'Atiqot 105, 2021

Faunal Remains from the Late Chalcolithic, Late Roman, Byzantine and Ottoman Periods at Yehud, Ashkenazi Market

Nuha Agha

INTRODUCTION

This paper presents the faunal remains from a salvage excavation conducted in Ashkenazi Market, Yehud. The excavation uncovered Late Chalcolithic-period shafts, Roman-period kilns, Byzantine-period houses and pits, and Ottoman-period houses, refuse pits and cesspits. The architectural remains are typical of a rural agricultural settlement (see Jakoel, this volume). The faunal remains were retrieved from most of the contexts.

This study examines the taxonomic composition of the faunal remains, the representation of skeletal elements and the demographic profile of the herd animals. Taphonomic evidence of human modification of the remains, such as butchery marks, and of environmental modification, such as weathering, is also considered. It should be noted that the consideration of these data and of the diachronic patterns in animal consumption at the site is limited by the small size of the sample.

Methods

The material for this study was retrieved from well-stratified and clearly-dated contexts. The remains from the topsoil and from disturbed or undated contexts, among them a few duck/goose bones, are not included in the report. The bones were mostly collected manually, except for the partial sieving of sediments from the Chalcolithic shafts (see Jakoel, this volume). All the bones were washed with tap water and shade-dried to remove dust and adhering sediments to facilitate the identification of surface modifications, such as butchery marks, carnivore gnawing marks and weathering. The bones, including the fragments of long-bone shafts, ribs, vertebrae and crania, were assigned to skeletal element. The completeness of each bone was determined by recording the presence or absence of its diagnostic parts, rather than the less detailed approach of recording the surviving percentage of the whole bone (Klein and Cruz-Uribe 1984). The long bones were divided into five diagnostic parts: proximal articulation, proximal shaft, mid-shaft, distal shaft and distal articulation. The anatomical description of the other bone fragments

was based on Dobney and Rielly (1988); a more detailed description was used for some of the bones (e.g., the scapula 'neck').

The bones were identified to biological taxon, at the genus or species level where possible, or otherwise to a size class: medium-sized mammals (e.g., sheep/goat, gazelle, pig) and large-sized mammals (e.g., cattle and equids). The identification was conducted based on the comparative osteological collection of the National Natural History Collections at the Hebrew University of Jerusalem. The morphologically similar bones of sheep and goats were distinguished based on Zeder and Lapham's criteria (2010). Bones that could not be securely assigned to either sheep or goat were allocated to the category 'sheep/ goat'. The bones of donkeys and horses were distinguished based on Johnstone's (2004) morphological criteria, or otherwise assigned to the general category 'equid'. The age at death of the animals was reconstructed by assigning the teeth to dental attrition stages (Grant 1982), and the bones to fusion stages, using Zeder's (2006) criteria for caprines and Silver's (1969) criteria for cattle.

The ungulate skeletal element representation was reconstructed by assigning the bones to five body parts: head (skull, horn, maxilla, mandible and loose teeth), trunk (vertebrae, sacrum, ribs and pelvis), forelimb (scapula, humerus, radius and ulna), hind limb (femur and tibia) and feet (metapodials, tarsals, calcaneum, astragali and phalanges). Due to the small assemblage size, skeletal element frequencies within each of the five body parts were calculated using three different indexes: the number of identified specimens (NISP) belonging to each element, the minimum number of elements (MNE) represented by these specimens and the minimum animal units (MAU) determined by dividing the MNEs by the number of skeletal elements in a complete skeleton (Appendix 1). The MAU values, which range between 1 and 2 (see Appendix 1), are not very informative because of the small sample size.

The bones were measured using a manual caliper with an accuracy of 0.1 mm (see Appendix 2), following the measurements used by Driesch and Wodtke (1997). The remains could not be sexed, neither morphologically, due to the absence of pelvic elements, nor metrically, due to the small number of measurable bones with size dimorphism. The surface of each identified bone was examined with a magnifying glass under direct light (Blumenschine, Marean and Capaldo 1996) to identify signs of human activity, such as burning (Binford 1981; Rixson 1989; Seetah 2006), and evidence of post-depositional processes, such as gnawing by predators or rodents (Binford 1981; Blumenschine, Marean and Capaldo 1996), root marks and weathering (Behrensmeyer 1978).

RESULTS

The assemblage is generally well-preserved, showing little evidence of weathering or the impact of predators. It consists of 295 bones, teeth and horns that could be identified to a biological taxon or size group. Of these identified remains, 250 originated from well-defined stratigraphic contexts, representing 47 loci, and could be allocated to the different periods (Table 1). The remains belong mostly to mammals. Large bones and species, in particular

Table 1. NISP and Relative Frequencies of Species by Period

Taxonomy	Late		Early		Late Ro	man	Roman		Roman-		Byzant	ine	Ottoma	п
	Chalco	lithic	Roman						Byzanti	ne				
	NISP	%	NISP	%	NISP	%	NISP	%	NISP	%	NISP	%	NISP	%
Sheep (Ovis aries)											3			
Goat (Capra hircus)	2								-		1		2	
Sheep/goat (Caprine)	4				6				2		6		16	
Sheep and goat	9	22.2	-		6	33.3	3		3	16.7	13	26.5	18	28.6
Cattle (Bos taurus)	11	40.7			8	44.4			8	44.4	18	36.7	18	28.6
Suid (Sus scrofa)	9	22.2												
Camel (Camelus cf.		3.7			4	22.2				5.6	2	4.1	2	3.2
dromedarius)														
Equid (Equus sp.)									4	22.2	12	24.5	1	1.6
Donkey (Equus cf. asinus)									-	5.6				
Horse (Equus cf. caballus)									-	5.6			2	3.2
Gazelle (Gazella cf. gazella)	3	11.1												
Dog (Canis familiaris)											1	2.0	Э	4.8
Chicken (Gallus domesticus)											3	6.1	19	30.2
TOTAL (NISP = 179)	27	100.0	I		18	100.0	ŝ		18	100.0	49	100.0	63	100.0
Size-class taxa														
Medium mammal	7	50.0	1		3	42.9			1		9	14.0	1	33.3
Large mammal	7	50.0			4	57.1			2		37	86.0	2	66.7
TOTAL (NISP = 71) size-class	14	100.0	Ι		7	100.0			3		43	100.0	3	100.0
GRAND TOTAL (NISP = 250)	41		2		25		n		21		92		66	

cattle, appear to be overrepresented in the assemblage, whereas small bones appear to be underrepresented, and small species, such as fish, birds, reptiles and rodents, are absent. This is probably the result of hand-picking of the remains in the excavation (Payne 1972; 1975; Shaffer 1992).

The remains include 41 bones from the Chalcolithic period; 30 bones from different phases of the Roman period, mostly from the Late Roman phase; 21 bones from the Roman–Byzantine period; 92 bones, from the Byzantine period; and 66 from the Ottoman period.

The Late Chalcolithic Period

Taxonomy. The 41 Chalcolithic-period bones (Table 1; Appendix 3) were found within shafts. All the identified remains belong to mammals: cattle, caprines (sheep/goats), pig, camel and gazelle. The frequency of cattle (*Bos taurus*, including the bones of large-sized animals) is particularly high (44%), while caprines (*Ovis aries/Capra hircus*, including the bones of medium-sized animals) account for only 32% of the identified remains. The cattle in the Chalcolithic-period assemblage are even more abundant than in the Ottoman-period one (30%; see below). This species composition is somewhat unusual, as most Chalcolithic faunal assemblages are dominated by caprines, while those of the Ottoman period are often dominated by cattle. An even higher frequency of cattle was documented in another small Chalcolithic assemblage from Yehud (62%; Marom 2020). The high frequency of cattle in both assemblages may be attributed to the lack of sieving in most of the excavated contexts and/or the small sample size. Pigs (*Sus* sp.; 17%) are the third-most common species. It could not be determined whether the remains belong to domestic animals or wild boars due to the absence of measurable teeth and long-bone epiphyses.

The remains of the domestic animals represent at least one cattle individual, two pigs, and two caprines, including one goat. The only wild animal, gazelle (*Gazella gazella*), is represented by a pelvis bone, a mandible with teeth and a horncore that morphologically belong to a male; these remains represent at least one individual.

The camel (*Camelus* sp.) is represented by a single bone, a 1st phalanx (L324, B3043). This was probably a dromedary camel (*Camelus* cf. *dromedarius*) rather than the twohumped Bactrian camel, as most of the camel remains from the Southern Levant belong to the former species (Hakker-Orion 1984; Wapnish 1984; Horwitz and Rosen 2005). While wild dromedaries may have existed in the Negev in the fourth millennium BCE (Lernau 1978), the presence of a camel in a Chalcolithic context at Yehud, far beyond its natural distribution range, is conspicuous. Until recently, the earliest camel remains from Israel were considered to date to Iron Age I (Hakker-Orion 1984; Horwitz and Rosen 2005), and their frequency in the faunal assemblages of the region was shown to have increased during Iron II and the Persian period (Wapnish 1984; Horwitz and Rosen 2005). However, to date, the earliest secure evidence of camel comes from the 'Arava Valley, where the remains are reliably dated to the last third of the tenth century BCE, i.e., early Iron Age IIA (Sapir-Hen and Ben-Yosef 2013; see also Grigson 2012). The few camel bones found in earlier contexts, such as in the Late Bronze Age at Tell Jemmeh (Wapnish 1984), should be considered intrusive. Camel bones previously documented at Yehud in Chalcolithic and MB IIA contexts were considered intrusive in both cases (Brink et al. 2014; Nimrod Marom, pers. comm.). Here too, the camel bone should be considered a later intrusion. This conclusion is reinforced by the presence of a few Roman- and Byzantine-period pottery sherds in the same context as that of the camel bone (see Jakoel, this volume). Nine additional camel bones were retrieved from the Roman, Byzantine and Ottoman strata at the site.

Skeletal Element Distribution. The small assemblage (Table 2:a) does not permit a detailed analysis of the skeletal distribution pattern. Nevertheless, it can be cautiously noted that most of the cattle and caprine remains, including those attributed to the large- and mediumsized taxonomic categories, represent meat-poor anatomical parts, such as the heads and feet (phalanx, metatarsal and metacarpal bones), likely representing butchery refuse; only a few meat-rich parts representing food disposal, such as the fore- and hind limbs (Hellwing and Gophna 1984), are present. A different pattern is shown for the suid remains as they represent mostly consumption waste, with only one bone that can be classified as butchery refuse. The association of the butchery and consumption refuse indicates that both the slaughtering and the consumption of the domestic animals occurred at the site. However, the differences in the skeletal-element distribution between the species might be partially due to the small size of the samples. In other Chalcolithic contexts at Yehud, caprine remains were dominated by consumption waste rather than by butchery refuse (Marom 2020:27*). The presence of different body parts of a gazelle, including both skull parts and a scapula, indicates that the animal may have been hunted near the site and transported in its entirety.

Demographic Profile. The few remains for which it was possible to determine the age of the animals do not permit a precise reconstruction of the herd demography. The caprine remains include a single fused metapodial of a goat, indicating an age-at-death <18–30 months. The cattle epiphyses include two fused phalanges that belong to animals older than 12–18 months when slaughtered, and two unfused metatarsals of animals younger than 27–36 months. A cattle worn third molar indicates a mature individual (Grant's Wear Stage H). Two unfused suid bones belonged to animals younger than 1 year at death, while a single fused suid bone indicates an older animal. The slaughtering of young pigs was common in antiquity, as these animals were kept mostly for their meat.

Bone Surface Modifications. Three bones show evidence of butchery: two foot bones, a cattle metatarsal and a goat metacarpal, with marks related to the removal of the skin, and a metatarsal of a large-sized animal with a cut mark, the function of which is not clear (Table 3; Appendix 4). The fracture morphology of five bone fragments indicates the intentional breakage of fresh bones to obtain the marrow, which was valued for its high caloric content (Villa and Mahieu 1991). The absence of burning marks may indicate that the preparation of the meat involved cooking rather than roasting. The evidence for weathering, detected

Part	Caprine		Cattle		Pig	
	NISP	%NISP	NISP	%NISP	NISP	%NISP
(a) Late Chalc	olithic					λ
Head	4	30.8	3	16.7		
Trunk	4	30.8	4	22.2		
Forelimb			4	22.2	5	83.3
Hind limb	2	15.4				
Feet	3	23.1	7	38.9	1	16.7
Total NISP	13	100.0	18	100.0	6	100.0
(b) Late Roma	n					
Head	2	22.2	2	16.7		
Trunk	2	22.2	1	8.3		
Forelimb	3	33.3	3	25.0		
Hindlimb			1	8.3		
Feet	2	22.2	5	41.7		
Total NISP	9	100.0	12	100.0		
(c) Roman-By	zantine	,		,		
Head	2	50.0	1	10.0		
Trunk	1	25.0	1	10.0		
Forelimb			4	40.0		
Hind limb			2	20.0		
Feet	1	25.0	2	20.0		
Total NISP	4	100.0	10	100.0		
(d) Byzantine						
Head	3	15.8	7	12.7		
Trunk	4	21.1	31	56.4		
Forelimb	3	15.8	7	12.7		
Hindlimb	6	31.6	2	3.6		
Feet	3	15.8	8	14.5		
Total NISP	19	100.0	55	100.0		
(e) Ottoman						
Head	4	22.2	3	15.0		
Trunk	4	22.2	8	40.0		
Forelimb	6	33.3	2	10.0		
Hind limb	2	11.1	2	10.0		
Feet	2	11.1	5	25.0		
Total NISP	18	100.0	20	100.0		

Table 2. Skeletal Element Composition by Body Parts for the Main Species in each Periodⁱ

ⁱ Remains of medium- and large-sized mammals were included with those of caprines and cattle, respectively.

Type of Modifi	cation	Late Chalcolithic	Late Roman	Roman– Byzantine	Byzantine	Ottoman
Weathering	Sample	9	9	10	29	26
	Weathered ⁱ	1	1	3	5	1
	%	11.1	11.1	30.0	17.2	3.9
Gnawing	Sample	35	24	19	90	63
	Gnawed	1		1		
	%	2.9		5.3		
Burning	Sample	35	24	21	90	63
	Burned					
	%					
Breakage	Sample	13	9	10	29	26
	Fresh bone fracture	5		1	5	3
	%	38.6		10.0	17.2	11.5
Butchery	Sample	35	24	19	90	63
	Cut marks	3	4		18	14
	%	8.6	16.7		20.0	22.2

Table 3. Bone Surface Modifications by Period

ⁱ Weathering Stage 2 and above (Behrensmeyer 1978).

on only nine bones, is negligible, classified as Stage 3 (following Behrensmeyer 1978). Predator gnawing was found on only one bone. The limited impact of weathering and predators indicates the rapid burial of the Chalcolithic assemblage.

To conclude, the livestock economy of the Late Chalcolithic period at Yehud was based primarily on cattle and caprines, including pigs and wild animals as supplementary components. This taxonomic composition is characteristic in water-rich environments of the Chalcolithic period in the Southern Levant (Ducos 1968; Grigson 1995).

The Late Roman Period

The 30 Roman-period bones and teeth are attributed mostly to the Late Roman phase (n = 25), only two bones dating from the Early Roman phase, and three generally classified as Roman. The Late Roman assemblage is presented below.

Interestingly, the remains came mostly from the kilns (n = 15), possibly indicating the deposition of refuse after the installations fell out of use. The bones bear no burning marks so it is unlikely that they were used as burning material in the kilns. This observation also hints at cooking rather than roasting the meat. The other bones were collected from accumulations above walls (n = 6) and within structures (n = 4).

Only three species were identified in the Roman-period assemblage—cattle, caprines and camel—each represented by one individual. As in the Chalcolithic assemblage, the combined frequency of cattle and large-sized animals (48%) is greater than that of caprines (36%), probably due to the manual collection of the bones. The three camel cervical vertebrae were all found inside one architectural unit (L742, B7210).

The skeletal element composition of both the cattle and the caprines (Table 2:b) seems to represent the presence of both consumption and butchery refuse. Two cattle bones indicate the age-at-death—a fused phalanx (>1.5 years) and a fused proximal radius (>1.0–1.5 years)—below the optimal age for cattle slaughtering (2.0–2.5 years). These data do not reveal much regarding the economic role of the animals. Two caprine mandibles with sequences of worn teeth (M1–M3, Grant's Wear Stages M, M, L; M1–M3, Grant's Wear Stages G, G, L) indicate mature animals (>4 years). The presence of mature animals in the caprine herd indicates that it was kept at least partially for producing milk and/or wool (Sasson 2010).

Bone Surface Modifications. Butchery is attested on four bones (16%; Table 3), in the form of delicate cutting marks, resulting from the use of thin-blade knives (Appendix 4). The location of these marks indicates that their purpose was for joint disarticulation (n = 2) and meat removal (n = 2). No evidence was found for the breakage of fresh bones. Only one bone presents evidence of weathering, the degree of which is moderate (Stage 3).

To conclude, despite the small size of the assemblage, it is characteristic of a Roman-period rural husbandry. Cattle and caprines comprise the bulk of the remains, while the absence of wild animals is probably the result of their marginal economic role and the small sample size. The absence of pigs may also be due to the small sample size, not necessarily indicating an ethnic or religious choice.

The Roman–Byzantine Period

The accumulations overlying the Roman-period walls and kilns, attributed to the Roman-Byzantine periods, yielded 21 bones, teeth and horns (Table 1; Appendix 3). Most of the remains belong to large animals—cattle, equids (donkey and horse) and camel—and only four specimens (19%) belong to caprines or medium-sized animals.

The cattle remains mainly comprise the limb bones, meat-rich parts of the body, considered as consumption refuse. The cattle butchery refuse includes only one phalanx bone, but given the small sample size, the possibility that slaughtering did take place at the site cannot be ruled out.

The age-at-death for cattle could be determined based on the state of fusion of four bones: a fused femur proximal end (<4.5 years), a fused femur distal end (>3.5–4 years), a fused 1st phalanx (<1.5 years) and a fused radius proximal end (<1–1.5 years). The bones belonging to the older individuals indicate that the animals must have been kept for their

secondary products and/or employed as beasts of burden. Two equid bones—a horse and a donkey—are fused, possibly indicating a mature population. This accords with the data obtained from the equid teeth, including a single worn horse upper molar, and a sequence of worn donkey teeth (PM2–M3), all belonging to mature animals.

No butchery marks or burning marks were found. The only evidence for human modification is a single bone fragment that may have been broken when fresh to obtain the marrow. Weathering impact, Stage 3 or higher, was found on three bones. Only one bone showed gnawing marks; this may reflect an extended period of exposure of the bones on the ground, and a minimal presence of predators.

The Byzantine Period

Taxonomy. The Byzantine assemblage consists of 92 bones (Table 1) that originated from living surfaces (n = 16); refuse pits (n = 41) and associated loci (n = 11); accumulations overlying or abutting the walls (n = 14); and soil fills (n = 10). The remains of cattle, including bone fragments in the large mammal category, comprise 60% of the assemblage, while caprines comprise 21%. Sheep remains (n = 3) are more common than those of goats (n = 1). The presence of chicken (*Gallus domesticus*) indicates the use of its meat and eggs in the local economy. Scant remains of beasts of burden, equids and a camel, and a single bone of a dog (*Canis familiaris*), were also found.

The absence of pig remains in the Byzantine assemblage is of interest, considering that it is the largest sample in the present excavation. Faunal assemblages of the Roman and Byzantine periods in Israel generally demonstrate a marked increase in the frequency of pigs, interpreted as the 'Romanization' of the region (King 1999). However, pig frequencies during this period vary considerably from site to site, and are thought to reflect ethnic or cultural choice rather than the influence of climatic or economic factors (Horwitz and Studer 2005). Jews were prohibited from consuming pork meat, although the *Talmud* and additional textual sources reveal that Jews did raise and sell pigs, including cases where legal compensation was pursued for the damage caused by pigs (Safrai 1994:172–173). Assemblages from sites inhabited mostly by Jews, such as Horbat Sumaq (Horwitz, Tchernov and Dar 1990) and Jerusalem (Horwitz and Tchernov 1989; Horwitz 1996), contain no or very few pigs. At Horbat 'Eleq, it was suggested that the wealthy Jewish landowners consumed a small amount of pig despite the religious prohibition (Horwitz 2000). The presence of a Jewish population at Yehud may explain the absence of pig remains in the Byzantine period.

Skeletal Element Distribution. The assemblage consists of an unusually high proportion of ribs (34%), including fragments with fresh breaks inflicted during the excavation. The removal of these freshly-broken fragments from the analysis of the skeletal element composition reveals similar frequencies of consumption and butchery refuse to the other assemblages from the site (Table 2:d).

Demographic Profile. The only ageable specimens of herd animals include a fused cattle distal femur (<3.5-4 years), two fused sheep bones—a distal tibia (<18-30 months) and a 1st phalanx (12-18 months)—and two sheep/goat bones—a distal humerus (6-12 months) and a proximal radius (6-12 months). As the fused bones only provide a minimum indication of the actual age-at-death, the herd demography and production strategy could not be analyzed in detail. The ageable equid bones (n = 6) belong to donkeys and horses, and indicate a generally mature population. The camel remains, including worn mandibular and maxillary teeth, are all osteologically mature.

Bone Surface Modification. Butchery marks were identified 18 bones and horns (Table 3; Appendix 4). Judging from the anatomical position of the bones, and from the depth of the marks and their shape (see Rixson 1989; Seetah 2006), some were made by light-weight knives, some by heavier blades and others by heavy-duty tools used for chopping, probably axes. A marked difference is evident between cattle and caprines in the method of processing: only one of the five caprine butchery marks was a chopping mark (20%), whereas seven of the 13 cattle butchery marks were related to chopping (54%), including three cattle metatarsal bones with both chopping and knife marks. According to the location and morphology of the cutting marks found on the cattle metatarsal and metacarpal bones, the butchery method involved the separation of the feet from the limbs using axes and heavy knives. One cattle lower jaw displays a cut mark related to skinning the carcass. Six cut marks associated with meat removal were found on the cattle bones, three of which were observed on the ribs. A cut mark on another rib indicates that it was cut to fit a small container ('pot-sizing'). Light-weight knives were used to disarticulate the caprine foot bones and remove the horn sheathes from the cranium.

Five bone fragments display the 'spiral' fracture outline typical of the breakage of fresh bones, which was aimed at obtaining the marrow. No burned bones that could indicate roasting by direct exposure to open fire were found. Five bones indicate a medium degree of weathering (>Stage 2).

The Ottoman Period

The Ottoman-period assemblage consists of 66 bones, teeth and horns. Chickens are the most common species (30%), followed by cattle and caprines, represented in equal proportions (c. 29%), equids (5%), dogs (5%) and a camel (3%).

The distribution of skeletal elements indicates that both consumption and butchery waste are present. The cattle epiphyses show that one individual was slaughtered before the age of three, and another over the age of four (Table 4). Two worn teeth, M2 (Grant's Stage H) and M3 (Grant's Stage K), belonged to mature animals. Although the sample is small, the results indicate that some of the cattle were kept for their milk and/or to serve as beasts of burden, and others were slaughtered for their meat when still young.

Element	Fused	Unfused
Distal humerus	1	
Phalanx 2	1	
Second year	2	
Distal metacarpal	1	
D. metatarsal	1	
Calcaneus		1
Third year	2	1
Distal Radius	1	
Fourth year	1	
Grand Total	5	1

Table 4. Epiphyseal Fusion Data for Cattle

The mortality data for caprines include an unfused proximal humerus (<4 years) and the remains of a single fetus (L805, B8031)—two humeri, two radiae, a tibia and a femur. In addition, a jaw with milk teeth (dp3, dp4; Grant's Stage C) belongs to a very young individual (<1 year). The presence of young animals indicates that the herds were raised, and probably consumed locally. This is in accordance with the high proportion of chicken, a domestic animal traditionally raised among self-sufficient agrarian societies (Redding 2015:353). The presence of male chickens in the assemblage is indicated by the finding of spurs. The assemblage also contains two worn horse teeth, a fused equid metatarsal and a fused camel phalanx, all of mature animals.

Bone Surface Modifications. Butchery marks were identified on 13 bones, including those of cattle, caprines and a camel (Table 3). They attest to the removal of the head and horns, skinning, disarticulation of the limbs and foot bones, the removal of meat and 'pot-sizing' of the ribs. Of special interest is a cut mark on an equid bone that attests to skinning.

Intentional breakage of fresh bones was attested on three out of 26 bone fragments. Evidence of weathering was limited to one bone (>Stage 2), indicating a rapid burial process. No evidence of predator impact was found.

DISCUSSION

The faunal assemblages from all the periods at Yehud comprised mainly the remains of sheep, goats and cattle. A few remains of gazelles, a game animal, were found in the Chalcolithic-period shafts. A few chicken remains were found in Byzantine-period contexts, while in the Ottoman period, chickens were the most abundant species. The generally high proportions of cattle indicate that the assemblages may be biased to some extent in favor of the bones of large animals, due to the manual collection of the bones in the field. This bias also implies that the bones of small animals, including chicken, are underrepresented in the assemblages (see Payne 1972; 1975; Shaffer 1992).

Scant remains of equids and a camel were found in all the assemblages from the Roman period onward; the single camel phalanx retrieved from a Chalcolithic context is most probably a later intrusion. The evidence of skinning of a horse in the Ottoman period is noteworthy.

Pig remains are absent in both the Roman- and Byzantine-period assemblages, although only the later assemblage, given its larger sample size, provides convincing evidence for the ethnic identity of the inhabitants of the site. The presence of a Jewish population at Yehud in the Byzantine period may be reinforced by the absence of butchery marks on the hind limbs of caprines, which could be related to the religious practice of 'muscle stripping', associated with the removal of the sciatic nerve (*nikur*) (Cope 2004). The recent discovery of an assemblage of cattle forelimbs at Bet She'an–Nysa Scythopolis (Har'el 2015) attests to the importance of the *nikur* custom in the Jewish butchery practices of the Byzantine period (cf. Greenfield and Bouchnik 2011).

An interesting question is whether cattle-raising was practiced by the inhabitants of the Ottoman-period settlement of Yehud, el-'Abasiyyah/el-Yehudiyyah, as reported in a historical source of that time (Khalidi 1992:233–235). Whilst the cattle remains from the Ottoman period indicate local butchering and consumption, the small sample size precludes the reconstruction of a demographic profile of the herds, and hence, it cannot be concluded whether the animals were indeed raised by the local inhabitants.

Part	Element		Caprines			Cattle	
		NISP	MNE	MAU	NISP	MNE	MAU
(a) Byzantine	Period						
Head	Horn	2	2	1			
	Skull				1	1	1
	Maxilla	1	1	1			
	Mandible (without teeth)				6	3	2
	Total	3	3	1	7	4	2
Trunk	Atlas						
	Axis						
	Cervical vertebrae						
	Thoracic vertebrae						
	Lumbar vertebrae				1	1	1
	Sacrum						
	Ribs	3	3	1	28	20	1
	Pelvis	1	1	1			
	Total	4	4	1	29	21	1

APPENDIX 1. Skeletal Element Representation of Caprines and Cattleⁱ

ⁱ Remains of medium- and large-sized mammals were included with those of caprines and cattle, respectively.

Part	Element		Caprine	S		Cattle	
		NISP	MNE	MAU	NISP	MNE	MAU
Forelimb	Scapula	1	1	1	3	3	2
	Humerus	1	1	1	1	1	1
	Radius	1	1	1	2	1	1
	Total	3	3	1	6	5	2
Hind limb	Femur	1	1	1	1	1	1
	Tibia	5	3	2	1	1	1
	Total	6	4	2	2	2	1
Feet	Metacarpal	1	1	1	3	2	1
	Metatarsal	1	1	1	4	4	2
	Astragalus				1	1	1
	Phalanx 1	1	1	1			
	Phalanx 2						
	Phalanx 3						
	Total	3	3	1	8	7	2
(b) Ottoman	Period						
Head	Horn	1	1	1			
	Skull				1	1	1
	Mandible (without teeth)	3	2	1	2	2	1
	Total	4	3	1	3	3	1
Trunk	Axis	1	1	1			
	Thoracic vertebrae	1	1	1	1	1	1
	Ribs	2	2	1	6	1	1
	Total	4	4	1	7	2	1
Forelimb	Humerus	4	4	2	1	1	1
	Radius	2	2	1	1	1	1
	Total	6	6	2	2	2	1
Hind limb	Femur	1	1	1	1	1	1
	Tibia	1	1	1	1	1	1
	Total	2	2	1	2	2	1
Feet	Metacarpal				1	1	1
	Metatarsal				1	1	1
	Astragalus				2	2	1
	Phalanx 2				1	1	1
	Total				5	5	1

APPENDIX 1. (cont.)

NUHA AGHA

Bone	Species	Locus	Period		Meas	surements (in mm) ⁱ	
				Glpe/GL	Вр	SD	Bd	Dd
Metatarsal	Cattle	9	Late Chalcolithic				53.44	
Metatarsal	Cattle	215	Byzantine		49.51			
Metatarsal	Cattle	265	Ottoman				50.73	
Metatarsal	Sheep/ Goat	246	Late Roman		25.73			
Metatarsal	Sheep/ Goat	224	Ottoman		23.34			
Metatarsal	Equid	76	Byzantine	219.37	36.00	22.00	31.63	25.99
Metacarpal	Cattle	81	Byzantine		45.66			
Metacarpal	Cattle	244	Late Roman		52.22			
Metacarpal	Cattle	239	Ottoman				54.02	
Metacarpal	Sheep/ Goat	247	Late Roman		29.24			
Metacarpal	Horse?	72	Byzantine	173.75	36.44	24.00	33.75	24.17
Metacarpal	Horse?	80	Byzantine	180.11	35.16	23.50	32.27	25.11
Metacarpal	Horse?	221	Byzantine				36.59	
Femur	Dog	212	Byzantine				30.85	
Tibia	Sheep	19	Byzantine				33.22	24.60
1st phalanx	Cattle	235	Late Roman	66.02	27.42	24.77	26.86	
1st phalanx	Cattle	279	Roman- Byzantine	63.90	29.23	24.7	25.01	
1st phalanx	Sheep	130	Byzantine				14.01	
1st phalanx	Donkey	79	Byzantine	65.27	30.51	21.06	34.10	
1st phalanx	Donkey	206	Byzantine	74.30	37.64	24.03	33.10	
1st phalanx	Horse?	257	Byzantine	71.52	41.77	25.82	43.13	

APPENDIX 2. Bone Measurements (after Driesch 1976)

ⁱ Bp = breadth of proximal end; SD = smallest breadth of diaphysis in the middle of the diaphysis; Bd = breadth of distal end; Dd = distal depth; GL = greatest length; GLpe = greatest length of peripheral half.

Element	Sheep/Goat	Goat	Cattle	Pig	Camel	Gazelle	LM ⁱ	MM ⁱⁱ	
(a) <i>Late Chalcolithic</i>									
Humerus				2				1	
Mandible			1			1			
Mandible (M3)			1						
Mandible (M2–M3)						1			
Maxilla	3		2						
Maxilla (M)			1						
Maxilla (M1/2)	1								
Maxilla (M3)	2								
Maxilla (P3)			1						
Metacarpal	1			1					
Metatarsal			1				1	1	
Metapodial		1	1						
Pelvis						1			
Phalanges			2		1				
Phalanx 1			1		1				
Phalanx 2			1						
Radius				1			1	1	
Rib							1	3	
Scapula			1	2			2		
Skull		1				1			
Horncore		1				1			
Tarsals			2						
Astragalus			1						
Central 4th			1						
Vertebrae			1				2	1	
Cervical							2		
Thoracic			1						
Unidentified								1	
Total (NISP = 41)	4	2	11	6	1	3	7	7	
(b) Late Roman									
Femur				1					
Humerus				1					
Mandible	2	2	1						
Mandible body		2							
Mandible (M3)			1						
Mandible (M1–M3)	2								
Metacarpal	1	1							
Metatarsal	1	1		1					
Phalanges		1							
Phalanx 1		1							

APPENDIX 3. List of all Identified Fragments Presented by Taxon, Element and Period

ⁱ LM = large-sized mammal.

ⁱⁱ MM = medium-sized mammal.

Appendix	3.	(cont.)
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Element	Sheep/Goat	Goat	Cattle	Pig	Camel	Gazelle	LM ⁱ	MM ⁱⁱ		
Phalanx 2										
Radius	1	1								
Rib				1	2					
Scapula		1			1					
Tarsals		1								
Calcaneus		1								
Ulna	1									
Vertebrae			3							
Cervical			3							
Total (NISP = 25)	6	8	4	4	3					
c) Roman–Byzantine										
Femur			2							
Humerus						1				
Mandible			1	1						
Mandible body			1							
Mandible (P2–M3)				1						
Maxilla	1			1						
Maxilla (M)				1						
Maxilla (M1/2)	1									
Metacarpus	1		1							
Metatarsus				1						
Metapodial				1						
Pelvis			1							
Phalanges			1							
Phalanx 1			1							
Radius			1			1				
Rib							1			
Scapula			1							
Skull		1			1					
Frontal and parietal					1					
Horncore		1								
Tarsals				1						
Astragalus				1						
Tibia				1						
Total (NISP = 21)	2	1	8	6	1	2	1			
(d) Byzantine										
Femur	1			1			1	1		
Humerus	1								1	
Mandible				4	1	2				
Mandible-body				4	1				2	
Mandible (M1–M3)						2				
Maxilla	1				1					

Element	Sheep/Goat	Goat	Cattle	Pig	Camel	Gazelle	LM ⁱ	MM ⁱⁱ		
Maxilla (M)					1					
Maxilla (M3)	1									
Metacarpal	1			1	4				2	
Metatarsal	1			4	1					
Pelvis	1									
Phalanges		1			3					
Phalanx 1		1			3					
Radius	1			1					1	
Rib									28	3
Skull		1	1	1	2					
Frontal				1						
Horn		1	1							
Petrosum					1					
Tarsal				1						
Astragalus				1						
Tibia	2	1							1	2
Tibiotarsus								2		
Ulna				1						
Vertebrae				1					2	
Lumbar				1						
Unidentified									2	
Total (NISP = 92)	9	3	1	18	12	2	1	3	37	6
(e) Ottoman	1								1	
Femur	1		1			1	4			
Humerus	4		1				2			
Mandible	2	1	2							
Mandible body	2									
Mandible (M1/M2)			1							
Mandible (dp3–M1)		1								
Mandible (M2/M3)			1							
Maxilla				2						
Maxilla (M)				2						
Metacarpal			1							
Metatarsal	2		1	1					1	
Pelvis						1	1			
Phalanges			1		1					
Phalanx 1					1					
Phalanx 2			1							
Radius	2		1				1			
Rib	2		5		1			1		
Skull		1	1				1			
Horn		1								

APPENDIX 3. (cont.)

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Element	Sheep/Goat	Goat	Cattle	Pig	Camel	Gazelle	LM ⁱ	MM ⁱⁱ		
Occipital condyle			1							
Skull (complete)							1			
Sternum							1			
Tarsal			2							
Calcaneus			2							
Tarsometatarsus							2			
Tibia	1		1							
Tibiotarsus							5			
Ulna							1			
Vertebrae	2		1			1	1	1		
Axis	1									
Lumbar						1				
Sacrum							1			
Thoracic	1		1							
Unidentified								1		
Total (NISP = 66)	16	2	18	3	2	3	19	2	1	

Appendix 3. (cont.)

Taxon ⁱ	Period	Locus	Element	Location	Function	Tool
Cattle	Late	324	Metatarsal	Distal shaft	Skinning	Knife
Goat	Chalcolithic	337	Metapodial	Distal shaft	Skinning	Knife
LM ⁱ		334	Metatarsal	Middle shaft	?	Knife
Cattle	Late Roman	722	Scapula	Posterior scapula blade	Meat removel	Knife
Cattle		739	Radius	Proximal, medial	Disarticulation	Knife
Caprine		748	Metatarsal	Proximal, lateral	Disarticulation	Knife
Caprine		616	Radius	Middle shaft	Meat removel	Knife
Cattle	Byzantine	235	Mandible	Dentary, lateral	Skinning	Knife
Cattle		810	Metatarsal	Proximal, lateral and distal shaft	Disarticulation	Knife and chopper
Cattle		810	Metatarsal	Proximal, lateral and distal shaft	Disarticulation	Knife and chopper
Cattle		810	Metatarsal	Proximal, lateral and distal shaft	Disarticulation	Knife and chopper
Cattle		810	Radius	Middle shaft, caudal	Meat removal	Knife
Cattle		733	Metacarpal	Distal shaft	Disarticulation	Chopper
Cattle		207	Scapula	Posterior scapula blade	Meat removal	Knife
Cattle		733	Metatarsal	Distal shaft	Disarticulation	Chopper
Caprine		801	Metatarsal	Proximal, lateral	Disarticulation	Knife
Caprine		707	Metacarpal	Proximal, lateral	Disarticulation	Knife
Caprine		718	Femur	Proximal shaft	Disarticulation	Knife
Sheep		235	Horn	Horncore base	Horn sheath removal	Knife
Goat		751	Horn	Horncore base	Horn sheath removal	Knife
LM		235	Tibia	Distal shaft	Meat removal	Chopper
LM		718	Rib	Shaft	Meat removal	Knife
LM		718	Rib	Shaft	Meat removal	Knife
LM		718	Rib	Shaft	Pot-sizing	Chopper
LM		819	Rib	Shaft	Meat removal	Knife
Cattle	Ottoman	805	Phalanx	Shaft, plantar	Skinning	Knife
Cattle		805	Rib	Shaft	Meat removal	Knife
Cattle		805	Rib	Shaft	Pot-sizing	Chopper
Cattle		805	Rib	Shaft	Meat removal	Knife
Cattle		805	Rib	Shaft	Meat removal	Knife
Caprine		805	Rib	Shaft	Meat removal	Knife
Caprine		805	Vertebrae	Axis	Slaughter	Knife
Caprine		805	Rib	Shaft	Meat removal	Knife
Caprine		825	Humerus	Proximal, lateral	Disarticulation	Knife
Caprine		825	Humerus	Proximal, lateral	Disarticulation	Knife
Goat		257	Horn	Horncore base	Horn sheath removal	Knife
LM		241	Rib	Shaft	Pot-sizing	Chopper
Camel		805	Rib	Shaft	Meat removal	Knife
Equid		257	Metatarsal	Distal shaft	Skinning?	Knife

APPENDIX 4. Butchery Marks: Location and Affecting Tool Function

ⁱ LM = Large mammal.

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