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Butchers' Waste: Zooarchaeological Analysis of a Crusader/Ayyubid Bone Deposit from Jerusalem Street, Safed (Ẓefaṭ)

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Introduction

Animal remains from archaeological sites provide significant information about the development and complexity of urban societies. The species-composition of faunal assemblages indicates what animals were used and the relative importance of each species in the diet. The completeness of the skeletal elements offers further insights into food preparation and eating habits, as well as to the quality of meat cuts used (Klein and Cruz-Uribe 1984; Hesse and Wapnish 1985; Davis 1987; Reitz and Wing 1999). The nature of bone modifications can indicate butchering practices, as well as site formation processes (Lyman 1994). In urban settlements, domesticates may provide not only food, but also raw material for craftsmen. Thus, archaeozoological studies expand our knowledge of urban lifeways and provide valuable information pertaining to methods of food production, trade and markets (Crabtree 1990; Zeder 1991; Bartosiewicz 1995; O'Connor 2003; see also Serjeantson and Waldron 1989 and papers therein).

Faunal remains are recovered from the majority of archaeological sites in Israel; yet, to date much of the archaeozoological research concentrated on pre- and proto-historic periods, while faunal reports of later periods, in particular from the Crusader period onward, are extremely rare. It is only in recent years that the value of faunal analysis for later periods has been recognized (see review in Horwitz 2002).

This paper presents the analysis of a small faunal assemblage collected during a salvage excavation on Jerusalem Street, Safed, in 2005 (see Barbé, this volume).[2] The assemblage comes from strata that date to the second half of the twelfth–thirteenth centuries CE, and one Ottoman-period locus. All the faunal material was collected by hand picking through the excavated deposits.

The complete research protocol and dataset for each of the identified archaeozoological specimens are stored in the Israel Antiquity Authority's Archives, or may be obtained from the authors. The goal of the paper is to present a summary analysis of the faunal remains that were collected and to describe the taxonomic representation of the predominant livestock species. The analysis focused on taphonomy, in order to discern patterns of bones deposition and site formation processes. Following the description of the fauna, the data are compared with contemporaneous faunal assemblages in Safed and northern Israel (Table 1).

Faunal Analysis Procedures

All the animal bones that arrived at the laboratory were examined and documented.

Cleaning and Recording

All animal bones from stratified loci were immersed in diluted acetic acid (5%) for approximately one hour to remove calcrete deposits. Each excavation unit was treated separately. Subsequently, the bones were rinsed in fresh water and dried slowly. This procedure enabled the detection of a range of taphonomic modifications on the surface of the bones, including butchery marks, burning and signs

Table 1. Relative Frequencies of Taxa in Post-Byzantine Sites from Northern Israel (arranged chronologically)

Site	Period	Total Counts	Sheep	Goat	Sheep/ Goat	Cattle	Ass/ Horse	Pig	Dog	References
Caesarea, Area CC (Cemetery)	Early Islamic	258	-	-	103	47	14	92	2	Cope 1999
Caesarea, Area I6	Islamic	537	-	-	265	112	40	118	2	Cope 1999
Bet She'an	Umyyad (2nd half of 7th c.)	-	-	-	28%	10%	1%	15%	-	Manor, Rabinovich and Horwitz 1996
Bet She'an	Abassid and Fatimid (post 749)	-	-	-	30%	20%	5%	3%	1%	Manor, Rabinovich and Horwitz 1996
Caesarea, Area I4	Islamic–Crusader	374	-	-	142	80	42	110	-	Cope 1999
'Akko-Amal	Crusader (12th c.)	28	2	1	17	6	0	2	-	Raban-Gerstel, Tepper and Bar-Oz, forthcoming
Bet She'an 3537/0	Crusader (12th–mid 13th c.)	32	1	1	14	11	4	1	-	Raban-Gerstel, Bar-Oz and Tepper, forthcoming
Safed, Jerusalem St.	Crusader/Ayyubid (mid-12th–13th c.)	85	12	12	50	8	2	1	1	Bar-Oz and Raban-Gerstel, this volume
Bet She'an 3537/0	Mamluk (13th–14th c.)	258	3	6	58	35	23	1	79	Raban-Gerstel, Bar-Oz and Tepper, forthcoming
Safed, al-Waṭa	Mamluk (14th–15th c.)	1208	99	35	997	40	37	-	-	Bar-Oz and Raban-Gerstel, forthcoming
Nazareth, Mary's Well	Mamluk (14th–15th c.)	116	-	2	10	3	5	1	95	Raban-Gerstel and Bar-Oz 2012
Nazareth, Shihab ad-Din	Crusader–Mamluk	64	1	3	24	18	13	5	-	Raban-Gerstel, Bar-Oz and Tepper 2011
Bet She'an	Mamluk	-	-	-	12%	18%	32%	25%	-	Manor, Rabinovich and Horwitz 1996
Ḥ. Sumaq	Medieval	214	-	-	138	47	12	17	-	Horwitz, Tchernov and Dar 1990
Safed, Jerusalem St.	Ottoman (late 19th/early 20th c.)	22	1	1	14	-	5	1	-	Bar-Oz and Raban-Gerstel, this volume
Nazareth, Shihab ad-Din	Ottoman (early 19th c.)	335	9	4	174	61	61	12	14	Raban-Gerstel, Bar-Oz and Tepper 2011

of animal activities. All identified bones were recorded and coded in a standard Windows Excel (2000) worksheet.

Sorting, Labeling and Packing
Bones from each excavation unit were weighed, and then separated to identified and unidentified fragments. Unidentified bone fragments longer than 40 mm were counted. Selected skeletal elements, such as complete epiphyses and teeth, were separated from the rest of the assemblage and were then labeled and packed separately.

Taxonomic Identification
Bone remains were identified to bone elements and species using the comparative collection of the Laboratory of Archaeozoology, University of Haifa. When necessary, morphological markers aided in differentiating closely related species (e.g., Davis 1987: Fig. 1.8 for sheep and goat). Separation of sheep (*Ovis aries*) from goat (*Capra hircus*) was based on morphological criteria of selected bones (following Boessneck 1969 and Zeder and Lapham 2002). Sheep and goat skeletal elements that could not be identified to species were pooled into a sheep/goat category.

Measurements
Bone measurements followed the procedures outlined by von den Driesch (1976). Measurements, recorded to 0.1 mm, were made using a digital caliper (Sylvac model S225). Bones with fusion marks or porous epiphyses, indicating incomplete ossification, were not measured.

Quantification
The relative abundance of different taxa was quantified using NISP (number of identified specimens), MNE (minimum number of elements) and MNI (minimum number of individuals). These values were calculated using the assumptions described by Klein and Cruz-Uribe (1984) and Lyman (1994). NISP was used as a basic measure of taxonomic abundance (Grayson 1984).

Recording of Taphonomic Data
Recorded elements were inspected for macroscopic bone-surface modifications, such as butchery marks and signs of animal activity (i.e., rodent gnawing, carnivore punctures, and digestion; Lyman 1994). Butchery marks were divided into two basic groups: 'chop marks', which apparently resulted from the use of a heavy instrument such as a cleaver, and 'cut marks', which appear to have been caused by a knife. Cut marks were coded and interpreted according to Binford's descriptions of butchery techniques (Binford 1981), and were classified into three categories corresponding to three stages in the butchery sequence: removal of the skin; dismemberment of the carcass; and filleting of meat from the bones.

Burning
The state of burning was recorded for each of the identified elements. Two categories of burnt bone were recorded: (1) partially or completely carbonized, and (2) calcined.

The Faunal Assemblage

A small assemblage of 162 complete and fragmentary bones was retrieved. Of these, 98 bones were identified to species: NISP = 74, from the second half of the twelfth century and the early thirteenth century CE strata, and NISP = 24, from the Ottoman stratum. The distribution of the identified and non-identified bone remains that were retrieved are detailed in Table 2, organized according to the chronological phases that were defined by the excavator (see Barbé, this volume), and within each phase according to locus and basket.

The faunal remains comprise predominantly domesticated livestock. The distribution of animal bones by species in the two occupation periods is given in Table 3. Figure 1 presents the distribution of the faunal remains from the twelfth–thirteenth-century strata by species. The most frequent species are sheep and goat with a considerably smaller number of domestic fowl (*Gallus gallus*) and cattle (*Bos taurus*). On

Table 2. Distribution of Identified and Non-Identified Bone Remains Retrieved from Jerusalem Street, Safed, according to Chronology, Locus and Basket

Period	Phase	Locus	Basket	No. of Identified Bones	No. of Unidentified Bones	Total No. of Bones per Period	Weight (g)
Mid-12th–13th c.	1	67	146	7	6		82.4
	2	32	118	2	4		42.9
	2	65	144	14	8		305.5
	2	68	126	7	3		53.8
	2	68	147	3	4		107.0
	3	41	124	7	7		238.1
	3	59	136	21	10		221.2
	4	37	120–2	13	6		351.5
	-	64	142	7	4	123	135.0
Ottoman		45	138	17	12	39	379.9
Total				*98*	*64*	*162*	*1917.3*

the basis of bones that showed taxonomically distinctive features, sheep (*Ovis aries*) and goat (*Capra hircus*) are represented in the assemblages in more-or-less equal proportions. Other species include an equid, represented by two bones (first phalanx and metapod condyle), a pig (*Sus* sp.), represented by a distal humerus, and a dog (*Canis* sp.), represented by a thoracic vertebra. In addition, a single shell fragment (*carpace*) of a tortoise (*Testudo graeca*) and two fish head-fragments were identified.

The small Ottoman assemblage comprises mainly sheep and goat. It also contains five bones of an equid, a single mandible tooth of a pig, two fowl bones (a vertebra and a distal femur) and two fish bone-fragments. The equid remains in both layers appear to be too small for a horse, and most probably represent the domestic ass (*Equus asinus*), a common labor and transport animal in many historic sites in Israel (e.g., Wapnish and Hesse 1991). Measurements of the skeletal elements are listed in Appendix 1.

The presence of porous and low-density bones, and of bird bones, attests to the good state of bone preservation. It seems reasonable to assume that losses of bones due to post-depositional processes were minor.

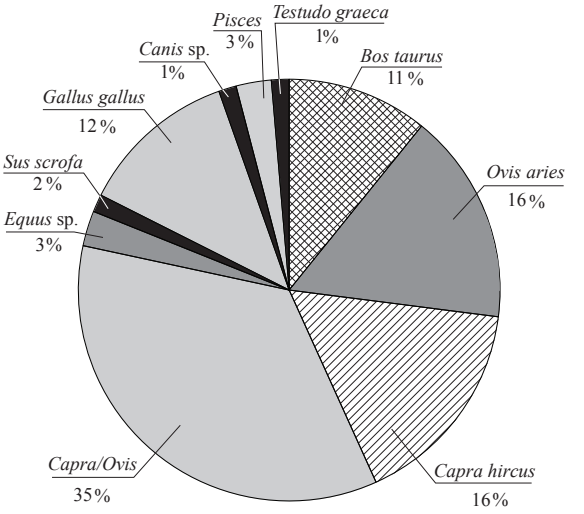

Fig. 1. Distribution of animal remains from the twelfth and the thirteenth centuries CE.

We found several bone-surface modifications that provide some information regarding the depositional history of the bone assemblages. Butchery marks demonstrate that many of the remains represent food refuse, while carnivore gnawing- and tooth-marks indicate that some of the remains were discarded by dogs.

Table 3. Number of Identified Specimens (NISP), Minimum Number of Elements (MNE) and Minimum Number of Individuals (MNI) of Each Taxon Represented in the Mid-Twelfth and Thirteenth Centuries CE Strata (A) and Ottoman Strata (B)

Species / Bones	*Bos taurus*		*Ovis aries*		*Capra hircus*		*Capra/Ovis*		*Equus sp.*		*Sus scrofa*		*Canis sp.*		*Gallus gallus*		*Pisces*		*Testudo graeca*	
	NISP	MNE	NISP	MNE	NISP	MNE	NISP	MNE	NISP	MNE	NISP	MNE	NISP	MNE	NISP	MNE	NISP	MNE	NISP	MNE
Head																	2	2		
Occipital			1	1																
Petrosum							2	2												
Mandible Ramus							1	1												
Mandible Teeth							4	2												
Maxilla Teeth							2	1												
Body																			1	1
Atlas			1	1																
Ver: Cervical	1	1																		
Ver: Thoracic													1	1						
Ver: Lumbar							4	2												
Rib frag.							3	2												
Sternum															1	1				
Forelimb																				
Scapula Glenoid Fossa			1	1			1	1												
Humerus Shaft															3	2				
Humerus Distal			1	1			1	1			1	1			2	2				
Ulna Proximal							1	1												
Radius Proximal			1	1																
Metacarpus Complete			1	1																
Metacarpus Proximal	1	1			2	2														

Table 3. (cont.)

Species / Bones	*Bos taurus*		*Ovis aries*		*Capra hircus*		*Capra/Ovis*		*Equus sp.*		*Sus scrofa*		*Canis sp.*		*Gallus gallus*		*Pisces*		*Testudo graeca*		
	NISP	MNE	NISP	MNE	NISP	MNE	NISP	MNE	NISP	MNE	NISP	MNE	NISP	MNE	NISP	MNE	NISP	MNE	NISP	MNE	
Hindlimb																					
Pelvic acetabulum							1	1													
Femur Proximal							1	1													
Femur Complete															1	1					
Tibia Proximal	1	1	2	2																	
Tibio-Tarsus Shaft															1	1					
Astragalus			1	1	1	1															
Calcaneus	2	2			1	1	1	1													
Metatarsus Proximal					1	1	2	2													
Metatarsal IV																					
Tarsus-Metatarsus															1	1					
Toes																					
Phalanx 1	2	2	1	1	7	6			1	1											
Phalanx 2			2	2																	
Metapod cond.	1	1					2	2	1	1											
NISP	8		12		12		26		2		1		1		9		2		1		74
%NISP	10.81%		16.22%		16.22%		35.14%		2.70%		1.35%		1.35%		12.16%		2.70%		1.35%		100%
MNI	1		2		2		1		1		1		1		2		1		1		13

Carnivore chewing-marks and teeth punctures were observed on the surface of six bones from the twelfth–thirteenth-centuries strata and three Ottoman-period bones. Butchery marks were found on fourteen bones from the twelfth and thirteenth centuries strata. These include eleven sheep and goat and two cattle bones, as well as a single cut mark on an equid metapodial. The cut mark on the equid bone relates to skinning, and thus, although the possibility that equids were eaten cannot be ruled out, appears to indicate a different treatment and manner of disposal than that of common food animals. The Ottoman assemblage includes three bones with butchery marks; all belong to sheep and goat. These marks preserve evidence for all stages of carcass processing, including decapitation, hanging the carcass, dismembering the animal, and filleting the meat from the bones (Table 4).

Further bone modifications indicate the significance of butchery practices in the formation of the assemblages. Of the fourteen bones with butchery marks that were found in the assemblage of the twelfth–thirteenth centuries, ten had been chopped. Chopped bones were identified by clean cuts through the bone. The most common chopping pattern was found on five vertebrae (four sheep and goat, and one cattle) that were cut dorso-ventrally in half along the mid-line of the body (Fig. 2). In addition, two distal humeri (sheep/goat and pig), a single acetabulum of sheep/goat, a single first phalanx and a proximal tibia of a sheep were chopped, most probably with a cleaver. Two bones from the Ottoman layer were also chopped (a proximal radius of an ass and an acetabulum of a sheep/goat). Chopping facilitates rapid and systematic disarticulation of carcasses, and the high frequency of chopped bones, resembles modern industrial butchery techniques. Intriguingly, none of the bones from either period had signs of burning.

The bone assemblage is too small to allow detailed analysis of anatomical representation or age-related patterns. Yet, given the importance of this particular site and the nature of the deposits, some analyses were undertaken. We grouped the elements into meat refuse (long bones, scapulae and pelves) and butchery waste (hooves, lower limbs, heads and necks). It appears that the occurrence of sheep and goat skeletal elements represents a mixture of both types of refuse, and there is no preference for either meaty or less meaty elements (skull, lower limbs and hoof). The anatomical representation is interpreted, therefore, as reflecting the disposal of complete butchered carcasses. It is probable that such refuse accumulation was created by specialized butchers prior to the distribution of meat cuts.

The absence of unfused long bones or deciduous teeth of sheep and goat indicates that animals were slaughtered after they reached maturity. This pattern suggests a husbandry system that placed a high value on products obtained from living animals, such as milk and wool.

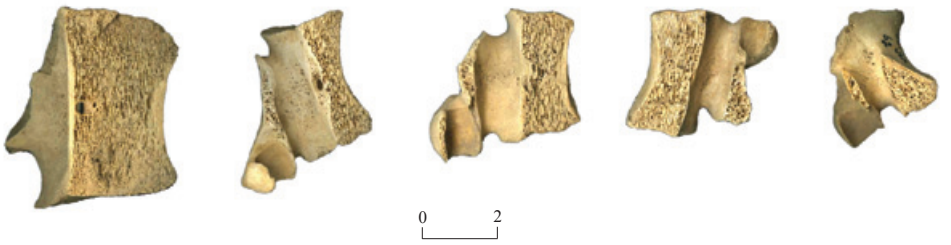

Fig. 2. Chopped vertebrae of sheep and goat from the twelfth and thirteenth centuries CE strata.

Table 4. Distribution of Butchery Marks, according to Period, Species, Bone, Cut-Mark Typology (following Binford 1981) and Butchery Activity

Species / Bones	*Ovis aries*		*Capra hircus*		*Capra/Ovis*		*Equus assinus*		*Sus scrofa*		*Gallus gallus*		*Pisces*	
	NISP	MNE	NISP	MNE	NISP	MNE	NISP	MNE	NISP	MNE	NISP	MNE	NISP	MNE
Head														
Mandible Teeth									1	1				
Maxilla Teeth					1	1								
Body														
Rib frag.					2	2								
Vertebrae											1	1		
Forelimb														
Scapula Glenoid Fossa			1	1										
Humerus Distal	1	1												
Ulna Proximal					1	1	1	1						
Radius Proximal							1	1						
Radius Complete							1	1						
Metacarpus Proximal					1	1								
Hindlimb														
Pelvic acetabulum					2	2								
Femur Distal											1	1		
Tibia Proximal							1	1						
Metatarsus Proximal					2	2								
Calcaneus					1	1								
Toes														
Phalanx 1							1	1						
Phalanx 2					1	1								
Phalanx 3					1	1								
NISP	*1*		*1*		*12*		*5*		*1*		*2*		*2*	24
%NISP	*4.2%*		*4.2%*		*50.0%*		*20.8%*		*4.2%*		*8.3%*		*8.3%*	100%
MNI	*1*		*1*		*2*		*2*		*1*		*1*		*1*	9

Conclusions

The faunal remains at the site reveal that the subsistence strategies relied heavily on domesticates (livestock and fowl). The taxa found were primarily food resources, but include also species that live in association with human habitation (dog and tortoise). The majority of the faunal remains are of sheep and goat, species that formed the basis for the regional animal-economies (Table 1).

The excellent bone preservation may suggest that bone refuse was buried regularly. However, gnawing marks on some bones suggest that dogs had some access to refuse or that garbage occasionally remained on the surface for prolonged periods.

The absence of young sheep and goat reflects a pattern of slaughtering mature individuals that conforms well to exploitation of secondary products, with milk and wool production playing a significant role in the economy (Davis 1987). Animal economy based on large herds of sheep and goats, exploited primarily for milk or wool and to a lesser extent for meat, is the "traditional middle eastern subsistence pattern" (Horwitz, Tchernov and Dar 1990).

The anatomical representation of sheep/goat skeletal elements seems to indicate a context of a butcher's shop that functioned also as an abattoir. It appears that much of the butchery was done on the spot before its distribution for sale in the city. Large proportions of dorso-ventrally chopped vertebrae indicate that sheep and goat carcasses were cut lengthwise into sides of meat. Thus, it appears that butchery practices of sheep and goat carcasses in thirteenth-century Safed were similar to the ones employed today. Butchering a whole carcass into two sides requires hanging it by the hind limbs on a stand and then chopping it down the mid-line from tail to head. Furthermore, the filleting marks indicate that meat removal was also carried out in the butcher's shop. Absence of burnt bones, which typically result from exposure of bones to flame during food preparation and cooking, further attests to the excavated refuse being principally the leftovers of butchery deposits.

The previous conclusion is further supported by the total number of butchery modifications. A combined total of more than 38% of the identified bones from the twelfth and thirteenth centuries assemblages bore evidence of knife cutting and chopping. Such a preponderance of butchered bones characterizes the remains of large industrial butchery waste areas. Disarticulation and chopping was the most common practice of preparing carcasses in urban sites. The high frequency of chopped bones resembles other medieval urban industrial butchery sites (Maltby 1989; Bartosiewicz 1995). Such a pattern most likely resulted from frequent use of cleavers for rapid disarticulation and meat removal. This may explain why animal remains from urban contexts are usually heavily butchered and the carcasses tend to be dismembered in a consistent manner. The phenomenon most probably reflects an intensive and systematic approach to carcass subdivision (see also Cope 1999; O'Connor 2003), as is still the practice today.

Notes

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[2] We thank Hervé Barbé for inviting us to study the bone assemblage; Eyal Dan, for his help in washing and sorting the remains; and Nimrod Marom and Danny Kaufman, for their comments on an earlier draft of the paper.

APPENDIX 1: Measurements (in mm) of Sheep, Goat and Cattle Bones, according to Species and Element; Measurements are Based on von den Driesch 1976 (see this reference for Key to Measurements).

Cat. No.	Period	Bone	Element						
			Bp						
10	Crusader–Ayyubid	Metacarpal	48.34						
			Bp	Gl	Bd	SD			
52	Crusader–Ayyubid	Phalanx 1	31.11	64.66	30.19	24.34			
72	Crusader–Ayyubid	Phalanx 1	25.38	50.79	22.74	19.9			
			Gli	GLm	Bd	Di	Dm		
15	Crusader–Ayyubid	Astragalus	31.37	29.37	19.63	16.24	18.28		
16	Crusader–Ayyubid	Astragalus	29.42	27.2	17.82	16.95	16.83		
			Bp	Gl	Bd	SD			
24	Crusader–Ayyubid	Metacarpal	23.3	110.5	26.94	13.87			
69	Crusader–Ayyubid	Metacarpal	26.14						
68	Crusader–Ayyubid	Metatarsal	21.26						
73	Crusader–Ayyubid	Metatarsal	20.48						
			Bp	Gl	Bd	SD			
32	Crusader–Ayyubid	Phalanx 1	12.21	33.68	11.4	10.16			
33	Crusader–Ayyubid	Phalanx 1	11.92	32.45	11.04	9.92			
66	Crusader–Ayyubid	Phalanx 1	13.79		13.92	12.08			
34	Crusader–Ayyubid	Phalanx 2	16.15	25.11	13.16	11.82			
35	Crusader–Ayyubid	Phalanx 2	12.16	20.06	9.78	9.73			
			DLS						
94	Ottoman	Phalanx 3	28.88						
			LG	GLP	BG	SLC			
26	Crusader–Ayyubid	Scapula	24.97	31.85		17.48			
54	Crusader–Ayyubid	Scapula	28.44	35.53	22.55				
85	Ottoman	Scapula	32.03	37.62	24.07	26.13			
			BT	Bd					
22	Crusader–Ayyubid	Humerus	27.73	28.99					
42	Ottoman	Humerus	33.84	30.94					
			L	B					
4	Crusader–Ayyubid	M3↑	20.02	6.95					
			Bd						
25	Crusader–Ayyubid	Radius	32.6						
			27	28	29	30			
27	Crusader–Ayyubid	Occipital	49.3	65.19	22.24	19.07			
			Bd						
9	Crusader–Ayyubid	Metapod	50.08						
			Bp	BFp	Dp	Gl	Bd	BFd	SD
8	Crusader–Ayyubid	Phalanx 1	49.15	46.27	36.52	84.01	43.17	40.18	30.95
84	Ottoman	Phalanx 1	34.17	31.64	23.84	64.51	29.59	29.41	22
			Bp	BFp					
87	Ottoman	Radius	67.87	59.34					

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