption should lead to average $\delta^{13}C$ values of -11.5‰ in enamel bioapatite of preindustrial large ruminants (Balasse et al. 2006:172), while $\delta^{13}C$ values of about 1 ± 1.2‰ can be expected for animals exclusively feeding on a $C_4$-based diet. Generally, enamel $\delta^{13}C$ values of above -8‰ indicate significant portions of $C_4$ plants in the consumed fodder. Both plant groups occur in southern Turkmenistan (Bocherens et al. 2006:254; Winter 1981). Archaeobotanical data from Monjukli Depe point to a predominance of $C_3$ plants, which also prevail in the mountains. In contrast, in the Karakum lowlands, proportions of $C_4$ plants were higher than at the settlement or in the mountains (Toderich et al. 2007). Therefore, variation of the $\delta^{13}C$ values in the sampled teeth can indicate grazing on different pastures. Animals permanently kept at the site or moved to the mountains likely received predominantly $C_3$ plant fodder. In contrast, constantly or periodically higher $\delta^{13}C$ values may point to animals that originated from the steppe or were seasonally pastured there. Combining carbon isotope and oxygen isotope data from the same samples links dietary and seasonal information. In other words, it indicates whether the same or different sources of food or grazing localities were used in different times of the year.

### *Sample Selection, Preparation, and Analysis*

This study focuses on eleven mandibular cheek teeth—third molars—from adult sheep (N = 6) and goats (N = 5, Table 1.3.2). Distinction between sheep and goat third molars for this analysis was attempted based on criteria summarized by Zeder and Pilaar (2010), and the outcome is shown in Table 1.3.2. However, such identifications are fraught with uncertainty and, as the authors themselves point out, lack accuracy (Zeder and Pilaar 2010:241–242). Given the limitations of the method, we consider our sheep or goat identifications as tentative.

To avoid multiple sampling of the same individuals, only third molars from lower left jaws were selected for analysis. Third molars were chosen because they record a comparatively long time of enamel formation. Sheep third molars are formed between the end of the first year and the end of the second (Zazzo et al. 2010:3574). The sample selection also depended on the availability of suitable teeth in the exported faunal remains. The teeth represent all four Aeneolithic levels and different functional contexts inside and outside buildings, such as deposits above surfaces, room fill, and ashy layers.

Sample preparation took place at the Curt-Engelhorn–Center Archaeometry (Mannheim, Germany). The enamel surface of each tooth was mechanically cleaned by removing all cementum using a dental drill. Six to nine samples, placed parallel to each other between the occlusal surface and the root, were milled out from the buccal side of each tooth using a diamond drill bit. Midpoints of all sampling positions were recorded to a tenth of a millimeter using digital calipers. The isotopic composition of the enamel was determined without any chemical pretreatment. We decided for this procedure because comparisons of different pretreatment methods reported different degrees of alteration of the isotopic composition, also in modern enamel (Balasse et al. 2012; Pellegrini and Snoeck 2016). Balasse and colleagues (2012) found that modern enamel that was pretreated with sodium hypochlorite and acetic acid yielded around 1‰ higher $\delta^{18}O$ values than enamel that did not receive any pretreatment. Pelegrini and Snoeck (2016) confirmed a similar increase of $\delta^{18}O$ values of archaeological and modern enamel due to pretreatment with 0.1 M or 1 M acetic acid and reported unsystematic differences for different ways of organic removal or both. Differences of $\delta^{13}C$ values due to pretreatment with acetic acid were well below 1‰ for modern and archaeological enamel, while organic removal with sodium hypochlorite resulted in an increase of up to about 1.5‰. Since enamel is generally very resistant to post-burial alterations (Budd et al. 2000) and the teeth selected in this study were particularly well preserved, at least macroscopically, we favored the avoidance of any artificial alteration of the isotopic signals over a remaining risk of partial diagenetic overprint. From each sample, 800 to 850 µg of enamel powder were weighed into borosilicate Exetainer® vials, which were closed with silicone rubber septa. After flushing with helium, the samples were reacted with concentrated phosphoric acid for 2 h at 70°C. The isotope composition of the resulting $CO_2$ was measured using a GasBench II coupled to an isotope ratio mass spectrometer (Thermo Finnigan™ MAT 253) at the Department of Applied and Analytical Palaeontology, Institute of Geosciences of the University of Mainz, Germany. Carbonate contents of the enamel samples were extrapolated from signal

Table 1.3.2. Stable carbon ($\delta^{13}C$) and oxygen ($\delta^{18}O$) isotope ratios for sheep/goat teeth from Monjukli Depe. M3 = third mandibular molar. ERJ = enamel-root junction. Mean values are arithmetic averages of all values measured in a tooth with one standard deviation of all measured values of a tooth. Δ = difference between highest and lowest value in a tooth. V–PDB stands for Vienna–Pee Dee Belemnite standard.

| ID | Stratum | Context | Tooth | ERJ (mm) | $\delta^{13}C$ (‰ V–PDB) | $\delta^{18}O$ (‰ V–PDB) | Mean $\delta^{13}C$ | Δ $\delta^{13}C$ | Mean $\delta^{18}O$ | Δ $\delta^{18}O$ |
|---|---|---|---|---|---|---|---|---|---|---|
| MD–1 | I–II | Eastern Midden* (outside area) | M3 (Sheep) | 6.1 | -9.79 | -5.28 | -7.6 ± 1.2 | 3.28 | -5.1 ± 2.1 | 6.56 |
| | | | | 10.9 | -6.56 | -8.90 | | | | |
| | | | | 14.4 | -6.82 | -6.40 | | | | |
| | | | | 18.2 | -6.51 | -4.95 | | | | |
| | | | | 23.5 | -7.53 | -3.47 | | | | |
| | | | | 27.6 | -8.56 | -2.34 | | | | |
| | | | | 32.5 | -8.38 | -3.28 | | | | |
| | | | | 36.8 | -6.75 | -6.25 | | | | |
| MD–2 | I–II | Eastern Midden (outside area) | M3 (Sheep) | 5.1 | -10.07 | -5.28 | -9.5 ± 0.3 | 0.97 | -5.7 ± 1.7 | 4.30 |
| | | | | 10.9 | -9.60 | -7.83 | | | | |
| | | | | 15.8 | -9.19 | -6.75 | | | | |
| | | | | 19.4 | -9.10 | -5.35 | | | | |
| | | | | 22.9 | -9.27 | -3.73 | | | | |
| | | | | 31.5 | -9.48 | -3.53 | | | | |
| | | | | 40.9 | -9.52 | -7.36 | | | | |
| MD–4 | I–II | Eastern Midden (outside area) | M3 (Sheep) | 2.6 | -8.63 | -7.24 | -8.8 ± 0.2 | 0.39 | -4.6 ± 1.9 | 5.38 |
| | | | | 5.0 | -9.02 | -5.01 | | | | |
| | | | | 7.4 | -8.83 | -3.53 | | | | |
| | | | | 10.5 | -8.71 | -1.86 | | | | |
| | | | | 14.2 | -8.68 | -4.32 | | | | |
| | | | | 16.8 | -8.63 | -5.81 | | | | |
| MD–5 | I | Ash layer (Building 1) | M3 (Goat) | 4.4 | -8.15 | -4.60 | -8.0 ± 0.8 | 2.30 | -5.0 ± 1.8 | 5.06 |
| | | | | 8.2 | -8.15 | -1.85 | | | | |
| | | | | 12.1 | -9.27 | -3.17 | | | | |
| | | | | 15.8 | -8.02 | -5.92 | | | | |
| | | | | 19.3 | -6.97 | -6.84 | | | | |
| | | | | 22.4 | -7.05 | -6.91 | | | | |
| | | | | 25.9 | -7.37 | -5.28 | | | | |
| | | | | 29.5 | -8.67 | -5.54 | | | | |
| MD–6 | I | Room fill (Building 11) | M3 (Goat) | 3.3 | -7.78 | -5.57 | -7.3 ± 0.5 | 1.21 | -4.6 ± 1.7 | 4.84 |
| | | | | 5.8 | -6.89 | -7.08 | | | | |
| | | | | 10.1 | -6.93 | -5.27 | | | | |
| | | | | 12.5 | -6.73 | -3.67 | | | | |
| | | | | 15.0 | -7.79 | -2.24 | | | | |
| | | | | 17.7 | -7.93 | -3.82 | | | | |

*The "Eastern Midden" is a large outside space that was filled with ash, animal bones, and other waste materials, and could be closed off from the center of the settlement by a gate. The settlement's residents most likely used it collectively, probably in order to deposit the remains of large-scale feasts (Eger 2019).

Table 1.3.2. (cont.) Stable carbon ($\delta^{13}$C) and oxygen ($\delta^{18}$O) isotope ratios for sheep/goat teeth from Monjukli Depe.

| ID | Stratum | Context | Tooth | ERJ (mm) | $\delta^{13}$C (‰ V–PDB) | $\delta^{18}$O (‰ V–PDB) | Mean $\delta^{13}$C | $\Delta$ $\delta^{13}$C | Mean $\delta^{18}$O | $\Delta$ $\delta^{18}$O |
|---|---|---|---|---|---|---|---|---|---|---|
| MD–8 | II | Room fill (Building 3) | M3 (Sheep) | 4.5 | -8.09 | -6.03 | -5.9 ± 1.3 | 3.33 | -6.8 ± 1.6 | 4.01 |
| | | | | 9.7 | -5.32 | -8.54 | | | | |
| MD–8 | II | | | 12.4 | -5.08 | -8.43 | | | | |
| | | | | 14.8 | -4.76 | -7.65 | | | | |
| | | | | 17.7 | -5.58 | -5.60 | | | | |
| | | | | 20.8 | -6.83 | -4.53 | | | | |
| MD–10 | II | Room fill (Building 3) | M3 (Sheep) | 5.6 | -6.15 | -7.72 | -5.8 ± 0.7 | 1.86 | -7.5 ± 1.4 | 4.43 |
| | | | | 9.3 | -6.38 | -7.71 | | | | |
| | | | | 11.7 | -5.26 | -6.40 | | | | |
| | | | | 17.8 | -7.01 | -4.91 | | | | |
| | | | | 21.4 | -5.98 | -6.17 | | | | |
| | | | | 24.3 | -5.16 | -7.96 | | | | |
| | | | | 27.5 | -5.61 | -8.69 | | | | |
| | | | | 31.3 | -6.05 | -9.34 | | | | |
| | | | | 34.8 | -4.74 | -8.88 | | | | |
| MD–11 | II | Room fill (Building 3) | M3 (Goat) | 4.4 | -7.41 | -5.73 | -6.1 ± 0.8 | 2.25 | -6.3 ± 2.6 | 6.95 |
| | | | | 6.7 | -7.11 | -7.63 | | | | |
| | | | | 9.8 | -5.25 | -8.77 | | | | |
| | | | | 13.4 | -5.82 | -9.31 | | | | |
| | | | | 17.7 | -5.62 | -8.77 | | | | |
| | | | | 20.9 | -5.16 | -6.98 | | | | |
| | | | | 24.3 | -6.08 | -3.24 | | | | |
| | | | | 27.7 | -6.20 | -3.66 | | | | |
| | | | | 32.1 | -6.66 | -2.36 | | | | |
| MD–12 | IV | Deposit above surface (Building 3) | M3 (Goat) | 5.7 | -9.56 | -8.48 | -9.2 ± 0.4 | 1.35 | -7.7 ± 1.5 | 3.98 |
| | | | | 8.6 | -9.16 | -8.60 | | | | |
| | | | | 11.6 | -9.23 | -7.27 | | | | |
| | | | | 15.7 | -9.36 | -5.26 | | | | |
| | | | | 19.8 | -10.11 | -5.66 | | | | |
| | | | | 23.4 | -8.76 | -8.03 | | | | |
| | | | | 27.4 | -8.90 | -9.25 | | | | |
| | | | | 31.6 | -8.86 | -9.24 | | | | |
| MD–13 | IV | Room fill (Building 14) | M3 (Goat) | 3.5 | -6.34 | -0.67 | -6.2 ± 1.3 | 3.24 | -1.8 ± 4.5 | 10.96 |
| | | | | 6.9 | -7.01 | 2.43 | | | | |
| | | | | 9.3 | -7.26 | 2.45 | | | | |
| | | | | 12.0 | -7.30 | -0.52 | | | | |
| | | | | 15.8 | -5.12 | -5.85 | | | | |
| | | | | 18.3 | -4.06 | -8.51 | | | | |

Table 1.3.2. (cont.) Stable carbon ($\delta^{13}C$) and oxygen ($\delta^{18}O$) isotope ratios for sheep/goat teeth from Monjukli Depe.

| ID | Stratum | Context | Tooth | ERJ (mm) | $\delta^{13}C$ (‰ V–PDB) | $\delta^{18}O$ (‰ V–PDB) | Mean $\delta^{13}C$ | Δ $\delta^{13}C$ | Mean $\delta^{18}O$ | Δ $\delta^{18}O$ |
|---|---|---|---|---|---|---|---|---|---|---|
| MD–25 | III | Room fill (Building 9) | M3 (Sheep) | 4.1 | -7.99 | -5.41 | -8.5 ± 0.3 | 0.79 | -5.7 ± 2.1 | 5.94 |
| | | | | 6.0 | -8.53 | -2.77 | | | | |
| MD–25 | III | | | 8.7 | -8.57 | -4.25 | | | | |
| | | | | 11.4 | -8.78 | -6.16 | | | | |
| | | | | 14.2 | -8.59 | -7.13 | | | | |
| | | | | 16.7 | -8.77 | -8.71 | | | | |

intensities of the internal IVA–Carrara marble standard (100% $CaCO_3$). The average values of the teeth varied between 5.6 ± 0.4% and 6.9 ± 0.4% (average: 6.1 ± 0.4%), falling into the upper range of values reported for modern enamel (Sydney-Zax et al. 1991; Zazzo et al. 2005), but they might be to some extent affected by the uncertainty of the extrapolation method. Signal heights of the enamel samples were in all cases within the range of those of the $CaCO_3$ standards included in each run. The isotopic raw data were corrected against the internal IVA–Carrara marble standard with $\delta^{18}O$ = -1.91‰ V–PDB and $\delta^{13}C$ = 2.01‰ V–PDB. Each run included twelve internal standards of three times each 45, 65, 90 and 120 ± 5 µg. The average internal precision (1 SD) was 0.03 for both isotope ratios (N = 36). Two to three samples of NBS–19 (NBS stands for the National Bureau of Standards), which is a calcium carbonate from a marble of unidentified origin with values of $\delta^{18}O$ = -2.20‰ and $\delta^{13}C$ = 1.95‰, were included in each run for quality check. They yielded average values of -2.19 ± 0.03‰ (N = 7) for $\delta^{18}O$ and 1.94 ± 0.02‰ (N = 7) for $\delta^{13}C$. Results are expressed as per mill (‰) relative to the Vienna–Pee Dee belemnite standard (V–PDB).

## Results

### *Oxygen and Carbon Isotope Ratios*

The results of the stable carbon and oxygen isotope measurements are presented in Table 1.3.2. The $\delta^{13}C$ values varied between -10.11‰ and -4.06‰, while $\delta^{18}O$ values ranged from -9.34‰ to 2.45‰. Plotting the carbon and oxygen isotope values in relation to the distance of the samples from the Enamel–Root Junction (ERJ) illustrates changes of the isotope signals along the tooth crowns and differences or similarities between teeth (Figure 1.3.3). Patterns in the data are visually clearer when only the carbon isotope values of each tooth were plotted against the distance from the ERJ (Figure 1.3.4A–B), or in scatter plots of $\delta^{13}C$ against $\delta^{18}O$ values from the same samples (Figure 1.3.4C–D).

With regard to the carbon isotope ratios, two groups became apparent. In four teeth (MD–2, MD–4, MD–12, and MD–25; three sheep, one goat) the $\delta^{13}C$ values were consistently below -8.0‰, the threshold for considerable $C_4$ plant contribution. Their mean $\delta^{13}C$ values varied between -9.5 ± 0.3‰ (MD–2) and -8.5 ± 0.3‰ (MD–25) with $\delta^{13}C$ ranges (differences between highest and lowest values) of the intratooth variation between 0.39‰ (MD–4) and 1.35‰ (MD–12). The best example was individual MD–2, whose $\delta^{18}O$ profile confirms homogeneous $\delta^{13}C$ values throughout a whole year (Figure 1.3.3). The $\delta^{18}O$ values of the teeth from group 1 ranged from -9.24‰ to -1.86‰, with amplitudes of variation between 3.98‰ (MD–12) and 5.94‰ (MD–25) and mean $\delta^{18}O$ of values from -7.7 ± 1.5‰ to -4.6 ± 1.9‰.

The remaining seven teeth (MD–1, MD–5, MD–6, MD–8, MD–10, MD–11, and MD–13; three sheep, four goats) were assigned to a second group. This assignment is based on the $\delta^{13}C$ values being completely (MD–6, MD–10, MD–11, and MD–13) or partially (MD–1, MD–5, and MD–8) above -8.0‰. The $\delta^{13}C$ values of these teeth varied considerably along the crowns forming sinusoidal curves. Their $\delta^{13}C$ values ranged from -9.79‰ to -4.06‰, with amplitudes of intratooth variation from 1.21‰ to 3.32‰, and mean $\delta^{13}C$ values ranging from -8.0 ± 0.8‰ to

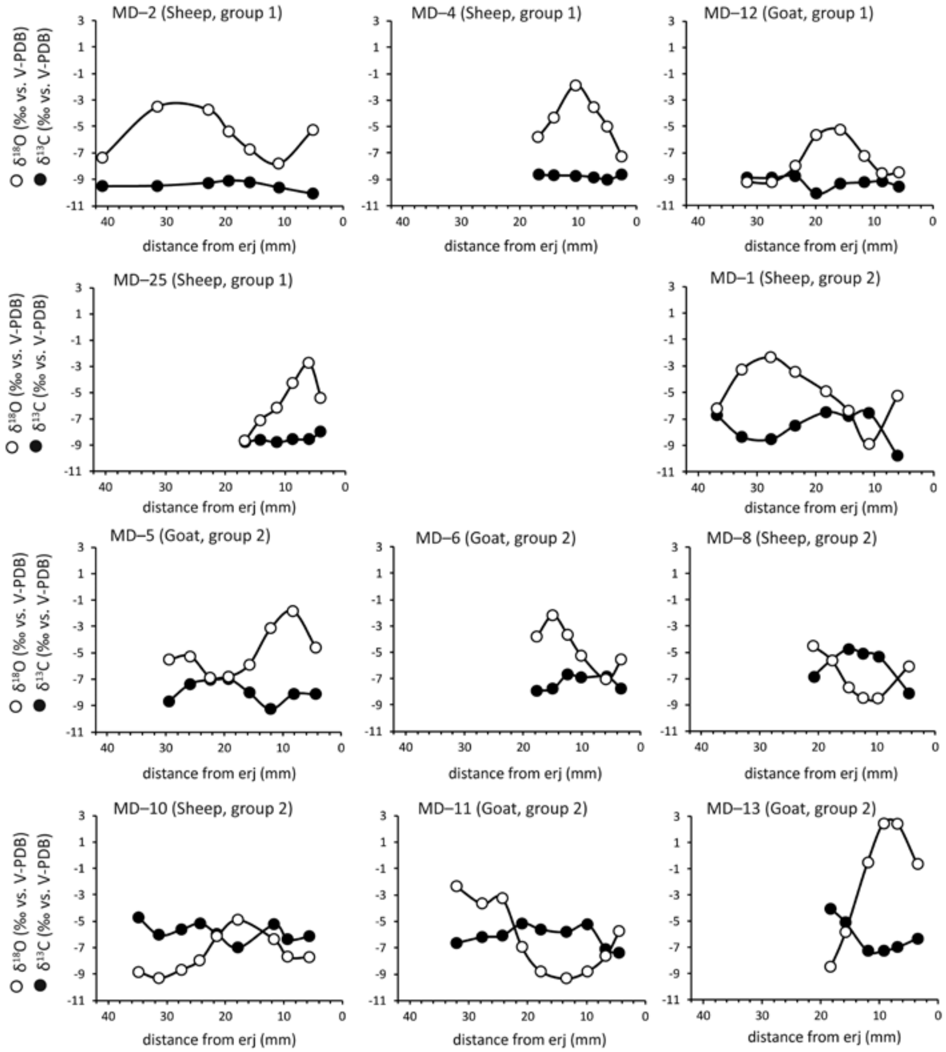

Figure 1.3.3. Intratooth variation of carbon ($\delta^{13}C$, black circles) and oxygen (δ18O, white circles) isotope ratios of tooth enamel bioapatite from sequentially sampled third molars of sheep/goat from Monjukli Depe. ERJ = Enamel-Root Junction. The graphs for each sheep/goat individual are arranged according to similarity in patterns of carbon and/or oxygen values. Division into groups is based on the criterion of $\delta^{13}C$ values being below or above -8‰.

-5.8 ± 0.7‰. The $\delta^{18}O$ values of the teeth from group 2 ranged from -9.34‰ to 2.45‰, with amplitudes of intratooth variation between 4.01‰ and 10.96‰. The mean $\delta^{18}O$ values varied from -7.5 ± 1.4‰ to -1.8 ± 4.5‰. Within individual teeth, high $\delta^{13}C$ values coincided with low $\delta^{18}O$ values (Figure 1.3.4 D). Correlation coefficients (*r*) of $\delta^{13}C$ and $\delta^{18}O$ data ranged between -0.40‰ (MD–11) and -9.53‰ (MD–13). For individual MD–13 the negative correlation was statistically significant, and MD–5 revealed a tendency toward a negative relation (Pearson correlation MD–13: $p = 0.003$, N = 6; MD–5: $p = 0.083$, N = 8).

A scatter plot of the averages and standard deviations of the $\delta^{18}O$ and $\delta^{13}C$ values from each sequentially sampled tooth highlights the differences in carbon and the similarity in oxygen isotope data among individuals (Figure 1.3.5). A One-Way Analysis of Variance (ANOVA) identified statistically significant differences between the mean $\delta^{13}C$ values of the eleven molars ($F$ [10, 69] = 17.80, $p = < 0.001$). Pairwise multiple comparisons (Holm-Sidak method) emphasized the differentiation of data groups suggested above. The $\delta^{13}C$ values of teeth from group 1 (low and homogeneous $\delta^{13}C$ values; MD–2, MD–4, MD–12, and MD–25; white symbols in Figures 1.3.4 and 1.3.5) did not reveal any statistically significant differences when tested against each other. Teeth from group 2 can be differentiated further, as indicated by black symbols (subgroup 2a: MD–8, MD–10, MD–11, and MD–13) and grey symbols (subgroup 2b: MD–1, MD–5, and MD–6) in Figures 1.3.4 and 1.3.5. Within these groups, differences are statistically insignificant, whereas the differences between each pair of teeth from group 1 and from subgroup 2a were highly significant, with $p < 0.001$ for each pair. Seven pairwise comparisons between

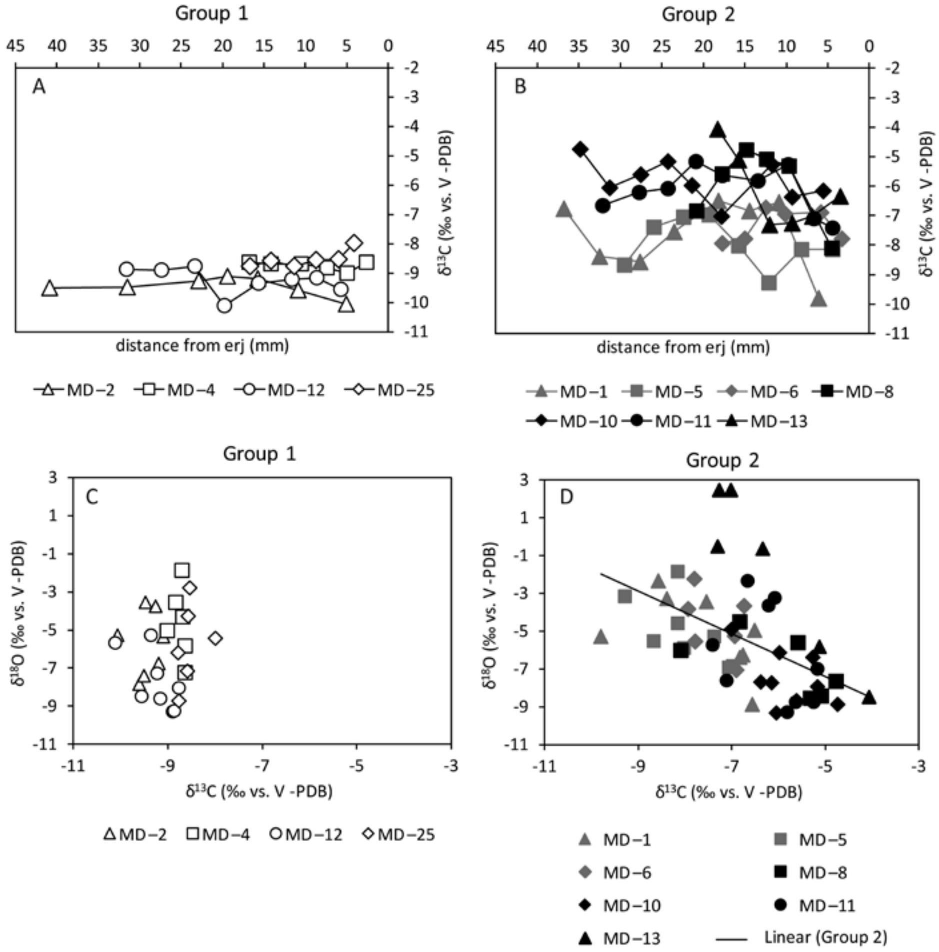

Figure 1.3.4. Plot of $\delta^{13}C$ values against the distance of Enamel-Root Junction (ERJ; top) as well as plot of $\delta^{13}C$ values against $\delta^{18}O$ values (bottom) of eleven third molars from sheep/goat. Left (A + C): Group 1 with homogenous $\delta^{13}C$ ratios of consistently < -8‰—white symbols; right (B + D): Group 2 with variable $\delta^{13}C$ values continuously > -8‰—black symbols—or partially > -8‰—grey symbols. For group 2, the $\delta^{13}C$ and $\delta^{18}O$ values are negatively correlated with each other.

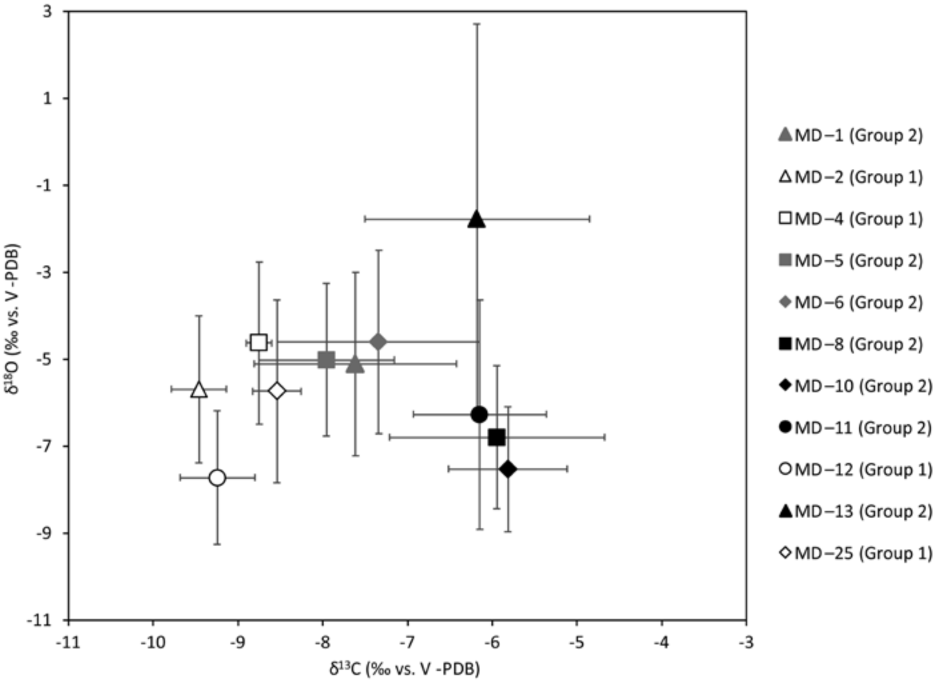

Figure 1.3.5. Mean isotopic composition of enamel structural carbonate from the sampled sheep/goat individuals. The mean $\delta^{13}C$ and $\delta^{18}O$ values were calculated for all samples of each mandibular molar, and bars indicate one standard deviation.

the $\delta^{13}C$ values of subgroup 2a and 2b were statistically significant (*p* between 0.05 and 0.001), while the difference between MD–10 and MD–5 was highly significant ($p < 0.001$). The differences between the teeth from subgroup 2b and group 1 were significant for four of the pairwise comparisons.

These differences in the carbon isotope ratios among individuals are not, however, reflected as clear differences in the oxygen isotope ratios. In fact, the $\delta^{18}O$ ranges overlap extensively with the representatives of both groups. Most noteworthy was, however, MD–13 with a difference between lowest and highest $\delta^{18}O$ values of 10.96‰, which is more than twice as large as the amplitudes for MD–6, MD–8, and MD–10. The ANOVA analysis identified, in general, significant differences between teeth ($F$ [10, 69] = 3.93, $p = < 0.001$). However, the Holm-Sidak method revealed that MD–13 was responsible for this result as it was significantly different from MD–12 ($p = < 0.001$), MD–10 ($p = < 0.001$), MD–8 ($p = 0.008$), and MD–11 ($p = 0.011$). The mean $\delta^{18}O$ values between all other tooth pairs were not significantly different. Both patterns, homogeneous $\delta^{13}C$ values (group 1) and $\delta^{13}C$ values that are inversely related to the $\delta^{18}O$ values (group 2) are found in all four Aeneolithic strata of Monjukli Depe without any chronological shifts (Table 1.3.2). Taking our differentiation between sheep and goat, there are tentative differences between the two taxa. As with any samples subdivided by groups, strata, or context, limitations exist and, in this case, differences may be due to the low number of specimens in each group. Whereas group 1 includes three sheep and one goat, there are three sheep and four goats in group 2. Thus, the proportion of goats appears higher in the second group.

## Discussion

The analytical results of the sheep and goat teeth from the Monjukli Depe samples demonstrate either similarity, group 1, or systematic variation of the carbon isotope ratios throughout the year, group 2 (Figures 1.3.3–1.3.5). Applying the enamel–diet enrichment factor (+14.1‰), the $\delta^{13}C$ values measured in the teeth from group 1 reflect a diet with $\delta^{13}C$ values ranging between about -22.0‰ and -24.0‰. Considering also the fossil fuel effect (Balasse et al. 2006; Cerling and Harris 1999), this converts into values between about -23.4‰ and -25.4‰ falling into the upper ranges of $\delta^{13}C$ values of modern $C_3$ plants in dry areas (Hartman and Danin 2010; Kohn 2010). The data therefore point to a predominance of grazing on $C_3$ plants with possibly minor contributions of $C_4$ plants and very little variation over the year. Archaeobotanical evidence attests to a prevalence of $C_3$ plants among the natural and cultivated vegetation at Monjukli Depe. We can therefore expect that animals that consumed fodder from habitats near the site or agricultural byproducts and waste would present $\delta^{13}C$ values typical of a $C_3$-plant-diet. In fact, a large volume of crops and crop processing debris deriving from dung was found among plant macroremains from Monjukli Depe, including six-row barley, glume, and bread wheat (Masoumeh Kimiaie, personal communication 2016). Thus, the presence of some parts of the herds at or near the village, where they could be grazing in the same habitat throughout the year, is a plausible explanation for group 1, which has constantly low carbon isotope ratios. These animals may represent a local component of the pastoral system, although movements between areas with similar environmental conditions—that is, a predominance of $C_3$ plants—cannot be excluded.

The results from group 2 indicate a different forage composition, for parts of the year at least. While the lowest carbon isotope values of group 2 are similar to those of group 1, and thus suggest mainly $C_3$ plants, the highest $\delta^{13}C$ values convert to $\delta^{13}C$ values of around -18.1‰ in the past and up to -19.5‰ in modern vegetation. This exceeds the isotopic ranges of $C_3$ plants, even in dry environments (Hartman and Danin 2010; Kohn 2010). With differences between the lowest and the highest values of up to 3.3‰, the internal variation of the $\delta^{13}C$ values of most teeth from group 2 is also more than twice as large as of those from group 1. Analyses of modern $C_3$ vegetation revealed seasonal variations of approximately 1–2‰ between samples from the wet and the dry season (Hartmann and Danin 2010; Smedley et al. 1991; Tornero et al. 2016). Since the amplitudes of most $\delta^{13}C$ curves of group 2 exceed this variation and either some or all values along the teeth are beyond the typical spectrum for $C_3$ plants, the seasonal variation seen in that group cannot be solely due to the natural variation of the $\delta^{13}C$ values of $C_3$ plants caused by water. Presuming similar carbon concentrations of $C_3$ and $C_4$ plant forage, we estimate maximal contributions of 45% to 60% of $C_4$

plants during enamel formation in the warmer periods.[1]

To evaluate these results regarding animal husbandry and seasonal mobility, archaeological and archaeobotanical evidence as well as current knowledge of the environmental conditions need to be taken into account. A possible explanation is that $C_4$ plants were indeed available in the vicinity of the site, even though direct evidence is scarce in the botanical record. Most cultivated and wild plant species identified in archaeobotanical samples from Monjukli Depe are $C_3$ plants, such as wheat and barley (Miller 2011; Ryan 2011). There are also some species with representatives in both systems, such as Poaceae, Brassicaceae, Chenopodiaceae, Boraginaceae, and Asteraceae (Masoumeh Kimiaie, personal communication 2017). However, their identification is at the family level and therefore does not convincingly indicate the presence of $C_4$ plants near the site. In phytolith samples wild Pooid and Panicoid grasses, including *Setaria* sp. and *Aegilops* sp., are documented, as are cones from sedges (Ryan 2010, 2011:225). $C_4$ plants are usually active during times of hot weather and several species of Chenopodiaceae flower at the end of the dry season (Batanouny 2001:97). Therefore, higher $\delta^{13}C$ values would be expected to coincide with high $\delta^{18}O$ values that represent the warmer periods (Tornero et al. 2016:31–33). However, $\delta^{13}C$ values of the teeth from group 2 vary in the opposite way: the lowest carbon isotope values are associated with the highest oxygen isotope ratios, suggesting a predominantly $C_3$-based diet during warmer seasons. Conversely, the highest carbon isotope ratios appear with the lowest oxygen isotope values, indicating significant inclusions of $C_4$ plant food in sheep and goat diet in colder periods of the year. A possible explanation of this pattern by feeding the animals on local resources is stockpiling growth rich in $C_4$ plants during the summer and providing it to the animals in winter (Makarewicz and Pederzani 2017; Makarewicz and Tuross 2006). These must have been wild and weedy species as there are neither indications for cultivated $C_4$ plants in Monjukli Depe nor did $C_4$ crops, such as millet, reach Central Asia before the third millennium BC (Herrscher et al. 2018; Miller et al. 2016). Therefore, stockpiling of agricultural byproducts and waste from $C_4$ crop plants is rather unlikely. Instead, fodder might have been collected during the peak of abundance of $C_4$ plants. As a result, the $\delta^{13}C$ values associated with enamel formation in winter became higher than those associated with enamel formation in summer when $C_4$ plants should have been naturally available. If the inhabitants of Monjukli Depe collected $C_4$ plants in the warm season as winter fodder, it raises the question as to why only some animals of the herd were provisioned with such food, whereas others (group 1) received forage of primarily $C_3$ plants year round. Possible explanations of the different feeding strategies include variation among different herders or households and dissimilarities between individual years.

An alternative set of explanations for the fluctuating $\delta^{13}C$ values of the teeth from group 2 involves mobility. One of these options is that parts of the herd were seasonally moved into the uplands. In such a case, the mixture of $C_3$ and $C_4$ plants would represent the forage from near the settlement and used in winter, while the lower summer values would represent mountain pastures with only a minor contribution of $C_4$ plants. Since the volume of $C_4$ plants reduces with altitude, lower $\delta^{13}C$ values should correlate with higher $\delta^{18}O$ values, if the animals were herded in the uplands during summer (Bocherens et al. 2001:72–73). Based on their expected variation with altitude, we explored the oxygen isotope data for information supporting or rejecting the possible use of upland pastures. The averages, amplitudes, and also minima and maxima of the $\delta^{18}O$ curves of the potentially mobile animals from group 2 were very similar to those of group 1, being likely animals kept relatively stationary, and were unrelated to the differences in the carbon isotope compositions (Figures 1.3.2 and 1.3.4). Especially the similarity of the maximum $\delta^{18}O$ values of both groups does not support the use of upland pastures in summer because this practice should have caused lower $\delta^{18}O$ values in the animals from group 2. The only exception from the overall similarity is individual MD–13. However, the very high $\delta^{18}O$ summer maximum of its tooth contradicts the expectations for the use of mountain pastures in summer.

Converting the $\delta^{18}O$ data of enamel carbonate into oxygen isotope compositions of the drinking

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[1] This estimation uses the following parameters: average $\delta^{13}C$ values of $C_3$ plants: -25.6‰, average $\delta^{13}C$ values of $C_4$ plants: -13.1‰, $\delta^{13}C$ increase between plants and enamel: 14.1‰, maximal $\delta^{13}C$ values in enamel of group 2: -6.0‰ to -4.0‰. Linear regression: $y = 8x + 92$ ($x = \delta^{13}C$ enamel; $y = C_4$ contribution in %).

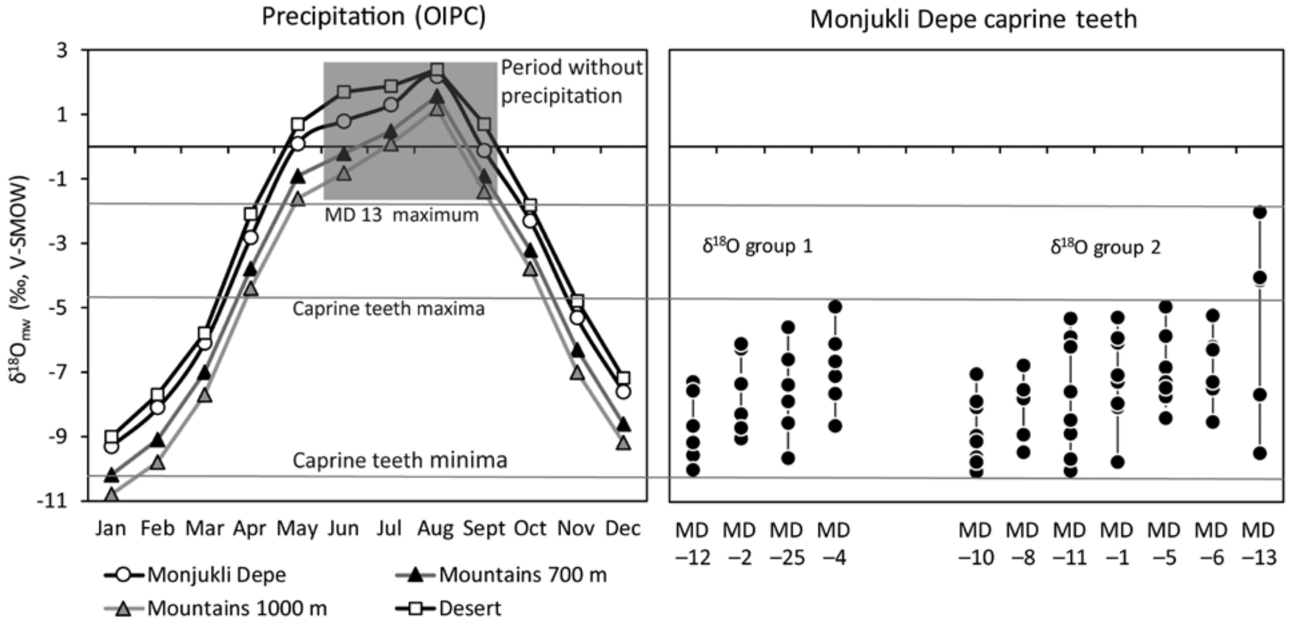

Figure 1.3.6. Left: Modeled monthly average $\delta^{18}O$ values of precipitation at Monjukli Depe in comparison to the Kopet Dag (700 m and 1,000 m asl) and in the desert based on the Online Isotopes in Precipitation Calculator (OIPC). Right: Oxygen isotope ratios of the sheep/goat teeth from Monjukli Depe converted into $\delta^{18}O$ values of the ingested water. MD = Monjukli Depe, sample identification no.: e.g., MD–1, MD–2, etc.

water fits well with the modeled oxygen isotope composition of precipitation falling in winter and spring as modeled using OIPC (Figure 1.3.6).[2] A differentiation between upland and lowland pastures is, however, not straightforward in this case. All teeth have considerably lower maximal $\delta^{18}O$ values than the modeled summer precipitation in both the mountains and the lowlands. This agrees with the expectations, since although the models produce $\delta^{18}O$ values for precipitation in the area, there is no significant rainfall in summer that could contribute substantially to the drinking water of the animals. Instead, the maximum values fit generally to the modeled $\delta^{18}O$ values of modern precipitation in spring, while the minimum values are in accordance with winter precipitation. However, neither the modeled precipitation data nor the converted enamel data are precise enough to differentiate reliably among upland and lowland pastures. Besides the lack of direct data from near the site, the fluctuation of precipitation values from one month to the next in the same landscape often exceeds the variation between landscapes and blurs spatial diversity. Moreover, the conversion from enamel carbonate to water values involves high uncertainty, and water that originates from the mountains feeds rivers and groundwater reservoirs in the lowlands. Therefore, the $\delta^{18}O$ data do not clearly support upland pasturing of the animals from group 2 during the summer, but low data resolution does not exclude it either.

The assumption that a predominance of $C_3$ plants indicates upland pastures and a mix of $C_3$ and $C_4$ forage was typically fed in the lowlands also has consequences for the interpretation of the animals from group 1. Their constant and low $\delta^{13}C$ values would then imply feeding on mountain pastures year round. This seems, however, unlikely because it would have required permanent settlements in the mountains for which there is so far no archaeological evidence. In winter, the mountains are even colder and more uninviting than the plains with subzero temperatures and snow cover on the plateaus. Moreover, such a scenario would imply movement of the animals into the lowlands at Monjukli Depe only for culling or even just transporting the carcasses to the site.

Another explanation for the higher $\delta^{13}C$ values in winter than in summer is moving out into the

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[2] Conversion steps: V–PDB standard to V–SMOW standard (Standard Mean Ocean Water); $\delta^{18}$Ocarbonate (V–SMOW) to $\delta^{18}$Ophosphate ($\delta^{18}$Ophosphate = 0.98 * $\delta^{18}$Ocarbonate - 8.5); $\delta^{18}$Ophosphate to $\delta^{18}$Odrinking water ($\delta^{18}$Odrinking water = ($\delta^{18}$Ophosphate - 27.21) / 1.48) equation for sheep/goat (Henton et al. 2010).

steppe or desert portions of the landscape in the colder months. While vegetation is overall sparse during the dry summers in this landscape, enhanced plant growth can be expected with winter and spring precipitation. At such times, seasonal mobility would be possible, and forage consumed from there may have included more $C_4$ plants than potentially available near the site. A possible reason to move herds further away from the village would be to keep crops from being eaten by the animals. The danger to crops is not so much to be expected in the colder months, as the cold season is unlikely to have been the growing season for barley and wheat. However, barley may have been a winter crop, which was sown in fall and harvested between May and July, thus requiring protection of fields in winter. This could have been achieved by moving the herds out of the vicinity in winter. The scenario of movement to the edge of the Karakum Desert rather than into the Kopet Dag also fits the wild animal contributions to Monjukli bone collection, with onager and gazelle as the most frequent wild taxa. Overall, more bones from animals inhabiting semidesert habitats and steppes are present than bones of animals from mountain habitats. Furthermore, the desert vegetation in Turkmenistan is known to be used as a valuable food resource for sheep grazing throughout the year (Rustamov 1994). Chenopodiaceae and other $C_4$ plants occur in steppe-like environments and in the vegetation of the Karakum Desert (Toderich et al. 2007), but further information on plant composition in the Karakum Desert is required to evaluate this proposal. The modeled $\delta^{18}O$ values of precipitation at Monjukli Depe and at locations further out in the steppe or desert are too similar to expect any significant differentiation in the teeth.

The isotopic patterns of group 1 and 2 occurred over the complete span of the Aeneolithic occupation of the site were noted. Also no spatial patterns within the site. Moreover, both groups included sheep and goat, which implies that both species were raised and kept together in the same herds. At present, deciding in favor of one of the scenarios formulated is difficult, and more data is needed to confirm or refute these possibilities. However, the similarity of the $\delta^{18}O$ values in both groups indicates habitats with similar climatic conditions. This would support that all animals grazed on local pastures, with some animals receiving supplementary winter fodder that was rich in $C_4$ plants, or on winter pastures further out in the steppe or desert rather than summer pastures in the mountains. The possibility that a considerable portion of the herd stayed year round at pastures near the village is supported by the results from an examination of wear stages on sheep/goat teeth (Eger 2018). In this analysis various stages of dental attrition of the deciduous lower fourth premolars were estimated providing a precise determination of age-at-death up to roughly a few months (Blaise and Balasse 2011:3091; Grant 1982). From the presence of all wear stages in the faunal assemblage it is suggested that animals stayed close to the village during all four seasons and, combining this evidence with the anatomical representation, were culled at the site. Thus, at least a portion of the animal population was not moved away from the settlement.

## Conclusion

Carbon and oxygen isotope ratios of sequentially sampled caprine teeth have implications for animal husbandry strategies at Aeneolithic Monjukli Depe but also for the role of herd movement more generally in this early village society. The analysis of sheep and goat molars aimed at testing the occurrence of seasonal movements of livestock. The initial hypothesis was driven by scenarios of vertical pastoral nomadism postulated for the Iranian highlands during the same chronological period. Oxygen and carbon isotope ratios were used to estimate the season in which these movements could have occurred, as well as to detect seasonal changes in diet through the period of enamel mineralization. The carbon isotope ratios suggest that a minority of the sampled sheep and goats grazed on $C_3$ plants all year round. Archaeobotanical evidence points to a predominance of $C_3$ plants in the habitats around Monjukli Depe, implying that these animals were kept near the site. A larger portion of the herds revealed higher and more variable carbon isotope ratios along the tooth crowns, indicating contribution of $C_4$ plants to their diet. Opposite trends observed in the $\delta^{13}C$ and $\delta^{18}O$ curves of some of the teeth indicate that $C_4$ plant consumption was more important in winter than in summer. However, overall similar averages and amplitudes of the $\delta^{18}O$ data point to similar environmental conditions in the habitats where $C_3$ and $C_4$ plants grew. The result contradicts general expectations of favorable growth and availability of $C_4$ plants in summer and generally under warmer conditions. Among the possible explanations for our findings, stockpiling of $C_4$-plant-containing forage in summer for winter feeding and moving the herds toward the southern fringes of the Karakum Desert in winter are more likely than the use of upland pastures in summer. However, none of these explanations exclude other options. More comparative data from the mountains, the near vicinity of the site, and the Karakum Desert are required. Data evaluation of the striking pattern of enhanced $C_4$ plant contribution in winter would also benefit from further analyses of animal teeth and the inclusion of other isotope systems, such as radiogenic strontium isotopes and carbon and nitrogen isotope ratios of bone collagen. If the observed pattern was associated with moving out from the site during the cold season, a possible motive might have been the cultivation of winter barley, which would have required keeping the animals away from the cultivated fields. In conclusion, animal husbandry and provision at Monjukli Depe involved different feeding and mobility strategies. So far, however, the results do not clearly indicate vertical seasonal nomadism but rather local livestock breeding with variable winter-feeding strategies and/or movement within the lowlands, including the fringes of the Karakum Desert.

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# 1.4 | The Butchered Faunal Remains from Nahal Tillah, an Early Bronze Age I Egypto-Levantine Settlement in the Southern Levant

Jeremy A. Beller,* Haskel J. Greenfield,† and Thomas E. Levy‡

## Abstract

The examination of butchering technology and patterns from archaeological sites provides insight into various socio-economic aspects of past societies, including diet, technology, and cultural identity. This study presents the analysis of 183 butchered animal bones recovered from the Early Bronze Age I site of Nahal Tillah, located on the northern fringe of the Negev Desert, Israel, in an effort to elucidate some of this information. The butchered assemblage is comprised primarily of domestic taxa, of varying ages, which exhibit a range of butchery-mark types that are the result of the full suite of butchering-related activities—from slaughter to toolmaking. As such, this report contributes to understanding the butchering practices and subsistence economy of early sedentary societies of the southern Levant.

## Keywords

*Early Bronze Age, butchering patterns, southern Levant, butchery marks, Nahal Tillah, filleting, disarticulation, toolmaking, ovicaprines, slice*

## Introduction

The recovery of faunal remains from archaeological contexts permits inquiry into the associated butchering patterns and technology. This inquiry has provided information on aspects of carcass processing, diet, ethnic identity, and technology of past communities (Binford 1981; Greenfield 2002; Lyman 1987a; Potts and Shipman 1981). However, such information is lacking from the Early Bronze Age (hereafter EB) I, 3400–3100 BC, of the southern Levant. During this period, agriculturalists and nomads of the southern Levant subsisted within the reaches of interaction with Predynastic Egypt (5300–3000 BC; Levy et al. 1995). As such, the butchering assemblages have the potential to offer insight into the nature of subsistence in early sedentary societies.

This report presents and discusses the faunal remains that exhibit evidence of butchering, comprised of 183 bones, from the EB I site of Nahal Tillah (Israel). In this manner, taphonomic aspects, age profiles, and the types and distribution of butchering are explored. The results indicate that the residents of EB I Nahal Tillah consumed both domestic and wild animals, and preferentially culled animals once they reached subadult/adult age.

## Background on Nahal Tillah

The site of Nahal Tillah, near Kibbutz Lahav, is located on the border between the northern Negev Desert and the southern *Shephelah*—foothills in Hebrew—regions in modern Israel (Figure 1.4.1). The *nahal*—stream in Hebrew—is a small secondary seasonal drainage system that runs along the base of the terrace on which the nearby site of Tell Halif—Tell Khuweilifeh in Arabic—sits and ultimately empties into the larger Nahal Gerar before proceeding westward to the Mediterranean Sea (Levy et al. 2001). The *nahal* and surrounding environs served

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as a strategic intersection for north–south and east–west movement and exchange networks across the region during the EB (Levy et al. 1995).

During the EB I, a gradual Egyptian presence increased in the southern Levant, possibly through the involvement in various exchange networks—for example copper, olive oil, wine—(Genz 2003; Ketelaer and Hauptmann 2016; Levy et al. 2002). As a result, the residents of the Nahal Tillah region experienced socioeconomic interaction with Egypt (Levy et al. 1995, 2001). The focus of the Nahal Tillah Regional Archaeology Project (1994–1996), directed by Thomas Levy of the University of California–San Diego and late David Alon of the Israel Antiquities Authority, was to investigate the end of the Chalcolithic period and the role of early Egyptian civilization in the rise of urban communities in the southern Levant through the examination of a series of EB I sites situated on the Halif Terrace (Levy 2013; Levy et al. 2001). The Halif Terrace extends over an area of around 13 ha on the eastern side of Tel Halif (Levy et al. 1995). Here the excavations focused on a broad horizontal sounding—ca. 800 m$^2$—on the Halif Terrace and several nearby cave sites (Figure 1.4.2; Levy et al. 1997). These excavations uncovered a variety of remains, including public and residential architecture, grain silos, local and Egyptian pottery (Kansa and Levy 2002), and lithics from the EB I A—currently thought to be ca. 3600–3400, previously 3500–3300 BC, and from both early and late phases of the EB I B—currently thought to be ca. 3400–3200, previously 3300–3000 BC (Regev et al. 2012). It is from these contexts that the zooarchaeological remains for this study originate.

The following study focuses on the butchering patterns associated with a sample of the faunal assemblage from Nahal Tillah. An initial report on the faunal material was composed by Caroline Grigson and described 1,125 specimens (Levy et al. 1997). Later collective reports on all seasons reported a total of 37,000 specimens of which 7,523 could be identified to taxon and element (Kansa et al. 2006; Kansa in press). The assemblage is housed in the archaeozoological storage unit of the National Natural History Collections (Institute of Earth Sciences, Hebrew University, Givat Ram campus, Jerusalem) and was made available for this analysis.

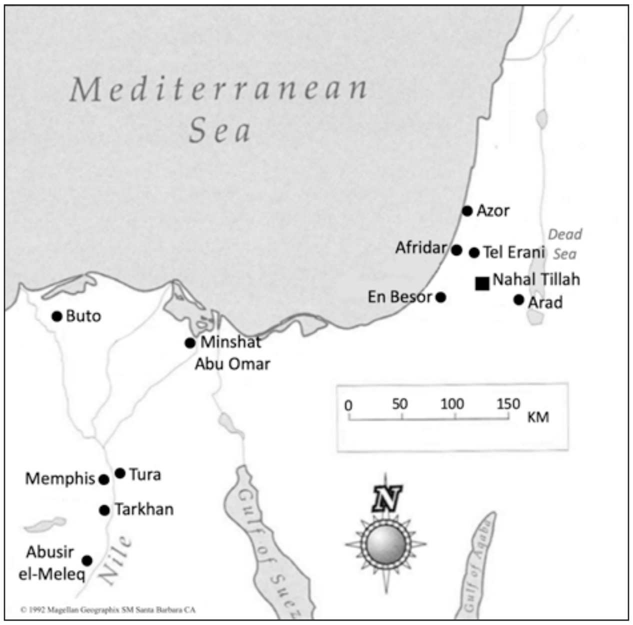

Figure 1.4.1. Map of Early Bronze Age southern Levant and Egypt with location of Nahal Tillah and Halif Terrace. (Modified after Levy et al. 1995:30.)

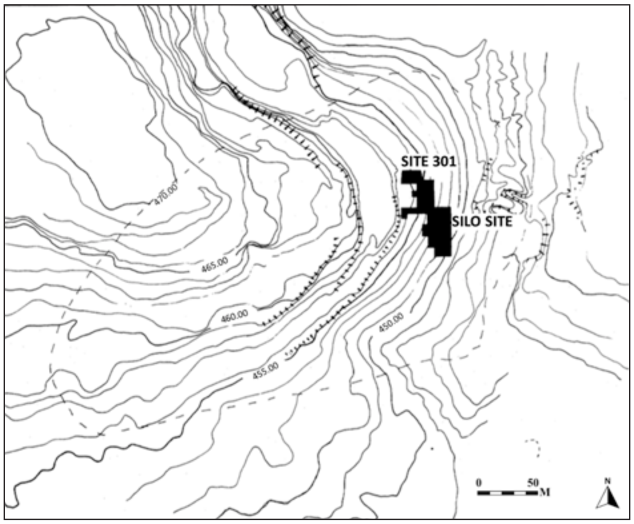

Figure 1.4.2. Topographic map of Halif Terrace and excavation areas. (Modified after Levy et al. 1997:5.)

A total of 183 bones exhibit evidence of butchering. Although this number is small in relation to the larger faunal assemblage, it is similar to that found in other nonmarine or waterlogged assemblages of contemporary and earlier periods (Allentuck and Greenfield 2010; Greenfield and Brown 2016; Greenfield and Horwitz 2012). These butchered bones can be divided among three successive time periods at the site (Table 1.4.1). The number of butchered bones per period mirrors that of the overall total of bones. In this respect, most bones (NISP=4,050) originate from EB I B–late levels overall (Kansa in press), as

Table 1.4.1. Distribution of butchered bones and butchering incidences by period. NISP = Number of Identified Specimens; NBI = Number of Butchery Incidences.

| | NISP # | NISP % | NBI # | NBI % |
|---|---|---|---|---|
| EB I A | 7 | 3.8% | 10 | 3.0% |
| EB I B–early | 11 | 6.0% | 15 | 4.5% |
| EB I B–late | 149 | 81.4% | 287 | 85.4% |
| EB I, indeterminate | 3 | 1.6% | 4 | 1.2% |
| Topsoil | 4 | 2.2% | 7 | 2.1% |
| Unknown | 9 | 4.9% | 13 | 3.9% |
| **TOTAL** | **183** | **100.0%** | **336** | **100.0%** |

do the vast majority of butchered bones (NISP=149), which account for 81.4% of the butchered assemblage. By total of bones, the EB I A and EB I B–early are similar in count, with a NISP of 471 and 415 respectively (Kansa in press). However, the number of butchered bones slightly differs, as more occur during the EB I B–early (NISP=11, 6.0% of the butchered assemblage) than the EB I A (NISP=7, 3.8% of the butchered assemblage). Several butchered bones originate from the EB I indeterminate (1.6%) and topsoil (2.2%), while others could not be assigned to a specific period (4.9%). This study largely focuses on interpretations from the EB I–late, as most of the butchered bones originate from it, but considers other subperiods as well in order to establish the nature of EB I butchering at the site. A parallel report on the butchering technology associated with the butchered assemblage from Nahal Tillah can be found in Greenfield et al. (2018).

## Methods

This present study involved two components: (1) the identification of butchered bones and (2) the documentation of butchery marks and patterns. First, the bones exhibiting potential butchering marks were exported to the Near Eastern and Biblical Archaeological Laboratory (NEBAL) at the University of Manitoba. Using the comparative zooarchaeological collection, the butchered bones were identified to their element and taxon. Second, butchery and other damage were examined with a combination of the naked eye, hand-held illuminated magnifying glass, and binocular microscope (25×) observations. Several specimens were tested by submitting silicone molds for analysis within a scanning electron microscope to ensure their identification as butchering marks and to determine the raw material of the butchering implement used (Greenfield et al. 2018). For each bone, the type of butchery mark, number of marks, location, and activity represented were noted. Based on previous descriptions (Fisher 1995; Greenfield 1999, 2000; Lyman 1987b, 1994; Olsen 1988; Walker 1978; Walker and Long 1977), it is possible to discern several types of butchering damage in the Nahal Tillah assemblage: bashes, chops, gouges, nicks, notches, sawing, scrapes, and slices.

(1) Bashes are caused by heavy blows from a blunt object, such as a hammerstone, in an attempt to break open the bone. They manifest as irregularly shaped grooves with no evident striations.

(2) Chops are the result of heavy impact to a bone, typically with a sharper implement than those used for bashes, such as an axe, with the intention to dismember or break open a bone. They appear as short broad linear grooves with a V-shaped cross section. The edges are usually straight with the edge opposite the direction from which the blow was struck having a higher profile than the other. A relatively straight edge remains with no striations evident within the groove. The V-shaped cross-section shows micro-depression fractures oriented downward into the groove.

(3) Gouges result from a direct puncture—minute angular cavity—into the bone surface by a sharp implement. These are often incidental, as the intention was to separate tougher portions of flesh.

(4) Nicks are caused by light incidental contact between a sharp implement and the bone. As such, these are represented by extremely short grooves. These are isolated occurrences and typically shallow in nature, often going unnoticed.

(5) Notches are similar to nicks, but leave a broader groove, as more force is applied.

(6) Sawing results from repeated back-and-forth slicing action by a sharp implement. It leaves behind multiple striations in a single series within a wide groove. The groove also exhibits a V-shaped cross section.

(7) Scrapes result from the surficial removal of

flesh along the bone. They appear as a series of shallow parallel striations, typically elongated and orientated with the longitudinal axis of the bone.

(8) Slices result from the removal or cutting through soft tissues—e.g., muscles—using a sharp implement. A slice appears as a single elongated, relatively narrow, linear striation. Although the shapes seen in cross section exhibit some variation, they usually are V-shaped with flat regular sides and fine parallel striations oriented with the long axis of the main groove.

The data are reported by the Number of Identified Specimens (NISP) and the Number of Butchery Incidences (NBI). The NISP only counts a single specimen once. The NBI reflects the number of times that one type of butchering activity occurred on the same bone fragment. For instance, if there are separate butchering grooves on two different sides of the bone, then the NISP would be one, but the NBI would be two. This allows a more suitable analysis of butchering patterns and avoids double counting of elements and taxa (Greenfield and Brown 2016; Greenfield et al. 2016).

## Assemblage Description

### *Taphonomy*

An evaluation of the taphonomy of the assemblage is essential for understanding what might be missing or biased in assemblages (Lyman 1987b, 1994). Several variables are quantified in this respect (Greenfield 1986), as taphonomic and other relevant zooarchaeological data are presented.

Weathering. Overall, the butchered assemblage is in relatively good condition (Table 1.4.2). The majority is lightly weathered (79.7%). In contrast, medium (9.9%) and heavy (0.3%) weathering occur in much lower proportions. These patterns attest to the relatively high level of preservation and suggest that the bones were quickly discarded after meat consumption or use.

Table 1.4.2. Weathering of butchered assemblage by period (N = 183).

| | WEATHERING INTENSITY | | | | |
|---|---|---|---|---|---|
| | **Heavy** | **Medium** | **Light** | **None** | **TOTAL** |
| EB I, indeterminate | 0.0% | 25.0% | 75.0% | 0.0% | 100.0% |
| EB I A | 0.0% | 10.0% | 90.0% | 0.0% | 100.0% |
| EB I B–early | 0.0% | 28.6% | 64.3% | 7.1% | 100.0% |
| EB I B–late | 0.3% | 8.7% | 79.4% | 11.5% | 100.0% |
| Topsoil | 0.0% | 14.3% | 85.7% | 0.0% | 100.0% |
| Unknown | 0.0% | 7.7% | 92.3% | 0.0% | 100.0% |
| **TOTAL** | **0.3%** | **9.9%** | **79.7%** | **10.1%** | **100.0%** |

Fragmentation. Fragment size is often an indication of an assemblage's quality (Table 1.4.3). The butchering assemblage is heavily fragmented, as most (71.1%) bones represented by an estimated <25% of the original element. In addition, more than half (54.7%) of the bones represent <10% of the original element. It should be noted that this degree of fragmentation complicates taxonomic identification and can skew any kind of taxonomic quantification. The only complete bones (NISP=4) are two astragali, a cuboid, and a mandible. These compact elements are more resistant to fragmentation than most other elements in the skeleton.

Heat Treatment. All bones were evaluated for thermal alteration using traditional zooarchaeological techniques based on color and texture (Greenfield and Beattie 2017; Shipman et al. 1984). Just over half (NISP = 95, 51.9%) of the butchered assemblage received some form of heat treatment (Table 1.4.4). Such alterations are a result of boiling (33.3%) and burning (18.6%). Burnt bones occur in the EB I indeterminate (33.3%), EB I B–late (18.1%), and EB I A (14.3%), but do not occur in the EB I B–early. Boiled bones are present in each period with the EB I B–late (35.6%) containing the highest proportion, followed by EB I indeterminate (33.3%), EB I B–early (18.2%), and EB I A (14.3%).

Gnaw Marks. Very few bones (4.4%) in the butchering assemblage exhibited any evidence of gnaw marks. This extremely low proportion demonstrates that canids and rodents were not a significant taphonomic factor affecting the visibility of butchery marks and condition of the assemblage.

Table 1.4.3. Condition and fragmentation of butchered assemblage by period (N = 183).

| | ESTIMATED PERCENTAGE OF ELEMENT REMAINING | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1% | 5% | 10% | 15–25% | 30–50% | 70–95% | 100% | Unknown | TOTAL |
| EB I A | 0.0% | 71.4% | 14.3% | 14.3% | 0.0% | 0.0% | 0.0% | 0.0% | 100.0% |
| EB I B–early | 0.0% | 18.2% | 45.4% | 9.1% | 18.2% | 0.0% | 0.0% | 9.1% | 100.0% |
| EB I B–late | 1.3% | 32.2% | 17.4% | 18.2% | 13.5% | 6.7% | 2.6% | 8.1% | 100.0% |
| EB I, indeterminate | 0.0% | 33.3% | 33.3% | 0.0% | 0.0% | 0.0% | 0.0% | 33.3% | 100.0% |
| Topsoil | 0.0% | 25.0% | 25.0% | 0.0% | 25.0% | 0.0% | 0.0% | 25.0% | 100.0% |
| Unknown | 0.0% | 77.8% | 0.0% | 11.1% | 0.0% | 11.1% | 0.0% | 0.0% | 100.0% |
| **TOTAL** | **1.0%** | **35.0%** | **18.6%** | **16.4%** | **12.6%** | **6.0%** | **2.2%** | **8.2%** | **100.0%** |

Table 1.4.4. Heat treatment of butchered assemblage by period (N = 183).

| | FORM OF HEAT TREATMENT | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Boil | | Burn | | None | | TOTAL | |
| | NISP # | NISP % | NISP # | NISP % | NISP # | NISP % | NISP # | NISP % |
| EB I A | 1 | 14.3% | 1 | 14.3% | 5 | 71.4% | 7 | 100.0% |
| EB I B–early | 2 | 18.2% | 0 | 0.0% | 9 | 81.8% | 11 | 100.0% |
| EB I B–late | 53 | 35.6% | 27 | 18.1% | 69 | 46.3% | 149 | 100.0% |
| EB I, indeterminate | 1 | 33.3% | 1 | 33.3% | 1 | 33.3% | 3 | 100.0% |
| Topsoil | 2 | 50.0% | 2 | 50.0% | 0 | 0.0% | 4 | 100.0% |
| Unknown | 2 | 22.2% | 3 | 33.3% | 4 | 44.4% | 9 | 100.0% |
| **TOTAL** | **61** | **33.3%** | **34** | **18.6%** | **88** | **48.1%** | **183** | **100.0%** |

Worked Bone. As a strong, but elastic material, bone can be modified to serve as a variety of tool forms (Maeir et al. 2009). Repeated interaction between the bone and another material—for example, palm of the hand, polishing stone—can result in smoothing of the bone surface, loss of surface detail, and creation of bone surface polish (Shipman and Rose 1988). Surface polish is scaled by the intensity of light reflected off the bone. As such, it is a common taphonomic variable with the capacity to reduce the visibility or completely erase shallow butchery marks.

Overall, a very high proportion (73.2%) of the bones with butchery marks exhibit surface polish. This modification was ranked according to intensity. Light polish (36.6%) was the most common, followed by medium (25.1%), and high (11.5%). These data indicate that a high proportion of bones with butchery marks were modified for use as tools.

Six identifiable tools were discovered among the butchering assemblage, as shovels (NISP = 3), points (NISP = 2), and what is likely a handle (NISP = 1). It should be noted that most of the polished long bones may also represent handles, but they are too fragmented to confirm with certainty. In addition, two complete astragali were discovered with light-medium polish, which were possibly used as game pieces (Gilmour 1997) or tokens (Sasson 2007). These bone tools and game pieces all originate from the EB I B–late assemblage.

Table 1.4.5. Taxonomic representation within butchered assemblage by period (N = 183).

| | **EBI, indeterminate** | **EB I A** | **EB I B –early** | **EB I B –late** | **Topsoil** | **Unknown** | **Grand Total** |
|---|---|---|---|---|---|---|---|
| *Bos taurus* | | 2 | | 20 | | 1 | 23 |
| *Canis familiaris* | | | | 3 | | | 3 |
| *Capra hircus* | 1 | 2 | | 15 | | 1 | 19 |
| Cervidae–medium | | | | 1 | | | 1 |
| *Equus asinus* | | | 2 | 6 | | | 8 |
| *Equus* sp. | | | | 1 | | | 1 |
| *Gazella gazella* | | | | 4 | | | 4 |
| Leporidae | | | | 1 | | | 1 |
| Mammal–large | | | | 1 | | | 1 |
| Mammal–medium | 2 | 1 | 2 | 30 | 3 | 2 | 40 |
| *Ovis aries* | | | 1 | 7 | | | 8 |
| *Ovis/Capra* | | 2 | 6 | 59 | 1 | 4 | 72 |
| *Sus domesticus* | | | | 1 | | | 1 |
| Unknown | | | | | | 1 | 1 |
| **Grand Total** | **3** | **7** | **11** | **149** | **4** | **9** | **183** |

### *Taxonomic Representation*

The taxa present in the butchered assemblage are almost entirely domestic species (N = 177, 96.7% of NISP, Table 1.4.5). The most common taxa are *Ovis/Capra* (N = 72, 39.3%), *Capra hircus* (N = 19, 10.4%), and *Bos taurus* (N = 23, 12.6%). Other present domestic taxa include *Ovis aries* (N = 8, 4.4%), *Equus asinus* (N = 8, 4.9%), *Canis familiaris* (N = 3, 1.6%), and *Sus domesticus* (N = 1, 0.6%). The few wild taxa are represented by *Gazella gazella* (N = 4, 2.2%), Cervidae (N = 1, 0.5%), and Leporidae (N = 1, 0.5%).

The EB I B–late contains both domestic and wild taxa. In fact, the entire range of species is present during this period, including dog, pig, and donkey in their previously stated small proportions. Additionally, *Ovis/Capra* (altogether 54.1%, n = 99) and medium mammals (N = 40, 21.8%) dominate the assemblage with *Bos taurus* (N = 23, 12.5%) as next highest. A similar pattern of domestic taxa frequency is seen among the EB I indeterminate, EB I A, and EB I B–early where goats, sheep, and medium mammals—likely *Ovis/Capra*—are prevalent.

It should be noted that if the vast majority of medium mammals are considered to be *Ovis/Capra*, then the total frequencies of sheep and goats combined throughout the three periods become EB I A (71.4%), EB I B–early (81.8%), and EB I B–late (60.7%). These frequencies are fairly similar to those observed in the overall assemblage—that is, EB I A = 66.2%, EB I–early = 75.4%, and EB I B–late = 74.6% (Kansa in press). Similar frequencies between the EB I B–late butchered assemblage and the larger EB I B–late assemblage are also apparent with the following species—frequencies listed respectively (Kansa in press): *Gazella gazella* (2.7%, 3.6%), *Bos taurus* (13.4%, 11.9%), *Canis familiaris* (2.0%, 2.2%), *Equus asinus* (4.0%, 4.1%), and *Sus* (0.7%, 1.4%). Consequently, the taxonomic frequencies in the butchered assemblage and the larger faunal assemblage align well.

### *Element Representation*

Several observations can be made regarding the proportions of elements in the butchered assemblage (Appendix 1.4.1). Overall, the NISP distribution by body section is as follows:

(1) Trunk: hyoid, axis, vertebrae, scapulae, ribs, and innominate = 58
(2) Forelimb: humeri, radii, ulnae, and metacarpals = 46
(3) Hindlimb: femora, tibiae, cuboids, calcanei, metatarsals, and astragali = 31
(4) Cranial: cranium and mandibles = 12
(5) Indeterminate fragments: long bones, flat bones, and unknown = 36

More specifically, ribs (NISP = 33) are the most common followed by indeterminate long bones (NISP = 27) and various vertebrae (NISP = 18). Identifiable long bones appear in moderate frequencies, such as humeri (NISP = 17), radii (NISP = 13), femora (NISP = 8), and tibiae (NISP = 8). It should be noted that if these are combined with the indeterminate long bones, then long bones—in general—are the most abundant category (NISP = 73).

In relation to various taxa, several observations can be made regarding the frequency of elements. For example, the majority of ribs (73%) and various long bone elements (84%) originate from the collective group of medium mammals, *Ovis aries* and *Capra hircus*. Even though most of the ribs and long-bone fragments cannot be directly attributed to a specific taxon, for example sheep versus goat, it is clear that such animals typically constitute the bulk of meat consumed at the site and are likely the dominant herding livestock. Scapulae also appear in moderate frequencies (NISP = 11) and most (55%) originate from *Bos taurus*. Similarly, smaller elements, for example, astragali, cuboids, and calcanei, mainly originate from larger mammals, such as *Bos taurus* and *Equus asinus*, but still appear in minute amounts (NISP < 5). Lastly, the portions of cranial bones (NISP = 12) are mostly too fragmented to fully identify. However, based on their thickness and limited morphology, they are likely *Ovis*/*Capra* or medium mammal remains.

## *Age Profiles*

Age distribution of butchered taxa exhibits several distinct patterns that are noted below (Appendix 1.4.2). The overall emphasis in each taxon on subadult/adult specimens is clearly taphonomically induced: older animals are more likely to survive the various attritional forces since their bones are denser and more durable (Binford 1981; Lyman 1994). If we reduce the influence of the indeterminate age classes—such as subadult/adult—and focus instead on the more clearly age-definable specimens—namely, juvenile, subadult, and adult—several interesting patterns begin to emerge that cannot be simply attributed to bone attrition. The age classes are fairly similar among the large mammalian taxa. In both cases, subadults are dominant, while the juvenile and adult frequencies are much smaller. For *Bos taurus*, most specimens are from the subadult/adult (N = 9, 39.1%) and subadult (N = 8, 34.8%) age classes, with far fewer adults (N = 5, 21.7%) and even fewer juveniles (N = 1, 4.3%). For *Equus asinus*, the specimens are subadults (N = 2) and subadult/adult (N = 4), while juveniles and adults are represented by one specimen each. These differences suggest that taphonomy may be the overriding variable in bone distributions.

The age distribution for medium mammals varies depending on whether they are common food animals. For example, dogs are rarely present and are equally divided between juvenile, subadult/adult, and adult. In contrast, the distributions for *Capra hircus* and *Ovis aries* are quite similar. Across both taxa, juveniles are the most common (*Capra* = 6, 31.6%; *Ovis* = 4, 50%). There is a small proportion of subadults among *Capra* (N = 2, 10.5%) and none among *Ovis*, though subadult/adults are present in high proportions (*Capra* = 6, 31.6%; *Ovis* = 2, 25%). The adults are present in roughly equal frequencies for each (*Capra* = 5, 26.3%; *Ovis* = 2, 25%). These frequencies suggest a greater selection for younger animals–juveniles, almost no subadults, and some adults. They are further reminiscent of culling ages for meat-providing taxa. The missing subadults (N = 17, 23.6%) appear among the indeterminate *Ovis*/*Capra*. Also, the younger individuals—fetal (N = 1) and infant (N = 2)—are present among this group, albeit in extremely small proportions. These distributions illustrate the difficulty of identifying age class preference with sheep and goats since so many elements are difficult to assign to a taxon, especially those from young individuals.

Cervidae, Leporidae, *Sus domesticus*, and *Equus* sp.—probably *E. asinus*—specimens are from subadults/adults. Lastly, *Gazella gazella* remains are equally distributed among subadults/adults and adults, while *Canis familiaris* specimens range from juvenile to adult in equal proportions.

Table 1.4.6. Distribution of element–butchery marks by number of butchery incidences.

| | TYPE OF BUTCHERY MARKS | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | **Bash** | **Chop** | **Gouge** | **Nick** | **Notch** | **Saw** | **Scrape** | **Slice** | **TOTAL** |
| Astragalus | | | | | | | | 4 | 4 |
| Axis | | | | | | | | 2 | 2 |
| Calcaneus | | | | | | | 1 | 8 | 9 |
| Cervical vertebra | | | | | | | | 5 | 5 |
| Cranium | | 1 | | | | | | 6 | 7 |
| Cuboid | | | | | | | | 6 | 6 |
| Femur | | | | | | | 2 | 26 | 28 |
| Flat bone | | | | | | | 1 | 11 | 12 |
| Humerus | 2 | 1 | | 2 | 1 | | 2 | 33 | 41 |
| Hyoid | | | | | | | | 1 | 1 |
| Innominate | | | | | | | | 6 | 6 |
| Long bone | 1 | | | | | | 11 | 36 | 48 |
| Mandible | | | | | | | | 7 | 7 |
| Metacarpal | | | | | | | | 6 | 6 |
| Metatarsal | 1 | 1 | | | | | | 5 | 7 |
| Radius | | | 2 | | | | 9 | 19 | 30 |
| Rib | | 2 | | 2 | | | 4 | 37 | 45 |
| Scapula | | | | | | | 1 | 21 | 22 |
| Thoracic vertebra | 1 | | | | | | | 4 | 5 |
| Tibia | | 1 | 1 | | | 1 | 4 | 18 | 25 |
| Ulna | | | | | | | | 3 | 3 |
| Unknown | | | | | | | | 2 | 2 |
| Vertebra | | | | | | | | 15 | 15 |
| **TOTAL** | **5** | **6** | **3** | **4** | **1** | **1** | **35** | **281** | **336** |

In small samples sizes, such as at Nahal Tillah, it is important to consider the indeterminate mammal size categories since they often contain the elements and age distributions absent from the more identifiable part of the assemblage. Large mammals are represented by a single subadult/adult specimen, while medium mammals retain a proportion of subadult/adult and subadult, with no adults.

## *Butchery Marks*

Butchery marks are present in a variety of forms and on various locations of the skeletal elements. Additional documentation can be found in Greenfield et al. (2018), as well as in the extensive fauna catalogue that cannot be compressed into this volume (available on request), but portions of it have been summarized in Tables 1.4.6–1.4.7. Several observations can be made regarding the distribution of the 336 butchering incidences within the assemblage.

Slices are by far the most common type of butchery mark (84%). These appear as narrow elongated grooves with a V-shaped cross section (Figures 1.4.3–1.4.4). Slices are found on every type of element in the butchered assemblage, often in higher quantities on long bones, ribs, and vertebrae. They occur in

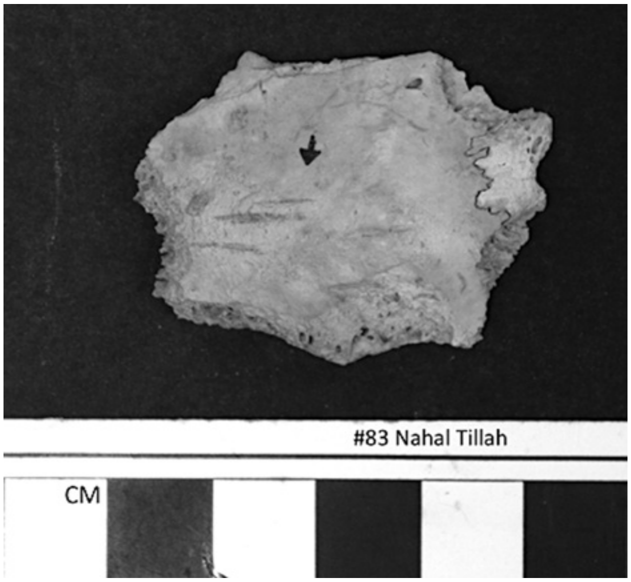

Figure 1.4.3. Slice incidence #83 on *Ovis*/*Capra* cranial fragment (EB I B–late). (Photograph by H. Greenfield.)

Figure 1.4.4. Slice incidence #273 on *Ovis*/*Capra* vertebrae (EB I B–late). (Photograph by H. Greenfield.)

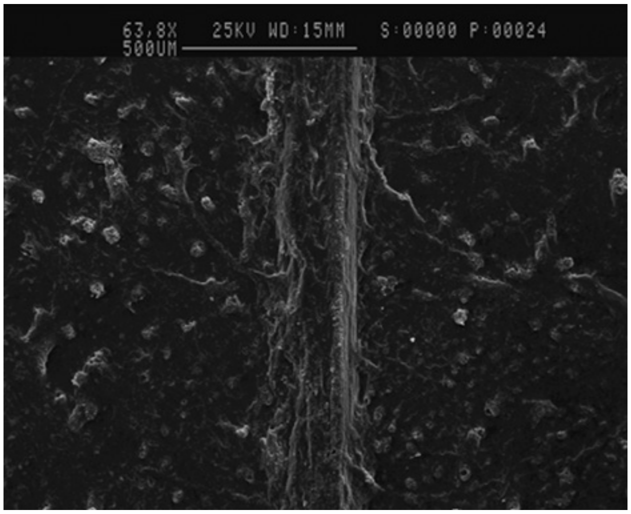

Figure 1.4.5. Scanning electron microscope images of slice marks. Note the asymmetrical nature of the groove, which is indicative of stone. (Photograph by H. Greenfield.)

highest frequencies on the shaft of long bones and across the spinous and transverse processes of vertebrae. Results from the scanning electron microscopy analysis demonstrate that stone was the raw material used to make the butchering tools that caused the slice marks (Figure 1.4.5; Greenfield 2006; Greenfield et al. 2018).

The second most common type of butchery mark is scrapes (10%). These often accompany slices and appear in highest quantities on long bone shafts. The heavy impacts of chops and bashes are also evident. For the former, they are present on a cranium, the shafts of a humerus, metatarsus, tibia, and on two ribs. Bashes occur on the shafts of two humeri, a metatarsus, and an indeterminate long bone, as well as on a thoracic vertebra.

A gouge appears on the shaft of a tibia, while two others are located on the proximal half of two separate radii. Two nicks are found on a distal rib and the other two on two separate humeri. Lastly, a single saw mark is located on a tibia and a notch on a humerus.

## Butchering Patterns

Butchering activities can be present in a variety of forms. Traditionally, they are interpreted from the type of butchery mark (see Methods) and its location on the body (Binford 1981). The most common activities are listed below.

(1) Slaughter: incision, strike, or blow intended to kill animal, typically around the neck or head
(2) Skinning: removal of hides and skin, mainly on distal extremities or cranium.
(3) Dismemberment: division of body with heavy implements, typically a separation of a limb from the trunk.
(4) Disarticulation: calculated division of one bone from another, typically division of the limb into smaller units.
(5) Filleting: removal of meat around and along bones.
(6) Marrow extraction: destruction of the long bone to retrieve the marrow from the shaft.

(7) Toolmaking: further removal of residual flesh to completely expose the bone (such marks are indistinguishable from routine filleting, and the two activities are grouped together for bones that were tools).

The butchering activities associated with the butchered faunal assemblage appear in a variety of forms (Figure 1.4.6), but some are more prevalent than others. For example, filleting (particularly when associated with defleshing for tool production; both together represent NBI = 65%) is the most common occurrence, followed by disarticulation and dismemberment. All other forms of butchering appear in extremely low proportions. These patterns are interpreted from the extensive data summarized in Tables 1.4.7–1.4.8. These data are used to augment the discussions in the following sections with regard to the distribution of butchery marks and their implications for butchering activities associated with each taxon. The taxa are described in alphabetical order, with ovicaprines described separately and together as a whole.

### *Bos taurus*

Skinning and removal of the hides occurs in the form of butchering incidences located on cranium fragments. Disarticulation is found as a series of slice incidences and a chop incidence on several limb bones—metatarsalus, cuboids, calcaneus, and astragalus—that were performed in attempts to divide up the lower limb. Further indications of disarticulation are discovered on several scapulae, where attempts to separate the scapulae from the trunk—ribs—were made. Extensive filleting and toolmaking activities, in the form of slice and scrape incidences, occur on the midshafts of several humeri, ribs, and a scapula. Two scapulae were fashioned into shovels. Isolated filleting is also found on the midshafts of other elements—humerus, radius, rib, scapula—and on a vertebra. The majority of bovine bone tools were either boiled or burnt.

### *Canis familiaris*

Dismemberment of the forelimb occurs as two slice incidences and a chop on the proximal half of the humerus. Filleting activity is present in the form of a nick on a humerus and three slice incidences on a metacarpus.

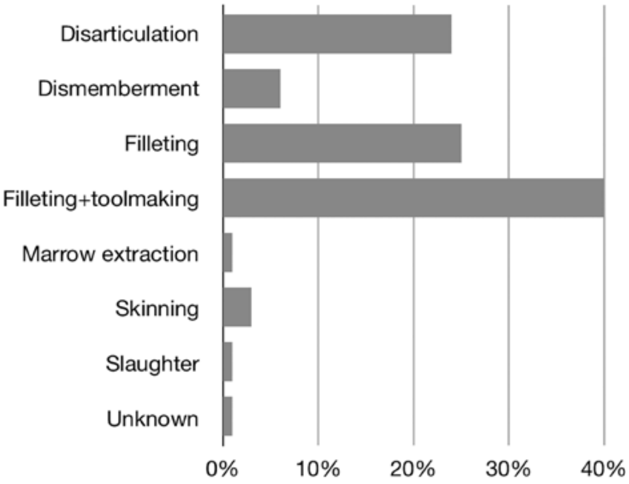

Figure 1.4.6. Proportions of butchery activities.

### *Cervidae*

Disarticulation, specifically that of the scapula from trunk, is observed in a slice incidence found on a scapula. The bone was also boiled.

### *Equus asinus*

A slice incidence on the axis is a tentative indication of slaughter, given its position at the forefront of the neck. Similarly, the slice incidence on the hyoid may be due to slaughter or possibly filleting. In the case of the latter activity, the hyoid may be removed for access to the tongue. The slice incidence on the calcaneus is likely the result of disarticulation. Lastly, filleting and toolmaking activity occurs as a series of slice and scrape incidences on the humerus, radius, ribs, and metacarpus.

### *Gazella gazella*

Slice incidences on a left innominate and proximal end of one femur are likely the result of disarticulation of the hindlimb from the trunk. Further evidence of disarticulation of the limbs occurs on two femora, where slice incidences are present on the distal ends of both femora and on an astragalus. Additional slice incidences on the shaft of one femur are indicative of filleting and toolmaking. The astragalus was likely utilized as a game piece or token, as it exhibits considerable polish.

Table 1.4.7. Distribution of taxa–butchering activity by Number of Butchery Incidences.

| TAXON | BUTCHERING ACTIVITY | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Slaughter | Skinning | Dismemberment | Disarticulation | Filleting | Filleting and toolmaking | Marrow extraction | Unknown | TOTAL |
| *Bos taurus* | | 2 | 4 | 19 | 10 | 10 | | | 45 |
| *Canis familiaris* | | | 3 | | | 4 | | | 7 |
| *Capra hircus* | 1 | 1 | 2 | 13 | 5 | 14 | 1 | | 37 |
| Cervidae | | | | 1 | | | | | 1 |
| *Equus asinus* | 1 | | | 2 | 7 | 12 | | | 22 |
| *Gazella gazella* | | | 6 | 5 | 1 | 5 | | | 17 |
| Leporidae | | | | | 1 | | | | 1 |
| Mammal–large | | | | | | 3 | | | 3 |
| Mammal–medium | | 2 | | 3 | 19 | 38 | 1 | 1 | 64 |
| *Ovis aries* | | 1 | 2 | 14 | | | | | 17 |
| *Ovis/Capra* | | 3 | 4 | 25 | 38 | 49 | | | 119 |
| *Sus domesticus* | | | | | 2 | | | | 2 |
| Unknown | | | | | | | | 1 | 1 |
| **TOTAL** | **2** | **9** | **21** | **82** | **83** | **135** | **2** | **2** | **336** |
| % | **0.6%** | **2.7%** | **6.3%** | **24.4%** | **24.7%** | **40.2%** | **0.6%** | **0.6%** | **100.0%** |

Table 1.4.8. Distribution of butchering activity by butchery mark, first presented by count followed by percentage.

| Activity | Bash | Chop | Gouge | Nick | Notch | Saw | Scrape | Slice | Grand Total |
|---|---|---|---|---|---|---|---|---|---|
| Disarticulation | 4 | 3 | | 1 | | 1 | 1 | 72 | 82 |
| Dismemberment | | 1 | | | | | | 20 | 21 |
| Filleting | | | 2 | 2 | | | 7 | 72 | 83 |
| Filleting and toolmaking | | | 1 | 1 | 1 | | 27 | 105 | 135 |
| Marrow extraction | 1 | 1 | | | | | | | 2 |
| Skinning | | 1 | | | | | | 8 | 9 |
| Slaughter | | | | | | | | 2 | 2 |
| Unknown | | | | | | | | 2 | 2 |
| **Grand Total #** | **5, 1.5%** | **6, 1.8%** | **3, 0.9%** | **4, 1.2%** | **1, 0.3%** | **1, 0.3%** | **35, 10.4%** | **281, 83.6%** | **336, 100%** |

### *Leporidae*

Two slice incidences on a rib fragment possibly represent filleting activity to remove meat. They are located on the lateral face of the rib. The bone was also boiled.

### *Mammal–large*

A long bone fragment exhibits three slice incidences that are likely the result of filleting and toolmaking, as the shaft is moderately polished.

### *Mammal–medium*

The heavy fragmentation of this group of bones impedes the secure identification of butchering activities by taxon. Two slice incidences found on subadult and juvenile cranium bones are likely the result of skinning activity. Disarticulation occurs in the form of several slice incidences located on the medial and cranial face of the scapula. Dismemberment is present a chop on the proximal end of a rib. The tools range in polish intensity from light to high. Most are long bone shafts, but others are points made from flat bones. As such, any bone fragment with incidences associated with filleting also has toolmaking as a secondary activity. This is evident with the large quantity of slice and scrape incidences that occur on various shafts of long bones and ribs, as well as flat bones. Isolated filleting activity is found on a similar distribution of bone elements, though in lower proportions. Finally, the long bone shaft of a juvenile exhibits a bash that is probably the result of marrow extraction as the bash breaks open the bone and exposes the interior cavity. Nearly every bone, especially all the tools, has been boiled or burnt.

### *Ovicaprines*

First, each taxon will be separately described. Then the patterns for all combined ovicaprines will be discussed to illustrate differences between and within the various taxa.

*Capra hircus*. There is a wide range of butchering activities associated with *Capra hircus* remains. Slaughter possibly occurs as a slice incidence upon the axis vertebra, though it is possible that these marks appeared postmortem. The cranium fragment retains a slice incidence that may indicate skinning activity. Disarticulation and filleting are the two major activities. The former is represented by a series of slice incidences, as well as a nick on various limb bones—cuboids, astragalus, metatarsus, and radius—and a mandible. Similarly, filleting, and toolmaking, occurs as multiple slice incidences on several limb bones, two mandibles, and a vertebra. A slight gouge on a humerus is associated with filleting, rather than a failed attempt at marrow extraction as the mark does not fully penetrate through the cortical bone. Lastly, a chop mark on the shaft of a metatarsal bone indicates dismemberment and marrow extraction as it severed the bone, exposing the interior cavity. A tibia, a metatarsus, and three humeri were boiled, while a fourth humerus was burnt.

*Ovis aries*. The juvenile mandible retains a slice incidence that may indicate skinning activity. The slice incidences on the two innominates represent attempts to disarticulate the hindlimb from the trunk. Disarticulation is the predominant activity found on sheep remains. This is evident from the series of slice incidences found on the calcaneus, scapula, metatarsus, and humerus.

Combined ovicaprines. In this section, the *Ovis aries*, *Capra hircus*, and *Ovis/Capra* data are summarized. In this regard, filleting—combined with toolmaking—is the most frequent butchering activity, constituting over half of the incidences. Several slice, scrape, and gouge incidences are the result of filleting. These occur mostly upon ribs, scapulae, long bones, and vertebrae. The majority of long bones retain evidence of filleting that is also associated with toolmaking, as most are tools. Two infant bones and the lone fetal specimen retain small slice incidences, which are likely due to filleting. Disarticulation appears as the next frequent butchering activity, albeit in a considerably lower frequency than filleting. This pattern stands in contrast to that exhibited by the species separately, where filleting is not present on *Ovis aries* remains and occurs in nearly similar frequencies to disarticulation on *Capra hircus* remains. Several disarticulation marks occur at the distal and proximal portions of long bones and ribs as well as on the dorsal body of a vertebra. The separation of the hindlimb from the trunk, occurs as several slice incidences on the proximal end of three femora and on several innominates. Lastly, three cranial fragments and two juvenile mandibles exhibit slice incidences that are likely the result of skinning. Dismemberment is evident from bash, chop, and saw incidences.

### *Sus domesticus*

Two slice incidences on a rib fragment represent filleting to remove portions of meat. Access was through the upper left side of the trunk.

## Discussion

Given the small size of the sample, it is difficult to establish statistically significant patterns. But, some tentative general observations can be made. In total, 183 bones exhibit 336 butchering incidences on them. The majority of bones demonstrated multiple incidences and most incidences are those of slices (NBI = 280). These are followed by scrapes (NBI = 35), while all others—bashes, chops, gouges, nicks, notches, sawing—are comparatively rare (NBI < 10).

While the assemblage has undergone heavy fragmentation, it is not considerably weathered, nor have canids significantly affected the condition. However, bone fragmentation has likely caused some of the smaller taxa and younger individuals to be minimally present or entirely absent. Similarly, it is evident that compact bones, such as calcanei, are more likely to survive intact. The causes of fragmentation in the majority of bones are not always clear. However, it is clear that only a few can be confidently associated with butchering (such as chops and bashes) and toolmaking (such as smoothed edges).

Several taxa are underrepresented in the Nahal Tillah butchering assemblage when compared to the larger assemblage. This is likely a function of sample size. Yet some observations can be made. The butchered taxa reflect the proportions in the greater faunal assemblage (see larger assemblage data in Kansa et al. 2006; Kansa in press). As in the larger assemblage, *Ovis*/*Capra*, medium mammals (probably *Ovis* and *Capra*), *Bos taurus*, and *Capra hircus* are followed by the most common taxa by NISP in the butchered assemblage. These are also the most common domestic taxa regularly exploited during the EB by pastoral nomads and early sedentary societies for their primary and secondary products. However, it is apparent that the residents of Nahal Tillah were not limited to domestic animals and acquired a few wild animals—like *Gazella*, Cervidae, and Leporidae—for their diet and other uses as well.

In general, the age distribution of the butchered assemblage extends from fetal to adult. However, it should be noted that there is only one fetal and two infantile remains. Hence, these very young age classes are not common. As suggested above, there was not heavy differential attrition of the younger age classes, then they were likely not a routine part of the culling pattern or diet. As shown above with respect to the culling patterns of the major medium mammal food taxa—for example, all ovicaprines—the age distribution for both sheep and goat are remarkably similar. In this respect, most individuals are of juvenile and subadult age. These frequencies differ from those of the large mammals where subadult and adult are the predominant age classes, suggesting that taxonomic body size may be a mediating variable here. It should be emphasized that the butchered assemblage is a small subsample of the entire faunal assemblage. Consequently, these conclusions are tentative and subject to modification. It is more than likely that the majority of bones in the entire assemblage represent consumption for subsistence.

All stages of butchering activities are represented at Nahal Tillah, albeit in varied frequencies. The data are based upon the number of incidences as more than one activity is often present on the same bone. Our interpretations regarding the relationship between types of butchering marks and activities are based on notable butchering studies, such as Binford (1978, 1981) and Lyman (1994), and personal observation of modern slaughterers and butchers. These allow us to relate marks at particular locations to specific activities.

Butchering activities range from slaughtering to toolmaking (Table 1.4.8). Filleting—and filleting combined with toolmaking—is by far the most frequent (65%). These activities typically produce slices and scrapes, as the intention is meat removal. The slicing marks found at the proximal and distal ends of bones are most closely associated with joint disarticulation (24%). Heavier blows—such as bashes and chops—were primarily utilized for dismemberment (6%). Although the activities associated with slice incidences are quite variable, ranging from slaughter to toolmaking, the majority (63%) were applied for filleting (and toolmaking) and disarticulation (24.4%). Skinning (2.7%) is largely manifested upon cranial and mandibular bones. None of the slicing marks on the lower limbs could be securely identified as skinning marks. Most (if not all) seem to be disarticulation marks. Slice marks that are possible indications of slaughtering (0.7%) are found on the ventral faces of two axis vertebra—from a *Capra hircus* and *Equus asinus*—and possibly a hyoid. However, they may also be a function of disarticulation. Slaughtering is one of the most difficult processes to identify given that animals could have been slaughtered without damaging any of the bones. Lastly, there are some indications of marrow extraction (0.6%), as demonstrated by heavier blows to fracture the long bones.

If all the butchered taxa are considered together, then the entire suit of butchering activities is present at Nahal Tillah. However, only filleting (and toolmaking) and disarticulation are present for most taxa. For many bones, toolmaking occurred after boiling and consumption. Consequently, it is mainly secondary and tertiary stages of the butchering process that are represented by the Nahal Tillah assemblage, where the carcass undergoes division into smaller portions and cuts of meat and later bone working (Rixson 1989).

## Conclusion

In this study, we have tried to cope with the complexity of data that exists on butchering patterns, carcass processing, and technology at the site of EB I Nahal Tillah, Israel. Unfortunately, no other assemblage from this region or time period has been investigated to such an extent for these variables to provide suitable comparisons. As such, this report contributes to elucidating the butchering patterns and carcass processing at a southern Levantine settlement situated within the interaction sphere of Egypt. Consequently, this study is an initial step toward understanding the butchering practices and subsistence economy of early sedentary societies of the southern Levant.

The taxonomic profile of the butchered assemblage from Nahal Tillah reflects the most common species in the region. Sheep and goat make up the majority of butchered animals. The age-at-death for butchered specimens varies by taxon, with younger individuals being preferred for ovicaprines and slightly older individuals for larger mammals. All stages of butchering are present at Nahal Tillah, with filleting as the dominant butchering activity.

Finally, it should be added that all butchery marks were made by stone implements. Metal tools had not yet been integrated into such quotidian activities (Greenfield et al. 2018). Evidence for metal technology for butchering activities is absent throughout the southern Levant during the EB I–III, and only begins to make its appearance at the end of the third millennium BC. Even then, it is present in minimal quantities (Greenfield 2013).

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Appendix 1.4.1. Element representation within butchered assemblage by taxon—proportion by taxon.

| | | TAXON | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ELEMENT | | ***Bos taurus*** | ***Canis familiaris*** | ***Capra hircus*** | Cervidae | ***Equus asinus*** | ***Gazella gazella*** | Leporidae | ***Ovis aries*** | ***Ovis/ Capra*** | ***Sus domesticus*** | Mammal –large | Mammal –medium | Unknown | TOTAL |
| Astragalus | NISP # | 1 | | 1 | | | 1 | | | | | | | | 3 |
| | % | 33.3% | 0.0% | 33.3% | 0.0% | 0.0% | 33.3% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 100.0% |
| Calcaneus | NISP # | 2 | | | | 1 | | | 1 | | | | | | 4 |
| | % | 50.0% | 0.0% | 0.0% | 0.0% | 25.0% | 0.0% | 0.0% | 25.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 100.0% |
| Cranium | NISP # | 1 | | 1 | | | | | | 2 | | | 2 | | 6 |
| | % | 16.7% | 0.0% | 16.7% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 33.3% | 0.0% | 0.0% | 33.3% | 0.0% | 100.0% |
| Cuboid | NISP # | 1 | | 2 | | | | | | | | | | | 3 |
| | % | 33.3% | 0.0% | 66.7% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 100.0% |
| Femur | NISP # | | | | | | 2 | | | 6 | | | | | 8 |
| | % | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 25.0% | 0.0% | 0.0% | 75.0% | 0.0% | 0.0% | 0.0% | 0.0% | 100.0% |
| Humerus | NISP # | 4 | 2 | 4 | | 1 | | | 2 | 4 | | | | | 17 |
| | % | 23.5% | 11.8% | 23.5% | 0.0% | 5.9% | 0.0% | 0.0% | 11.8% | 23.5% | 0.0% | 0.0% | 0.0% | 0.0% | 100.0% |
| Hyoid | NISP # | | | | | 1 | | | | | | | | | 1 |
| | % | 0.0% | 0.0% | 0.0% | 0.0% | 100.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 100.0% |
| Innominate | NISP # | | | 2 | | | 1 | | 2 | 1 | | | | | 6 |
| | % | 0.0% | 0.0% | 33.3% | 0.0% | 0.0% | 16.7% | 0.0% | 33.3% | 16.7% | 0.0% | 0.0% | 0.0% | 0.0% | 100.0% |
| Mandible | NISP # | | | 3 | | | | | 1 | 2 | | | | | 6 |
| | % | 0.0% | 0.0% | 50.0% | 0.0% | 0.0% | 0.0% | 0.0% | 16.7% | 33.3% | 0.0% | 0.0% | 0.0% | 0.0% | 100.0% |
| Metacarpal | NISP # | | 1 | | | 2 | | | | 1 | | | | | 4 |
| | % | 0.0% | 25.0% | 0.0% | 0.0% | 50.0% | 0.0% | 0.0% | 0.0% | 25.0% | 0.0% | 0.0% | 0.0% | 0.0% | 100.0% |
| Metatarsal | NISP # | 1 | | 2 | | | | | 1 | 1 | | | | | 5 |
| | % | 20.0% | 0.0% | 40.0% | 0.0% | 0.0% | 0.0% | 0.0% | 20.0% | 20.0% | 0.0% | 0.0% | 0.0% | 0.0% | 100.0% |
| Radius | NISP # | 1 | | 1 | | 1 | | | | 10 | | | | | 13 |
| | % | 7.7% | 0.0% | 7.7% | 0.0% | 7.7% | 0.0% | 0.0% | 0.0% | 76.9% | 0.0% | 0.0% | 0.0% | 0.0% | 100.0% |

| | | TAXON | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ELEMENT | | *Bos taurus* | *Canis familiaris* | *Capra hircus* | Cervidae | *Equus asinus* | *Gazella gazella* | Leporidae | *Ovis aries* | *Ovis/ Capra* | *Sus domesticus* | Mammal –large | Mammal –medium | Unknown | TOTAL |
| Rib | NISP # | 5 | | | | 2 | | 1 | | 17 | 1 | | 7 | | 33 |
| | % | 15.2% | 0.0% | 0.0% | 0.0% | 6.0% | 0.0% | 3.0% | 0.0% | 51.5% | 3.0% | 0.0% | 21.2% | 0.0% | 100.0% |
| Scapula | NISP # | 6 | | | 1 | | | | 1 | 2 | | | 1 | | 11 |
| | % | 54.5% | 0.0% | 0.0% | 9.1% | 0.0% | 0.0% | 0.0% | 9.1% | 18.2% | 0.0% | 0.0% | 9.1% | 0.0% | 100.0% |
| Tibia | NISP # | | | 1 | | | | | | 7 | | | | | 8 |
| | % | 0.0% | 0.0% | 12.5% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 87.5% | 0.0% | 0.0% | 0.0% | 0.0% | 100.0% |
| Ulna | NISP # | | | | | | | | | 1 | | | | | 1 |
| | % | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 100.0% | 0.0% | 0.0% | 0.0% | 0.0% | 100.0% |
| Vertebra | NISP # | 1 | | 1 | | | | | | 9 | | | | | 11 |
| | % | 9.1% | 0.0% | 9.1% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 81.8% | 0.0% | 0.0% | 0.0% | 0.0% | 100.0% |
| Axis vertebra | NISP # | | | 1 | | 1 | | | | | | | | | 2 |
| | % | 0.0% | 0.0% | 50.0% | 0.0% | 50.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 100.0% |
| Cervical vertebra | NISP # | | | | | | | | | 3 | | | | | 3 |
| | % | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 100.0% | 0.0% | 0.0% | 0.0% | 0.0% | 100.0% |
| Thoracic vertebra | NISP # | | | | | | | | | 2 | | | | | 2 |
| | % | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 100.0% | 0.0% | 0.0% | 0.0% | 0.0% | 100.0% |
| Flat bone | NISP # | | | | | | | | | | | | 7 | | 7 |
| | % | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 100.0% | 0.0% | 100.0% |
| Long bone | NISP # | | | | | | | | | 4 | | 1 | 22 | | 27 |
| | % | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 14.8% | 0.0% | 3.7% | 81.5% | 0.0% | 100.0% |
| Unknown | NISP # | | | | | | | | | | | | 1 | 1 | 2 |
| | % | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 50.0% | 50.0% | 100.0% |
| TOTAL | NISP # | 23 | 3 | 19 | 1 | 9 | 4 | 1 | 8 | 72 | 1 | 1 | 40 | 1 | 183 |
| | % | 12.6% | 1.6% | 10.4% | 0.5% | 4.9% | 2.2% | 0.5% | 4.4% | 39.3% | 0.5% | 0.5% | 21.9% | 0.5% | 100.0% |

Appendix 1.4.2. Age profiles per taxon. Total 1: all specimens. Total 2: only specimens from well-defined age classes. * Unknown taxa and age classes are excluded.

| | AGE CLASS* | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Foetus** | | **Infant** | | **Juvenile** | | **Subadult** | | **Subadult/ adult** | **Adult** | | **Total 1** | **Total 2** |
| **TAXON** | # | % | # | % | # | % | # | % | # | # | % | # | # |
| *Bos taurus* | | | | | 1 | 7.1 | 8 | 57.1 | 9 | 5 | 35.7 | 23 | 14 |
| *Equus asinus* | | | | | 1 | 25.0 | 2 | 50.0 | 5 | 1 | 25.0 | 9 | 4 |
| *Canis familiaris* | | | | | 1 | 50.0 | | | 1 | 1 | 50.0 | 3 | 2 |
| *Capra hircus* | | | | | 6 | 46.2 | 2 | 15.4 | 6 | 5 | 38.5 | 19 | 13 |
| *Ovis aries* | | | | | 4 | 66.7 | | | 2 | 2 | 33.3 | 8 | 6 |
| *Ovis/Capra* | 1 | 2.6 | 2 | 5.1 | 11 | 28.2 | 17 | 43.6 | 33 | 8 | 20.5 | 72 | 39 |
| Ovicaprines combined | 1 | 1.7 | 2 | 3.4 | 21 | 36.2 | 19 | 32.8 | 41 | 15 | 25.9 | 99 | 58 |
| Cervidae–medium | | | | | | | | | 1 | | | 1 | 0 |
| *Gazella gazella* | | | | | | | | | 2 | 2 | 100.0 | 4 | 2 |
| Leporidae | | | | | | | | | 1 | | | 1 | 0 |
| *Sus domesticus* | | | | | | | | | 1 | | | 1 | 0 |

# 1.5 | Sweating the Small Stuff

## Microdebris Analysis at Tell eṣ-Ṣâfi/Gath, Israel

Annie Brown,* Haskel J. Greenfield,* and Aren M. Maeir†

### Abstract

Most modern excavations intensively collect data from flotation, including both light and heavy fractions. While the light fraction (floated) is usually extensively analyzed by archaeobotanists, the heavy fraction or microdebris is often ignored or minimally examined since it requires intensive efforts at the microscopic level to recover and identify the remains. In recent years, a few studies have demonstrated the utility of intensive examination of the microdebris from archaeological sites as a means for investigating behavior on the microscopic level. When collected systematically across surfaces, the analysis of microdebris allows for the identification of different activities and deposits that are often less visible with macroscopic remains. This paper describes the goals and collection methods for microdebris analysis and presents some preliminary analysis of the microdebris from the excavations of the Early Bronze III nonelite residential neighborhood at Tell eṣ-Ṣâfi/Gath, Israel. The results demonstrate that various types of materials are deposited differentially between depositional contexts. Some types of deposits yield very little microdebris (e.g., alleyways), while others are characterized by their abundance (e.g., room interiors). Consequently, the systematic collection and analysis of contextually differentiated microdebris samples from across archaeological surfaces can help guide excavation strategies since it allows for certain deposits to be clearly targeted for intensive examination..

### Keywords

*Early Bronze Age, southern Levant, flotation, heavy fraction, activity areas, Tell eṣ-Ṣâfi/Gath, microdebris, microresidue analysis, neighborhoods*

## Introduction

Many modern archaeological excavations collect flotation data, including both light and heavy fractions (Rainville 2012, 2015; Ullah 2012; Ullah et al. 2015). While the light fraction, which floats, is usually extensively analyzed by archaeobotanists, the heavy fraction, also known as microdebris, which sinks, is often ignored or minimally examined, even though it has long been recognized to have high utility particularly for faunal remains (Payne 1972). Microdebris are the minute, microscopically visible, artifactual and ecofactual remnants embedded on and within floors that are not completely cleaned up after an activity is completed.

In recent years, a few researchers have demonstrated the utility of intensive and systematic examination of the microdebris as a means to investigate spatial behavior through microscopic analysis. Microdebris analysis is a profitable means for the study of activities distributed across surfaces. It can provide insight into past behaviors and activities, particularly in household archaeology (Rainville 2012; Shahack-Gross 2011; Ullah 2012).

The analysis of microdebris provides us with a wealth of information not always available from the larger artifacts at the site, which may have been moved from their original use location. Microdebris provide additional information on the use of spaces, attesting to activities that often remain archae-

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ologically invisible when only standard macro-level artifact collection and analysis techniques are employed (Rainville 2012). Microdebris can also provide the means to reconstruct the local microclimate and environment (Rosen 1989), offer insights on whether and which pests were present or absent (Hassan 1978a), when rooms in a house were used or abandoned (Shahack-Gross 2011), or inform on missing sources of food not retrieved by hand collection, like plants, fish, and smaller remains (Hassan 1978a; Payne 1972; Rosen 1989), and on the human behavior behind these activities (Hassan 1978b; Rainville 2012; Rosen 1989; Weiner 2010).

Microdebris are subject to the same taphonomic forces as macroremains. They can be crushed, scavenged, and weathered. However, they are also subject to additional taphonomic forces. Indeed, they are often swept or dumped into corners or against walls in active living spaces and easily trampled into the soft dirt floors. At the same time, they are less likely to be moved a substantial distance from where they were used or initially discarded. Their proximity to these sheltered locations means that they are often more protected and consequently less damaged by the various taphonomic forces affecting macro artifacts. Examining the differences between the distributions of macro- and microdebris across surfaces helps to determine the extent of cleaning activities. Furthermore, if microdebris are systematically collected across different surfaces and depositional contexts, their analysis can help to guide excavation and recovery strategies, identification where such debris is located, which deposits are worth floating, the identification of activity areas within rooms, pest distributions within rooms, and more (Rainville 2012; Rosen 1989; Steadman 1996; Weiner 2010). Consequently, this technique is very useful for the analysis of human behavior (Rainville 2001, 2012).

In this paper, the utility of microdebris analysis is demonstrated through the preliminary analysis of the data from the Early Bronze Age (EB) excavations in Area E at Tell eṣ-Ṣâfi/Gath, Israel.

## *Previous Studies*

Long ago, Payne (1972) laid out the need for systematic collection strategies when analyzing zooarchaeological remains. He compared the efficiency and reliability of hand collection, dry sieving, and wet sieving and demonstrated that both dry and wet sieving are useful for the collection of small finds such as lithics, ceramics, and bone. When both dry and wet sieving utilized with progressively finer mesh sizes, it was discovered that hand collection was the least systematic and least consistent in recovery of especially small remains. Dry sieving yielded more consistent results but still missed substantial quantities of microdebris. Wet sieving yielded the best results for the smaller remains because the mesh is smaller and the remains are cleaned in the process, making them easier to recognize and sort. At the same time, Payne recognized that, it would be very expensive and time consuming to sift, float, and analyze the microdebris from an entire site, while it would be ideal. As a consequence, he argued that sieving should be selective, based on the research goals of the excavation. This early study of the collection methods for microdebris helped set the stage for the current methods, in general, and those used in our study in particular. Since then, many studies have compared the effect of different collection strategies on the interpretation of faunal and other types of archaeological remains (e.g., Clason and Prummel 1977; Sapir-Hen et al. 2017). As a consequence, floatation and water sieving for the collection of microdebris have become a standard recovery tool in both zooarchaeology and archaeobotany for the systematic recovery of representative biological assemblages (Dennell 1972; Legge and Hacker 2010; Shaffer 1992). However, a factor that few have considered is the level of training necessary to identify microscopic material (Ullah et al. 2015).

While all of the specialist disciplines have long examined the heavy and light fractions from floatation samples, most analysts function more or less independently of each other and produce separate specialist reports. In recent years, some have argued for a more integrated approach to microdebris analysis that considers all the different types of artifacts and ecofacts in a single analytical framework. One of the first scholars to systematically apply this approach to microdebris remains in the southern Levant was Arlene Rosen (1993). She conducted microdebris analyses on two separate sites in Israel, Tel Halif and Tel Miqne-Ekron, and found that the microdebris complemented the macroremains. Rosen concluded that it would not have been possible—or would have been very difficult—to identify the function of spaces if only the macro artifacts had been examined. She

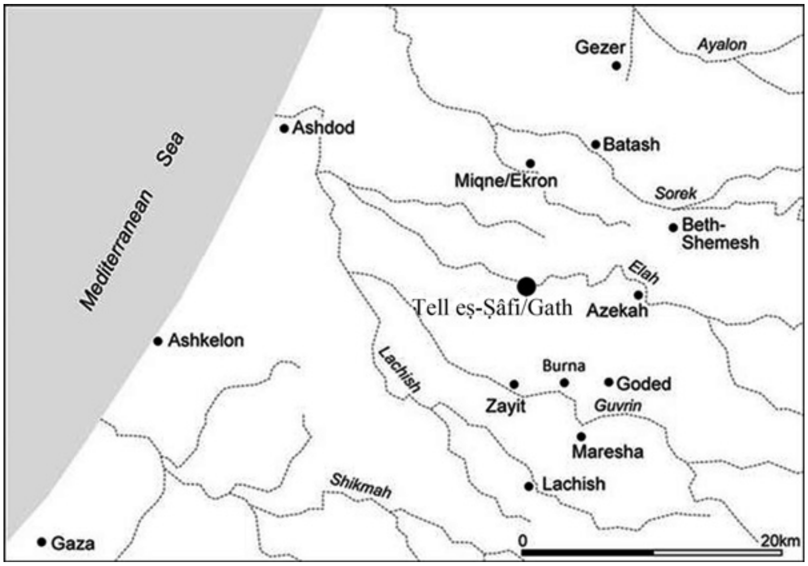

Figure 1.5.1. Map showing the location of Tell eṣ-Ṣâfi/Gath in central Israel and some nearby sites. (Photograph courtesy of the Tell eṣ-Ṣâfi/Gath archaeological project.)

shed new light on the differences between residences, different social classes, and site formation processes that occurred during and after occupation.

Rainville (2000, 2001, 2005, 2012) was the first to systematically apply microdebris analysis to spatially distributed samples across many parts of a site. She collected the heavy fraction from floatation samples taken from floors, hearths, and middens from the EB site of Titriş Höyük in Turkey. She was also the first to evaluate the spatial significance of different classes of raw material—ceramics, bone, chipped stones, mud brick, plaster, shell, charcoal, and botanical matter—for different contexts across the excavation area (Rainville 2000:291). Each of the samples was weighed, quantified, and their densities calculated and graphed. The results from the microdebris were then compared to those of the macrodebris. The analysis demonstrated that there were clear differences within and between the rooms of houses even within the same neighborhood. Cooking versus storage spaces were more clearly defined, even within the same room. The use of these rooms would have remained more elusive had only the macro artifacts been analyzed.

Ullah (2009) built upon Rainville's earlier study by including spatial analytic statistics to determine significant patterns. He employed basically the same analytic procedure as described by Rainville: collection of spatially distributed samples and calculation of frequencies of both macro- and microdebris. Ullah (2009) used an extensive set of statistical and spatial techniques to analyze distributions. He calculated the mean density of each grid as a cluster sample; entered the density data from each grid unit into a GIS program (GRASS GIS); regularized the data with spline-tension interpolation to create a density probability surface for each grid square; and, finally, converted the information from each map into Z-score units away from the mean to distinguish areas that had higher and lower artifact densities from those with average densities. He concluded from the microdebris analysis that many types of activities were performed within the houses and that certain activities were performed in specific locations: for example, food preparation occurred near the hearth, stone-tool manufacturing and use occurred in areas where there was natural light and access to the outdoors. Cleaning of the house and its floors also occurred, probably at a regular basis, with waste being swept out of the doorway. In this chapter, we present our analysis of the microdebris from the EB site of Tell eṣ-Ṣâfi/Gath.

### *The Site of Tell eṣ-Ṣâfi/Gath*

Tell eṣ-Ṣâfi/Gath is a large multiperiod tell site with a long and rich cultural history (Maeir and Uziel 2020). It is located in central Israel. The settlement sits atop a natural large crescent-shaped hill. Tell eṣ-Ṣâfi/Gath is a large urban center, ca. 24 ha in size,

Figure 1.5.2. Balloon aerial photograph of Area E at Tell eṣ-Ṣâfi/Gath. (Photograph courtesy of the Tell eṣ-Ṣâfi/Gath archaeological project.)

of an EB III (ca. 2850–2550 BC) polity (Figure 1.5.1). At the eastern end of the tell, Area E (Figure 1.5.2), a large domestic EB nonelite quarter, has been intensively excavated since 2004. Microdebris have been systematically recovered and analyzed from the late EB III Stratum E5, which comprises three different phases (E5a, b, and c). This stratum terminates ca. 2550 BC (Greenfield et al. 2016, 2017; Shai et al. 2012, 2014, 2016).

## Material and Method

To date, 27 spatially dispersed point samples—10 L of sediment each—have been analyzed. These contained 13,133 specimens (Table 1.5.1). They come from various ash layers above floors, fill layers, mudbrick collapse, installations, accumulations found on floors, and the floors themselves within and outside of the various rooms in the excavation, and from the alleyway between the buildings. Burnt (carbonized) plant remains were collected separately but are excluded from this analysis since they have not yet been quantified.

The microdebris were separated from sediments through the use of a floatation machine with separate heavy and light fraction recovery systems. Microdebris collection from Area E at Tell eṣ-Ṣâfi/Gath has been an integral part of the excavation for several field seasons. Drawing on the results of previous studies (Rainville 2000; Ullah et al. 2015), our goal was to determine if there were similar patterns at EB Tell eṣ-Ṣâfi/Gath. The goal of this paper is to present a preliminary quantification of the microdebris samples. The data from several years of excavation (2012–2015) within the three E5 strata from Area E are summarized here.

### *Field Collection Protocol*

Excavation. The field collection methods used in this study are based on those presented by Rainville (2000, 2012) with minor changes to account for the smaller building sizes. Excavation squares of 5 × 5 m were subdivided into 1 × 1 m squares only where space permitted and where there was clear indication of a floor surface. Strategic point samples were also taken in spaces where rooms were too small for subdivision or for features of interest, for example, hearths or ash layers (Figure 1.5.3). Each sample was recorded using a total station, which determined the X, Y, and Z location. All samples from the field were collected in 10 L samples (10 L = one field bucket)

Table 1.5.1. Frequencies of EB microdebris from the E5 strata based on context from Tell eṣ-Ṣâfi/Gath.

| Context type | Bone | | Flint | | Mud brick | | Pottery | | Shell | | Modified/ unusual stone | | Special find | | Total NISP | Total % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | NISP | % | NISP | % | NISP | % | NISP | % | NISP | % | NISP | % | NISP | % | | |
| Accumulation on floor | 2,511 | 64.25% | 668 | 53.23% | 1,869 | 70.61% | 1,131 | 60.48% | 1,579 | 58.85% | 375 | 51.87% | 32 | 68.09% | 8,165 | 62.17% |
| Mud-brick collapse | 294 | 7.52% | 239 | 19.04% | 311 | 11.75% | 214 | 11.44% | 259 | 9.65% | 178 | 24.62% | 5 | 10.64% | 1,500 | 11.42% |
| Floor | 373 | 9.54% | 83 | 6.61% | 365 | 13.79% | 230 | 12.30% | 200 | 7.45% | 39 | 5.39% | 3 | 6.38% | 1,293 | 9.85% |
| Alleyway | 461 | 11.80% | 143 | 11.39% | 0 | 0.00% | 160 | 8.56% | 401 | 14.95% | 23 | 3.18% | 5 | 10.64% | 1,193 | 9.08% |
| Installation | 246 | 6.29% | 108 | 8.61% | 100 | 3.78% | 129 | 6.90% | 244 | 9.09% | 68 | 9.41% | 2 | 4.26% | 897 | 6.83% |
| Ash pit | 23 | 0.59% | 14 | 1.12% | 2 | 0.08% | 6 | 0.32% | 0 | 0.00% | 40 | 5.53% | 0 | 0.00% | 85 | 0.65% |
| **Grand Total** | **3,908** | **100%** | **1,255** | **100%** | **2,647** | **100%** | **1,870** | **100%** | **2,683** | **100%** | **723** | **100%** | **47** | **100%** | **13,133** | **100%** |

Figure 1.5.3. Photograph of Square 82D in Area E from above in preparation for microdebris sampling. (Photograph courtesy of the Tell eṣ-Ṣâfi/Gath archaeological project.)

from clear depositional contexts. These contexts included floors, doorways, occupational debris levels, pits, installations, and special features.

Sorting. Each soil sample was taken off-site for processing at the excavation field laboratory because of the need for a constant water source to process the sediment through the floatation machine. During the floatation process, the light- and heavy-fraction samples were separated. The light fraction floated to the surface and was analyzed separately by the project's archaeobotanists (Frumin et al. 2021). Once the heavy and light fractions had been separated, the heavy-fraction samples (Figure 1.5.4) were placed outside in the shade for a day or two to dry slowly in order to prevent damage to the specimens. Rapid drying in the sun would have caused fracturing and bleaching, leading to the degradation of specimens. This would have made it more difficult, if not impossible, to sort and identify specimens.

### *Field Laboratory Analysis*

Once dry, the microdebris was sorted into several categories, such as stone, flint, bone, shell, unique finds, and charcoal (Figure 1.5.5). After the preliminary recording of weight and frequency, the microdebris categories were analyzed according to relevant raw material, such as ceramic, lithic, bone, and others.

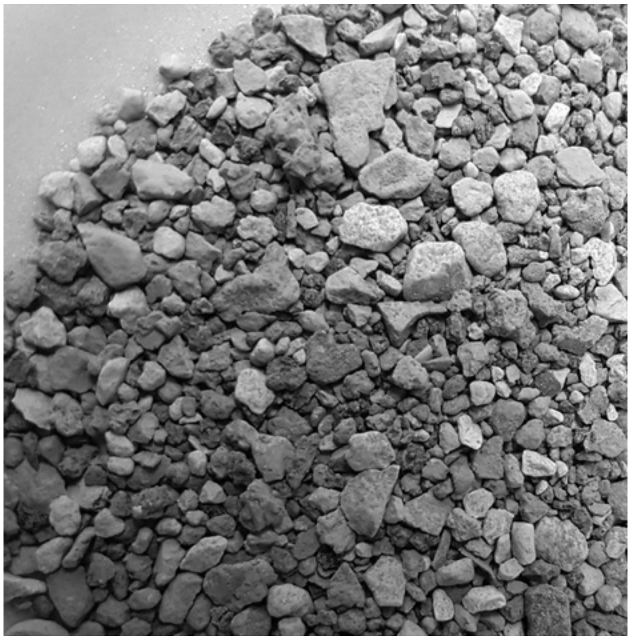

Figure 1.5.4. Photograph of unsorted heavy fraction. (Photograph A. Brown.)

Stones. Stones found in the microdebris may enter the archaeological record for many reasons. Some may have been collected as tools and are culturally modified, such as grinding stones and semiprecious stones. Others may appear in a natural state since they were used for production, such as ceramic temper and ochre, or as a fill, for example, to even out an erosional feature or to be used as floor substrate. Collection and analysis of stones are important because they may indicate the location of various activities, such as manufacturing or storage—for example, jewelry as evidence for trade—based on provenance source. The stones quantified here are those that are unusual either in shape or origin (e.g. nonlocal) and whose presence signify some kind of cultural behavior.

Shells. All types of shell materials were collected. They can be used to determine the changing local environment, subsistence, trade, adornment, and more. Due to the inland location of the site, any marine shells would either indicate trade or collection forays to the coast, while inland snails can be indicative of local plant life—for example, tree snails would be indicative of trees.

Bones. Collection and analysis of the microdebris enables a higher degree of recovery of the smaller

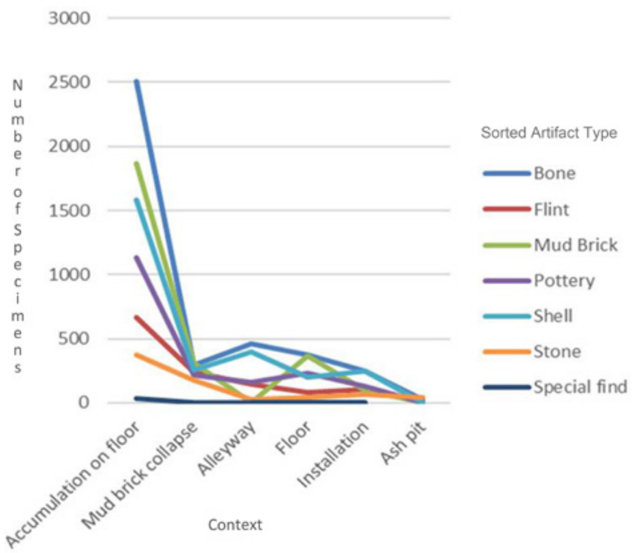

Figure 1.5.5. Line graph (based on Table 1.5.1) showing frequencies of microdebris by context. All samples are from the E5 strata within Area E.

bone elements of larger taxa, and a more representative assemblage of smaller taxa such as fish, bird, or microfauna. These enable more subtle reconstructions of subsistence, discard, and other behaviors (Payne 1972; Sapir-Hen et al. 2017).

Some of the fauna recovered in the microdebris may include intrusive species such as rats, mice, songbirds, or lizards. These can be species that are present at the site naturally but are not related to either animal husbandry or human activities in general. The presence/absence of such taxa may indicate changes in environmental conditions or human occupation at the site—or even in specific rooms—during deposition (Rosen 1993; Sapir-Hen et al. 2017). A sudden or long-term change of these species may indicate a shift in environmental conditions in and/or around the site, such as drought.

Ceramics. Ceramics recovered in the microdebris can be identified to the size of the vessel—given wall thickness—and the type of vessel. Consequently, it is feasible to infer their possible uses within the living space. It also allows for the identification of the location of orginal vessel use, particularly of those that were removed from a space after fragmentation. These can then be compared with the ceramics recovered in the macrodebris.

Mud brick. Mud-brick fragments can be quantified according to size, frequency, texture, color, etc. From these data, specific mud-brick types can be identified. By identifying the degree of weathering, one can determine whether the mud brick was slowly eroded from exposure or quickly collapsed and used to form a substrate for the next phase of construction.

Flint (Chipped Stone Tools). The frequency and variety of chipped stone tool types (cores, blades, scrapers, awls, saws, etc.) and debitage may suggest activity types, such as food production, textile production, tool production, and modification.

Carbonized material. Carbonized material includes burnt seeds, wood, and organic material. Identified carbonized material, whether in concentrations or not, can provide information on the type of materials that were burnt and consumed. These data can be used to distinguish between use and discard locations, food production areas, and storage locations/installations, for example, storerooms and granaries.

Special finds. Special finds can appear in varying frequencies within the microdebris. They include any identifiable culturally made and/or modified items, such as tool fragments, beads, game pieces, and decorations. These items can indicate many things about the site and houses. Isolated beads or concentrations of beads, for example, may represent accidental loss or purposeful storage since they were likely once part of a necklace or bracelet.

## Discussion

### *Observation on the Data Distributions*

There is a clear pattern in the distribution of microdebris between different types of depositional contexts. The highest concentration of material comes from ash accumulations that occur directly above the dirt floors and clearly relate to occupational activities (62%; Table 1.5.1 and Figure 1.5.5). These are the direct remains of activities that took place within spaces inside and outside the buildings—for example, food preparation, cleaning, and storage.

There is a substantial gap between the accumulations above floors and the next category of microdebris. Mud-brick wall and roof-collapse layers are the second highest frequency (11.42%; Table 1.5.1 and Figure 1.5.5). The microdebris from such deposits likely derive from either the mud-brick matrix—and hence from earlier strata—or from the collapse of the walls and upper floor/roof. In most cases, it is difficult at Tell eṣ-Ṣâfi/Gath to distinguish between these possibilities.

The alleyway and the physical floor makeup are the next most common categories (9.08% and 9.85% respectively; Table 1.5.1). Originally, we expected that there would be a relatively high concentration of microdebris in the alleyway since streets in many ancient cities are often used as dumping grounds for rubbish (Rainville 2000, 2005). The results of this preliminary study show that this is not the case. While the alleyway is full of macrodebris—more so than any other contemporary deposit—it is relatively clear of microdebris when compared to other depositional contexts, such as the accumulations above the floors.

The microdebris in the floor makeup is much lower than in the accumulations above the floor. Elsewhere, more material was found in the floor makeup (Rainville 2000, 2003, 2005) since this is where artifacts would end up when trampled into the floor makeup.

Installations, such as hearths, have the second smallest concentrations (6.83%), followed by ash pits from cooking and heating, which have the fewest remains (0.65%; Table 1.5.1 and Figure 1.5.6). The low frequency of remains in these deposits and likely relates to the high degree of burning since most of the makeup is ash in both types of deposits.

### *Implications for Interpretation*

The implication of these results is that the pattern in one site is not necessarily true of all sites. For example, the larger-sized debris in the alleyway suggests that they were not simply thrown out as garbage but instead purposefully placed there possibly as fill. The larger debris is a means to stabilize the alleyway as parts of it became furrowed due to runoff and foot traffic. Debris from inside the houses, garbage, and other unused materials, including unmodified stones, are then deposited in the small pits and other irregularities in the alley and packed down with fresh dirt to level its surface. However, the dearth of microdebris from the alley may suggest that the microdebris were differentially destroyed and/or washed downslope given the alley's relatively steep slope. However, this is an unlikely explanation given that the alley is relatively flat toward the northwest, and only declines fast toward the southeast. This result can only be deduced from the microdebris data.

The situation is very different inside the buildings where the floors were relatively flat. The relatively high percentage of debris found in the accumulation on the floors suggests that floors within the buildings were poorly cleaned. When the inhabitants dump the debris onto the floor—either intentionally or unintentionally—some of that material is trampled into the ash accumulation above the floor makeup and covered with fresh ash or soil. This results in the formation of a layer of debris that appears to be floating builds up just above the floor and is separated from the floor makeup.

## Conclusion

Microdebris represents the physical remains of activities that are preserved even when the macroremains are cleaned up and deposited elsewhere. They can occur inside and outside of buildings. Investigation of microdebris remains can help investigate aspects of human behavior, such as the nature of households (Antonites 2012; Rainville 2012; Steadman 1996).

By creating a standardized method for microdebris collection and analysis, it is possible to ascertain missing data from archaeological assemblages. Microdebris can not only aid in discovering production and activity sites (Antonites 2012; Rainville 2000, 2012) but may also lead to a more detailed understanding of human behavior. In addition, through the study of the microdebris from inside and outside of houses, it is possible to interpret the use of these houses: how they relate to each other within the context of the urban neighborhood and where the primary usage areas might be in and around each house. While some deposits yield more microdebris than others, all deposits are useful and need to be investigated. Those with little to no microdebris are just as important as those that contain microdebris remains.

From our preliminary results at Tell eṣ-Ṣâfi/Gath, it is evident that the focus of microdebris analysis should be on the occupational debris accumulating immediately above floors. Such deposits can be most intensively sampled since they are likely to yield higher frequencies and variety of remains. The other deposits, however, should not be ignored, but can be sampled differentially. Sampling, as part of microdebris analysis, is important since it is nearly impossible to sample equally all features and all areas at all times, particularly at large multiperiod tell sites (Sapir-Hen et al. 2017).

The accumulations found on and above the floors show the heaviest concentrations and allow for the most fruitful path to investigate spatial distribution of activities. Additional analysis of these concentrations may help to further determine the different types of activities and differences between the activity areas between and within rooms. In contrast, floor makeup deposits are the least productive and therefore should take less priority. The alleyway is unusual in the low density of the microdebris remains found, but that may result from the fact that it is an open-air yet narrow space that is subjected to winter rainfalls, resulting in the higher attrition of smaller microdebris material, leaving the macro artifacts in place.

It is impossible to subject all deposits to unlimited microdebris recovery and analysis, especially in large-scale and long-term excavations of sites such as tells. Deposits need to be sampled strategically and selectively—this is clear from a number of independent studies (Payne 1972; Rainville 2000, 2003, 2005; Sapir-Hen et al. 2017). Microdebris analysis should therefore focus on those depositional contexts likely to contain higher frequencies of microdebris. In the case of the EB neighborhood excavated at Tell eṣ-Ṣâfi/Gath, the accumulations above the floors were the most productive. Yet, it is important also to *sample* other deposits and contexts, even the spaces where nothing is expected, because empty spaces (null cells) mark the spatial limits (e.g., boundaries) of activities or where the nature of activities does not lead to microdebris deposits being created (e.g., gardening; Greenfield et al. 2005).

The analysis presented here demonstrates that it is possible to differentiate between types of depositional contexts based on the frequency and nature of microdebris and to increase our understanding of the nature of these deposits. Excavators need to create collection and analytical strategies for microdebris in order to process them efficiently and strategically, thus producing a representative sample. Strategies can change over time as new and different deposits are encountered during excavation. These can lead to an increased understanding of the processes that created deposits in a site and the behaviors behind them.

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# 1.6 | Bad Contexts, Nice Bones — and Vice Versa?

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## Abstract

Intrasite comparisons of faunal data from a Late Bronze Age settlement at Oymaağaç Höyük, Turkey are presented here. The main features comprise a multiphase temple, a city gate, a silo, and an underground stairway. The faunal samples studied derive from the temple area and the silo. Samples and contextual aggregations were chosen and defined in accordance with researchers occupied with the stratigraphy and pottery. A contextual framework is provided for each unit. Some samples seem related to well-defined human actions—namely, to ritual activities, and to specific pottery. They derive from single acts representing "closed" or "good" contexts. Other bulky samples accumulated during construction works; they are from the fill used to stabilize foundations. Regarded as secondary or tertiary waste by residual, multiperiod pottery ("bad" contexts), it is shown that zooarchaeological interpretations do not always conform to assessments based on other find groups. The samples are compared according to the composition of the domestic triad (NISP and weight) and skeletal-part profiles. Special attention is paid to the groupings and dispersions of data points derived from related or mutually exclusive taphonomic pathways. In some cases, the original interpretation of contexts was supported by the faunal remains. In others, it was at odds.

## Keywords

*complex building, construction fill, contextual aggregation, domestic triad, Hittite Empire, intrasite comparison, ritual deposit, silo, taphonomy, temple*

## Introduction

Archaeological investigations have been carried out since 2008 at the site of Oymaağaç Höyük, which is situated in the Black Sea region of Turkey, province of Samsun in the district of Vezirköprü. The site is located on the western outskirts of the eponymous village in the Vezirköprü basin, about 75 km away from the southern shore of the Black Sea, and just west of an ancient crossing over the Kızılırmak River. Geographically, this is the transition zone between the more humid and temperate climate along the Black Sea coast and the more continental conditions of central Anatolia. Regarding ecoregions, the original vegetation would have been Euxine–Colchic deciduous forest and northern Anatolian conifer and deciduous forest, respectively. It is also the border area between the western and central subregions of the Black Sea Region according to the biogeographical classification of Turkey (Kürschner et al. 1995).

The archaeological project, directed by R. Czichon (Uşak University) and J. Klinger (Freie Universität Berlin), is mainly financed by the Deutsche Forschungsgemeinschaft (DFG; German Research Foundation). It focuses on the northeastern part of the hilltop (285 m asl). Apart from a few stray finds from the Middle Palaeolithic and Chalcolithic periods, the oldest settlement structures belong to the Early Bronze Age (EBA). The remains of a multiphase monumental building, interpreted as a temple, parts of a gate and a city wall, an underground stairway, and a walled Silo belong to the Late Bronze

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Age (LBA), which historically corresponds to the Hittite Empire era. Both text finds and excavation results suggest an identification of Oymaağaç Höyük with the ancient city of Nerik. According to Hittite religious literature, Nerik was a veneration site of the weather god, which also comprised a holy underground spring. The monumental building at the hilltop, independent of function, is the northernmost example of Hittite monumental architecture discovered so far. It is still unclear how far the LBA settlement extended beyond the surveyed and excavated area of the hilltop. Hittite features are overlaid by a dense concentration of Iron Age (IA) pits and finally by a Hellenistic-Roman-Byzantine cemetery.

This paper discusses selected archaeozoological results of the LBA structures, which are the focus of research at Oymaağaç. Principal information about the site and preliminary results can be obtained from Czichon et al. (2011, 2016) and from the website http://www.nerik.de (in German).

## Bronze Age Stratigraphy at Oymaağaç

The general layout and the Bronze Age (BA) archaeological structures of the excavation field are as it appeared in 2015, including some results from the geophysical survey (Figure 1.6.1). A grid of 10 × 10 m squares was superimposed over the hilltop. By the field season 2016, thirty squares had been excavated. The square number may be derived by combining the horizontal and the vertical numbers in Figure 1.6.1—e.g., the Silo is situated in square 7383. The southwestern part of the Courtyard and the northwestern part of the New (younger) Temple were deliberately left unexcavated for future investigations.

The excavation areas are partly separated from each other and thus it is not always possible to establish a continuous stratigraphic scheme for the entire site. This is not due to the excavation method—fine stratigraphy—employed but rather to the site formation processes at work on the hilltop. Most of the older stratigraphy was disturbed down to a depth of 2–4 m when the younger monumental building was erected in the final Hittite phase. On the other hand, this disturbance frequently provides insights into the earlier stratigraphy as soon as the foundation fills of this building are removed. Consequently, the excavation field bears some resemblance to situations normally observed in urban archaeology.

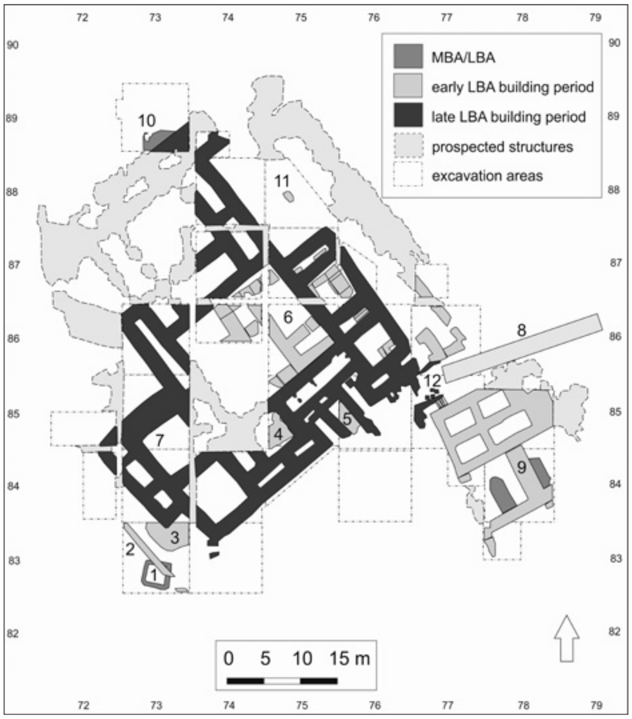

Figure 1.6.1. LBA structures at Oymaağaç Höyük: (1) Silo; (2) ditch; (3)–(5) cult-related deposits; (6) Old Temple; (7) New Temple; (8) Underground Stairway; (9) East Gate and adjacent sections of the wall; (10) house remains; (11) wall remains; (12) pot pits; the Underground Stairway belongs both to the early and late LBA building period; only selected features of the geophysical survey are indicated. (After Hnila in Czichon et al. 2016, redrawn.)

Therefore, the EBA and older LBA stratigraphy at Oymaağaç Höyük has to be based on the results of both ceramic studies and archaeological features and must still be regarded as preliminary (Czichon et al. 2016). EBA house and oven structures in the southern hillside—square 7383—represent the earliest true settlement features, while the Middle Bronze Age (MBA), regionally also referred to as “Karum period”, may in fact represent a local stratigraphic gap encompassing several centuries. It is only at the transition between the MBA and LBA that settlement activities become more clearly visible. This transition relates to the Hittite settlement of the area and starts a new chapter in the local history. Including the following LBA, three building periods can be discerned, which can be further broken down into building phases.

An outstanding feature of the MBA/LBA transition period was the installation of a Silo (Figure 1.6.1:structure 1), cutting more than 4 m deep into prehistoric layers. These structures were probably designed to store solid food items such as grains. The stonewalled, roughly square-shaped structure measured 2.5 × 2.5 m at its top, tapered slightly toward its base, and was covered with plaster in its lower parts. It possibly was in use for a short period only. This is indicated by the lack of repair in the masonry as well as the presence of EBA and early Hittite pottery throughout the fill. It was probably abandoned before the erection of the first monumental building occurred. Similar structures may have been present in its immediate surroundings, but this area has not been excavated to the same depth. Regarding architecture, the best parallels are known from Alaca Höyük (Richter in Czichon et al. 2016). Other remnants of the MBA/LBA transition period are wall fragments in 7389, within the East Gate (Figure 1.6.1:structures 10, 9), and erosion layers underneath the older monumental building (Table 1.6.1: Old Temple F0 outer walking horizon).

The next building period is defined by the construction of the older monumental building (Old Temple), which is assumed to have taken place in the seventeenth/sixteenth century BC. Interpretation of this building as a temple is based on the composite type of masonry used, its layout, the orientation corresponding to the New Temple, and the associated finds—e.g., fragments of bull terracottas, and cult-specific pottery. As can be inferred from the areas unconcealed by younger architecture, its principal visible components are an oblong room (7 × 5.5 m) with an entrance hall. These represent the core elements of any Hittite temple. Similarly, there were smaller rooms along the sides, and the building may have stretched further south, but this cannot be confirmed due to the overlying strata. Its documented surface covers 235 $m^2$. Living floors, the only ones documented, survived inside two rooms, Old Temple C (see Table 1.6.2 and p. 101 below). All rooms were deliberately filled up in the second building phase of the Old Temple in order to provide stable foundations for the building.

The excavated parts of the city wall, the East Gate, and the Underground Stairway (Figure 1.6.1: structures 9 and 8), all typical elements of Hittite urbanism, likely were constructed at the same time. Since faunal remains from these parts are not treated here, their building history (see Czichon et al. 2011, 2016) is not described in detail. According to the geomagnetic survey, features interpreted as walls delimit an area of approximately 2 ha. This renders the existence of a lower town quite likely. All mentioned structures were rebuilt or repaired several times. A number of smaller archaeological features fit either into a later phase of this period or into the interval between the Old Temple and New Temple. Apart from a ditch (Figure 1.6.1:structure 2), a series of pits or depressions with undoubted ritual content indicated by special pottery types could be located underneath the southeastern corner and the entrance area of the New Temple (Figure 1.6.1:structures 3–5; Old Temple A, see Table 1.6.2 and p. 101). The Old Temple was burnt around the fifteenth/fourteenth century BC.

Erosion debris accumulated above the ruins and there may have been a settlement hiatus or only makeshift building activities for about the next 150 years. This is indicated by the pottery spectrum of the Old Temple and dendrochronological dating of wooden constructions of the New Temple. The postulated gap is in accordance with historical sources indicating a Hittite retreat from this area and namely the temporary loss of the sacred city of Nerik, possibly to the Kaskians. This does not necessarily imply an interruption of ritual activities and the mentioned cultic deposits (Old Temple A) could well originate from this period. The younger temple was only erected, at the earliest, around the second third of the thirteenth century BC. During this last Hittite settlement period, the Underground Stairway was reused, but the fortifications apparently were not. If fortifications existed, these were outside of the prospected area.

The foundation works for the New Temple brought about heavy interventions into older strata, down to a depth of 4 m, and were accompanied by stone robbing from the Old Temple. Its walls were left intact only in places where they were needed for the new construction's stability. Superimposed upon a base of rocks, the walls of the New Temple were also built in a "composite" manner, consisting of alternating blocks of mud brick and half-timbered constructions filled with rocks and mud bricks. According to the excavators, all boxes inside the walls, all rooms behind them, and the Courtyard were already filled up in the course of the building process in order to enhance the foundations' stability. Therefore, all remaining architectural parts do not represent cellars or basements but substructures, which were mostly not visible during the time of occupation. Independent evidence for this is indicated by the burning observed in the sediments of the room fills, including on animal bones, which can be related to the final conflagration event. Surfaces that are practically devoid of finds survive only outside of the building. The layout of the New Temple, an asymmetrical arrangement of rooms around a central courtyard, is apparent from the excavation plan and the results of the survey (Figure 1.6.1:structure 7). It reached farther north and probably farther south than the older building covering a surface of 1440 m$^2$. Its multiple rooms make it look antique compared to coeval Hittite temples. It is possible that its outline had to follow the one of the Old Temple: with the single entrance facing south toward the slope, the different levels of the Courtyard and the outside area had to be bridged by a ramp and a staircase. This presented the architects with a special challenge. For archaeologists, it resulted in a quite complicated stratigraphy including at least three building phases. With a staircase and a columned hall, this entrance area is without parallel in Hittite architecture, although its elements are known elsewhere. Due to the repeated reconstruction works, rubbish resulting from the use phase of the New Temple, including ritual activities, accumulated in squares 7585 and 7685. Some of these renovations may have become necessary due to structural reasons and/or damages caused by earthquakes. As in the case of the preceding temple, the combination of architectural features, selected types of pottery, and small finds—which include so-called ritual deposits and cult-related texts (Czichon et al. 2016)—allow for the structure's identification as a temple rather than a palace. A devastating fire that occurred at the beginning of the twelfth century BC destroyed the New Temple. This event is likely to be related to, if not coincident with, the end of the Hittite empire.

## Animal Bone Samples: Definition of Contextual Aggregations

Because animal bone studies rely primarily on comparisons of relative abundance, the definition of analytical units, or contextual aggregations (Marom and Bar-Oz 2013), is important. This holds especially true for complex archaeological situations involving built structures like at Oymaağaç Höyük. In an earlier study about the site, animal bone samples from a limited number of features were compared according to their occurrence in excavation squares, appearance in context types, and provisional stratigraphic affiliations (Kunst et al. 2016). Further, remains from the overlying IA deposits and data from other Hittite or IA sites in the wider region (von den Driesch and Pöllath 2004; Zeder and Arter 1994) were included. Admittedly, some of the stratigraphic terms, especially concerning the BA, were imprecisely or incorrectly applied. For the following reasons, it is now possible to define the origins of faunal data much more precisely and to put them into a coherent contextual framework:

(1) An advanced stratigraphy of the BA has been finalized, namely the discovery of the Old Temple, in the course of ongoing excavations and the different building phases of both the Old Temple and the New Temple;
(2) The results of intensive pottery studies since 2015 can be broadly included; although Hittite pottery is not suited for precise chronology, it can provide important information concerning function and origin of contexts;
(3) The animal remains database has been enlarged considerably; during the last campaigns, an emphasis was put on the study of samples from areas deemed essential by the excavators.

Therefore, this study relies entirely on intrasite comparisons of BA samples from the wider area of both the Old Temple and the New Temple and from the Silo. This implies a certain temporal depth and spatial extension. Altogether, over 30 samples from 8 squares, comprising about 4,700 identifiable specimens, are available. Two important structures had to be largely omitted from analysis: the faunal remains around the East Gate, an important element of the older-temple period, have scarcely been studied so far. In addition, the fill of the Underground Stairway, which certainly represents the most spectacular surviving monument at Oymaağaç Höyük, obviously represents a time-averaged mixture of BA and IA material. Furthermore, the IA material is no longer used as an out-group for comparative purposes. It has been sufficiently demonstrated that the taphonomic and cultural background of the IA samples is quite different for both species and skeletal-element composition (Kunst et al. 2016).

In the following discussion, an overview of the chosen samples and information on their contexts is presented, especially regarding the assumed site formation processes and the principal features of associated pottery. To allow for a comparison with the database on the website, locus numbers are sometimes indicated; these appear in the following format: number of square:ordinal number—e.g. 7586:155, fill of the Courtyard of the New Temple. Loci exhibiting sufficient specimen counts are treated as individual entities and used for further analysis. A minimum number of 70 specimens of the main domesticates was taken as the lower limit (Table 1.6.1).

Table 1.6.1. Fragment counts and weights of main domesticates.

**FRAGMENT COUNTS (N)**

| | **OYM_1** | **OYM_2** | ***Bos*** | ***O/C*** | ***Sus*** | **N3** | **% *Bos*** | **% *O/C*** | **% *Sus*** |
|---|---|---|---|---|---|---|---|---|---|
| Courtyard fill | 7586 | 85 | 173 | 663 | 37 | 873 | 19.8 | 75.9 | 4.2 |
| Courtyard fill | 7586 | 103 | 26 | 110 | | 136 | 19.1 | 80.9 | 0.0 |
| Courtyard fill | 7586 | 155 | 24 | 179 | 3 | 206 | 11.7 | 86.9 | 1.5 |
| Courtyard fill | | all | 241 | 993 | 42 | 1,276 | 18.9 | 77.8 | 3.3 |
| Room fill | 7585 | 140 | 13 | 133 | 9 | 155 | 8.4 | 85.8 | 5.8 |
| Room fill | 7585 | 156 | 21 | 176 | 1 | 198 | 10.6 | 88.9 | 0.5 |
| Room fill | 7585 | 166 | 35 | 222 | 4 | 261 | 13.4 | 85.1 | 1.5 |
| Room fill | | all | 69 | 531 | 14 | 614 | 11.2 | 86.5 | 2.3 |
| Accumulation | 7383 | 223 | 216 | 95 | 69 | 380 | 56.8 | 25.0 | 18.2 |
| Accumulation | 7383 | 225 | 54 | 28 | 20 | 102 | 52.9 | 27.5 | 19.6 |
| Accumulation | 7383 | 240 | 18 | 49 | 15 | 82 | 22.0 | 59.8 | 18.3 |
| Accumulation | 7383 | 242 | 29 | 145 | 11 | 185 | 15.7 | 78.4 | 5.9 |
| Accumulation | 7383 | 249 | 47 | 57 | 32 | 136 | 34.6 | 41.9 | 23.5 |
| Accumulation | 7383 | 256 | 46 | 46 | 18 | 110 | 41.8 | 41.8 | 16.4 |
| Accumulation | 7383 | 259 | 36 | 34 | 16 | 86 | 41.9 | 39.5 | 18.6 |
| Accumulation | | all | 536 | 570 | 227 | 1,333 | 40.2 | 42.8 | 17.0 |
| Silo | 7383 | 248 | 28 | 87 | 33 | 148 | 18.9 | 58.8 | 22.3 |
| Silo | 7383 | 257 | 33 | 262 | 54 | 349 | 9.5 | 75.1 | 15.5 |
| All | | all | 61 | 349 | 87 | 497 | 12.3 | 70.2 | 17.5 |
| Old Temple | cult-related | A2 | 6 | 223 | 4 | 233 | 2.6 | 95.7 | 1.7 |
| Old Temple | cult-related | A3 | 28 | 66 | 2 | 96 | 29.2 | 68.8 | 2.1 |
| Old Temple | cult-related | A4 | 12 | 139 | 3 | 154 | 7.8 | 90.3 | 1.9 |
| Old Temple | cult-related | A all | 46 | 428 | 9 | 483 | 9.5 | 88.6 | 1.9 |
| Ditch | early LBA | B | 7 | 15 | 7 | 29 | 24.1 | 51.7 | 24.1 |
| Old Temple | room fill | C | 16 | 48 | 8 | 72 | 22.2 | 66.7 | 11.1 |
| Old Temple | small pits | D | 1 | 3 | 1 | 5 | 20.0 | 60.0 | 20.0 |
| Old Temple | mud brick | E | | | 2 | 2 | 0.0 | 0.0 | 100.0 |
| Old Temple | outside floor | F0 | 5 | 11 | 3 | 19 | 26.3 | 57.9 | 15.8 |

Table 1.6.1. (cont.) Fragment counts and weights of main domesticates.

**FRAGMENT COUNTS (N) (cont.)**

| | **OYM_1** | **OYM_2** | ***Bos*** | ***O/C*** | ***Sus*** | **N3** | **% *Bos*** | **% *O/C*** | **% *Sus*** |
|---|---|---|---|---|---|---|---|---|---|
| Old Temple | destruction layer | F | 14 | 83 | 4 | 101 | 13.9 | 82.2 | 4.0 |
| New Temple | above floor | G1 | 9 | 45 | | 54 | 16.7 | 83.3 | 0.0 |
| New Temple | above G1) | G2 | 14 | 112 | 8 | 134 | 10.4 | 83.6 | 6.0 |
| New Temple | above pavement | G3 | 1 | 16 | 2 | 19 | 5.3 | 84.2 | 10.5 |
| New Temple | above G3) | G4 | 20 | 440 | 5 | 465 | 4.3 | 94.6 | 1.1 |
| New Temple | Pavol_G_total | G all | 44 | 613 | 15 | 672 | 6.5 | 91.2 | 2.2 |
| Ramp | reconstruction | | 15 | 138 | 2 | 155 | 9.7 | 89.0 | 1.3 |

**FRAGMENT WEIGHT (gr)**

| | **OYM_1** | **OYM_2** | ***Bos*** | ***O/C*** | ***Sus*** | **G3** | ***Bos*** | ***O/C*** | ***Sus*** |
|---|---|---|---|---|---|---|---|---|---|
| Courtyard fill | 7586 | 85 | 2,730.4 | 2,888.5 | 232.2 | 5,851.1 | 46.7 | 49.4 | 4.0 |
| Courtyard fill | 7586 | 103 | 605.1 | 587.5 | | 1,192.6 | 50.7 | 49.3 | 0.0 |
| Courtyard fill | 7586 | 155 | 295.3 | 921.7 | 22 | 1,239 | 23.8 | 74.4 | 1.8 |
| Courtyard fill | | all | 3,839.3 | 4,607 | 263 | 8,709.3 | 44.1 | 52.9 | 3.0 |
| Room fill | 7585 | 140 | 174.4 | 372.2 | 45.1 | 591.7 | 29.5 | 62.9 | 7.6 |
| Room fill | 7585 | 156 | 233 | 546.1 | 9 | 788.1 | 29.6 | 69.3 | 1.1 |
| Room fill | 7585 | 166 | 254.1 | 574.5 | 24 | 852.6 | 29.8 | 67.4 | 2.8 |
| Room fill | | all | 661.5 | 1,492.8 | 78.1 | 2,232.4 | 29.6 | 66.9 | 3.5 |
| Accumulation | 7383 | 223 | 5,325.8 | 613.4 | 1,409.8 | 7,349 | 72.5 | 8.3 | 19.2 |
| Accumulation | 7383 | 225 | 778 | 128.9 | 186.8 | 1,093.7 | 71.1 | 11.8 | 17.1 |
| Accumulation | 7383 | 240 | 653.9 | 189.4 | 246.2 | 1,089.5 | 60.0 | 17.4 | 22.6 |
| Accumulation | 7,383 | 242 | 423.9 | 758.7 | 74.8 | 1,257.4 | 33.7 | 60.3 | 5.9 |
| Accumulation | 7383 | 249 | 882.6 | 200.2 | 374.4 | 1,457.2 | 60.6 | 13.7 | 25.7 |
| Accumulation | 7383 | 256 | 1,304.4 | 236.3 | 380 | 1,920.7 | 67.9 | 12.3 | 19.8 |
| Accumulation | 7383 | 259 | 507.8 | 192.3 | 176.2 | 876.3 | 57.9 | 21.9 | 20.1 |
| Accumulation | | all | 12,121.6 | 2,982.2 | 3,639.7 | 18,743.5 | 64.7 | 15.9 | 19.4 |
| Silo | 7383 | 248 | 716.2 | 371.9 | 393.2 | 1,481.3 | 48.3 | 25.1 | 26.5 |
| Silo | 7383 | 257 | 901.7 | 625.4 | 373.5 | 1,900.6 | 47.4 | 32.9 | 19.7 |
| All | | all | 1,617.9 | 997.3 | 766.7 | 3,381.9 | 47.8 | 29.5 | 22.7 |
| Old Temple | cult-related | A2 | 106.8 | 552.8 | 22.3 | 681.9 | 15.7 | 81.1 | 3.3 |
| Old Temple | cult-related | A3 | 431.7 | 268.4 | 20.9 | 721 | 59.9 | 37.2 | 2.9 |
| Old Temple | cult-related | A4 | 193.9 | 360.4 | 10.6 | 564.9 | 34.3 | 63.8 | 1.9 |
| Old Temple | cult-related | A all | 732.4 | 1,181.6 | 53.8 | 1,967.8 | 37.2 | 60.0 | 2.7 |

Table 1.6.1. (cont.) Fragment counts and weights of main domesticates.

| **FRAGMENT WEIGHT (gr) (cont.)** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | **OYM_1** | **OYM_2** | ***Bos*** | ***O/C*** | ***Sus*** | **G3** | ***Bos*** | ***O/C*** | ***Sus*** |
| Ditch | early LBA | B | 118.3 | 56.8 | 60.1 | 235.2 | 50.3 | 24.1 | 25.6 |
| Old Temple | room fill | C | 224 | 238.1 | 87.3 | 549.4 | 40.8 | 43.3 | 15.9 |
| Old Temple | small pits | D | 8.4 | 5.3 | 5 | 18.7 | 44.9 | 28.3 | 26.7 |
| Old Temple | mud brick | E | | | 4.8 | 4.8 | 0.0 | 0.0 | 100.0 |
| Old Temple | outside floor | F0 | 90.6 | 51.1 | 18.7 | 160.4 | 56.5 | 31.9 | 11.7 |
| Old Temple | destruction layer | F | 249.5 | 239.6 | 10.5 | 499.6 | 49.9 | 48.0 | 2.1 |
| New Temple | above floor | G1 | 99.9 | 166.2 | | 266.1 | 37.5 | 62.5 | 0.0 |
| New Temple | above G1 | G2 | 98.1 | 332.3 | 17.7 | 448.1 | 21.9 | 74.2 | 4.0 |
| New Temple | above pavement | G3 | 4.5 | 76 | 12.6 | 93.1 | 4.8 | 81.6 | 13.5 |
| New Temple | above G3 | G4 | 175.8 | 853.1 | 35.3 | 1,064.2 | 16.5 | 80.2 | 3.3 |
| New Temple | Pavol_G_total | G all | 378.3 | 1,427.6 | 65.6 | 1,871.5 | 20.2 | 76.3 | 3.5 |
| Ramp | reconstruction | | 207 | 349.5 | 13.7 | 570.2 | 36.3 | 61.3 | 2.4 |

### *Contextual Aggregations*

Defined by the state of both pottery and animal-bone research, the following aggregations of contextual units were used for intrasite comparisons. Starting with the supposed earliest findings, they are presented not strictly in their chronological order but rather as functional units. The areas and loci involved as well as the provisional stratigraphic affiliations are also indicated in Table 1.6.2.

Silo (Figure 1.6.1:structure 1). The two loci included here represent different levels of the Silo fill. Both EBA—prehistoric—and early Hittite pottery are present. The former is dominant, which points to an early date for the fill process that probably antedates the construction of the Old Temple. Given the spacious dimensions of the Silo, the amount of animal bone finds is comparatively low, especially in the lower part of the fill. This section alone comprises more than 3 m of depth but yielded only about 2 kg of bones.

Accumulation around the Silo. Originally interpreted as house foundations, house interiors, or operation surfaces for the Silo, now are more neutrally regarded as unspecified accumulations. This group of closely associated contexts possibly represents the top layers of further, yet unexcavated, filled-up silos. Resulting from an area not directly related to either of the temples, it forms the most important "out-group" studied so far for faunal analysis. Altogether, over 1,300 identifiable specimens with a weight of more than 13 kg were retrieved from these units. Their pottery content, which has not been in the focus of research recently, consists of a mixture of EBA and MBA/LBA transition period sherds. Like in the Silo fill, EBA sherds are dominant here, but the percentage of undiagnostic fragments is remarkably high in some loci. The formation of these loci, therefore, may also have taken place before the erection of the Old Temple, only somewhat later than the fill of the Silo proper. Seven loci, which mostly represent artificial units, produced sufficient faunal remains to allow their treatment as individual subsamples. Although some differences regarding species composition and average fragment weights become apparent among these samples (see Figures 1.6.2 and 1.6.3 below), due to their contiguous stratigraphic positions, all units belonging to the Accumulation are also treated as

Table 1.6.2. Contextual aggregations.

| Context | Square (OYM 1) | Loci (OYM 2) | Sufficient sample | Relative chronology |
|---|---|---|---|---|
| Silo fill | 7383 | 248, 257 | yes | before construction of Old Temple |
| Accumulation around Silo | 7383 | 223, 225, 240, 242, 248, 249, 256, 257, 259 | yes | ? before construction of Old Temple |
| Old Temple A2 cultic deposits | 7383 | 133, 176, 185, 186, 190, 193, 202 | yes | construction of Old Temple or later |
| Old Temple A3 cultic deposits | 7585 | 237 | yes | construction of Old Temple or later |
| Old Temple A4 cultic deposits | 7685 | 142 | yes | construction of Old Temple or later |
| Old Temple B ditch | 7383 | 136, 140, 141, 148, 184, 188, 189 | no | construction of Old Temple or later |
| Old Temple C1 living floors | 7486 | 35 | no, only combined | construction/use period of Old Temple |
| Old Temple C2 living floors | 7586 | 84, 72 | no, only combined | construction/use period of Old Temple |
| Old Temple C3 living floors | 7587 | 33, 48, 53, 57, 59, 60 | no, only combined | construction/use period of Old Temple |
| Old Temple C4 living floors | 7587 | 29, 35, 44, 46, 47, 52, 54, 55, 66, 67 | no, only combined | construction/use period of Old Temple |
| Old Temple D small pits | 7686 | 116, 125 | no | use of Old Temple or earlier |
| Old Temple E | 7686 | 101 | no | construction of Old Temple |
| Old Temple F0 | 7686 | 115, 118, 120, 121 | no | use of Old Temple or later |
| Old Temple F destruction horizon | 7486 | 44 | no, only combined | use of Old Temple or later |
| Old Temple F destruction horizon | 7686 | 98, 103, 104, 111, 112, 113, 114, 117 | no, only combined | use of Old Temple or later |
| New Temple deposits and fills G1 | 7585 | 143, 102 | no, only combined | use of New Temple |
| New Temple deposits and fills G1 | 7685 | 169 | no, only combined | use of New Temple |
| New Temple deposits and fills G2 | 7585 | 81, 93, 101, 122, 126, 133 | yes | use of New Temple |
| New Temple deposits and fills G3 | 7685 | 144, 145, 151 | no, only combined | use of New Temple |
| New Temple deposits and fills G4 | 7685 | 95, 103, 108, 114, 115, 116, 128, 134, 135, 138, 141, 153, 154 | yes | use of New Temple |
| New Temple ramp | 7585 | 108, 113, 123 | yes | use of New Temple |
| New Temple courtyard fills | 7586 | 85, 103, 136, 148, 154, 155 | yes | construction of New Temple |
| New Temple room fills | 7585 | 140, 156, 166 | yes | construction of New Temple |

a summarized entity. This also holds true for all the other aggregations described here.

Old Temple A Cultic Deposits/Deposits with Ash (Figure 1.6.1:structures 3–5). This group combines spatially separated, well-delimited contexts classified as small pits, an ash pit, deposits with ash, jar horizons, and more. Bones from A1 have not been analyzed yet. A2 encompasses a set of seven spatially closely related loci, which were originally interpreted as resulting from a foundation sacrifice. A3 and A4 consist of one single locus each. In-situ photographs of both units, showing dense concentrations of sherds and, in the case of A4, also of animal bones, are presented by Hnila (Czichon et al. 2016:Figure 10; Kunst et al. 2016:Figure 10.6). As described above, all these deposits were a priori defined as closed, cult-related contexts because of their limited pottery spectrum comprising mainly small jars, bowls, and plates ("microvessels"), including complete vessels—all commonly related to ritual activities. Locus 7685:142 alone contained over 100 typological specimens (Czichon et al. 2016). There is also a negligible percentage of EBA sherds in A2.

The similarity in the associated pottery collections justifies the combination of the animal-bone assemblages from units A2–4 into one single aggregation, although they were retrieved from contexts 10–30 m apart from each other (Figure 1.6.1:structures 3–5). Because an immediate connection between these contexts and the stratigraphy of the Old Temple is lost, they can only provisionally be linked to its construction period. They might even result from the period after the destruction of the Old Temple because cult activities may have been going on beyond that event.

Old Temple B Ditch (Figure 1.6.1:structure 2). The number of animal remains from a shallow ditch running above the Silo is insufficient for further analysis. However, it is noteworthy that all groups of the domestic triad are present in rather balanced proportions. The chronological position of the fill may be comparable to Old Temple A.

Old Temple C1–4 Living Floors. Various loci from three different, yet adjacent, squares represent the use phase of the Old Temple. These contexts, interpreted as accumulations, fill horizons, or mud-brick debris, may also have accumulated between two subsequent building stages of the Old Temple. Apart from 20–35% of EBA pottery, ceramics of older Hittite character—seventeenth–fifteenth/fourteenth century BC—prevail. These often appear to be related to household activities and comprise a more varied spectrum than the cultic deposits. They include jars, cooking pots, and lids. Further, fragments of bull terracottas have been found. The animal bone finds from the living floors, conceivably representing more "unspecialized" activities, would make a good comparative group for the "cultic" deposits. Unfortunately, only a small number of faunal remains were recovered from these contexts, leaving only the combined aggregation (C1–4) amenable for analysis.

The aggregations Old Temple D small pits, Old Temple E mud-brick layer, and Old Temple F0 outer walking horizon all produced only few animal remains. Therefore, they do not allow for any detailed quantitative comparisons. However, compared to the cultic deposits—Old Temple A—and the fills of the New Temple, these small assemblages are characterized by the consistent presence of all main domesticates in most samples and, mostly, by the absence of caprine dominance. Scattered human remains were present in F0 outer walking horizon.

Old Temple F Destruction Horizon. These contexts derive from two squares separated by about 10 m from each other. Only when combined do they provide a sufficiently large aggregation of faunal remains for analysis. The loci were defined as mud-brick debris, accumulations of burnt clay, charcoal, and bricks or loose rubble of building materials. Locally, concentrations of pottery and animal bones were observed and heat influence on the bones and other remains is widespread. Percentages of EBA pottery vary between 5% and 40%, but generally LBA pottery dominates.

New Temple G Deposits and Fills from the Use Period of the New Temple. The contexts from groups G1–4 in fact represent a stratigraphic sequence from two adjacent squares around the entrance area of the New Temple. G1 and G3 include fills, which accumulated above floors and pavements, while G2 and G4 were situated directly on top of them, respectively. These top layers contribute the majority of the finds. All these contexts were generated in the course of repeated renovation works, thus belonging to the use period of the New Temple.

In addition, all contained important accumulations of cult-related pottery, most notably G4. From Locus 7685:103 and Locus 7685:108 alone come over 150 restorable typological specimens of small bowls and plates, including complete specimens, all wheel-thrown pottery produced quickly and haphazardly. Small jugs and libation vessels are the main ceramic types represented. In comparison to Old Temple A cultic deposits, the pottery spectrum is even more limited, and most types can be interpreted as cult or votive vessels in a stricter sense. Residual EBA pottery normally is less than 10% of the finds. These dense accumulations of pottery are often accompanied by equally extensive concentrations of animal bones. Thus, G2 and G4 contained sufficient material and could be treated as independent aggregations.

New Temple Ramp. Collected from the same entrance area as G1–4, these contexts derive from an outer part of the Ramp, where no floor or pavement could be documented. Cult-related pottery was present as well, albeit a smaller percentage. All aspects considered, this aggregation is very similar to that at the New Temple G1–4, both regarding its chronology and assumed taphonomic pathway.

New Temple Courtyard Fills. The six loci included here are more or less artificially divided into subunits or levels even though they come from basically the same context. They derive from one square, which encompasses the southeastern corner of the central Courtyard of the New Temple. This is the largest contiguous area of the Courtyard excavated so far. As previously mentioned, this fill was purposefully created in order to enhance the stability of the foundations of the New Temple. The pottery found here frequently comprises sherds with rounded edges, including larger specimens. Prehistoric pottery attains percentages of up to 30%. Beyond that, the finds yielded a good survey of older Hittite pottery (seventeenth–fourteenth century BC). As opposed to the pottery of the last Hittite phase, they are characterized by higher diversity and quality. Some pieces appear even younger and may correspond to the building period of the New Temple. Fragments of animal figurines have also been found.

According to Mielke (Czichon et al. 2016:48), most of these artifacts probably derive from bodies of sediment previously deposited nearby and deliberately dug out when fill material was needed in the course of the foundation works. Three of the loci produced sufficient animal remains to be treated as individual aggregations. The total sample from the Courtyard, with more than 1,250 (8.7 kg) remains of the main domesticates, occupies the second place after the Accumulation around the Silo. In contrast to the pottery, there appear to be few signs of redeposition among the animal remains.

New Temple Room Fills. Like the Courtyard fills, the three loci summarized here are artificially separated levels of the same fill, albeit from the entrance area of the New Temple. They, too, derive from one square adjacent to the Courtyard in the south, but they were deposited inside one of the casemate structures or Rooms of the southern wall. Thus, a taphonomic pathway similar to the Courtyard can be assumed for both the pottery and animal-bone assemblages. Like in the Courtyard, this fill does not represent the use phase of the temple but a constructive element of its foundations. The percentage of EBA—prehistoric—pottery is higher here, reaching up to 40%. Therefore, the sediment was probably brought in from a different area or in the course of a separate process. All three loci produced sufficient animal remains for an individual analysis, although the overall amount is considerably smaller than in the Courtyard (614 NISP of main domesticates or 2.4 kg).

The contextual aggregations selected for study present a dataset sufficiently heterogeneous for intrasite comparison. This is already reflected in the names assigned to different areas and, more specifically, from their pottery content. The following sections focus on investigating whether these differences are also corroborated by faunal evidence and whether these occur consistently throughout the different levels of the contextual aggregations. Due to the fact that the main domesticates—cattle, caprines (sheep and goat), and pig—account for the majority of identified specimens in all samples, tripolar graphs (cf. O'Connor 2003) were deemed the appropriate tool for demonstrating patterns of taxonomic variability, both regarding fragment (specimen) counts and fragment weights. N3 and G3 indicate the total of the specimen counts (NISP) and the total weights of these main domesticates in any contextual category. Beyond taxonomic representation, all other data categories commonly studied—osteometry, age-at-death, bone modifications, and the like—were also

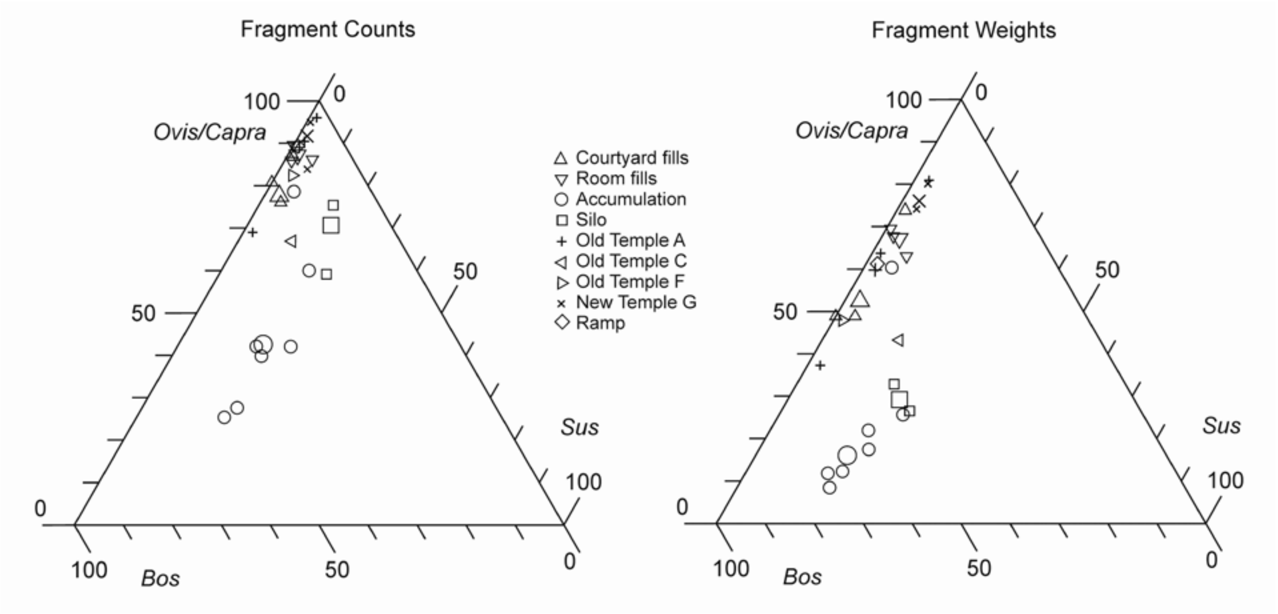

Figure 1.6.2. Tripolar graphs indicating the relative frequencies of the main domesticates for fragment (specimen) counts and fragment weights (N3 and G3) in the text. Within context groups (Courtyard fills, Old Temple G, etc.) the same symbols are used for each sample, while means for context groups are indicated by the larger symbols.

recorded. Average fragment weights and skeletal part frequencies were also found to be of some relevance for categorization.

## Results

### *Relative Proportions of the Main Domesticates*

The results regarding specimen counts (NISP) and weights (N3 and G3, for the three groups of the main domesticates: cattle, caprines, and pigs, respectively) for any category with at least 70 specimens of the group total (N3>70) are indicated in Figure 1.6.2; the database is presented in Table 1.6.1. Results for smaller samples are indicated in Table 1.6.1 but were not included in Figure 1.6.2. Groupings are apparent in both the NISP and the weight diagrams of Figure 1.6.2 but do not necessarily represent a congruent pattern.

Fragment Counts (N3). With the exception of the Accumulation around the Silo, the data points tend to cluster toward the caprine maximum, exhibiting a proportion of 70% caprines or more. Furthermore, it is only in the Silo that pigs take the second position ahead of cattle. Both the Silo and the Accumulation present an almost consistent amount of 20% pigs, which was not observed anywhere else. The main variability, however, occurs along the connecting line between caprines and cattle. The highest caprine percentages, around 90% or more, are attained by individual data points of the cultic contexts of Old Temple A, New Temple G, and the Ramp, followed by the room fills, Old Temple F—destruction horizon—and the Courtyard fills. There is, however, a considerable overlap among the first four categories—Old Temple A, New Temple G, Ramp, and room fills—which makes this area of the diagram densely populated and thus somewhat difficult to read.

On the other hand, room and Courtyard fills are clearly separated. There are some noteworthy outliers, however, namely 7383:242 of the Accumulation, which exhibits a relatively high percentage of caprines (78.4%), and Old Temple A3, with just under 70% of caprines. The position of Old Temple C, the only context defined archaeologically as containing unspecific settlement debris, indicates a rather balanced distribution, at least among the results from the proper temple area. Admittedly, the N3 values of these two samples are below 100 and the results should therefore be treated with some caution. The widest dispersion of individual data points from one category was greatest in the Accumulation followed by the Silo. The two cultic/ritual groups Old Temple A and New Temple G, apart from the outlier, exhibit an intermediate pattern, while Courtyard fills and room fills appear as rather homogenous categories. These dispersions are mainly caused by differences in the caprine:cattle ratio.

Fragment weight (G3). The Accumulation and the Silo samples, with the exception of the outlier (7383:242), appear shifted toward the cattle maximum and are significantly less dispersed than in the NISP diagram. Pig percentages remain almost unaffected (20–30%), indicating important differences in skeletal-part preservation among the smaller species. The other data points are rather loosely scattered along the caprine:cattle line. Overall dispersion is higher here than in the NISP diagram and differences among context groups other than the Silo and the Accumulation are more clearly visible. The outliers Old Temple A3 and Old Temple C retain marginal and central positions respectively. In the weight diagram, the cult-related samples from New Temple, together with Old Temple A2, occupy the caprine maximum (75–82%). They are accompanied by 7586:155 from the Courtyard fills, which points to a combination of comparatively light remains of cattle with rather heavy ones of caprines. In other contexts, both room fills and Courtyard fills exhibit a consistently clustered distribution of data points, remaining clearly separated from each other. The remainder from Old Temple A, the Ramp, and the outlier of the Accumulation are situated between them. The data point for the destruction horizon from Old Temple F is located among the Courtyard fills.

Summarizing the results, the following observations appear to be of interpretative value: the N3 and G3 proportions of the only two categories originating from outside of the temple area, the Accumulation and the Silo, are set apart from the rest, as well as plotting next to each other. This is due to their balanced species distribution, which may also account for the considerable dispersion of individual data points in the NISP—fragment counts—diagram. Presently, it cannot be decided if their species composition is controlled by their spatial or rather by their chronological position, which is deemed earlier than the remainder of the samples (Table 1.6.2). At the opposite end of the distribution of the data points, maximum caprine values are consistently represented by categories with a cultic/ritual aspect: Old Temple A and New Temple G. However, caprine dominance appears to be less consistent in Old Temple A. This may be related to the fact that this aggregation consists of discrete, spatially separated contexts (Figure 1.6.1), which are only subsumed in one category because of their archaeological interpretation—primarily based on pottery. The highly structured nature of some of these samples is, in principle, in accordance with an interpretation as "ritual refuse."

The two large groups of fills, resulting from the Courtyard and from the Room(s), exhibit relatively consistent differences in their respective cattle:caprine ratios, with generally higher amounts of caprines in the room fills. Furthermore, with one single exception, both give the impression of being rather homogenous and structured entities throughout. This is evidenced by the generally low dispersion of data points in these two categories. This observation may be at odds with the idea that they result from randomly picked sediment bodies, as has been hypothesized for the pottery from these fills. It instead indicates a strong shaping agent being responsible for their formation. If any category appears randomly selected and accumulated, it would be the Accumulation (p. 99).

Although the minor samples are not very large, their composition requires further attention. For instance, the Old Temple C sample, allegedly collected from room fills and living floors of the Old Temple, appears in fact to be the most balanced category from the temple area in terms of expected taxonomic composition. Although they cannot be analyzed statistically due to their small sample size, categories like Old Temple B, an early LBA ditch, and Old Temple F0, a living surface outside of the Old Temple A, are likewise not characterized by a dominance of caprines. Instead, all elements of the three main domestic taxa are present. Indeed, even some of the large samples from the Courtyard fills (7586:103), room fills (7585:156), New Temple G4, and the Ramp, are almost devoid of pig remains.

### *Average Fragment Weight of Cattle and Caprines*

In order to provide more details about the taphonomic history of the contextual categories chosen for analysis, the average fragment weights for both cattle and caprines are presented in Table 1.6.1. In order to avoid referring twice to the same set of data, the means for the categories (Courtyard fills, Old Temple A, etc.) are not indicated in Figure 1.6.3. Some categories exhibit clear groupings. For

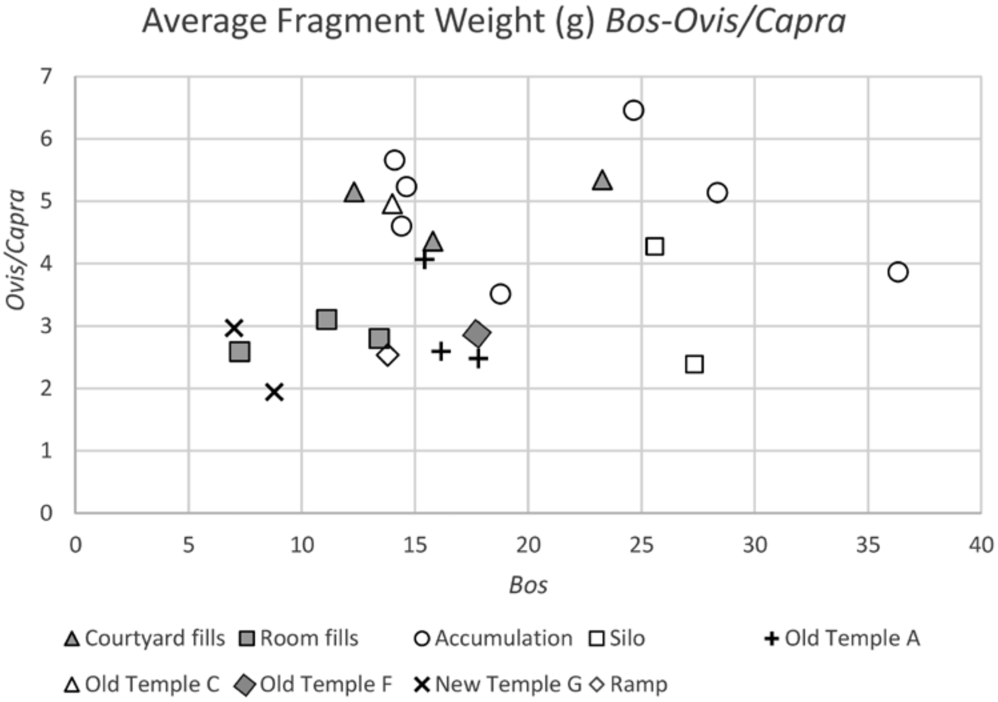

Figure 1.6.3. Scatterplot indicating average weight of cattle and caprine (sheep and goat) remains for individual contexts as shown in Figure 1.6.2. Means for context categories omitted in order not to overload diagram.

instance, the room fills and the cult-related aggregations of the New Temple G and the Ramp exhibit low average weights in both taxonomic groups, especially in regard to the caprines. Furthermore, the average of caprine samples remains fairly the same across the three different samples of room fills, which again suggests homogeneity. The opposite is true for the cult-related aggregations of the Old Temple A, where cattle remains tend to be more prominent by weight.

In the Courtyard fills, the average weights of caprine remains are higher but remain fairly consistent, while those of cattle appear to be rather inconsistent. As in Figure 1.6.2, the data points for Courtyard fills and room fills do not overlap, possibly indicating different taphonomic pathways. Values for the Accumulation around the Silo exhibit a considerable dispersion for some of the seven individual aggregations. This is caused by important variability in the average fragment weights among both cattle and caprines. The Silo fill proper is characterized by bias toward cattle and against caprines, which would explain some of the differences in data positions between the two diagrams in Figure 1.6.2. More generally, these examples demonstrate that closer examination of the interrelationship between taxonomic composition and fragment size/weight is necessary.

### *Skeletal-Part Representation of Caprines*

Skeletal-part profiles were assessed only for caprines because they represent the dominant taxonomic group in most contexts and the only one producing sufficient remains for this analysis. Caprines' skeletal-element data were collected for the Silo, the Accumulation, room fills and Courtyard fills, Old Temple A, New Temple G, and the Ramp. Sample sizes (NISP/weight; Table 1.6.1) vary between 138/349 g (Ramp) and 993/4,607 g (Courtyard fills) and are otherwise well over 300/900 g. These figures have been deemed adequate for the assessment of skeletal-element abundances (cf. Marom and Bar-Oz 2013:234).

Probably due to their smaller size and differences in their butchery and disposal, caprine skeletal profiles tend to deviate less from expected frequencies than those of cattle. Nevertheless, patterns of intrasite differences or marked overrepresentations of certain elements are not infrequently reported and commented upon in the zooarchaeology of

Table 1.6.3. Relative weight percentages of selected caprines' skeletal elements (% of total weight in skeleton or samples).

| | Skeleton | Ramp | New Temple G | Old Temple A | Room fills | Courtyard fills | Accumulation | Silo |
|---|---|---|---|---|---|---|---|---|
| Mandible | 5.3 | 13.2 | 7.0 | 11.9 | 10.6 | 18.3 | 34.1 | 25.8 |
| Vertebrae, Ribs | 30.7 | 27.6 | 35.8 | 17.9 | 16.7 | 19.1 | 8.1 | 4.9 |
| Humerus, Femur | 11.6 | 13.2 | 8.8 | 14.9 | 14.0 | 15.3 | 11.1 | 12.7 |
| Radius/Ulna, Tibia | 11.2 | 10.5 | 21.0 | 18.7 | 23.9 | 17.2 | 18.6 | 19.5 |
| Metapodials | 4.9 | 0.0 | 4.1 | 4.9 | 9.8 | 6.5 | 5.7 | 7.3 |
| Basipodium, Phalanges | 5.6 | 7.9 | 8.5 | 3.1 | 6.7 | 3.2 | 1.9 | 2.1 |

Southwest Asia (e.g., Lev-Tov and McGeough 2007; Marom and Zuckerman 2012; Meadow 1983). At Oymaağaç, bone weights were routinely recorded for each specimen. Skeletal-part frequencies are therefore presented by relative weight percentages. The weight percentages of anatomical areas within the respective samples were compared to the standard provided by the IPNA/University of Basel (2018). Thus, it becomes possible to integrate even highly fragmented yet identifiable specimens (e.g., vertebrae and ribs, lose teeth) into the analysis.

In Table 1.6.3 and Figure 1.6.4, results for the aforementioned contextual aggregations are compared to the standard, which represents the expected anatomical representation for a complete skeleton. The anatomical groups included are the mandible, vertebrae and ribs, the upper limbs (humerus and femur), the lower limbs (radius/ulna, tibia), basipodium (carpals and tarsals), phalanges, and the metapodials. Percentages of skulls and shoulder elements as well as pelvic girdle are not shown because incidental occurrences of complete specimens among these groups would strongly influence the diagram.

Figure 1.6.4 indicates important differences between the aggregations. In the lower part of the diagram, the weight percentages of mandibles and axial elements often appear to be negatively correlated. While vertebrae and ribs occur in expected percentages or even higher in the Ramp and New Temple G, and still in about half of their "expected" values in Old Temple A and in both room fills and Courtyard fills, they are much less represented in the Accumulation and Silo. The mandible, on the other hand, is overrepresented everywhere but least so in New Temple G, the room fills, and in Old Temple A. It attains five to six times its expected values in the Accumulation and Silo. Loose mandibular teeth were included in the mandible category, but contribute little to overall weight. While differences between the weight percentages of upper limb elements are comparatively small, those of lower limbs are more accentuated. Radius/ulna and tibia are overrepresented almost throughout but more so in the room fills, New Temple G, and in the Silo. These elements along with the humerus are easy to identify even in heavily fragmented conditions due to their diaphyseal morphologies. Metapodials are overrepresented in all aggregations not immediately linked to ritual activity, most notably in the room fills. However, representing butchery waste, these robust elements often occur in high percentages in faunal assemblages significantly affected by taphonomic processes. This also holds true for the mandible and for skull parts in general. Somewhat contrary to expectation, small elements of the basipodium and phalanges, usually interpreted as waste of initial butchery as well, are best represented in New Temple G, the Ramp, and the room fills. Rather than linked to functional reasons alone, this may be due to a taphonomic environment favoring small-sized specimens. Moreover, these three aggregations also produced the lowest average fragment weights for caprines (Figure 1.6.3). These effects may be interrelated.

The overall bias in skeletal-part profiles appears moderate and none of the assemblages may in fact derive from a single functional source. The deficit of skull parts and the fair representation of the axial skeleton in New Temple G can be interpreted in a straightforward way. These remains likely represent,

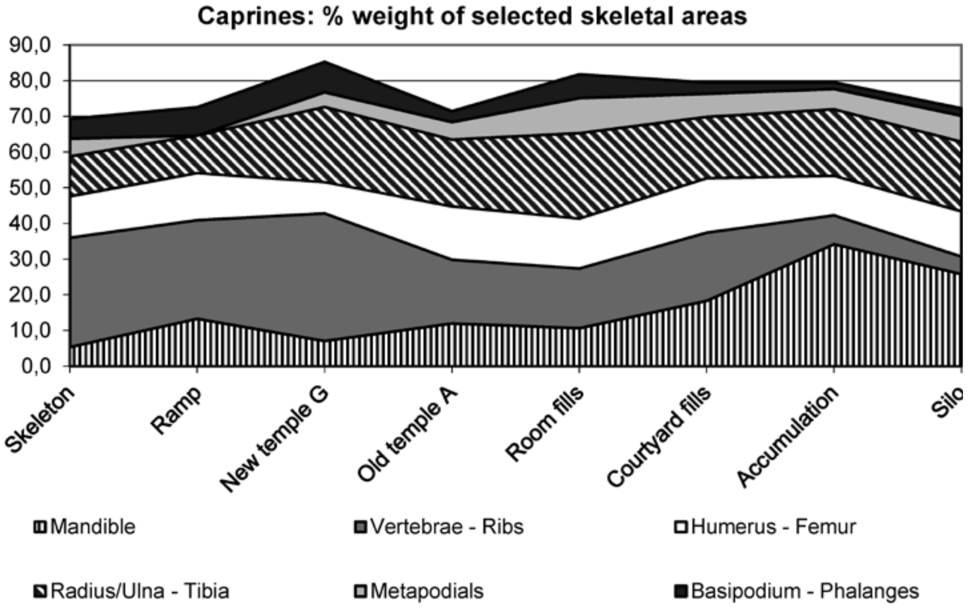

Figure 1.6.4. Relative weight of selected skeletal elements of caprines, expressed as percentages of a skeleton or of sample weights; elements of the skull, the shoulder, and pelvic girdle not shown. Standard skeleton from IPNA/University of Basel (2018).

for the most part, food remains. The same holds true for the Ramp, albeit mandibles are better represented there. There is an obvious cline toward assemblages influenced more by butchery waste, like the Accumulation and Silo. The fills and Old Temple A occupy an intermediate position. These latter, interpreted as an aggregation of in situ contexts, and the room fills produced similar profiles. The percentages of distal-limb parts increase, by comparison, in the room fills. Furthermore, New Temple G exhibits a lower diversity of skeletal parts since the anatomical regions presented in Figure 1.6.4 sum up to over 85% of the complete sample weight. This is the maximum value of the seven aggregations analyzed here; the expected percentage would be approximately 70%.

## Discussion

In this section, we take a closer look at the processes thought responsible for the accumulation of animal remains around the temples. These processes can be better understood through references to the functions and evolution, or rather "life-cycles" (LaMotta and Schiffer 1999), of these buildings. They can also be viewed as agents in different taphonomic processes in the formation of the faunal assemblages recovered there. Most analytical categories like species and skeletal-part representation, age profiles, and others are influenced by taphonomic processes, whether mainly anthropogenic or purely natural. Practically all concepts and ideas relevant for this type of approach and for intrasite faunal comparisons in general can be found in Meadow's (1983) study on the faunal remains of the Neolithic dwelling at Hajji Firuz in Iran. "Differential disposal, deposition, and preservation" are key concepts used by Meadow in explaining intrasite variation in faunal assemblages. They cause differential representation and distribution of species and elements at the site (Meadow 1983:370). Both disposal practices (anthropogenic activities) and uneven preservation due to variable robustness between different anatomical elements contributed toward the observed patterns. Consequently, variations in summary data calculated for each phase cannot be simply viewed in terms of chronological development (Meadow 1983:401). This touches on another important issue, namely relationship of animal bone collections to decisions by the excavators on which area of a site to investigate. At Oymaağaç for example, there is an obvious bias favoring contexts close to the temples and built structures in general, all of which were regarded as areas of primary research interest. Samples collected from outside this area, therefore, derive almost exclusively from the Silo and Accumulation, also investigated thanks to the excavation field layout (Figure 1.6.1). Excavations are rarely undertaken with the primary aim of collecting faunal samples or providing reliable coverage for intrasite faunal variability. A consistent difference in taphonomic conditions between house interior and exterior areas is held by Meadow to be one key factor causing variation (1983:370). For example, "bones from exterior loci are more exposed to destruction by weather, trampling, and scavengers" (1983:402), resulting in marked differences in skeletal-part patterns. This indicates a protective taphonomic environment in the case of house interiors and important taphonomic pressure in the outside areas.

One further issue addressed by Meadow concerns the temporal resolution of assemblages and their relation to developmental stages of a dwelling. At Hajji Firuz, certain bone accumulations from house interiors "might represent the remains of a single consumption activity" (Meadow 1983:402). Anticipating abandonment of the dwelling, these assemblages were allowed to accumulate in areas otherwise kept free of waste and may result from a single season, if not from a single event. In contrast, a sample from an exterior locus is believed to have accumulated over a longer period of time. As a consequence, the idea of an "average" faunal assemblage in settlement archaeology is rightly questioned by Meadow (1983:402).

Meadow also makes implicit use of the concept of the "life cycle of dwellings" developed by Schiffer (LaMotta and Schiffer 1999) and the corresponding accumulation processes, including their bearing on faunal analysis. Basically, it implies a sequence of habitation or use, abandonment, and post-abandonment phases of built structures, which are somehow—though not directly—related with episodes of deposition or accretion of primary, secondary, and tertiary refuse (LaMotta and Schiffer 1999). Exchanging "refuse" with "bone," the resulting categories of bone deposition are described as follows in Marom and Zuckerman (2011):

(1) "Primary deposition of bone reflects refuse discarded at the place of animal processing and consumption and thereby provides the highest resolution information on domestic activity areas" (Marom and Zuckerman 2011:42). However, because primary refuse tends to be small-sized, it can be collected only by wet sieving and may thus be of limited identifiability.

(2) "Secondary deposition of bone: … since most identifiable bone fragments are large …, and may prove a sanitary disturbance and a hindrance to movement inside domestic space, they cannot be assumed to be found in primary depositional contexts. … larger bone fragments are routinely removed from household floors to either the area immediately adjacent to the house or to central dumps, which are usually located near the primary consumption area" (Marom and Zuckerman 2011:43). Secondary depositions are therefore regarded as the main source of zooarchaeological data because they "present time-averaged 'samples' of the subsistence activities carried out in a domestic area and are thus of prime importance to the derivation of species, skeleton element abundance, and demographic data" (Marom and Zuckerman 2011:43). If secondary deposition occurs inside buildings, it is likely to indicate abandonment. According to Marom and Bar-Oz, "this secondary accumulation of larger, and therefore more identifiable bones—on living floors—would likely dampen the signal of fewer, smaller bones in primary deposition" (Marom and Bar-Oz 2013:433). Marom and Bar-Oz recommend to solve this dilemma (i.e., sufficient number of finds *versus* sufficient contextual information) by focusing on deposits from streets and open spaces inside settlements because "these contexts would reflect with greater accuracy the time-averaged daily consumption activities of nearby functioning architectural spaces" (Marom and Bar-Oz 2013:433).

(3) "Bones in tertiary position are accumulations brought as construction material—mud bricks or fills—to their archaeological context or otherwise removed from their archaeological context" (Marom and Zuckerman 2011:43). Therefore, they are deemed to be "of little value to faunal analysis as their original spatial and temporal provenance is not known" (Marom and Zuckerman 2011:43). Marom and Zuckerman (2012) explicitly exclude bones from "constructive fills" from their analysis, along with those from topsoil or uncertain stratigraphic provenances.

The adoption of the concept of "life cycle of dwellings" and the different categories of bone depositions may bring about a ranking of contexts with the consequence that some categories are believed to be of greater value than others. Drawing from the rich pool of ideas and data concerning BA cities provided by the authors cited above, we here tested if these concepts can successfully be used for the evaluation of the contextual aggregations at Oymaağaç. It is admittedly questionable whether concepts developed for simple dwellings are adequate in cases of complex, multiphase buildings, including palaces, temples, and industrial or economic installations. Namely, the formation-stages scheme of house-floor assemblages and the accompanying deposition processes provided by LaMotta and Schiffer (1999:20, Table 2.1) does not account for processes linked to construction, repair, and reconstruction. As noted initially, many of the assemblages observed at Oymaağaç accumulated in the course of such episodes, which were often accompanied by deep interventions into older strata. Further insights were established in different areas and periods. For example, Pluskowski comments on the taphonomy of crusader castles in the Baltic region that "[t]he construction history of each castle … accounts for the complicated taphonomy of these sites. Episodes of demolition and rebuilding often truncated earlier phases" (Pluskowski 2012:155).

Regarding the contextual aggregations defined for Oymaağaç, the following categorizations, which are not necessarily mutually exclusive, are suggested:

(1) *Silo and Accumulation*. These two aggregations probably represent secondary depositions in the sense defined above, an assumption that would also account for the large volume of zooarchaeological data generated. These faunal remains may be representative of economic activities from the period of the fill and sediment accumulation. In the case of the Silo fill, abandonment of a production-related structure is evident. Moreover, these are the only larger aggregations definitely deposited outside built spaces.

(2) *Old Temple A and New Temple G*. In the case of Old Temple A, the definition as spatially limited in-situ "sacrificial deposits" (Marom and Bar-Oz 2013:237) is evidenced both by the general archaeological context and the associated pottery. This may also be the case for New Temple G, but this aggregation probably also includes above-floor and floor deposits (Marom and Zuckerman 2011:44). This is also the only available archaeological information concerning the Ramp. Renovation processes are certainly involved in the formation of the latter two aggregations. At least in the case of Old Temple A, some of the spatially discrete contexts may represent primary deposits but of a different nature than those described above. The term sacrificial dump appears to be more adequate.

(3) *Old Temple C living floors*. This aggregation probably comes closest to what is defined as "domestic context" (e.g., Marom and Zuckerman 2012:577), which also explains its "unspecialized" nature.

(4) *Old Temple F destruction horizon*. This and other smaller aggregations are rather self-explanatory. They can be broadly classified as secondary deposits that are at least partially accumulated outside or in close proximity to the building.

(5) *New Temple Courtyard fills and room fills*. Although, based on their formation processes, these aggregations correspond exactly to the "constructive fills" mentioned by Marom and Zuckerman (2012:577), the faunal material does not, at least exclusively, consist of tertiary bone depositions (*sensu* Marom and Zuckerman 2011). They were therefore included in the analysis. A certain structuring found in these assemblages, especially concerning taxonomic composition, indicates that these animal remains were not entirely randomly collected or exclusively brought here with sediments. Apparently, these fills also contain animal-bone assemblages corresponding to in-situ contexts, deriving from little disturbed and discrete dumping episodes. These also holds true for parts of the pottery collection (Dirk Paul Mielke, personal communication 2018). Together with the Silo fill and the cultic deposits, these animal remains, in addition to the sediments they derive from, are the only ones deposited deliberately, albeit for different reasons.

Concerning skeletal-part distribution of caprines, no straightforward interpretation can be provided because several equifinal processes may be involved. Both Marom and Bar-Oz (2013:236) and Lev-Tov and

McGeough (2007:98) report the presence of butchered remains around temple precincts at BA sites in Israel. Therefore, a combination of meat-bearing elements and primary butchery waste can be expected also here.

## Conclusion

It has been shown that basic and easily comparable zooarchaeological data, like relative frequencies of the main domesticates and skeletal-part representations of well-represented taxa, can be successfully used for intrasite comparisons. This may especially hold true if the contextual aggregations, used as basic analytic units, derive from complex, multiphase buildings. Variability among samples, due either to human behavior or to other taphonomic processes, is quickly assessed and can be compared with the results from, for example, pottery studies. We believe that any variability observed within faunal data from one site or building is likely to be of some heuristic value. Further, these data can be easily adapted to any scale of analysis deemed sensible within the project (horizons, areas, buildings, context types, association with certain artifacts). Tripolar graphs, both for NISP and bone weights, prove to be an adequate tool for recognizing both groupings and outliers.

In addition to these conventional data, mean element weights of the main domestic mammals and the dispersion of data points observed among contexts from the same aggregation may also contribute to the better understanding of individual taphonomic pathways. At a minimum, the approach provides an opportunity to independently test the homogeneity of aggregations defined by the excavators.

The concepts of “life-cycle” of domestic structures and of primary, secondary, and tertiary deposition can be used in the case of complex buildings as well. In the present case, there is, however, a need for a widening of the concepts because important faunal materials were accumulated in the course of construction and repair works. It cannot be decided if the constructive fills’ formation, containing well-structured faunal samples, is specific for Oymaağaç or indeed represents a wider phenomenon. It was therefore decided to include all samples into the analysis that could be defined contextually and chronologically. Thus, information on intrasite variation can be gained and peculiarities of specific contexts also become more visible.

### *Acknowledgments*

Gratitude and thanks are due to Pavol Hnila and Dirk Paul Mielke from the project team at Oymaağaç who provided essential information concerning the stratigraphy and chronology of the site and the results of the pottery studies, as well as for their open-mindedness to discuss the relevance of any faunal sample at hand. The ongoing research at the Oymaağaç Höyük is financed mainly by the DFG and supported by the Ministry of Culture and Tourism of the Republic of Turkey.

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# 1.7 | Animal Exploitation and Community Behavior at a Middle Bronze Age Village on Cyprus

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and Patricia L. Fall¥

## Abstract

Analysis of faunal remains from the Bronze Age village of Politiko-*Troullia* in central Cyprus offers the opportunity to add detail to the ongoing effort to characterize societal changes during the Middle Bronze Age, prior to the emergence of Late Bronze urbanism on the island. Politiko-*Troullia*, located in the northern foothills of the Troodos Mountains, has a radiocarbon chronology that indicates an occupation around 2100–1900 cal BC. Sheep and goat bones dominate the faunal assemblage, with bones from Mesopotamian fallow deer (*Dama mesopotamica*), cattle, and pigs following in descending frequency. Excavated architectural remains include a household compound, two large open courtyards and an adjacent alley with bone-rich trash deposits. Analysis of the bone assemblages from these spaces reveals consistencies about butchering as well as patterns of animal exploitation and consumption, which distinguish household subsistence and communal feasting behaviors. These lines of evidence can augment a developing understanding of village social identity and reflect larger patterns of social change prior to the first urbanism on Cyprus.

## Keywords

*Cyprus, Middle Bronze Age, Politiko-*Troullia*, faunal survivorship profiles, faunal carcass distribution,* Dama mesopotamica, *feasting, communal behavior, orchard cultivation, household-scale metallurgy*

## Introduction

### *Bronze Age Society on Cyprus*

This analysis focuses on the settlement of Politiko-*Troullia*, Cyprus (Figure 1.7.1), as it exemplifies agricultural economy, particularly animal exploitation, just prior to the development of urbanized society on Cyprus (Table 1.7.1; Knapp 2008; Steel 2004). The Cypriot Chalcolithic Period featured a landscape of largely self-sufficient agrarian communities (Held 1993; Knapp 2008; Peltenburg 1996). The subsequent Philia "facies," identified primarily by funerary evidence, has been interpreted as a regional ceramic tradition (Stewart 1962) or as the earliest component of the Bronze Age (BA; Dikaios 1969) or a combination of the two (Webb and Frankel 1999). The ensuing Early Cypriot (EC) and Middle Cypriot (MC) periods (or the "Prehistoric Bronze Age"; see Knapp 2008:Table 1) featured pre-urbanized society with interacting villages of varying sizes, architectural configurations, and economic profiles (Knapp 2008:68–87). EC and MC agriculture incorporated animal management for secondary products, the introduction of cattle-plow farming, and heightened copper exploitation (Knapp 1990, 2008). At the end of these periods, MC III and Late Cypriot (LC) I jointly form a relatively quick transition to urbanized society and widespread international trade, which characterized LC II and III (Catling 1973; Knapp 2008; MC III–

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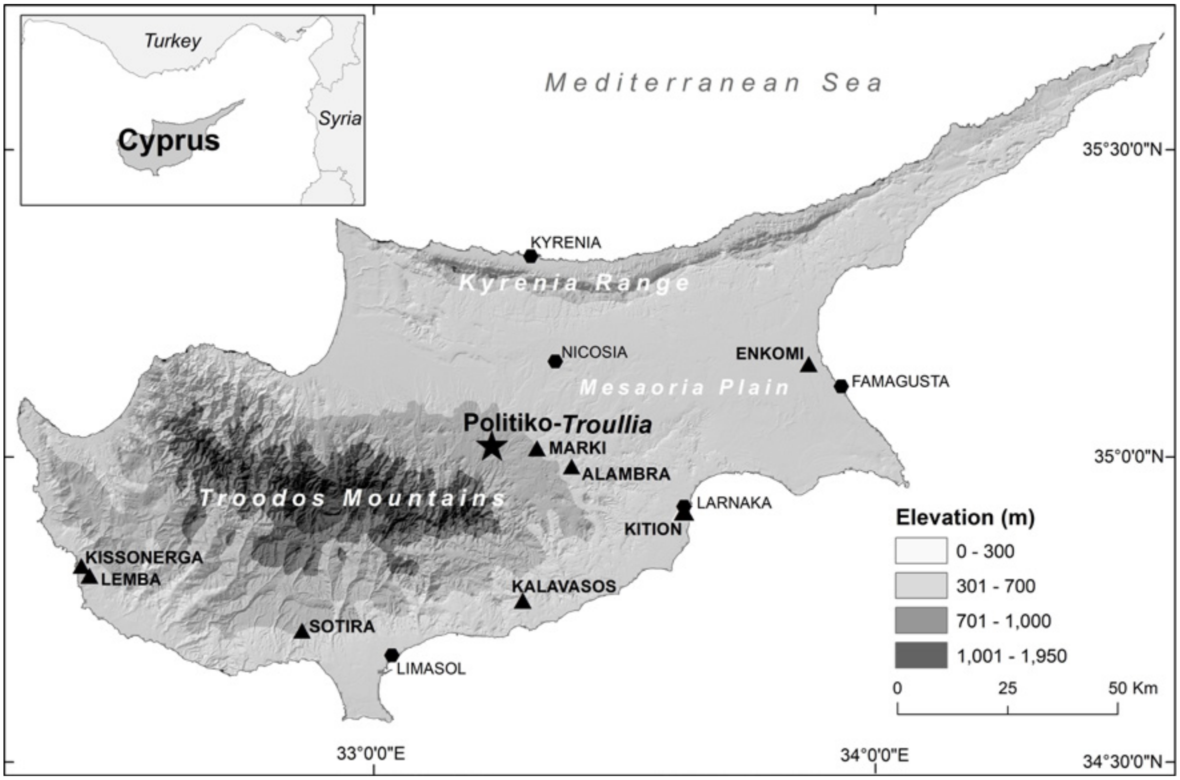

Figure 1.7.1. Map showing location of Politiko-*Troullia* on the island of Cyprus and other archaeological sites discussed.

LC III are also known as the "Protohistoric Bronze Age"). LC coastal cities like Enkomi and Kition became important nodes in expanded trade networks throughout the eastern Mediterranean (Keswani 1996; Knapp 1997a, 1997b; Manning 1993; Merrillees 1982; Peltenburg 1996).

### *Research Setting*

The archaeological remains of Politiko-*Troullia* lie buried in the foothills of the copper-bearing Troodos Mountains, at the southern edge of the arable Mesaoria Plain of central Cyprus. This village site sits on an alluvial terrace between Kamaras Creek on the west and the streambed of the Pediaios River on the east (Figure 1.7.2).

The Pediaios, which is now dammed just upstream of Politiko-*Troullia* and dry downstream of the dam, is the longest river course on Cyprus. Springs less than 1 km to the south, which still feed Kamaras Creek, would have provided easily accessible perennial water along the settlement's western edge. The nearby hills feature large surface exposures of the Troodos ophiolite, which would have provided ready access to high-quality copper ore (Singer 1986, 1995).

Table 1.7.1. Archaeological chronology for prehistoric Cyprus. (After Steel 2004:Table 1.1; see also Knapp 2008:Tables 1 and 3.)

| Period | Approximate Dates |
|---|---|
| Late Cypriot III | ca. 1200–1000 BC |
| Late Cypriot II | ca. 1400–1200 BC |
| Middle Cypriot III/Late Cypriot I | ca. 1700–1400 BC |
| Middle Cypriot I–II | ca. 2000–1700 BC |
| Early Cypriot I–III | ca. 2400–2000 BC |
| Philia | ca. 2500–2400 BC |
| Chalcolithic | ca. 4000–2500 BC |

Material culture—most noticeably potsherds and ground stone—spreads over an expanse of about 20 ha, encompassing agricultural terraces on the hillsides of Politiko-*Koloiokremmos* overlooking Politiko-*Troullia* (Fall et al. 2012). Within this area, dense concentrations of Red Polished Ware ceramics and

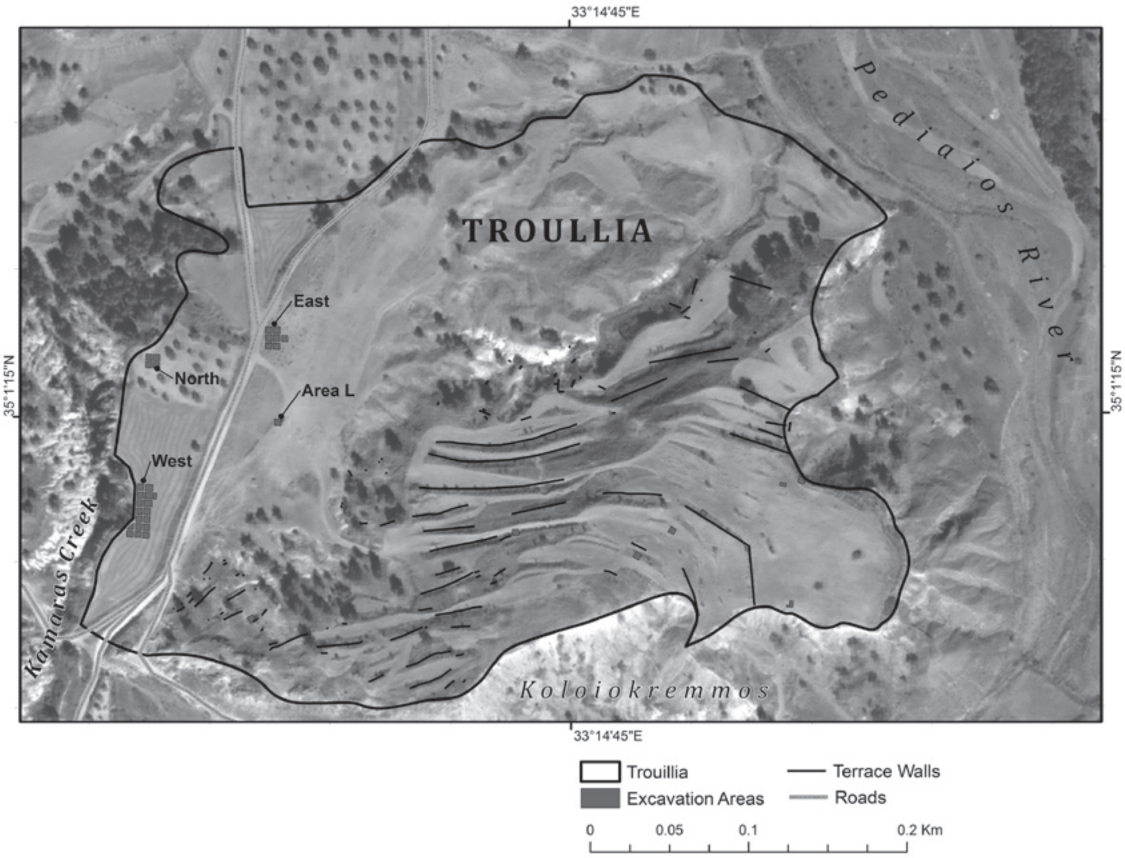

Figure 1.7.2 Quickbird image of Politiko-*Troullia* and surrounding landscape showing excavation fields. (After Ridder et al. 2017:Figure 2.)

ground-stone implements, accompanied by clear signatures of buried architecture revealed by soil resistivity survey, indicate a BA settlement covering at least 2 ha (Falconer and Fall 2013). Modeling of surface ceramic distributions associated with local terracing suggests an ancient, intensively managed agricultural landscape surrounding the village of Politiko-*Troullia* (Fall et al. 2015; Galletti et al. 2013; Ridder et al. 2017).

### *Research Questions*

We hypothesize that spatial patterns of excavated animal bones and teeth from the BA village of Politiko-*Troullia* will allow us to distinguish different use areas at the site. Further, sheep and goat deposition will vary when compared to deer bones in terms of abundances and proportions. We expect that meat-rich carcass portions—upper forelimb and upper hind limb—of sheep and goat and deer will be differentially deposited in the village. We also expect that patterns of animal species and faunal elements will be expressed most clearly in Politiko-*Troullia* West's Northern and Southern Courtyards, in contrast to patterns from the Metallurgical Workshop in Politiko-*Troullia* East and other areas of domestic refuse.

## Methods

Field excavations between 2007 and 2015 were undertaken in 4 × 4 m units separated by 1 m wide balks, which were removed periodically to permit broader, multiunit exposures. Since architecture often frames differing patterns of behavior (Finlayson et al. 2011; Goring-Morris and Belfer-Cohen 2008; Hardy-Smith and Edwards 2004; Rapoport 1990), we organized the excavated evidence from Politiko-*Troullia* according to "sectors" that correspond to distinct architecturally defined spaces, ranging from enclosed rooms to open exterior areas of varying sizes. All excavated sediments were dry-sieved through 1 × 1 cm mesh to maximize recovery of material remains, especially animal bones (Falconer and Fall 2013; Fall et al. 2008).

The bones recovered from Politiko-*Troullia* excavations were washed and air-dried at the field lab in the nearby town of Pera Orinis. A small number of bones—about 40—recovered with calcareous deposits were soaked in a mild acetic solution to dissolve the deposits. The preservation of the bones was generally good. Bones recovered from contexts near the modern ground surface were typically weathered and abraded more than bones recovered from deeper strata. Bones were identified with reference to comparative literature, including Boessneck (1969), Boessneck et al. (1964), France (2008), Getty (1975), Schmid (1972), von den Driesch (1976), Zeder and Lapham (2010) and Zeder and Pilaar (2010).

Animal bone data are quantified as NISP (Number of Identified Specimens) to enable spatial comparison of relative frequencies of animal bones (Crabtree 1990:159–160; Grayson 1984:94–96; O'Connor 2000:55; Reitz and Wing 2008:202–210). Survivorship data were calculated primarily from tooth wear of mandibular tooth rows. For survivorship calculations of sheep and goats, mandibular deciduous fourth premolars and permanent third molars were also used. Plant remains—that is, charcoal fragments and carbonized seeds—were recovered through manual, nonmechanized water flotation of excavated sediments with burned organic content (see Fall et al. 2015; Klinge and Fall 2010). Samples were poured through nested mesh sieves, and all remains measuring at least 0.5 mm were sorted using a binocular microscope.

## Results

### *Architectural Configuration*

Excavation of Politiko-*Troullia* East—in eight 4 × 4 m units (see Figure 1.7.3)—uncovered a two-room domestic compound with small outbuildings to the north and east buried in one meter of archaeological sediment. The absence of material culture or adjacent buildings to the south or west suggests that this compound lay at the northern edge of the settlement (Fall et al. 2008). A partially covered exterior metallurgical workshop (Sector 6) produced the most abundant floral and faunal remains in Politiko-*Troullia* East. This exterior space revealed metallurgical manufacturing debris and tools, for example, copper tongs, a carved limestone casting mold, ceramic crucible fragments, copper slag, and chunks of ore, suggesting that this space served as a household-scale copper workshop (Falconer and Fall 2013). The architecture and material evidence in Politiko-*Troullia* North was excavated in four units and generally resembles that of *Troullia* East. In *Troullia* North, an enclosed room is surrounded by exterior spaces that produced utilitarian ceramic remains and further evidence of copper metallurgy in the form of slag and ore.

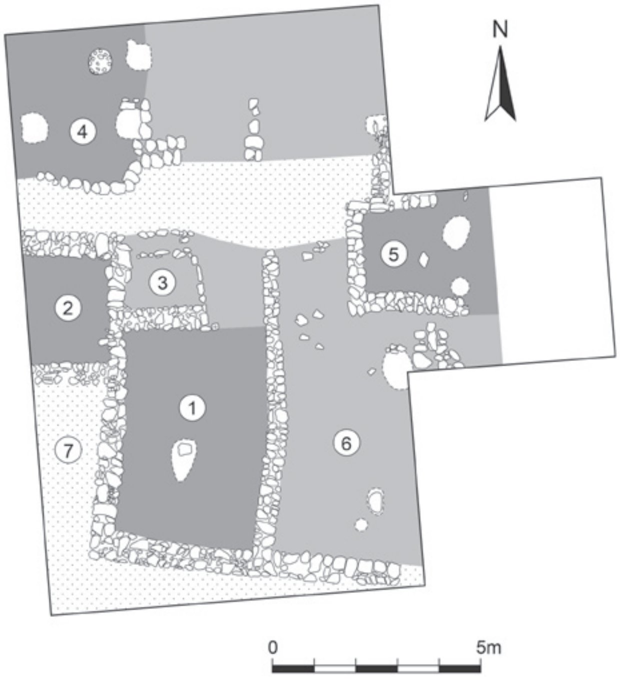

Figure 1.7.3. Map of Politiko-*Troullia* East showing domestic architecture (Sector 1) and associated outbuildings (Sectors 2 and 3), open-air work spaces (Sectors 4 and 5), and the Metallurgical Workshop (Sector 6). (After Falconer and Fall 2013:Figure 6.)

The major spaces uncovered through excavation of Politiko-*Troullia* West—incorporating 17 units (see Figure 1.7.4)—are two large courtyards. The Northern Courtyard (Sector 8) was entered from the north, adjacent to a well located within the site. The Southern Courtyard (Sector 9) had a later entrance at its southwest corner and an earlier one in its southern wall (Figure 1.7.4).

Comparably sized "exterior" courtyards excavated at other BA Cypriot villages (Frankel and Webb 2006:Figures 11.1–11.8; Swiny et al. 2003:58) and an ethnoarchaeological study of traditional Cypriot houses (Swiny et al. 2003:58) suggest that

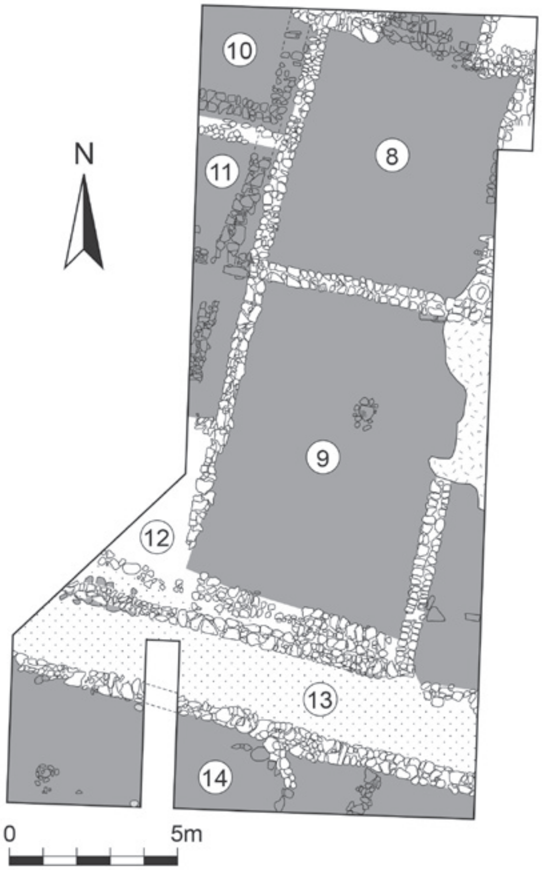

Figure 1.7.4. Map of Politiko-*Troullia* West, centered on the Northern Courtyard (Sector 8) and the Southern Courtyard (Sector 9); with Well (Sector 10), Alley (Sector 13), partially preserved rooms west of the courtyards (Sectors 11 and 12), and exterior space beyond the Alley (Sector 14). (After Falconer and Fall 2013:Figure 8.)

these courtyards probably were open and unroofed (Falconer and Fall 2013). The Southern Courtyard is bounded by parallel east–west walls to the south, framing an Alley (Sector 13) that sloped down toward the stream level of Kamaras Creek and thereby provided immediate access to water. This Alley was the scene of substantial community trash deposition, as reflected by rich, highly stratified sediments with abundant plant and animal remains. Recovery of very limited material evidence south of the Alley suggests that its southern wall may have constituted a settlement boundary. Additional domestic features in Politiko-*Troullia* West include a well (Sector 10) to the northwest of the Northern Courtyard and partially preserved rooms to the west of both courtyards along Kamaras Creek (Sectors 11 and 12, see Figure 1.7.4).

The remains of Politiko-*Troullia* constitute at least five phases of architectural building and rebuilding buried in one meter of archaeological sediment in *Troullia* East and more than three meters of deposition in *Troullia* West. The site's ceramic assemblage, which is dominated by Red Polished Ware, suggests occupation primarily during the MC Period (Falconer and Fall 2013). A suite of nine calibrated radiocarbon ages narrows the likely occupation span to roughly two centuries centered about 2000 cal BC.

### *Archaeobotanical Evidence*

The inhabitants of Politiko-*Troullia* clearly practiced intensive arboriculture and fuelwood harvesting, as indicated by excavated charcoal and carbonized seeds (see Fall et al. 2015; Klinge and Fall 2010). Seeds were recovered most abundantly from olive (*Olea europea*), grape (*Vitis vinifera*), fig (*Ficus carica*), and pistachio (*Pistacia* sp.). Less frequently recovered plants included annual cereals, for example, wheat (*Triticum* sp.) and barley (*Hordeum* sp.), and also wild taxa. Analysis of charcoal fragments indicates burning of oak (*Quercus* sp.), pine (*Pinus* sp.), and olive much more abundantly than at contemporary BA settlements in deforested settings in the Southern Levant (Fall et al. 2015). Based on this evidence, the landscape surrounding Politiko-*Troullia* combined extensive orchard cultivation, possibly including hillside agricultural terracing (Fall et al. 2015; Galletti et al. 2013; Ridder et al. 2017), amid surrounding woodlands that provided abundant fuelwood and food for forest-dwelling game.

### *Faunal Remains*

Nearly two-thirds of the excavated animal bones from Politiko-*Troullia* come from domesticated sheep (*Ovis aries*) and goat (*Capra hircus*), with much less abundant evidence of pig (*Sus* sp.) and cattle (*Bos taurus*) and considerable remains of Mesopotamian fallow deer (*Dama mesopotamica*; Table 1.7.2). The proportions of sheep and goat bones average relative to bones from other taxa about 66% across the excavation fields and architectural sectors considered in this analysis, which underscores the general importance of village-wide sheep and goat meat consumption.

Faunal remains are much less abundant in Politiko-*Troullia* East than in West (Table 1.7.2). The

Table 1.7.2. Faunal remains from Politiko-*Troullia* expressed as Number of Identified Specimens (NISP; see Figures 1.7.3 and 1.7.4 for location of sectors); Caprines (*O/C*).

| **Area (sector)** | ***O/C*** | ***Dama*** | ***Bos*** | ***Sus*** | **Total** |
|---|---|---|---|---|---|
| PT East (1–7) | 65 | 10 | 11 | 19 | 105 |
| N Courtyard (8) | 481 | 215 | 35 | 54 | 785 |
| S Courtyard (9) | 1,370 | 566 | 137 | 113 | 2,186 |
| Well (10) | 87 | 19 | 5 | 3 | 114 |
| Court Ext (11&12) | 67 | 29 | 1 | 7 | 104 |
| Alley (13) | 2,446 | 688 | 249 | 153 | 3,536 |
| S Ext (14) | 229 | 65 | 39 | 15 | 348 |
| **TOTAL** | **4,745** | **1,592** | **477** | **364** | **7,168** |

Table 1.7.3. Faunal remains by taxa from Politiko-*Troullia* according to grouped sectors, and expressed as NISP; $\chi^2 = 96.65$, df = 6, $p < 0.0001$. Caprines (*O/C*); *Ovis*:*Capra* (*O*:*C*) ratios shown for each of the grouped sectors and for the site as a whole. Note: PT East has a comparatively small sample size; the remainder of the site reflects very consistent *Ovis-Capra* ratios of 0.70–0.72.

| **Area (sectors)** | ***O/C*** | ***Dama*** | ***Bos*** | ***Sus*** | **Total** | ***O*:*C*** |
|---|---|---|---|---|---|---|
| PT East (1–7) | 65 | 10 | 11 | 19 | 105 | 1.44 |
| Courtyards (8,9,11,12) | 2,080 | 846 | 211 | 182 | 3,319 | 0.70 |
| PT West Ext (10,13,14) | 2,762 | 772 | 293 | 171 | 3,998 | 0.72 |
| **TOTAL** | **4,745** | **1,592** | **477** | **364** | **7,168** | **0.72** |

Politiko-*Troullia* East bone assemblage is constituted overwhelmingly by domestic animals, especially sheep and goat, accompanied by the site's highest relative frequencies of pig and cattle and the lowest values for deer bones. The evidence from *Troullia* West includes the vast majority of animal bones excavated from Politiko-*Troullia,* and the largest numbers of faunal remains were found in the Southern Courtyard, the Alley, and the Northern Courtyard. The eastern and western portions of the settlement may be distinguished most fundamentally by the abundance of deer and low frequencies of pig and cattle in *Troullia* West, in contrast to the more substantial proportions of swine and bovids, and the near absence of deer in *Troullia* East.

The faunal evidence from distinct architectural sectors in *Troullia* East and West describes several contrasting patterns that underlie our inferences of domestic subsistence and communal feasting. A Chi-square analysis demonstrates that the taxonomic composition of these deposits differs significantly (Table 1.7.3; $\chi^2 = 96.65$, df = 6, $p < 0.0001$). The Metallurgical Workshop (Sector 6) provides two-thirds of the bone evidence from *Troullia* East, in which sheep and goat bones form a strong majority, accompanied by lesser amounts of pig and cattle, and, much less frequently, deer. In *Troullia* West, our grouped sectors reveal much more substantial bone deposition, with a common pattern of much greater frequencies of deer and much less swine, especially in the two courtyards and their associated sectors. The Alley, in particular, provides a robust bone assemblage, with more than twice the frequency of deer but less than one-third the frequency of pig than are seen in *Troullia* East (see Table 1.7.2). A similar pronounced patterning is apparent in the Northern and Southern Courtyards, which jointly contribute assemblages almost as large as the Alley, with even higher fre-

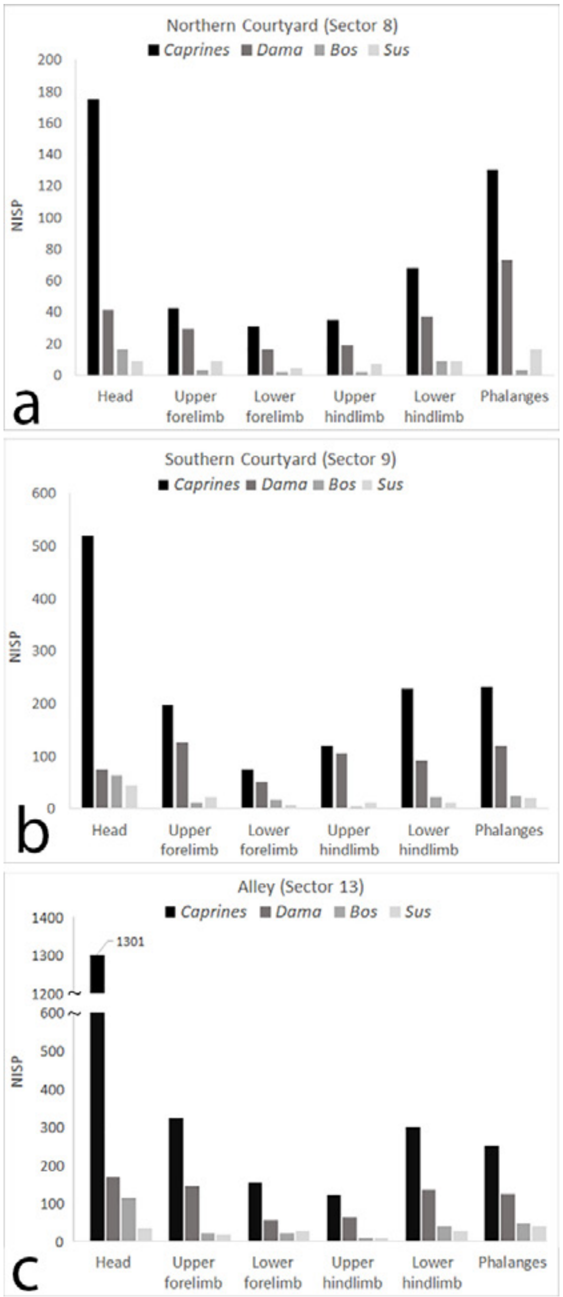

Figure 1.7.5. Carcass distribution of caprines, deer, cattle, and pigs in the Northern Courtyard (Sector 8), Southern Courtyard (Sector 9), and Alley (Sector 13) of Politiko-*Troullia* West. Groups of skeletal elements used to define sheep/goat and deer body portions (after Croft 2006). Head: skull, maxilla, mandible, axis and atlas vertebrae. Upper forelimb: scapula, humerus, proximal radius, complete radius, radius diaphysis, proximal ulna, ulna diaphysis. Lower forelimb: distal radius, distal ulna, carpals, metacarpal. Upper hind limb: innominate, femur, patella, proximal tibia, tibia diaphysis. Lower hind limb: distal tibia, tarsals, astragalus, metatarsal, metapodials. Phalanges: phalanges 1, 2, and 3, sesamoid.

quencies of deer bones. The spatial patterning across Politiko-*Troullia* summarized in Table 1.7.3 reveals significantly differing bone assemblages that are best interpreted in terms of modest household deposition in Politiko-*Troullia* East, substantial village refuse in Politiko-*Troullia* West exterior contexts—including the Alley—and heavy deposition, particularly of *Dama*, in open courtyards, suggestive of community feasting.

This patterning is particularly noteworthy in the Southern Courtyard where abundant deer bones are accompanied by several forms of evidence rarely found elsewhere at Politiko-*Troullia*. More specifically, the Southern Courtyard reveals the site's largest concentration of stone loom weights and highly decorated ceramic spindle whorls, as well as virtually all of Politiko-*Troullia*'s sizable collection of anthropomorphic plank-figure fragments (Falconer and Fall 2013; Falconer et al. 2014).

### *Spatial Distribution of Animal Carcasses*

Several lines of evidence illuminate patterns of butchering in the courtyards and deposition in the Alley of Politiko-*Troullia* West. Evidence of cut marks created by stone or copper tools reiterates the importance of butchering practices as they contributed to the spatial distribution of carcass portions. Cut marks characteristic of animal butchery at Politiko-*Troullia*, probably involving both stone and copper tools, underscore the utilitarian orientation of metallurgy at Politiko-*Troullia*.

The bone remains represent all portions of the skeleton for both sheep/goat and deer. The Alley bone assemblage includes more abundant remains of sheep and goat, including meat-bearing upper forelimbs, but also bone elements that suggest refuse from butchering activities, for example, cranial fragments and phalanges (Figure 1.7.5). This sheep- and goat-carcass pattern in anatomical representation is roughly repeated for deer-carcass portions, although at lower bone counts, particularly for head portions. The carcass patterns for all species reflect NISP. Elements from crania and phalanges are quite abundant but are used in Figure 1.7.5 to assess carcass-disposal patterns rather than a precise calculation of relative frequencies. The sheep- and goat-carcass distribution in the Northern Courtyard is similar, with lower bone counts due to the smaller sample size. Once again, the sheep and goat evidence reflects predominantly cranial fragments, teeth, and phalanges, with much less abundant limb bones; the remains of deer repeat this distribution at still lower counts. The larger bone assemblage of the Southern Courtyard includes the predictable abundances of sheep and goat bones, especially cranial fragments and phalanges. However, deer bones show a striking departure in which the most frequent carcass portions are meat-bearing upper forelimbs and hind limbs. In overview, the highest numbers of meat-bearing sheep and goat bones are found in the Alley, whereas the most meat-oriented deer assemblage is found in the Southern Courtyard.

### *Mortality Profiles*

Age-at-death data are based on mandibular tooth wear. The tooth-wear data of the combined sheep/goat cohort follow protocols developed by Payne (1973) and Price et al. (2013), which consider mandibular tooth rows, deciduous fourth premolars (dP4), and permanent third molars (M3). The mandibular wear-stage values for *Dama mesopotamica* are based on Bowen et al. (2016) for fallow deer mandibles.

A variety of models may be used to interpret the survivorship of sheep and goat herds according to age classes. The models range along a continuum from killing a majority of animals within the first year of life in order to maximize milk production to a model of maximized wool production in which animals typically live beyond four years. Zooarchaeologists (e.g., Payne 1973) have noted that herds in pre-urban societies were rarely kept for a single purpose and that herding goals were continually adjusted in light of environmental conditions.

Survivorship curves based on mandibular tooth wear for the combined sheep and goat herd indicate a sharp drop-off in which about 70% of the animals were killed by their third year and 90% by the fourth year (Figure 1.7.6a). This management strategy suggests a mixed animal-management strategy or a possible focus on secondary products from adult animals. The finding contrasts with husbandry strategies that seek to maximize meat yield and animals are killed prior to the end of their second year, as noted at Marki-*Alonia* (Croft 2006), an E/MC settlement several kilometers to the east of Politiko-*Troullia*.

Deer mandibular tooth-wear stages were assessed for *Dama mesopotamica*. Most of the deer mandibles represent animals that had tooth wear indicative of complete mature dentition (about 24 months), and some mandibles represent individuals that were much older. The *Dama* curve shows a more continuous decline in survivorship that indicates that most deer were living longer than sheep and goats, with no discernible pattern of age-specific culling (Figure 1.7.6b).

### *Domestic Sheep and Goat, and Wild Deer*

As expected, the sheep and goats at Politiko-*Troullia* were domesticated. In comparison with median bone measurements for selected elements from mature caprines at the Cypriot Chalcolithic site of Kissonerga-*Mosphilia* (Croft 2003), faunal remains from Politiko-*Troullia* are consistently smaller in size (Table 1.7.4), illustrating one effect of continued domestication into the BA. In contrast, minimum and maximum bone-element measurements from *Dama mesopotamica* at Politiko-*Troullia* are similar in size to those from the Cypriot Neolithic village of Parreklisha-*Shillourokambos* (Vigne 2011). This result demonstrates that *Dama mesopotamica* had not changed in size over several millennia (Table 1.7.5) and most likely continued to represent a population of wild deer.

In her 2013 dissertation on deer on Cyprus, Daujat synthesized research on deer osteometry, demographic profiles, and patterns of carcass exploitation, noting that her findings “failed to provide any evidence that the Mesopotamian fallow deer was ever domesticated on Cyprus” (Daujat 2013:45). Hunting of Mesopotamian fallow deer on Cyprus began during the Neolithic period and extended into the BA (Croft 2002). Early experiments in deer husbandry may have taken place, but on balance Croft posits that fallow deer were “free-living, hunted animals” and that “hunting of deer would have been conducted in a controlled, sustainable way within a system of game management” (Croft 2002:175). Speth (2013) considers reasons why a bone assemblage representing a large hunted animal, like fallow deer, would contain few bones from juveniles. The reasons likely do not relate to taphonomy or seasonality but rather reflect a decision by hunters to invest their time and effort in procuring adult animals that provide greater quantities of meat and fat than smaller-bodied juveniles. With Speth’s observations in mind, the Politiko-*Troullia Dama* survivorship curve suggests

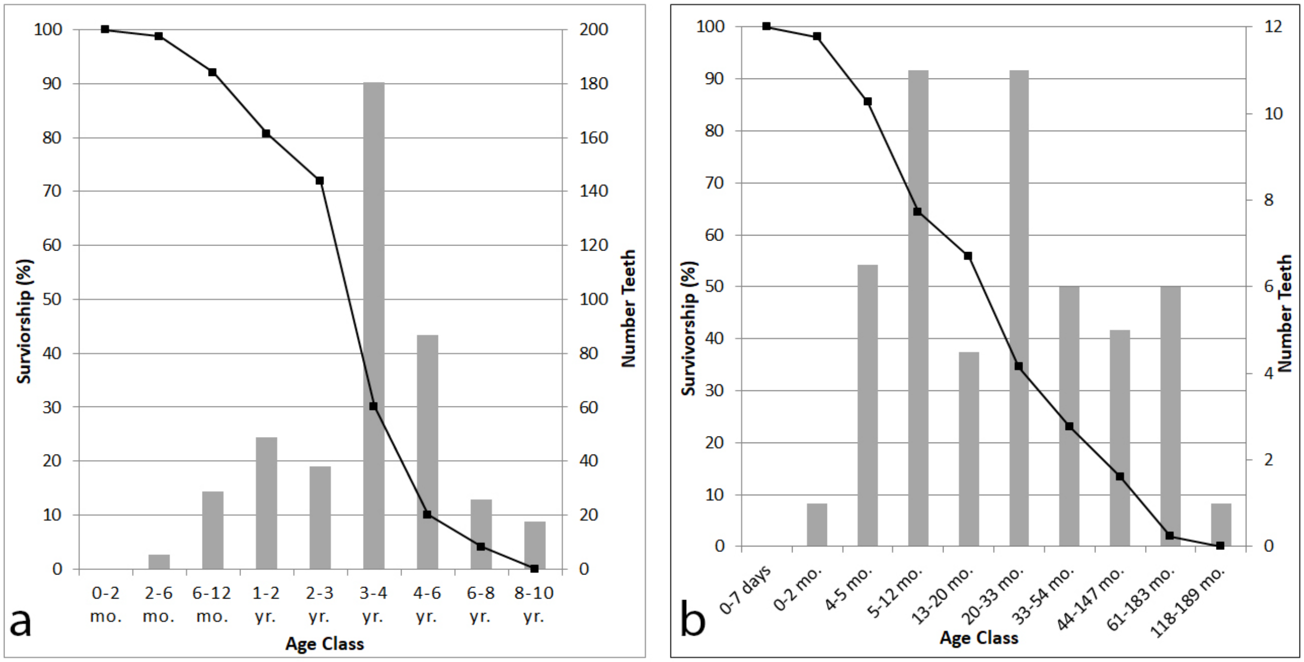

Figure 1.7.6. Survivorship curves for (a) *Ovis*/*Capra* and (b) *Dama* based on tooth eruption and wear from Sectors 8, 9, and 13 at Politiko-*Troullia* West.

Table 1.7.4. Summary statistics—median, mean, standard deviation—of measured values (in mm) for selected elements of mature caprines in Sectors 8, 9, and 13 at Politiko-*Troullia*. Median values are presented for Kissonerga-*Mosphilia* (Croft 1998) to evaluate potential changes in size of these selected elements between the Chalcolithic and the Early Bronze Age. Rad Bp = Radius proximal breadth; Mtc Bp = Metacarpal proximal breadth; Mtt Bp = Metatarsal proximal breadth; Hum Bd = Humerus breadth of distal trochlea; Scap GLP = Scapula greatest length of distal articular process; Nav–cub GB = Naviculo–cuboid greatest breadth; Tib Bd = Tibia distal breadth.

| | | **Rad Bp** | **Mtc Bp** | **Mtt Bp** | **Hm Bd** | **Scap GLP** | **Nav-cub Bp** | **Tib Bd** |
|---|---|---|---|---|---|---|---|---|
| Sector 8 | N | 4 | 13 | 10 | 6 | 3 | 3 | 9 |
| | Median | 30.35 | 23.00 | 19.25 | 29.25 | 31.30 | 26.30 | 25.40 |
| | Mean | 30.68 | 22.69 | 20.55 | 30.88 | 31.97 | 25.43 | 25.63 |
| | Std dev. | 4.91 | 1.75 | 3.37 | 4.70 | 5.63 | 3.48 | 1.89 |
| Sector 9 | N | 34 | 24 | 34 | 40 | 8 | 2 | 24 |
| | Median | 31.15 | 22.50 | 19.65 | 30.30 | 34.50 | 23.00 | 26.25 |
| | Mean | 31.90 | 22.77 | 19.88 | 30.48 | 33.86 | 23.00 | 26.64 |
| | Std dev. | 3.72 | 2.21 | 1.56 | 2.61 | 3.23 | 2.83 | 3.76 |
| Sector 13 | N | 61 | 45 | 34 | 64 | 25 | 0 | 68 |
| | Median | 30.00 | 24.20 | 20.1 | 30.15 | 30.8 | NA | 26.05 |
| | Mean | 30.51 | 23.97 | 20.68 | 30.66 | 31.78 | NA | 25.95 |
| | Std dev. | 3.35 | 2.12 | 3.28 | 3.19 | 3.88 | NA | 1.90 |
| Kissonerga | Median | 36.40 | 28.20 | 21.90 | 34.90 | 44.20 | 36.00 | 30.90 |

Table 1.7.5. *Dama mesopotamica* minimum and maximum values for selected measured elements (in mm) in Sectors 8, 9, and 13 at Politiko-*Troullia*. These values are compared to the same selected elements from Parreklisha-*Shillourokambos* (Vigne 2011), a Neolithic site, to evaluate potential changes in size over time.

| | | **Tib** | **Hum** | **Rad** | **Mtc** | **Mtt** | **Scap** | **Astrag** | | | **Ph1** | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **Bd** | **Bd** | **Bp** | **Bp** | **Bp** | **GLP** | **Bd** | **GLl** | **GLm** | **Bp** | **Bd** | **GLPe** |
| Sector 8 | N | 9 | 5 | 2 | 9 | 0 | 4 | 7 | 9 | 7 | 24 | 25 | 22 |
| | Min | 28.0 | 39.3 | 40.7 | 23.8 | NA | 42.0 | 22.5 | 28.4 | 34.5 | 12.6 | 11.0 | 36.0 |
| | Max | 37.4 | 44.8 | 41.7 | 30.0 | NA | 45.6 | 25.6 | 39.0 | 37.4 | 18.4 | 17.0 | 47.2 |
| Sector 9 | N | 15 | 20 | 15 | 16 | 2 | 10 | 9 | 8 | 10 | 56 | 56 | 53 |
| | Min | 22.5 | 37.3 | 32.6 | 26.5 | 26.6 | 40.5 | 23.2 | 35.5 | 34.9 | 12.8 | 11.8 | 36.0 |
| | Max | 36.3 | 48.5 | 44.0 | 34.4 | 27.9 | 50.5 | 26.7 | 41.7 | 40.5 | 17.8 | 15.8 | 46.1 |
| Sector 13 | N | 40 | 23 | 17 | 15 | 0 | 11 | 3 | 4 | 4 | 68 | 71 | 66 |
| | Min | 30.3 | 37.3 | 36.0 | 27.0 | NA | 37.8 | 25.7 | 38.8 | 37.0 | 13.6 | 12.0 | 37.7 |
| | Max | 40.5 | 47.7 | 46.7 | 32.0 | NA | 48.6 | 26.4 | 41.7 | 40.0 | 25.1 | 16.2 | 47.3 |
| Shillourokambos | N | 70 | 133 | 38 | 16 | 18 | 62 | 71 | 72 | 69 | 66 | 64 | 56 |
| | Min | 31.1 | 36.9 | 37.6 | 24.4 | 24.4 | 39.0 | 23.0 | 36.8 | 34.2 | 14.5 | 12.5 | 40.3 |
| | Max | 42.0 | 51.7 | 48.5 | 36.0 | 31.2 | 51.4 | 29.4 | 44.6 | 42.1 | 19.8 | 17.2 | 48.5 |

hunting of deer at a variety of ages, including adults, in keeping with hunting of wild animals, rather than management of a domesticated herd.

## Discussion

### *Feasting*

Spatial patterning of bone deposition in a variety of architecturally defined contexts provides evidence of communal feasting at Politiko-*Troullia*. Remains of sheep/goat bones and teeth, the most abundant animal taxon, occur in comparable frequencies across the settlement. In contrast, deer bones reveal distinctly different spatial patterning in which carcass-part profiles and mortality profiles suggest substantial meat consumption in open public space.

The small faunal sample from the Metallurgical Workshop in Politiko-*Troullia* East primarily reflects sheep and goat-based domestic subsistence with very little evidence of deer (see Tables 1.7.2 and 1.7.3). The sizeable assemblage from the *Troullia* West Alley (Sector 13), and a more modest assemblage from the Well (Sector 10) and exterior space (Sector 14) tends to reiterate sheep and goat exploitation on a larger scale. The comparably large Southern Courtyard assemblage (Sector 9), along with faunal remains from the Northern Courtyard (Sector 8) and other spaces associated with the courtyards (Sectors 11 and 12), features the highest densities of deer bones found in the settlement. This patterning fits well with characteristics of communal feasting deduced in a variety of other archaeological studies (Crabtree 1990; Dietler 2001:89; Steel 2002, 2004), including a distinct spatial concentration, a focal food source, and bone-element deposition indicative of consumption and disposal. The abundant bone assemblage from Politiko-*Troullia* West includes all parts of sheep, goat, and deer carcasses (Tables 1.7.4 and 1.7.5, and Figure 1.7.5). The deposition of foot bones, for example, suggests skinning and butchering were carried out in the same place. This contrasts with evidence from Late Bronze Age Kalavasos (South 2008) where foot bones are nearly absent, suggesting that skinning was a separate operation carried out in a different location from butchering, probably by a different person.

Finally, the rich faunal record at Politiko-*Troullia* contrasts with the evidence from settlements of LC urbanized society. Spigelman (2008) describes large LC sites at which the faunal assemblage is dominated by sheep and goat. At these LC sites evidence for hunting of deer is nearly absent, and cattle and pig bones occur only in very low numbers. Associated kill-off patterns suggest that sheep and goat herds were intensively managed for wool and milk (Spigelman 2008). This pattern is different from the evidence at Politiko-*Troullia* where mixed strategy sheep/goat herding (see Figure 1.7.6a) was complemented by cattle and pig husbandry and hunting of wild deer representing a wide range of ages (see Figure 1.7.6b). Ethnographically, feasting often centers on meat (e.g., Dietler 1996), involving sheep/goat and especially deer meat at Politiko-*Troullia.* Thus, diverse animal-exploitation practices at Politiko-*Troullia* may have been designed to minimize risk while simultaneously supporting feasting.

In the Southern Courtyard, the profusion of deer bones is accompanied by pronounced deposition of spindle whorls as well as distinct patterning of ground-stone implements (Falconer and Fall 2013). BA villages on Cyprus produced spindle whorls that are notable for their intricate incised, often lime-filled ornamentation (Crewe 1998:15). These whorls provided the weight necessary for a thin spindle to rotate and twist fibers into thread or yarn. The Cypriot BA also witnessed the introduction of the warp-weighted loom and the accompanying use of stone loom weights. The joint appearance of this new textile technology contributes to a working hypothesis that open spaces with looms often became focal points of community activity (Crewe 1998:37–38). Deposition of ground stone reveals complementary patterning also indicative of group behavior, in this case based on ground-stone portability ratios—calculated as the number of smaller "handstones" relative to the number of larger non-portable implements (see Brooks 1993; Byrd 1994; Frankel and Webb 2006:201; Kadowaki 2008; Webb 2000; Wright 2000). According to this measure, assemblages with low portability ratios—for example, based on relatively abundant large ground-stone implements—often reflect group workspaces. The Alley (Sector 13) generates a very high portability ratio, which reflects an abundance of discarded "handstones" consistent with household refuse disposal, while low ratios in the Metallurgical Workspace (Sector 6) and in the Southern Courtyard (Sector 9) imply focal points for situated supra-household behavior. A final line of evidence features fragments of plank figures, which are stylized ceramic anthropomorphic depictions, possibly indicative of the emergence of community identity during the Cypriot BA (a Campo 1994:100–106; Knox 2012:146–150, Figure 44; Mogelonsky 1988:32–36; Morris 1985:142–144). A substantial assemblage of fragmentary plank figures and a hallmark example of a large complete limestone plank figure found in the Southern Courtyard provide a final, compelling line of evidence for group behavior at Politiko-*Troullia* (Falconer et al. 2014). Finally, the emphasis on arboriculture could have provided another common component of feasting behavior: the conspicuous consumption of wine (Steel 2004). Thus, distinct and complementary patterning of deer bones, spindle whorls, ground-stone implements, and plank figures supports the inference of communal group behavior in the Southern Courtyard of Politiko-*Troullia* in which feasting on Mesopotamian fallow deer played a conspicuously prominent role.

## Conclusions

The animal bones in the Metallurgical Workshop and other refuse deposits at Politiko-*Troullia* reflect small-scale household consumption of mostly sheep and goats. In contrast, bones recovered from the Southern Courtyard, Northern Courtyard, and Alley reflect consumption of large quantities of sheep, goats, and particularly deer. The abundant bone assemblage from Politiko-*Troullia* West includes all parts of the animals. Both sheep/goat and deer bones include foot bones, which suggests butchering occurred at the site in or adjacent to the courtyards.

The courtyards at Politiko-*Troullia* provided space for many communal activities, including food processing (large ground-stone querns), leisure (large gaming stones), textile work (spindle whorls and loom weights), ritual (plank figurines), which were incorporated with feasting on both sheep and goat and especially deer. Whole deer carcasses were brought to the Northern and Southern Courtyards, where our evidence indicates that they were consumed communally. Thus, fallow deer would have provided a particularly important source of meat that was consumed in the open-air courtyards of the ancient village of Politiko-*Troullia* as a key element in the social dynamics of BA Cypriot agrarian communities.

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# 1.8 | Old Dentitions and Young Post-crania

## Sheep Burials in the Ptolemaic–Early Roman Animal Necropolis at Syene / Upper Egypt

Ursula R. Mutze,* Wolfgang Müller,† Mariola Hepa,* and Joris Peters‡

### Abstract

Excavations at the Ptolemaic–Early Roman animal necropolis at Syene/Aswan in Upper Egypt revealed the presence of more than 300 domestic animal skeletons. Sheep predominate in this assemblage, but dogs, cats, and cattle were ritually buried as well. Animals have been deposited in toto in shallow pits without prior mummification. Ongoing archaeozoological analysis of sheep shows some interesting patterns meriting a closer look. Methodologically the discrepancy between age estimates based on eruption and/or abrasion of teeth and the individual's epiphyseal status is of particular interest. To quantify this discrepancy, we compared recordings with those obtained from a modern population of known-age sheep: the Karakul population housed in the Julius Kühn Collection in Halle an der Saale, Germany. The rate at which tooth wear takes place in the different populations is evaluated and possible causal relationships discussed. Being essential to reconstruct demographic profiles, an approach to estimate tooth-wear rate in ancient sheep populations will be presented.

### Keywords

*Ptolemaic–Roman Egypt, animal necropolis, sheep, aging criteria, tooth wear, mandibles, dental attrition*

## Introduction

The animal necropolis of Syene was excavated between 2011 and 2015 by the joint mission of the Swiss Institute of Architectural and Archaeological Research in Cairo and the Aswan Inspectorate of the Ministry of State for Antiquities (Müller 2014; Pilgrim et al. 2012, 2015; Pilgrim and Müller 2013, 2014). It is in the ancient town of Syene—modern Aswan in Upper Egypt—and is situated in the southeastern corner of the Late Period town wall near the Temple of Isis.

Animals were buried around Building 1 (Figure 1.8.1), a structure consisting of a podium with a staircase to its north. Over time, several courtyards were added to the layout. Massive dung accumulations in these courtyards indicate that animals were not only buried but also kept in the area of the necropolis (Hepa et al. 2018). While the archaeological evidence clearly shows that there is a connection between burials and the building, the exact nature of this relationship has yet to be established. In the absence of parallels for the building in Egypt, the architectural features suggest a tentative interpretation as a small podium temple of a type known from other parts of the eastern Mediterranean in the Late Classical and Hellenistic periods (Conze and Schazmann 1911). The architectural development of the building

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Figure 1.8.1. Site plan with Building 1 and the animal burials. (Plan by W. Müller and M. Hepa, courtesy of the Swiss Institute of Architectural and Archaeological Research on Ancient Egypt in Cairo.)

and its surrounding architecture was organized into three major phases.

The necropolis was used from the first half of the second century BC until the end of the first century AD (Pilgrim et al. 2016). While the southern, eastern, and northern limits of the necropolis are defined, it continues toward the west under a modern street. The excavated area of the cemetery covers around 420 $m^2$. Approximately 320 animal burials have been excavated within this area. Numerous empty pits and dislocated bones scattered all over the site constitute evidence of a significantly higher number of original burials. Burials could be attributed to the architectural phases of Building 1. The number of burials increased over time and reached its peak in the second half of the first century AD, just before the area around Building 1 was reorganized into a domestic quarter of the town (Koch and Müller 2014).

Most of the animals were sheep, but some dogs, cats, and young cattle were buried as well. Animals were deposited in shallow pits without prior mummification. In the course of the necropolis's use, some changes in burial customs were observed. During the earliest phase of the necropolis, some pottery–mostly small bowls and plates—was found in or around the pits. During the later phases, no more pottery was deposited in graves, but the heads or bodies of the animals were covered with sherds from large vessels. Such a sheep burial is shown in Figure 1.8.2.

Figure 1.8.2. Sheep burial (skeleton 207, 14–2–61–3/1). The ram's head was covered with potshards. (Photograph by W. Müller and M. Hepa.)

## Material and Methods

### *Ancient Sheep Herd Composition*

From a total of 247 sheep burials, 197 had been analyzed archaeozoologically as of September 2018 and are included in this study. For slightly more than 50% of these it was possible to determine the sex (48 males and 57 females), while in 92 individuals sexing was problematic due to either their very young age or only partial preservation. Based on the greatest lengths (GL) of all long bones available per individual, we calculated the individual withers height by applying the factors proposed by Teichert (1975). Adult rams averaged 68.3 cm (N = 32, minimum = 60.8 cm; maximum = 77.3 cm) and ewes 63.9 cm in withers height (N = 44, minimum = 55.3 cm; maximum = 72.1 cm).

According to epiphyseal fusion age provided by Habermehl (1975), sheep from Syene could be classified into seven age classes (Table 1.8.1). From this we can conclude that nearly one-fifth of individuals died in their first year, while more than half of deposited sheep were older than four years of age.

Table 1.8.1. Age distribution in Syene sheep.

| Age | % | N |
|---|---|---|
| <3 months | 12.2 | 24 |
| 3 months–1 year | 7.6 | 15 |
| 1–2 years | 4.6 | 9 |
| 2–3 years | 5.1 | 10 |
| 3–4 years | 14.2 | 28 |
| 4–5 years | 24.9 | 49 |
| >5 years | 31.5 | 62 |

Such an age distribution indicates natural deaths rather than selective, human-controlled kill-off. In sheep older than three years of age, a sex-related difference can be observed. Among animals aged between three to five years old, ewes outnumber rams, while in the elder group–more than five years of age—males exceed females in numbers: $\chi^2$ (df = 1, N = 90) = 12.321; $p$ = 0.00045. Since the epiphyses of ewes are known to fuse slightly earlier than those of rams (Davis 2000), this bias may have been even more pronounced since, compared to rams, the ages of ewes tend to be underestimated. Ewes' higher mortality, early in adulthood, might be explained by causes of death associated with reproduction, such as birthing complications, mastitis, nutritional deficiencies, or similar.

### *Dental versus Epiphyseal Aging*

During archaeozoological examination, dental wear stages were recorded following the scoring system proposed by Payne (1973, 1987). Payne's stages can be allocated to four broad stages:

(1) Eruption
(2) Early wear stages (1A to 8A for $M_1$ and $M_2$, 1A to 10G in $M_3$)
(3) Long-lasting mature wear stage (9A for $M_1$ and $M_2$, 11G for $M_3$)
(4) Gradual wearing away of the base of the infundibula (>9A for $M_1$, $M_2$, >11G for $M_3$)

Epiphyseal fusion of long bones and vertebrae was documented as well. However, Syene's sheep demographic profiles produced with the two methods yielded consistently different results. Age estimates based on dentition indicated much older individuals than age estimates based on bone epiphyseal fusion. This discrepancy can be explained either by accelerated tooth wear or delayed bone epiphyseal fusion. For several reasons, the former is a more likely explanation. Popkin et al. (2012), for instance, noted a maximum delay of 12 months in the fusion of late fusing bone epiphyses due to poor nutrition. In Syene's sheep, however, we observed discrepancies of up to five years of age, which cannot be explained by delayed bone epiphyseal fusion only. There are additional arguments pointing to tooth wear as the main reason for the observed discrepancy. Understandably, food intake has a major effect on tooth wear (Healy and Ludwig 1965; Grant 1978), and nutrition in sheep in southern Egypt might not be comparable to that of Europe or Southwest Asia. Moreover, in Syene's faunal assemblage extreme tooth wear is not only restricted to sheep but has also been noted for dogs. Their upper and lower dentitions are extremely worn with extensive exposure of dentine and even antemortem tooth loss. The problem is also well known in humans. In his article on dental problems in human skeletons and mummies from the Old Kingdom, Filce Leek (1984) states that "almost every dentition from early childhood onwards" shows heavy wear of the teeth (Filce Leek 1984:125). He offers several explanations for this phenomenon, although not all of them apply to our material, like the intentional adding of sand prior to grinding cereals. He also mentions what we noted during fieldwork, namely that "anyone who has experienced eating food on a windswept desert will not be surprised that mineral particles become incorporated in their food" (Filce Leek 1984:125). Naturally, this observation also applies to animals. Grant (1982) gives combinations of molar stages in sheep and goat mandibles from nine archaeological sites in the United Kingdom. Combinations with advanced wear on $M_1$ are on the right-hand side and those with more advanced wear on $M_3$ on the left-hand side of Table 3 in that publication. The combinations found in Syene's assemblage—if indicated in the table at all—appear in the middle to right-hand side, which indicates a faster abrasion as well. A comparison with the stage combinations of $M_1$ and $M_3$ observed by Jones (2006) also showed that in Syene $M_1$ wear was comparably more advanced, indicating a faster abrasion.

If we accept that accelerated tooth wear among sheep from Syene is the main reason for the discrepancy observed between dental and bone epiphyseal ages, then it must be acknowledged that tooth wear depends on several parameters. Besides nutrition, which is of central importance (Healy and Ludwig 1965), an animal's sex and, in males, castration have some influence as well (Behr 1928, Davis 2000). For example, according to Davis (2000), teeth wear more slowly in ewes than in rams or wethers. However, since in Syene's assemblage the discrepancy concerns all sheep independent of their sex, this explanation seems unlikely.

This leaves us with nutrition as the primary cause for the condition observed, necessitating a closer look at how it affects tooth wear. In agricultural and archaeozoological literature, two main factors are considered responsible: ingested soil and hard-plant components like ligneous fibers and phytoliths. Healy and Ludwig (1965) observed that the quantity, rather than quality, of ingested soil was the primary factor influencing incisor wear. Deniz and Payne (1982) noted differences in wear rate between incisors and cheek teeth. More specifically, abrasion in incisors is higher because the main wear occurs during grazing activity, while cheek teeth are mostly used to comminute contents of the rumen, which might already contain a reduced portion of soil. The same authors suggested that phytoliths are the main agent of wear in cheek teeth.

In sheep mandibles excavated at Syene, incisors were missing in almost all cases and only cheek teeth could be recorded. Although Baker et al.

(1959) found phytoliths to be harder than enamel, later studies could not confirm these results. Lucas and others (2014), in contrast, conclude from their measurements that phytoliths are unlikely to wear enamel because of their insufficient hardness. They "propose the hypothesis, that phytoliths, whilst not being the actual agents of wear, are instead deployed to mimic dust and grit during the mastication of plant tissue by animals, causing them to reduce or avoid consumption and therefore providing wear protection by deception." (Lucas et al. 2014:150). By comparing different ungulate species, Damuth and Janis (2011) found a positive correlation between a grazing diet and the degree of hypsodonty, that is, high-crowned dentition. In addition, they also found higher degrees of hypsodonty in browsing ungulates that browse closer to the ground, compared to those browsing higher. Based on these observations, they conclude that dust and grit, rather than phytoliths, are likely to be the most important agents of tooth wear in ungulates and that they are mostly attached to plants close to the ground, such as grass. Sanson and others (2017) also question the role of phytoliths in tooth wear because they found profoundly different phytolith intakes in African buffalo with no observable differences in tooth wear. Since phytoliths can hardly explain the pronounced abrasion observed in dogs' teeth at the animal necropolis of Syene, dust and grit remain the most likely agents of significant wear in sheep teeth at this site. The thickness of dung layers in the courtyards associated with the necropolis, as well as the incidence of intra-articular pathologies (Mutze et al. in press; Mutze 2021) indicate that sheep were kept under crowded conditions, probably not only at night. It seems therefore likely that they were fed inside enclosures regularly. Possibly originating from some distance, the provided fodder may have contained dust and soil particles. We will return to this point later.

The unexpectedly high tooth-wear rate in the Syene sheep represents an interesting methodological challenge to work on demographic profiles. Established methods of dental aging either give relative ages (Grant 1975, 1982) or assume a specific value for the rate of tooth wear (Deniz and Payne 1979, 1982; Jones 2006; Payne 1973) to obtain absolute ages. The findings at Syene show that applying Payne's age estimates method (1973) will produce misleading results because the rate of tooth wear in Syene's sheep diverges so much from Payne's source data. The same is true for age estimates proposed by Jones (2006). Of course, when studying complete skeletons, this can be easily recognized, since epiphyseal fusion can be used for aging as well. However, archaeozoologists usually deal with isolated bone specimens from settlement refuse. In such cases, analysis of dental wear data can only produce reliable results when the tooth wear rate is correctly estimated.

It is therefore essential to develop a method allowing researchers to estimate the rate of tooth wear in mandibular tooth rows from archaeological sheep. The underlying assumption is that due to their successive eruption—a process considered to be genetically determined (Zeder 2006)—the consecutive molars ($M_1$–$M_3$) will pass through similar wear stages at different moments during the animal's life. However, the higher the intensity of tooth abrasion, the shorter the duration of each of these wear stages. To determine the rate of abrasion, an approach is needed that interrelates the degree of wear for each molar in a tooth row. To pursue this idea, we compared the intramandibular molar wear observed in sheep from Syene with those from an early twentieth century AD sheep population raised in captivity. To this purpose, we analyzed Karakul sheep skeletons housed at the Julius Kühn Collection in Halle an der Saale, Germany. The Karakul is a fat-tailed breed exploited mainly for lambskins. The breed probably originated in the region of Bukhara in present-day Uzbekistan. The flock in Halle's "Haustiergarten" was based on eighty-one Karakul sheep, imported from Bukhara between 1903 and 1928 (Frölich and Hornitschek 1954). In fact, some more rams were imported that left progeny in Halle, but these were soon passed on to other institutions. In the "Haustiergarten," Karakuls were kept in consistent conditions (Frölich 1928) and the dates of birth and death were accurately documented. Considering feeding conditions at Halle, it can be assumed that the Karakul sheep experienced moderate tooth wear. Ages determined according to Payne (1973, 1987) and Jones (2006) match the documented ages of the animals quite well, which confirms this assumption. This population is therefore perfectly suitable as reference material.

## Results and Discussion

First, an attempt was made to examine intramandibular molar wear applying the indices proposed by Ducos (2000) for the first and the third lower molars.

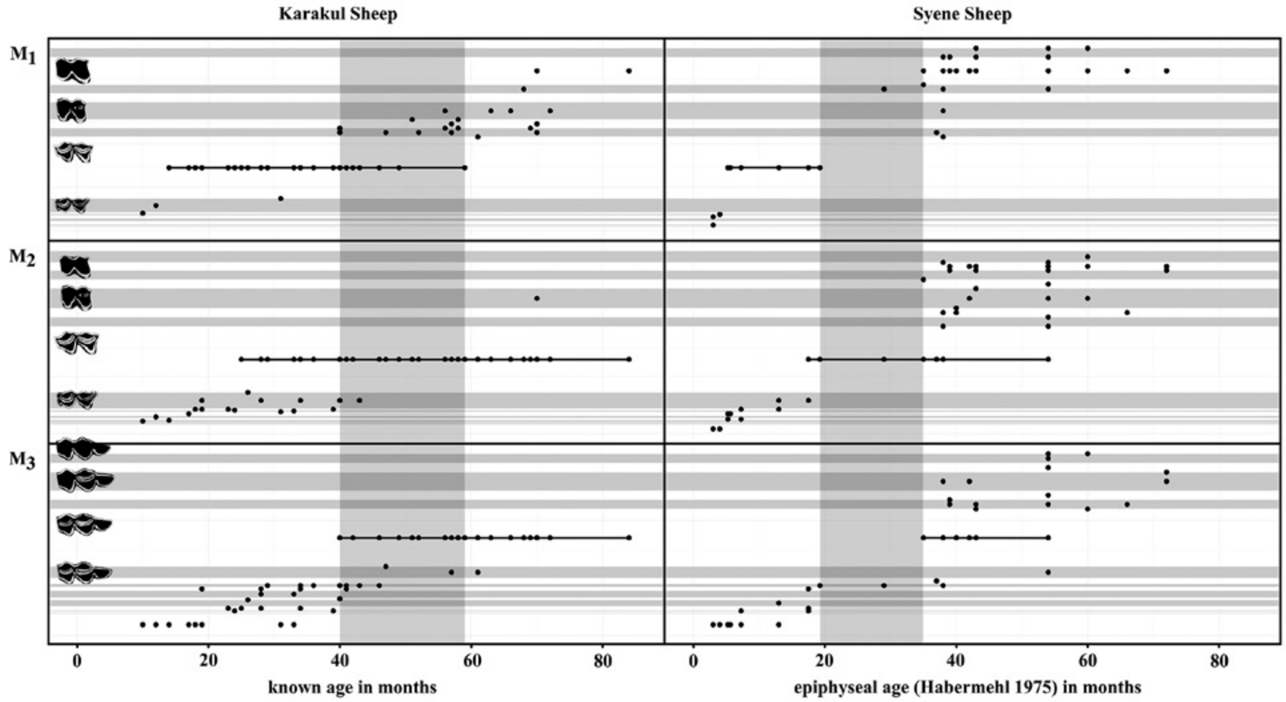

Figure 1.8.3. Wear stages of the three lower molars against age for the Karakul sheep and Syene's sheep.

This approach failed for several reasons. Firstly, the method requires animals old enough to have their $M_3$ fully formed. It turned out that this is only the case after the tooth has already passed several wear stages (Twiss 2008). Although this is not a problem for Syene's sheep, it becomes a problem when dealing with settlement refuse, since many sheep are slaughtered before reaching this age. Secondly, when the $M_3$ is measurable, the $M_1$ is almost worn down, even in populations with slow rates of abrasion. We, therefore, modified our approach by comparing $M_1$ with $M_2$ and $M_2$ with $M_3$. Unfortunately, the differences were small even in populations with very different tooth wear rates. Thirdly, another major obstacle when applying Ducos's method is that it requires breaking mandibles to access individual teeth. Complete mandibles are scientifically valuable specimens and their future potential should not be compromised to measure individual teeth.

For these reasons we decided to abandon that approach and shifted to quantifying patterns of intramandibular tooth abrasion with the aid of wear stages published by Payne (1973). In Figure 1.8.3, the horizontal gray and white bars symbolize the consecutive wear stages, whereby broad bars correspond to longer and narrow bars to shorter time intervals. Here, the assumption is made that the tooth structure, and particularly the relative depth of the infundibula within the crown, is similar in all sheep, regardless of breed, sex, or other differences. Since it is determined by the tooth's inner structure, the duration of each wear stage in relation to the others is also considered equal in all sheep. The graphical representation of these relationships in Figure 1.8.3 is based on an extensive study undertaken by Jones (2006). For all molars, the stages with long-lasting wear—$M_1$ and $M_2$: 9A; $M_3$: 11G (following the Reference Codes proposed by Payne 1987)—are highlighted by a black line. The diagram illustrating molar wear in the Karakul population shows that at an estimated age of 40 to 60 months, the long-lasting wear stages in all three molars temporally overlap—left vertical gray bar. During this phase, the occlusal surfaces of all three molars can exhibit the classic selenodont—crescent-shaped—cusp pattern typical in ruminants. Conversely, in Syene's sheep, such overlapping was absent (Figure 1.8.3). Indeed, by the time $M_3$ is fully functional with all three lobes in use and completed selenodont cusps in the first two lobes, $M_1$ had already passed the mature-wear stage 9A. This situation explains the gap between the corresponding wear stages of $M_1$ and $M_3$, indicated

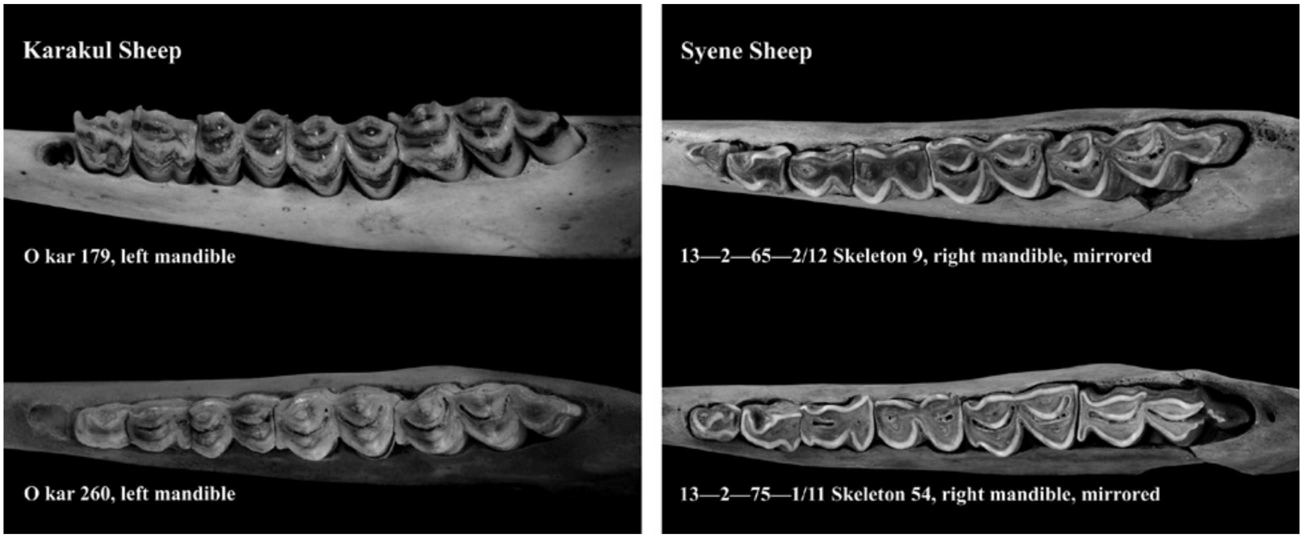

Figure 1.8.4. Example specimens from the Julius Kühn Collection in Halle on the left side and from the animal necropolis of Syene on the right side. The mandibles show the conditions illustrated in Figure 1.8.3—gray bars. (Photographs by U. Mutze.)

by the right vertical gray bar. Figure 1.8.4 presents examples of mandibles from Karakul and Syene's sheep, illustrating the differences in the rate of intramandibular molar wear.

Based on these results, we can conclude that by combining wear stages of the three molars, patterns of intramandibular molar wear can be generated allowing us to estimate the rate of molar abrasion. Thus, presence or absence of specific combinations of wear stages in an assemblage of sheep mandibles can be used for estimating the rate of tooth wear. We modeled this for two fictitious populations: one with lower rates of abrasion and one with higher rates of abrasion (Figure 1.8.5), whereby upon an animal's death ( = d), the lifetime of a lower molar is the sum of the period before eruption (= e) plus the time (= w) elapsing while passing through the consecutive wear stages until the death of the animal. Although animal's sex as well as castration and nutrition may affect the timing of (pre-)molar eruption, Worley et al. (2016) could not find any significant difference between ewes, rams, and castrates or between high and low levels of nutrition. Hence, it can be reasonably assumed that the timing of tooth eruption in sheep is genetically determined within comparably narrow limits. Most authors propose an age of three months for the eruption of $M_1$ (Elbers 1926; Habermehl 1975; Jones 2006; for improved breeds, see Silver 1969). For $M_2$, eruption dates vary from nine months (Habermehl 1975; Miller and Robertson 1959) up to twelve months (Elbers 1926; Silver 1969 for improved breeds; Getty 1975). Jones (2006) recorded that $M_2$ was erupted in less than half of the 9-months-old sheep and more than half of the 10-months-of-age individuals, which matches well the results of the above-mentioned studies. Eruption of $M_3$ was found to be more variable. Early eruption occurs at the age of 18 months (Habermehl 1975), but in late maturing breeds eruption may vary between 19 and 30 months (Elbers 1926). Similar times are given by Jones (2006) with $M_3$ eruption spread from 18 to 27 months. Much later eruption dates are provided by Silver (1969) for sheep defined as "semi-wild hill sheep", but these derive from a source dated from 1790. Because those results have not been confirmed by later studies, these values have been omitted from further consideration. Even though variability of eruption in $M_3$ is higher than in $M_1$ and $M_2$, passage through the consecutive wear stages is even more variable. Compared with tooth wear, tooth eruption can therefore be considered constant.

Returning to our model, Figure 1.8.5 shows the wear conditions in a population with a lower (a) and one with a higher (b) rate of tooth wear. The timing of tooth eruption is considered the same in the two populations. However, the time intervals corresponding to the consecutive wear stages are shorter in the population with higher wear, and correspondingly the overall duration of the process ( = w) is shorter. One major premise in the proposed model

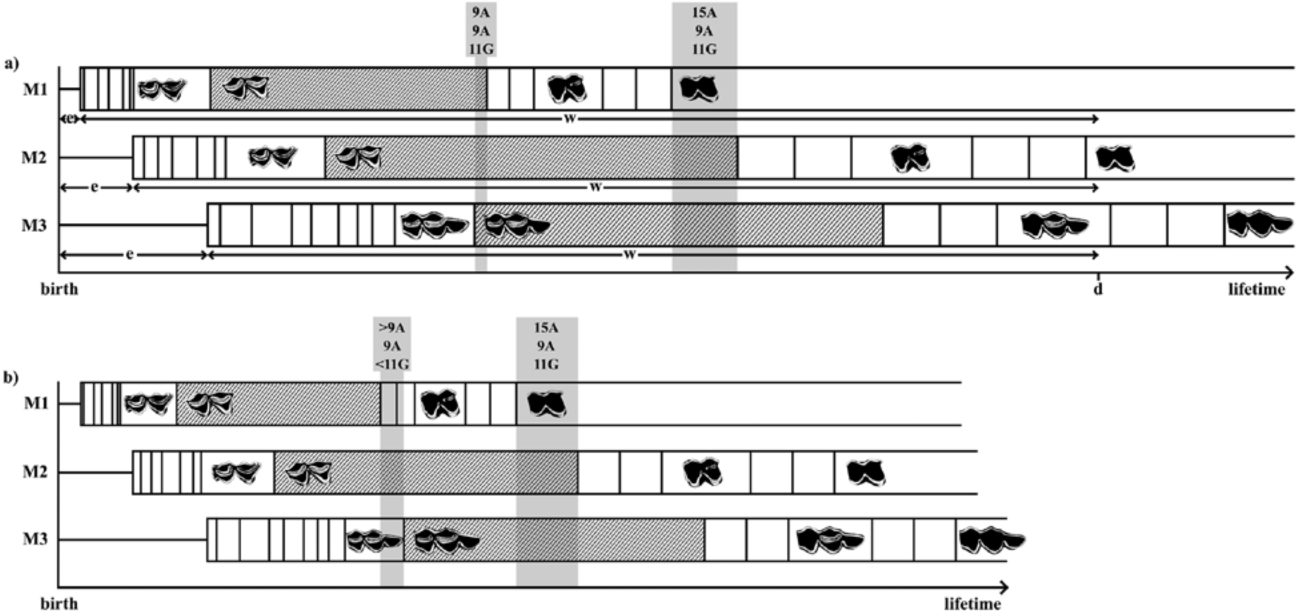

Figure 1.8.5. Model of wear conditions in a fictitious population with lower rates of wear (a) and one with higher rates of wear (b). Eruption times (= e) are the same in the two populations, but the overall lifetime of a molar in a mandible (= w) is significantly shortened in the population with a higher tooth wear rate (b).

is that, independent of the wear rate, the relative duration of each wear stage remained the same compared to either the preceding or succeeding stage(s) (cf. Jones 2006), since the tooth's inner structure primarily determines it. Moreover, we assume that abrasion affects all three molars similarly, implying that if the M$_1$ wear rate increases by a factor of two, the same is also true for M$_2$ and M$_3$.

Figure 1.8.5 helps to visualize and explain the differences noted between Karakul and Syene sheep (Figure 1.8.3). Any variation in tooth wear will cause wear stages to shift between the three molars. Consequently, certain combinations of wear stages will be characteristic for populations exhibiting low rates of tooth wear, such as combination "9A 9A 11G" in Figure 1.8.5a and in Karakul sheep. Other combinations will be indicative of distinctly more pronounced tooth wear as combination ">9A 9A <11G" in Figure 1.8.5b and in Syene's sheep. Other combinations can be seen in both Figures 1.8.5a and b, which means they reflect fairly wide ranges of tooth wear—like "15A 9A 11G." Thus, if in an archaeological assemblage a sufficient number of observations of comprehensive combinations is available, accommodating all observations in a single pattern can be attempted in order to estimate a population's average tooth wear rate.

In sum, analysis of intramandibular molar wear illustrates that the sheep population of Ptolemaic–Roman Syene was kept in peculiar living conditions. The latter obviously caused significantly higher rates of wear in M$_1$–M$_3$ compared to an early twentieth-century AD sheep population kept in Central Europe. This observation limits previous assertions about a general high correlation between estimated and absolute ages made for example by Greenfield and Arnold (2008). Nutrition being particularly relevant in this respect, we refer to Healy and Ludwig (1965), who consider the quantity rather than the quality of ingested soil the most relevant factor. Since we assume that at least a part of the fodder was provisioned (p. 133), it may have been contaminated with sand and dust during its transportation and, once deposited inside the enclosures, contaminated further by trampling or pulling of food. It is, therefore, possible that the unexpectedly high abrasion of cheek teeth is related to the on-site environmental conditions. With the method presented here and currently being developed further, it will be possible to determine tooth wear rate in archaeological sheep mandibles from other sites along the Nile Valley, in order to detect the extent of this phenomenon.

## Conclusions and Prospects

Comparative analysis of dental profiles in early twentieth-century AD Karakul sheep and the sheep mandibles from the animal necropolis at Syene revealed differences in intramandibular molar wear. The intake of sand and dust particles during feeding is the most likely reason for the fast abrasion of dentitions in the latter population.

To develop a model for molar wear in sheep mandibles, the following premises are essential:

(1) Compared with tooth wear, the eruption times of cheek teeth vary only little and can, therefore, be considered constant.
(2) Ratios between time intervals assigned to wear stages in a molar depend on the species-specific inner structure of the tooth and are therefore considered constant as well.
(3) Accelerated or decelerated tooth wear affects all molars of a mandible to the same degree.

The resultant model (Figure 1.8.5) shows that variations in tooth wear cause a shift of wear stages in the three molars. Some combinations, such as those observed in the sample of Karakul sheep, reflect moderate wear, while others are indicative of intense wear, such as in the case of Syene's sheep.

Our goal is to produce a method that allows quantification of tooth wear rate using a computer program. This method will be based on the results and approaches presented here. A preliminary version of the program is currently being tested with different known-age populations. The use of a computer allows the calculation of all ages simultaneously by applying the determined tooth wear rate. Finally, the program will be made available as a script in the free computer language R together with documentation. Using it will not require programming knowledge.

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# 1.9 | Osseous Artifacts from the Late Iron Age Site of Kale–Krševica (Southern Serbia)

## Seasons 2013–2016

Selena Vitezović* and Ivan Vranić*

### Abstract

The bone industry from the Iron Age of southeast Europe is still insufficiently explored. This paper presents some preliminary results on the osseous artifacts from the Late Iron Age site of Kale–Krševica, situated in the vicinity of the town of Vranje in southeastern Serbia. Systematic archaeological excavations revealed settlement remains, including fascinating architectural features, as well as rich portable material strongly reminiscent of settlements from ancient Macedonia and northern Greece. Excavations and finds analyses are still ongoing. In this paper, we present the osseous artifacts from seasons 2013–2016. Raw materials include bones, antlers, teeth, and mollusk shells. The typological repertoire includes some common, widespread artifact types, such as awls and needles, but also modified astragali, a few ornamental items, and similar items. Manufacturing debris was also noted, including sheep horncores with traces of cutting, suggesting that the keratinous horns were also used. In this paper we discuss raw material choices, aspects of production, the typological repertoire, and the place of the osseous industries from Kale–Krševica within the wider geographical and cultural context.

### Keywords

*Late Iron Age, Kale–Krševica, southern Serbia, Mediterranean influences, osseous industry, osseous technology, manufacturing techniques, modified astragali, mollusk ornaments*

## Introduction: Archaeological Background

The site of Kale is situated deep in the Balkan hinterlands, in the village of Krševica in the vicinity of the town of Vranje, southeastern Serbia (Popović 2006, 2012; Figure 1.9.1). This fortified Iron Age (IA) settlement was located on a dominant hill next to a small stream, the Krševička *reka*—that is, river. After small-scale initial excavations in 1966, systematic research at Kale–Krševica began in 2001 and is still in progress. The settlement covered an area of about five hectares and about six percent of the settlement has been revealed to date. The excavations unearthed structures built in accordance with Late Classical and Early Hellenistic Greek architectural technology—that is, ashlar and mud-brick ramparts, a barrel-vaulted water reservoir, and other finds with Greek-like characteristics The architecture indicates an important, yet unnamed, settlement dating from the beginning of the fourth until the first half of the third century BC. The communities that inhabited this settlement had strong yet not sufficiently comprehended social, cultural, and economic connections with the Mediterranean world (Popović 2006, 2008, 2012; Popović and Vranić 2013; Vranić 2012, 2014a, 2014b, 2018).

The site consisted of an acropolis located on the plateau with several building horizons. The last phase consists of a complex of public buildings and domestic dwellings surrounded by fortifications and a deep, wide trench oriented toward the mountain Rujen. After a detailed field survey, small-scale excavations, and geophysical testing, it was concluded that the major part of the settlement was in fact

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situated on the slopes and at the foot of the hill descending toward the river (Popović 2005, 2006). Hence, the largest area was investigated at the foot of the site, about 1,100 m$^2$, where a large fortified complex was discovered, with buildings, walls, many post holes—which once held posts to support horizontal wooden beams—as well as domed ovens. The most prominent structure here is a subterranean barrel-vaulted water reservoir built in accordance with the Early Hellenistic period architectural technology related to Macedonian royal burial chambers (Vranić 2019).

During the excavations, numerous finds were recovered that shed some light on the organization and way of life in Krševica, allowing for some detailed insights into the complexity of Late IA cultural dynamics and interrelations. A large proportion of the material consists of locally produced wheel-made Gray Hellenized ceramic vessels, in addition to numerous imports of Attic Red Figure and Early West Slope ware, followed by a kind of painted pottery ascribed to North Aegean workshops. Numerous amphorae were also imported, mainly originating from Thasos, Mende, Chios, and other wine-producing centers (Krstić 2005; Popović 2005, 2006). The major part of the repertoire, however, consists of various forms of locally produced tableware, cooking, and storage vessels (Vranić 2009).

The metal finds are less frequent, and exist mainly in the form of various pieces of jewelry, such as hinged and Thracian fibulae, and similar items (Popović 2007a), as well as tools, parts of bronze vessels, iron clamps, nails, small knives, and similar items (Popović 2017). Besides a few spearheads, weaponry was not found at the site. Numismatic finds are represented by a dozen pieces spanning from Phillip II, silver drachms of Alexander the Great, to a silver piece of Pelagia (Popović 2007b). Also, one early Damastion tetradrachm and one of the Paeonian rulers, Audoleont, were found in the vicinity of the site (Mitrović and Popović 2009).

A large number of weights (about 3,000), recovered from various parts of the settlement, indicates intensive weaving activity (Popović and Vranić 2006). The presence of the necessary resource—wool—is testified by the zooarchaeological analysis that confirmed the relatively high percentage of sheep (*Ovis* comprised about 36% of the assemblage; Blažić 2005:273–275).

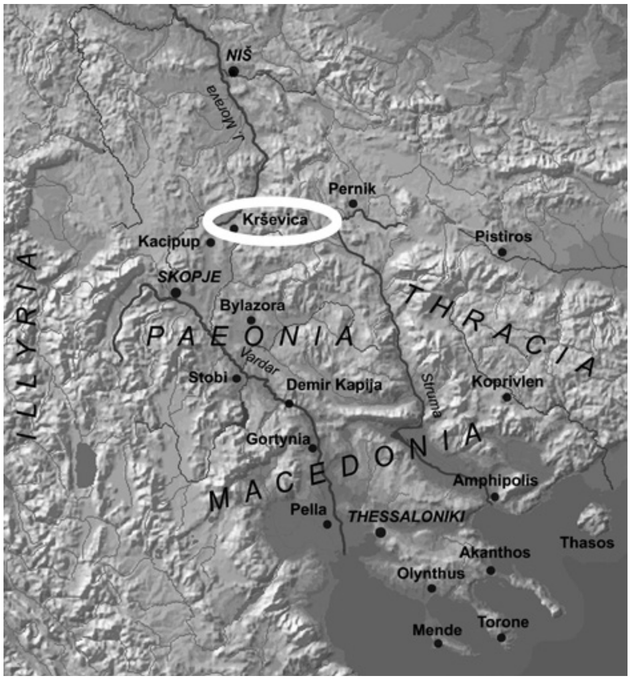

Figure 1.9.1 Map showing the position of the Kale–Krševica site and several roughly contemporary sites in the region. (Map after Popović and Vranić 2013.)

The preliminary results of faunal analysis revealed a predominance of domestic fauna, about 90%, with Bovidae being the best represented (40–53% in different features). Also, domestic pigs were noted, as well as a few elements of domestic dog and bones of equids—*Equus caballus* and *Equus asinus*. Wild fauna accounted for only 10% of the collection, mainly red deer and wild boar, and just a few bones from bear, roe deer, wolf, and others (Blažić 2005).

## Materials

### *Bone Artifacts*

Apart from other portable finds, the site of Kale–Krševica also yielded artifacts made from osseous raw materials—bone, antler, teeth, and mollusk shells (Vitezović and Vranić 2017). Both finished and used objects were discovered in addition to manufacture debris. The analysis is still ongoing, and at present only the results from the seasons 2013–2016, encompassing almost 50 artifacts, are available. These artifacts were recovered from the acropolis area of the settlement and belong to the phases dating from the last decades of the fourth and the beginning of the third centuries BC.

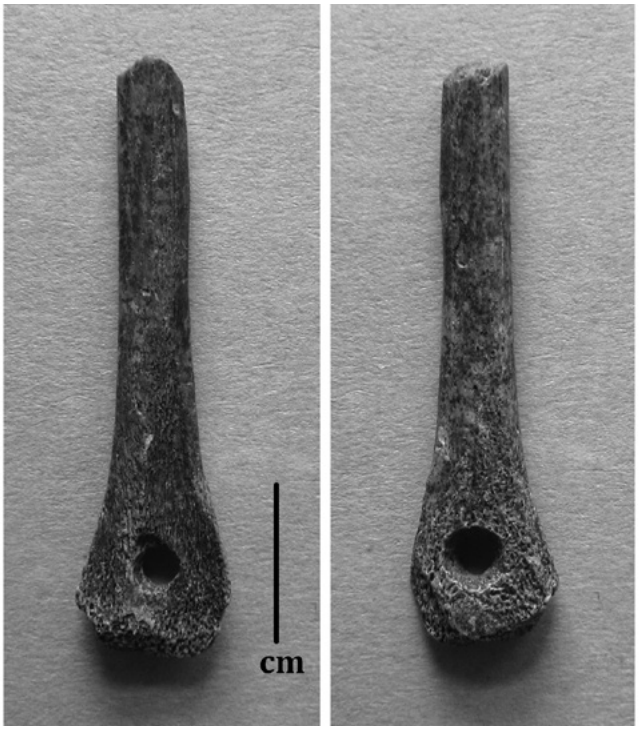

Figure 1.9.2. Pointed tool—needle—with perforation, from a pig fibula. (Photograph S. Vitezović.)

Besides finished, easily recognizable artifacts, and identified as such during the excavations, the entire faunal assemblage was also double-checked for pieces with less prominent marks of modification. Traces of manufacture and use wear were interpreted following established methodology (Semenov 1976) and experimental results (e.g., Campana 1989; Christidou 1999, 2008; Cristiani and Alhaique 2005; Legrand and Sidéra 2006; Maigrot 2003). Thus far, these objects have only been examined with low magnification (10–20x), with detailed microscopic studies yet to ensue.

The typological repertoire is not very diverse; therefore, the elaborated classification is still incomplete. For the time being, artifacts were grouped following the widely accepted typological classification for prehistoric artifacts, based on the work of H. Camps-Fabrer (1966, 1979; see also Vitezović 2016 and references therein), with some modifications.

### *Raw Materials*

The most common raw material is bone: mainly from long bones and astragali, followed by other bones, from sheep/goats, cattle, red deer, and occasionally pigs. Red deer antlers were also used. Teeth and mollusk shells occur in small numbers. In addition, the presence of horncores from horns of both sheep/goats and cattle with *débitage* traces should be mentioned, suggesting keratinous horns were used as well.

## Results: Techno-Typological Repertoire

### *Group of Pointed Tools*

Pointed tools are not very numerous; they consist of a small number of fine- and medium-sized pointed tools—that is, needles and awls. They were made from long bones, mainly long bones from small ungulates, such as metapodials or ulnae. Some of them have a fine perforation at the base, usually made with a metal perforator.

Especially noteworthy is a fragmented needle made from the fibula of a young domestic pig. Its proximal epiphysis was used as the basal part, the medial portion was minimally modified, and the distal end is missing. It has a fine perforation at the base—only 2 mm in diameter—and polish from use is observable, although is not very well preserved. Such a fine needle could have been used in textile production (Figure 1.9.2).

### *Groups of Objects with Special Use*

Several astragali with traces of manufacture and/or use were discovered, exclusively from even-toed ungulates—sheep/goats, cattle, red and roe deer. Modified and used astragali are known in numerous prehistoric communities, since the Neolithic and in historical periods, especially in Greek and Roman Antiquity (e.g., Armandry 1984; Bozbay 2012 and references therein, 2013; Carè 2013; De Grossi Mazzorin and Minniti 2013; Poplin 1984). They are often interpreted as dice used for gaming and/or oracles, following analogies with Classical Antiquity and the ethnographic record (see Bozbay 2012, 2013; Sidéra and Vornicu 2016 and references therein), although it has previously been suggested that they could have had different purposes (Carè 2013), including being related to textile manufacturing activities (Rísquez and García Luque 2007, cited in De Grossi Mazzorin and Minniti 2013:378). However, the only thing these objects have in common is the skeletal element, and to a certain extent the form, dictated by the natural morphology of the bone, but they dis-

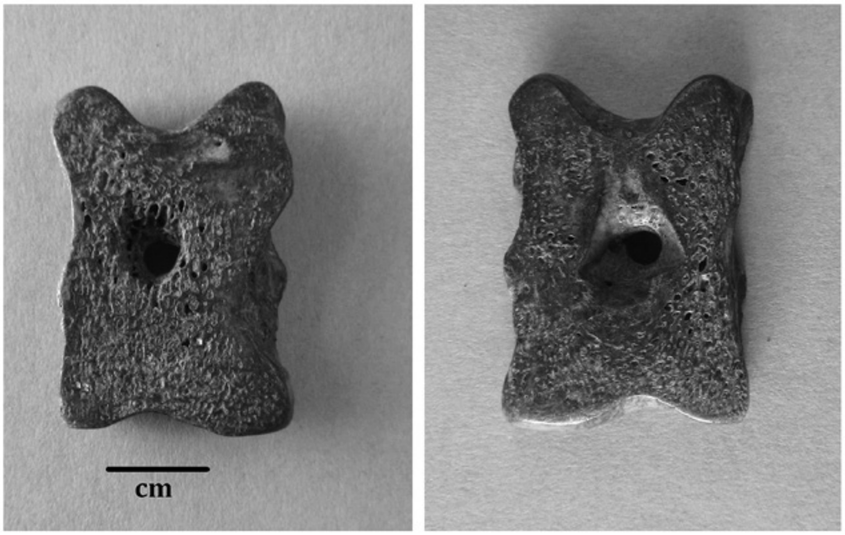

Figure 1.9.3 Ground, small ungulate astragalus with perforation in the center. (Photograph S. Vitezović.)

play a variety of modifications and use-wear traces, which clearly show that these artefacts were used for very different purposes. However, they display a variety of modifications and use-wear traces, which clearly show that these artifacts were used for very different purposes. Modified astragali differ not only in time and space, but they can also display diverse traces within a single site (e.g., Carè 2013).

In the case of Kale–Krševica, we distinguished several subtypes according to morphological and use-wear criteria.

The first subtype is astragali that were heavily modified by grinding and burnishing. They were then transformed into rectangular and completely flat objects. They come from both small and large even-toed ungulates. Their surfaces display traces of modification: they were probably abraded with a (metal) rasp, but the exposed spongy tissue was also compressed, polished, and worn from use. Some of them have perforations placed in their center. One such astragalus, from a small ungulate—most likely sheep or goat—is only 5–6 mm thick (Figure 1.9.3). Fine parallel lines and shallow grooves, perpendicular to the bone, can be noticed. These are traces of grinding done in order to make the object thinner and flat. These traces are most visible at the ends, while the medial portions on both surfaces—ventral and dorsal—are heavily worn and polished, with intensive shine; the spongy tissue is barely recognizable. This astragalus presents a slightly worn perforation of 3 mm in diameter at its center. These astragali probably served as some kind of burnishers or polishers on soft, organic materials, such as leather hides or plant fibers (Legrand 2007; Peltier 1986; Semenov 1976).

The second subtype is astragali with traces of use located only on their condyles. They often have a centrally positioned perforation. Within the analyzed contexts, astragali from small even-toed ungulates predominate, but the ratio may change once the remaining material is examined. The extent and intensity of use wear is not even; some have minimal traces on their condyles, while on others a significant volume loss can be observed. These astragali were perhaps used as loom weights or for some tasks connected with fiber processing. Experiments with astragali as loom weights have previously been successfully attempted (Grabundžija et al. 2016). However, still more experiments are needed to establish with certainty what type of use wear results from their use in textile activities.

The third subtype is astragali from large even-toed ungulates with deep holes that are differently positioned. One *Bos* astragalus in particular should be mentioned (Figure 1.9.4). It has one perforation in one of the condyles—more or less perpendicular to the bone axis—and two deep holes: one ventral and the other on the dorsal side. The holes are circular and up to 1.2 cm in diameter. One of the holes shows changes in color: inside are well-preserved traces of some black substance, most likely residues of material with which they were once filled. These astragali could have been gaming pieces, but they could as well have been used as weights for careful measurements.

Figure 1.9.4 Modified *Bos* astragalus with perforation and holes. (Photograph S. Vitezović.)

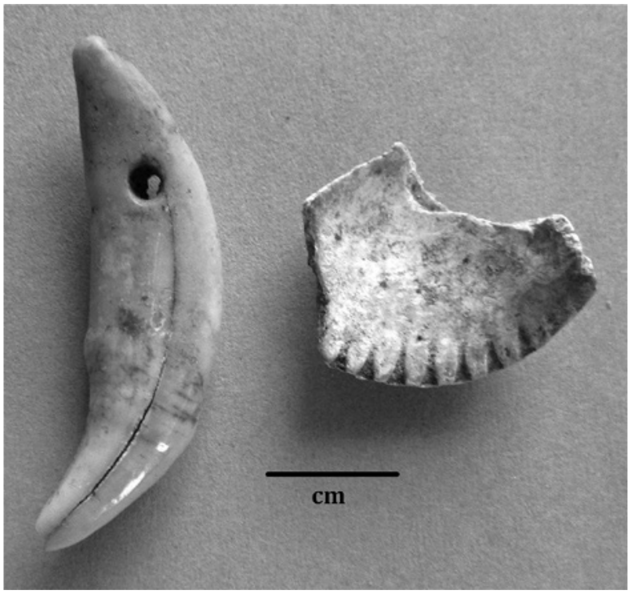

Figure 1.9.5 Decorative items: left, pierced tooth, probably used as a pendant; right, fragment of a *Cardium* shell, probably a fragment of an appliqué or pendant. (Photograph S. Vitezović.)

As mentioned above, differently modified astragali are found in large numbers throughout the Mediterranean. Heavily abraded astragali are encountered, for example, at the sites of Lapis Nigra, Varranone–Poggio Picenze, Populonia, and many more (see De Grossi Mazzorin and Minniti 2013). A particularly rich set of astragali was discovered at the site of Locri Epizefiri, a Hellenistic necropolis in southern Italy, partially contemporary with our site (Carè 2013 and references therein).

Astragali similar to the examples from Kale–Krševica are noted, among others, at sites such as Lapis Nigra and Locri Epizefiri (Carè 2013; De Grossi Mazzorin and Minniti 2013). These astragali were heavily abraded and flattened on both or just one side (ventral or dorsal). Some presenting perforation in their center are frequent at both of these sites (Carè 2013:Figure 4; De Grossi Mazzorin and Minniti 2013). Finds from Locri Epizefiri also include astragali filled with lead (Carè 2013).

Astragali discovered at the site of Pistiros, in Bulgaria—roughly contemporary with our site (see Figure 1.9.1)—were completely flattened by abrasion, therefore similar to our first subtype, but occasionally had deep holes like in our third subtype, and some of them had inscriptions in Greek, although usually just a few letters (Domaradzka 2013). Perhaps the purpose of this variant of worked astragali was to serve as some sort of weights, and a metal filling was needed to adjust the bones to the desired weight. Further studies, which will include experimental work as well, will hopefully shed more light on these enigmatic objects.

### *Decorative Items*

Two artifacts probably were personal ornaments, that is, jewelry (Figure 1.9.5). One is a fragmented piece of a *Cardium* shell valve, perhaps some kind of pendant.

The other find is a canine tooth from a domestic dog, with a small two millimeter diameter perforation at the apex: it is round in shape, made by drilling from both sides, and slightly polished from use.

Also, one fragment of antler with perforations represents some kind of decorative piece. The object in question is completely preserved: it is rectangular in shape, cut out from the cortex of an antler beam, and is entirely flat—the shape of a small tile. Fine traces of sawing are observable on its edges. It has circular perforations at both short ends. The surfaces are smoothed, and the outer surface of the antler has traces of scraping—a result of smoothing the naturally rough surface—while the inner side has traces of burnishing, probably with a rasp. Traces of manufacture are still clearly visible but no use wear is recognizable, suggesting this piece may have been unfinished—perhaps decoration still needed to be executed—or at least unused. It was probably intended for the decoration on a wooden box or something similar.

### *Manufacture Debris and Technical Pieces*

Particularly interesting is the relatively high amount of manufacture debris. Bone workshops or working areas are generally difficult to identify on prehistoric sites for numerous reasons. Beside site taphonomy, it is also difficult to recognize the manufacturing debris during excavations as well as afterward, during analysis, if preservation is not very good. As for the IA, only a few workshops have been recognized in the Mediterranean area so far. Special mention can be made of the workshop from the site of Tell eṣ-Ṣâfi/Gath in Israel (Horwitz et al. 2006; Maeir et al. 2009), where 141 pieces of worked bone were discovered in a single context.

Manufacture debris and technical pieces from Kale–Krševica include large segments of long bones and ribs with traces of cutting, sawing, and breaking, horncores with traces of cutting and sawing at the base, and segments of antlers with different traces of manufacture.

Bone manufacture is represented by debris of ribs with traces of transversal cutting and sawing, and long bone segments with traces of cutting, chopping, and hacking. These traces were distinguished from butchery marks by their position—they are usually on the medial portions, not near the joints—and by the nature of traces: cutting and sawing marks are especially clear, carefully made and executed from one end of the bone to the other, meaning that the remaining portion was not roughly broken off, but the bone was carefully divided into segments (criteria for comparison with butchery marks after Fisher 1995; Lyman 2001:294–353, and references therein; Poulain 1976:44; Reitz and Wing 2008:128–129).

Similar traces were also recorded at the above-mentioned workshop at Tell eṣ-Ṣâfi/Gath. These can be classified as coming mainly from the primary, and to a lesser extent the secondary, stages of production (Horwitz et al. 2006:170). These stages represent initial processing of unworked bones into smaller, workable pieces, and conversion of these pieces into blanks and rough-outs.

Antler debris represents manufacturing waste without doubt, and includes tine and cortex segments with traces of cutting and sawing. The presence of horncores is particularly interesting, since it testifies to the use of horns' keratinous segments, which otherwise are not preserved in archaeological contexts (see MacGregor 1985). Use of horns as raw material is known only for later periods and/or when preservation is exceptionally high, as seen, for example, in premodern times (e.g., Rijkelijkhuizen 2013) and from ethnographic examples. For earlier periods, however, only indirect evidence may be found—for example, the Roman period workshop at Apulum contained several such horncores with sawing traces (see Ciugudean 2001). In our case, horncores of both cattle and sheep/goats have traces of careful sawing or traces of more irregular cutting with an axe or adze. These traces are located at the very base of the horn, suggesting their purpose was to extract the largest possible segment of the keratinous horn. As for what types of artifacts were made out from this, we can only guess.

All these finds clearly show that a workshop for production of diverse osseous artifacts existed at Kale–Krševica's settlement. However, these finds were not located within a single context, therefore the exact position of the workshop cannot be detected. Furthermore, pieces in a final stage of production or finished, but unused objects, are missing among the finds discovered so far. Further analyses of osseous artifacts and other portable material, as well as excavations on other portions of the site will, hopefully, reveal more details about the process and organization of the production of osseous artifacts at the site of Kale–Krševica.

## Discussion and Concluding Remarks

Bone industries from the Late IA period are poorly studied, especially in southeastern Europe. This is a very interesting period, since it is a time of preliterate societies that had very complex social, economic, and cultural connections with the Mediterranean. Analyses of bone objects may provide additional information on the organization of craft production, trade and exchange patterns, and other aspects of economy. Furthermore, as Kale–Krševica has very rich archaeological remains connected with the Greek civilization, future research will also be able to include analyses of similarities and differences of these forms of material culture with the contemporary sites from both the Balkan Hinterland and the Mediterranean.

Preliminary results show that osseous raw materials were still rather important in this period, despite a widespread belief that the bone industry went into decline following the introduction of metallurgy. Raw materials were rather diverse including bones, antlers, horns, and occasionally teeth and mollusk shells. Red deer antlers were relatively well represented, suggesting that, although red deer were only occasionally hunted, antlers were recognized as an important source of raw material, and their collection was probably a planned and systematic activity. This assemblage also provided information on the use of the keratinous raw materials, otherwise almost or completely invisible in the archaeological record. Raw materials were mainly those obtained locally—bones from domestic animals and horns. However, they also included those obtained in the vicinity of the settlement—antlers and wild animal bones—and, rarely, those that were obtained through some sort of trade or exchange—for example, marine mollusk shells.

Typologically, some of the artifact types represented here find analogies in contemporary sites of the Mediterranean area, especially Hellenistic period sites. It is, however, at present difficult to assess what is typical or atypical among the technological types found at the site, since there are only a few studies of bone assemblages from contemporary sites in the area.

Further studies may show whether some of them are characteristic for the wider region and/or for this period, or if there are any traits specific to the Kale–Krševica settlement.

Some of the artifacts can be related to textile production, which seems to have been a particularly important activity at the Kale–Krševica settlement, perhaps even one of the major activities (Popović and Vranić 2006). Future research may provide more information on craft production in general and in particular on activities related to textile processing.

Finally, it is important to note that bone tool manufacture was carried out at the site, suggesting the presence of craftspersons who practiced bone working, either only occasionally or on a more regular basis.

Future, more detailed research on the bone artifacts—including microscopic examination, experiments, and similar—will, hopefully, reveal more detail regarding the production as well as the use of bone artifacts.

Similarities and differences with comparable sites from the Balkan interior as well as the Late Classical and Early Hellenistic period settlements from the northern Aegean will help in studying the social, economic, and cultural relations between these regions. Furthermore, information obtained from bone assemblages, which have never been the focus of previous researches, which were interested in more prominent material culture remains, will most certainly shed some light on Late IA cultural dynamics.

### *Acknowledgments*

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# Part 2

## Subsistence Economies of Early and Late Complex Societies in Southwest Asia and Adjacent Areas

# 2.1 | Exploring Ubaid-Period Agriculture in Northern Mesopotamia

## The Fifth-Millennium BC Animal Remains from Tell Ziyadeh, Syria

Scott J. Rufolo*

Abstract

Excavations at the Syrian site of Tell Ziyadeh in the 1990s yielded a considerable body of archaeological evidence documenting life at a fifth-millennium BC settlement in northern Mesopotamia. The findings paint a picture of a pioneer community founded around 4800 BC, and a site subsequently occupied for several hundred years, thus spanning the later Northern Ubaid and initial Late Chalcolithic periods of the region. Providing one of the largest zooarchaeological datasets from the Khabur Basin for this temporal range, the Ziyadeh faunal material is described here as part of an examination of the animal-based economy of a rural site during a critical phase of sociocultural transition in northern Mesopotamia. The closing centuries of the fifth millennium are noted for cultural shifts preceding the emergence of urban life over the course of the fourth and third millennia; therefore, the societies of the Ubaid and immediate post-Ubaid periods are commonly viewed as forming a bridge between the Neolithic Revolution and the Urban Revolution. Recent archaeological work supports the notion that an indigenous trajectory toward urbanization was established in northern Mesopotamia by the end of the fifth millennium, but it also indicates that sociocultural evolution in the north did not mirror the pattern of urbanization documented for the south during the Uruk period. The animal remains from Tell Ziyadeh offer a window into the early stages of the North's distinct path as it unfolded among a cluster of small hinterland settlements, recording their evolution from localized agricultural practices into a more integrated, regional economic network connecting neighboring pioneer settlements. This transformation is in line with a trend toward greater sedentarization and expanding social networks already recognized by other archaeological analyses concerning fifth-millennium BC northern Mesopotamia.

Keywords

*Khabur Basin, Late Chalcolithic, Middle Khabur sites, northern Mesopotamia, Northern Ubaid, Post-Ubaid society, Tell Ziyadeh faunal assemblage, Ubaid expansion*

## Introduction

From a broad archaeological perspective, Southwest Asia as a region appears to be standing on the threshold leading into the realm of urban life and text-based history by the end of the fifth millennium BC. The subsequent centuries of the fourth millennium would witness the rise of the world's first cities and their accompanying bureaucratic structures in the Sumerian heartland of southern Mesopotamia, eventually giving birth to—among many other things—the written record (Mieroop 2015:21–43). As an academic subject, this "Urban Revolution" has traditionally commanded much attention (Smith 2009), although significant archaeological effort in recent decades has sought to better understand the developments of the immediately preceding periods (Carter and Philip, eds. 2010; Stein and Özbal 2007). In the chronology of prehistoric Mesopotamia (Figure 2.1.1), the precursors to the earliest urban phases are contained in the Ubaid and Late Chalcolithic (LC) periods, a broad span of time that, as archaeology has begun to show, harbored a range of cultures more diverse and sophisticated than once thought (Carter and Philip 2010; Frangipane 2001; Marro, ed. 2012; McMahon and Crawford 2014; Pittman 2001).

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| Old World Chronology | Dates (cal BC) | Regional Periodization (Northern Mesopotamia) | Cultural Period (Jazireh Region) | Ziyadeh Stratigraphy |
|---|---|---|---|---|
| **Chalcolithic** | 4400–4200 | Late Chalcolithic 1 | Post-Ubaid/ Kuranian | South Side:<br>*Levels VI–VIII (4762-4241 cal BC)*<br>East Side:<br>*Levels XII–XXIV (4762-4241 cal BC)* |
| | 5200–4400 | Northern Ubaid | Ubaid | South Side:<br>*Levels I–V (4987-4661 cal BC)*<br>East Side:<br>*Levels I–XI (4901-4586 cal BC)* |
| **Neolithic** | 5400–5200 | Halaf–Ubaid Transitional | Halaf–Ubaid Transitional | N/A |
| | 5900–5400 | Halaf | Halaf | N/A |

Figure 2.1.1. Comparison of chronological terms for northern Mesopotamia covering the period of time discussed in this work. General dating and regional terminology follow Akkermans and Schwartz (2003) and Rothman (ed. 2001); cultural periods for the Jazireh—traditional appellation for the region in which the Khabur Basin is located, roughly equivalent to the core of northern Mesopotamia—and specific radiocarbon dates for Ziyadeh are derived from Tonoike and Hole (2016).

To continue the metaphor employed at the beginning of this paragraph, it is becoming more and more evident that Southwest Asia not only approached the threshold of urbanism in the fifth millennium BC, but likely also experienced the first societal reconfigurations resulting in some communities in the region crossing over.

One of the most important general observations that has emerged from archaeological explorations of later prehistoric Mesopotamia is the fact that the northern and southern areas of the region followed distinct paths toward urbanization (Oates et al. 2007; Ur 2014; Wilkinson 2009). The early Sumerian city-states formed during the Uruk Period of southern Mesopotamia, emerging to become the world's first societies of undisputed urban character as the fourth millennium BC unfolded in what is now central and southern Iraq (Foster and Foster 2009:15–34; Nissen 2001). On the northern periphery of the Sumerian world, in what today is eastern Syria and northern Iraq, cities, which were organized in a similar fashion to those of the Iraqi alluvium along the Persian Gulf, made a later appearance, emerging during the mid-third millennium (Ur 2010). The evolution of urban society in both regions, however, was marked by variable and complex sociocultural processes (Algaze 2008; Lawrence and Wilkinson 2015; Pollock 2001) that unfolded over the course of centuries. Also of increasing interest to scholars is the fact that the roots of urbanism in northern Mesopotamia appear to ultimately stretch back into the fifth millennium, where proto-urban settlement configurations have been identified for several sites (Brustolon and Rova 2008; Ur et al. 2007; Ur, Karsgaard, and Oates 2011; Ur, Khalidi, and Al-Quntar 2011).

Northern Mesopotamia during the first half of the fifth millennium BC was part of the Ubaid phenomenon (Becker 2013), a seemingly progressive expansion of cultural elements with origins in southern Mesopotamia into adjacent territories of Southwest

Asia.[1] These elements first crystallize around 6500 BC in the southern Iraqi flood plain and include certain characteristic components of material culture—common domestic architectural plans, shared ceramic technology and repertoire of decorative motifs and forms, the presence of baked clay nails and mullers, etc. (Carter and Philip 2010:4)—as well as particular social and economic practices such as increasing use of communal cemeteries (Hole 1989), headshaping (Lorentz 2010), and participation in long-distance obsidian trade networks of a complex but not yet fully understood nature (Breniquet 1989:327; Healey 2010:188–193; Khalidi et al. 2016). This cultural "package" eventually spread outwards, being adopted to varying degrees in areas as diverse as northern Mesopotamia, Anatolia, the Levant, the Arabian Peninsula, and even Iran and the Caucasus. During the sixth and fifth millennia it formed what is regarded by many archaeologists as the first large-scale cultural interaction sphere (Carter and Philip, eds. 2010; Henrickson and Thuesen, eds. 1989). As a chronological entity, the Ubaid is also often viewed as a period of transition between agrarian-based subsistence economies and urban-centered economic networks (Henrickson and Thuesen 1989), a span of time during which increased social complexity developed in numerous ways (Iamoni 2016; Rothman 2004). Counted among the signals of this greater complexity is the higher number of permanent settlements, which in some areas exhibit hierarchical relationships in terms of size and location as well as indications of economic stratification (Ur 2010:393–401). However, the extent of political ranking and the level to which a social elite emerged during the Ubaid remains contested (Akkermans and Schwartz 2003:178–179). Complicating matters, the basic subsistence strategies and agricultural economy of the Ubaid are poorly known, as archaeobiological studies for this period are few (Grossman and Hinman 2014:203; Stein 2010:28).

Nonetheless, the archaeological data that do exist for the fifth millennium BC demonstrate that the Ubaid phenomenon coincides with a patchwork of proto-urban developments and incipient forms of social stratification in Mesopotamia. These varied forms of greater social complexity likely shifted within a set of diverse patterns over time, advancing and retreating in some areas, solidifying into a permanent change in others. Summed over the region, however, those societal changes with longevity established a foundation for future urban emergence distinctive to northern Mesopotamia (Lawrence and Wilkinson 2015; Ur 2010). It is also increasingly clear that the expansion of Ubaid cultural currency to form an archaeological horizon was the result of a diverse set of regional sociocultural processes rather than a coordinated and monolithic act of conquest, colonization, or economic imperialism (Baldi 2016; Stein 2010). Geographic areas entered the Ubaid sphere in a variety of ways and with differing degrees of interconnection, often without uniform adoption of the complete range of Ubaid cultural signals. Similarly, the closing centuries of the fifth millennium—for northern Mesopotamia broadly treated as the Post-Ubaid[2] phases that preceded the Uruk Expansion—also seem to have been characterized by multifaceted and dynamic social processes that played out in both directions between the north and the south (Marro 2012). In neither the Ubaid nor immediate post-Ubaid periods, however, does the interplay between the two Mesopotamian regions—nor, for that matter, that between Mesopotamia and its neighbors—appear to have involved large-scale migration and displacement of populations (Breniquet 1996; Carter and Philip 2010:7). Smaller-scale movements of people certainly did occur (Frangipane 2012:42n2; Oates 2004), however, and archaeological investigations in the Khabur Basin of northeastern

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[1] Most scholars discuss the distinctive cultural features of the Ubaid as having first evolved in southern Mesopotamia, subsequently spreading outward and moving mostly in a northerly direction. It should be noted, however, that there is some evidence that this might not have been the case—at least regarding certain components of Ubaid material culture—and some researchers question the direction of movement (e.g., Campbell and Fletcher 2010; Karsgaard 2010). Certain elements of the "Ubaid package" may actually have appeared first in the north and then made their way southward.

[2] The term "Post-Ubaid" is employed in this paper as a chronological entity encompassing the first few centuries following the general disappearance of the distinctive Ubaid cultural styles and forms in northern Mesopotamia and surrounding regions where this disappearance occurs around the mid-fifth millennium BC. It is not formally recognized as such in most of the literature, although the term frequently occurs, but it is often eschewed as a proper designation in favor of local chronological terminology. The capitalized form is used here in opposition to "post-Ubaid", which may be understood as any and all periods following the Ubaid in any region.

Figure 2.1.2. Map of the Khabur Basin region of northeastern Syria indicating the location of sites mentioned in the text, with inset situating the area within the broader setting of Southwest Asia. The locations of three sites—Kosak Shamali, Köşk Höyük, and Tell Kurdu—are shown on the inset map.

Syria provide evidence of such movements in northern Mesopotamia.

The site of Tell Mashnaqa, located on the middle stretch of the Khabur River (Figure 2.1.2), has been interpreted as containing the remains of a settlement established by a small group of migrants during the Ubaid (Thuesen 2000), assumed by its excavator to have traveled northward along the river from the southern Mesopotamian zone.

The nearby sites of Tell Ziyadeh and Mulla Matar also hosted communities founded during the Ubaid, part of a broader episode of new settlement within the Khabur Basin, along with small agricultural installations established further north at sites such as Kashkashok III, Beydar III, and Tell Kuran (Hole and Tonoike 2016d:391–397). The essentially simultaneous appearance of these sites on either virgin ground or territory long abandoned strongly suggests that their establishment was due to immigration, and the artifacts recovered at Tell Ziyadeh in particular have been interpreted as recording the foundation and evolution of a small homestead by an enterprising group of pioneers (Hole 2016). Possessing one of the largest fifth-millennium BC archaeological datasets for a small rural community of northern Mesopotamia, Ziyadeh provides an example of how the Ubaid phenomenon was expressed in a localized fashion as its associated cultural hallmarks spread into northern Mesopotamia, evolving over time through various stages of sociocultural transmission and transformation. The Chalcolithic faunal assemblage from Tell Ziyadeh is described here in order to highlight those aspects of the animal-based economy that reflect the pioneer origins of the ancient community, followed by a brief discussion of how the zooarchaeological data contribute to a broader understanding of the sociocultural dynamics underlying the Ubaid phenomenon and its relationship with subsequent developments in urban social organization.

## The Ubaid Phenomenon in Northern Mesopotamia

Before profiling Tell Ziyadeh as an archaeological site, a brief exploration of the Ubaid as it was expressed in northern Mesopotamia—today the Jazireh of northeastern Syria and northwestern Iraq along with the area of southeastern Turkey bordering its northern edge—is in order so that the data from Ziyadeh may be understood within their broader regional context. Stein (2012) provides a detailed assessment of northern Mesopotamia during the Ubaid and subsequent LC phases, and what follows here is largely a summary of the most important points of this work. The periods under consideration with reference to Tell Ziyadeh (Figure 2.1.1) are the Northern Ubaid (ca. 5200–4400 BC), corresponding to the Ubaid 3 and Ubaid 4 phases of the southern Mesopotamia chronology (Lebeau 2011), and the LC1 designation (ca. 4400–4200 BC) of the LC chronology erected for northern Mesopotamia (Rothman 2001), which overlaps with the Terminal Ubaid/Ubaid 5 phase of the southern alluvium (Forest 1996:387).

During the first half of the fifth millennium BC, northern Mesopotamia witnessed the spread of the Ubaid material-culture complex, which commingled with the waning native cultural traditions of the preceding Halaf period of the sixth millennium (Özbal 2010). These became integrated into an overarching, Ubaid-derived set of cultural expressions and modes of social organization, thereby creating a new identity centered in participation within a broad interaction sphere that united northern Mesopotamia economically and symbolically with surrounding regions (Breniquet 1989, 1996). Such changes were also accompanied by the emergence of greater economic differentiation and disparities in social status. The archaeological correlates of this include site distributions of greater complexity that exhibit a more densely settled landscape, with distinct two-tiered settlement hierarchies in areas such as the Balikh drainage basin (Trentin 2010) and large regional centers in the Upper Khabur and Hamrin plains of the Jazireh (Ball 1990; Brustolon and Rova 2008; Wilkinson et al. 2003); indications in both the artifacts and faunal remains that some communities intensified their involvement in pastoralism to heighten the extraction of milk and wool (Grossman and Hinman 2014; Sudo 2010); the procurement of luxury goods through long-distance trade networks (Forster and Grave 2012; Oates 1993; Tobler 1950) and the possible use of painted pottery in feasting rituals to signify social status (Helwing 2003); and the presence of administrative devices such as seals, sealings, and clay tokens (Pittman 2001; Rothman 2007). Overall, however, disparities in social status appear to have been minimal, and the Ubaid period in northern Mesopotamia seems to have been characterized by nascent economic ranking and the gradual development of limited forms of social stratification. This incipient socioeconomic complexity is generally viewed as the result of a process of social replication in which northern communities shifted their political structures so that small corporate groups within villages and settlement clusters—perhaps even accompanied by the emergence of headmen or chiefs—gained limited control of the collection and distribution of agricultural goods, initially generated by and subsequently enabling the maintenance of their status through mutual trade and social exchanges with staple finance-based chiefdoms of the south (Nissen 2001; Stein 1994).

Unfortunately, the subsequent Post-Ubaid or LC1 phase of northern Mesopotamia is poorly documented due to a relative lack of archaeological data for this time period (Stein 2012:132). The information that is available indicates that the trends toward socioeconomic differentiation and the emergence of a social elite continued from the Ubaid, and may even have accelerated (Marro 2012).[3] Some continuities in material culture are present as well, with the retention of certain Ubaid forms and styles, but these display alterations characteristic of the Post-Ubaid, and most components of the Ubaid cultural assemblage disappear over the course of the second half of the fifth millennium BC. Evidence of far-ranging, centralized political control—such as a consistent pattern of large public buildings or a formal organization of settlements into urbanized arrangements (Ur and Wilkinson 2008; Wilkinson and Tucker 1995)—or strongly hierarchical social status in the form of segregated household activities and economic production (Gurdil 2010) or differential burial practices (Akkermans and Schwartz 2003:175–178), remains lacking.

The number of zooarchaeological studies whose subject are Ubaid or Post-Ubaid period assemblages from northern Mesopotamian sites is small. Grossman and Hinman (2014:212–213) tally eight sites with published zooarchaeological analyses, including only those with assemblages containing one hundred or more specimens identified to taxonomically useful categories and that also have a secure stratigraphic association. To these may be added the site of Tell Aqab (Bartosiewicz 2016), which possesses a very early Northern Ubaid assemblage—dating to around 5300–5100 BC. Of these, five are located outside of the Khabur Basin—Tell Kurdu on the Amuq Plain, Tell Zeidan on the Balikh River, Kosak Shamali in the Upper Euphrates Valley, Khanijdal East in

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[3] However, see Kennedy (2015) for an opposing view that posits a levelling of social differentiation in northern Mesopotamia during the LC1.

the Iraqi Jazireh, and Kenan Tepe in the Upper Tigris region. The remaining four are situated within the Khabur Basin: three on the banks of the Khabur River itself—Tell Kuran in the northwestern portion of the basin and Tell Mashnaqa and Tell Ziyadeh[4] on the middle course of the Khabur—and one in the far north of the basin within the Wadi Dara drainage system—Tell Aqab. A survey of the basic zooarchaeological profiles for these nine sites reveals that an array of subsistence strategies was employed during the Ubaid, with four of the assemblages characterized by a variable but overall high percentage of wild species (ranging from 27% to 57%), and the others exhibiting very high proportions of domesticated species (87% or greater). Moreover, the presence of a large number of remains from wild taxa does not correlate well with site location or size, so a reliance upon hunted resources does not appear to have been more common in marginal areas of settlement with little rainfall to support extensive agricultural production. Sites with a significant domestic component reveal a concentration on sheep and goat, although detailed analyses of herding-management practices are not yet available for Kenan Tepe (Parker et al. 2008:114–122) or Tell Kurdu (Özbal et al. 2004:64–68; Yener et al. 2000:78–80). At Zeidan, caprines were managed primarily to maximize meat yield, although the age-at-death profiles indicate that milk was also likely extracted to a small but significant extent (Grossman and Hinman 2014:209). Although chemical analyses have shown that dairy was an important component of pastoral practice in Southwest Asia as early as the seventh millennium BC (Evershed et al. 2008), and there is residue evidence for dairy products such as butter during the Chalcolithic (Sauter et al. 2003), the progress of the "Secondary Products Revolution" in the region was likely a gradual one (Grigson 2000), so it is not surprising that coordinated pastoral endeavors and centers for milk and wool production are not in evidence for Ubaid northern Mesopotamia.

As for the Ubaid, very few faunal studies have been published for the Post-Ubaid period of northern Mesopotamia. Some data do exist for Khabur Basin sites, however. The sites of Mashnaqa and Kuran continued to host small populations into the Post-Ubaid period, and their zooarchaeological assemblages reveal a similar pattern to that of the Ubaid (Zeder 1998b). At Mashnaqa there was little change, with domesticates continuing to dominate the animal-based economy, whereas for Kuran wild resources are predominant in the faunal assemblage, a shift from the Ubaid profile in which caprines were most abundant. However, with only 53 identifiable specimens in a total of 357 recovered bones, the Post-Ubaid Kuran assemblage is small and so must be interpreted with caution. Faunal material from large sites and their satellite communities in the northern Khabur Basin, such as Tell Brak and Tell Majnuna (Dobney et al. 2003; Weber 2007), dates to LC2 and later, therefore it is not comparable in age to the assemblages from Kuran, Mashnaqa, and Ziyadeh. The latest fifth-millennium BC remains at such sites, however, suggest that intensification of wool production may have begun in the Upper Khabur region as early as the LC2 (ca. 4200–3850 BC) and later became a small but significant part of the economy by the mid-fourth millennium.

## Archaeological Investigation at Tell Ziyadeh

Located in northeastern Syria, Tell Ziyadeh is located upon the right bank of the Khabur River, originally sitting on an east-west running bend of the river but now at a point where the waters flow into the northern edge of the reservoir of the middle Khabur dam (Figure 2.1.2). The present form of the site is a mound measuring approximately 120 m long by 90 m wide (Figure 2.1.3), and rising 8 m above the surrounding river terrace (Hole 2000), although it has been periodically partially surrounded by the reservoir lake since the creation of the dam (Hole and Tonoike 2016e:2).

During its occupation, the site likely never achieved a size greater than one hectare (Hole and

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[4] The Ziyadeh data presented in Grossman and Hinman (2014) are derived from earlier studies by Zeder (1995, 1998a, 1998b). Zeder's work presents the results of an initial sorting and identification of the Ziyadeh material that sought only to assign preliminary taxonomic identifications and obtain counts and weights by species. The Ziyadeh data presented in this work represent a second, more detailed analysis (Rufolo 2016) in which material was carefully selected according to secure stratigraphic contexts and subjected to a greater range of data extraction—identifications were refined where necessary, information concerning fragmentation was collected, measurements were performed, butchery marks were recorded, and more.

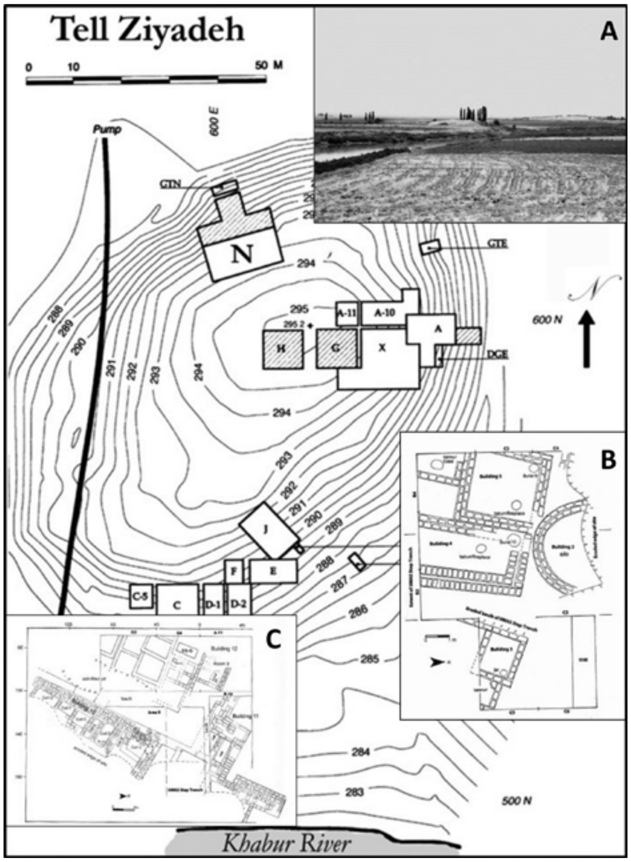

Figure 2.1.3. Plan of Tell Ziyadeh depicting the main excavation units, based on map by Stephen Hughey as provided in Hole (1999), with details presented in insets: A. Photograph of Tell Ziyadeh (Photograph courtesy of F. Hole); B. Plan of Ubaid domestic architecture and associated rounded storage building exposed in excavation area A, reproduced from Hole and Tonoike (2016a:Figure 5.7); C. Plan of Kuranian/Post-Ubaid architectural remains exposed in excavation area X, reproduced from Hole and Tonoike (2016a:Figure 5.27), including domestic units—upper portion of plan—and the remains of a large, complex structure that may have housed storerooms—lower portion.

Tonoike 2016b:51), and the areal extent of the inhabited areas at any one time was probably considerably less. Preliminary archaeological investigations at Tell Ziyadeh were conducted in 1988–1990 by the International Institute of Mesopotamian Archaeology (Buccellati et al. 1991), with more extensive excavations undertaken by the Yale University Khabur Basin Project in 1996 and 1997 (Hole and Arzt 1998). Both excavation projects were initiated in response to an appeal made to the international archaeological community in 1984 for foreign participation in salvage operations to document archaeological sites that would become threatened with flooding upon completion of a new irrigation and hydroelectric development project within the Khabur Basin (Bahnassi 1984; Bounni 1990).

Tell Ziyadeh is a multiperiod site, with earliest occupation probably dating to the sixth millennium BC. Little remains of this Halaf period settlement,[5] however, with most of it either lost to flooding, destroyed by subsequent construction, or buried beneath the extensive overlying remains of the Late Ubaid settlement of the early fifth millennium (Hole and Tonoike 2016e:2). The ceramics, architecture, and general artifact inventory clearly demonstrate that Ziyadeh was part of the Ubaid sphere in terms of material culture, exhibiting numerous features characteristic of Ubaid affiliation, such as painted pottery, tripartite buildings, and labrets. Smaller remnants of a Post-Ubaid and an Early Bronze Age occupation were also uncovered, although these have both suffered greatly from erosion. The Post-Ubaid layers are present only along the southern and eastern slopes of the central mound. Radiocarbon dating places the Late Ubaid occupation around 4800–4600 BC and the immediately succeeding post-Ubaid inhabitation—referred to as the Kuranian, a local expression of the LC1—around 4600–4300 BC (Hole 2001).

Today, the middle stretch of the Khabur River is surrounded by arid steppe and is not well suited to rain-fed agriculture; however, in the fifth millennium BC, northern Mesopotamia likely experienced an overall stable environment (Wilkinson 2003). This resulted in a richer vegetation in the Khabur Basin along the river banks including stretches of riparian forest and an environmental regime that fostered a greater agricultural potential (Hole and Tonoike 2016c). The site is estimated to have hosted a small village of forty to sixty inhabitants during both the Late Ubaid and Kuranian/LC1 (Hole and Tonoike 2016f:407). Remains of domestic architecture and storage structures were uncovered, although no single domestic unit was excavated in its entirety for either period. The community likely consisted of no more than five or six residential compounds at any one time during its Ubaid and Post-Ubaid incarnations.

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[5] A few Halaf-period ceramics worked into later deposits are the only evidence of a possible sixth-millennium occupation at Ziyadeh. As the Halaf settlement documented at the nearby site of Umm Qseir predates the Ubaid remains at Ziyadeh by nearly one thousand years, Ziyadeh's excavator regards the Ubaid settlement as essentially an establishment made on virgin soil.

Table 2.1.1. General assemblage data for the fifth millennium BC Tell Ziyadeh faunal remains, presented by broad stratigraphic categories—Ubaid-period depositional units, Post-Ubaid depositional units, and the large Post-Ubaid midden. Counts and weights are reported for the identifiable material—specimens that could be identified to meaningful taxonomic units, generally family level or lower—versus the unidentifiable material—fragmentary remains that could only be assigned to broad categories such as medium-sized mammal. NISP: Number of Identified Specimens; NUSP: Number of Unidentified Specimens.

| | # Analyzed Specimens | # Identified Specimens (NISP) | Weight (Identified) | # Unidentified Specimens (NUSP) | Weight (Unidentified) |
|---|---|---|---|---|---|
| **Post-Ubaid** | 21,710 | 2,687 | 25.87 kg | 19,023 | 28.55 kg |
| **EXV Midden** | 5,261 | 754 | 6.14 kg | 4,507 | 9.26 kg |
| **Ubaid** | 26,023 | 3,473 | 31.00 kg | 22,549 | 32.31 kg |

The material culture of Tell Ziyadeh suggests that the fifth-millennium BC occupation was initiated by migrants from southern Mesopotamia who established homesteads in clusters along the middle and upper stretches of the Khabur River (Hole 2016). The ceramic inventory of the site—fabrics indicate that nearly all of the vessels were manufactured locally and not imported (Tonoike 2016; Všianský and Gregerová 2016)—includes decorated bell-shaped vessels whose form and painted imagery has exact parallels in the Ubaid-period finds from Eridu in southern Mesopotamia. A similar pattern is seen in the material culture of the nearby Ubaid settlements: excavations at Kashkashok II and Mashnaqa also yielded pottery, boat models, and bent clay nails identical in appearance to finds at southern sites. Ziyadeh's inhabitants appear to have brought their Ubaid-period styles and practices with them. Through societal processes of immigration, adaptation, and the emergence of new traditions they gradually attenuated and evolved over the centuries into the distinctive cultural features of the Kuranian.

## The Tell Ziyadeh Faunal Assemblage

In light of the story told by the artifacts and architecture of Tell Ziyadeh, certain aspects of the fifth-millennium zooarchaeological data are presented here to explore the animal-based economic activities of the site's inhabitants from their initial settlement along the Khabur River around 4800 BC until the community's abandonment around 4300 BC. The select set of information provided here is intended to permit a reconstruction of the basic hunting and animal-management practices of the pioneer settlement during its founding period, with a focus on detecting any signals in the data that might indicate changes in the subsistence economy that evolved between the Ubaid and Post-Ubaid phases. The full suite of zooarchaeological data that were collected is contained in Rufolo (2016), along with a more detailed analysis.

The fifth-millennium BC levels of Tell Ziyadeh provided a faunal assemblage numbering over 51,000 specimens, making it one of the largest yet recovered from a northern Mesopotamian site for the later Chalcolithic period. Although numerous depositional units were recognized during excavation, these could not be reliably correlated across the site due to the distances between excavation units (Hole and Tonoike 2016b). Therefore the faunal assemblage is analyzed using the two broad stratigraphic groupings of Ubaid and Kuranian—Post-Ubaid—levels. Within excavation areas, dividing the recovered faunal material into the recognized depositional units resulted in subassemblages that were too small to permit a rigorous chronological analysis, so it is not possible to consider changes over time within the Ubaid or Post-Ubaid levels. Comparisons between these two periods of time, however, are robust, as both the Ubaid and Kuranian strata are represented by large total sample sizes (Table 2.1.1) with similar fragmentation profiles (Rufolo 2016:Figure 12.6). Ubaid material was largely recovered from the southern side of the mound (Figure 2.1.3; excavation areas C, D, E, F, and J), whereas the majority of the Kuranian/Post-Ubaid finds were uncovered on the mound center and eastern slope (Figure 2.1.3; excavation areas A,

Table 2.1.2. Taxonomic identifications for the fifth-millennium BC Tell Ziyadeh faunal assemblage. The data presented here represent the identifiable material and are categorized by taxon and period/stratum. Certain taxonomic categories, such as cervid, rodent, reptile, contain material positively identified to species; see Rufolo (2016) for a list of the species collapsed here into these broad categories. It should be noted that for the Ubaid-period domestic remains, the three cat specimens come from the same individual, and 89 of the 145 dog bones belong to one animal.

| | **Ubaid** | | | **EXV Midden** | | | **Post-Ubaid** | | |
|---|---|---|---|---|---|---|---|---|---|
| | **NISP** | **%** | **Weight (g)** | **NISP** | **%** | **Weight (g)** | **NISP** | **%** | **Weight (g)** |
| **Sheep**<br>*Ovis orientalis*<br>f. dom. *aries* | 109 | 3.14 | 505.1 | 7 | 0.93 | 54.6 | 78 | 2.90 | 440.5 |
| **Goat**<br>*Capra aegagrus*<br>f. dom. *hircus* | 38 | 1.09 | 165.3 | 2 | 0.27 | 6.1 | 40 | 1.49 | 223.0 |
| Sheep/goat | 1,063 | 30.61 | 4,521.5 | 67 | 8.89 | 287.4 | 641 | 23.86 | 2,734.4 |
| Caprine (Total) | 1,210 | 34.84 | 5,191.9 | 76 | 10.08 | 348.1 | 759 | 28.25 | 3,397.9 |
| **Pig**<br>*Sus scrofa*<br>f. dom. *domesticus* | 76 | 2.19 | 421.8 | 8 | 1.06 | 41.9 | 54 | 2.01 | 488.4 |
| **Cattle**<br>*Bos primigenius*<br>f. dom. *taurus* | 243 | 7.00 | 4,679.2 | 20 | 2.65 | 303.5 | 203 | 7.55 | 5,359.5 |
| Dog<br>*Canis lupus*<br>f. dom. *familiaris* | 145 | 4.18 | 369.9 | 12 | 1.59 | 58.8 | 54 | 2.01 | 251.9 |
| ***Canis* sp.** | 10 | 0.29 | 22.5 | - | - | - | 8 | 0.30 | 18.1 |
| Small Canid | 1 | 0.03 | 0.3 | - | - | - | - | - | - |
| Small Carnivore | - | - | - | - | - | - | 1 | 0.04 | 0.1 |
| **Cat**<br>*Felis silvestris*<br>f. dom. *catus* | 3 | 0.09 | 2.5 | - | - | - | - | - | - |
| ***Felis* sp.** | 1 | 0.03 | 1.0 | - | - | - | - | - | - |
| ***Gazella* sp.** | 631 | 18.17 | 1,975.4 | 208 | 27.59 | 497.3 | 509 | 18.95 | 1,508.6 |
| Cervid | 23 | 0.66 | 127.6 | 2 | 0.27 | 0.9 | 8 | 4.26 | 10.5 |
| **Aurochs**<br>*Bos primigenius* | 20 | 0.58 | 1,116.2 | 4 | 0.53 | 376.3 | 6 | 0.22 | 442.0 |
| ***Equus* sp.** | 829 | 23.87 | 15,881.5 | 273 | 36.21 | 4,023.6 | 713 | 26.54 | 13,175.2 |
| **Wolf**<br>*Canis lupus* | 1 | 0.03 | 1.0 | 1 | 0.13 | 2.2 | 3 | 0.11 | 26.4 |
| **Fox**<br>*Vulpes* sp. | 24 | 0.69 | 20.7 | 4 | 0.53 | 2.2 | 24 | 0.9 | 19.1 |
| **Caracal**<br>*Caracal caracal* | 1 | 0.03 | 0.9 | 1 | 0.13 | 1.2 | 1 | 0.04 | 1.3 |

Table 2.1.2. (cont.) Taxonomic identifications for the fifth-millennium BC Tell Ziyadeh faunal assemblage.

| | Ubaid | | | EXV Midden | | | Post-Ubaid | | |
|---|---|---|---|---|---|---|---|---|---|
| | NISP | % | Weight (g) | NISP | % | Weight (g) | NISP | % | Weight (g) |
| **Lion**<br>*Panthera leo* | - | - | - | 2 | 0.27 | 13.4 | 5 | 0.19 | 26.8 |
| **Hare**<br>*Lepus capensis* | 8 | 0.23 | 3.0 | 1 | 0.13 | 0.3 | 10 | 0.37 | 5.7 |
| Mustelid | 2 | 0.06 | 0.08 | - | - | - | 4 | 0.15 | 0.8 |
| Rodent | 9 | 0.27 | 10.7 | 5 | 0.67 | 0.3 | 18 | 0.67 | 2.3 |
| Hedgehog | 1 | 0.03 | 0.5 | - | - | - | 1 | 0.04 | 0.2 |
| Mongoose | - | - | - | 1 | 0.13 | 0.3 | 3 | 0.11 | 0.6 |
| Bird | 24 | 0.69 | 27.5 | 7 | 0.93 | 14.9 | 21 | 0.78 | 24.5 |
| Reptile | 65 | 1.88 | 167.7 | 90 | 11.92 | 157.0 | 112 | 4.17 | 189.5 |
| Fish | 10 | 0.30 | 2.4 | 4 | 0.53 | 0.4 | 21 | 0.78 | 6.9 |
| Crab | 1 | 0.03 | 0.1 | - | - | - | - | - | - |
| Mollusk | 135 | 3.88 | 976.6 | 35 | 4.64 | 294.6 | 149 | 5.54 | 917 |

G, and X), although area J in the south also exposed a considerable depth of Kuranian-age strata.

The taxonomic composition of the Ubaid and Kuranian zooarchaeological assemblages are summarized in Table 2.1.2 and shown graphically in Figure 2.1.4. In the upper portion of Figure 2.1.4, the Post-Ubaid assemblage is shown in two forms: the first pie chart includes data from the entire range of specimens recovered from Post-Ubaid strata, while the second chart excludes data from the animal bones recovered from a large midden dating to this period—originally designated as locus X–030 by the excavators, comprising Stratum EXV of Area X.

The depth and extent of this refuse accumulation indicate that it does not represent a single event but was rather used over a period of time. But since no other areas of the site contained a large midden deposit of similar nature—and it may contain refuse from periodic events (discussed further below)—it has been excluded from the analysis of very broad categories such as wild versus domestic taxa. It can readily be seen from the taxonomic profiles that the representation of species, both wild and domestic, in the Ubaid and Kuranian assemblages appear to be rather similar. Pearson's chi-squared tests indicate that there actually is a statistically significant difference in the taxonomic proportions between the two periods for both the domestic—counting the associated dog and cat remains as one specimen each within the *Other* category ($\chi^2 = 17.82$ for $df = 5$, significant at a $p$ value of 0.005)—and wild ($\chi^2 = 28.71$ for $df = 3$, significant at a $p$ value of 0.001) spectra, but the association between taxon counts and period is very weak in both cases: for the domestic taxa ($\phi^2 = 0.007$) and for the wild ($\phi^2 = 0.008$); a $\phi^2$ value of 0 indicates no correlation between variables, a value of 1 returned for a perfect association. There is a slightly greater representation of cattle and goat during the Kuranian as well as a reduced presence of aurochs and a broader emphasis on more diverse, small-sized game, but the difference is so small as to be negligible.

Throughout the fifth millennium BC, occupants of Tell Ziyadeh balanced domestic and wild resources, supplementing a small-scale livestock production focused primarily on sheep and goat with a broad array of wild game.[6] Cattle were maintained in small

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[6] These results differ from those obtained by Zeder (Zeder 1995, 1998a, 1998b) during her first stage analysis of the Ziyadeh faunal assemblage. The preliminary analysis indicated a strong emphasis on hunting during the Ubaid,

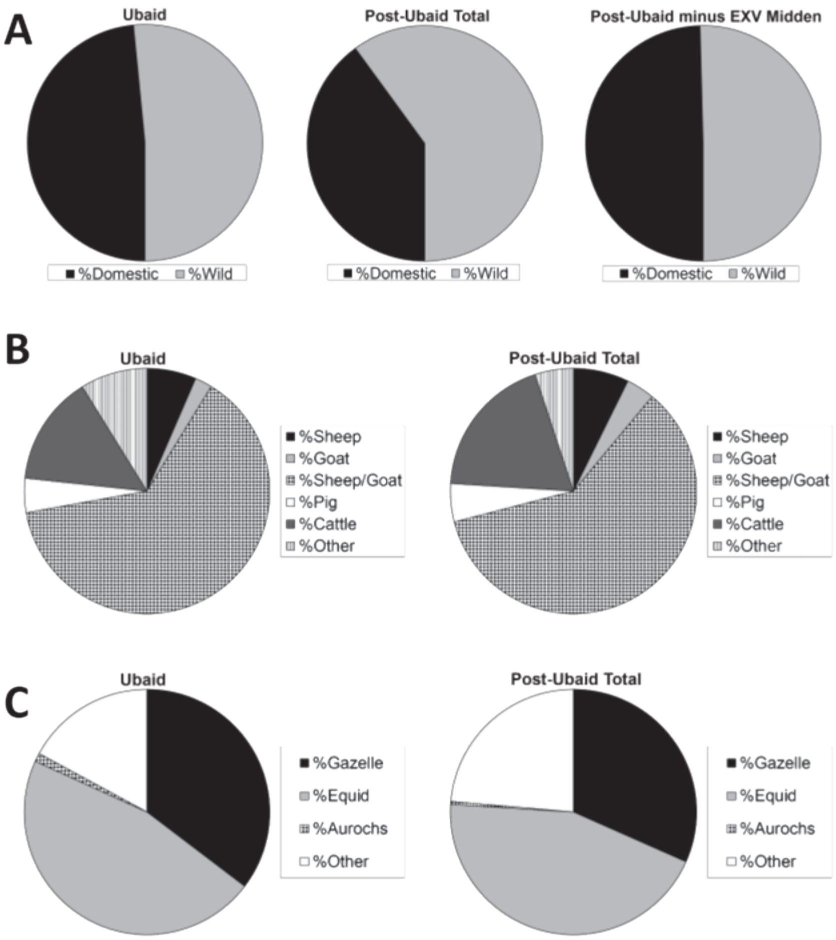

Figure 2.1.4. Charts depicting the basic taxonomic breakdown of the Tell Ziyadeh faunal assemblage. A. Domesticated *versus* wild taxa. Sample sizes: Ubaid N = 3,462, Post-Ubaid Total N = 2,687, Post-Ubaid minus EXV midden N = 754—note that these counts exclude material identified as *Canis* sp., *Felis* sp., small canid, and small carnivore because these categories may represent domesticated or wild species; B. Proportions of domesticated taxa. Sample sizes: Ubaid N = 1,677, Post-Ubaid Total N = 1,070; C. Proportions of wild taxa. Sample sizes: Ubaid N = 1,784, Post-Ubaid Total N = 1,608.

numbers, likely kept primarily as a source of traction for use in working nearby agricultural plots, as were swine, a household-level husbanding of pigs ensuring a ready supply of meat as security during leaner seasons of the year. Equids, most likely the onager or wild half ass, and gazelles were the most important wild species hunted throughout the fifth millennium.

The large Kuranian/Post-Ubaid midden found in Area X deserves some separate consideration. Although not detailed here, the zooarchaeological profile of this deposit does exhibit some noteworthy characteristics (Rufolo 2016:298–305, 319–320). The midden overall preserves a greater proportion of remains from wild taxa compared to both the Ubaid and Post-Ubaid assemblages (Figure 2.1.4), although the overall composition of the domestic and wild components mirror those of the surrounding Kuranian deposits: for domesticates ($\chi^2 = 7.64$ for $df = 5$) and for wild taxa ($\chi^2 = 1.06$ for $df = 3$). Neither therefore is significant at a $p$ value of 0.18 or less. The midden material does include examples of some rare, exotic taxa, however, such as the caracal and steppe lion, and also exhibits a different fragmentation pattern compared to remains from Ubaid deposits. The midden material—indeed the Kuranian assemblage in general—contains a greater percentage of unidentified to identified large-mammal remains, meaning that the Post-Ubaid large-mammal material is more

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with around 70% of the recovered remains representing wild species, followed by a dramatic change in the Kuranian, whose assemblage features over 65% domesticated forms. The discrepancy with the results presented here is likely due to criteria for inclusion: for Zeder's work, all specimens thought at the time to have been recovered from Ubaid and Post-Ubaid contexts were included in the study. For the present analysis, only material from secure contexts as determined from examination of the field notes and more recent assessments of the stratigraphy by the excavators was selected (Rufolo 2016:290–291). The preliminary analysis thus likely included a small but still significant amount of material from mixed and incorrectly assigned contexts.

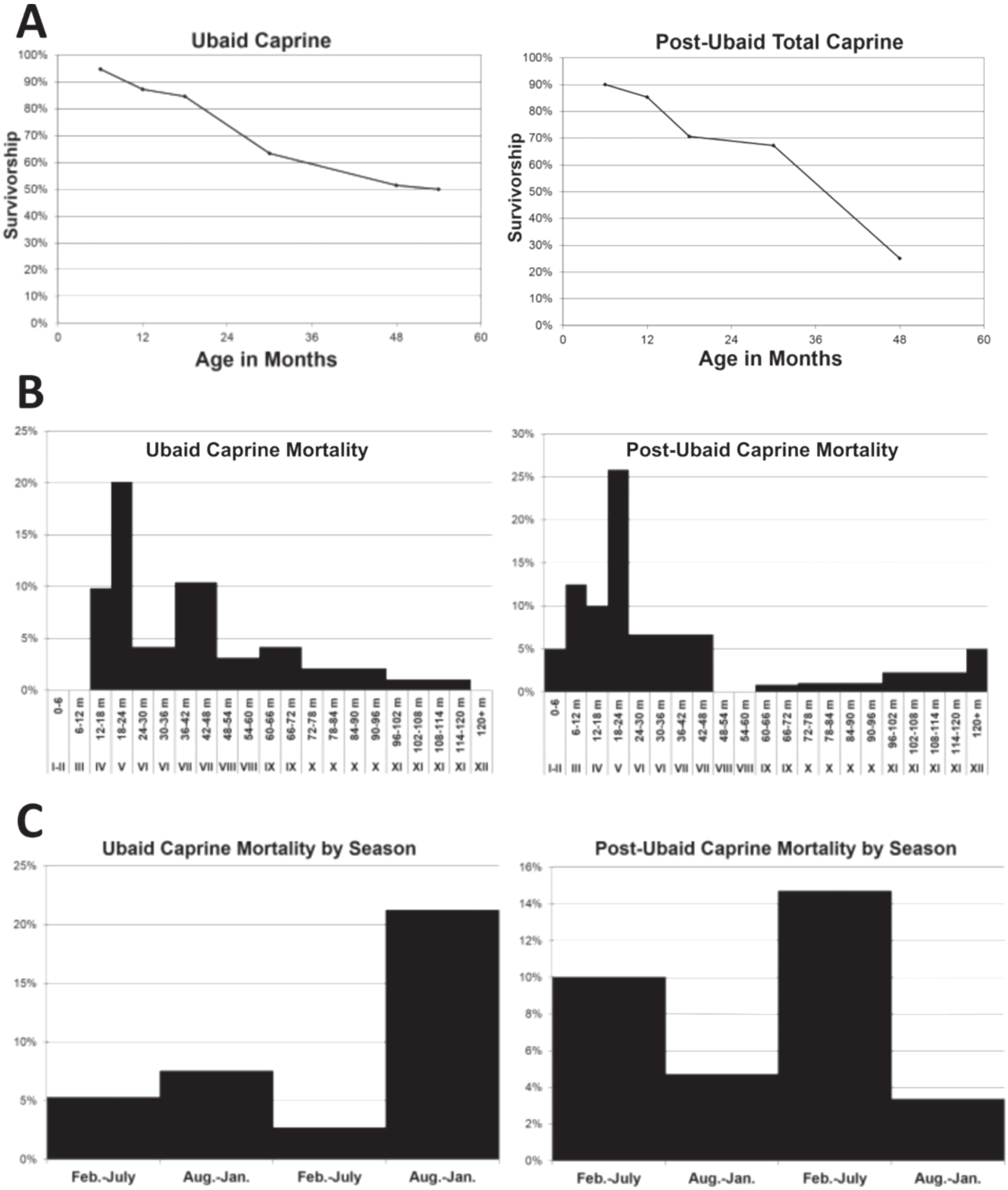

Figure 2.1.5. Charts presenting the survivorship data for caprine material of the Tell Ziyadeh faunal assemblage. A. Caprine survivorship curves based on long-bone fusion. Sample sizes: Ubaid N = 187, Post-Ubaid Total N = 150; B. Caprine mortality profiles based on dental wear. Sample sizes: Ubaid N = 24 mandibles, Post-Ubaid Total N = 20 mandibles; C. Caprine mortality over the first two years of age calibrated to season. Sample sizes: Ubaid N = 151, Post-Ubaid Total N = 124.

highly fragmented. This may signal that large animal carcasses, likely those of the onager, were being processed differently during the Kuranian. Additionally, a significant proportion of equid, gazelle, and soft-shelled turtle remains in the midden are blackened, much higher percentages of burnt bones being present for these taxa than in other contexts.

### *Caprine Culling Profiles*

The culling profiles for caprines (sheep and goat) are shown in Figure 2.1.5. As there was an insufficient number of elements positively identified to the genus level, the caprine data must be considered in aggregate—combining information from specimens that were identified as being either sheep, goat, or sheep/goat.

The ratio of sheep to goat in the differentiated caprine material ranges from 2.0:1.0 to 2.9:1.0 for the fifth-millennium strata, therefore the combined caprine dataset likely contains similar proportions of the two species. The fusion-based survivorship curves derived from long bones, presented at the top of Figure 2.1.5, and the mortality histograms based on dental eruption and wear, comprising the central band of the figure and based on the method developed by Zeder (2006). Both sets of data serve as a means of detecting pastoral management strategies as they plot the attrition of individuals in a hypothetical herd composed of all the caprines found for the period in question. The data derived from long-bone fusion track this attrition as the cumulative percentage of individuals who survive over the course of four years following birth. Data from caprine dentition record the percentage of animals from the original herd that die within a particular age range. They are thus the inverse of the survivorship data but are capable of tracking changes up to eight years.

The caprine culling profiles for Tell Ziyadeh indicate that there was a strong interest in slaughtering animals in the 12–48 month age range during both the Ubaid and Kuranian, with a particular preference for culling animals in the 12–24 month interval. In both periods, over 30% of individuals were culled by the age of two and a half years. Additionally, there is a particularly strong peak at the 18–24 month interval in the dentition-based mortality data for the Kuranian/Post-Ubaid. Caprines obtain their prime muscle mass during the second year of life, so residents of Ziyadeh throughout the fifth millennium managed their flocks primarily for meat yield, with a distinct concentration during the Post-Ubaid on animals likely to provide the most meat. At the older end of the age spectrum, over 10% of the reconstructed herd survives beyond six years of age in both periods, signaling that dairy production of a scale sufficient to meet the immediate needs of the community was likely also part of the subsistence strategy. The older remains would therefore be those of females that were kept alive longer in order to provide milk, likely also affording a reliable source of wool for the homestead's residents.

Interestingly, seasonality profiles for the slaughter of caprines (shown in the lower portion of Figure 2.1.5) detect a shift in the timing of primary culling episodes between the Ubaid and Kuranian periods. These graphs present the dentition-based mortality data for the age range 0–24 months as calibrated to the months of the year based on the birthing seasons of sheep and goat populations maintained in the environments of southwestern Asia (Zeder 1994), thereby serving to indicate the intensity of animal kill-off during certain parts of the year. Assuming a lambing and kidding season that runs from February to March as is typical for the region today, the caprine mortality data reveal a distinct difference in the timing of kill-offs between the Ubaid and Post-Ubaid periods at Ziyadeh. During the Ubaid, culling peaks in the late summer through early winter when members of the herd were approaching two years of age. The Kuranian assemblage yielded data that reveal a change in strategy, with slaughter intensifying during the spring and focusing on younger animals—one to one and a half years old. This new pattern probably reflects the activities of transhumant pastoralists who exploited summer and autumn pastures further to the north, moving south along the Middle Khabur during the late winter and early spring for better forage there during the rainy season. The Ubaid pattern thus likely indicates that residents of Ziyadeh during the earlier fifth millennium were largely managing their own flocks in lands nearby without moving animals great distances throughout the year.

## Interpreting the Subsistence Economy at Tell Ziyadeh

Even though only a limited set of data is presented here, the basic zooarchaeological profile constructed from this information nonetheless documents important general trends that characterized the fifth-millennium BC animal-based economy at Tell Ziyadeh. The animal-bone assemblage recovered from the earliest phases of occupation dating to the Northern Ubaid clearly represents a general subsistence strategy balancing domestic and wild fauna in a manner that would support the primary dietary needs of the community. Nearly half of the identified assemblage is composed of the remains of domesticated species, largely sheep and goat, and the wild component is dominated by onager and gazelle. As it is assumed that the Ubaid-period inhabitants of Ziyadeh most likely represent migrants from southern Mesopotamia, it might be expected that the domestic suite would exhibit a stronger emphasis on cattle and pigs, since these taxa are dominant—generally representing over 50% of the domestic remains—in the data presented by the few available zooarchaeological analyses for southern communities of the early fifth millennium (Desse 1985–1986, 1996; Flannery and Wright 1966). This does not appear to be the case, however. The earliest Ubaid levels excavated at Ziyadeh were exposed along the base of the southern slope of the tell, yielding 573 bones from domestic animals, of which cattle represented 11% and pig only 1% of the total. Cattle never reach more than 28% of the domesticate remains in any Ubaid level with a sample size of 100 faunal specimens or more, pigs never exceed 5%. Rather than speak against the southern origins of the settlers, however, whose material culture exhibits strong ties with that of southern Mesopotamia as mentioned previously, the faunal profile for the Ubaid is likely an indication of the demands of the local environment. The drier northern plains with extensive steppe were simply better suited to a focus on caprine husbandry.

The community's staple supply of meat was provided in large part by pastoralists based at Tell Ziyadeh who did not range far for much of the year. The principal culling of sheep and goat occurred during the hot summer months and the opening weeks of the rainy season, with animals approaching two years of age preferentially targeted. The heightened culling activity coincides with the driest span of the year during which local plant growth is minimal, and resident pastoralists are likely responsible for furnishing the main meat supply during the annual period of greatest environmental stress. Following the winter rainy season, as the surrounding land became comparatively richer in forage, the flocks could be moved out into the steppe. Wild game, now roaming the steppe in greater numbers to take advantage of the new growth, could be hunted with greater ease and frequency. Meat from gazelle and onager probably greatly supplemented the diet at this time, reducing the need to slaughter domesticates during the winter and spring months. Small numbers of pigs and cattle could be used to round out the diet throughout the year, with smaller wild taxa such as birds, fish, and hare also likely serving in this role. There are no indications of a highly specialized pastoralism; caprines were maintained principally for their meat and secondarily as a source of milk and likely also wool for domestic use.

During the Kuranian/Post-Ubaid, residents of Tell Ziyadeh appear to have changed their general subsistence strategy little, maintaining an animal-based economy largely similar to that of the earlier phases of occupation. Domesticated animals as well as wild species contributed nearly equally to the diet, and sheep and goat continue in their role as the dominant component of the livestock. There is no significant change in the basic pastoral management, the zooarchaeological data for the Post-Ubaid continue to signal a herding strategy focused on obtaining a steady supply of meat. The small increase in the numbers of animals surviving to older age classes seen in the Post-Ubaid caprine mortality profile (Figure 2.1.5 B) may evidence a shift in culling patterns indicative of a growing economic interest in yield increase of secondary products, although meat procurement remains the dominant focus. There is some indication, however, of a growing set of more complex and extensive economic relationships. The seasonal culling pattern for sheep and goat during the Post-Ubaid assemblage is the opposite of that for the Ubaid material, exhibiting spikes in the kill-off intensity for the late winter and into the spring months. This pattern likely indicates that caprines are being managed further out in the steppe, and probably by largely nonresident transhumant pastoralists, who would have been returning to the region from summer and autumn pastures further to the north so that the flock could graze on the steppes surrounding the Khabur River over the rainy season (Zeder 1994:108). In this scenario, sheep and goat would have most often been obtained on the hoof through trade with these pastoral groups moving along the middle region of the Khabur Basin or perhaps through a mobile sector of the population of Ziyadeh that spent much of the year off-site involved in pastoral activities. Isotopic studies of the caprine remains should be able to detect such a shift in the source of animals; such work is currently being planned as a means of potentially providing additional evidence for this scenario.

The distinctive nature of the Area X midden documents intensified hunting practices and provides a signal of more complex social interactions. In terms of the procurement of wild game, the midden material may be a sign of a more developed corporate strategy for hunting. In the early fourth millennium BC, the occupants of Tell Kuran engaged in the mass hunting of gazelles (Bar-Oz et al. 2011; Zeder et al. 2013), likely with the use of kites to funnel the movements of the animals to make capturing and killing them easier. Excavations at Tell Kuran revealed a large midden containing large quantities of gazelle bone, with few specimens of other species being present. Unlike the Kuran gazelle assemblage, however, the Area X midden is characterized by a multi-species profile rich in remains from two larger taxa—gazelle and onager—as well as a variety of smaller wild forms. Nor does the Ziyadeh midden exhibit a body-part profile dominated by a concentration of foot elements or other expected butchery waste, as is the case for the Kuran midden. As previously mentioned, though, the Ziyadeh midden assemblage is notable for its high percentage of burned bones. It therefore likely does not represent a single event but, considering its contents as well as its depth and size, more likely preserves the remains of several large, successive meals over time. These meals might have followed a communal hunting foray, perhaps as an associated special feast, the midden therefore capturing the occurrence of what was likely an event of community-wide participation and significance.

## Discussion and Conclusion

The data derived from the animal-bone remains paint a picture that is consistent with the interpretation of Ziyadeh as having been a homestead community founded in an uninhabited region by a small group of pioneers. Throughout the site's occupation across the fifth millennium BC, the general subsistence economy involving animals and animal-derived products was organized at a scale intended primarily to meet the daily needs of the settlement and maintain the self-sufficiency of its inhabitants to the greatest extent possible. Specialized pastoral pursuits designed to capitalize on a newly emerging market for wool or dairy products that may have been developing elsewhere in Mesopotamia never fully matured at Ziyadeh. With game animals and other wild resources readily available on the steppes and along the river banks, residents of the site could support their community through combining hunting and the rearing of livestock without having to invest in an agropastoral system more focused on connecting them economically into a broader regional economy. However, all the homesteads newly established within the Khabur Basin during the Northern Ubaid, Ziyadeh included, undoubtedly had to rely on social and economic interactions with one another to a certain degree from the moment of their founding (Hole and Tonoike 2016f:407–408). Changes in the zooarchaeological profile for the site as derived from the later fifth-millennium BC faunal assemblage indicate that such intercommunity ties may have intensified during the Post-Ubaid period.

The Kuranian/Post-Ubaid data detect a minor socioeconomic shift in the procurement of meat from caprine species. The culling profiles for this period indicate a change in the seasonal pattern of slaughter for sheep and goats, with the majority of prime-aged animals being killed during the spring and early summer. This is probably due to a change in animal management strategy, the community no longer maintaining its herds largely nearby and shepherded by members who resided at Ziyadeh much of the year. Instead, groups of transhumant pastoralists—either mobile residents of the surrounding steppe land who were not affiliated with the settled community or perhaps members of the homestead who now spent much of the year off-site—supplied caprine-derived goods to Ziyadeh and nearby settlements as they moved southward along the Khabur River to summer pastures. Ziyadeh, therefore, may have become one node in a localized economic system involving a more integrated, mutual dependence between mobile pastoral groups and the more sedentary communities stationed along the river. The remains found in the Area X midden may also be a result of this new relationship: they evidence the occurrence of communal activities meant to reinforce corporate identity at Ziyadeh, forge and strengthen relationships with other homesteads, and maintain amicable interactions with pastoralists.

The mid- to late fifth millennium BC is the period during which the internal socioeconomic differentiation of communities and societies began to heighten in Mesopotamia, with a concomitant development of nascent forms of social inequality built on an emerging elite status and the control of goods and symbols associated with prestige (Algaze 2001, 2008; Wengrow 2010:54–65). In Syria, the Late Ubaid and immediate post-Ubaid phases seem to have been characterized by a diverse assemblage of overlapping social networks that formed in response to certain sectors of the population adopting an increasingly more sedentary lifestyle while mobility throughout Mesopotamia was being deemphasized overall (Akkermans and Schwartz 2003:158). The patterns in the zooarchaeological data seen for the Post-Ubaid strata at Ziyadeh may reflect this general trend, because the development of larger settlements and proto-urban social structures in northern Mesopotamia forced economic restructuring within the Khabur Basin. The homesteads strengthened local ties with each other in order to maintain their independence. But they also established a socioeconomic connection with more mobile pastoralist groups that were beginning to specialize in servicing the growing larger centers of permanent settlement.

The middle reaches of the Khabur Basin were situated within a largely marginal area that bordered the territories of several newly expanding settlements. Tell Brak, a large site in the northern Khabur Basin well known for its urban configuration in the third millennium BC (Early Bronze Age), was already showing signs of complex, centralized economic activities by the late fifth millennium (Oates et al. 2007). The site of Khirbat al-Fakhar, located in the eastern periphery of the Upper Khabur region close to another Early Bronze Age urban center (Tell Hamoukar), also displays proto-urban proportions during the LC1/Post-Ubaid time span (Ur, Khalidi, and Al-Quntar 2011). In the Iraqi Jazireh, evidence for social stratification and a differentiated local economy with connections to regional trade networks is found at Grai Resh (Kepinski 2011), a large settlement that featured defensive fortifications by the end of the fifth millennium. It has also been noted that the Khabur Basin may have begun to function as a gateway region during the immediate post-Ubaid centuries (Stein 2010:34), the Khabur River serving as a conduit for regional trade between larger settlements in the north, such as Brak, and communities to the south of the Khabur's confluence with the Euphrates. By the final decades of its occupation, Ziyadeh may have been more like a small hamlet whose inhabitants made their living by interacting with the traffic moving upon the river. Ziyadeh and nearby communities likely also served as an interface with the mobile polities of the hinterland, funneling goods into and from the steppe. Such arrangements have been described for the LC of the southern Levant (Hermon 2008), where settlement clusters occur in particular geographic regions that permitted groups of interrelated communities to act as an independent unit, primarily exploiting local resources and supplementing their economy by tapping into broader trade networks for certain goods only.

Social mechanisms for developing a stronger corporate identity among the homestead communities, as well as for encouraging and maintaining new relationships with pastoralists or merchants, may well have included communal meals between the residents of the small Khabur Basin settlements and perhaps even cooperative mass hunts. Smaller-scale community events, such as those interpreted here to have been responsible for the Ziyadeh stratum EXV midden, may represent the foundations for later, larger-scale events intended to generate greater social cohesion as proto-urban forms of living were originating in northern Mesopotamia. In the fourth millennium BC, feasting and communal meals are thought to have played an important role in the development of centralized authority at Tell Brak (Weber, in press), where the consumption of exotic taxa such as lion and bear appears to have served as a signal of prestige (Weber 2014). The site of Arslantepe in Turkey also preserves evidence of the importance of feasts during the Uruk Period (D'Anna and Guarino 2010). Earlier Anatolian sites contain examples of communal dining activities, indicating that such events had a long evolution over the course of the Chalcolithic. At Early Chalcolithic Köşk Höyük, whose occupation dates to 6200–5400 BC (equivalent to the Halaf in northern Mesopotamia), numerous roasting pits have been found that contain significant quantities of animal bone, including higher proportions of wild species than other middens and refuse deposits on the site (Arbuckle 2012). The body-part representation in the pit deposits also differs from that of faunal assemblages recovered from other areas, being weighted toward meaty portions of the hind- and forelimbs and displaying a pattern that suggests that cattle and equid cuts were apportioned according to a particular socially prescribed logic. Such a pattern is not present in the EXV midden, whose body-part representations do not differ from other deposits of the site, supporting the notion that Ziyadeh hosted a homestead community with little social differentiation in terms of status.

The information obtained from the Tell Ziyadeh faunal remains certainly provides a valuable addition to the archaeological record for fifth-millennium BC northern Mesopotamia, enlarging our understanding of the variability in subsistence economy and animal management strategies during the Ubaid and Post-Ubaid periods. As with the Ubaid sites of Mashnaqa (Zeder 1998b) and Kosak Shamali (Gourichon and Helmer 2003), the faunal assemblage from Ziyadeh exhibits a large component of remains from wild taxa, but standing at over 50% for both the Ubaid and Post-Ubaid phases, it is noticeably greater than the proportion of wild species represented in the Mashnaqa (31%) and Kosak Shamali (39%) assemblages. All three stand in contrast to the only other Ubaid-period assemblages documented in the archaeological literature with relatively large sample sizes—Kenan Tepe (Parker et al. 2008), Khanijdal East (Wilkinson and Tucker 1995:42), Tell Aqab (Bartosiewicz 2016), Tell Kurdu (Özbal et al. 2004), and Tell Zeidan (Grossman and Hinman 2014)—whose faunal remains are dominated by domesticated species. Such diversity in agropastoral systems among fifth-millennium BC settlements in Southwest Asia has also been noted for other areas of the Levant, such as modern-day Israel (Price et al. 2013) and Jordan (Müller-Neuhoff 2014), where the Chalcolithic subsistence economy evolved to include a greater interconnectedness between sedentary and mobile sectors of the population. This dynamic between settlements and pastoralists may even have played some role in the spread of Ubaid material culture and ideology.

Sites such as Tell Ziyadeh demonstrate that one avenue for the Ubaid phenomenon to progress was through the movement of small pioneer groups. In the Khabur Basin, the Ubaid period is marked by the establishment of a network of homesteads founded by immigrants from the south. As with the material culture, they brought certain agricultural practices and strategies with them, which they employed and adapted as needed to suit their new environment. The zooarchaeological data support an interpretation of a self-sufficient subsistence economy at Tell Ziyadeh during the Ubaid that equally integrated both locally managed domesticated herd animals and ample wild game from the nearby gallery forests and grasslands. As these homesteaders transitioned into a distinct regional entity culturally, the animal-based economy likely evolved in service of this process: it further integrated the clusters of post-Ubaid communities through the development of new economic relationships, such as transhumant pastoralism on a regional scale within the Khabur Basin. The developments in the animal-based economy during the Kuranian may have been part of a strategy to maintain independence and a separate ethnic identity from the larger settlements growing in the northern Khabur Basin and on its periphery. Banning (2011) has documented the various ways that communities in the southern Levant attempted to establish cultural independence while at the same time supporting economic stability and fostering social prestige during the Chalcolithic. Ziyadeh and its fellow homesteads are likely another case of this process in action during the fifth millennium BC, one example of the diverse ways in which northern Mesopotamian communities responded to the fluctuating network of socioeconomic changes associated with eventual urban emergence in the region.

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# 2.2 | Animal Bones from the 2009–2012 Excavations at the Early Bronze Age Site of Shengavit, Yerevan, Armenia

## A First Look

Pam J. Crabtree* and Jennifer Piro†

### Abstract

Shengavit is a well-known archaeological site in Armenia that has been a subject of archaeological excavation since the 1930s. This paper focuses on the animal bone remains recovered from the excavations that took place at Shengavit between 2009 and 2012 when H. Simonyan served as excavation director and Prof. M. Rothman served as field director. The excavations concentrated on the Early Bronze Age levels, dated to between 2900 and 2450 BC, that are attributed to the Kura-Araxes II culture. Our paper focuses on the species identified from the most recent excavations at the site and the evidence for the economic utilization of the domestic mammals. In addition, we address the thorny problem of the identification of the equid material from the site and the question of the presence or absence of domestic horse remains.

Keywords

*Armenia, Shengavit, Early Bronze Age, Kura-Araxes, South Caucasus, domestic mammals, equids*

## Introduction

Shengavit is an Early Bronze Age (EBA) site located on the southwestern outskirts of Yerevan, Armenia, that has a long history of excavation dating back to the 1930s (Figure 2.2.1A). The site is located on a hill southeast of the modern Lake Yerevan, which was created in the 1960s. The site covers about 6 ha, although a portion of the settlement was destroyed by the construction of a Soviet-era hospital ward. A small museum is located at the apex of the site and some of the settlement was previously covered with illegal orchards, but these have since been removed. About 15% of the site has been excavated.

The earliest excavations were carried out in the late 1930s by E. Bayburdian and additional excavations were conducted by S. A. Sardarian in the 1950s. Sardarian's work was poorly documented. Some of the inaccurate Soviet-era reconstructions of the structures at the site are shown in Figure 2.2.1B. Modern excavations began in 2000 under the direction of Hakob Simonyan, who served as the field director of the project from 2000 to 2008. Simonyan was joined by our colleague, Prof. Mitchell Rothman of Widener University, who served as the field director and co-director of the project for the final three seasons in 2009, 2010, and 2012. Rothman's research was sponsored by the National Geographic Society, the Shelby White and Leon Levy Program for Archaeological Publications (Harvard University), and the Ministry of Culture of the Republic of Armenia.

The zooarchaeological history of the site is also complex. The find material from the 1965–1980 excavations carried out by Sardarian was examined by our colleague, Dr. Nina Manaseryan. Manaseryan also identified the animal remains excavated between 2003 and 2007 (Manaseryan 2018). When Professor Rothman joined the project, he invited one of

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us (JP) to join the project since she had extensive experience in the analysis of Bronze Age material from eastern Anatolia. Piro worked on some of the material from the 2009 excavation season, but she left the project to take a position as an academic administrator at Columbia University. Crabtree joined the project in 2012. During the 2012 field season and the subsequent 2013 lab season she identified the remaining material from the 2009 season, as well as the material that was excavated in the 2010 and 2012 field seasons. This article is based primarily on Crabtree's and Piro's research, although the earlier studies carried out by Uerpmann and Uerpmann and Manaseryan will be included in the final site publication (Simonyan and Rothman forthcoming).

In terms of the archaeological background, Shengavit is an EBA site dating to the third millennium between 2900 and 2450 BC. The dating is based on a combination of a series of radiocarbon dates and ceramic relative chronology. The calibrated dates from good archaeological contexts have been published in Simonyan and Rothman (2015:11, Table 1). The site was used irregularly in the early Middle Bronze Age (MBA) until about 2200 BC, and it is associated with the EBA Kura-Araxes II culture. The site of Shengavit, which at 6 ha is large for its place and time, is surrounded by a substantial cyclopean wall. Modern excavations have revealed round and rectangular structures that seem to form compounds. In addition, a series of ritual installations with elaborate hearths was discovered in the 2010 and 2012 excavation seasons. The site also produced large silos that were used for grain storage. Artifacts recovered from the modern excavations at Shengavit provide evidence for metal working and flint and obsidian knapping. In addition, these excavations have yielded a large and well-collected faunal assemblage that can shed light on animal husbandry practices and hunting patterns at this important EBA site.

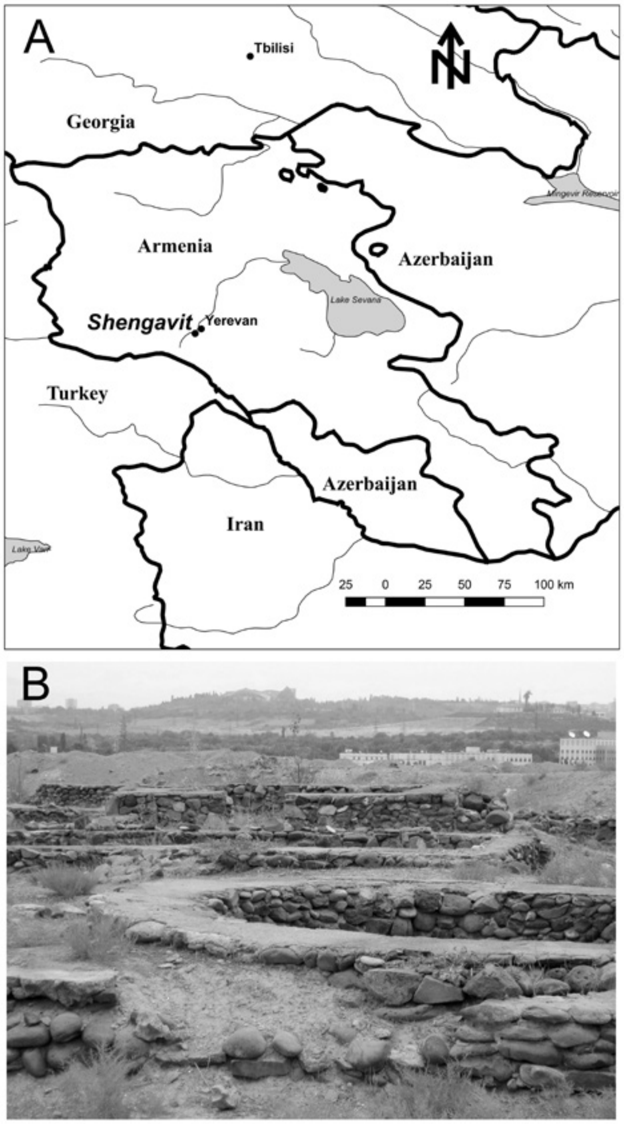

Figure 2.2.1. Shengavit, Armenia. A. Map of Armenia showing the location of Shengavit; B. Soviet-era reconstructions of some of the structures at Shengavit. (Photograph by P. Crabtree.)

## The Faunal Remains

We will begin with the animal bones identified by previous analysts. Manaseryan examined the materials that were recovered from the excavations carried out between 1965 and 1980 and the bones excavated during the more recent excavations between 2003 and 2007. Since the earlier faunal materials were selectively collected, they should be used to estimate species ratios with caution, but they can give an indication of the range of species present in the assemblages from these early excavations. The domestic animals identified by Manaseryan include cattle (*Bos taurus*), sheep (*Ovis aries*), goat (*Capra hircus*), pig (*Sus scrofa domesticus*), dog (*Canis familiaris*), donkey (*Equus asinus*), and horse (*Equus caballus*). Her list of wild species includes red deer (*Cervus elaphus*), roe deer (*Capreolus capreolus*), fox (*Vulpes vulpes*), wolf (*Canis lupus*), beaver (*Castor fiber*), stone marten (*Martes foina*), weasel (*Mustela nivalis*), marbled polecat (*Vormela peregusna*), badger

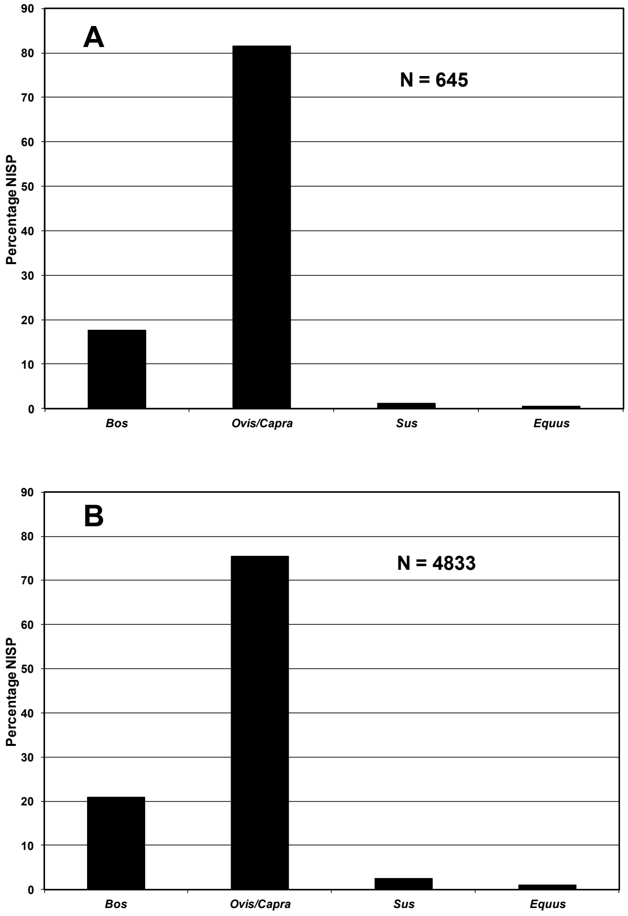

Figure 2.2.2. (A) Species ratios for large domestic mammals, including equids, identified by Piro; (B) Species ratios for large domestic mammals, plus equids, identified by Crabtree.

(*Meles meles*), onager (*Equus hemionus*), wild sheep (*Ovis orientalis*), wild goat (*Capra aegagrus*), goitered gazelle (*Gazella subgutturosa*), and wild boar (*Sus scrofa*). Manaseryan's (2018) data indicate that her assemblages were dominated by the remains of caprines in terms of Number of Identified Specimens (NISP, see Lyman 2008), followed by domestic cattle, with smaller numbers of pigs and equids.

Piro examined a total of 2,052 animal bones and fragments recovered during the 2009 excavation. The domestic species she identified included cattle, sheep, goat, pig, donkey, and dog. The wild species included red deer, roe deer, brown hare (*Lepus europaeus*), fish, and bird. The species ratios—based on NISP—for the large domestic animals including the equids are shown in Figure 2.2.2A. Caprines are best represented based on NISP, followed by cattle. Cattle, however, would have provided the bulk of the edible meat based on their larger size. Pigs and equids played only a minor role in the Shengavit economy. Identified sheep bones outnumbered goat remains by a ratio of nearly four to one.

In 2012 and 2013, Crabtree examined a total of 35,647 animal bones and fragments, a majority of which were unidentified fragments of mammal bone. The identified material included the remains of domestic cattle, sheep, goats, pigs, and dogs, in addition to 47 equid remains. The wild animal remains included the bones of red deer, roe deer, fox, hare, badger, otter (*Lutra lutra*), and four bones of brown bear (*Ursus arctos*), plus small numbers of birds and fish. Measurement data indicate that the Shengavit assemblage also includes small numbers of wild cattle (*Bos primigenius*) and wild sheep (*Ovis orientalis*) bones. There is no clear evidence for wild boar but only a very few of the pig bones were measurable. Species ratios for the domestic mammals, plus the equid remains, are shown in Figure 2.2.2B. In general, Crabtree's results mirror Piro's quite closely, although Crabtree identified a slightly larger proportion of cattle and fewer sheep and goats. The other difference is that the sheep-to-goat ratio for Crabtree's material was closer to 2:1.

In terms of settlement patterns, Shengavit was a relatively large settlement, although it is more like a small town than a city. It was surrounded by two smaller village sites that lay just outside the settlement walls, although these were destroyed by modern activities before they could be properly surface-collected. In theory, Shengavit seems to be a small center that was part of a two-tiered settlement system in which the sites like Shengavit represent the upper tier, while the smaller agricultural villages represent the lower tier. The importance of Shengavit lies in its defenses and its easy access to large salt deposits. We were, therefore, interested in determining whether the residents of Shengavit were raising their own livestock or whether they were obtaining animals from the surrounding villages and pastoral camps. Since sheep and goats made up the majority of the animals consumed at Shengavit, we examine the age profiles for the caprines using dental eruption and wear. We recorded the state of dental eruption or wear for each tooth following Grant (1982), and we grouped the mandibles into age classes following Payne (1973). Crabtree's analysis is based on 108 sheep, goat, and indeterminate sheep/goat mandibles that were complete enough to be as-

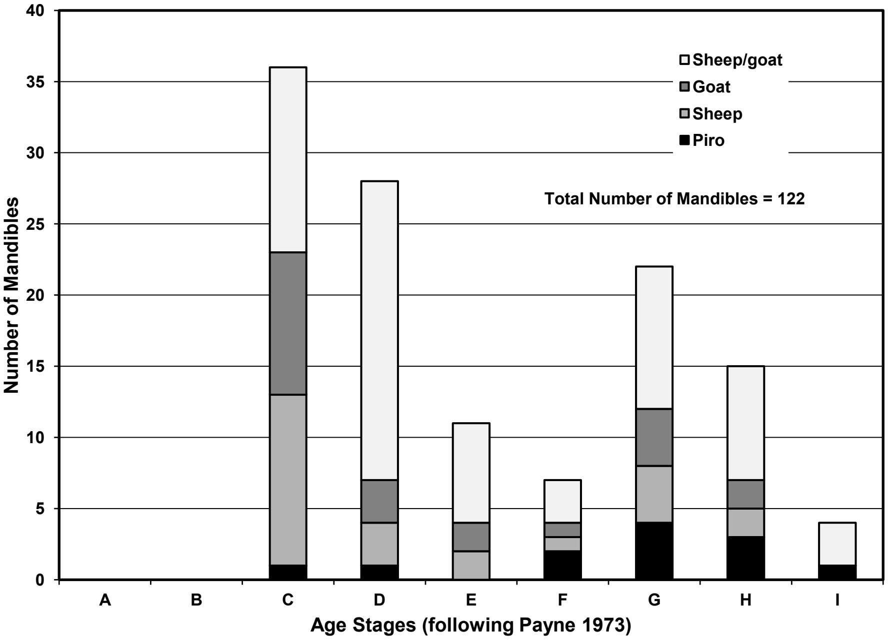

Figure 2.2.3. Kill-patterns for sheep and goats recovered from the 2009–2012 excavations at Shengavit.

Figure 2.2.4. Ritual hearth and installation from “Operation M5.” (Photograph by M. Rothman.)

signed to one of the classes defined by Payne. Piro identified and analyzed an additional 14 sheep/goat mandibles which have been added to Crabtree’s data (Figure 2.2.3). No very young animals—under six months of age—were recovered from the 2009–2012 excavations at Shengavit. The assemblage includes a substantial number of animals culled in the later first and second years of life and many older animals that may have been kept primarily for secondary products such as wool, hair, and dairying. These data, and particularly the total absence of very young animals, suggest that many of the animals that were consumed at Shengavit may have been supplied by pastoral specialists and/or surrounding farms and villages. If caprines were kept on the site on a year-round basis, we would expect to see some neonatal or perinatal mortalities. This finding, however, need not imply pastoral nomadism. It may simply imply seasonal transhumance or trade between Shengavit and the surrounding farming communities.

One of the most striking features of the Shengavit excavations is the presence of a series of ritual installations with elaborate hearths. We wanted to determine whether the animal bones associated with these installations differed in any significant way from the animal bones that were recovered from other areas within the site. We took a close look at the faunal remains identified from the ritual installa-

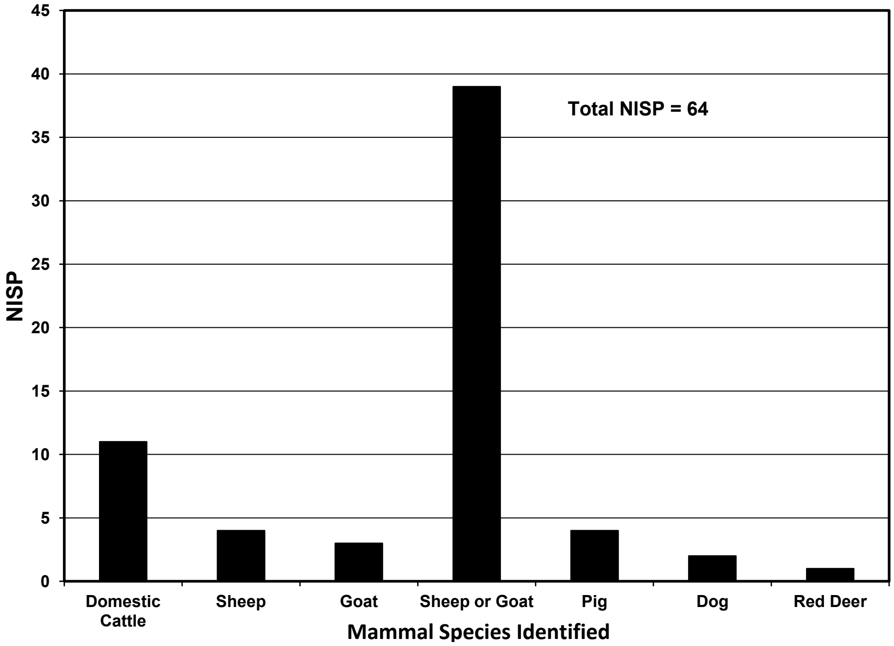

Figure 2.2.5. Species identified from the ritual installation in "Operation M5."

tion in "Operation M5," which was excavated during the 2012 field season (Figure 2.2.4). These contexts yielded the remains of cattle, sheep, goats, pigs, red deer, and fish. The species ratios (Figure 2.2.5) mirror those seen in the site as a whole. There is no evidence at present to suggest that these structures were associated with specialized ritual feasting (Simonyan and Rothman 2015).

Finally, let us address the thorny question of equids. The first point to be made is that the number of equid remains recovered from the 2009–2012 excavations at Shengavit is very small. Only 47 equid fragments were identified in the material that Pam Crabtree analyzed, and an additional 3 fragments were identified from the material that Jennifer Piro analyzed, 2 of which were positively identified as donkey based on dental morphology of lower cheek teeth. Some archaeologists and archaeozoologists have suggested that horses, which appear to have been first domesticated in the steppe regions of Kazakhstan, south Russia, and Ukraine in the second half of the fourth millennium BC (Outram et al. 2009), were introduced to Mesopotamia via the Caucasus. In 2010 Simonyan announced that horse bones had been found at Shengavit, although Hans-Peter and Margarethe Uerpmann have argued that these bones may have been recovered from disturbed contexts and that the earliest horses in the region come from MBA Nerkin Naver (Uerpmann and Uerpmann forthcoming). We wanted to be very careful of our identification of any possible horse remains. We had hoped to use Eisenmann's (1986) characteristics on the mandibular cheek teeth since Hite's (2008) research indicated that her criteria effectively distinguished horses, onagers, and donkeys at the Chalcolithic, Bronze Age, and Iron Age site of Godin in Iran. Unfortunately, we did not recover any complete mandibular cheek teeth in the material analyzed by Crabtree. We then looked at the first phalanx, since Simon Davis and his Portuguese colleagues (Davis et al. 2008; see also Dive and Eisenmann 1991) have suggested that measurements on the first phalanx can also be used to distinguish between the remains of horse, donkey, and onager. We recovered one partially measurable first phalanx from the Shengavit material that we examined. Its SD measurement was 26.2 mm. Based on Davis et al. (2008), our first phalanx is probably a donkey or possibly a small onager. It is clearly smaller than all the horse remains measured by Davis and his colleagues. The other measureable equid bones analyzed by Crabtree (Table 2.2.1) are consistent with onagers. The best that can be said at present is that there is no clear evidence for horse remains from the EBA faunal assemblage recovered during the 2009–2012 campaigns at Shengavit. In addition, the small numbers of equid re-

Table 2.2.1. Measurements (in mm) on other equid remains recovered from the 2009–2012 excavations at Shengavit. (After von den Driesch 1976.)

| Measurements (in mm) | Context | GL | Bp | SD | Bd | Dd |
|---|---|---|---|---|---|---|
| Metacarpus | Layer III | | | | 43.1 | 31.3 |
| Metacarpus | Layer VIII | | | | 42.0 | |
| Second phalanx | Layer I | 40.4 | 40.8 | 34.3 | 36.1 | |
| Second phalanx | Layer II | 38.4 | 38.5 | 35.8 | 34.9 | |
| Second phalanx | Layer V–VII | | 39.0 | 34.3 | 34.3 | |

mains identified from the large Shengavit faunal assemblage recovered between 2009 and 2012 suggests that these animals played only a very minor role in meat consumption at EBA Shengavit. Assuming that these remains are in fact onager, they would point to a limited role for hunting in general.

## Future Directions

The analysis of the faunal remains from Shengavit is a work in progress. Additional studies of the stratigraphy and the ceramic remains have allowed the zooarchaeological data to be subdivided into eight distinct cultural layers. The final report on the Shengavit material will allow us to trace possible changes in animal use at Shengavit throughout the first half of the third millennium BC. These analyses will be presented in the forthcoming site report (Crabtree and Piro forthcoming). In addition, we note that the species ratios from Shengavit share similarities with those that have been published for other Kura-Araxes communities. These similarities include large numbers of caprines and very small numbers of pigs. For example, the faunal assemblage from Arslantepe dated to ca. 3000 BC shows a decrease in cattle, increased numbers of caprines, and very few pigs (Frangipane 2014; see also Clason and Buitenhuis 1998). Our ongoing research, however, points to substantial variations in age profiles and animal-use patterns between different Kura-Araxes communities, and this is an issue that we plan to investigate further (Crabtree and Piro forthcoming).

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# 2.3 | Animal Economy at Karkemish from the Late Bronze to the Iron Age

## A Preliminary Assessment

Elena Maini* and Antonio Curci*

Abstract

The systematic zooarchaeological study of faunal assemblages from the excavations carried out between 2011 and 2016 by the Joint Turco–Italian Archaeological Expedition at Karkemish (province of Karkamış, Gaziantep, Turkey) is based on a sample of about ten thousand osteological remains. Data derive from different sectors of the urban settlement, including administrative, cultic, productive, residential, and funerary areas from the beginning of the Late Bronze Age down to the Iron IV/Achaemenid period. The faunal assemblage presents a good level of preservation with 30% of the sample determined to species level. Domestic animals were predominant in all periods, with sheep and goats covering almost half of the Number of Identified Specimens (NISP), followed by cattle and equids—both donkeys and horses—while pigs, dogs, and camels are rather scarce. The animal economy of Karkemish was evidently based on pastoralism, including the exploitation of both primary and secondary products as showed by the estimation of age-at-death. Wild animals were rare but included deer, fallow deer, and gazelle, and some exceptional examples of exotic animals.

Keywords

*Bronze Age, Iron Age, Hittite, Turkey, Karkemish, sheep and goat, gazelle, exotic animals, pastoralism, ancient diet*

## Introduction

This preliminary zooarchaeological study concerns the faunal remains excavated by the Turco–Italian Archaeological Expedition at Karkemish (Karkamış province, Gaziantep, Turkey) from excavations carried out starting in 2011 and continuing. The study is based on a sample of nearly eighteen thousand animal osteological remains (17,906).[1] The materials pertain to different sectors of the urban settlement, including administrative, cultic, productive, residential, and funerary areas dated from the Middle Bronze Age to the Islamic period (for a general introduction to the site, see Marchetti 2014, 2015a, 2015b, 2016; Figure 2.3.1). In general, even if there was a high degree of fragmentation due to different anthropogenic causes, bone surfaces show a good level of preservation. Here we discuss the preliminary archaeozoological analysis of some of the sectors analyzed to date, a sample size of 10,568 bone fragments with 29.9% of this sample identified to species level (3,159 fragments, Tables 2.3.1 and 2.3.2).[2]

At the moment, the zooarchaeological analysis is primarily focused on materials dated between the Late Bronze Age (LBA) I and Iron Age (IA) IV/Achaemenid period—sixteenth–fourth century BC—as determined by the pottery studies. Zooarchaeologi-

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[1] The Turco–Italian Expedition at Karkemish is carried out in partnership between the University of Bologna, the University of Gaziantep, and the University of Istanbul, with additional funding from the Italian Ministry of Foreign Affairs and the Sanko Holding, A.Ş.

[2] Faunal remains were collected together with other archaeological finds from stratigraphical excavations without applying any sampling strategy, but no sieving was carried out.

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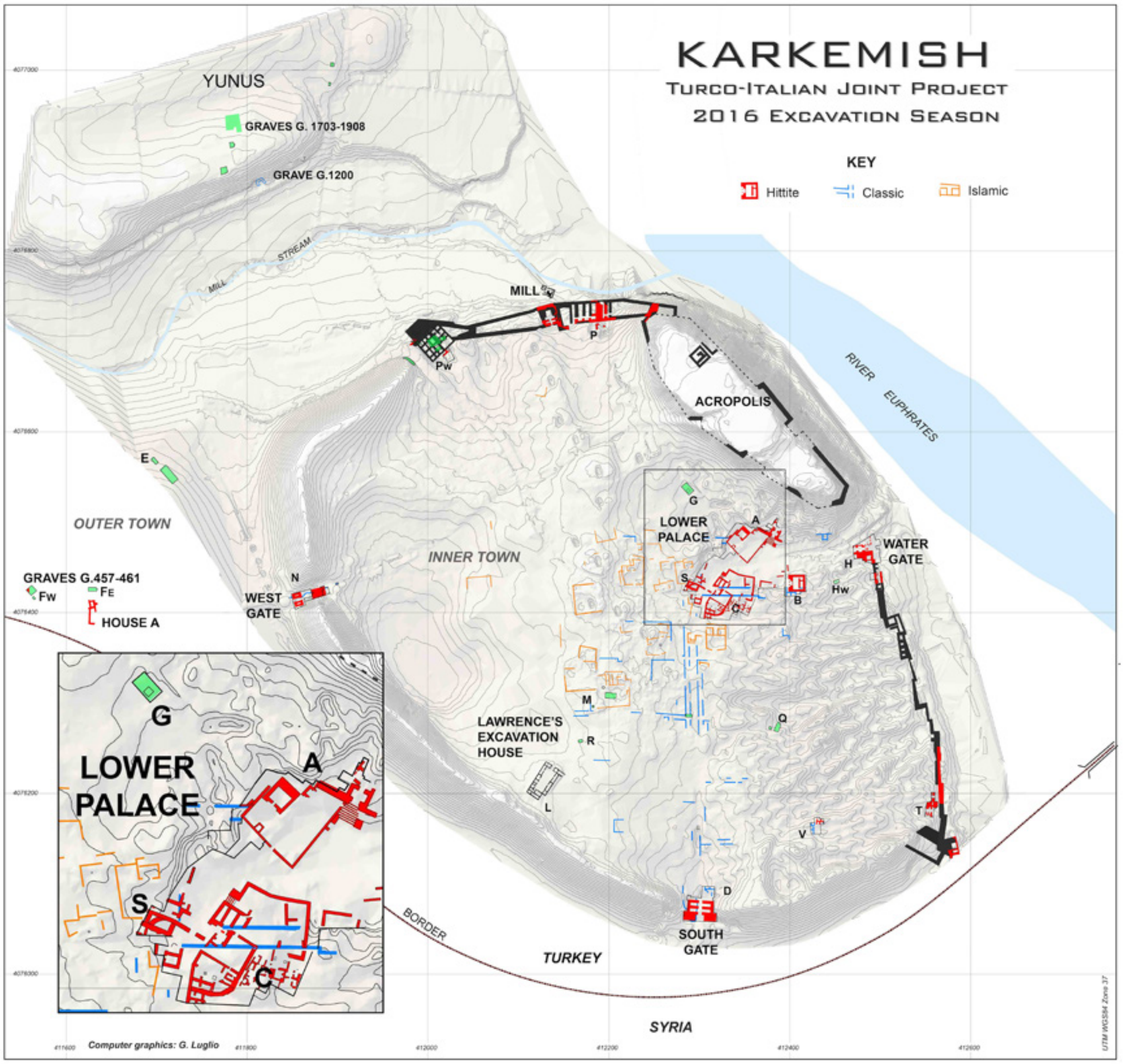

Figure 2.3.1. Topographical map of Karkemish—oriented north–south with UTM geographic coordinates—with the areas mentioned in the text inside the box. (Courtesy of the Turco–Italian Archaeological Expedition at Karkemish.)

cal study, as well as the archaeological excavation, of Area G and Area A has now been completed, while samples from the entire Lower Palace Area—Area S, Area C East, and Area C South—have been only partially analyzed.[3] In fact, zooarchaeological research advances seasonally synchronously with the progress of the archaeological excavations.

## Late Bronze Age

LBA levels at Karkemish yielded a rather limited faunal assemblage compared to the later periods for a total sample of only 1,235 fragments analyzed (compared to almost 10,000 fragments from the IA; Table 2.3.1).

### *Area A—Late Bronze Age I (Sixteenth–Fifteenth Centuries BC)*

The majority of faunal remains dated to the LBA belong, so far, to Area A. This area is located in the Lower Palace Area. Excavations during the 2014

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[3] Zooarchaeological study of the site's other sectors has also been completed; however, the dating of these areas falls outside the chronological range considered in this contribution. The additional sectors will be presented in subsequent papers.

Table 2.3.1. Preliminary faunal composition of the Late Bronze Age levels in Area A and Area C East at Karkemish (updated to the 2017 field season). NISP = Number of Identified Specimens.

| **Taxa & animal groups** | **Area A** | | | **Area C East** | | | **Total LBT** | |
|---|---|---|---|---|---|---|---|---|
| | **NISP** | **%NISP** | **%NISP groups** | **NISP** | **%NISP** | **%NISP groups** | **NISP** | **%** |
| *Equus caballus* | - | - | - | - | - | **0.7** | **1** | **0.3** |
| *Equus asinus* | - | - | | - | - | | | |
| *Equus* sp. | - | - | | 1 | 0.7 | | | |
| *Canis familiaris* | 14 | 8.4 | **8.4** | 2 | 1.5 | **1.5** | **16** | **5.7** |
| *Sus domesticus* | 16 | 9.6 | **9.6** | 8 | 5.9 | **5.9** | **24** | **7.9** |
| Sheep/goats | 66 | 39.5 | **52.1** | 76 | 55.9 | **60.3** | **169** | **55.8** |
| *Ovis aries* | 14 | 8.4 | | 3 | 2.2 | | | |
| *Capra hircus* | 7 | 4.2 | | 3 | 2.2 | | | |
| Small ungulates | 11 | 6.6 | **8.4** | 10 | 7.4 | **22.1** | **44** | **14.5** |
| Small–medium ungulates | 3 | 1.8 | | 20 | 14.7 | | | |
| *Bos taurus* | 18 | 10.8 | **10.8** | 3 | 2.2 | 2.2 | **21** | **6.9** |
| Large–medium ungulates | 1 | 0.6 | **6** | - | - | 1.5 | **12** | **4.0** |
| Large ungulates | 9 | 5.4 | | 2 | 1.5 | | | |
| *Gazella* sp. | - | - | - | 1 | 0.7 | **0.7** | **1** | **0.3** |
| Lagomorphs | 1 | 0.6 | **0.6** | 1 | 0.7 | **0.7** | 2 | 0.7 |
| Birds | 4 | 2.4 | **2.4** | 5 | 3.7 | **3.7** | **9** | **3.0** |
| Reptiles | 1 | 0.6 | **0.6** | - | - | - | **1** | **0.3** |
| Fish | 2 | 1.2 | **1.2** | 1 | 0.7 | **0.7** | **3** | **1.0** |
| **Total** | **167** | 100 | **100** | **136** | 100 | **100** | **303** | **100** |
| Indeterminate bones | 550 | | | 442 | | | 992 | |
| **Total** | 717 | | | 578 | | | 1,295 | |

and 2015 campaigns (Marchetti 2015a) revealed the presence of LBA phases at the foot of the Acropolis. The most intriguing architectural evidence is a large building, Building 1, of which only two rooms have been excavated. On the basis of the available data, it is possible to preliminarily interpret the building as a residential structure with evidence of productive activities testified by the presence of various storage vessels, ovens, and tools used for food processing, as well as of a high number of faunal remains (717 remains; Pizzimenti and Scazzosi 2017). Most of this sample (76.7%) was not identifiable to species due to poor preservation of the bones. The part of the sample identified to species resulted in a rather differentiated range of animals represented. Sheep and goats—with sheep about twice as numerous as goats—account for 52.2% of the remains (for the distinction between sheep and goats, see Boessneck 1969; Zeder and Pilaar 2010). The evaluation of age-at-death for sheep/goats revealed the exploitation of different age classes with adult individuals between two and four years old predominating. Cattle represent only 10.8%, while pigs account for 9.6% of the entire sample. Small and large ungulates, not more precisely identifiable, cover between 8.4 % and 6.0% of the total.[4] Dog skeletal elements—fourteen in total related to at least two different individuals[5]—were also found along with one lagomorph bone and four elements of unidentified birds. Finally, the identification of one lizard bone and two fish vertebrae is still in progress (see NISP=Number of Identified Specimens and related percentages in Table 2.3.1).

### *Area C East—Late Bronze Age II (Fourteenth–Thirteenth Centuries BC)*

The 2017 excavation in Area C East of the Lower Palace Area uncovered two rooms dated to the LBA II, where 578 faunal remains have been found. Only 23.5% of those remains were identified to species level. The majority of identified bones are of sheep and goats (60.3%) or of small and small–medium ungulates in general (22.1%). Cattle, pigs, and other domestic and wild animals—dogs, equids, birds, fish, hares, and gazelles—are scarce (Table 2.3.1). The preliminary evaluation of age-at-death for sheep/goats revealed the exploitation of different age classes; although juvenile and very young animals are represented, adult and subadult animals were the preferred choice.

## Iron Age

Iron Age (IA) contexts are better preserved at Karkemish compared to the Bronze Age ones, and, as a consequence, the faunal remains are far more abundant in these levels. To date, 9,273 faunal remains have been studied from the five areas of the site considered in this paper (Table 2.3.2), which cover the entire chronological range from the IA I to the IA IV/Achaemenid period (twelfth–fourth centuries BC).

### *Area S—Iron Age I (Eleventh–Tenth Centuries BC)*

Excavation in Area S of the Lower Palace Area uncovered an open area with productive and storage structures dated to Late IA I, which had later been leveled during the construction of the massive King's Gate in the IA II. The ongoing zooarchaeological analysis has so far completed analysis of 1,769 animal remains. Species determination was possible only for 455 bone fragments (ca. 25% of the total). Sheep/goats and small and indeterminate small–medium ungulates (326 remains, equal to 74.3% of the identified sample) are the most frequent, followed by cattle and large ungulates (81 elements) and equids (11 remains; Table 2.3.2). Pigs and dogs are represented by two bones each. Regarding wild animals, gazelles are the most abundant species (11 post-cranial bones and one horn core) but one element of fallow deer and another of hare are also present. Bird remains are in a very poor state of preservation and only one of the 13 fragments was positively identified to the order Galliformes.

The archaeozoological analysis of Area S also led to the discovery of four different elephant bones—cf. *Elephas maximus*, possibly *Elephas maximus asurus*—including: one distal portion of a tibia, one third metatarsal, one fragment of a distal femoral epiphysis, and another indeterminate leg-bone fragment, probably all belonging to the same subadult individual (Maini et al. 2018).

### *Area G—Iron Age I, II, III (Twelfth–Seventh Centuries BC)*

Area G is located at the foot of the Acropolis, west of the Lower Palace Area. Excavations carried out during the 2012–2014 campaigns revealed a long archaeological sequence covering the Bronze and Iron Ages (Zaina 2018), but only the Iron Age levels included animal remains (Maini 2018).

IA I levels (twelfth–tenth centuries BC) excavated in Area G produced only 83 animal bone fragments, recovered from two different pebble floors. Species determination was not possible for about half of this sample. Indeterminate remains included mainly fragments of ribs and vertebrae from both small and large animals, while the 43 identified bone fragments testify to a differentiated sample. Nine bone fragments of adult and subadult sheep and goats represent at least three individuals, while 12 fragments of bovids came from at least two adult individuals. Three bone fragments come from one adult pig; six equid bones testify to at least one horse and one donkey (for the identification of equids according to their dental anatomy, see Baxter 1998).

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[4] The categories "small and small–medium ungulates" (e.g., sheep, goats, and gazelles) and "large and large–medium ungulates" (e.g., cattle, equids, etc.) usually derive from the thickness of not well-identified bone fragments.

[5] NISP includes all skeletal elements, but the presence of two different animals has been ascertained thanks to the presence of two different left hind limbs.

Table 2.3.2. Preliminary faunal composition of the Iron Age levels in Area S, Area A, Area C East, and Area C South (Well) at Karkemish (updated to the 2017 field season).

| | Area S (IA I) | | | Area G (IA I–III) | | | Area C East (IA I–IV) | | | Area C South (Well) (IA III) | | | Total IA | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Taxa & animal groups** | **NISP** | **%NISP groups** | | **NISP** | **%NISP groups** | | **NISP** | **%NISP groups** | | **NISP** | **%NISP groups** | | **NISP** | **%NISP groups** |
| *Equus caballus* | 2 | 0.4 | **2.4** | 2 | 0.4 | **11.3** | 2 | 0.2 | **11.0** | 1 | 0.2 | **1.5** | **221** | **7.7** |
| *Equus asinus* | 2 | 0.4 | | 4 | 0.7 | | 9 | 0.7 | | - | - | | | |
| *Equus* sp. | 7 | 1.5 | | 55 | 10.2 | | 129 | 10.2 | | 8 | 1.3 | | | |
| *Canis familiaris* | 2 | 0.4 | **0.4** | 12 | 2.2 | **2.2** | 10 | 0.8 | **0.8** | - | - | - | **24** | **0.8** |
| *Sus domesticus* | 2 | 0.4 | **0.4** | 19 | 3.5 | **3.5** | 17 | 1.3 | **1.3** | 11 | 1.9 | **1.9** | **49** | **1.7** |
| Sheep/goats | 137 | 30.1 | **37.1** | 100 | 18.6 | **35.3** | 410 | 32.3 | **40.0** | 155 | 26.1 | **52.9** | **1,181** | **41.4** |
| *Ovis aries* | 20 | 4.4 | | 67 | 12.5 | | 64 | 5.0 | | 111 | 18.7 | | | |
| *Capra hircus* | 12 | 2.6 | | 23 | 4.3 | | 34 | 2.7 | | 48 | 8.1 | | | |
| Small ungulates | 35 | 7.7 | **34.5** | 76 | 14.1 | **19.0** | 72 | 5.7 | **20.3** | 133 | 22.4 | **25.1** | **665** | **23.3** |
| Small–medium ungulates | 122 | 26.8 | | 26 | 4.8 | | 185 | 14.6 | | 16 | 2.7 | | | |
| *Bos taurus* | 62 | 13.6 | **13.6** | 109 | 20.3 | **20.3** | 202 | 15.9 | **15.9** | 33 | 5.6 | **5.6** | **406** | **14.2** |
| Large–medium ungulates | 7 | 1.5 | **4.2** | 9 | 1.7 | **7.2** | 16 | 1.3 | **4.6** | 3 | 0.5 | **1.3** | **124** | **4.3** |
| Large ungulates | 12 | 2.6 | | 30 | 5.6 | | 42 | 3.3 | | 5 | 0.8 | | | |
| *Cervus elaphus* | - | - | - | - | - | - | - | - | - | 2 | 0.3 | **0.3** | **2** | 0.1 |
| *Capreolus capreolus* | - | - | - | - | - | - | - | - | - | 1 | 0.2 | **0.2** | **1** | **< 0.1** |
| *Gazella* sp. | 12 | 2.6 | **2.6** | - | - | - | 2 | 0.2 | **0.2** | 9 | 1.5 | **1.5** | **23** | **0.8** |
| *Dama* sp. | 1 | 0.2 | **0.2** | 4 | 0.7 | **0.7** | - | - | - | 1 | 0.2 | **0.2** | **6** | **0.2** |
| *Camelus* sp. | - | - | - | 1 | 0.2 | **0.2** | 18 | 1.4 | **1.4** | - | - | - | **19** | 0.7 |
| *Elephas maximus* | 4 | 0.9 | **0.9** | - | - | - | - | - | - | - | - | - | **4** | **0.1** |
| *Giraffa camelopardalis* | - | - | - | - | - | - | 1 | 0.1 | **0.1** | - | - | - | **1** | **< 0.1** |
| *Pantera* sp. | - | - | - | - | - | - | - | - | - | 1 | 0.2 | **0.2** | **1** | **< 0.1** |
| *Felis* sp. | - | - | - | - | - | - | 1 | 0.1 | - | - | - | - | **1** | < 0.1 |
| *Vulpes vulpes* | 2 | 0.4 | **0.4** | - | - | - | - | - | - | - | - | - | **2** | **0.1** |
| Lagomorphs | 1 | 0.2 | **0.2** | 1 | 0.2 | **0.2** | 9 | 0.7 | **0.7** | 15 | 2.5 | **2.5** | **26** | **0.9** |
| Other mammals | - | - | - | - | - | - | 20 | 1.6 | **1.6** | 15 | 2.5 | **2.5** | **35** | **1.2** |
| Birds | 13 | 2.9 | **2.9** | - | - | - | 20 | 1.6 | **1.6** | 22 | 3.7 | **3.7** | **55** | 1.9 |
| Reptiles | - | - | - | - | - | - | 1 | 0.1 | **0.1** | 1 | 0.2 | **0.2** | **2** | **0.1** |
| Fish | - | - | - | - | - | - | 5 | 0.4 | **0.4** | 3 | 0.5 | **0.5** | **8** | **0.3** |
| **Total** | **455** | 100 | **100** | **538** | 100 | **100** | **1,269** | 100 | **100** | **594** | 100 | **100** | **2,856** | **100** |
| Indeterminate bones | 1,341 | | | 492 | | | 2,986 | | | 1,598 | | | 6,417 | |
| **Total** | 1,796 | | | 1,030 | | | 4,255 | | | 2,192 | | | 9,273 | |

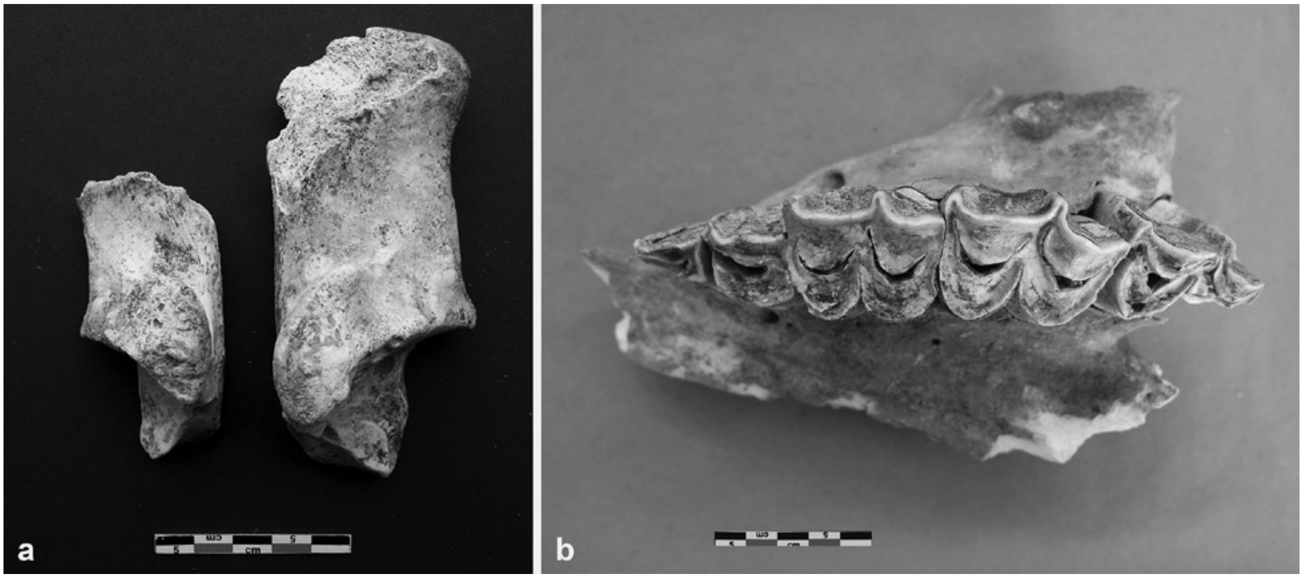

Figure 2.3.2. Animal bones from Area G: (a) Iron Age II, ventral views of equid calcanea, that is, donkey (left) and horse (right); (b) Iron Age III, left camel upper jaw, maxillary. (Photographs by E. Maini.)

Dog is represented only by one element: a mandible with traces of a traumatic pathology on a premolar (for a detailed analysis of animal remains from Area G, see Maini 2018). The sample also includes 12 bone fragments of small to large ungulates. No wild animals have been found in these levels.

Most of the faunal remains retrieved from Area G (824 fragments corresponding to ca. 82% of the entire IA sample of Area G) came from street levels dated to the IA II (tenth–eighth centuries BC). More than half of the remains from these contexts (445 fragments equaling 54.0%) were identified to the species level. Domestic animals were clearly predominant, with sheep and goats represented by 161 bone fragments, followed by cattle (89 fragments) and equids, including both donkeys and horses (Figure 2.3.2a), represented by 54 fragments. Pigs (14 fragments) and dogs (1 bone fragment only) are instead quite scarce (for a detailed analysis of animal remains from Area G, see Maini 2018).

In contrast, faunal remains are rare in the floor levels and in the numerous pits dated to the IA III (seventh century BC). In total, 123 bone fragments corresponding to ca. 11% of the entire IA sample of Area G have been found in these levels. Sheep/goats and small ungulates were represented by 29 fragments. These account for at least nine different individuals, which were preferentially slaughtered as subadults or adults between one and six years of age. Large animals are less common. The eight bovid remains indicate the presence of at least two individuals: one adult and one calf of a few months of age, identified by an upper jaw fragment with deciduous tooth. One donkey was also identified, while the two pig bones indicate the presence of a single young individual. Also present in this layer is one fragment of an adult camelid's jaw, which includes one incisor and the $P^3$–$M^3$ maxillary left tooth row (Figure 2.3.2b).[6]

### *Area A (Temple)—Iron Age III (Seventh Century BC)*

Two distinct dog depositions were found in the IA III levels behind the temple in Area A. This type of deposition is already documented at Karkemish, where at least four more dogs were found buried in contexts dated to both the Bronze and Iron Ages. This practice was probably related to specific rituals in the context of the foundation and/or decommissioning of specific structures or areas (Figure 2.3.3).

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[6] Additional morphometric analyses will allow for a more precise definition of the species (Curci and Maini 2017). Indeed, both dromedaries and two-humped camels were present in Southwest Asia during this period (Becker 2008). For the distinction between dromedaries and two-humped camels, we follow Steiger (1990).

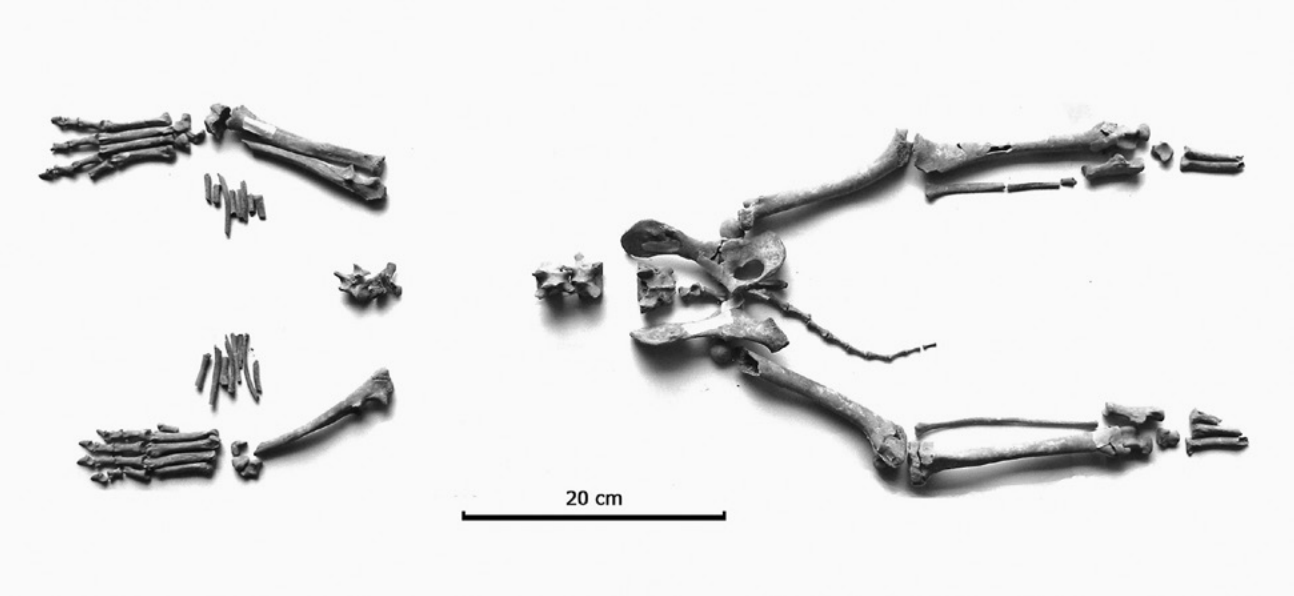

Figure 2.3.3. Area A (Temple), Iron Age III: dorsal view of the entire skeleton of a juvenile (6–7 months) dog. (Photograph by E. Maini.)

### *Area C East—Iron Age II to IV levels (Ninth–Fourth Centuries BC)*

For Area C East, the analysis of the faunal assemblage dated to IA II–IV/Achaemenid levels from below the Neo-Hittite and Neo-Assyrian building is still in progress. However, the large number of animal remains already analyzed (4,255 fragments) allows for a preliminary evaluation of the animal economy of the Lower Palace Area and its possible evolution from the foundation of the palatial compound in the ninth century BC to its transformation with a partial reuse of the palatial compound associated with domestic buildings and some small-scale productive installations during the Achaemenid period (Pizzimenti and Zaina 2016).

In the palatial compound of Katuwa and Yariris (for a detailed historical and structural description, see Pizzimenti and Zaina 2016:364–365), 455 animal remains have been found to date in levels dating to IA II. Only 163 of these remains (36.3%) were identified to species. Sheep and goats, in accordance with the evidence from the other areas of the site, are again the most represented taxa. The percentage of sheep, goats, and indeterminate small and small–medium ungulates is very high (80.4%). Large ungulates account for less than 12% of the identified remains, with cattle represented by 13 bone fragments from at least two subadult animals. Equids are represented by four remains, all probably from the same individual, a donkey. Finally, pigs are represented by two bones only; birds and hares by one bone each.

Approximately three thousand animal remains (3,082 precisely) were recovered from levels related to the palatial complex of Sargon II, which dates to the IA III. Only 28.5% (878 bones) of this sample was identifiable to species. Although sheep/goats and small to small–medium ungulates are still the most common group with 514 remains (equal to ca. 58.5% of the NISP), the faunal composition is more diversified than in other areas of the site.

Large and medium–large ungulates—including bovids, equids, and camelids—account for 351 remains, 153 of which related to cattle and 96 to equids. Most of the equids are donkeys, but there are also some horse teeth, and one mandible possibly testifies to the presence of an onager (*Equus hemionus*; Baxter 1998). Eighteen bird remains derive from at least three different animals: one Galliform, one Columbid, and, probably, one goose. Among wild mammals, there are remains of gazelles and hares and mustelids have also been identified. Finally, the sample contained three fragments of fish bones.

The faunal assemblage from this area includes also an exceptional collection of remains from a stone-lined pit dating to the IA III. The sample, whose analysis is still ongoing, includes numerous complete skeletons of both domestic and wild species, which show numerous butchery marks. Moreover, the femur of a subadult giraffe testifies to the presence of this exotic animal at Karkemish.

Analysis of the sample from the IA IV/Achaemenid levels is ongoing. Of the 718 remains studied to date, 230—including depositions of entire carcasses—have been determined to species. As usual, the identified remains include a majority of sheep and goats and small and medium–small ungulates (112 remains equal to 49.0%) followed by equids—both horse and donkey (40 bone fragments, 18.0%), cattle (36 remains, 16.0%), and indeterminate large ungulates (16 remains, 7.0%). Five camelid remains come from two different individuals—one subadult and one adult—and testify to the use of these large animals not only as beasts of burden but also for food: taphonomic analysis identified cut marks on the lower jaw of a camel (Figure 2.3.4).[7]

The complete skeleton of a cow—four to six years of age—was found in perfect anatomical arrangement inside a pit that cut the fill of a room located in the main building (Figure 2.3.5). The feature dates to the beginning of the IA IV/Achaemenid period, when the palace was abandoned and the area partially reused as a residential area with firing installations.

Figure 2.3.4. Area C East, Iron Age IV/Achaemenid: lateral view of a *Camelus* sp. right lower jaw. (Photograph by E. Maini.)

Figure 2.3.5. Area C East, Iron Age IV/Achaemenid: entire skeleton of a female *Bos taurus* laid on its left side. (Photograph by E. Maini.)

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[7] See above, n. 6.

Figure 2.3.6. Area C South (Well), Iron Age III: dorsal view of a *Pantera* sp. medial first anterior phalanx. (Photograph by E. Maini.)

### *Area C South (Well)—Iron Age III (Seventh Century BC)*

A well dated to the IA III in Area C South contained 2,192 faunal remains. Even if the statistical analysis of this assemblage is still ongoing, some preliminary results are available. First, the number of remains not identifiable to species is particularly high (ca. 73%) probably due to the peculiar nature of the context. Sheep/goats and indeterminate small ungulates are by far the most common group, with 463 remains (ca. 78% of the NISP). Large and medium–large ungulates, including bovids and equids, account for 50 remains—33 bones of cattle and nine of equids. Pigs are represented by 11 fragments.

The few remaining bones include the exceptional discovery of a *Pantera* sp. first phalanx—probably a lion (Figure 2.3.6)—as well as of a cluster of 38 sheep and goats' knucklebones—that is, astragali—several of which were polished or pierced. Anthropic modified knucklebones were very common in ancient Southwest Asia from prehistory to the Roman period and even later, they were commonly used in divination practices or as gaming dice (Affanni 2008; Gilmour 1997; Minniti and Peyronel 2005).

## The Animal Economy at Karkemish from the Late Bronze Age to Iron Age IV

In general, sheep/goats are by far the most abundant taxa in all the occupational phases and areas of Karkemish from the Late Bronze Age to Iron Age IV/Achaemenid period (sixteenth–fifth centuries BC). Small–medium size ungulates, mainly domestic sheep and goats, make up most of the faunal assemblage. Large ungulates, such as bovids and equids, are consistently less abundant, while pigs are very rare (see Tables 2.3.1 and 2.3.2).

Even if domestic animals were clearly predominant in the site's subsistence strategy, wild animals were occasionally present throughout the different phases including ungulates such as red deer, fallow deer, and gazelles and occasionally also lagomorphs.

Of particular interest are the remains of camelids discovered in IA III levels of Area G and in IA IV/Achaemenid levels of Area C East. Detailed morphometric analyses to determine the species is ongoing. However, this evidence confirms the use of camelids in southeastern Turkey for food as well as for transport during the IA. Moreover, there are some exceptional discoveries from the Lower Palace Area, including a lion bone found inside the filling of a well in Area C South and dated to the IA III, four elephant bones discovered in the IA I levels of Area S, and one giraffe bone from the IA III levels of Area C East.

Considering the general trend suggested by the preliminary evaluation of animals' age-at-death, the animal economy at Karkemish was evidently based on pastoralism including the exploitation of both primary and secondary products.

As for the age at slaughter of the different species, there was a general trend towards the exploitation of animals at the end of their growth cycle, as evidenced by the relative abundance of remains from subadult or adult individuals. Equids, including both horses and donkeys, were killed mainly as adults. They were not primarily exploited for food but instead mainly functioned as beasts of burden and possibly also as status symbols. In contrast, sheep/goats show a diversified killing strategy due to their exploitation not solely for meat consumption but also for secondary products such as wool, milk, and skin for leather. Cattle were also killed as subadults, when they still provided good-quality meat, or as adults to maximize meat production and prolong as much as possible their role in plowing and pulling vehicles. The few pigs were instead usually slaughtered young to obtain better-quality meat.

The ratio between NISP and MNI (Minimum Number of Individuals) of species relevant to food consumption, calculated to obtain information about animal exploitation for secondary products, further stresses the economic importance of sheep and goats in contrast to the insignificant amount of protein contributed by pigs.

A comparable exploitation strategy of faunal resources has been proposed for IA levels of other sites in the region and for sites located in comparable agroecological zones. A similar distribution of taxa to that identified at Karkemish was documented at Tell Ta'yinat, where sheep/goats accounted for more than 80% of the protein demand during IA II (Lipovitch 2008). Sheep/goats were also dominant in IA I and II assemblages from Tell Shiukh Fawqani (Vila 2005). However, it is possible to note minor variations in animal exploitation within the dominant trend for a pastoral economy.

At Karkemish, all taxa were generally exploited until the end of their growth cycle and young animals are scarce compared to adults. However, the faunal assemblages from the IA levels at ʿAin Dara (Frey and Marean 1999), Tell Afis (Wilkens 1992), Tell Mastuma (Tomé and Nishiyama 2005), and Tell Shaikh Hamad/Dur-Katlimmu (Becker 2008) in Syria included a higher proportion of young individuals, mainly sheep/goats. The site of ʿAin Dara also yielded a larger number of pigs, which—in contrast to the situation at Karkemish—represented the second most exploited meat resource (Frey and Marean 1999:126, Table 4). The same trend, with a higher proportion of pigs, is documented also in IA levels of Tell Mastuma (Tomé and Nishiyama 2005:105) and Tell Afis (Wilkens 2002:58–60). These variations between comparable contexts are probably related to the availability of water and the consequent degree of humidity in the rural areas surrounding the cities, where herders and animals roamed.

Finally, the scarcity of bird and fish bones in the faunal assemblage at Karkemish might be due to taphonomic and methodological factors leading to their underrepresentation.[8] In fact, considering the site's proximity to the Euphrates River and the presence of numerous other freshwater sources in the area, such resources should have been exploited at Karkemish as frequently as at other comparable sites.

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[8] See above, n. 2.

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## 2.4

# The Subsistence Economy of a Highland Settlement in the Zagros during the Bronze and Iron Ages

## The Case of Gūnespān (Hamadan, Iran)

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### Abstract

Gūnespān is located in the southeastern part of Malayer, in Hamadan Province in Iran. The main occupation occurred during the Bronze Age and Late Iron Age (Median) periods. The study of archaeozoological assemblages from these periods revealed that sheep/goat and cattle constitute the bulk of the exploited animal resources, showing that these human communities were highly dependent on pastoralism. During the Iron Age, the role of cattle seems to have become more predominant, which might be an indication of agricultural development in this region. Also, another feature in common with other sites in Iran is the increase of suid remains, which shows the growing importance of domestic pig during the Iron Age. In parallel, equid remains are also more numerous. The same pattern is visible when comparing Gūnespān to Godin Tepe and Nush-i Jan. The identified wild species (12%), the majority of which are herbivores, belong to wild sheep (*Ovis orientalis*), wild goat (*Capra aegagrus*), red deer (*Cervus elaphus maral*) or Persian fallow deer (*Dama dama mesopotamica*), wild boar (*Sus scrofa*), and gazelle (*Gazella* cf. *subgutturosa*). Other identified wild taxa are wild or domestic cat (*Felis silvestris/catus*), hare (*Lepus europaeus*), heron (*Ardea* sp.), duck (Anatidae), and tortoise (*Testudo graeca*).

### Keywords

*Zagros Mountains, Godin Tepe, Nush-i Jan, Bronze Age, Iron Age, Median period, agropastoralism, donkey, onager, chicken*

## Introduction

In light of long-term archaeological investigations in Iran, much information is now available from Bronze and Iron Ages. Several well-known sites such as Nush-i Jan (Stronach et al. 1978; Stronach and Roaf 2007), Godin Tepe (Young and Levine 1974), Baba Jan (Goff 1977, 1985), and Ziweyeh (Mo'tamedi 1996) have yielded significant information about these periods in Central Zagros. However, the Median culture of Iron Age (IA) III—Median period—has rarely been investigated until now.

The site of Gūnespān is located in the southeastern part of Malayer, 1 km from the Kalan Dam, on the bank of the Kalan River (Hamadan Province, Central Zagros, Iran) in the village of Pattapeh, at an elevation of 1,936 m. The site stands 27 m above the surrounding fields and covers about 3.24 ha (Figure 2.4.1). Gūnespān was excavated over six seasons as part of an archaeological salvage project inside the dam reservoir. The fourth and fifth seasons of excavations were conducted by one of the authors (RN), when four trenches were excavated, revealing IA III and Bronze Age (BA) deposits (Naseri 2009a, 2009b). Gūnespān is represented by a sequence stretching from the BA to the Islamic period. Locally the earliest levels of occupation belong to the Early Bronze Age (EBA) and are contemporaneous to Godin IV and III levels of Godin Tepe (Gopnik and Rothman 2011), although the main occupation is referred to

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as the Middle and Late Bronze Age (MBA and LBA; Godin III) and IA III (Naseri et al. 2016). The building excavated at the site shows close similarities to other Median architecture at nearby Godin Tepe (Gopnik and Rothman 2011:Figure 2.8) and Nush-i Jan (Stronach and Roaf 2007:Figure 1.9). Archaeozoological studies from these periods are still scarce in this part of Iran and only Godin Tepe (Crabtree 2011; Gilbert 1979) and Nush-i Jan (Stronach et al. 1978) are directly comparable with Gūnespān (Figure 2.4.1).

## The Faunal Spectrum of Gūnespān

The archaeozoological study of the faunal remains from the fourth and fifth seasons was undertaken at the archaeozoology section of the Bioarchaeology Laboratory of the University of Tehran (2012–2014). The faunal assemblage of Gūnespān is very small, in comparison to those from Godin Tepe (N = 5,704) and Nush-i Jan (N = 14,862), and its preservation is satisfactory: about 55% of the bones were highly fragmented and 45% of the bones were identifiable to a taxonomic level. The animal remains are consumption waste, as indicated by the presence of cut marks (28%), chopping marks (6.1%), and heated surfaces (17.5%) on some bones.

This analysis derives from a total of 1,004 bone fragments (total weight 9 kg) out of which 94 fragments belong to Godin IV, 467 fragments to Godin III, and 443 fragments to the IA levels (Table 2.4.1).

All anatomical parts of the skeleton are present in the assemblage. For taxonomic identifications, the osteological reference collections of the laboratory were used as well as several atlases (Barone 1986; Hilson 1986; Pales and Garcia 1981; Schmidt 1972; Walker 1985). Caprines—sheep/goat—constitute the bulk of the identified remains (84%, N = 356). To distinguish between sheep and goat, the following references were used: Boessneck 1969; Clutton-Brock et al. 1990; Halstead et al. 2002; Helmer 2000; Helmer and Rocheteau 1994; Payne 1985. A total of 190 specimens could not be identified as either sheep or goat, while 53 specimens were allocated to domestic sheep (*Ovis aries*), 3 to wild sheep (*Ovis orientalis*), 78 to domestic goat (*Capra hircus*), and 4 to wild goat (*Capra aegagrus*). Cattle (*Bos taurus*) bones total 9% of the Number of Identified Species (NISP = 68 specimens). Thus, during the BA (Godin III) and IA III (Median period) the bulk of the site's subsistence economy relied on the exploitation of small and large domestic ruminants with a clear emphasis on small herbivores.

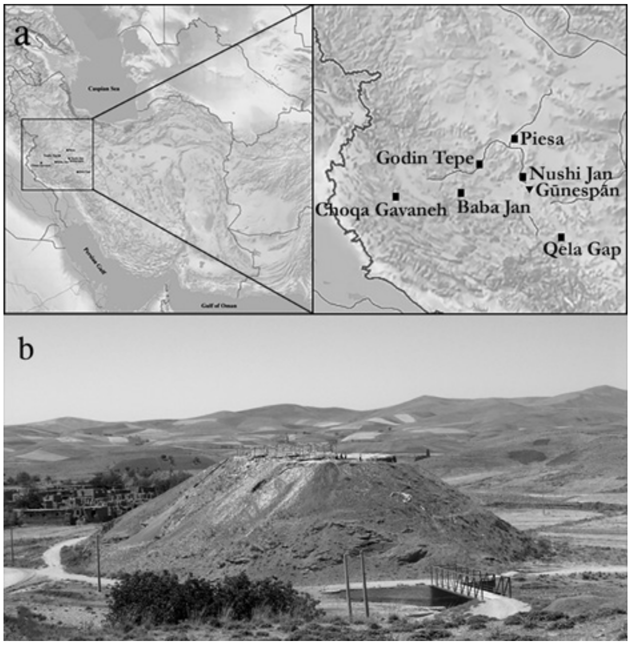

Figure 2.4.1. (a) Location of Gūnespān and other sites in Central Zagros of Iran; (b) general view of Gūnespān.

Other taxa were also present at Gūnespān: gazelle (*Gazella* cf. *subgutturosa*, less than 1%), red deer or Persian fallow deer (*Cervus elaphus maral/Dama dama mesopotamica*, 1%), wild boar or domestic pig (*Sus scrofa*, 4.4%), and equids (3.5%) out of which one specimen was identified as a hemione (*Equus hemionus*). Carnivore species consisted of domestic dog (*Canis familiaris*) and wild or domestic cat (*Felis silvestris/catus*). Finally, two hare bones (*Lepus europaeus*), two bone fragments of tortoise (*Testudo graeca*), and seven bird specimens were recovered, including chicken (*Gallus gallus*), a heron (*Ardea* sp.), and a duck (Anatidae; Figure 2.4.2; Table 2.4.1). In total, during Godin III and IA III, 93% of the faunal assemblage belonged to domestic animals and 7% to wild species.

## Characterization of Equid and Bovid Populations at Gūnespān

### *Methodology for Biometric Analyses*

Equid remains were measured following codes established by Eisenmann (2007a, 2007b, 2009). The method used to specifically identify the equid post-cranial bones is based on a logarithmic method

Table 2.4.1. Distribution of the faunal remains at Gūnespān.

| | | **Godin IV (Early Bronze)** | | **Godin III (Middle Bronze)** | | **Iron Age III** | | **Total** | |
|---|---|---|---|---|---|---|---|---|---|
| | | **NISP** | **Weight** | **NISP** | **Weight** | **NISP** | **Weight** | **NISP Total** | **Weight Total** |
| **IDENTIFIED SPECIES** | | | | | | | | | |
| Caprini | *Ovis/Capra* | 20 | 131.8 | 94 | 581.3 | 76 | 769.6 | 190 | 1,482.7 |
| | *Capra hircus* | 3 | 44.4 | 48 | 280.4 | 27 | 286.7 | 78 | 611.5 |
| | *Capra aegagrus* | | | 4 | 14.5 | 0 | 0 | 4 | 14.5 |
| | *Ovis aries* | 8 | 126.3 | 30 | 182.3 | 15 | 198 | 53 | 506.6 |
| | *Ovis orientalis* | 1 | 26.8 | | | 2 | 59.8 | 3 | 86.6 |
| *Bos taurus* | | 3 | 40.6 | 19 | 398.2 | 46 | 1,723.4 | 68 | 2,162.2 |
| *Gazella subgutturosa* | | | | 1 | 9.6 | | | 1 | 9.6 |
| *Sus scrofa* | | 1 | 6 | 1 | 8.5 | 17 | 454.3 | 19 | 468.8 |
| Cervidae | | 1 | 168.8 | 1 | 14.7 | 3 | 85.1 | 5 | 268.6 |
| Equidae | Equidae | | | 1 | 19 | 11 | 506.8 | 12 | 525.8 |
| | *Equus asinus* | | | 1 | 23.7 | | | 1 | 23.7 |
| | *Equus hemionus* | | | | | 1 | 96.2 | 1 | 96.2 |
| Carnivores | *Canis familiaris* | | | | | 1 | 6.2 | 1 | 6.2 |
| | *Felis* sp. | | | | | 1 | 4.4 | 1 | 4.4 |
| | Small carnivore | | | 4 | 4.4 | | | 4 | 4.4 |
| Minor species | *Lepus europaeus* | | | | | 2 | 6.6 | 2 | 6.6 |
| | *Testudo graeca* | 4 | 55.4 | 7 | 43.4 | | | 11 | 98.8 |
| | *Gallus gallus* | | | | | 2 | 3.6 | 2 | 3.6 |
| | *Ardea* sp. | | | | | 1 | 0 | 1 | 0 |
| | Anatidea | | | 1 | 0.6 | | | 1 | 0.6 |
| | Unidentified Aves | | | 2 | 1.3 | 1 | 3.3 | 3 | 4.6 |
| **Total of identified species** | | **41** | **600.1** | **214** | **1,581.9** | **206** | **4,204** | **461** | **6,386** |
| **UNIDENTIFIED SPECIES** | | | | | | | | | |
| Mammals | Large Mammal | 9 | 161.5 | 30 | 407 | 58 | 825.8 | 97 | 1,394.3 |
| | Small Mammal | 9 | 32.6 | 9 | 13 | 20 | 54.7 | 38 | 100.3 |
| Small Ruminant | | 35 | 120.6 | 199 | 591.4 | 135 | 653.3 | 369 | 1,365.3 |
| Unidentified | | | | 15 | 12.2 | 24 | 56.9 | 39 | 69.1 |
| **Total of unidentified species** | | **53** | **314.7** | **253** | **1,023.6** | **237** | **1,590.7** | **543** | **2,929** |
| **Grand Total** | | **94** | **914.8** | **467** | **2,605.5** | **443** | **5,794.7** | **1,004** | **9,315** |

known as Simpson's ratio diagrams (Simpson 1941), where measurements are converted into decimal logarithms and compared with a standard. Here the standard animal is the Persian onager (*Equus hemionus onager*; Eisenmann and Mashkour 2000). Specifically for the first phalanx measurements, we used the mean value of the first anterior phalanges of a Persian onager as the standard, following Dive and Eisenmann (1991).

For other taxa, we used the measurement codes published by von den Driesch (1976). Sheep and goat biometric analysis was also performed using a logarithmic method but with a slight difference: the "Size Index Method" developed by Uerpmann (1979) and simplified by Meadow (1999). This provides a straightforward and easy way to compare various sites and visualize their differences. Because bones or parts of bones have different scale proportions, for example, length and breadth, all measurements are converted to logarithms to diminish the effect of these scale differences. The basic idea is to relate every find measurement to the respective measurement of a known and preferably recent individual, the so-called Standard. The distance from the Standard (S) is then used as an indication (= Index) of the size for the unknown individual (X) from which the find was derived, and a "Log-Size Index" (LSI) or ratio is obtained (LSI = Log X - Log S). For sheep and goat standards, we used measurements from a wild sheep (*Ovis orientalis*) and wild goats (*Capra aegagrus*) as published by Uerpmann and Uerpmann (1994). For cattle standard, we used measurements from a female cow (*Bos primigenius* f. *taurus*) from Carmague (Southern France), as published in Helmer 1992.

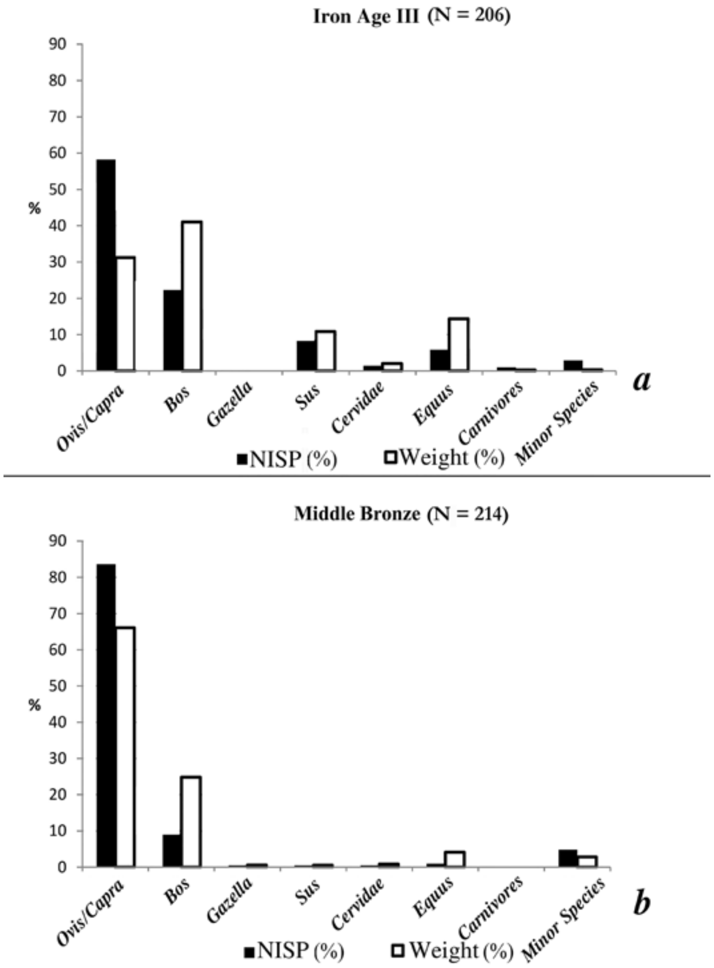

Figure 2.4.2. (a) Taxonomic distribution of the faunal remains at Gūnespān in the Iron Age III (Median period); (b) taxonomic distribution of the faunal remains at Gūnespān in the Bronze Age (Godin III).

## *Identification of Equid Bones*

Of the eight equid bones that were collected at Gūnespān, seven specimens belong to IA III and one to the BA. Only three could be measured: one BA first phalanx, one IA metacarpal, and two superior molar teeth.

Log ratios of the archaeological specimens are projected with the four potential options for the Iranian Plateau alongside the onager, which is used as the Standard (see above, *Methodology for Biometric Analyses*): horse (*Equus caballus*), donkey (*Equus asinus*), hybrids, for instance, mules and hinnies (*E. caballus* X *E. asinus*), and another wild ass, the Turkmen kulan (*Equus hemionus kulan*), besides, of course, the Persian onager (*E. h. onager*) that is already included as the standard.

The profile of Gūnespān's first phalanx is generally much smaller than the one of the donkey (*E. asinus*; Figure 2.4.3a). However it should also be noted that the proportions of this bone and its overall profile are comparable to the one of the horse. The small size of the bone cannot be due to age as the bone belongs to an adult specimen. At this stage of uncertainty, only genetics could bring a secure answer. In either case, the finding is very interesting and should be documented and compared with future finds in the region.

This first phalanx is dated to the second half of the third millennium BC. The earliest remains of identifiable domestic ass (*E. asinus*) on the Iranian

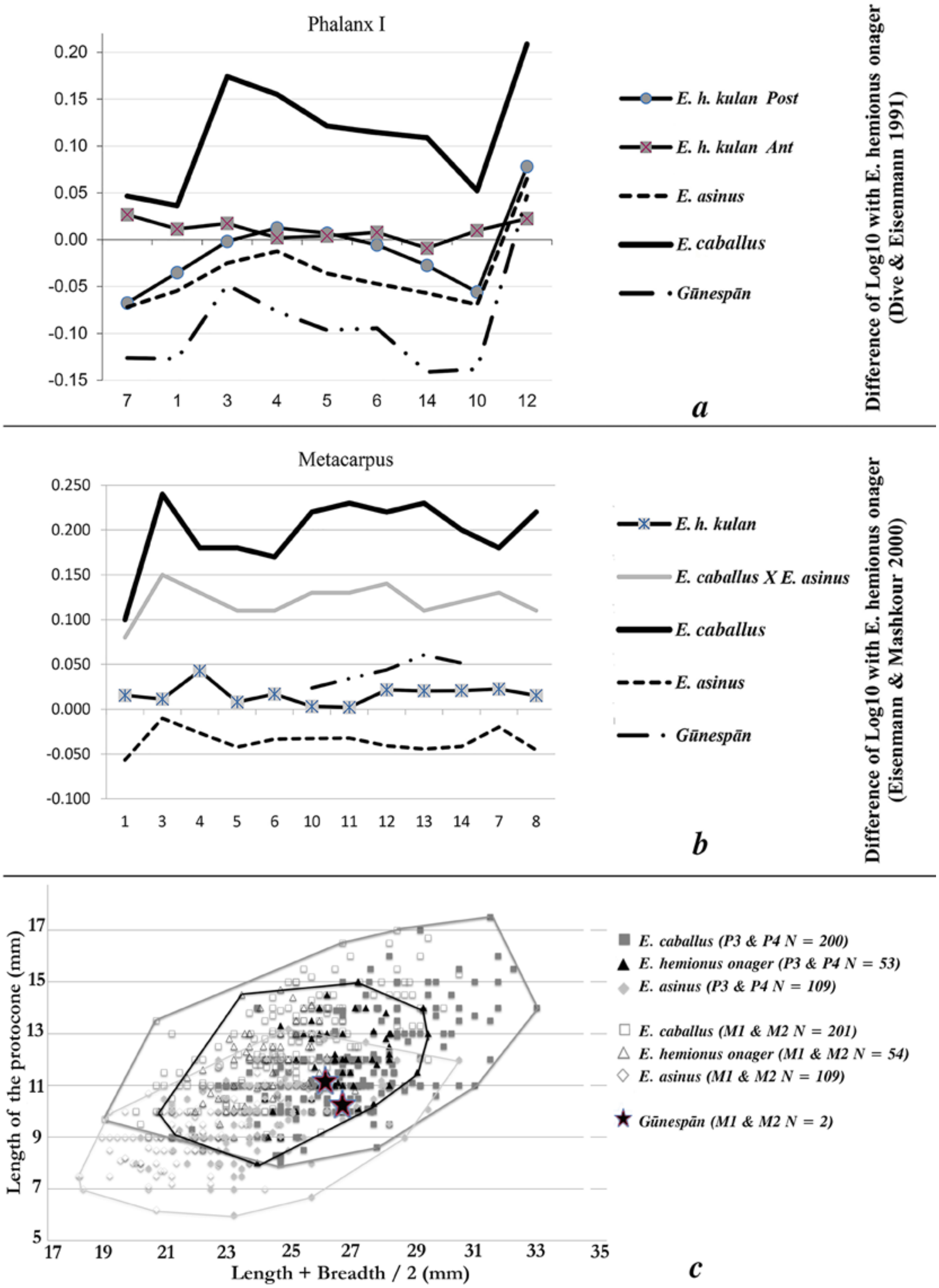

Figure 2.4.3. (a) Logarithmic ratio diagrams of equids' first phalanges; (b) logarithmic ratio diagrams of equids' third metacarpal; (c) bivariate diagram of equids' upper teeth. P: premolar, M: molar. (Modified after Mashkour 2001:214.)

Plateau were found in Qabrestan—mid-fourth millennium BC (Mashkour et al. 1999)—and Arisman—second half of the fourth millennium to early third millennium BC (Benecke 2011). In neighboring regions in Iraq, Turkey, and Syria they are present from the Uruk period (Vila 2006) and might be at the origin of the eastward spread of this animal (Vila and Mashkour 2020).

The presence of domestic ass at Gūnespān is interesting, although it is later than the two other mentioned cases above. Indeed, the presence of donkey remains rare on the Iranian Plateau even during the third millennium. However, as stated above, the possibility that the bone belongs to a very small horse considering its logarithmic profile resemblance with the horse should not be ruled out.

For the IA, the only measurable bone is a metacarpal (Figure 2.4.3b). The logarithmic differences show that this was from a middle-sized animal relatively similar to the standard that is the mean for Persian onager (*Equus hemionus onager*).

The two upper molars found in IA III (context 5005) were compared to modern and fossil measurements (Mashkour 2001:214). We projected the measurements of the upper first or second molar in this graph (Figure 2.4.3c). The two specimens fall in the lower part of the horse variation but are also within the variation of hemiones. The morphology of the teeth in this case presents no diagnostic features that allow distinction between horse and hemione.

The presence of a wild equid at Gūnespān is noteworthy for this period. It is known that hemiones were hunted in the Zagros during prehistory (Bakken 2000; Bennett et al. 2017) and this find adds to the zoogeographic record for the presence of this species in the area. Today the hemione is totally absent from the Zagros and lives only in very remote places, within protected areas in the center of the Iranian Plateau (Denzau and Denzau 1999). It occupies a very different habitat from the Zagros highlands today and lives in steppe to semi-stepped arid zones.

### *Identification of Sheep, Goat, and Cattle Populations of the Central Zagros*

In total, 47 goats, 38 sheep, and 26 cattle bones were measurable (Appendix 2.4.1a–2.4.1c). These were compared to the measurements of other sites in the Central Zagros or Iranian Plateau (Mashkour 2001).

For comparison, we used metric data from several sites in the Zagros region that either predate Gūnespān or are contemporaneous in order to evaluate the diachronic changes in size. The sites of Tepe Asiab (Bökönyi 1977; Zeder and Hesse 2000) and other sites of the Zagros studied by Bökönyi (1977), such as Sarab (Late Neolithic), Siahbid (Early and Middle Chalcolithic), Dehsavar (Late Chalcolithic), as well as Tepe Qela Gap from the Late Neolithic to the LBA (Amiri et al. 2014) are all located in the Zagros region not very far away from Gūnespān.

Goat—*Capra*. Goat measurements were only available for the MBA and IA III. It should be noted that there were no EBA measurable bones for goat. LSI diagrams highlight that the shift in the size of goat populations (Figure 2.4.4a) seems to be between the MBA and IA III. However, the size variation in goat populations within the compared sites is not significant between the IA III level of Gūnespān and most of the sites (Appendix 2.4.2a, see Student *t* test results) except Asiab, an early Neolithic site of the Zagros composed of wild animals, and Sarab, a late Neolithic site composed of a mixture of wild and domestic animals (Bangsgaard and Yeomans, personal communication 2018; Bökönyi 1977). The only highly significant difference ($P < 0.001$) is visible between Qela Gap (Late Chalcolithic) and Gūnespān ($p = 0.001$). In addition, the mean of Asiab can reasonably be used as the minimum limit for the presence of wild goat in other sites. At Gūnespān four specimens are above this limit and can be allocated to wild goats; they are indicated in the graph by black triangles. It is interesting also to note that wild goat hunting was more frequent than sheep hunting, particularly at the nearby sites of Qela Gap and Sarab.

Sheep—*Ovis*. LSI diagrams show that sheep at Gūnespān from the fourth to the first millennium BC (Figure 2.4.4b) were smaller, especially during the MBA and IA III periods, however, with no significant statistical difference compared to the EBA period (Appendix 2.4.2b). The *t* test shows that Gūnespān sheep populations were significantly smaller than that of Asiab. The only other significant difference is between the MBA period of Gūnespān and the Late Chalcolithic population of Gela Gap, where animals are very large. It should be noted that large specimens indicated by LSIs around 0.05 or more were also present during the EBA and IA III and could be

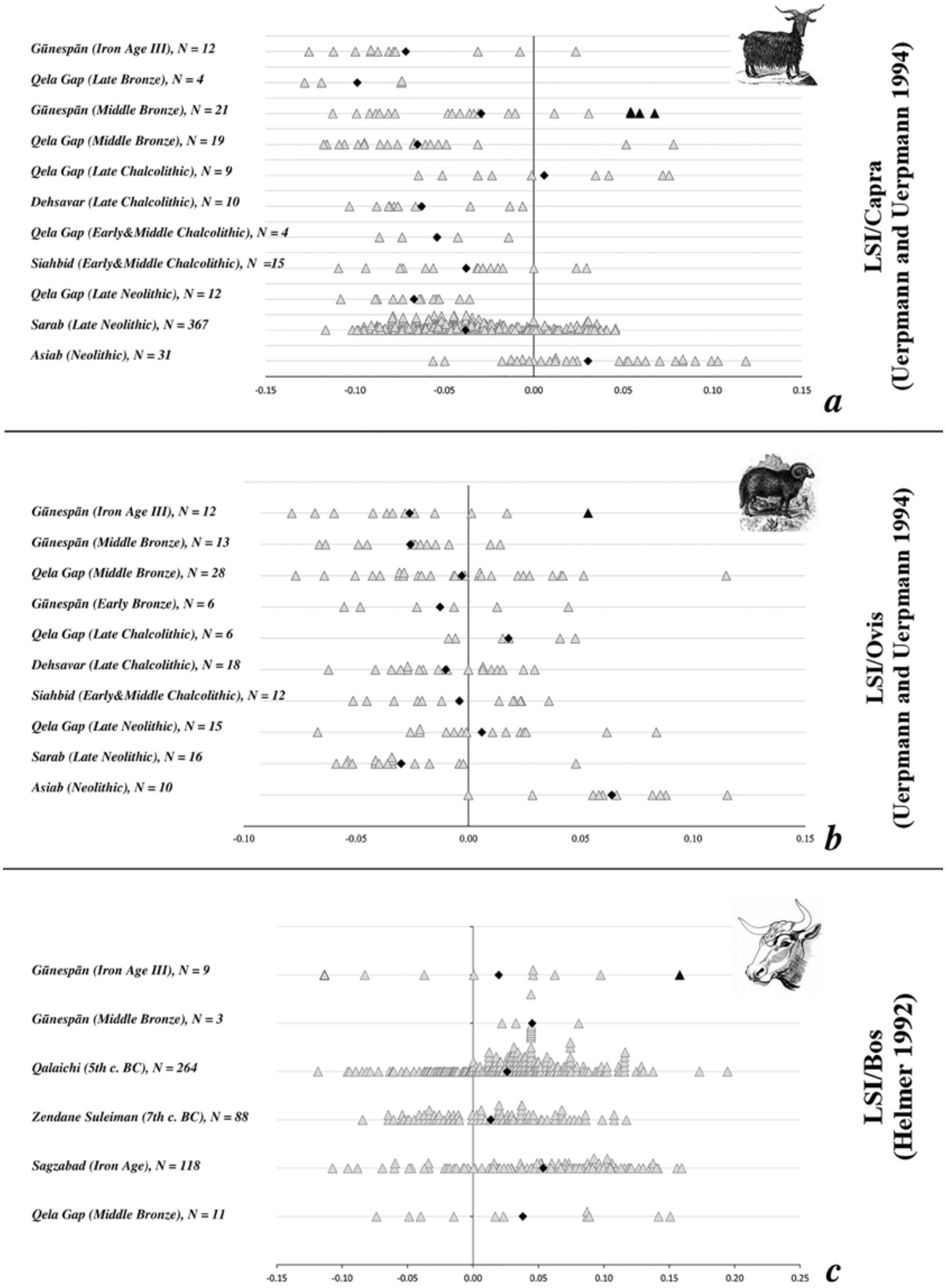

Figure 2.4.4. (a) Comparison of the size of goat (*Capra*) populations at Gūnespān and other assemblages from the fourth to the first millennium BC in the Zagros using Log-Size Index; (b) comparison of the size of sheep (*Ovis*) populations at Gūnespān and other assemblages from the fourth to the first millennium BC in the Zagros using Log-Size Index; (c) comparison of the size of cattle (*Bos*) populations at Gūnespān and other assemblages from the fourth to the first millennium BC in the Zagros using Log-Size Index.

allocated to the wild, here again indicated by a black triangle.

Cattle—*Bos*. The cattle population of Gūnespān was compared to several other nearby populations. The Iranian populations are all larger than the standard on average (Figure 2.4.4c). However, no significant difference is seen between the six compared populations (Appendix 2.4.2c). One specimen—indicated by a black triangle—in Gūnespān IA III is very large and may be either a very large male or an aurochs.

### *Kill-Off Patterns*

The low number of sheep and cattle teeth recovered did not allow a precise analysis of exploitation strategies. For the statistical treatment of the data and for producing a kill-off pattern we used tooth eruption and wear based on Payne (1973) and Helmer and Vigne (2007).

Based on 27 molar and premolar tooth remains and an MNI of 15 individuals, it was only possible to reconstruct kill-off pattern for goats from the BA level. The profile obtained is clearly biased. The absence of isolated teeth and even mandibles of animals under two years of age cannot be explained by taphonomic factors alone or the lack of water sieving during the excavation. In addition, it is surprising to see the high frequency of animals killed between 2–4 years of age (E–F for Payne), which account for almost 70% of the remains (Figure 2.4.5). The remaining part of culled animals is distributed between older specimens (G and H–I).

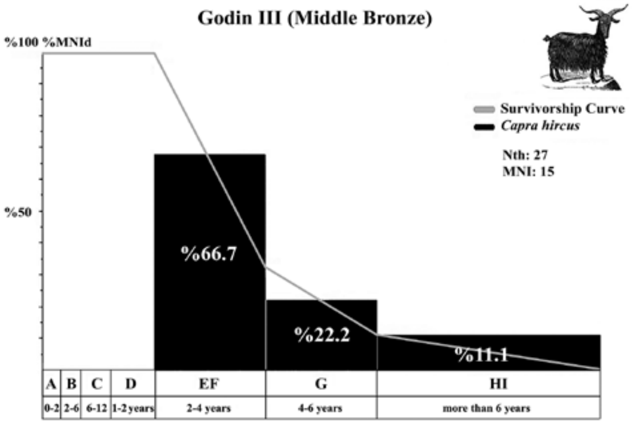

Figure 2.4.5. Reconstruction of kill-off pattern for goats (*Capra hircus*) during the Godin III period.

The absence of animals under two years of age may be a strong indication that at least in the excavated part of the site, where the faunal remains were collected, young goats were not killed or consumed. Also, this truncated profile bears another interesting information that is the indication for the use of hair due to the presence of very old specimens. This idea is also supported by the presence of spindle whorls and bone and bronze needles that are common during the Godin III period in this area (Henrickson 2011).

## Identification of Chicken Bones

Very few bird bones were recovered in Gūnespān from the two chronological phases of the LBA and IA. The two humeri that were measured were identified as *Gallus gallus* using the collection of the National Museum of Natural History in Paris (Appendix 2.4.1d). The history of the domestication or introduction of chicken on the Iranian Plateau is not known (Seigle 2018). Very few sites have reported the presence of this taxon and those that do record remains mostly from the LBA and IA (Boessneck and Krauss 1973; Bökönyi 1978; Krauss 1975; Osten-Sacken 2015). The presence of chicken is more clearly documented for antiquity and the medieval period (Mashkour 2013). The two specimens found in Gūnespān can thus be considered the earliest firm evidence that could ideally be subjected to DNA analysis. The limited number of measurements cannot be used for the distinction of *Gallus gallus domesticus.*

## Discussion

The taxonomic diversity of Gūnespān provides some indication of the subsistence economy at the site and palaeoenvironmental conditions, particularly during the MBA/LBA (Godin III period) and the IA III. The identified remains from the EBA (Godin IV) are scarce, but several wild herbivores were identified—wild sheep and goat, wild boar, red deer or Persian fallow deer, possibly aurochs and hemione. These animals live in various ecological settings ranging from highlands and piedmonts to steppe forests and arid steppes. Gūnespān is located in a geographical area surrounded by all these varied landscapes within accessible distances. This patchwork situation seems to be very common in many prehistoric sites

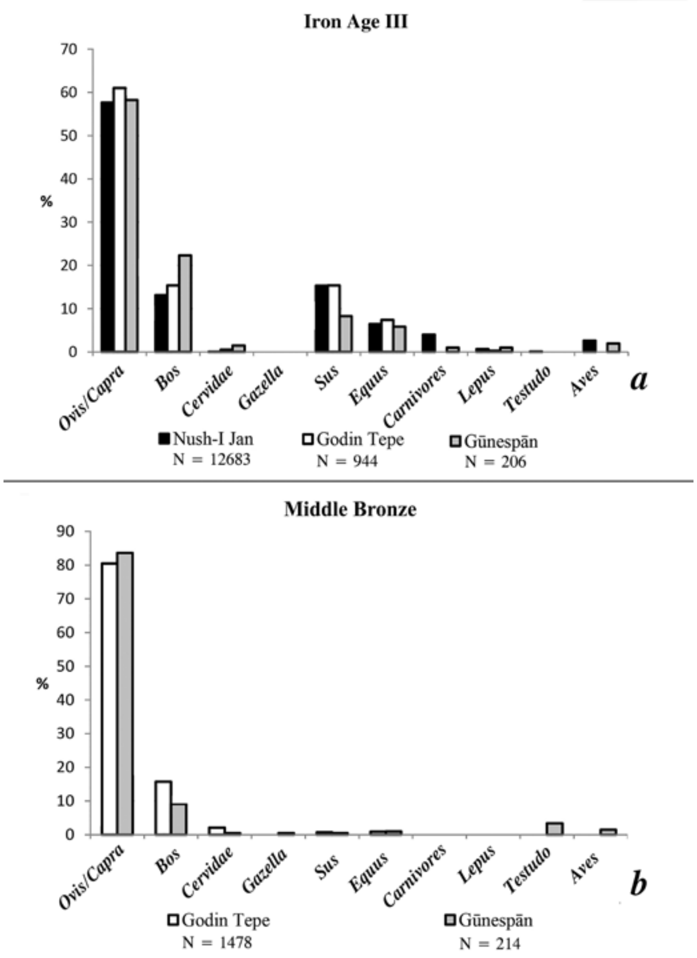

Figure 2.4.6. (a) Distribution of identified species during Iron Age III (Median period); (b) distribution of identified species during the Godin III period.

Figure 2.4.7. Luristan Bronze cheek piece, example with intact bit. Metropolitan Museum, accession no. 1979.352.2, https://www.metmuseum.org/art/collection/search/326620.

of Iran and especially in areas located on the foothills or valleys (Mashkour 2001, 2002). Although the inhabitants of Gūnespān exploited wild animal resources during the MBA, LBA, and IA III, they were highly dependent on agropastoralism. The domestic caprines—sheep/goat—and cattle constitute the most important meat and by-product animal resources at the site during the Bronze and Iron Ages in terms of NISP and weight of recovered bones. The same pattern is visible when comparing Gūnespān to the nearby sites of Godin Tepe and Nush-i Jan (Figure 2.4.6).

Sheep populations of Gūnespān show little difference when compared to other sites of the region except Asiab, while goats show more variation as explained above. It should also be noted that goats outnumbered sheep in Gūnespān. During the IA the role of cattle seems to have become more important, and this is particularly visible in terms of the weight of recovered bones. This trend has been observed generally on the Iranian Plateau (Mashkour 2001:Figure 57) and might be an indication for the emergence of a more agriculturally oriented economy in this period. All collected cattle bones belong to adult individuals. However, it was not possible to document any pathologies on the bones that would suggest the use of cattle as draft animals.

Another feature Gūnespān has in common with other prehistoric trends of subsistence economy in Iran is the increase of suids (Mashkour 2006) and equids (Mashkour 2001, 2002; Mashkour et al. 1999) during the IA. In the case of suids, it seems that human communities showed a growing interest in the animal on the Iranian Plateau over time. However, the proportion of suid remains never exceeds an average 10% of animal resources in most areas. This is the case of Gūnespān with suids representing approximately 6% of the faunal remains, which is lower that the contemporaneous sites of Godin and Nush-i Jan.

As for equids, the development of horse breeding and the spread of the donkey from Mesopotamia are also clearly visible at Gūnespān, despite the small size of the assemblage, as they are in the two aforementioned neighboring sites. This increase might be a response to socioeconomic changes such as the regional development of trade, increased population mobility, and new techniques of war (Hnila Gilibert 2004; Potts 2014:48–58). The profusion of the bronze production highlights the importance of horse and donkey for the LBA and IA societies. Known today as the Bronzes of Luristan (Muscarella 1989, Overlaet 2006; Figure 2.4.7), they include a great number of ornaments, tools, weapons, horse-fittings, and exceptional horse cheek pieces, together with a rich iconography depicting equids.

In relation to herding strategies of the main ungulates, namely, sheep, goat, and cattle, it should be noted that the site is located in a highland region with environmental conditions and pasturelands suitable for these taxa. It is important to integrate the analysis of faunal remains with other finds, such as botanical remains and architecture, which both bring different insights on economic and settlement practices. Most of the botanical remains from the southern part of the site were collected from ash layers and pits, both possible indications for continuous settlement at the site (Naseri 2009b). As for the architectural remains, Gūnespān was a Median complex during the IA, comparable with contemporaneous key sites in the Zagros such as Nush-i Jan and Godin. The building is composed of four rectangular rooms and one more irregular room in the north of the site, all surrounded by an oval fortification wall (Naseri et al. 2016). Such rooms are usually described as storage rooms. Although the precise function of the site could not be defined, it is far from being a minor settlement. The storage rooms, the presence of several pilasters, and part of a fortification point to an administrative or military function of the site. Sheep, goat, and cattle were herded around the site, taking advantage of the available pastures present in the vicinity of Gūnespān. However, we are not able to understand the truncated kill-off pattern for goat during the IA. For the moment we can only report this case as an uncommon kill-off pattern with the absence of animals under the age of two years. Finally, it is interesting to note the presence of chicken in the BA levels.

The archaeozoological study of Gūnespān is the only existing record for the subsistence economy of the Bronze and Iron Ages in the region of Malayer, now buried under the water of the Kalan Dam.

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Appendix 2.4.1. (a) Postcranial bone measurements for goat (*Capra*); (b) postcranial bone measurements for sheep (*Ovis*); (c) postcranial bone measurements for cattle (*Bos*); (d) postcranial bone measurements for chicken (*Gallus gallus*). In “Period” IA = Iron Age; G = Godin. A * after the specimen number—with #—refers to “cf. Wild.”

## (a) Goat *(Capra)*

**Scapula**

| Context | Period | Code | SLC | LCG | GLP | LG | BG |
|---|---|---|---|---|---|---|---|
| 3013 | IA III | #2 | 14.7 | 20.9 | 28.6 | 20.5 | 18.4 |
| 3031 | IA III | #159 | 18.4 | 24.5 | 28.5 | 22.8 | 20.5 |
| 4028 | IA III | #69 | 14.2 | 17.4 | | | 16.9 |
| 5005 | IA III | #59 | 21.0 | 20.4 | | 26.2 | |
| 2020 | G III:5 | #21 | 20.7 | | 31.1 | 22.7 | |
| 2035 | G III:6 | #45 | | | 31.2 | 23.3 | 19.8 |
| 2045 | G IV | #130 | 19.7 | 24.5 | 29.0 | 24.0 | 21.3 |

**Humerus**

| Context | Period | Code | Bd | Dd | Bt | Ht | Ad |
|---|---|---|---|---|---|---|---|
| 3013 | IA III | #3 | 29.2 | 24.9 | 27.0 | 16.8 | 12.5 |
| 3013 | IA III | #4 | | | 26.5 | 16.3 | 12.5 |
| 3020 | IA III | #121 | 24.1 | 20.4 | 22.0 | 14.4 | 10.7 |
| 3022 | IA III | #165 | 29.0 | 24.3 | 28.5 | 17.3 | 13.4 |
| 4010 | IA III | #139 | 33.0 | 26.9 | 31.5 | 18.6 | 14.2 |
| 4010 | IA III | #140 | 28.7 | | 27.5 | 17.2 | 12.8 |
| 3049 | G III | #155 | 28.2 | | 27.9 | 15.7 | 13.3 |
| 2008 | G III:4 | #95 | 34.9 | 29.4 | 32.8 | 19.3 | 15.1 |
| 2015 | G III:5 | #87 | 31.9 | | 30.5 | 17.0 | 15.2 |
| 2020 | G III:5 | #23 | | 23.8 | | 16.7 | 12.8 |
| 2035 | G III:6 | #49 | 29.5 | 24.8 | 27.1 | 15.4 | 13.3 |

**Radius**

| Context | Period | Code | Bp | Dp |
|---|---|---|---|---|
| 2002 | G III:2 | #164 | 29.0 | 15.8 |

**Metacarpal**

| Context | Period | Code | GL | Bp | Dp | Bd | Dd | Sd | Sd ap | 3M | 4M | 3L | 4L |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4010 | IA III | #141 | | | | 23.2 | 15.2 | | | 10.3 | 10.2 | 10.0 | 9.5 |
| 2020 | G III:5 | #16 | 95.8 | 22.7 | 16.3 | 25.0 | 15.6 | 14.5 | 9.9 | 11.0 | 9.3 | 10.8 | 8.4 |

**Femur**

| Context | Period | Code | Bp | Dp | Dc |
|---|---|---|---|---|---|
| 2008 | G III:4 | #96 | 36.7 | 21.8 | 18.3 |
| 2008 | G III:4 | #97 | 32.5 | 19.2 | |

**Metatarsal**

| Context | Period | Code | GL | Bp | Dp | Bd | Dd | Sd | Sd ap | 3M | 4M | 3L | 4L |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3046 | IA III | #83 | 113.5 | 20.1 | 18.7 | 23.4 | 14.9 | 10.9 | 11.0 | 10.8 | 8.8 | 10.4 | 9.1 |

**Talus**

| Context | Period | Code | GLl | GLM | DLm | DLl | GB |
|---|---|---|---|---|---|---|---|
| 4028 | IA III | #72 | 26.1 | 24.7 | 14.4 | 14.1 | 17.0 |
| 2008 | G III:4 | #98 | 24.4 | 23.4 | 14.4 | 13.1 | 15.2 |
| 2008 | G III:4 | #99 | 25.4 | 24.2 | 14.2 | 13.5 | 16.2 |
| 2012 | G III:4 | #147 | 28.9 | 27.5 | 16.6 | 16.7 | 19.6 |
| 2014 | G III:4 | #158 | 25.8 | 25.1 | 14.9 | 13.5 | 16.5 |
| 2020 | G III:5 | #14 | 27.4 | 26.4 | 19.2 | 15.7 | 19.1 |
| 2020 | G III:5 | #15 | 26.9 | 26.7 | 17.1 | 15.1 | 19.6 |
| 2035 | G III:6 | #27 | 28.5 | 27.6 | 17.2 | 16.2 | 18.7 |

**Phalanx 1**

| Context | Period | Code | GL | Bp | Dp | Bd | Dd | Sd | Sd ap |
|---|---|---|---|---|---|---|---|---|---|
| 3043 | IA III | #110 | 35.7 | 11.3 | 14.2 | 10.9 | 10.4 | 8.40 | 7.8 |
| 3049 | G III | #154* | 38.6 | 12.5 | 15.1 | 10.7 | 10.0 | 9.7 | 10.2 |
| 2014 | G III:4 | #156 | | | | 12.8 | 11.0 | 11.5 | 8.7 |
| 2020 | G III:5 | #17* | 35.5 | 11.8 | 13.6 | 11.7 | 10.1 | 10.5 | 9.3 |
| 2020 | G III:5 | #18* | 35.2 | 13.0 | 13.4 | 12.4 | 10.6 | 11.4 | 9.6 |
| 2035 | G III:6 | #31* | 35.1 | 12.3 | 13.5 | 12.3 | 10.5 | 10.7 | 10.0 |
| 2035 | G III:6 | #32 | 34.7 | 11.1 | 14.0 | 10.2 | 9.4 | 8.5 | 9.4 |
| 2035 | G III:6 | #33 | 36.7 | 11.4 | 15.0 | 10.4 | 8.9 | 8.9 | 9.9 |

**Phalanx 2**

| Context | Period | Code | GL | Bp | Dp | Bd | Dd | Sd | Sd ap |
|---|---|---|---|---|---|---|---|---|---|
| 3043 | IA III | #111 | 21.8 | 11.4 | 12.5 | 8.8 | 10.6 | 8.1 | 8.2 |
| 3043 | IA III | #112 | 26.6 | 13.6 | 12.5 | 10.7 | 12.1 | 9.3 | 9.8 |
| 2020 | G III:5 | #19 | 24.9 | 13.1 | 12.8 | 9.8 | 11.6 | 9.9 | 9.4 |
| 2024 | G III:5 | #151 | 26.4 | 15.0 | 13.4 | 11.4 | 12.1 | 11.3 | 10.4 |

**Phalanx 3**

| Context | Period | Code | DLS | MBS | LD |
|---|---|---|---|---|---|
| 2031 | G III:6 | #161 | 30.6 | 6.1 | 19.5 |
| 2035 | G III:6 | #36 | 34.4 | 6.1 | |

## (b) Sheep *(Ovis)*

**Scapula**

| Context | Period | Code | SLC | LCG | GLP | LG | BG |
|---|---|---|---|---|---|---|---|
| 3013 | IA III | #1 | 18.6 | 17.5 | 29.4 | 23.6 | 19.9 |
| 3024 | IA III | #133 | 18.7 | | | | |
| 4017 | IA III | #51* | | 20.1 | | | 22.5 |
| 2029 | G III:6 | #11 | 17.9 | 17.8 | | 24.0 | 19.9 |
| 2038 | G III:6 | #93 | 19.8 | 18.6 | 32.8 | 25.5 | 20.1 |
| 2041 | G IV | #57 | 19.5 | 17.7 | 32.3 | 25.3 | 19.7 |
| 2051 | G IV | #149 | 22.5 | 23.7 | | 25.2 | 24.2 |

**Humerus**

| Context | Period | Code | Bd | Dd | Sd | Sd ap | Bt | Ht | Ad |
|---|---|---|---|---|---|---|---|---|---|
| 3002 | IA III | #150 | 27.5 | 22.5 | 12.6 | 16.9 | 25.3 | 16.3 | 13.3 |
| 2010 | G III:4 | #78 | 31.4 | 25.0 | | | 28.1 | 17.7 | 13.3 |

**Radius/Ulna**

| Context | Period | Code | GL | Bp | Dp | Bd | Dd | Sd | Sd ap | SDO | DPA |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 5005 | IA III | #60 | 150.9 | 29.3 | 14.6 | 27.6 | 18.3 | 17.4 | 9.7 | | |
| 4013 | IA III | #80 | | 33.7 | 17.6 | | | 18.5 | 10.1 | 23.2 | 27.6 |
| 2047 | G IV | #104 | | 34.5 | 18.5 | | | | | | |

**Metacarpal**

| Context | Period | Code | GL | Bp | Dp | Bd | Dd | Sd | Sd ap | 3M | 4M | 3L | 4L | 3 | 4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3043 | IA III | #107 | | | | 25.3 | 17.5 | | | 11.7 | 11.7 | 11.6 | 11.5 | | |
| 3043 | IA III | #108 | | | | 22.0 | 14.6 | | | 10.2 | 10.2 | 9.6 | 9.7 | | |
| 4008 | IA III | #116 | 119.5 | 23.0 | 15.6 | 23.8 | 15.6 | 13.6 | 10.2 | 11.1 | 11.2 | 10.7 | 10.5 | | |
| 2015 | G III:5 | #89 | | | | | | 13.5 | 11.8 | | | | | 12.2 | 12.5 |
| 2028 | G III:6 | #102 | 140.1 | | 17.9 | | | | | | | | | 11.8 | 11.4 |

**Talus**

| Context | Period | Code | GLl | GLM | DLm | DLl | GB |
|---|---|---|---|---|---|---|---|
| 4009 | IA III | #128 | 28.8 | 27.6 | 16.9 | 15.5 | 18.6 |
| 2007 | G III:4 | #25 | 26.7 | 26.1 | 14.8 | 14.5 | 16.8 |
| 2010 | G III:4 | #79 | 26.9 | 25.8 | 15.3 | 14.5 | 17.3 |
| 2020 | G III:5 | #12 | 31.4 | 30.8 | 19.2 | 16.9 | 20.5 |
| 2020 | G III:5 | #13 | 30.3 | 29.4 | 18.4 | 16.8 | 19.3 |
| 2035 | G III:6 | #26 |  | 26.9 | 16.1 | 15.4 |  |
| 2044 | G IV | #9 | 26.9 | 26.2 | 16.4 | 15.5 | 17.2 |

**Metatarsal**

| Context | Period | Code | Bd | Dd | 3M | 4M | 3L | 4L |
|---|---|---|---|---|---|---|---|---|
| 4012 | IA III | #126 | 22.3 | 16.3 | 10.7 | 11.4 | 9.6 | 10.0 |
| 2047 | G IV | #105 | 22.7 | 15.6 |  |  |  |  |
| 2047 | G IV | #115 | 24.1 | 16.5 | 11.6 | 12.0 | 10.4 | 10.8 |

**Metapodial**

| Context | Period | Code | Bd | Dd | 3M | 4M | 3L | 4L | 3 | 4 |
|---|---|---|---|---|---|---|---|---|---|---|
| 3018 | IA III | #147 | 23.3 | 15.7 | 11.4 | 11.0 | 10.7 | 10.3 |  |  |
| 2035 | G III:6 | #44 |  |  |  |  |  |  | 11.4 | 11.1 |

**Phalanx 1**

| Context | Period | Code | GL | Bp | Dp | Bd | Dd | Sd | Sd ap |
|---|---|---|---|---|---|---|---|---|---|
| 3013 | IA III | #8 | 33.2 | 10.5 | 12.9 | 10.4 | 9.6 | 9.2 | 8.7 |
| 3020 | IA III | #122 |  |  |  | 11.4 | 10.7 |  |  |
| 2008 | G III:4 | #100 | 35.0 | 11.8 | 14.4 | 11.4 | 10.8 | 9.9 | 10.1 |
| 2035 | G III:6 | #28 | 35.0 | 11.9 | 14.8 | 11.5 | 9.4 | 10.2 | 8.9 |
| 2035 | G III:6 | #29 | 34.7 | 12.1 | 15.1 | 11.7 | 10.7 | 10.3 | 9.3 |
| 2035 | G III:6 | #30 | 36.8 | 11.4 | 14.6 | 10.1 | 9.1 | 8.7 | 9.1 |

**Phalanx 2**

| Context | Period | Code | GL | Bp | Dp | Bd | Dd | Sd | Sd ap |
|---|---|---|---|---|---|---|---|---|---|
| 2035 | G III:6 | #34 | 22.8 | 11.2 | 12.4 | 9 | 9.9 | 8.3 | 7.7 |

**Phalanx 3**

| Context | Period | Code | DLS | MBS | LD |
|---|---|---|---|---|---|
| 2035 | G III:6 | #35 | 27.9 | 6.80 | 21.9 |
| 2041 | G IV | #58 | 31.9 | 7.5 | 22.6 |

## (c) Cattle *(Bos)*

**Humerus**

| Context | Period | Code | Bp | Bd | Dd | Bt | Ht | Ad |
|---|---|---|---|---|---|---|---|---|
| 4013 | IA III | #81 | | | | 47.0 | | 36.7 |
| 5005 | IA III | #64 | | | | | | 34.6 |
| 5005 | IA III | #65* | | 84.2 | 72.8 | 76.7 | 40.5 | 29.9 |
| 5005 | IA III | #66 | 89.0 | | | | | |

**Radius**

| Context | Period | Code | Bp |
|---|---|---|---|
| 2016 | G III | #145 | 29.5 |

**Metacarpal**

| Context | Period | Code | Bp | Dp | Sd | Sd ap | 3 | 4 |
|---|---|---|---|---|---|---|---|---|
| 3004 | IA III | #75 | 48.0 | 26.9 | 25.2 | 18.8 | | |
| 4008 | IA III | #118 | | | | | 27.0 | 25.7 |

**Femur**

| Context | Period | Code | Bp | Dc |
|---|---|---|---|---|
| 3046 | IA III | #85 | | 35.5 |
| 5005 | IA III | #67 | 111.1 | 40.3 |

**Patella**

| Context | Period | Code | GB |
|---|---|---|---|
| 2020 | G III | #22 | 50.6 |

**Tibia**

| Context | Period | Code | Dp | Bd | Dd |
|---|---|---|---|---|---|
| 3030 | IA III | #160 | 41.7 | | |
| 4028 | IA III | #70 | | 48.7 | 38.4 |

**Talus**

| Context | Period | Code | GLl | GLM | DLm | DLl | GB |
|---|---|---|---|---|---|---|---|
| 3024 | IA III | #132 | 62.2 | | | 32.9 | |
| 4028 | IA III | #73 | | | | | 36.3 |
| 5005 | IA III | #61 | 69.0 | 66.2 | 38.7 | 38.6 | 41.8 |
| 5005 | IA III | #62 | | 57.8 | 34.5 | 34.3 | |

**Metatarsal**

| Context | Period | Code | Bp | Dp | Bd | Dd | 3M | 4M | 3L | 4L | 3 | 4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4006 | IA III | #54 | | | | 35.1 | | | | | 29.0 | 24.8 |
| 4010 | IA III | #142 | 35.5 | 34.0 | | | | | | | | |
| 3047 | G III | #94 | | | 59.2 | 32.8 | 28.6 | 25.0 | 26.8 | 23.3 | | |

**Phalanx 1**

| Context | Period | Code | GL | Bp | Dp | Bd | Dd | Sd | Sd ap |
|---|---|---|---|---|---|---|---|---|---|
| 4017 | IA III | #50 | 61.5 | 33.9 | 33.9 | 31.5 | 23.0 | 28.4 | 25.6 |
| 2038 | G III | #92 | 64.2 | 29.2 | 33.7 | 28.4 | 20.3 | 22.8 | 17.9 |

**Phalanx 2**

| Context | Period | Code | GL | Bp | Dp | Bd | Dd | Sd | Sd ap |
|---|---|---|---|---|---|---|---|---|---|
| 3046 | IA III | #86 | 41.6 | 28.1 | 31.2 | 23.0 | 28.6 | 21.7 | 21.1 |
| 4009 | IA III | #129 | 41.0 | 29.2 | 30.2 | 24.9 | 29.3 | 24.8 | 22.0 |
| 2020 | G III | #20 | 34.0 | 26.6 | 29.9 | 22.2 | 24.7 | 21.6 | 19.7 |
| 2042 | G IV | #114 | | | | 23.9 | 26.3 | 25.9 | |

**Phalanx 3**

| Context | Period | Code | MBS |
|---|---|---|---|
| 2003 | G III | #162 | 25.8 |

### (d) Chicken *(Gallus gallus)*

**Humerus**

| Context | Period | Code | GL | BP | Bd | SC |
|---|---|---|---|---|---|---|
| 3046 | IA III | #3 | 42.5 | 15.8 | 9.8 | 4.4 |
| 2002 | G III | #7 | | | 10.0 | 4.5 |

Appendix 2.4.2. Student *t* test for the comparison of Gūnespān LSIs and other population in the Zagros: (a) goat(*Capra*), (b) sheep (*Ovis*), (c) cattle (*Bos*) populations at Gūnespān and other assemblages from the fourth to the first millennium BC in the Zagros using Log-Size Index. In bold the P values < 0,001. Neo = Neolithic; LN = Late Neolithic; E&MC = Early and Middle Chalcolithic; LC = Late Chalcolithic; EBA = Early Bronze Age; MBA = Middle Bonze Age; LBA = Late Bronze Age; IA = Iron Age.

Appendix 2.4.2a

| ***Capra*** | **Asiab (Neo)** | **Sarab (LN)** | **Qela Gap (LN)** | **Siahbid (E&MC)** | **Qela Gap (E&MC)** | **Dehsavar (LC)** | **Qela Gap (LC)** | **Qela Gap (MBA)** | **Gūnespān (MBA)** | **Qela Gap (LBA)** | **Gūnespān (IAIII)** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Asiab (Neo)** | | **0.000** | **0.000** | **0.000** | **0.001** | **0.000** | 0.182 | **0.000** | **0.000** | **0.000** | **0.000** |
| **Sarab (LN)** | | | 0.003 | 0.963 | 0.338 | *0.021* | **0.000** | **0.001** | 0.270 | **0.000** | **0.001** |
| **Qela Gap (LN)** | | | | *0.031* | 0.365 | 0.709 | **0.000** | 0.903 | *0.037* | *0.032* | 0.753 |
| **Siahbid (E&MC)** | | | | | 0.466 | 0.117 | *0.031* | 0.102 | 0.637 | *0.012* | 0.048 |
| **Qela Gap (E&MC)** | | | | | | 0.666 | 0.061 | 0.689 | 0.418 | 0.085 | 0.481 |
| **Dehsavar (LC)** | | | | | | | 0.003 | 0.893 | 0.101 | 0.080 | 0.604 |
| **Qela Gap (LC)** | | | | | | | | 0.004 | 0.137 | 0.004 | **0.001** |
| **Qela Gap (MBA)** | | | | | | | | | 0.047 | 0.227 | 0.724 |
| **Gūnespān (MBA)** | | | | | | | | | | 0.028 | *0.036* |
| **Qela Gap (LBA)** | | | | | | | | | | | 0.272 |
| **Gūnespān (IAIII)** | | | | | | | | | | | |

Appendix 2.4.2b

| *Ovis* | Asiab (Neo) | Sarab (LN) | Qela Gap (LN) | Siahbid (E&MC) | Dehsavar (LC) | Qela Gap (LC) | Gūnespān (EBA) | Qela Gap (MBA) | Gūnespān (MBA) | Gūnespān (IAIII) |
|---|---|---|---|---|---|---|---|---|---|---|
| **Asiab (Neo)** | | **0.000** | **0.001** | **0.000** | 0.000 | **0.009** | **0.001** | **0.000** | **0.000** | **0.000** |
| **Sarab (LN)** | | | 0.004 | *0.023* | *0.032* | **0.001** | 0.234 | *0.021* | 0.674 | 0.765 |
| **Qela Gap (LN)** | | | | 0.456 | 0.144 | 0.479 | 0.316 | 0.469 | *0.014* | *0.033* |
| **Siahbid (E&MC)** | | | | | 0.548 | 0.144 | 0.615 | 0.946 | 0.059 | 0.120 |
| **Dehsavar (LC)** | | | | | | *0.025* | 0.866 | 0.509 | *0.092* | 0.161 |
| **Qela Gap (LC)** | | | | | | | 0.128 | 0.230 | 0.002 | *0.018* |
| **Gūnespān (EBA)** | | | | | | | | 0.606 | 0.365 | 0.466 |
| **Qela Gap (MBA)** | | | | | | | | | 0.067 | 0.094 |
| **Gūnespān (MBA)** | | | | | | | | | | 0.970 |
| **Gūnespān (IAIII)** | | | | | | | | | | |

Appendix 2.4.2c

| *Bos* | Qela Gap (MBA) | Sagzabad (IA) | Zendane Suleiman (7th c. BC) | Qalaichi (5th c. BC) | Gūnespān (MBA) | Gūnespān (IAIII) |
|---|---|---|---|---|---|---|
| **Qela Gap (MBA)** | | 0.394 | 0.127 | 0.439 | 0.879 | 0.629 |
| **Sagzabad (IA)** | | | **0.000** | **0.000** | 0.798 | 0.099 |
| **Zendane Suleiman (7th c. BC)** | | | | *0.033* | 0.233 | 0.719 |
| **Qalaichi (5th c. BC)** | | | | | 0.504 | 0.700 |
| **Gūnespān (MBA)** | | | | | | 0.639 |
| **Gūnespān (IAIII)** | | | | | | |

# 2.5 | Animal Exploitation in the Samarkand Oasis (Uzbekistan) at the Time of the Arab Conquest

## Zooarchaeological Evidence from the Excavations at Kafir Kala

Eleonora Serrone*, Elena Maini,† Antonio Curci,† Simone Mantellini,*
and Amriddin E. Berdimuradov‡

### Abstract

Since ancient times, Central Asian economy has been based on a combination of irrigated agriculture and pastoralism. While research on ancient irrigation systems is relatively abundant, zooarchaeological studies in Central Asia are rather scarce. This paper presents the results of the zooarchaeological study of animal bones found at the citadel of Kafir Kala during the Uzbek-Italian excavations. In the Early Middle Ages (sixth–seventh centuries AD), this site was a major administrative center located along the local Silk Road routes. After the Arab conquest at the beginning of the eighth century AD, the site was settled for residential purposes. Preliminary zooarchaeological analysis was conducted on over 6,000 faunal remains retrieved from the 2001–2014 excavation seasons. Domestic animals were predominant. Sheep and goats represent ca. 80% of the total, followed by cattle and a small number of equids, pigs, dogs, and cats. A limited number of bird bones—Galliformes—were also recognized. Among the wild animals, fox is the most common, followed by wild boar and scant remains of small to medium ungulates. Evaluation of the age-at-death provides important information about the diet and the production/processing of secondary products.

### Keywords

*Samarkand, Uzbekistan, pre-Islamic, Islamic, caprids, Silk Road, Middle Zeravshan Valley, Kafir Kala*

## The Site of Kafir Kala

The archeological site of Kafir Kala covers ca. 20 ha along the middle section of the Dargom canal, 12 km from Afrasiab, that is, ancient Samarkand. According to its size and layout it is one of the most impressive earthen-built settlements in the entire Middle Zeravshan Valley. The citadel rises 25 m from the ground, making Kafir Kala a landmark in the cultivated and flat flood plain, which is irrigated by the Dargom and other canals diverted from the Zeravshan (Masson 1928). Following the main road that connects Samarkand with Shahrisabz—ancient Kesh—in the Kashkadarya Valley through the pass of Amankutan in the Karatyube Mountains, one had to cross the Dargom close to Kafir Kala (Berdimuradov et al. 2009; Mantellini and Berdimuradov 2005). The strategic location of Kafir Kala and its fortified monumental architecture were certainly related to the role this settlement played in the economic and sociopolitical context of ancient Samarkand, especially to control the passage along the local Silk Road routes.

After intermittent investigations during the entire nineteenth century by different Soviet archaeologists, Kafir Kala was first excavated by a team of the Institute of Archaeology of Samarkand in the early 1990s. The excavation of the upper citadel provided

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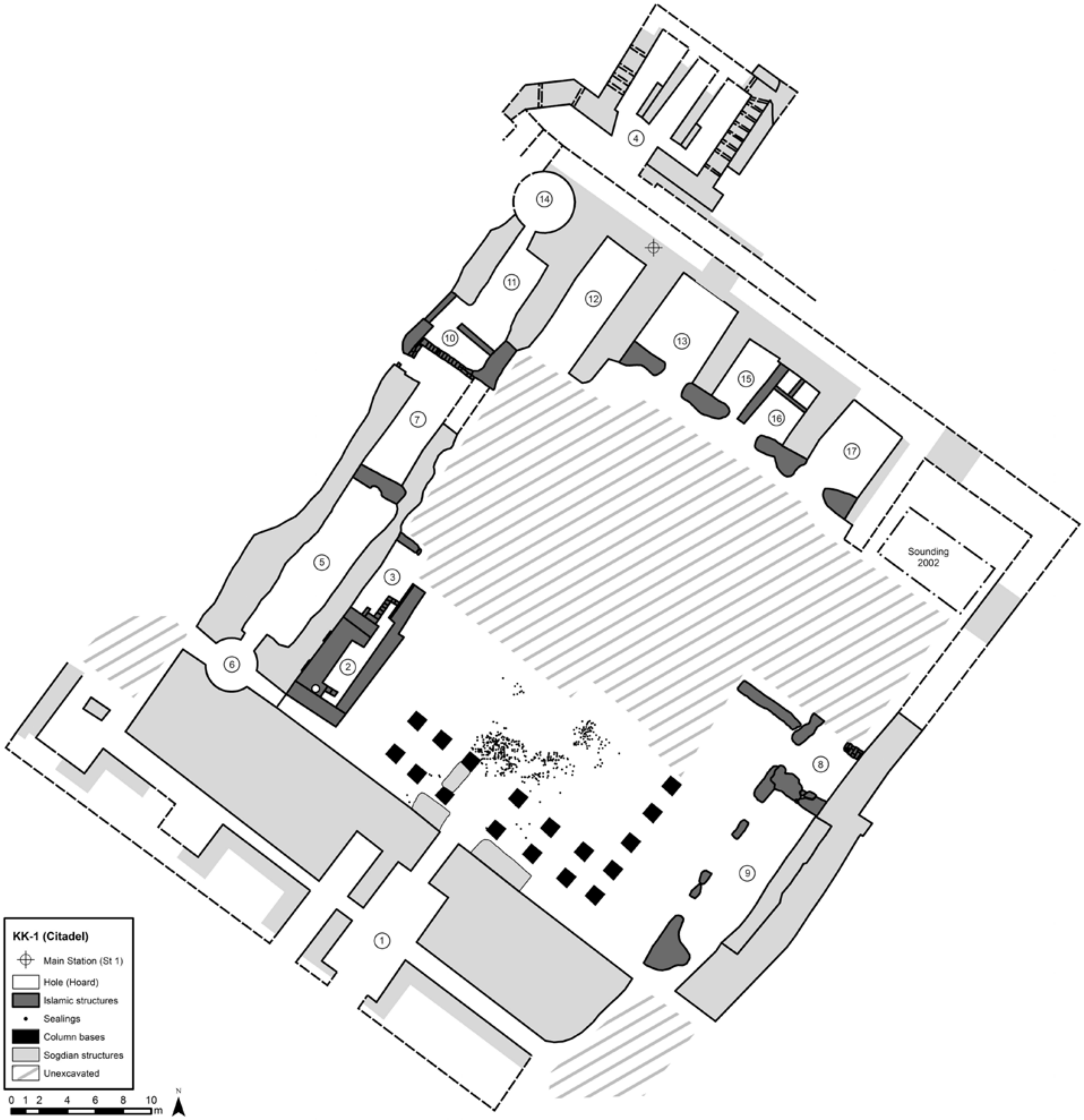

Figure 2.5.1. General plan of Kafir Kala's citadel. Number within circle refers to room number. (Photograph courtesy of the Uzbek-Italian Archaeological Expedition.)

evidence for a systematic occupation during the so-called Sogdian period, which in the Zeravshan Valley usually refers to the centuries (fifth–early eighth century) before the Arab conquest of Central Asia (first half of the eighth century). A new program of systematic research at Kafir Kala began in 2001 with the Uzbek-Italian Archaeological Project "Samarkand and Its Territory." During nine field seasons, between 2001 and 2014, the early excavations in the citadel were resumed and soundings in the lower settlement were opened to understand the settlement's natural setting and its relationship with the Dargom canal (Malatesta et al. 2012).

Archaeological excavations revealed two major periods of occupation (Figure 2.5.1). The earliest dates to the pre-Islamic period (late seventh–early eighth century) and is characterized by the exceptional discovery of a set of ca. 650 clay sealings,[1] which suggest the presence of an important administrative center (Cazzoli and Cereti 2005). The sealings were discovered on a beaten-earth floor covered by a thick layer of collapsed burnt wooden beams. The presence of eighteen wooden column bases on the same floor suggests that there had been an inner courtyard, surrounded by a portico. According to pottery and coins, the fire occurred in the early eighth century and was possibly connected to the Arab conquest of Samarkand in 712 AD, as the name of the site itself—Kafir Kala = "nonbelievers" castle—also seems to suggest.

The upper citadel was then abandoned for a short period. Subsequent changes were significant. The administrative center gave place to a residential unit with many rooms and cooking installations. The pre-Islamic monumental architecture was reused to set up new rooms. The building technique for the construction of the Islamic walls is remarkably inferior in skill and quality of materials compared to the previous one and mud bricks from the previous period are often recycled. The inner central courtyard was left empty and used to discard pottery, animal bones, and architectural remains, including baked bricks and tiles. Nevertheless, the discovery in Room Two (season 2006) of a hoard containing 132 coins, most of which were silver Abbasid *dirhams* dated to the eighth century (Berdimuradov et al. 2012), suggests that the site was still occupied by someone important.

## Kafir Kala Faunal Analysis

A total of 6,009 animal bones has been retrieved from Kafir Kala (Mantellini et al. 2016). All the animal remains recovered during the excavations have been analyzed and are presented here by chronological period. This subdivision was possible due to the presence of destruction layers, composed of charcoal, ashes, and combustible woods, which were generally spread over the entire citadel's area and may be associated with the Arab conquest of Samarkand in 712 AD.

Anatomical and species determination was possible only for 2,140 remains, corresponding to 35.6% of the total. Most of these bones come from the Islamic strata (eighth–twelfth century AD).

The assemblage is dominated by caprines—sheep and goats—which represent 80% of the total Number of Identified Specimens (NISP).[2] In a few cases, it was possible to distinguish between sheep and goat. For the distinction between sheep and goat we used Boessneck (1969), Halstead et al. (2002), and Zeder and Pilaar (2010). Cattle are the second highest represented domestic taxon, though with a NISP far smaller than that of sheep/goat, followed by equids. Remains of pigs, dogs, and cats are relatively rare.

Among the wild animals, fox is the most common (3.6% of the assemblage), followed by wild boar, roe deer, ibex, and red deer. Additionally, although bird and microfaunal remains have been found, they have not been studied yet in detail.

## Faunal Composition of the Pre-Islamic Period (Late Seventh–Early Eighth Century AD)

A total of 2,033 remains were found in the pre-Islamic layers, but identification to species level was possible only for 617 specimens (28%, Table 2.5.1). In the faunal composition of this period, caprines have the highest representation among the domestic animals (with a NISP of 460), followed by cattle with 73 remains. Equids are only represented by six specimens, while pigs and camelids are represented by very few remains: three and two fragments, respectively. Birds, including Galliforms and Columbids, represent a high NISP compared to larger animals, even though there are only 35 remains.

Wild animals are very rare; among them foxes are the most abundant with 22 specimens (3.6% of the total determined species). Finally there are also 3 unidentified microfaunal remains.

### *Domestic Animals*

Within the domestic fauna, caprines are the most abundant with 460 remains of which 28 could se-

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[1] This amount refers to the clay sealings discovered by the Uzbek-Italian excavations. Other sealings have recently been discovered by the Uzbek-Japanese Expedition.

[2] For anatomical determination of species, we used the following comparison atlases: Schmidt (1972), Barone (1976), and the reference collection of ArcheoLaBio–Research Center for Bioarchaeology, Department of History and Cultures, Alma Mater Studiorum–University of Bologna, located in Ravenna.

Table 2.5.1. Faunal composition of pre-Islamic period.

| **Taxa & animal groups** | **NISP** | **% NISP** | **MNI** | **% MNI** | **Animal groups** | **NISP** | **% NISP** | **MNI** | **% MNI** |
|---|---|---|---|---|---|---|---|---|---|
| *Equus caballus* | 6 | 1.0 | 2 | 3.4 | Equids | 13 | 2.1 | 6 | 11.3 |
| *Equus asinus* | 1 | 0.2 | 1 | 1.7 | | | | | |
| *Equus* sp. | 6 | 1.0 | 3 | 5.2 | | | | | |
| *Sus domesticus* | 3 | 0.5 | 1 | 1.7 | Pigs | 3 | 0.5 | 1 | 1.9 |
| Caprines | 422 | 68.4 | 26 | 44.8 | Caprines | 460 | 74.6 | 37 | 69.8 |
| *Ovis aries* | 28 | 4.5 | 8 | 13.8 | | | | | |
| *Capra hircus* | 10 | 1.6 | 3 | 5.2 | | | | | |
| *Bos taurus* | 73 | 11.8 | 8 | 13.8 | Cattle | 73 | 11.8 | 8 | 15.1 |
| *Camelus* sp. | 2 | 0.3 | 1 | 1.7 | Camels | 2 | 0.3 | 1 | 1.9 |
| Small-medium wild ungulates | 5 | 0.8 | 2 | 3.4 | Others | 66 | 10.7 | - | - |
| *Cervus elaphus* | 1 | 0.2 | 1 | 1.7 | | | | | |
| *Vulpes vulpes* | 22 | 3.6 | 2 | 3.4 | | | | | |
| *Aves* | 35 | 5.7 | - | - | | | | | |
| Micromammal | 3 | 0.5 | - | - | | | | | |
| **Total** | **617** | **100** | **58** | **100** | **Total** | **617** | **100** | **53** | **100** |

curely be attributed to sheep and only 10 to goats. Age-at-death was assessed on jaws, maxillae, and isolated teeth.[3] To determine the Minimum Number of Individuals (MNI), we based our calculations on the number and sides (left and right) of humerus, ulna, scapula, and tibia—the most abundant anatomical elements in the sample. The MNI shows the presence of at least 37 individuals of which eight are sheep and three goats. Amongst the individuals belonging to this group we found one foetus, one young, one young adult sheep, one young adult between 12 and 18 months, and two other young adults between 18 and 24 months. Among the adult individuals, five were slaughtered between 2 and 3 years of life, one between 3 and 4 years, and one between 4 and 6 years. Three adult goats and seven adult sheep show undetermined age.

Cattle are represented by 73 specimens, which came from at least eight individuals. The majority of cattle bones belong to limbs. We estimated age-at-death using mandibles, maxillae, and tibiae, which were the most numerous bones represented (Figure 2.5.2).[4] Our MNI calculations indicate that these remains represent at least one calf around 5–6 months of age, one young individual of undeterminable age, one young adult, one adult between 3 and 4 years old, and four adults of undetermined age.

Equids were identified from 13 specimens from at least six different individuals. It was possible to identify three horses (one subadult and two adults, of which one was less than 42–48 months old), one donkey, and two equids of undetermined age (Baxter 1998).

Pigs are only represented by three remains, all belonging to a minimum of one adult male. Sex was determined due to the presence of a lower canine tooth (for the slaughtering trends of pigs, see Bull and Payne 1982).

Two camel remains—a fragment of a radius and a partial first phalanx—could be attributed to only

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[3] Age-at-death based on sheep/goat tooth eruption/wear was estimated following the method developed by Payne (1973); see also Silver (1969) and Grant (1982).

[4] Age-at-death for cattle was estimated based on the degree of long-bone fusion and on tooth eruption/wear following the methods developed by Barone (1976) and Grant (1982).

Figure 2.5.2. Bovine left lower jaw with cut marks—SU 22, pre-Islamic period. (Photograph by E. Maini.)

Figure 2.5.3. Fox paw with cut marks on the metapodials—SU 683, pre-Islamic period. (Photograph by E. Maini.)

one individual, probably from an adult judging by size and thickness of the anatomical elements (Steiger 1990).

### *Wild Animals*

Fox is the most represented species in the wild faunal sample, with 22 skeletal remains attributable to two different individuals. Bones were identified with the distal end of limbs and show cut marks consistent with skinning (Figure 2.5.3).

In addition to fox remains, a third phalanx belonging to red deer was also found. Five additional specimens come from two different individuals of small–medium ungulates. The morphology of the bones is different than that of domestic taxa and appears compatible with various wild ungulates, such as gazelle, roe deer, ibex, saiga, chamois, and others (Geptner 1988). However, a specific determination requires further and more detailed study. For the moment, we can only recognize the presence of wild, small–medium ungulates according to the size, shape, and thickness of bone fragments.

## Faunal Composition of the Islamic Period (Early Eighth–Early Twelfth Centuries AD)

Remains from the Islamic period total 3,983, of which 1,523 (38.2%) were identified to species level (Table 2.5.2). Caprines are still the most abundant group with 1,151 remains and a sheep-to-goat ratio of three to one. Also during the Islamic occupation, the second most represented species is again cattle with 189 remains. Equids are more numerous than during the previous period, while pigs and camel are still very scarce. Finally, there is evidence for the presence of dogs and cats, which were not attested in the pre-Islamic period.

The wild fauna in this phase is again scarcely represented, and, similarly, only foxes seem to have drawn the interest of Kafir Kala inhabitants to a certain extent. Birds are present with 88 specimens, for the most part attributable to Galliforms and Columbids, while for the microfauna six long-bone diaphyses could not be identified to species.

### *Domestic Animals*

As in the pre-Islamic sample, caprines' remains are the most abundant (1,151 remains), with 111 attributed to sheep and 39 to goats. The estimated MNI shows the presence of at least 107 individuals, among which 25 were identified as sheep and 10 as goats. The ages represented by this assemblage of sheep and goats are as follows: one foetus/newborn; at least 20 young individuals, one of which is extremely young (between 0 and 2 months old), ten that are between 2 and 6 months of age (two goats

Table 2.5.2. Faunal composition of Islamic period.

| **Taxa & animal groups** | **NISP** | **% NISP** | **MNI** | **% MNI** | **Animal groups** | **NISP** | **% NISP** | **MNI** | **% MNI** |
|---|---|---|---|---|---|---|---|---|---|
| *Canis familiaris* | 7 | 0.5 | 3 | 1.9 | Canids | 7 | 0.5 | 3 | 2 |
| *Equus caballus* | 17 | 1.1 | 6 | 3.8 | Equids | 37 | 2.4 | 11 | 7.3 |
| *Equus asinus* | 6 | 0.4 | 2 | 1.3 | | | | | |
| *Equus* sp. | 14 | 0.9 | 3 | 1.9 | | | | | |
| *Sus domesticus* | 7 | 0.5 | 5 | 3.1 | Pigs | 7 | 0.5 | 5 | 3.3 |
| Caprines | 1,001 | 65.7 | 72 | 45.0 | Caprines | 1,151 | 75.6 | 107 | 71.3 |
| *Ovis aries* | 111 | 7.3 | 25 | 15.6 | | | | | |
| *Capra hircus* | 39 | 2.6 | 10 | 6.3 | | | | | |
| *Bos taurus* | 189 | 12.4 | 22 | 13.8 | Cattle | 189 | 12.4 | 22 | 14.7 |
| *Camelus* sp. | 3 | 0.2 | 2 | 1.3 | Camels | 3 | 0.2 | 2 | 1.3 |
| *Sus scrofa* | 4 | 0.3 | 2 | 1.3 | Others | 129 | 8.5 | - | - |
| Small–medium wild ungulates | 3 | 0.2 | 2 | 1.3 | | | | | |
| *Cervus elaphus* | 2 | 0.1 | 1 | 0.6 | | | | | |
| *Vulpes vulpes* | 22 | 1.4 | 3 | 1.9 | | | | | |
| *Felis catus* | 3 | 0.2 | 1 | 0.6 | | | | | |
| Felid | 1 | 0.1 | 1 | 0.6 | | | | | |
| *Aves* | 88 | 5.8 | - | - | | | | | |
| Micromammal | 6 | 0.4 | - | - | | | | | |
| **Total** | **1,523** | **100** | **160** | **100** | **Total** | **1,523** | **100** | **150** | **100** |

and four sheep), and nine individuals slaughtered between 9 and 12 months of life; at least 15 young adults (including two goats and four sheep aged between 12 and 24 months old); at least 69 adults, 26 of which are between 2 and 4 years of age (six sheep and four goats) and thirteen of which are aged between 4 and 6/8 years (including two sheep); and two sheep butchered at senile ages between 8 and 10 years of life (Figure 2.5.4). For an additional 30 adult individuals, whose presence is inferred based on counts and size of the long bones, it was not possible to estimate the exact age-at-death.

The 189 cattle remains belong to at least 22 individuals. Among them were one calf less than 4 months old, one calf less than 12 months of age, one young individual 1 year old, three subadults around 2 or 3 years old, one adult aged between 4 and 6 years, two adults more than 6 years old, nine adults of undetermined age, and one senile individual that could have been more than 8 years old. On the basis of measurements made following von den Driesch's (1976) methodology, the following indexes were calculated: Nobis 1: 26.44 = female; Nobis 2: 15.43 = female/castrated. Withers heights, calculated with the Matolcsi's (1970) indices, resulted in a value of 118.7 cm.

The 37 equid remains attest to an MNI of 11 individuals. There were at least two donkeys—a young one between 12 and 24 months old and one adult of undetermined age. Six horses—two aged between 3–4 years and four adults of undetermined age—were also identified. Two other equid individuals remain of undetermined age and species.

In the Islamic phase, pigs are represented by only seven specimens from at least five individuals—one 4–6 month old piglet, one young adult less than two years old, one adult male, and two adults of undetermined age. The age of these individuals was calculated based on the fusion of the proximal

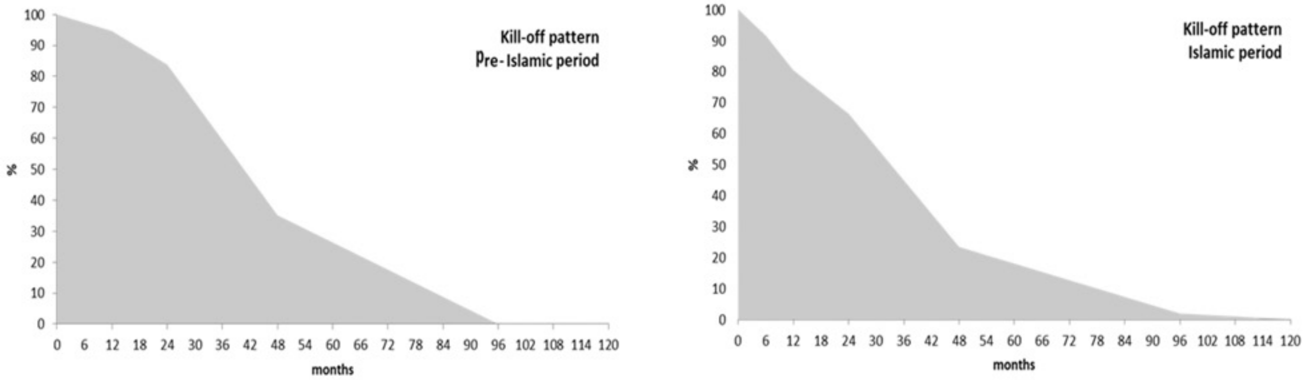

Figure 2.5.4. Sheep/Goat kill-off pattern—based on MNI: comparison between pre-Islamic (left) and Islamic (right) periods.

and distal epiphyses of the long bones and on the presence of a left maxilla. Sex was assessed based on the presence of a canine, which could securely be attributed to a male.

The three camel remains belong to two adult individuals of indeterminate age. Unfortunately, the high degree of fragmentation did not allow us to obtain further information.

As previously mentioned, during the Islamic phase dogs and cats are represented by seven and three specimens, respectively. Our MNI calculation indicates the presence of at least three dogs, including two adults of undetermined age and one elderly individual with worn teeth, and only one adult cat of undetermined age.

### *Wild Animals*

Foxes comprise the majority of the wild fauna from the Islamic period, with 22 remains belonging to at least three individuals of undetermined age. In particular, there are partial limbs and two hemi-mandibles. During this phase more wild animals were present when compared to the previous phase, including two wild boar specimens from at least two different individuals and three fragments from small to medium wild ungulates. On the basis of their appearance and size, one of these fragments may have come from a chamois. Further research is needed to attest the presence of this animal during the Middle Ages in Uzbekistan. Finally, a large felid humerus with cut marks has been identified in the Islamic period assemblage. Although we have not yet identified the felid remain at the species level, given the size of the skeletal element, we are considering a possible attribution to Pallas's cat (*Otocolobus manul*) a rare animal native of Central Asia.

## Taphonomic Analysis

Only 198 remains (ca. 9% of the determined assemblage) show relevant taphonomic markers. Ninety-six remains show butchering traces, 66 bear burning traces, and 20 specimens show gnawing marks made by rodents and carnivores.

The butchering marks are, for the most part, deep and thin subparallel striae, mostly located close to the joints. Such marks are related to carcass butchering, skinning, dismembering, and preparation of meat portions.

Cut marks are most evident on the bones of caprines, the group that dominates the assemblage (Figure 2.5.5a). Cut marks were also found on cattle, equids, and wild animals, especially foxes. On the latter, cut marks were found on the distal part of the extremities and are consistent with skinning.

The few burnt remains, especially limb bones, do not enable us to recreate details related to cooking practices or disposal of food waste. Given the presence of gnawing on part of the osteological sample, it is possible that domestic waste was abandoned in open-air areas accessible to scavenging animals. Sixteen fragments show evidence for bone-working, particularly sheep and goat astragali, which show abrasions and/or holes. One astragalus has a metal ring wraped around it and a pierced hole probably for suspension (Figure 2.5.5b). The use of knucklebones as pendants, dices, or tokens is well attested from the prehistoric up to the historic periods throughout the Eurasian continent (Gilmour 1997).

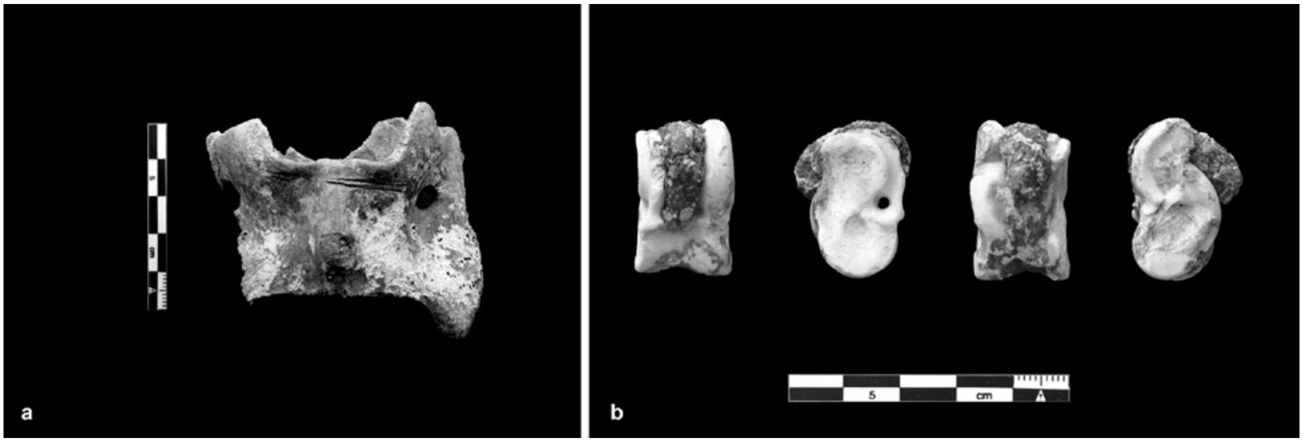

Figure 2.5.5. (a) Sheep atlas with cut marks—SU 681, pre-Islamic period; (b) worked sheep/goat astragalus—SU 5, Islamic period. (Photograph by E. Maini.)

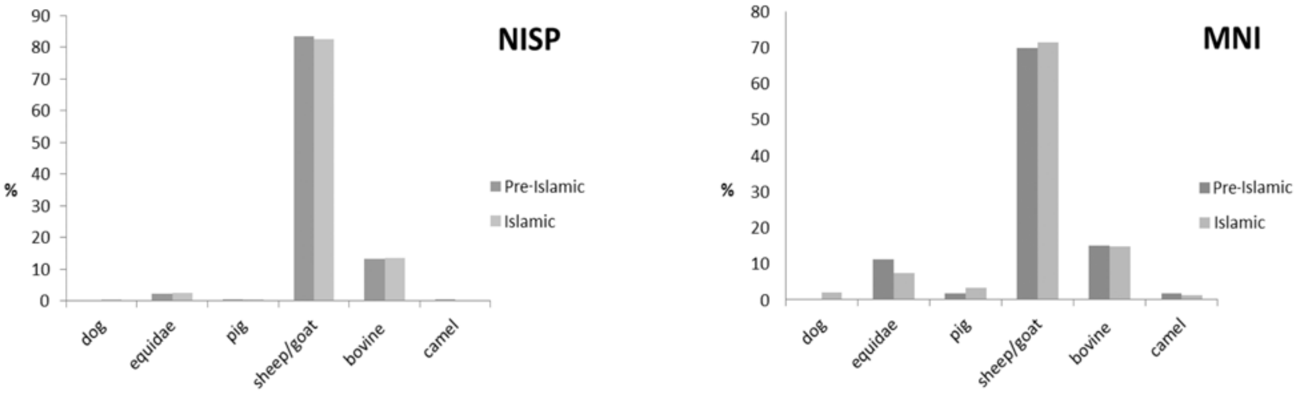

Figure 2.5.6. Number of Identified Specimens (NISP) of domestic animals: comparison between pre-Islamic/Islamic (on the left); Minimal Number of Individuals (MNI) of domestic animals: comparison between pre-Islamic/Islamic (on the right).

## Final Remarks

Despite the fact that the faunal assemblage dated to the Islamic occupation is much larger than the assemblage from the pre-Islamic phase, it is nevertheless possible to propose a reliable reconstruction of the animal economy at Kafir Kala during the Islamic transition. The faunal analysis suggests a substantial continuity in the exploitation of domestic animals with an almost exclusive exploitation of sheep and goats (Figure 2.5.6).

As attested elsewhere in Central Asia, wild animals still represented an important—though limited—resource evidently linked to environmental needs and their adaptability to a particular ecosystem (Lhuillier and Mashkour 2017). Occasionally, the inhabitants of Kafir Kala must have hunted ungulates to procure meat and skins, as well as possibly for prestige. Nevertheless, there is no evidence of stags or their antlers, which could have possibly been used as raw material for making instruments and jewelry or as hunting trophies. Foxes appear to be the most hunted animals, most likely for pelts, as suggested by the skinning marks found on the diaphyses of their metapodials.

The general increase in meat consumption during the Islamic period can be explained by the shifting of Kafir Kala's citadel from an administrative center to a residential area. The appearance of animal species, which are not related to meat consumption—dogs and cats—must also be seen in connection with the residential function of the citadel during the Islamic centuries.

The historical transition following the Arab conquest of the Samarkand region in 712 AD does not seem to have altered the animal economy at the site, which was essentially based on pastoralism during both occupation phases. Flocks provided not only meat, but most likely other products, such as wool, leather, and milk. Likewise, cattle were used as a food source and probably as traction animals. As indicated by a paucity of remains, pigs were evidently only an occasional source of meat.

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# Part 3

## Beyond Subsistence: Animals in the Symbolic World of Southwest Asia and Adjacent Areas

# 3.1 | Emerging Bees

## Identification and Possible Meanings of Insect Figures at Göbekli Tepe

Sebastian Walter* and Norbert Benecke†

### Abstract

Wild animals occupy a central position in the pictorial cosmos of the earliest Neolithic (Pre-Pottery Neolithic A) in Upper Mesopotamia. Together with abstract signs, animal figures are part of a "system of symbols," which has so far only been rudimentarily analyzed. Besides relatively large representatives of mammals, birds, and reptiles, comparatively small animals are also depicted in PPNA artworks: at various sites probable representations of arthropods have been found. Often different suppositions exist on which arthropod taxa might be represented. At Göbekli Tepe, bas-reliefs on several pillars of Building D show very similar, insect-like animals. It has been proposed that at least some of them might depict spiders. We attempted to identify those represented insect-like animals based on arthropods' anatomical features. These figures appear to be closely related to similar ones found at Körtik Tepe. Detailed comparative analyses indicate that bee- or wasp-like insects are depicted, some probably emerging from brood cells. The insects and their development may be connected to early Neolithic ideas of death and postmortal existence.

### Keywords

*Pre-Pottery Neolithic A (PPNA), southeastern Turkey, Göbekli Tepe, Körtik Tepe, insect representations, hymenoptera, spider, wasp, bee, symbolism*

## Introduction

At the transition from Pleistocene to Holocene, humans in Southwest Asia developed a sedentary way of life in village communities. The first Neolithic culture of hunter-gatherers is called Pre-Pottery Neolithic A (PPNA, ca. 9600–8700 BC; e.g., Badisches Landesmuseum Karlsruhe 2007; Özdoğan et al. 2011; Peters et al. 2014).

A main characteristic of the PPNA is an "explosion" of images, dominated by representations of wild animals (Özdoğan et al. 2011; Watkins 2011). The artworks are supposed to be part of a symbolic communication system, used to store cultural knowledge, which has so far only been rudimentarily analyzed (Köksal-Schmidt and Schmidt 2007; Stordeur 2010; Watkins 2010). In most cases, powerful, venomous, predatory, and often dangerous animals are depicted: for example, aurochs, leopards, vultures, foxes, and snakes (Helmer et al. 2004; Stordeur 2010). In addition, representations of comparably small animals are found at several PPNA sites, especially of scorpions and other arthropods (Helmer et al. 2004). Most of the probable arthropod representations were discovered at Göbekli Tepe and Körtik Tepe, two key PPNA sites of Upper Mesopotamia in Southeast Turkey (see *Locations and Site Description*, below), with many figurative artworks (Özdoğan et al. 2011; Özkaya and Coşkun 2011; Schmidt 2012).

At Göbekli Tepe more than ten figures on stone pillars might show arthropods, five of which are possibly representing insects (Schmidt 2012). For these

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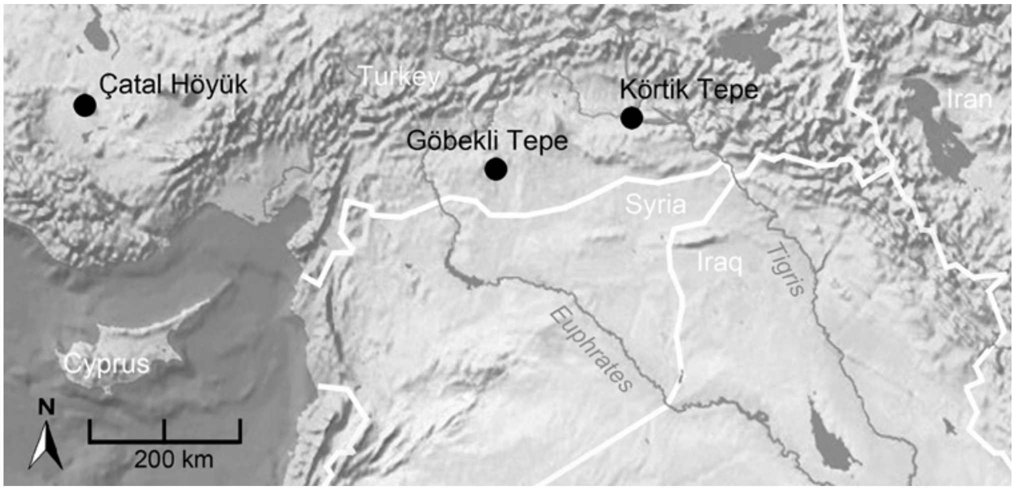

Figure 3.1.1. Map showing the location of archaeological sites mentioned in the text.

insect-like figures, there exist different suggestions on what kind(s) of animal(s) might be depicted. At Körtik Tepe very similar animal figures were found, which may help to identify the animal(s) represented at Göbekli Tepe.

## Materials and Methods

### *Locations and Site Description*

Göbekli Tepe (37° 13' N, 38° 55' E, ca. 770 m above sea level) is located in the Euphrates region, not far from the modern city of Şanlıurfa (Figure 3.1.1). Ongoing excavations since 1995 revealed an impressive megalithic architecture, probably used for ritual purposes: monolithic T-shaped pillars several meters high, decorated with reliefs and sculptures showing animals and abstract signs, were inserted into the walls of circular buildings (Notroff et al. 2016; Schmidt 2012).

Körtik Tepe (37° 48' N, 40° 59' E, ca. 520 m above sea level) is situated in the upper Tigris basin, near the junction of the Batman and Tigris Rivers, ca. 200 km northeast of Göbekli Tepe (Figure 3.1.1). All data indicate that during the PPNA Körtik Tepe was a permanent settlement. Many round buildings of 2.3–3 m in diameter were excavated. Such round buildings, probably single-family dwellings, are characteristic of the PPNA period. The excavations also revealed hundreds of skeletons, most of them (ca. 75 %) in hocker or semi-hocker position. A large proportion of burials were found beneath house floors and the majority of graves contained bone and/or stone artifacts, amongst them many decorated objects (Özkaya and Coşkun 2009, 2011).

### *Spiders or Insects of Building D at Göbekli Tepe*

At Göbekli Tepe depictions of arthropods were until now only found in Building D, the oldest of the excavated probable cult buildings so far. It was radiocarbon-dated to the middle of the tenth millennium BC (Dietrich et al. 2013). Possible insect depictions are found on three pillars: Pillar 21, Pillar 33, and Pillar 43 (Figure 3.1.2). On Pillar 33 there are two figures, worked as bas-reliefs (Figure 3.1.2a). One of them is situated at the pillar's base. Its lower half—hind part—is covered by a stone bench, into which the pillar is inserted. In what follows, the upper figure will be designated as G33A (G stands for Göbekli Tepe, 33 for Pillar 33), the lower as G33B (Figures 3.1.2b, c). Also the figure on Pillar 43, designated as G43 (Figure 3.1.2d), is worked as bas-relief. The lower—hind—part, however, is only partially worked out. On Pillar 21 there are again two figures, designated as G21A, upper figure, and G21B, lower figure, of which only the outlines are picked into the stone (Figure 3.1.2e). The figures measure between around 20 cm and 36 cm. The close resemblance of all of these figures makes it very probable that it is always the same animal category that is depicted (Schmidt 2012:167, 177, 178, 244, 245). However, there exist different hypotheses about the motif: it was proposed that the figures might represent insects or insect-like animals (Schmidt 2007a, Schmidt 2012:167, 177, 178, 244, 245), but also spiders (Schmidt 2012:168, 177, 178), possibly camel spiders (Schmidt 2007a). The figures on Göbekli Tepe–P33 have also been described as beetles (Lewis-Williams and Pearce 2005).

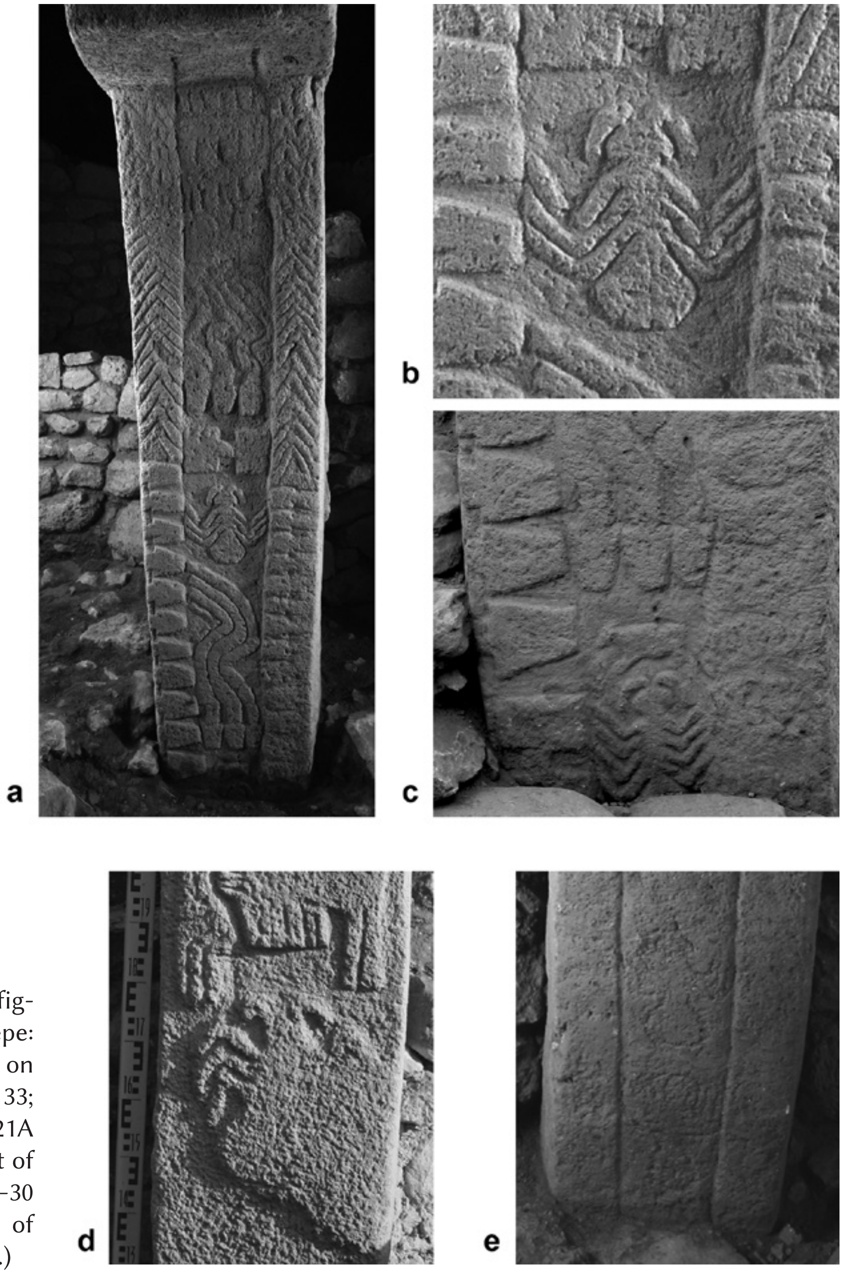

Figure 3.1.2. Possible insect figures in Building D, Göbekli Tepe: (a) Front of Pillar 33; (b) G33A on Pillar 33; (c) G33B on Pillar 33; (d) G43 on Pillar 43; (e) G21A and G21B on Pillar 21. Height of the figures is between ca. 20–30 cm. (Photographs courtesy of the DAI Göbekli Tepe Project.)

### *Probable Depictions of Insects at Körtik Tepe*

For reasons of comparison, we included in our investigations similar figures from PPNA layers, from Körtik Tepe (Figure 3.1.3). According to $^{14}$C dates of the respective layers, these figures out of burial contexts are of about the same age as those from Göbekli Tepe, between ca. 9600 and 9350 BC (Benz et al. 2012). Two of these figures are small bas-reliefs on stone plaques (K01 and K02; Figures 3.1.3a, b); another two are engraved on a bone plaque (K03 and K04; Figure 3.1.3c). For all of these figures it was suggested that they might represent insects (Coşkun et al. 2010; Özkaya 2004; Özkaya and Coşkun 2011).

### *Method of Analysis*

In our investigations we aimed at a better taxonomic identification of these figures based on the represented morphology. In these artworks the animals are represented in a rather abstract way without many details that are usually available for identification of real animals. We therefore could not apply the step-by-step procedure of an identification key. Furthermore, we did not aim at identifying at a species level. Of primary importance was to determine whether the animals represent insects or other arthropods, and if they are insects, which kind of insects. Identification was based on different sources, comparing morphological features of the depicted figures with the morphology of real animals: besides identification keys we used images of animals in question from literature on animal taxonomy (e.g., Bellmann 2017; Foelix 2011; Goulet and Huber 1993; Gullan and Cranston 2014; Klausnitzer 2002; Michener 2007; Punzo 1998; Weber 1966) and also web databases (e.g., BioLib [Zicha 1999–2019]; Fauna Europaea 2017). We also compared them with other, already identified, pictorial animal representations from the North Mesopotamian PPNA (e.g., Badisches Landesmuseum Karlsruhe 2007; Özdoğan et al. 2011; Peters and Schmidt 2004).

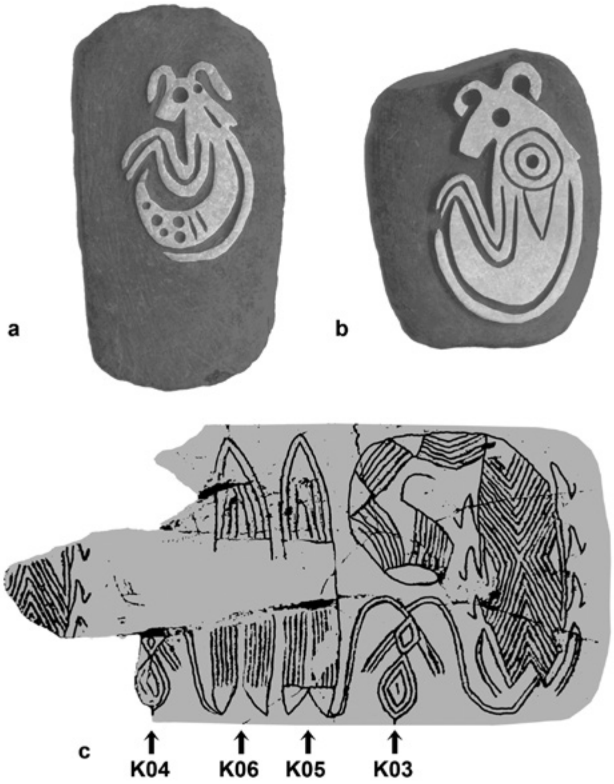

Figure 3.1.3. Probable insect figures from Körtik Tepe: (a) Stone plaque with K01 (height of the insect figure ca. 4 cm); (b) stone plaque with K02 (height of the insect figure ca. 5 cm); (c) incised bone plate with K03 (height of the insect figure ca. 3 cm), K04, K05, and K06. (All graphics are based on photographs by the Körtik Tepe excavation archive.)

## Results

### *Morphological Features of Göbekli Tepe's Figures Point to Bees or Wasps*

In our description of the morphological analyses, we concentrate here on Göbekli Tepe figures G33A and B (Figures 3.1.2b, c), because these contain the most details in comparison with the other figures.

Figure G33A shows three pairs of legs, indicating an insect (Gullan and Cranston 2014; Snodgrass 1993 [1935]; Weber 1966). Yet, the second figure on Pillar 33 (G33B) clearly shows four pairs of legs, pointing to a spider (Foelix 2011). However, besides four pairs of walking legs, spiders are also characterized by a cephalothorax: head and thorax are fused together (Foelix 2011). The partitioning of the body into three main parts—head, thorax, and abdomen—that is found with both figures G33A and B supports their identification as insects (Gullan and Cranston 2014; Snodgrass 1993 [1935]; Weber 1966). The members of a specific order of arachnids, the solifuges (Solifugae, camel spiders) appear to be partitioned like insects. Yet, the form of the figures' heads and the number of legs makes a representation of solifuges improbable. The enormous chelicerae—claws in front of the mouth—of solifuges are missing, and their long, leg-like pedipalps should appear as a fifth pair of legs (Punzo 1998). The figures' head extensions clearly look like antennae of insects, not like pedipalps or chelicerae. But what kind of insect might be depicted then?

The figures' legs apparently extend all from the same thorax-like body region. This is principally true for all insects, except however for a suggested beetle identification (Lewis-Williams and Pearce 2005): beetles are different from other insects in that they appear to be separated into head, "neck" with front legs, and the rest of the body with mid- and hind legs, usually covered by the wings (Gullan and Cranston 2014; Klausnitzer 2002).

Both figures show an important morphological feature: a narrow constriction between "thorax" and "abdomen," corresponding to a "wasp waist." This points to apocrite—wasp-waisted—hymenopterans, such as ants, bees, and various wasps (Goulet and Huber 1993; Gullan and Cranston 2014). There are no wings depicted, which means that the insect might be wingless. It could then indicate an ant or a wingless wasp, for instance a mutillid (for a more detailed analysis of the possibility of a mutillid motif, see Walter 2014). The sidewise backward-curved antennae rather suggest a wasp or a bee than an ant (Hölldobler and Wilson 2013). If the represented insects are winged, the shape of the relatively broad and rounded abdomen rather points towards bees than wasps (Figure 3.1.4a; Goulet and Huber 1993). Very similar figures can be found in the "English Garden" at the Tiergarten in Berlin (Figure 3.1.4c). They are part of a fountain created in 1995 by the Austrian artist Gerald Matzner, depicting a central beehive surrounded by wingless—honey—bees (Senatsverwaltung für Stadtentwicklung und Wohnen [SSW] Berlin 2017).

The figures on Pillar 21 (G21A and B) and Pillar 43 (G43) are very similar to those on Pillar 33, most likely showing the same animal. All of them have three pairs of legs only.

### *The Figures from Körtik Tepe Probably Also Show Hymenopterans*

For Körtik Tepe, figures K01 and K02 (Figures 3.1.3a, b), it has already been proposed that they might represent bees (Özkaya 2004; Özkaya and Coşkun 2011). It has also been noted that they resemble the figures from Göbekli Tepe (Köksal-Schmidt and Schmidt 2007; Schmidt 2007b).

In difference to Göbekli Tepe's figures, both figures from Körtik Tepe are represented in lateral view. There are several indications that indeed a bee-like insect is depicted: the line running along the figure's back most likely indicates wings. The curved head extensions look like bee or wasp antennae. The "snout" was formerly described as being reminiscent of a dog (Özkaya 2004); however, it also corresponds to the protruding mouthparts of bees/wasps. The protrusion on the back might be a prominent backshield—scutum and scutellum—that is characteristic for bees/wasps (Goulet and Huber 1993). A rather clear hint to a stinging insect is the sting-like abdominal extension of figure K01 (Schmidt 2007b). Two parallel lines in the center of K01's body may indicate the wasp waist or the banding pattern—or both—of bees/wasps. Similarly, the V structure of K02 may also indicate a wasp waist. The slim body, with a pointed abdomen, that in one case also shows a dot pattern (K01) may rather suggest a wasp than a bee (for a more detailed analysis of the Körtik Tepe figures, see Walter 2015).

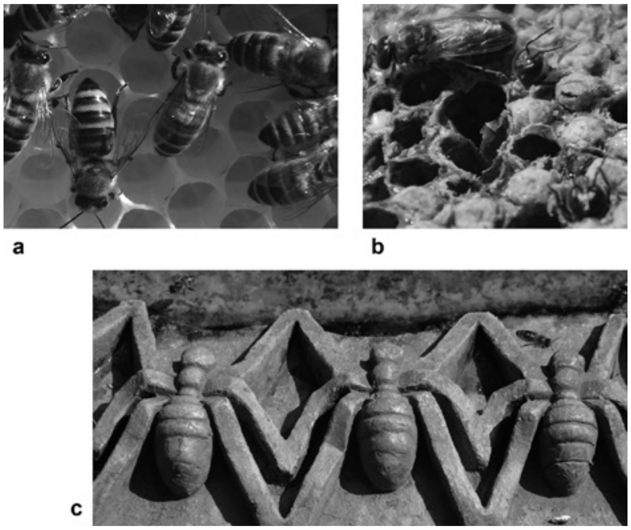

Figure 3.1.4. (a) Honey bees (*Apis mellifera*) on a new comb; (b) honey bees emerging from their brood cells; (c) detail of a fountain by Gerald Matzner at the Tiergarten in Berlin, depicting honey bees surrounding a beehive.

Due to the—probably—dorsal view in which the animals are represented, K03 and K04 show an even closer similarity to Göbekli Tepe's figures (Figure 3.1.3c). Only one of the probably originally identical figures is fully preserved (K03). Though a head seems to be missing, the six leg-like extensions at the thorax, which might also stand for two pairs of wings, together with the tripartite body structure clearly indicate an insect. The antennae are again curved backwards; yet, they are rather long for a bee or most wasps. However, the other depicted morphological features point again to a bee-like insect: this figure possesses six leg-like extensions at the thorax, a "wasp waist" between thorax and abdomen, and, in addition to the common features found with Göbekli Tepe's figures, a sting-like extension at the tip of the abdomen. Taken together, this strongly indicates the representation of a bee or wasp's imago.

### *The Figures May Represent Different Stages of Insect Life Cycles*

Körtik Tepe–figures K03 and K04 are both associated with a suspicious structure: an elongated ovoid form that is pointed at one end, and apparently split open at the other (K05, K06, Figure 3.1.3c). It was previously identified as a possible depiction of a fish (Coşkun et al. 2010). This structure next to the insect might, however, be the depiction of an opened brood cell—or cocoon—out of which the insect just emerged (Figure 3.1.4b). The insect's antennae might be unnaturally elongated to reach the brood cell's opening, to indicate a connection between insect and brood cell.

An interesting aspect of Körtik Tepe–figures K01 and K02 is their fetus-like crouched posture with bent legs. There are two possible explanations for this posture: the postures of K01 and K02 correspond to the crouched posture of dead wasps or bees, as well as to the hocker position in which humans were buried. Might the insect representation thus be understood as a representation of death? Or the postures of K01 and K02, especially the bent legs, could also correspond to that of a bee/wasp—pupa or imago—resting in the brood cell. The insect representations thus might also be understood as a symbol of new life.

Within this context, there might also be an explanation for the only partial visibility of two insect figures at Göbekli Tepe: of figures G33B and G43 only the frontal—upper—part of the body is visible (Figures 3.1.2c, d). The figure G33B seems to crawl out of the bench into which Pillar 33 is inserted, and the figure G43 looks like crawling out of the stone pillar itself. It was suggested that this partial visibility happened rather by accident (Schmidt 2012). It might, however, also be an intended parallel to the possible developmental aspects observed with Körtik Tepe's figures analyzed here. The only partially shown insects on Göbekli Tepe–Pillars 33 and 43 may depict bees, which are just about to emerge from their brood cell or brood chamber. Therefore, only the frontal part of the emerging insect is visible, the hind parts being still hidden in the cell.

At Körtik Tepe as well as at Göbekli Tepe there are, thus, indications that bees or wasps are depicted in different stages of their life cycle.

## Discussion

### *Summary of the Results*

The different analyzed figures from Göbekli Tepe as well as those from Körtik Tepe seem to all represent aculeate hymenopterans. While the Göbekli Tepe figures look more like bees, at least part of the Körtik Tepe figures look more like wasps. All depicted insects are most likely winged, even if no wings are shown, as is the case for figures in dorsal view. The insects seem to be represented in different developmental stages: inside the brood cell, emerging from the brood cell, and imago outside the brood cell.

In what follows, we will discuss the plausibility of wasp and bee depictions, especially their probable abundance during the PPNA and opportunities for Neolithic people to observe them and their life cycle, and whether bees and wasps might have been perceived as a common animal category. We will also discuss possible causes for the interest of early-Neolithic people in these insects, possible symbolic meanings, and relations to other possible depictions of bees during the Neolithic in Anatolia.

### *Environment and Probable Abundance of Aculeate Hymenopterans*

Findings on past environment suggest that aculeate hymenopterans were abundant during the PPNA. This is supported by literature on the current occurrence of hymenopterans in Anatolia and our own field observations.

Past Environment. Most hymenopteran species are thermo-xerophile: they prefer warm, rather dry and open biotopes. Furthermore, the habitat must offer a sufficient supply of flowering plants for most immature wasps also of other insects or spiders (Bellmann 2017; Witt 2009).

According to pollen records and macrobotanical remains, the Early Neolithic landscape in the area of Göbekli Tepe and Körtik Tepe was characterized by a relatively open park woodland, dominated by widely spaced stands of pistachio, almond, and oak and covered with grasses, which formed a major component of the vegetation. Along the rivers, gallery forests occurred with tree species such as *Tamarix* ssp., *Populus* ssp. and/or *Salix* ssp., *Alnus* ssp., *Fraxinus* ssp. (Benz et al. 2015; Neef 2003; Riehl et al. 2012). This steppe forest was probably an optimal habitat for many different kinds of wasps and bees during the PPNA.

*Hymenopteran Fauna Today.* Many different aculeate hymenopterans are found today in the region, which are in part of impressive size, for example scoliids (length up to 5 cm) or the oriental hornet (2–3 cm; see Madl 1997; Özbek and Anlaş 2011; Tez-

Table 3.1.1. Results of experimental insect observations at Göbekli Tepe.

| Order | Family | | May | September |
|---|---|---|---|---|
| Diptera | Asilidae | (robber flies) | +++++ | – |
| Diptera | Syrphidae | (hover flies) | + | ++ |
| Diptera | Calliphoridae | (blow flies ) | – | + |
| Diptera | Muscidae | (houseflies) | ++ | +++++ |
| Diptera | Trypetidae | (fruit flies) | – | + |
| Hymenoptera | Vespidae, *Vespa* | (hornets) | +++ | +++++ |
| Hymenoptera | Vespidae, *Vespula* | (yellow jackets) | ++ | + |
| Hymenoptera | Vespidae, Eumeninae | (potter wasps) | – | + |
| Hymenoptera | Sphecidae | (sand wasps) | + | ++ |
| Hymenoptera | Megachilidae | (mason bees) | ++ | – |
| Hymenoptera | Anthophoridae | (digger bees) | – | +++ |
| Hymenoptera | Apidae, *Apis* | (honeybees) | + | ++ |
| Hymenoptera | Formicidae | (ants) | +++ | +++++ |
| Coleoptera | Tenebrionidae | (darkling beetles) | + | ++++ |
| Coleoptera | Cerambycidae | (longhorn beetles) | + | – |
| Coleoptera | Coccinellidae | (ladybird beetles) | – | ++ |
| Orthoptera | Caelifera | (short-horned grasshoppers) | ++++ | +++++ |
| Orthoptera | Ensifera | (long-horned grasshoppers) | ++ | – |
| Mantodea | Mantidae | (mantids) | + | + |
| Mantodea | Empusidae | (empusids) | + | – |
| Neuroptera | Myrmeleonidae | (ant lions [imago]) | +++ | + |
| Odonata | | (dragonflies) | – | ++ |
| Lepidoptera | Papilionidae | (swallowtails) | + | – |
| Lepidoptera | Sphingidae | (hawk moths) | + | – |
| Lepidoptera | Lycaenidae | (gossamer-winged butterflies) | – | +++ |
| Lepidoptera | Pyralidae | (snout moths) | – | + |

Frequency of observation: – = not observed, + = very rare, ++ = occasional, +++ = regular, ++++ = frequent, +++++ = very frequent.

can et al. 2004). The western honeybee is represented by the subspecies *Apis mellifera meda* Skorikov, 1929 (Özdil et al. 2012). Literature from antiquity describes social wasps and hornets as a real plague in the eastern Mediterranean (Keller 1913). Vespid wasps, which include social wasps and solitary potter wasps, are represented today by many different species (Yildirim 2012), and different species of mutillids also occur (Yildirim 2006).

This is supported by results from our own experimental observations at Göbekli Tepe. Within a transect of about 1 km length, roughly in northwest–southeast direction, we were investigating which insects are easily observable during slow walks along this transect. The frequency of observations was recorded during two days in late spring and two days in autumn. The results of this observation (Table 3.1.1) show that today aculeate hymenopterans—bees, wasps, and especially hornets—are among the most often observed arthropods.

### *Possibilities of an Observation of Insect Development*

Many wasps, especially social wasps, and some bees are synanthropic: they build their nests on or in human houses, consume human food, and more (e.g., Fowler 1983; Mader 2000). They were likely present in Neolithic settlements. The constructions of some nests allow to watch how mature insects emerge from the brood cells and—as with the open combs of paper wasps (genus *Polistes*)—even to observe the development of larvae in the brood cells, without opening the nest (Fowler 1983; Witt 2009).

Also in the PPNA, foragers almost certainly opened bees' and possibly wasps' nests to collect honey as well as brood. Rock art depicting so-called honey-hunting scenes is known from different parts of the world (Crane 1999). A famous Neolithic or Mesolithic rock painting in the Cueva de la Araña in the Spanish Levant, for example, shows flying insects together with a human figure carrying a bag and standing on a ladder in front of a small dark "opening" in the rock face, apparently a nest of wild honeybees. Usually this scene is interpreted as depicting somebody collecting honey (Crane 1999; Hernández-Pacheco y Esteban 1924). However, in many different regions of the world not only honey, but also pupae and larvae of bees and wasps are collected and eaten (e.g., Crane 1999).

PPNA people, thus, probably had frequent opportunities to observe bees and wasps in different developmental stages.

### *Bees and Wasps as the Same Animal Category*

Variations in the represented morphology suggest that different aculeate hymenopterans were depicted: bees at Göbekli Tepe and wasps at Körtik Tepe. Is it possible that the various representations were understood as depictions of the same kind of animal, that bees and wasps were perceived as a common category?

Different from modern English, German, or French, other languages group(ed) bees and wasps into a common category of animals. In modern Turkish, wasps are a kind of bee (Tureng 2017): *arı* = bee; *bal arısı* = honeybee; *sarı(ca) arı* = wasp or "yellow bee"; *eşek arısı* = hornet or "donkey bee." In ancient Sumerian—fourteenth tablet of the *Har-ra = Hubullu*, library of Assurbanipal (seventh century BC)—wasps and bees belonged to the same category of insects, together with flies. The Sumerian language grouped insects and other arthropods by denominative prefixes: for instance, *buru* = orthopterous insects (locusts, grasshoppers, crickets, including mantids and possibly dragonflies); *girish* = butterflies. Together with flies, bees and wasps belonged to the same prefix group and ants to another: *num* = flies, bees, and wasps (such as *numlal* = honeybee or "honey fly") and *kishi* = ants (Bodenheimer 1960).

Treating bees and wasps as the same category of insect would be nothing extraordinary.

### *Biological Characteristics of Bees and Wasps That Might Have Caused the Interest of Neolithic People*

Now it is one thing to observe something, and another to depict it. Why did the creators of Göbekli Tepe and the inhabitants of Körtik Tepe depict bees and possibly wasps? There are quite a number of biological characteristics of bees and wasps (Bellmann 2017; Gauld and Bolton 1988; Goulet and Huber 1993; Gullan and Cranston 2014; Witt 2009) that might have caused Neolithic people to be especially interested in these insects:

(1) Aculeate hymenopterans are foragers, similar to PPNA hunter-gatherers. Most likely people at Göbekli Tepe and Körtik Tepe could observe in their daily surroundings how wasps prey on insects and spiders, like they themselves were hunting wild sheep, gazelles, and other game (Peters et al. 2014). As humans collected, for example, seeds and fruits from plants (Riehl et al. 2012) and probably stored them in specific small round buildings (Özkaya and Coşkun 2011), bees carry pollen to their nest and store their food in special cells.
(2) Social hymenopterans, like honeybees, hornets, and yellow jackets, live in—partially very large—communities, comparable to human communities.
(3) They construct nests, consisting of more or less circular cells, similar to human villages and PPNA houses (Özkaya and Coşkun 2011).
(4) They care for and defend their young and each other, like humans do.
(5) Females of the Aculeata possess a sting to inject venom. Getting stung is painful and can even

be dangerous. Today, getting stung by bees and wasps happens frequently in Turkey and can be associated with very serious complications (Kalyoncu et al. 1997). Bees and wasps might have been regarded as “brave” and powerful “warriors,” arousing human fear, and teaching respect.

(6) Many Aculeata show an aposematic coloration, often with stripes in black and yellow, or black and white, to warn predators. This might have elicited PPNA people’s aesthetic attention and appealed to their sense of beauty.

(7) And finally, the ontogenetic development of bees and wasps is characterized by a holometabolous metamorphosis: during the pupal stage the insect transforms from a first “form of life,” the worm-like larva, into a second, clearly different one, the winged imago, that emerges after several days from the pupal skin. Concealed in a cocoon, the pupa is neither feeding nor moving. The transformation of the insect body in a kind of sleep- or even death-like state might have been associated with beliefs about a continuation of human life after death, possibly—like the insect—in a changed form. That PPNA people believed in an afterlife is indicated by the high number of grave goods found at Körtik Tepe (Özkaya and Coşkun 2009, 2011). The symbolic association of insects with postmortal existence is, for example, well documented for Ancient Egypt, where the scarab beetle was regarded as a symbol of rebirth after death—in the context of funerary rites carved beetle figures were used since the third millennium BC (Cherry 1985; Levinson and Levinson 2001).

In sum, PPNA people could have perceived several parallels between themselves and bees, as well as wasps. The symbolic meaning of bees/wasps might have been based on their life cycle with a pupal stage before emerging as an imago from the brood cell, their ability to sting, and their “house-building” social communities.

### *Other Early Depictions of Aculeate Hymenopterans in Southwest Asia*

In Southwest Asia, other early representations of bee-like insects are until now only known from a clearly later phase of the Neolithic (ca. 6600 BC): very abstract figures on wall paintings at Central Anatolian Çatal Höyük were interpreted as showing a comb with developing bees—but also as possible representations of butterflies with caterpillars on flowers. Another painting at Çatal Höyük may show a goddess with a beehive on top of her head, surrounded by flying bees (Crane 1999; Mellaart 1967, 1989). The paintings from Çatal Höyük are very reduced and have been regarded as representations of bees mainly because of the association with comb- or hive-like structures.

If the paintings at Çatal Höyük indeed show bees in different developmental stages, perhaps there existed a continuing Neolithic tradition of this motif, originating from Göbekli Tepe and Körtik Tepe.

## Summary and Conclusions

Comparative morphological analyses of five animal figures represented on pillars at Göbekli Tepe and of four similar figures on artworks from Körtik Tepe suggest that all figures depict aculeate hymenopterans, that is, bees and/or wasps. Our results further substantiate previous suggestions that some of the investigated figures might depict bee-like insects (Özkaya and Coşkun 2011). Two figures from Körtik Tepe are probably associated with opened brood cells, two representations from Göbekli Tepe may depict the moment when the insect emerges from its brood cell, and two other figures from Körtik Tepe may show insects still resting inside the brood cell. They might, however, also depict dead insects or intentionally combine both aspects—dead and developing insect.

Aculeate hymenopterans were probably abundant during the PPNA, and early Neolithic people had many opportunities to observe them and their life cycle. They also could have perceived similarities between these insects and themselves. The symbolic importance of bees and/or wasps in Early Neolithic Upper Mesopotamia may have been based on their biological characteristics, especially also on certain aspects of their life cycle. At Göbekli Tepe as well as at Körtik Tepe the bee/wasp figures might have been associated with ideas of a connection between death and the emergence of new life. Findings from Çatal Höyük may indicate that the bee/wasp motif was passed down to later Neolithic cultures, in a perhaps continuous symbolic tradition.

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# 3.2 | The Cult of Horus and Thoth

## A Study of Egyptian Animal Cults in Theban Tombs 11, 12, and −399−

Salima Ikram* and Megan Spitzer†

### Abstract

Animal cults have been a feature of ancient Egyptian religion since ca. 3000 BC, enjoying intermittent popularity until the fourth century AD and the Christian dominion of Egypt. Under the direction of José Galán, the Proyecto Djehuty team has been working in Dra Abul Naga, west of Luxor, in the area of the Eighteenth Dynasty tombs of TT 11, TT 12, and −399−. Parts of these tombs, subsequent to their initial use, became the site of an animal cult dedicated to the gods Horus and Thoth. This paper explores the nature of the cult, the types of animals interred, their acquisition and mummification, and it speculates on their relationship to the different gods to whom the area was dedicated.

### Keywords

*socio-symbolic use of animals, past biodiversity, religion and animals, animal mummies, ancient Egypt, cult, shrews, raptors, ibis*

## Introduction

Ancient Egyptian deities often took theriomorphic forms, either completely, or partially. A deity's totemic animal manifested specific characteristics of the god or goddess to which it was attached. Thus, sun-colored raptors that flew high in the sky, had superb eyesight, and were fierce fighters were associated with the sun god, Re, or Horus, who was a manifestation of the divine ruler of Egypt. Shrews, with their extraordinary nocturnal vision and fierce temperaments, were considered the nocturnal manifestation of Re (Ikram 2005). Thoth, the god of wisdom and literacy, was most often shown as a Sacred Ibis (*Threskiornis aethiopicus*) or a man with an ibis head. Re, Horus, and Thoth were worshipped all over Egypt. Starting about 660 BC and continuing into the Roman era (ca. AD 340), an innovation in the worship of other gods is notable, vis à vis votive offerings. Instead of only giving statues, statuettes, and stelae to the gods in the hopes that the donors' prayers would be answered, mummies of the animal associated with the god were given as offerings. The idea that the sacrifice of a living creature would be more effective in answering the donor's prayers might have been partially responsible for this new type of votive offering (Ikram 2015a:5–15). Often, these *ex votos* were related to cults where an animal, thought to be the repository of a portion of the god/goddess's spirit, was worshipped. This cult animal would be treated like a living god, and upon its death the spirit of the god would move into another similarly marked creature that was then worshipped, much as is the cycle seen with the Dalai Lama. The dead animal was mummified and buried with great pomp in a catacomb/tomb dedicated to these Sacred Animals (Ikram 2015a:5–9; Ray 2001).

Although the Sacred Animal was a single creature at a time, the mummified votive offerings were numerous, each carrying a prayer to its associated deity and playing a significant part in the economy of Egypt (Ikram 2015b). After being consecrated to

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Figure 3.2.1. An overview of the site with TT 11, TT 366 and TT 12 (left to right) labeled. (Photograph courtesy of J. M. Galán.)

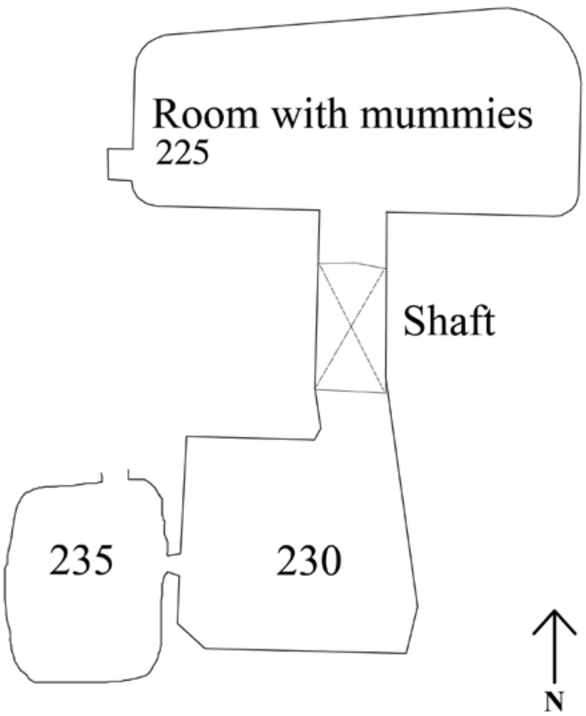

Figure 3.2.2 Schematic plan of the shaft and chambers UE230 and UE235. (Plan courtesy of N. Warner.)

the deity, the votive animals were also buried. Most commonly, a human tomb was reused and repurposed for vast numbers of animal burials.

## Materials

The west bank of Luxor—ancient Thebes—is riddled with sepulchres of kings, elites, and commoners. A group of tombs clustering together in an area known as Dra Abu al-Naga has been excavated by the "Proyecto Djehuty" since 2002 under the direction of José M. Galán (Figure 3.2.1).[1] Most of these rock tombs date from the sixteenth century BC. But some of these—Theban Tomb [TT] 11, 12, and Tomb −399− in particular—have proven to have a life that extended well beyond their original owners' intentions: they were taken over and used as burial places for animal mummies. Texts found painted in red on the walls, covering the original carved decoration in some instances, explain that the area was used to inter offerings to Horus and Thoth in the third century BC, extending into the second century BC (205–130 BC), at the very least (Di Cerbo and Jasnow 2021).

The tombs yielded several complete mummies, albeit blackened by smoke due to a—or a series of—fire(s), some of which are alluded to in the texts on the walls. Subterranean chambers accessed by shafts in TT 12 and Tomb −399− in particular (Figure 3.2.2), were filled in some cases with large linen bundles that contained fragments of burnt mummified remains as well as badly burnt bones and in other cases 13 to 25 cm thick deposits of burnt bone (Figure 3.2.3). These latter deposits, excavated in 2014 and coming from the irregularly shaped Chambers UE230 (measuring 3.1–3.25 m × 3.55–3.75 m and ca. 1.5 m high) and UE235 (measuring 2.73–2.10 m × 2.5–1.65 m × 1.25–0.8 m high) are the focus of this paper.

The burnt bone is all that remains of the many mummies placed as votive offerings in these tombs. A single or several conflagrations destroyed the textiles in which the animals were wrapped, and the oils and resins used in mummification fed the flames, causing the mummy bundles to be reduced to burnt and twisted bone, with colors ranging from black to white to blue and encompassing in-between shades.

## Methods

A strategy to retrieve and record the information within the limited time frame of the season and presence of the full team was implemented. After UE230 chamber was gridded out into nine roughly 1 × 1 m squares, the material was removed from each square within the chambers, taken outside and sieved. Before the material was removed from each square, samples of four liters were taken from four of the eight squares located at different parts of the room (V, VIII, IX) in order to provide results that reflected the contents of the entire chamber. As UE235 had a largely collapsed ceiling, in the interest of safety, it was not emptied, but one four-liter sample was taken from roughly the middle of the room, where the deposit was ca. 26 cm deep. The samples were scooped up by hand and thus some anatomical elements escaped inclusion, as we did not want to dig down too violently and break the bones, many of which had a tendency to snap and/or shatter. Each sample was analyzed to obtain an overall idea of species represented, minimum number of birds placed in the room, their ages, and whether entire birds had been mummified or just specific portions. Photographs provided *comparanda*. Information recorded

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[1] http://www.excavacionegipto.com.

Figure 3.2.3. The top level of UE230 with the burnt bones amidst the red and grey matrix. (Photograph by S. Ikram/F. Bosch.)

also included pathologies, anatomical element, and portion thereof, side, approximate age, and degree of burning. In addition, "cherry-picked" samples from the sieved remains of Chamber 230 were also analyzed with a view to gaining a better perspective on the range of animal remains present here.

## Results

A total of 3,867 bones derived from the samples and "cherry picking" were examined from UE230 and UE235. The Number of Identified Specimens (NISP) to family was 2,962, to genus 1,931 (Table 3.2.1 and Figure 3.2.4). A common feature in all of the samples was the preponderance of Threskiornithidae remains. These were followed, by a considerable margin, by Falconidae. Based on the four-liter samples, the dimensions of the room, and the depth of the deposit, the Minimum Number of Individuals (MNI) in chamber UE230 would have been approximately 10,000 ibises and 2,000 birds of prey—a large amount of avifauna coming from diverse ecosystems. It should be noted that the MNI in UE230 (Table 3.2.2) indicates more raptors than ibises. However, it needs to be repeated that this sample is reflective of "cherry picking," and thus does not reflect the true proportion of ibis to raptor.

The analyses of each sampled area yielded a slightly different profile (Table 3.2.1)—note that only squares V, VIII, and IX in UE230 and one in UE235 had four-liter samples; the rest of the material was derived from "cherry picking" from the sieve, ignoring the plentiful Sacred Ibis bones. Square IX not only had the greatest number of raptors but also the greatest diversity of raptor species—as well as the greatest number of bones from the sample. Square V yielded the largest number of Sacred Ibis bones and the least number of raptors. This distribution might reflect the mode of deposition of the mummy bundles.

The age range of animals varied; a total of 756 immature/juvenile bird bones was noted, ca. 19.5% of the total assemblage. It is difficult to differentiate species in bones belonging to such young birds—including fledglings—but the general impression was that at least 600 of these bones were of ibis. Fewer identifiable immature/juvenile birds of prey remains were found. It should be noted that in the area containing the mummies, the team found a jar with ibis eggs. Thus, these birds were represented from egg to mature adult.

Of the identified birds, 57 bones showed signs of pathology. These were mainly of ibises suffering primarily from broken legs, which had healed in an

Table 3.2.1. Distribution of species across the areas of UE230, including “cherry picked” ones.

| **Taxa** | **235** | **230** | | | | | | | | | **Grand Total** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **I** | **II** | **III** | **IV** | **V** | **VI** | **VII** | **VIII** | **IX** | |
| *Ardea* sp. | | | | 1 | | | | | | | 1 |
| *Egretta garzetta* | | | | 2 | | | 3 | | | | 5 |
| *Ciconia* sp. | | | | | | | | | | 1 | 1 |
| *Threskiornis aethiopicus* | 375 | 1 | 1 | 9 | 2 | 307 | 2 | 3 | 217 | 286 | 1,203 |
| *Plegadis falcinellus* | 7 | | | 5 | 1 | 1 | 8 | | 2 | 13 | 37 |
| Threskiornithidae | 127 | 1 | | 1 | | 352 | 3 | | 161 | 228 | 873 |
| *Pandion haliaetus* | | | 1 | | | | 1 | | 2 | 4 | 8 |
| *Pernis apivorus* | 1 | | | 1 | | | | | | 1 | 3 |
| *Elanus caeruleus* | | | | 2 | | 3 | 2 | 1 | | 5 | 13 |
| *Milvus* sp. | 4 | | | 12 | 1 | 2 | 11 | 1 | 4 | 16 | 51 |
| *Haliaeetus vocifer* | | | 2 | | | | | | | | 2 |
| *Neophron percnopterus* | | | | | | | | | 1 | 1 | 2 |
| *Gyps fulvus* | 6 | 5 | 3 | 7 | 5 | 3 | 3 | | 2 | 5 | 39 |
| *Torgos tracheliotus* | 1 | 4 | | 5 | 4 | 5 | 1 | | | 4 | 24 |
| Vulture | 8 | 25 | 14 | 28 | 25 | 6 | 28 | 2 | 2 | 17 | 155 |
| *Circaetus gallicus* | | | | 1 | | | | | | | 1 |
| *Circus* sp. | 1 | | | 5 | | | 2 | | 2 | 9 | 19 |
| *Accipter brevipes* | | | | 1 | | | | | | 1 | 2 |
| *Accipter nisus* | | | 1 | 10 | | | 4 | | 3 | 8 | 26 |
| *Accipter gentilis* | | | | | | | | | | 1 | 1 |
| *Buteo* sp. | 4 | | | 12 | | 3 | 12 | | 6 | 26 | 63 |
| *Aquila* sp. | 4 | 2 | 2 | 6 | | 4 | 3 | | 1 | 7 | 29 |
| Accipitridae | 5 | 1 | | | | 2 | 1 | | | 10 | 19 |
| Small raptor | | 1 | | 2 | | 4 | 1 | | 5 | 8 | 21 |
| Medium raptor | 4 | 1 | | 10 | | | 9 | | 1 | 13 | 38 |
| Large raptor | 1 | | | | | 1 | | 1 | | 5 | 8 |
| *Falco naumanni* | | | | 2 | | | | | | | 2 |
| *Falco tinnunculus* | | 4 | | 4 | | 4 | | | 3 | 10 | 25 |
| *Falco columbarius* | | | | 1 | | 2 | | | | | 3 |
| *Falco subbuteo* | | | | 1 | | 2 | | | | | 3 |
| *Falco biarmicus* | 3 | | 1 | 6 | | 15 | 12 | | 4 | 26 | 67 |
| *Falco peregrinus* | | | | | | | | | | 1 | 1 |
| *Falco* sp. | 1 | 5 | 2 | 96 | | 10 | 38 | 2 | 9 | 116 | 279 |
| *Fulica atra* | | | | 1 | | | | | | | 1 |

Table 3.2.1. (cont.) Distribution of species across the areas of UE230, including "cherry picked" ones.

| **Taxa** | **235** | **230** | | | | | | | | | **Grand Total** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **I** | **II** | **III** | **IV** | **V** | **VI** | **VII** | **VIII** | **IX** | |
| *Streptopelia senegalensis* | | | | | | | | | | 1 | 1 |
| *Cuculus canorus* | | | | | | | | | | 2 | 2 |
| *Tyto alba* | | | | 3 | | | | | | 5 | 8 |
| *Athene noctua* | | | | 2 | | | | | | | 2 |
| *Asio* sp. | | | | 1 | | | | | | 1 | 2 |
| Strigidae | | | | 1 | | | | | | | 1 |
| *Corvus* sp. | | | | | | | | | | 1 | 1 |
| Bird | 155 | | 2 | 1 | | 241 | 3 | 2 | 102 | 276 | 782 |
| Small bird | | 4 | | | | 5 | | | 4 | 4 | 17 |
| Large bird | | | | | | | | | | 1 | 1 |
| *Sus scrofa* | | | | 1 | | | | | | | 1 |
| *Capra hircus* | | | | | | | | | | 2 | 2 |
| Ovicaprid | | | 1 | | | | | 1 | | | 2 |
| Medium mammal | | | | 1 | | | | 2 | | | 3 |
| Lizard/snake | | | | | | | | | 12 | 5 | 17 |
| **Grand Total** | **707** | **54** | **30** | **241** | **38** | **972** | **147** | **15** | **543** | **1,120** | **3,867** |

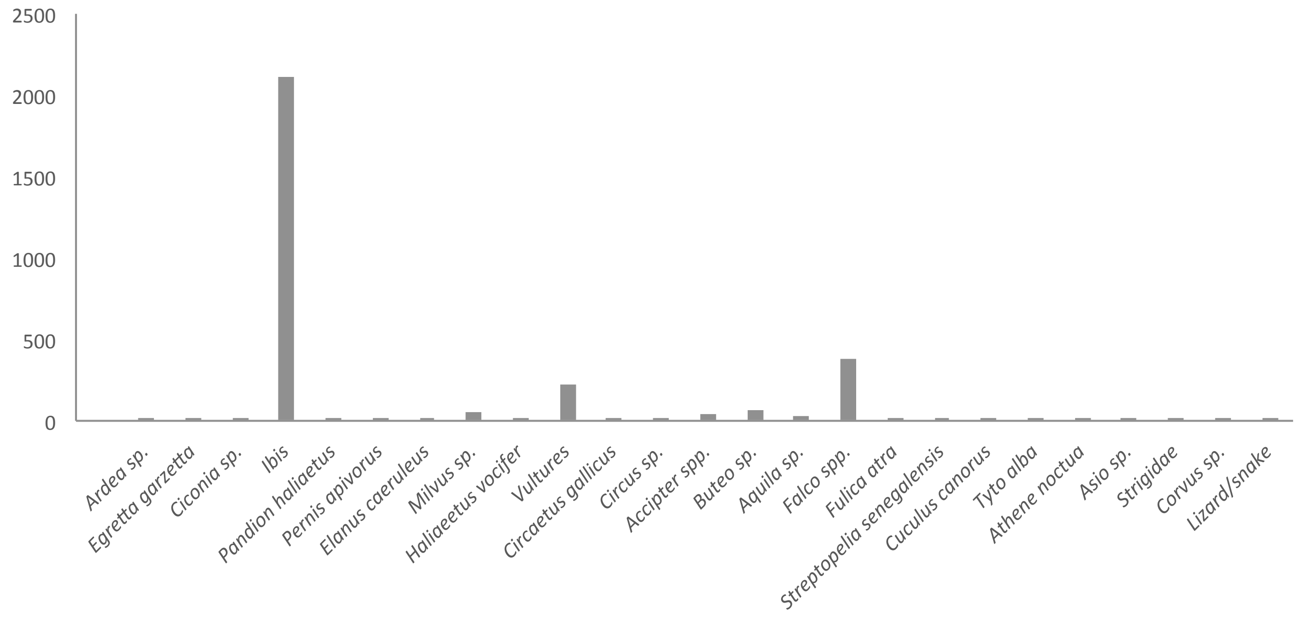

Figure 3.2.4. Chart showing NISP of different species in samples from UE230 and UE235

Table 3.2.2. Minimum Number of Individuals (MNI) in UE230.

| **Taxon** | **MNI** |
|---|---|
| *Ardea* sp. | 1 |
| *Egretta garzetta* | 3 |
| *Ciconia* sp. | 1 |
| *Threskiornis aethiopicus* | 57 |
| *Plegadis falcinellus* | 7 |
| *Pandion haliaetus* | 2 |
| *Pernis apivorus* | 2 |
| *Elanus caeruleus* | 5 |
| *Milvus sp.* | 13 |
| *Haliaeetus vocifer* | 1 |
| *Neophron percnopterus* | 1 |
| *Gyps fulvus* | 8 |
| *Torgos tracheliotus* | 5 |
| *Circaetus gallicus* | 1 |
| *Circus* sp. | 4 |
| *Accipter brevipes* | 2 |
| *Accipter nisus* | 9 |
| *Accipter gentilis* | 1 |
| *Buteo* sp. | 18 |
| *Aquila* sp. | 5 |
| *Falco naumanni* | 1 |
| *Falco tinnunculus* | 6 |
| *Falco columbarius* | 2 |
| *Falco subbuteo* | 2 |
| *Falco biarmicus* | 18 |
| *Falco peregrinus* | 1 |
| *Falco* sp. | 45 |
| *Fulica atra* | 1 |
| *Streptopelia senegalensis* | 1 |
| *Cuculus canorus* | 1 |
| *Tyto alba* | 3 |
| *Athene noctua* | 1 |
| *Asio* sp. | 1 |
| *Corvus* sp. | 1 |
| *Sus scrofa* | 1 |
| *Capra hircus* | 1 |
| Lizard/snake | 3 |

awkward fashion. They had not been treated, and thus, were not properly set. However, the birds had survived long enough for the injury to heal, indicating that they were safe from predators and that they were being fed. In addition to broken bones, some of the birds suffered from infections, reminiscent of what is found in zoo populations, based on Spitzer's personal observations and experience.

## Discussion

The large number of birds present in a single chamber—about 10,000 ibises and 2,000 birds of prey in UE230—just one of several such chambers, all thought to be active between 204–130 BC at least, demonstrates the extreme piety and number of pilgrims that dedicated these votive mummies to the gods. The vast number of mummies clearly means that sourcing these creatures must have been big business and a significant part of temple activities, both in terms of labor and economics (Ikram 2015b).

The presence of eggs in the adjoining chamber to UE230, and the age range of the birds in UE230 and UE235, suggest that ibises, at least, were actively being bred or kept in a controlled environment so that they ultimately could be "harvested" and mummified. It would be relatively simple to make a resident flock of ibis somewhat tame by regular feeding and the maintenance of a salubrious wet environment, perhaps close to the Nile or a canal or indeed a pond supplied by a canal. This last option makes it feasible for an ibis breeding installation to be located near the tombs' site in which they were found. Indeed, such a system of a controlled environment with food provided is in keeping with the finds in terms of the pathologies noted on the bones, where birds, especially ibises, had problems walking, but managed to survive surprisingly well. Thus, collecting—and perhaps even incubating—eggs and maintaining a relatively stable and large supply of ibises for mummification was simple. It is also possible that large, netted enclosures were constructed to better contain the birds. Certainly there is evidence for smaller-scale enclosures of this type on farms, where captured water birds were reared for food (Épron and Daumas 1939:Plates VI–VIII).

At the site of the Sacred Animal Necropolis at Saqqara, where a temple and catacomb for ibises and raptors existed, the discovery of a pond, garden, and eggs has led excavators to identify a possible ibis breeding area and hatchery (Davies and Smith 1997). Texts as well as archaeological remains support the idea of protected spaces for breeding and feeding ibises from Saqqara (Ray 1976:138) and other sites (Kessler and Nur el-Din 2015:120–130; Traunecker 1987; Vandorpe 1992:115). However, it should be noted that initial DNA work on a very limited sample provides some evidence against managed populations of ibis (Wassef et al. 2019). Edda Bresciani has suggested some sort of egg-hatchery and nursery for crocodiles that were to be mummified (Bresciani 2015:203–205), and it is possible that puppy farms served canine cults (Charron 2015; Ikram et al. 2013), all of which provide further evidence for the farming of certain species in order to supply the animal cults.

Fewer identifiable immature/juvenile birds-of-prey remains were found than of ibises. Although raptors are more difficult to capture and maintain, this can be successfully achieved, particularly for some *Falco* species. In fact, more bones of the smaller falcons were identified than of any other bird of prey. These birds are more plentiful in Egypt than many other raptors, are possibly easier to catch, and certainly easier to control and to breed. Indeed, other examples of kestrel (*Falco tinnunculus*) mummies that were force-fed suggest that they were kept in captivity (Ikram et al. 2015), and this might even have been the case with a harrier (Ikram 2017). This supports the idea of an active breeding program specifically created and maintained to supply the mummy industry. Of course, an alternative explanation for the young birds is possible: they might have been captured/collected from their nests as has been done by falconers through time (see Frederick II of Hohenstaufen 1943 [1241]:128–129). It is easier to capture nestlings and fledglings than adult raptors, so these "captures" might be the source for the immature/juvenile birds of prey.

Were the bones not so badly burned, it might have been possible to carry out DNA studies on a selection in order to see if the birds were related (Spigelman et al. 2008), which might have provided evidence for a breeding program. Perhaps in the future, other areas of the site will yield material that can be thus tested.

If the animals were not bred, but captured wild, this might indicate a slightly different environment to what is found in the area today. Sacred Ibis, regular members of Egypt's avifauna from the Predynastic era (4500 BC), if not before, have been largely extinct in Egypt since the mid- to late nineteenth century (Meinertzhagen 1930:438; *contra* Miles 1998:31 who claims that they occasionally appear as summer visitors, which possibly might be a new development). The decrease and eventual demise of Egypt's ibis population might have started due to the expansion of population and changes in the environment brought about by new crops, such as sugarcane, starting in the seventh but increasing during the ninth and tenth centuries AD (Bodenstein 2014; Hassan and Nasr 2008), and rice, particularly from the ninth/tenth centuries AD (Nesbitt et al. 2010). Old crops like papyrus were eradicated and all this would have changed the topography and ecosystems of the Delta and the areas abutting the Nile. Papyrus served as nesting places for ibises, such that its substitution with the latter crops would have affected the birds' available habitat. Certainly, the eventual eradication of the papyrus thickets that lined the Nile, a process that started in the tenth century AD when these plants were no longer used for paper, boats, rope, or food, must have been a major factor in the ibis's extirpation. It is unclear exactly when papyrus vanished from Egypt; it was present but no longer cultivated at the end of the sixteenth century (Alpin 1980 [1581–1584]:158–159; 2007 [1581–1584]:152). The papyrus that is found in Egypt today (*Cyperus papyrus*) was reintroduced in 1872 from botanical gardens in Paris, with some perhaps indigenous survivors noted in the Wadi Natrun, northwest of Cairo, in 1968 (Parkinson and Quirke 1995:9–10). As rice and sugar, which are intensively cultivated in the area around Luxor, radically altered the ecology of the area, this development was exacerbated by the introduction of cotton at the end of the eighteenth and the start of the nineteenth century (Richards 1982:8–25; Sayyid-Marsot 1984:155), the large-scale cultivation of which irrevocably changed the face of the Delta.

Such changes in the environment would have had less effect on the raptors, some of which flourish with the increase of agriculture, for example the Black-shouldered kite (Miles 1998:130). However, the range of raptors attests to a more varied avifauna than is present today (Goodman et al. 1989; Houlihan and Goodman 1986; Meinertzhagen 1930; Miles 1998). It is useful to note that their representation in the assemblage follows the pattern of their inhabitation of Egypt: the ones that even now are migrants/rare winter visitors, such as most of the eagles, are less well represented in the assemblage than those that breed in Egypt and spend longer periods here, such as many of the falcon species, which might have been bred intensively as well—for example, *F. tinnunculus* (Ikram et al. 2015). Possibly, some breeding raptors that were transiting through Egypt might have been forcibly kept in Egypt, yearlong, while others would have been wild-caught on a seasonal basis. Certainly, throughout Egypt there are many more ibis mummies than those of raptors, attesting to the relative ease with which the former can be bred and managed as opposed to the latter. This disproportion, however, should not reflect on the relative popularity of the two gods in Egypt; both Horus and Thoth were revered by the ancient Egyptians, who importuned them through the medium of bird mummies, in the hopes that their prayers would be answered.

### *Acknowledgments*

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2019 Mitogenomic Diversity in Sacred Ibis Mummies Sheds Light on Early Egyptian Practices. *PlosOne* 14(11): e0223964. https://doi.org/10.1371/journal.pone.0223964

# 3.3 | Animals and Ceremonies

## New Results from Iron Age Husn Salut (Sultanate of Oman)

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Abstract

This paper presents new results of the study of the faunal remains from the Iron Age site of Husn Salut (Oman). The archaeofauna from one specific building—named Basement—was analyzed. This building was occupied during the last quarter of the second millennium BC and hosted collective activities. Our research focused on the remains discovered inside a pit (Husn Salut–US35) interpreted by the excavators as evidence for a ceremony connected with the architectural renewal of the area: pottery shapes belong to types usually related to banquets and possibly rituals. The pit contained remains of at least fourteen goats (mainly females) four sheep, and two caprines. Adult animals predominate and butchery marks attest to the dismemberment and filleting of carcasses. The assemblage documents that collective consumption of mainly goat and some sheep meat was part of the ceremony. However, compared to the faunal remains from the entire Basement, the fauna from the pit shows no major differences: as such, the interpretation of the pit must derive from a comprehensive study of the context. These results indicate that the assemblage from the pit mirrors local herd management, aimed at secondary products, rather than a specific selection of animals for ceremonial activities.

Keywords

*Iron Age, Arabia, Oman, Husn Salut, animal exploitation, ceremonial deposit, pit, banquet, sheep/goat, butchery*

### Archaeological Context

This contribution reports the results of the archaeozoological study conducted on a specific context excavated at the prominent Iron Age site of Husn Salut, in central Oman. The results of the broader study of faunal remains from the site are published in Strolin and Studer 2018; see here for the methodology applied.

The extensive research program was carried out as a collaboration between the Natural History Museum of Geneva (MHNG) and the Italian Mission to Oman (IMTO) of the University of Pisa.

Husn Salut is a fortified site in central Oman (al-Dakhiliyah governorate), which, due to its position on an outcrop, dominates the plain of an inland oasis near the modern town of Bisya (Figure 3.3.1). Archaeological investigations in the fortress of Husn Salut were conducted by the Italian Mission to Oman (IMTO) of the University of Pisa between 2004 and 2014 under the direction of Prof. A. Avanzini, with the invaluable support of the Office of His Excellency the Advisor for Cultural Affairs to His Majesty the Sultan of Muscat.[1]

Recent excavations have shown that the site is connected with a large settlement that extends onto the surrounding plain (Tagliamonte and Avanzini 2018). Its position is favorable for settlement as

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[1] For an overview of the IMTO works in the Salut area see Phillips et al. 2015; a more detailed report on Husn Salut excavation can be found in Degli Esposti and Condoluci 2018.

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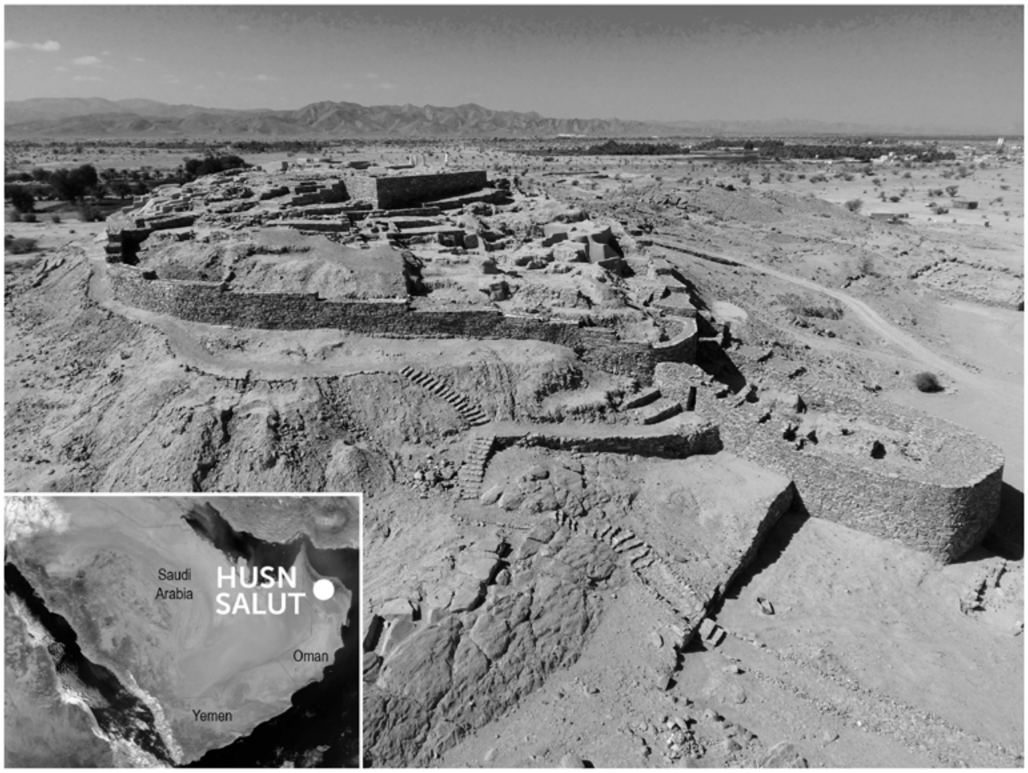

Figure 3.3.1. View of Iron Age Husn Salut and its geographical location in the Sultanate of Oman. The fortress is pictured from the east. (Photograph courtesy of IMTO.)

it is located near the junction of Wadi Saifam with Wadi Bahla, in the eastern piedmont of the Al-Hajjar mountains. The climate is arid with seasonal rainfall; palaeobotanical studies have reconstructed an ancient landscape dominated by shrubby vegetation (Bellini et al. 2011). While the mountain slopes are mostly rocky, the ancient occupational surfaces lie below the sandy topsoil and comprise silty-clayey soils.

The main occupation at the site is dated between 1300 and 300 BC, with a later reoccupation during Islamic times. Three chronological phases were distinguished: HSI (ca. 1300–1050 BC) and HSII (1050–650/600 BC) are characterized by typical southeast Arabian IA II material culture; while HSIII (650/600–300 BC) is characterized by an IA III assemblage (Degli Esposti and Condoluci 2018). The site, enclosed by massive fortification walls, mainly comprises a system of terraces with three buildings located in its uppermost part: the Basement and the Burnt Building belong to the original layout of the site (Figure 3.3.2a), while Building 1 was erected during the HSII phase above the buried remains of the Basement.

The site was likely self-sufficient in terms of subsistence, based on animal husbandry (Strolin and Studer 2018)[2] and on the agricultural exploitation of the plain. This was made possible by water wells and, at least in the later part of its existence, by at least one subterranean water channel, locally known as *falaj* (plural: *aflaj*), that is typical of the region (see Cremaschi et. 2018). Indications exist also for small-scale metalworking (Degli Esposti et al. 2016).

Husn Salut hosted communal activities, while the residential area—Qaryat Salut—was located along the adjacent hill slopes and in the adjacent plain (Tagliamonte and Avanzini 2018). The fortress's architectural features and material culture are associated with collective activities largely endowed with some type of ritual significance (Condoluci and Degli Esposti 2018). Specifically, representations of snakes are numerous as decorations on pottery and as bronze figurines: snake worship was a rele-

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[2] Previous preliminary archaeozoological studies concern material from other selected contexts. Wilkens 2007 (unpublished internal report) examined the remains from Husn Salut–US75 (NISP = 841) in the Burnt Building. Rasile (2011) studied remains from Area 4 (NISP = 1,150), but this research would require a revision of species identification. Due to different analytical procedures, these studies are not directly comparable with the results of the present research.

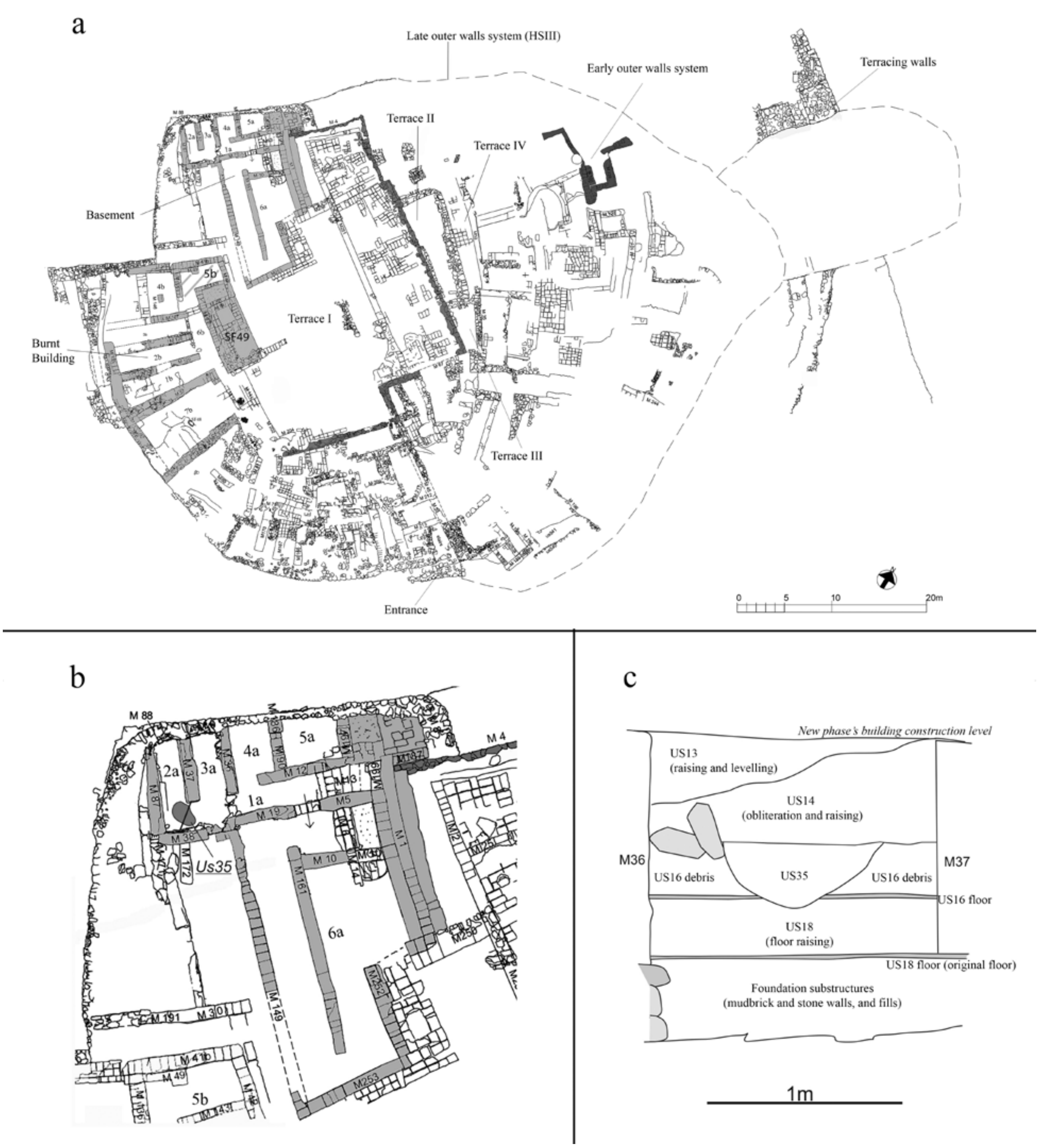

Figure 3.3.2. (a) General plan of Husn Salut HSI phase, showing the main buildings and the outline of the later outer stone wall; (b) detailed plan of the Basement, with location of pit Husn Salut–US35; (c) schematic section showing the stratigraphic position of Husn Salut–US35. (Plan courtesy of IMTO.)

Figure 3.3.3. A selection of archaeological finds from pit Husn Salut–US35: Basement. Top left: the snake-shaped handle in shape of a snake of a long-handled bowl (N. SL2005 A US 35 Cl12); bottom left: spouted jar (SL05A, US35, 2); right: goat skull fragment, right frontal bone and horn-core. (Photograph courtesy of IMTO.)

vant part of the ceremonies. This is consistent with the available documentation for Southeast Arabia, where the snake cult is widely attested in the IA and was associated with water and metallurgy (Benoist et al. 2015). However, in the absence of written sources, its precise nature remains elusive. In addition, several ceramic types among those found at Husn Salut are related to collective ceremonies, notably banquets: simple and carinated cups, spouted jars, and long-handled bowls used as censers or lamps (see Condoluci et al. 2018; Degli Esposti and Condoluci 2018).

The present study concerns the faunal remains recovered from Husn Salut–US35, a specific context excavated inside the Basement, one of the buildings mentioned above (Figure 3.3.2b). Calibrated radiocarbon dates indicate that this building was erected before 1250 BC and, after a first raising of the original floors (Figure 3.3.2c), remained in use until a large fire caused its partial collapse. Intentional obliteration of the structure took place before 1000 BC, when Building 1 was erected above it (Degli Esposti et al. 2018:373–376). Prior to this new construction, a pit, Husn Salut–US35 (1 m × 1.30 m in extension and 30 cm deep), was cut through the debris left by the fire-related collapse—Husn Salut–US16. The pit was not sealed, but substantial deposits—Husn Salut–US13 and US14—were laid above it to raise the floor level and provide a flat surface for the erection of Building 1 (Condoluci et al. 2018).

The pit contained a remarkable pottery assemblage, including twenty-five carinated cups, five spouted jars, seven bowls, five jars, one of which had a snake decoration, and five long-handled bowls. Two bowls had handles representing the body of a snake. One other bowl had the handle shaped into a ram's head and decorated with an axe and two fish shapes in relief. The pit also contained faunal remains (Figures 3.3.3 and 3.3.4). Only occasional coarse ware or storage jar fragments were found inside it. This rich and selected repertoire led to the interpretation of the pit as a (re)foundation ceremony that took place between the demise of the original building, the Basement, and the construction of a new, completely different one, Building 1 (Condoluci et al. 2018:104–105).

## Faunal Remains

This archaeozoological study investigates the possible exploitation of animals during ceremonies and/or rituals as well as subsistence strategies in the IA levels of the fortress. With this in mind, we examined whether there was any selection of animals that were eaten and/or sacrificed. We compared the faunal remains recovered from the closed context of the pit Husn Salut–US35 in the Basement with those recovered in the adjacent contexts within the same building. This approach also aims to elucidate whether an archaeozoological study is sufficient in itself to distinguish ceremonial deposits, or whether more variables must be taken into account.

### *The Pit Husn Salut–US35—Early Phase HSII*

Together with the ceramic assemblage mentioned above, a total of 448 identified faunal remains were collected by hand from the deposit Husn Salut–US35 (Figure 3.3.3). They comprise almost exclusively domestic caprines—the term here refers to domestic sheep and goat without distinction—with a NISP count of 443 bones (98.9% of the total; Table 3.3.1). Goats are dominant, as they amount to 72.8% of the total NISP. Three other taxa are also present: gazelle, two bones; cattle, one bone; and rodents, two bones.

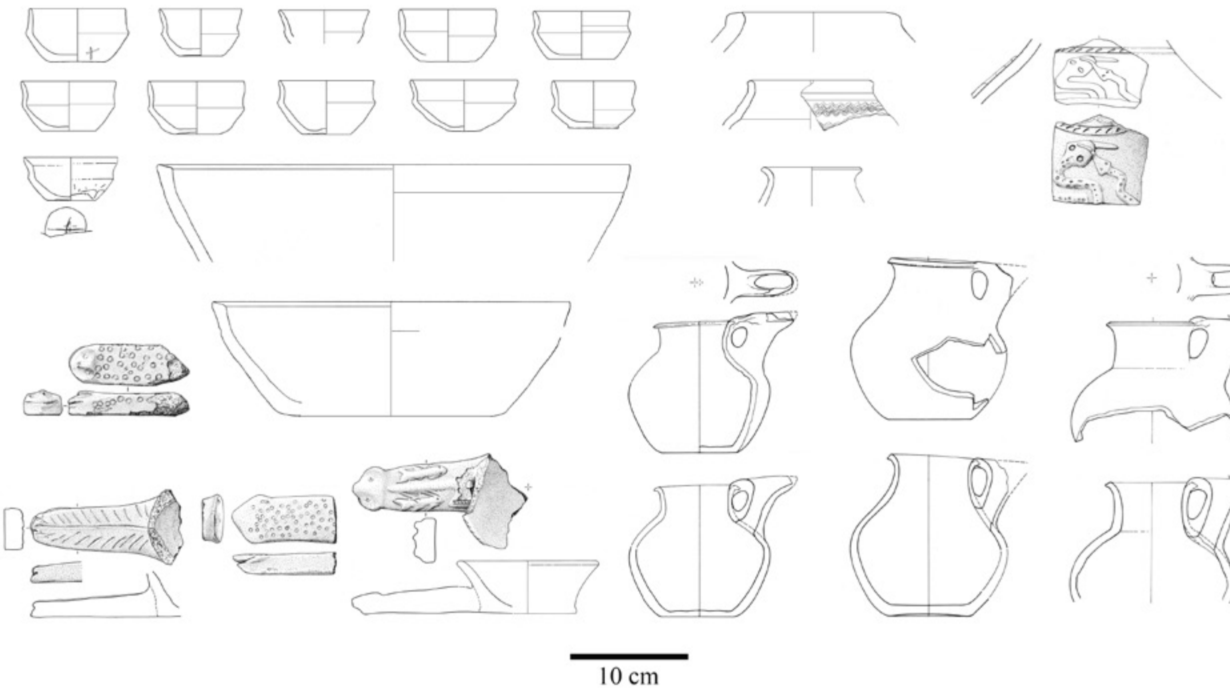

Figure 3.3.4. A representative sample of collected pottery from pit Husn Salut–US35: carinated cups (top left), long-handled bowls (bottom left), jars, including a specimen with applied snake decoration (top right), spouted jars (right). See Condoluci et al. 2018:Plates 30–33.

The pit contained an MNI (Minimum Number of Individuals) count of at least 20 domestic caprines, of which most were adults. Goats (*Capra hircus*) are represented by 14 individuals, among which 11 are females, based on counts of horn-cores, and one male, identified on a coxal bone. Sheep (*Ovis aries*) are represented by an MNI count of four individuals, among which one is female and two are males—identified with coxal bones—the latter being also attested by a right frontal with a horn-core (N. HS1605). This is one of the few ram skulls recovered at the site. The remaining two individuals from the pit are undetermined immature caprines younger than five months.

Based on 10 caprine mandibles, the mortality profile, illustrated in Figure 3.3.5, is dominated by adults; seven goats and one sheep are over three years of age, and only one goat is aged between one and two years of age (Mandible Wear Stages, MWS, after Grant 1982; see Strolin and Studer 2018:347 for details concerning methodology). Only one sheep/goat is aged around three to four months (MWS = 3). Furthermore, out of 133 remains providing information on bone fusion, 10% of the anatomical elements that fuse within the first 12 months are unfused—at least two sheep/goat are younger than five months.

Complete long bones of goats—four metacarpals and one metatarsal—indicate that withers height ranges from 52 to 57 cm (indexes calculated after Schramm 1967) and is similar to animals from other contemporaneous sites of the Arabian Peninsula, for example Qal'at al Bahreïn (Tomé 2003:257-261), Yala (Fedele 2009:Figure 10), Bithnah-44 (Skorupka and Mashkour 2013; see Strolin and Studer 2018:346 and references therein). Data for sheep are less numerous with only two complete metatarsals indicating withers height of 56 and 61 cm respectively (indexes calculated after Teichert 1975).

All body parts are represented in the pit,[3] with smaller anatomical elements present in a lower proportion, which is typical of assemblages collected by hand.

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[3] The values of the Minimum Number of Elements (MNE) are the following, excluding isolated teeth (MNE count/NISP count): cranium 16/71; hemimandible 26/47; atlas 3/3; axis 4/4; other cervical vertebra 9/9; thoracic vertebra 9/13; lumbar vertebra 13/14; sacrum 2/2; rib 9/22; scapula 25/59; humerus 7/13; radius 11/12; ulna 3/9; metacarpal 11/13; coxal bone 11/11; femur 14/19; patella 2/2; tibia 11/21; calcaneus 3/3; metatarsal 13/14; phalanx 4/4. MNE estimations after Lyman 1994.

Table 3.3.1. Quantification of identified faunal remains recovered at Iron Age Husn Salut in the building named Basement. NISP = Number of Identified Specimens; MNI = Minimum Number of Individuals. Malacofauna not yet studied.

| **Loci** | **Building** | | | | | | | | | **Pit** | | | **Building + pit** | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Phases** | **HSI (1300-1050 BC)** | | **HSII (1050-650/600 BC)** | | **HSIII (600-300 BC)** | | **Total** | | | **US35 (HSII)** | | | **TOTAL** | | |
| **Quantification** | **NISP** | **%** | **NISP** | **%** | **NISP** | **%** | **NISP** | **%** | **MNI** | **NISP** | **%** | **MNI** | **NISP** | **%** | **MNI** |
| Malacofauna total | 7 | <1 | 4 | <1 | 7 | <1 | 18 | <1 | . | 0 | 0 | . | 18 | <1 | . |
| Fish total | 1 | <1 | 0 | 0 | 0 | 0 | 1 | <1 | 1 | 0 | 0 | 0 | 1 | <1 | 1 |
| Kawakawa –*Euthynnus affinis* | 1 | <1 | 0 | 0 | 0 | 0 | 1 | <1 | 1 | 0 | 0 | 0 | 1 | <1 | 1 |
| Reptiles total | 0 | 0 | 1 | <1 | 0 | 0 | 1 | <1 | 1 | 0 | 0 | 0 | 1 | <1 | 1 |
| Spiny-tailed lizard –cf. *Uromastyx* | 0 | 0 | 1 | <1 | 0 | 0 | 1 | <1 | 1 | 0 | 0 | 0 | 1 | <1 | 1 |
| Birds total | 2 | <1 | 0 | 0 | 1 | <1 | 3 | <1 | 2 | 0 | 0 | 0 | 3 | <1 | 2 |
| Sandgrouse –*Pterocles* sp. | 1 | <1 | 0 | 0 | 0 | 0 | 1 | <1 | 1 | 0 | 0 | 0 | 1 | <1 | 1 |
| Dove –cf. *Streptopelia* | 0 | 0 | 0 | 0 | 1 | <1 | 1 | <2 | 1 | 0 | 0 | 0 | 1 | <1 | 1 |
| unidentified bird | 1 | <1 | 0 | 0 | 0 | 0 | 1 | <3 | 0 | 0 | 0 | 0 | 1 | <1 | 0 |
| Mammals total | 1,587 | 99.4 | 701 | 99.3 | 189 | 95.9 | 2,477 | 99.1 | 73 | 448 | 100 | 23 | 2,925 | 99.2 | 96 |
| Rodents | 5 | <1 | 0 | 0 | 0 | 0 | 5 | <1 | 2 | 2 | <1 | 1 | 7 | <1 | 3 |
| Red fox –*Vulpes vulpes* | 21 | <1 | 1 | <1 | 2 | 1 | 24 | <1 | 3 | 0 | 0 | 0 | 24 | <1 | 3 |
| Gazelle –*Gazella* sp. | 17 | <1 | 4 | <1 | 4 | 2 | 25 | 1 | 2 | 2 | <1 | 1 | 27 | <1 | 3 |
| Dog –*Canis familiaris* | 3 | <1 | 1 | <1 | 5 | 2.5 | 9 | <1 | 3 | 0 | 0 | 0 | 9 | <1 | 3 |
| Camel–*Camelus* cf. *dromedarius* | 10 | <1 | 7 | 1 | 7 | 3.5 | 24 | <1 | 4 | 0 | 0 | 0 | 24 | <1 | 4 |
| Equids –*Equus* sp. | 1 | <1 | 0 | 0 | 0 | 0 | 1 | <1 | 1 | 0 | 0 | 0 | 1 | <1 | 1 |
| Pig/wild boar –*Sus* sp. | 0 | 0 | 0 | 0 | 1 | <1 | 1 | <1 | 1 | 0 | 0 | 0 | 1 | <1 | 1 |
| Sheep/goat–*Ovis aries*/*Capra hircus* | 1,494 | 93.6 | 659 | 93.3 | 168 | 85.3 | 2,321 | 92.8 | 53 | 443 | 98.9 | 20 | 2,764 | 93.8 | 73 |
| Cattle –*Bos taurus* | 36 | 2.3 | 29 | 4.1 | 2 | 1 | 67 | 2.7 | 4 | 1 | <1 | 1 | 68 | 2.3 | 5 |
| **TOTAL** | **1,597** | **100** | **706** | **100** | **197** | **100** | **2,500** | **100** | **77** | **448** | **100** | **23** | **2,948** | **100** | **100** |

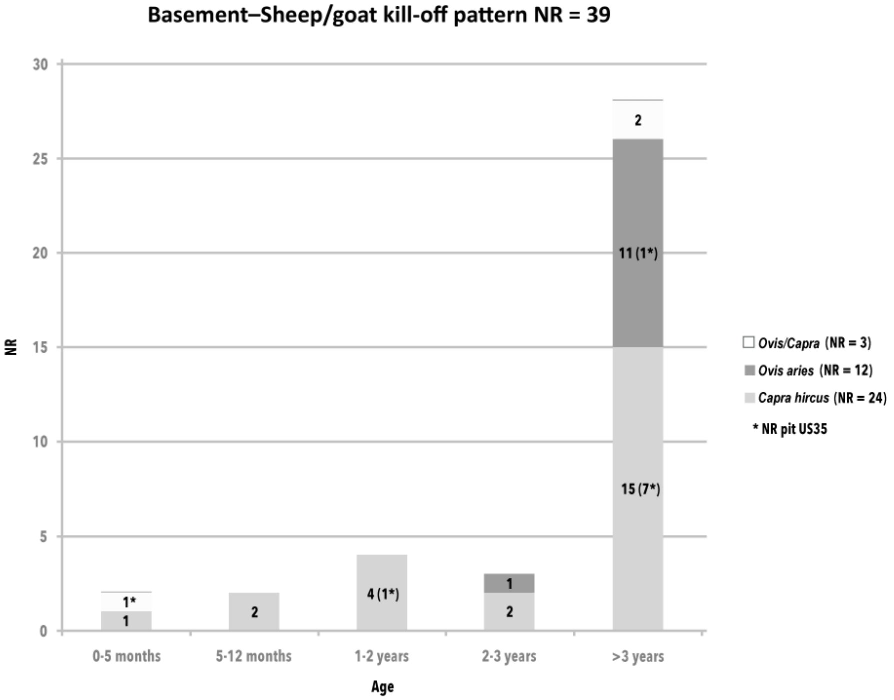

Figure 3.3.5. Histogram of sheep and goats mortality profile based on 39 mandibles from the Basement of Husn Salut (based on mandible wear stages MWS, after Grant 1982). NR = number of mandibles.

Chop and cut marks were observed on 6.3% of the remains. Both sheep and goats underwent the same carcass processing. Chop marks testify that carcasses were severed longitudinally down the spinal column and then portioned transversally. All joints exhibit disarticulation cuts. Long-bone shafts, ribs, and vertebrae underwent filleting as shown by the presence of numerous fine cut marks. Butchered skulls form a set of nine specimens (32.1% of butchered remains). Six female goat skulls have chop marks on their frontals. It is not clear if these marks are related to killing methods or to brain extraction. In addition, two fragments show cut marks characteristic of skin detachment as well as the above-mentioned ram skull, which bears a chop mark and thin cut marks between the horns. Only three bones exhibit burning traces from partial carbonization.

Skeletal anomalies are evident only in mandibles: seven elements (1.6%). A left mandible shows extended *ante mortem* tooth loss; a severe case of a partially healed fracture affects a goat's right mandible in its second year of life. These two injury cases would certainly have affected mastication and may have motivated the selection of these individuals for slaughter. The rest of anomalies seem to be age-related: one sheep and three goat mandibles have tooth wear irregularities, and another goat mandible shows light exostosis.

Besides caprines, one gazelle is represented by a fragmented right mandible and by a coxal bone (female), which exhibits chop marks produced to disarticulate the femur. In addition, only a small fragment of scapula blade belongs to cattle. Finally, rodents, which are represented by two bones, are most likely intrusive.

Altogether, pit Husn Salut–US35 can be considered as the result of the consumption of at least twenty caprines, mainly adult female goats, together with a few sheep—the latter with a more balanced sex ratio—as well as juvenile animals. The homogeneity of the faunal assemblage's composition in the treatment of carcasses, the good preservation of the remains, and the concentration of at least twenty individuals deposited together as dietary residue, confirm the archaeological interpretation that this pit is the result of a single event. The associated pottery finds suggests that this event was a kind of ceremonial gathering, in all likelihood a banquet, whose faunal leftovers were buried together with the vessels. Besides, the caprine aged three to four months provides an indication on the season during which this ceremony was held. In fact, according to information from local herders in Bisya, the present-day caprine birth season is in March–April. Animals in pit Husn Salut–US35, therefore, would have most likely been slaughtered between June and August.

### *The Basement, Excluding Pit Husn Salut–US35—Phases HSI, HSII, and HSIII*

Faunal remains from the rest of the building presumably also derive from collective activities and gatherings. As archaeological evidence indicates, this area of the fortress had indeed no residential function (see Condoluci and Degli Esposti 2018). The archaeozoological assemblage consists of a total of 5,936 remains, half of which were identified to species (NISP = 2,948; Table 3.3.1). All chronological phases show comparable features and will therefore be presented together. The assemblage is dominated by domestic species, in particular caprines followed by cattle, while the other 11 identified taxa are represented by less than 30 remains each.

Sheep and Goats. Both domestic sheep and goats occur in the assemblage (NISP = 2,321; 92.8% of identified remains) in every chronological phase with a total estimated MNI of 53 individuals—29 goats, 17 sheep, and 7 sheep/goat. Distinction between the two taxa reveals that goats largely outnumber sheep: out of a total of 655 caprine remains that could be identified to species, 457 (69.8%) belong to goats, and 198 (30.2%) to sheep. This proportion reflects a local specificity in goat herding that can be seen as the most efficient choice of species in an arid and rocky landscape.

Regarding sex profiles, goats are essentially represented by females with twenty-two females for one male (95.7% of sexed caprines). Female sheep amount to 57.4% of sexed animals with four females and three males. Although the sample size of sexed sheep is small, these results suggest a difference in exploitation: goat herding was mainly aimed at secondary products—milk, hair, skin—and reproduction, while sheep herding was probably less focused on milk and more on meat as well as wool.

Mortality profiles based on 29 mandibles (Figure 3.3.5)—16 goats, 11 sheep, and 2 sheep/goat—show that adult animals over three years of age were preferentially selected in both species, further supporting the management strategies outlined above. Data on caprine bone fusion document more young individuals in their first year of life (NISP = 43), including 30 bones from both sheep and goats in the first five months of life. A total of 10 bones of perinatal age, corresponding to at least five caprines, demonstrate that local herding was practiced. Mortality of individuals in the first weeks of life may be due to natural causes—thus attesting to the presence of live animals being raised at the site—or be a consequence of selection connected to the ceremonial function of the site (as previously observed by Wilkens 2007; see Strolin and Studer 2018:347–348).

Withers height based on fifteen metacarpals and two metatarsals for female goats ranges from 51 to 58 cm. The goat population is small in size and corroborates observations made on the remains from the pit. Information for sheep size is less reliable since only based on two complete metacarpals that give a size of 58 and 68 cm.

Butchery marks are visible on 7% of caprine remains. They are highly patterned and occur equally on remains of both sheep and goats. Cut marks near joints attest to disarticulation and filleting, while chop marks (15% of traces) concentrated on the axial skeleton are evidence for longitudinal and transversal portioning. Head treatment is documented in twenty-four specimens (15% of butchered remains) and includes butchery relating to its disarticulation—visible on two caprines younger than four months—as well as skinning and chopping of the skull. Burnt bones amount to 3% (NISP = 77) and were mostly found in hearths.

Caprine skeletal pathologies reflect an overall picture of healthy animals (descriptions after Bartosiewicz and Gál 2013). We observed pathologies on only fourteen caprine bones (0.6% of caprine remains), including healed fractures (six cases), linear enamel hypoplasia (four cases), stress or pregnancy-related depressions on female goat horn-cores (two cases), periodontal disease (one case), and irregular teeth abrasion (one case).

Cattle. Cattle remains (*Bos taurus*) are present in all phases of the Basement but in a low proportion; NISP counts 67 remains corresponding to 2.3% of the total identified assemblage, giving an estimated MNI of five animals. The low frequency of cattle is typical of IA faunal assemblages in this arid geographical area.[4] One coxal bone is attributed to a female; dental wear and bone fusion testify to animals culled at

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[4] For example: Muweilah (Uerpmann and Uerpmann 2017:Table 21.1), Mleiha (Gautier and Van Neer 1999:112), Qal'at al Bahrein (Tomé 2003:Table 48 and 49), Yala (Fedele 2009:Figure 6); see Strolin and Studer 2018:349–350, Table 2 and references therein.

one to two years old or later, and at least one animal over four years of age. Cut marks appear on 6% of cattle remains and indicate alimentary use. Exploitation as draught or labor animals is also possible, but no deformation typical of overwork was observed on the bones.

Other Taxa. Camels are attested in all phases (total NISP = 24), representing less than 1% of the total identified faunal assemblage. At least four individuals were identified—three adults and one individual younger than 15–18 months old (in phase HSI). An anterior phalanx II from phase HSIII matches the criteria for *Camelus dromedarius* (see discussion in Strolin and Studer 2018:342–343). Skeletal elements belonging to different parts of the body are represented. Both chop and cut marks are visible on 12.5% of camel bones, attesting to exploitation for meat.

The only evidence of an equid—*Equus* sp.—is a femur with asinine features (HSI). Despite a certain caution, an attribution to donkey is plausible and may be consistent with long distance transport.

Nine bones of *Canis familiaris* belong to at least three different individuals. The first is estimated to be six to nine months (from HSI), the second is an adult (from HSII), and the third is from a one-month-old (from HSIII).

Two other taxa represent food items imported by trade. Firstly, sea fish represented by a caudal vertebra of Kawakawa—*Euthynnus affinis* (HSI). This species is distributed in the Arab-Persian Gulf as well as the Sea of Oman and the Arabian Sea (Froese and Pauly 2017). Its presence indicates contacts with the coast. The second taxon is a wild or domestic pig, represented by a fragment of humerus that shows filleting cut marks. The rarity of *Sus* finds at Husn Salut and in IA Southern Arabia more generally, together with the arid climatic conditions of the region, suggests this specimen reached the site through trade exchange (see, for instance, Tomé 2003:283–284).

Evidence for hunting is also attested in all phases by a total of 27 remains of small-sized gazelles, which represent less than 1% of the identified fauna. Hunting seems therefore to have only seldom been practiced. Cut marks observed on 11% of gazelle remains suggest food processing and eventually skinning as well as horn separation. Capture of reptiles and probably birds is also documented. An *Uromastyx* sp. left dentary (from HSII) exhibits a cut mark testifying to the exploitation of this species already during the IA. A sandgrouse (*Pterocles* sp.) humerus and another from a dove (cf. *Streptopelia*) are the identified birds. It seems probable, though not certain, that these birds were caught and exploited by humans.

Two more wild taxa are considered non-anthropogenic. In particular, 24 red fox—*Vulpes vulpes*—remains do not bear any anthropic traces. Eighteen remains were in anatomical connection—belonging to a single mature individual—and were found in the last level of phase HSI. They could attest to the building abandonment, as also suggested by archaeologists based on stratigraphy. Gnaw marks caused by carnivores—foxes and/or dogs—appear on 17% of the assemblage. An intrusive origin also explains the occurrence of rodent remains, rodent activity (gnawing) affecting 4% of the bone assemblage.

## Discussion

Samples from pit Husn Salut–US35 and all remaining IA phases within the Basement show strong similarities. In fact, the preponderance of caprines (98.9% and 92.8% respectively), and notably among them goats (72.8% and 69.8% respectively of the total of identified caprines), is relatively constant. Age profiles are also comparable between the two contexts, with a majority of adult goats being older than three years of age (60% and 69% in the pit and in the Basement respectively based on mandible attrition). Sex proportions are similar too. Female goats outnumber males: 92% for a total MNI of 12, and 95.7% for a total MNI of 23. Sheep seem to present a different sex distribution: females represent 33% of a total estimated MNI of 3 in the pit and 57.4 % for a total MNI count of 7 in the Basement sample. Data for goats are more reliable as the sexed sheep sample is small. Nevertheless, both contexts show the presence of rams. Interestingly, the pit contained a long-handled bowl with the distal end configured as a ram (Condoluci et al. 2018:Plate 33/3; Degli Esposti and Condoluci 2018:52), and ram presence in the same pit was also attested by a skull fragment. The processing of caprine carcasses is characterized by a recurrent pattern both inside the pit and in the remaining Basement contexts.

Based on the above, the archaeological interpretation of pit Husn Salut–US35 as an intentional deposit related to a foundation ceremony must be mainly based on the specific ceramic assemblage. Faunal evidence supports this hypothesis but cannot prove it by itself. The twenty caprines recovered in the pit likely document a banquet for a large community as part of a ceremony that occurred between June and August. The season is indicated by the find of a caprine aged three to four months and by the absence of neonatal individuals that otherwise do occur in the Basement assemblage. The Basement fauna represents communal meals that occurred throughout the year or at other times in the year, in which refuse is not concentrated inside well-defined pits. One last difference concerns the faunal spectrum: only four identified species are represented in the pit compared to 13 in the rest of the building.

As a general comment, it is interesting to note that the presence in the Basement of neonatal caprines attests to pregnant females being kept and raised at the site. These females seem not to have been selected for culling. Nevertheless, we cannot exclude that they were part of special activities given the presence of neonatal remains in the assemblage.

## Other Evidence of Ceremonial Contexts in Southeast Arabia

Archaeozoological evidence is also available for another context at Husn Salut interpreted as a ceremonial deposit—Husn Salut–US75 in the Burnt Building. This building was flanked by a raised platform, Husn Salut–SF49 (Figure 3.3.2a). At the beginning of the HSII phase, Husn Salut–SF49 was enlarged with the obliteration of Room 5b and the deposition of Husn Salut–US75 (Condoluci et al. 2018:101). Thus, this deposit was also significantly related to a substantial architectural renovation. From this layer a remarkable variety of materials was recovered, including a long-handled bowl with snake decoration, bronze ladles probably used as banquet implements, a bronze snake figurine, a miniature bronze axe,[5] outstandingly preserved woven baskets, and animal remains (Condoluci 2018:227–233). Indeed, pottery represented only part of the offering. Radiocarbon dating on charred dates (*Phoenix dactylifera*) from Husn Salut–US75 ranges between 795 and 542 BC (95.4% probability, see Degli Esposti and Condoluci 2018:Figure 27). Faunal remains from Husn Salut–US75 are in part described by Wilkens (2007). Out of a total NISP count of 449 bones, 403 remains (90%) belong to caprines and correspond to an estimated MNI of nine: five adults and four juveniles under five months of age.[6] Only 39 remains are attributed to species and of these 58% are identified as goats. Approximately all body elements are represented but in different proportions. Epiphyseal fusion is documented for 160 bones: 51% of the 49 bones in the first year of life are unfused. Traces of burning are exhibited on 12% of the remains. Therefore, this IA deposit also seems to be connected with some kind of ceremonial events at Husn Salut and mirrors the involvement of sheep and goats of different ages as reported from the pit Husn Salut–US35.

Two other coeval sites provide evidence on the role of caprines in IA societies in the area. These examples should not be viewed as strict archaeological or functional comparisons. Rather, they indicate that caprines were endowed with symbolic value beyond their subsistence-related importance. The first site is Bithnah-44, located in the northern Al-Hajjar mountain range in the Emirate of Fujairah (U.A.E.). The site is part of a complex network of IA sites, each one distinguished by a preferential function,[7] with Bithnah-44 defined as a ceremonial/religious site strongly connected with the widespread snake cult that characterizes the region (e.g., Benoist et al. 2015). Twenty-three votive pits, excavated over four stratigraphic phases in the site's central area, contained animal bones deriving from sacrifices; some of the pits were lined with stones and some accurately sealed (Benoist 2007:40–42). Pottery with snake representations, long-handled bowls, and copper offerings are also part of the archaeological corpus. Faunal remains from eighteen pits were studied (Skorupka et al. 2013), and a total NISP of 8,699 remains were identified, almost exclusively attributed to caprines. With the exception of three pits, sheep bones predominate in comparison to goats. The MNI per pit corresponds to 1–3 individuals in small pits, 7–10 in medium ones, and 18–43 in large ones. These

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[5] A ritual axe is also depicted on the long-handled bowl from Husn Salut–US35 cited above (Condoluci et al. 2018:Plate 33/3).

[6] The rest of the assemblage counts: cattle bones (3 remains), fish (6 remains), birds (4 remains), unidentified reptiles (28 remains), and molluscs (5 remains). Rodent remains are considered intrusive.

[7] A fortress, funerary areas, and a site of copper extraction are also attested (see Benoist 2013).

are considered the result of cultic gatherings, probably banquets. Different age classes are represented as well as a wide range of anatomical elements, with some pits mainly containing head portions and others limb portions. Cut and chop marks occur on 1.7% of the remains, and burning on 11.1% record the anthropic impact on carcasses, including disarticulation and filleting, followed by combustion.

Another site that can be considered here is the funerary complex of Daba, in the Musandam Peninsula, at the border between Oman and the U.A.E. The analyzed fauna belongs to ritual deposits from a typical, long chambered tomb that can be dated to the IA (LCG–2; Maini 2017). The animal assemblage documents meat offerings, mainly of caprines, made during funerary practices with 85.4% of the 725 collected remains representing terrestrial mammals. Of these, 79.1% comprise caprine bones—mainly goats—of all age classes.

The evidence from the above-mentioned sites indicates that Husn Salut–US35 is not unique in Southeast Arabia with regard to its display of special relationships between animals—namely, caprines—and IA human communities, as manifested in ritual/ceremonial contexts. The case of Bithnah-44 is particularly interesting since this site has several common traits with Husn Salut (Benoist et al. 2015) and is part of the same cultural and chronological context.

## Final Remarks

The faunal remains recovered in pit Husn Salut–US35 and Basement loci provide a first picture on human-animal associations at IA Husn Salut. Taken together, the faunal composition is restricted to local species, mainly domestic caprines, hinting at a self-sufficient economy that relied on supplies available in the surroundings of the site. In particular, goats occupy the most salient place in these subsistence strategies. This is probably not a specific choice, but it reflects local herding practices that focused on goats, which are best suited to the arid and rocky environment, a pattern still observable today. Imported food items are represented by marine fish and pig, but these are exceptional finds. The features of the assemblage reflect butchery practices that were employed in processing whole animal carcasses, locally, for consumption.

Against this general background, the faunal remains recovered in the pit Husn Salut–US35 highlight the role of animals during ceremonial activities held at IA Husn Salut. The pit is in fact a closed context that preserved archaeological traces of a specific foundation ceremony. Therefore, the faunal evidence documents that caprines were the preferred and almost exclusive species used in this ceremony. The age and sex profiles seem to reflect the available herd composition, rather than a preferential choice. The only suspected selection concerns some female adult goats with pathologies and possibly an adult ram.

Archaeological comparisons between the Husn Salut fauna and those from other IA sites in Southeast Arabia are consistent with the selection of caprines for special occasions of ritual or social relevance. There is a tight connection in these examples that, perhaps significantly, is mirrored in the biblical episode of Isaac's sacrifice, and still informs present day Islamic festivities, such as *ʿīd al-aḍḥā*—the sacrifice feast—which in Islamic theology is also linked to that event.

Concerning the effectiveness of archaeozoological analyses in themselves being able to recognize ceremonial deposits at this site, no evident markers could be detected. In the case of Husn Salut–US35 and the Basement, indeed, no major differences were noticed between these assemblages except possibly for the greater focus on caprines in the pit assemblage, the faunal spectrum being wider in the rest of the building.

From what can be inferred so far, it seems that overall dietary habits—and probably activities linked to the Basement—were rather homogeneous. When animal consumption was related to collective or ceremonial occasions, mostly adult caprines were eaten. However, since caprines are common domestic species and since ceremonies included meat meals, the identification of banquet's remains cannot, in our case, only rely on archaeozoological analyses and requires a broader archaeological approach.

These conclusions strongly encourage further archaeozoological investigations not only of other ceremonial contexts at Husn Salut but also of contexts in the nearby settlement of Qaryat Salut. These will provide information about the daily animal economy and help define any possible features that distinguish it from ceremonial activities observed at Husn Salut.

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# 3.4 | Ornithological Interpretation of the Sixth-Century AD Byzantine Mosaics from Tall Bīʿa, Syria

Gábor Kalla* and László Bartosiewicz†

## Abstract

Tall Bīʿa is located on the left bank of the Euphrates River, east of present-day Raqqa in northern Syria. The ruins of an Early Byzantine monastery recovered at the site revealed mosaic floors with luxuriant avian imagery. The largest mosaic contained naturalistic depictions of 49 birds, whose ornithological identification is attempted in this paper. Mosaics in two smaller rooms also contained images of four birds each. In comparison with the diversity of species discussed in coeval codices and identified in archaeozoological assemblages in the region, it is clear that these mosaics represent only a limited range of the avifauna that surrounded people in the Byzantine Empire. While zoological information in artistic representation cannot always be taken at face value due to the discrepancies between the geographical distribution of avifauna and their free movement as decorative motifs, the large number and high quality of these images deserves attention from an archaeo-ornithological point of view. They potentially characterize relationships between people and birds in an important period through art, complementing the frequently meager osteological record.

## Keywords

*avifauna, iconography, bird remains, Byzantine Empire, mosaics, codices, symbolism, religious art, Syria, environment*

## Introduction

The settlement complex of Tall Bīʿa—Temple Mound—is located east of present-day Raqqa in northern Syria. It lies approximately 2.5 km north of the Euphrates near its confluence with the Balikh, its left-bank tributary. The site has widely been considered to represent the Babylonian city of Tuttul (Kalla 1999:131). Under Byzantine rule the city, then called Kallinikos and subsequently Niképhorion, played a key role as a designated trading post at the border between the Byzantine and Sassanid Empires.

The possible remains of the Early Byzantine Saint Zacchaeus monastery were identified on the highest, so-called E mound of the site, covering an area of ca. 650 × 750 m (Krebernik 1991). The AD 509–595 time span marked by two dated mosaics in the monastery encompasses a tumultuous period in ecclesiastic history when the Syriac Orthodox Church was established, resulting from the efforts of Jacob Baradaeus (Gregory 1991). He served as bishop of Edessa—present-day Şanlıurfa (Turkey) 160 km north of Raqqa—between AD 543/544–578.

The mosaics under discussion here show birds depicted with different levels of realism, for most allowing identifications at various degrees of precision—species, families or orders—along the principles of classical and modern avian taxonomies. The resulting list cannot only be compared to contemporaneous Byzantine mosaic representations but also with bird remains from archaeozoological assemblages in the region. This would help to gain a better understanding on how people associated individual taxa with earthly well-being and Christian symbolism.

Comparisons between mosaic art, osteological evidence, and Byzantine codices were based on

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the comprehensive work by Kádár (1978). He provided his own identifications for birds encountered in these richly illustrated documentary sources. The combined species lists found in the Byzantine written sources were considered to systematically summarize birds of common knowledge at the time. They were not affected by artistic selection dictated by the semiotics of highly symbolic mosaics. They were also free from the filter of utilitarian considerations that shaped the species composition of archaeozoological assemblages.

## Characteristics of Tall Bīʿa's Mosaics

The mosaic images of birds decorated three rooms of the monastery. The largest set (Mosaic 1 in the foreroom of the church, measuring 10.5 × 4 m) is dated to August AD 509 by a Syriac inscription. This mosaic contained an admixture of highly abstracted aesthetic and somewhat naturalistic depictions of 49 birds. Some are poorly identifiable, partly because they seem to combine features of various species. Another set of images dates to AD 595 (Mosaic 2 in the sanctuary, 3.7 × 3.5 m), and the last set, tentatively dated in-between the two aforementioned dates (Mosaic 3 in a funerary shrine; 4.0 × 3.1 m), also showed images of four birds each. The detailed description of related architectural features as well as the structure and dimensions of decorative patterns in the mosaics have already been presented by the first author (Kalla 1999:132–141). In the current study, birds were identified and classified using visual disjunction supported by the ornithological literature (Cottridge and Porter 2007; Porter and Aspinall 2010).

### *Arrangement of Images*

Prior to ornithological interpretation, structural characteristics of the composition at Tall Bīʿa are worth reviewing. The curious spatial syntagma represented by the birds in the older, large Mosaic 1, has already been discussed (Kalla 1991). The mid-section across the main entrance of this long room is decorated with a pair of peafowls facing each other, accompanied by a similar pair of doves (Figure 3.4.1, center).

These birds are shown sideways in a static manner, as if representing in such a way aimed at documenting their morphological features rather than their behavior (Kádár 1978:87). This motif depicting peafowls and doves may be considered a *topos* in the context of Early Byzantine religious architecture. At Tall Bīʿa, however, the composition also includes two ducks and two partridges in different, vivid positions, and not facing each other. The scenes to the right and left of the main entrance also show this contrast, between strictly organized symmetry and real-life dynamism. The southern section (Figure 3.4.1, bottom), right of the main door shows two columns of five pairs of birds symmetrically facing each other. With the exception of a rooster and hen, these birds are almost mirror images of one another. The northern left side of the room (Figure 3.4.1, top), on the other hand, is populated by a lively array of birds in various positions, which seems almost chaotic in comparison with the catalogue-like and rigid representations in the south. A pomegranate tree flanked by two symbolically important cypress trees defines this subtle system, in what looks like a very active scene. They are oriented the same way as the pair of peafowl at the main entrance, the three of them dividing the north section into four fields. Of these, the section near the northern wall is decorated by rather abstract images of three pairs of fish. Loosely arranged birds form rows in the remaining three fields around the trees. Some of these birds are in pairs: two facing roosters and two Guinea fowls, but they are mostly positioned in random and active postures. With the exception of the central entrance section, dominated by the images of peafowl, all birds are oriented head north, regardless of their arrangement. This means that their position is perpendicular to the three trees depicted in the room's northern section.

This complex arrangement is worth comparing to that documented at Caesarea, Israel (Reich 1985). Images there form what can be described as an "inhabited scroll" (Hachlili 2009:111–147): the 11.5 × 13.4 m central panel of that mosaic is divided into ten rows of twelve medallions, with a single bird shown in each, uniformly facing left. These 120 birds, however, represent relatively few species and are iterated in a strict mathematical order (Reich 1985:207 and pers. comm. 2017). As a result, the same species fall into diagonal directions across the design. Similar medallions encircling pairs of individual partridges and peafowls—in both cases facing each other—are shown in Mosaic 2 at Tall Bīʿa. Aside from the artistic value of this tight arrangement,

Figure 3.4.1. Overview picture of the most complex, large Mosaic 1 (AD 509). Note the different layouts of images in the north, center, and south sections. (Photograph by G. Kalla.)

Table 3.4.1. Sources used in the evaluation of bird imagery from Tall Bīʿa.

| **Source type** | **Mosaic floors** | | | **Osteological evidence** | | | **Codices** |
|---|---|---|---|---|---|---|---|
| Site | Tall Bīʿa | Caesarea | Petra | Troy | Jerf el Ahmar | Tell Hesban | |
| Reference | | *Reich 1985* | *Studer 2001* | *Krönneck 1995* | *Gourichon 2002* | *Boessneck 1995* | *Kádár 1978* |
| Code in Figure 3.4.1 legend | 1 | 2 | 3 | 4 | 5 | 6 | - |
| Number of images | 57 | 120 | 109 | - | - | - | - |
| Number of bird bones | - | - | - | 663 | 1,554 | 3,019 | - |
| Number of bird species | 15 | 10 | 14 | 28+1 | 50 | 45 | 64 |
| Number of bird orders | 5 | 5 | 7 | 11 | 10 | 8 | 16 |
| Habitat type | | | | Sea shore | Alluvial | Semi-arid | |
| Approximate distance, km | 0 | 700 SW | 850 SW | 2000 NW | 140 NW | 650 SW | |

Nissen (1953:19) points out that, in addition to the in-text illustrations, half of the 48 pictures in *Codex Vindobonensis* med. gr. 1. are arranged in a six-by-four table, reflecting a merger between ornithological scholarship and the visual language of mosaics and wall paintings. At Petra, Jordan (Studer 2001), the structural relationships between the images in the comparable Mosaic I (northern aisle; 22.23 × 3.34 m; ca. AD 525–550) fall in between the strict, almost heraldic, discipline seen at Caesarea and the complex pattern observed at Tall Bīʿa. Medallions at Petra are arranged into three columns and twenty-eight rows and are slightly flattened on the top and bottom of each row while the central medallion is somewhat compressed, therefore being smaller than the lateral ones (Waliszewski 2001:219). Animals, mammals, birds, and fish alike usually occur in the lateral column of medallions facing inward, that is, facing each other. Oftentimes, their feet or tails reach beyond the frame of the medallions, offering a somewhat more playful presentation than the tight and monotonous order seen at Caesarea. In Mosaic 1 at Tall Bīʿa, no medallions or individual frames were employed, but a symmetry-based tight order was retained in the southern section.

### *Colors Applied*

The mosaic images were composed of tesserae measuring 0.8–0.9 mm on each side. Their colors—in the decreasing order of relative frequency—are gray, black, white, red, pink, yellow, ochre, dark blue, green, and burgundy (Kalla 1999:135–136). While the largest numbers contributed to the background of birds, red and pink are of critical importance in the tentative identifications of several species, including purple heron and flamingo. Some of these identifications, however, remain zoologically uncertain. It is possible that the use of red was in certain cases based on purely artistic considerations. The use of red and pink tiles for the turtledove may be a sign of artistic freedom, increasing visual contrast against the white background. Moreover, there is also the possibility that some of the colors somewhat changed during the taphonomic process.

Multidisciplinary parallels to Tall Bīʿa's iconography are summarized in Table 3.4.1 and Figure 3.4.2.

## Complementary Evidence

In addition to the mosaics, two additional types of sources were consulted: bioarchaeological and textual.

Most of the excavated animal-bone assemblages included in the authoritative monograph on Byzantine archaeozoology by Kroll (2010) date to the Early Byzantine period (AD 395–642), when the Empire attained its maximum expansion. The difficulty in using these materials is that in many bird bones occur only sporadically. This is in part due to small sample sizes as well as the lack of systematic sieving at many excavations, indispensable in the retrieval of small bird-bone fragments.

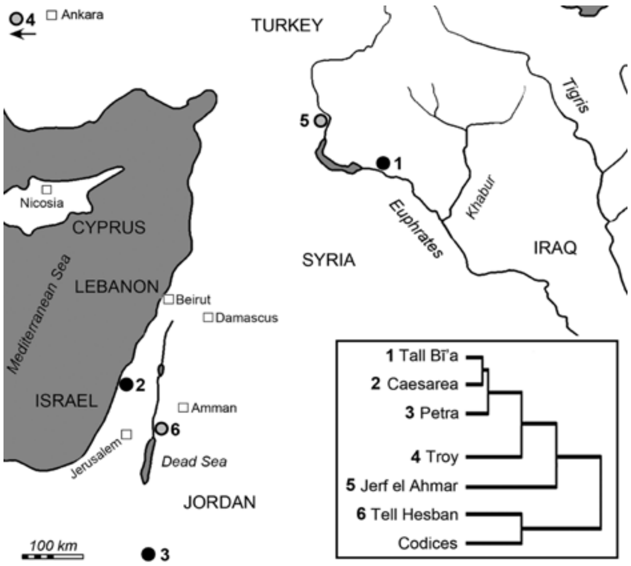

Figure 3.4.2. The location of sites detailed in Table 3.4.1. Black dots indicate mosaics, circles in gray stand for archaeozoological assemblages. Major present-day cities are indicated by empty squares. The insert serves as a legend to the map but also shows the Euclidian distances calculated between sites on the basis of ornithological diversity.

The repertoire of identifiable birds on the mosaics was thus compared to three large bone assemblages. These assemblages are representative of the bird species exploited by the inhabitants in each region, presuming that the latter—and their native avifaunas—did not substantially change in antiquity. For the purposes of this study, assemblages from different strata had to be conflated in order to obtain sufficiently large samples of representative sizes.

Of the three archaeological sites, the PPNA settlement of Jerf el Ahmar (Gourichon 2002) in the Euphrates River Valley was the closest to Tall Bīʿa. The even larger bird-bone assemblage from the Iron Age through Mamluk-period settlement of Tell Hesban (Boessneck 1995), located further south on the edge of the Transjordanian highland plateau, was chosen as a possible match to the mosaic images from Petra. Lastly, the Early Bronze Age to Roman-period bird-bone material from Troy in western Turkey (Krönneck 1995) represents a coastal avifauna against which the mosaic from Caesarea could be assessed.

More importantly, the geographical proximity of Troy to Constantinople made it relevant in the study of species listed in documentary sources chosen on the basis of archival research by Kádár (1978). One of the scholarly works considered is an anonymous paraphrase of the *Ornithiaca* by Dionysius of Philadelphia (first century AD) in the *Codex Vindobonensis* med. gr. 1. (a.k.a. "The Vienna Dioscurides") from Constantinople, dated to around AD 512. This work is the oldest surviving illustrated treatise on birds in Europe and includes 48 images. A complementary source analyzed by Kádár (1978:77) was the *Codex Vaticanus* Chis. F. VII 159 containing 70 bird illustrations. These birds represented the same species as those in the *Codex Vindobonensis* med. gr. 1. The only exception was the griffon vulture (*Gyps fulvus*), found only in the latter, the Vatican codex (Kádár 1978:84). Both works reflect the influence of Aristotelian classification in Byzantine zoological systems.

Quantitative comparisons between the three very different types of sources were limited to the analysis of taxonomic diversity based on the presence/absence of species in the mosaics, archaeozoological assemblages, and codices. The large size of the chronologically pooled archaeozoological find materials was particularly important from this point of view: taxonomic diversity in bird-bone samples tends to rapidly increase as the function of the number of identifiable bone specimens (Bartosiewicz and Gál 2007:40, Figure 4). Finally, all sources were compared on the basis of Euclidean distances between mosaics, archaeological assemblages, and pooled data in written sources. The basis of the comparison was the number of species present in those bird orders having over four species (as listed in boldface in Table 3.4.3).

## Results

All identifiable birds depicted at Tall Bīʿa were well known in the Byzantine world and—with a few exotic exceptions—were also physically present in archaeozoological assemblages originating from nearby excavations; the same is true for the contemporaneous mosaics of Caesarea and Petra toward the south. The special feature of Tall Bīʿa's mosaics is that, except for the sketchy representations of six fish in the north of Mosaic 1, their repertoire is emphatically limited to birds, with the exception of one fallow deer dominating Mosaic 3, while other vertebrate classes are well represented on the mosaics at both Caesarea and Petra. Avian species identified in Tall Bīʿa's mosaics are summarized according to present-day avian taxonomy in Table 3.4.2.

Table 3.4.2. Bird species shown in the Tall Bīʿa mosaics. The percentage of orders represented is based on the number of species occurrences (N). Parenthesized numbers indicate alternative identifications for the same image. Question marks stands for uncertain identifications.

| Species | | Room/Inventory number |
|---|---|---|
| Great egret (*Ardea alba* Linné, 1758) | | 1/17, 1/18 |
| Gray heron (*Ardea cinerea* Linné, 1758) | | 1/31, 1/32 |
| Purple heron (*Ardea purpurea* Linné, 1766) | ? | 1/9, 1/10 |
| Glossy ibis (*Plegadis falcinellus* Linné, 1766) | ? | 1/1, 1/2 |
| **Order: Pelecaniformes N = 8 (13.1%)** | | |
| Greater flamingo (*Phoenicopterus roseus* Pallas, 1811) | ? | (1/1, 1/2) |
| **Order: Phoenicopteriformes N = 2 (3.3%)** | | |
| Mallard (*Anas platyrhynchos* Linné, 1758) | | 1/3, 1/4, 1/13, 1/14, 1/23, 1/39, 1/40, 1/44, 1/45 |
| Domestic duck (*Anas domesticus* Linné, 1758) | ? | 1/15, 1/16 |
| Duck family (Anatidae Vigors, 1825) | | 1/22, 1/24, 1/29, 1/30, 1/36, 1/37, 1/38 |
| **Order: Anseriformes N = 18 (29.5%)** | | |
| Chukar (*Alectoris chukar* Gray, JE, 1830) | | 2/3, 2/4 |
| Rock partridge (*Alectoris graeca* Meisner, 1804) | ? | (2/3, 2/4) |
| Partridge genus (*Alectoris* Kaup, 1829) | | 1/21, 1/33, 1/34, 1/35 |
| Domestic hen (*Gallus domesticus* Linné, 1758) | | 1/11, 1/12, 1/19, 1/20, 1/41, 1/42, 1/43, 1/46, 1/47 |
| Indian peafowl (*Pavo cristatus* Linné, 1758) | | 1/26, 1/27, 2/1, 2/2 |
| Guinea fowl (*Numida meleagris* Linné, 1764) | | 1/5, 1/6, 1/48, 1/49 |
| **Order: Galliformes N = 23 (37.7%)** | | |
| Domestic pigeon (*Columba domestica* Linné, 1758) | ? | 3/3, 3/4 |
| Collared dove (*Streptopelia decaocto* Linné, 1758) | | 1/7, 1/8 |
| Red turtledove (*Streptopelia tranquebarica* Hermann, 1804) | ? | 1/25, 1/28, 3/1, 3/2 |
| **Order: Columbiformes N = 8 (13.1%)** | | |
| Rose-ringed parakeet (*Psittacula krameri* Scopoli, 1769) | ? | (1/7, 1/8) |
| **Order: Psittaciformes N = 2 (3.3%)** | | |

## *Bird Orders Represented*

Pelecaniformes. Among the wading birds, ardeids, great egret, and gray heron could be identified with relative certainty, although the great egret lacks a qualitative characteristic: the decorative feathers on the head. Purple heron, a species distinguished only by color, may be suspected on the basis of the wings' color in the pair facing each other (Nos. 1/9, 1/10; Figure 3.4.3, right).

Considering, however, that in purple herons the reddish feathers occur on the neck rather than the wings, chances are that the use of red tesserae on the latter reflects an aesthetic choice.

The identification of a wading bird with strongly curved beak (Nos 1/1, 1/2; Figure 3.4.3, left) is an

Figure 3.4.3. Flamingo (?; 1/1) and red heron (1/10) at Tall Bīʿa. (Photograph by G. Kalla.)

Figure 3.4.4. Possible domestic (1/15) and wild duck (1/22) at Tall Bīʿa in passive and active postures respectively. (Photograph by G. Kalla.)

even more complex task. The possibilities include glossy or bald ibis (Jos Welbedacht, Francis Koolstra, and Joris Peters, personal communication 2017) or greater flamingo, but the bird is also reminiscent of the pelican depicted in the Vienna Dioscourides, f. 479 v. A sacred ibis sporting an even stouter beak was identified at Petra while a rather heron-looking wader with a more slender beak was identified as a flamingo at Caesarea.

Among the excavated bones, flamingos were identified at Tell Hesban and Troy, whereas ibis bones were missing. Flamingos prefer shallow, saline or alkaline waters like those in lagoons or river deltas. Since this bird also had a touch of reddish color on Tall Bīʿa's mosaic, it was considered a flamingo with greater likelihood. Although both ibises and flamingos have been known from mosaics of Alexandrian influence as well as in Syria and Palestine, they are conspicuously absent from the two codices available for study (Kádár 1978:87).

Anseriformes. Depictions of a variety of geese and ducks are among the favorite themes of antique monumental iconography, a possible influence by Alexandrian Hellenism, also manifesting itself in Byzantine mosaic art (Kitzinger 1965). At Tall Bīʿa, this order is represented by diverse ducks. Most of them display a rich variety of patterns that have little resemblance to known species—a similar difficulty is encountered on the high-quality fifth- to sixth-century AD floor mosaic in the "Villa of the Amazons" at Şanlıurfa/Edessa. Mallard could be tentatively identified on the basis of its ringed neck in ten cases at Tall Bīʿa, although some of these animals have green necks and spotted patterns that contradict this opinion (Amos Belmaker, personal communication 2017). A pair of white ducks (Nos. 1/15, 1/16; Figure 3.4.4) were considered domestic.

With the exception of arid Tell Hesban, a plethora of wild-duck species were also identified in the archaeozoological materials. The difficulty with the remains of mallard and domestic duck is that their bones cannot be distinguished from one another. In Roman times duck husbandry was still restricted to keeping mallards in captivity. It is believed that real domestication did not take place until the Middle Ages (Benecke 1994:381). The white color of ducks at Tall Bīʿa, a sure sign of domestication, may indicate an earlier post-Roman date, although the possibility that the pictures show geese, which were

Figure 3.4.5. Two forms of domestic hens (1/16 and 1/12) at Tall Bīʿa. (Photograph by G. Kalla.)

already domesticated during the Iron Age, cannot be entirely ruled out (Amos Belmaker, personal communication 2017). While the beak and posture are quite duck-like, this rotund bird looks much like the white—that is, domestic—anseriform birds depicted on a fifth-century AD mosaic in the Great Palace of Constantinople, which throws doubt on precise identification at a genus level (anonymous reviewer, personal communication 2018). Meanwhile, the relatively stout neck of these birds on Tall Bīʿa's mosaic makes them more similar to ducks.

Galliformes. Fowl-like birds include a number of economically important and popular birds also depicted at Tall Bīʿa. Of the wild fowl, chukar partridge is the most likely identification for a pair of birds (Nos. 2/3, 2/4). Less evidently identifiable partridges are also present (Nos. 1/21, 1/33, 1/34, 1/35). Chukar bears a striking resemblance to rock partridge to the extent that Aristotle distinguished them on the basis of their voices alone (*Hist. Anim.* IV 9, 536 b 14). Although rock partridge today inhabits only southeastern Europe, its present distribution falls well within the former area of the Byzantine Empire in southeastern Europe (Randi 2006:370), where it may have entered the repertoire of avian motifs in art during antiquity. On the other hand, mosaics showing partridges of the genus *Alectoris* are ubiquitous in Southwest Asia. It may thus be hypothesized that many of these birds were depicted by local artists familiar with chukar partridges from everyday life (anonymous reviewer, personal communication 2018). Unless [rock] partridge had become a particularly conservative iconographic element in Byzantine Europe, its presence is less likely on Tall Bīʿa's mosaic. With the exception of Caesarea's mosaic, chukar partridge has been identified in all three types of sources consulted in this study. It also occurs in the aforementioned fifth–sixth century floor mosaic from Şanlıurfa/Edessa. Sand partridge (*Ammoperdix heyi* Temminck, 1825), found among the bird bones at Tell Hesban, may be ruled out as an alternative model for these images as it has a markedly different stripe pattern on the side (Amos Belmaker, personal communication 2017).

Domestic hen occurs in nine images on the mosaic at Tall Bīʿa, rivaled in numbers only by the previously discussed ducks. In Christianity, the rooster symbolizes vigilance and is also associated with Saint Peter. While in this mosaic it appears together with a hen (Nos. 1/19, 1/20), single roosters are depicted at Petra and none at Caesarea. On the other hand, a pair of hens apparently of markedly different types are also represented at Tall Bīʿa (Nos. 1/11, 1/12; Figure 3.4.5).

One of them (1/12) possibly combines the plumage of a pheasant with the comb of a domestic hen. The moderate spurs depicted may raise the question whether the distinctly different "hens," 1/11 and 1/12, actually show leggy capons. The castration of roosters seems to have already been practiced in classical antiquity (Gál 2013:225). Unfortunately, spurs are shown by the artist on this mosaic rather indiscriminately, even on wading birds. Therefore, no spurious speculations concerning caponization should be based on this unreliable morphological feature as shown in the mosaic. Generally, over 80% of bird bones recovered from Byzantine sites orig-

Figure 3.4.6. Turtledove (1/28) and parakeet (?; 1/8) at Tall Bīʿa. (Photograph by G. Kalla.)

inate from domestic hen (Kroll 2010) and are also well-represented at Tell Hesban and Troy; however, the large Jerf el Ahmar material is far too early to contain bones of domestic birds.

Two imported fowl species are of particular significance here. The aforementioned pair of Indian peafowls takes center stage in the design of Mosaic 1, but also occurs on the smaller Mosaic 2 (Nos. 1/26, 1/27, 2/1, 2/2). These magnificent birds are depicted on all the mosaics and codices studied here. The peafowl symbolized resurrection in Byzantine art as its flesh was thought not to be susceptible to decay (Saint Augustine, *City of God* xxi, c, iv). In a more secular setting, the peafowl was assigned to the empress in the Byzantine court, just as the eagle was the emperor's bird (Bartosiewicz 2012:180, Table 1; Ronnberg and Martin 2010:260). The absence of the latter bird in Tall Bīʿa's iconography indirectly confirms the religious meaning of peafowl, taking center stage in the design of Mosaic 1 in combination with the inscription. The posture of these birds further supports this hypothesis: the fan-tailed peafowl in antiquity symbolized Hera/Juno—the eagle stood for Jupiter—while that with a folded tail is more characteristic of early Christian/Byzantine mosaics in Italy and the Eastern provinces (Kádár 1978:77, 85). In addition to the three mosaics discussed here, those from Et Tabgha (Israel) serve as good examples of this religious aspect. The overwhelmingly symbolic rather than dietary value of peafowl is shown by the absence of its bones from the sizeable archaeozoological assemblages selected for study. According to Kroll (2010:181, 249), current osteological evidence is limited to only three sites in the Byzantine Empire: Nicopolis ad Istrum (Bulgaria), Naples (Italy), and Carthage (Tunisia).

Easily identifiable, splendid pairs of Guinea fowl, a species originating from Africa, are also shown on Mosaic 1 (Nos. 1/5, 1/6, 1/48, 1/49). They are a popular motif in all the pictorial sources consulted. However, similarly to peafowl, the bones of exotic Guinea fowls are missing from the bone assemblages studied.

Columbiformes. Doves and pigeons form the last order indubitably represented at Tall Bīʿa (Nos. 1/7, 1/8, 3/3, 3/4). With the exception of Caesarea's mosaic, they occur in all studied sources. It is, however, difficult to distinguish between doves and pigeons in the mosaic representations. The wild ancestor—rock pigeon (*Columba livia* Linné 1758)—not recognized on the pictures, is native to the area. The red wings and red shade on the chest may even suggest red turtledove (*Streptopelia tranquebarica* Hermann, 1804; Nos. 1/25, 1/28, 3/1, 3/2; Figure 3.4.6), even though the depictions lack the black collar characteristic of this species, which is nowadays distributed east of the Saharo-Arabic faunal region.

Although Byzantine trade routes connecting Constantinople with China (Walker 2010:196, Figure 8) were crossing Bagram and Peshawar, which fall within the area of the distribution of the modern red turtledove, this bird is completely unknown in present-day Raqqa (Amos Belmaker and Noushig Zarikian, personal communication 2017). Nevertheless, it seems more likely here, on Tall Bīʿa's mosaic, that the red tesserae were simply used to add visual contrast to the wings in the doves' representation.

The white dove symbolizes innocence (Matthew 10:16), yet the most widely understood meaning the dove has, in general, in Christian symbolism is its personification of the Holy Spirit, the Third Person of the Blessed Trinity (Luke 3:22). The closely related pigeon, on the other hand, represents self-indulgence and laziness. Taking the risk of circular reasoning one may only guess that—given the general atmosphere of Tall Bīʿa's mosaics and their distinguished location in a monastery—the birds shown here are most likely doves.

Psittaciformes. The last order, that of parrots and parakeets, cannot be unambiguously identified on the pictures. A pair of green birds (Nos. 1/7–8), which are clearly distinct in shape from doves, are reminiscent of rose-ringed parakeets (*Psittacula krameri* Scopoli, 1769). A fifth-century mosaic, at the Baltimore Museum of Art, shows 20 parakeets arranged in five rows of four, wearing ribbons around the neck. This mosaic was part of the floor recovered from the "House of Psyche's Boat" in the Daphne suburb of Antioch/Antakya (Turkey), located only 60 km west of Tall Bīʿa. The knotted ribbons that appear on this mosaic have been explained as the mosaicist working from a model and misinterpreting the dark collar in the plumage around the neck as a ribbon (Arnott 2007:202). However, the birds have nothing around the neck at Tall Bīʿa.

The Greek historian Diodorus Siculus (first century BC) mentioned parrots found in the furthest parts of Syria. This may imply that ringed-necked parakeets—wild or feral—already existed in the lower Euphrates region in antiquity (Arnott 2007:202). Although different looking, the Alexandrine parakeet (*Psittacula eupatria* Linné, 1766) is known to have been imported from India to aviaries in the Mediterranean region already in the classical age (Kádár 1978:86) and is shown on a Hellenistic mosaic from ancient Pergamum (Bergama, Turkey; Bethe 1939:335, Figure 12). Another Byzantine mosaic with parakeets—and one with an abundance of birds—was found in the Apostolic Church at Madaba, Jordan, a site best known for the contemporaneous mosaic map of the Holy Land (Piccirillo et al. 1991:97). Residents of present-day Raqqa recall the presence of parakeets in the region until the 1980s (Noushig Zarikian, personal communication 2017).

### *Comparing Different Sources*

In Table 3.4.3, the diversity of bird inventories can be compared between the three types of sources used in this study in order to determine the position of Tall Bīʿa's mosaics with respect to ornithological content. Bird orders represented by at least four species (boldface totals in Table 3.4.3) were used in constructing the small dendrogram inserted into the map in Figure 3.4.2. It shows Euclidian distances calculated from the data summarized in Table 3.4.3 (computed using the Ward method). Owls and perching birds, however—completely missing from the studied mosaics—were not included in the calculation.

In relation to the number of species in various avian orders discussed in codices and identified by archaeozoological assemblages, it becomes clear that mosaics show only a restricted range of the avifauna that surrounded people in the Byzantine Empire. The artistic repertoire of mosaics forms a tight cluster in Figure 3.4.2: bird mosaics from Tall Bīʿa and Caesarea are most closely related; Petra is next to join the two others. The smallest archaeozoological assemblage from Troy is closest to them due to low species diversity. At the other end of the scale, the great taxonomic abundance of bird remains in the archaeozoological assemblage from Tell Hesban may be considered statistically representative; as such it compares most favorably with the contents of codices, a benchmark of contemporaneous scholarly observation.

## Discussion

The results indicate that the canon of avian species depicted on the three studied mosaics was largely determined by early Christian symbolism. In addition to a limited range of birds associated with concrete religious meanings (Arnott 2007), quite a few species were added to the visual repertoire in an effort to enhance the splendid decoration in this sacred area. Peafowl and Guinea fowl stand out as exotic species, although some others may also represent distant geographical regions or their early presence in the avifauna of Syria.

Comparing mosaics and bird-bone assemblages from adjacent environmental regions offered ambiguous results. The geographical proximity of archaeological sites to the mosaics' location shows no particular affinity in ornithological content. Indeed, the consistent artistic selection—for example, the omission of raptors and perching birds from the three studied mosaics—overruled the idea of "properly" representing the entire spectrum of local birds in these works of art. Faunal information can be

Table 3.4.3. Taxonomic diversity by bird orders in three types of sources.

| **Bird type** | **Order name** | **Mosaic floors** | | | **Osteological evidence** | | | **Codices** | **Total** |
|---|---|---|---|---|---|---|---|---|---|
| | | Tall Bīʿa | Caesarea | Petra | Troy | Jerf el Ahmar | Tell Hesban | | |
| Ostriches | Struthioniformes | | | 1 | | | 1 | 1 | 3 |
| Storm birds | Procellariformes | | | | | | | 1 | 1 |
| Grebes | Podicipediformes | | | | 1 | | | | 1 |
| Wading birds | Ciconiiformes | | | | | 1 | 1 | 1 | 3 |
| Pelicans | Pelecaniformes | 3 | 2 | 2 | 2 | 1 | | 2 | **12** |
| Flamingos | Phoenicopteriformes | 1 | 1 | | 1 | | 1 | | **4** |
| Geese/ducks | Anseriformes | 2 | 2 | 2 | 11 | 14 | | 5 | **36** |
| Diurnal raptors | Falconiformes | | | 1 | 1 | 11 | 12 | 8 | **33** |
| Fowl-like birds | Galliformes | 6 | 4 | 5 | 3 | 4 | 3 | 8 | **33** |
| Cranes | Gruiformes | | 1 | | 3 | 3 | 8 | 6 | **21** |
| Gulls/waders | Charadriformes | | | 3 | 1 | 4 | | 4 | **12** |
| Pigeons/doves | Columbiformes | 2 | | 1 | 3 | 4 | 2 | 4 | **16** |
| Cuckoos | Cuculiformes | | | | | | | 1 | 1 |
| Nocturnal raptors | Strigiformes | | | | 1 | 3 | 2 | 2 | 8 |
| Roller/kingfisher | Coraciiformes | | | | | 1 | | 1 | 2 |
| Woodpeckers | Piciformes | | | | | | | 1 | 1 |
| Perching birds | Passeriformes | | | | 2 | 4 | 15 | 18 | 39 |
| **Total number of birds within taxa per source** | | **15** | **10** | **14** | **29** | **50** | **45** | **64** | **226** |

more reliably obtained from the magnificent scholarly works of the same time period as shown by the codices available through research by Kádár. While direct evidence in the form of osteological finds reflective of different natural habitats shows no correlation with the species depicted on mosaics, it does reveal a relatively strong connection with the birds listed in codices.

Given the selective nature of avian iconography, ideological functions of the ornithological signs on Tall Bīʿa's mosaics need to be briefly reviewed. Although it is presumptuous to ignore merely decorative and aesthetic criteria for the depiction of animals by Byzantine mosaicists, the use of animals in the semiotic system as a whole can be interpreted as relating to religiosity in the broadest sense. Jacobite imagery tended to avoid the depiction of mammals (Mundell 1977). That statement does not take into account the large AD 509 mosaic replete with 49 birds, which predates the ascent of Jacob Baradaeus and where a magnificently depicted fallow deer dominates Mosaic 3 in the funerary shrine (Kalla 2018:865). This mosaic is possibly contemporaneous with the emergence of Syriac Christianity. Nevertheless, there is a general fascination with birds—variegated in shape and color—that crosscuts cultural boundaries. As Hyland and Wilson (2016:5) wrote: "There is a romance about bird life which is irresistibly attractive to artists, as well as otherness." For example, postdating Tall Bīʿa's mosaics by an entire millennium, a Persian book of poems titled *The language of the birds* was illustrated by Habib Allah, who depicted a similarly rich array of species (Ronnberg and Martin 2010:239).

It is also likely that, beyond aesthetics, Tall Bīʿa's artist intended to present a reduced version of the "Garden of Eden." However, complete versions of this motif are typical of comparable "catalogs" in Byzantine mosaics (Hachlili 2009:269–273). They show the beauty of a great variety of animals—herbivores and carnivores alike—sharing the same visual space.

As detailed in the Results section above, many taxa identifiable on these mosaics have special cognitive significance well known in antique as well as early Christian iconography.

The wild/domestic dichotomy does not seem to be valid in the selection of species by Tall Bīʿa's artist. It is almost as a reminder that Aristotle specifically used the example of birds in arguing for a "natural" system of classification based on minute and comprehensive observation rather than the Platonic dichotomy (Kádár 1978:81): on the mosaics presented here each bird depicted in spectacular detail is present in its own right, regardless of its wild or domestic status.

There are, however, also some striking absences well worth addressing. While well represented in the faunal assemblages of Jerf el Ahmar and Tell Hesban, pictorial representations of diurnal raptors are rare in classical Graeco-Roman iconography. Byzantine examples include an eagle fighting a snake on the fifth-century mosaic of the Great Palace in Constantinople and another in the Vienna Genesis (produced in sixth-century Syria), where the animals leave Noah's Ark (anonymous reviewer, personal communication 2018). On the other hand, raptors are discussed in great detail in the two codices due to their practical significance in falconry (Kádár 1978: 84). Although in Christian iconography the eagle is a symbol of Christ and the emblem of Saint John the Evangelist, one may only speculate that birds of prey apparently had little place in the idyllic scenario suggested by each and every image of Tall Bīʿa's mosaics.

The other group entirely missing from this magnificent array of species is the order of perching birds—Passeriformes. Over half of the ten thousand known bird species in the world are classified within this order, including numerous spectacular-looking popular songbirds. Curiously enough, none of them is shown on the studied mosaics and even several of the perching birds illustrated in the two codices seem to have been appended to the original *Ornithiaca* subsequently (Kádár 1978:87). Remains of these birds tend to be rare in excavated assemblages as well, although the three collections chosen for study offer evidence of a decent range of species. However, in the three faunal reports quoted all analysts remark on the relative paucity of bones from perching birds, in spite of sieving aimed at recovering minute animal and plant remains.

## Conclusions

Iconographic sources reflecting attitudes toward animals should be considered integral components of archaeozoological work. On the other hand, cautious interpretation is required, since animals depicted in the Byzantine semiotic tradition lean towards naturalistic representation only in a schematic way. They are expressive, colorful, and repetitive, but in comparison to earlier classical Roman art the depictions tend to be less easily identifiable. The resulting iconographic information is thus not as "objective" as osteology, but nonetheless deserves analytical treatment. While the geographical distribution of birds in real life is determined by habitat preference, their occurrence in art is solely influenced by the artist's worldview, including actual knowledge of the animal and the message to be conveyed through its choice as a medium. With only few exceptions, all species on Tall Bīʿa's mosaic represent the recently defined Saharo-Arabic faunal region, wedged between the Palearctic and Afrotropical regions (Holt et al. 2013:75). The latter is home to one of the exotic species, the Guinea fowl. Indian peafowl and possibly parakeet imported from Eastern Asia—as well as red turtledove?—may represent the Oriental faunal region.

As shown in Figure 3.4.1, the layout of bird images on Mosaic 1 at Tall Bīʿa juxtaposes symmetry and geometric discipline (south) with a degree of playful disorder (north). Above all, these mosaics radiate heavenly harmony, worthy of a high-status religious architectural environment designed to impress. This aim is achieved through the artistic depiction of the following avian groups:

(1) Galliform species—including local and exotic domesticates—dominate in mosaics.
(2) Pelecaniform birds and ducks, popular in Byzantine iconography are also numerous.
(3) Doves, central to Christian symbolism, are often present.

(4) Aquatic orders are missing from the large bone assemblage from Tell Hesban but are amply represented on mosaics.

Osteological evidence is strong for raptors and even perching birds are present in excavated assemblages, but these orders are absent from Tall Bīʿa's mosaics. Meanwhile contemporaneous Byzantine documentary sources show taxonomic similarity to the composition of orders in major bone assemblages of representative sizes.

The birds at Tall Bīʿa represent a created world and serve as object-lessons for humans in morality and piety. Multidisciplinary treatment is thus necessary to identify patterns by which various taxa are represented and to relate them to past physical and cognitive environments.

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