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The Bone and Horn Industry in Late Ottoman Nazareth: The Evidence from Shihab ad-Din

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Introduction

Animal bones recovered from excavations are a fundamental component of archaeology, providing an important source of knowledge about past diets and subsistence practices, social and economic variability and cultural decisions (e.g., Davis 1987:20–22; Hesse and Wapnish 1985:1–5; Crabtree 1990; Zeder 1991; O'Connor 2003:69–73). Furthermore, analysis of skeletal-part representation and butchery damage reveals significant information concerning which animals were exploited and how they were processed and consumed (Lyman 1994; Reitz and Wing 1999; O'Connor 2000). For example, after slaughter, an animal can be butchered by various methods and the dismembered parts of the carcass traded or transported to several locations, where they are utilized in different ways. Certain bones may be separated from the carcass during initial butchering and disposed of almost immediately. Other skeletal parts may be removed from the butcher's assemblage and consumed elsewhere before being destroyed or deposited in some dump or refuse pit. Alternately, some parts may end up being used in other ways, including in the manufacturing of bone products (Ayalon 2005; see also Choyke and Bartosiewicz 2001). However, it is only in rare cases that actual bone workshops are found. These can be identified by the occurrence of bone refuse and half-finished objects (Ciugudean 2001; Ayalon 2005). Significantly, the discovery of refuse from bone-tool manufacturing on site demonstrates that the bone artifacts were locally produced.

In this report, the faunal remains from the 2003 trial excavation next to the tomb of Shihab ad-Din in Nazareth are presented (see Tepper 2009).[1] The main stratum identified at the site dates to the Ottoman period and contains a well and remnants of a building that served as a boys' school, both dating from the early nineteenth century CE. The Ottoman layer lies above a thin Crusader/Mamluk stratum, which in turn seals the remains of a prehistoric layer dated to 100,000–45,000 BP. After describing the faunal remains retrieved from the Crusader/Mamluk and Ottoman strata (no bones were retrieved from the earliest stratum), a tentative explanation will be given for the abundance of waste and half-finished products found in the Ottoman bone assemblage, indicating bone tool manufacturing at the site.

As more zooarchaeological assemblages come to light from contexts postdating the Roman–Byzantine periods in Israel, and as methods of bone recovery improve, it is becoming clear that faunal remains are ubiquitous in many sites. However, the importance of such assemblages for reconstructing past patterns of subsistence has rarely been emphasized in the literature (Horwitz 2002; Raban-Gerstel and Bar-Oz, in prep.). The present paper will demonstrate that comprehensive analysis of such faunal assemblages can provide primary data on the diversity of animals exploited, as well as on patterns of butchery and consumption. Such studies can provide important information that eventually will enable us to evaluate issues of broader, social importance (see, for example, Bartosiewicz 1995; O'Connor 2003).

FAUNAL ANALYSIS PROCEDURES

All the bones were derived from non-sieved deposits. The collected specimens were identified to the level of bone element and species, using the comparative collections of the Laboratory of Archaeozoology, University of Haifa. Skeletal elements were identified to the closest possible taxonomic unit. Elements for which species identification is less reliable (i.e., ribs, vertebrae, skull fragments and diaphysis shaft fragments) were grouped with the closest species category. All bones were weighed by basket (Table 1). Distinction between sheep and goats is based on morphological criteria (Boessneck 1963). Sheep and goat skeletal elements that could not be identified to the species level were combined in a collective sheep/goat category. 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 (1984:24–36) and Lyman (1994:97–113). The proportional representation of skeletal elements (% MNE) was quantified in order to analyze patterns of butchery and meat processing.

All recorded elements were inspected for various macroscopic bone surface modifications, such as butchery marks and signs of animal activity (i.e., rodent gnawing, carnivore punctures, scoring and digestion; Lyman 1994:193–219) under a ×5 magnifying lamp. Butchery marks were classified in three categories in accordance with Binford (1981:87–181). The three groups indicate sequential stages in the butchery process: skin removal, dismemberment of the carcass and filleting of meat from the bones. Bone tools and sawn bones were carefully inspected and photographed. Finally, due to the small sample of animal bones, and even smaller number of teeth, age at death was analyzed on the basis of epiphyseal closure (Silver 1963).

Table 1. Distribution of the Identified and Non-Identified Bone Remains according to Chronology, Locus and Basket

Period	Locus	Basket	No. of Ident. Bones	No. of Unident. Bones	Weight (g)
Crusader/ Mamluk	133	1093	5	6	245
		1102	3	1	45
		1109	6	16	485
		1119	1	2	45
		1125	4	8	458
	135	1099	10	12	450
		1107	2	3	70
		1115	1	0	30
		1121	3	0	55
		1136	1	2	70
	136	1100	3	2	210
		1126	7	4	180
	137	1601	3	0	120
	138	1104	2	3	125
		1120	3	7	270
	140	1110	6	9	460
	146	1129	2	5	125
		1140	4	2	85
Total (148)			*66*	*82*	
Ottoman	118	1017	25	13	630
		1031	20	5	645
		1060	21	12	585
		1069	23	15	755
		1089	3	1	90
	119	1018	4	1	105
		1030	1	0	30
		1039	7	1	150
		1043	6	1	120
		1044	10	3	440
		1058	3	0	60
	120	1022	1	4	95
		1032	18	29	565
	121	1026	1	1	30
		1029	13	4	755
	125	1038	18	8	370
		1040	2	3	105
		1046	10	7	225

Table 1. (cont.)

Period	Locus	Basket	No. of Ident. Bones	No. of Unident. Bones	Weight (g)
		1061	8	2	125
		1062	10	5	215
		1063	1	0	5
	126	1045	10	14	395
		1059	24	16	250
		1068	15	14	390
		1090	15	3	395
	127	1047	9	10	940
		1057	16	8	425
		1087	8	4	205
	128	1067	6	8	155
		1074	12	11	745
	129	1071	6	4	210
		1122	4	5	110
		1127	5	4	140
	130	1073	2	2	75
		1088	13	5	585
Total (574)			*350*	*223*	
Total (722)			*416*	*305*	*14,648*

THE FAUNAL ASSEMBLAGE

Species Abundance, Skeletal Elements and Age Profiles

A total of 416 complete and fragmentary identified bones were retrieved from the Ottoman (NISP = 350) and Crusader/Mamluk (NISP = 66) strata at Shihab ad-Din. In addition, 305 unidentified bones (larger than 4 cm long) were counted from the various excavation loci. The distribution of both identified and unidentifiable bone remains retrieved are detailed chronologically in Table 1 according to locus and basket. Bone measurements of the animal remains are given in Appendix 1 (for a list of the abbreviations, see Appendix 2).

The faunal remains from Shihab ad-Din comprise predominantly domesticated livestock. Distribution of animal bones from the Ottoman and Crusader/Mamluk deposits are given in Tables 2 and 3 respectively and in Fig. 1. Differences in sample size of the Ottoman and Crusader/Mamluk deposits most probably account for the higher abundance of taxa in the Ottoman bone assemblage.

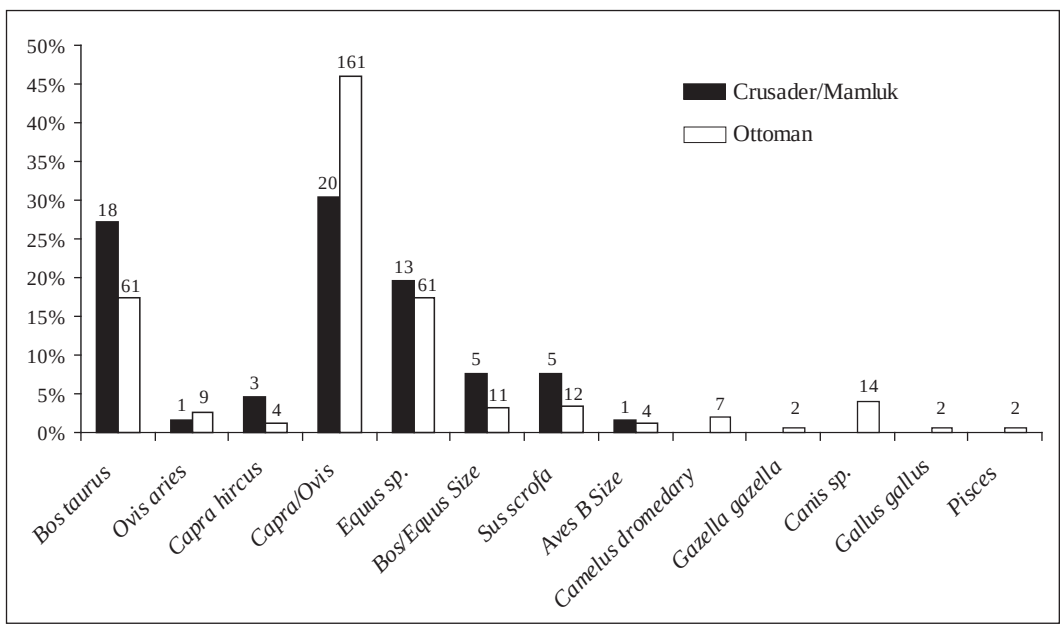

Fig. 1. Distribution of animal taxa from the two major occupation phases (Crusader/Mamluk and Ottoman periods) at Shihab ad-Din, Nazareth (NISP's are given for each column).

Table 2. Number of Identified Specimens (NISP), Minimum Number of Elements (MNE) and Minimum Number of Individuals (MNI) of Each Taxon from the Ottoman Deposits

	Species / Bones	Bos taurus		Ovis aries		Capra hircus		Capra/Ovis		Equus sp.		Bos/Equus Size	
		NISP	MNE	NISP	MNE	NISP	MNE	NISP	MNE	NISP	MNE	NISP	MNE
Head	Occipital							1	1				
	Petrosum											1	1
	Horn	21	12					36	20				
	Mandible Ramus	1	1					1	1				
	Mandible Teeth	4	2					14	3	16	3		
	Maxilla Teeth	2	1					15	4	7	2		
Body	Atlas							1	1	2	1		
	Axis							2	1	2	1		
	Ver: Cervical	3	2					3	2	1	1	2	2
	Ver: Thoracic	8	5					4	1				
	Ver: Lumbar	1	1					2	2	1	1		
	Rib frag.	4	4					10	7	3	3	7	6
	Sternum												
Forelimb	Scapula Glenoid Fossa			2	2			5	4	1	1		
	Humerus Proximal												
	Humerus Distal	1	1	5	5			13	7				
	Radius Complete												
	Radius Proximal			1	1			4	4	1	1		
	Radius Distal	1	1					2	2				
	Ulna Proximal							1	1				
	Metacarpus Complete					1	1						
	Metacarpus Proximal	1	1					4	2				
	Metacarpal III												
	Metacarpal IV									1	1		
Hindlimb	Pelvic acetabulum	1	1					14	5	2	2		
	Femur Complete												
	Femur Proximal	1	1					1	1				
	Femur Distal							2	2				
	Tibia Complete												
	Tibia Proximal												
	Tibia Distal							14	11	1	1		
	Astragalus									4	4		
	Calcaneus	1	1					4	3	3	3		
	4th Central	3	3							1	1		
	Metatarsus Proximal							8	5	2	2		
	Metatarsus Distal			1	1					1	1		
	Metatarsal II									1	1		
	Metatarsal IV									2	2		
Toes	Phalanx 1	3	3			3	3						
	Phalanx 2	3	3							2	2		
	Phalanx 3	1	1							4	4		
	Metapod cond.	1	1							3	3		
	Long bone											1	1
NISP		61		9		4		161		61		11	
% NISP		17.4		2.6		1.1		46.0		17.4		3.1	
MNI		6		3		1		10		3		1	

Camelus dromedarius		Gazella gazella		Sus scrofa		Canis sp.		Gallus gallus		Aves B Size		Pisces	
NISP	MNE	NISP	MNE	NISP	MNE	NISP	MNE	NISP	MNE	NISP	MNE	NISP	MNE
												2	2
		1	1										
1	1												
				2	2	1	1						
				1	1								
1	1					1	1						
						1	1						
1	1					1	1						
						1	1						
						1	1						
						1	1						
										1	1		
										1	1		
				2	2			1	1				
						1	1						
				1	1	1	1						
1	1												
				1	1								
				1	1	1	1						
				2	2								
								1	1				
						1	1						
1	1												
						2	2						
				1	1					1	1		
1	1												
										1	1		
				1	1								
						1	1						
1	1												
		1	1										

7	2	12	14	2	4	2	350
2.0	0.6	3.4	4.0	0.6	1.1	0.6	100%
1	1	2	1	1	1	1	32

Table 3. Number of Identified Specimens (NISP), Minimum Number of Elements (MNE) and Minimum Number of Individuals (MNI) of Each Taxon from the Crusader/Mamluk Deposits

	Species / Bones	Bos taurus		Ovis aries		Capra hircus		Capra/Ovis		Equus sp.		Bos/Equus Size		Sus scrofa		Aves B Size		
		NISP	MNE	NISP	MNE	NISP	MNE	NISP	MNE	NISP	MNE	NISP	MNE	NISP	MNE	NISP	MNE	
Head	Horn	1	1															
	Mandible Ramus	1	1															
	Mandible Teeth	4	1					6	2	5	2							
	Maxilla Teeth	2	1					1	1	2	1							
Body	Ver: Cervical	1	1					1	1									
	Ver: Thoracic	1	1							1	1							
	Rib frag.	1	1					1	1			3	2					
Forelimb	Scapula Glenoid Fossa									1	1							
	Humerus Proximal											1	1					
	Humerus Distal	1	1	1	1			2	2					2	2			
	Metacarpus Complete					1	1											
Hindlimb	Pelvic acetabulum							1	1	1	1							
	Femur Distal							1	1					1	1			
	Tibia Complete															1	1	
	Tibia Proximal							1	1			1	1					
	Tibia Distal							2	2	2	1							
	Astragalus							1	1									
	Calcaneus									1	1							
	Metatarsus Proximal	1	1					2	1									
	Metatarsus Distal	1	1															
	Metatarsal IV													1	1			
Toes	Phalanx 1	2	2			2	2	1	1									
	Phalanx 3	1	1															
	Metapod cond.	1	1											1	1			
NISP		18.0		1.0		3.0		20.0		13.0		5.0		5.0		1.0		66
% NISP		27.3		1.5		4.5		30.3		19.7		7.6		7.6		1.5		100
MNI		1		1		1		2		2		1		2		1		11

The most frequent species in both periods are sheep and goat, followed by cattle. On the basis of taxonomically distinctive features, it is clear that both sheep (*Ovis aries*) and goat (*Capra hircus*) are represented. Other species present in both strata include equids, pigs and domestic fowl. Measurements of the distal humerus of the pig bones (breadth of trochlea; BT) fall within the range of recent wild boar from northern Israel (Haber and Dayan 2004). This comparison indicates that the pig remains of Shihab ad-Din are those of wild boar (*Sus scrofa*). Morphological features of the equid teeth (Davis 1980) show that they represent remains of both horse (*Equus caballus*; NISP = 6) and ass (*Equus asinus*; NISP = 5). In addition, pronounced size differences of the equid teeth from the Ottoman stratum (Fig. 2) might suggest the existence of different ass breeds that were even smaller than the common ass. The Ottoman stratum also included remains of mountain gazelle (*Gazella gazella*), camel and dog.

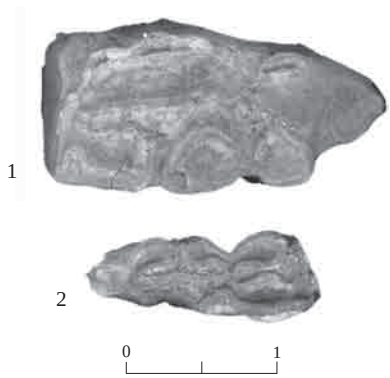

Fig. 2. Comparison of lower, permanent third molars of two donkeys (*Equus asinus*) identified in the assemblage, emphasizing the small size of Example No. 2: (1) Cat. No. 198; (2) Cat. No. 337.

Bone Modification

Traces of carnivore chewing, gnawing and tooth punctures, most probably attributable to dogs, were observed on several bones in the Crusader/Mamluk (NISP = 3) and Ottoman (NISP = 22) bone assemblages. Butchery marks were found predominantly on sheep, goat and cattle bones from the Crusader/Mamluk (NISP = 5) and Ottoman (NISP = 40) strata. These marks are found on bones associated with all stages of carcass processing, including skinning and dismembering, as well as filleting the meat from the bones (Table 4). In addition, a single cut mark was found on an equid bone (a distal tibia) from the Crusader/Mamluk assemblage (Cat. No. 98). The Ottoman bone assemblage contained sawing and butchering marks on the remains of gazelle (a horn, Cat. No. 477, and a distal metapodial, Cat. No. 362), camel (a first phalanx, Cat No. 26, and a 4th central tarsal, Cat. No. 246), equid (distal tibia, Cat. No. 122), boar (a distal humerus and two different

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

Period	Cat. No.	Species	Bone	Cut Mark Code No.	Activity Producing Mark
Crusader/Mamluk	98	*Equus sp.*	Tibia	?	?
	229	*Bos taurus*	Horn	S-4	Skinning/tool manufacturing
	453	*Capra/Ovis*	Tibia	Td-4	Filleting
	463	*Bos taurus*	Teeth-M3	M-4	Dismembering
	466	*Capra/Ovis*	Tibia	?	?
Ottoman	16	*Capra/Ovis*	Humerus	Hd-2	Dismembering
	26	*Camelus dromedareus*	Phalanx 1	?	Skinning for using the skin
	37	*Bos taurus*	Phalanx 1	?	Skinning for using the Skin
	122	*Equus sp.*	Tibia	Td-4	Filleting
	160	*Capra/Ovis*	Horn	S-4	Skinning/tool manufacturing

Table 4. (cont.)

Period	Cat. No.	Species	Bone	Cut Mark Code No.	Activity Producing Mark
Ottoman	163	*Capra/Ovis*	Pelvic-Ilium	PS-8	Dismembering
	166	*Capra/Ovis*	Humerus	Hd-2	Dismembering
	182	*Capra/Ovis*	Horn	S-4	Skinning/tool manufacturing
	246	*Camelus dromedareus*	4th Central Tarsal	?	Dismembering
	258	*Capra/Ovis*	Femur	Fp-3	Dismembering
	271	*Capra/Ovis*	Scapula	S-2	Dismembering
	275	*Capra/Ovis*	Scapula	S-2	Dismembering
	282	*Capra/Ovis*	Pelvic-Ilium Ischium	?	?
	290	*Capra/Ovis*	Horn	S-4	Skinning/tool manufacturing
	291	*Sus scrofa*	Pelvic-Ilium Ishchium Pubic	?	?
	294	*Capra/Ovis*	Metacarpal	?	Filleting?
	295	*Bos taurus*	Horn	S-4	Skinning/tool manufacturing
	299	*Bos taurus*	Horn	S-4	Skinning/tool manufacturing
	302	*Capra/Ovis*	Rib	RS-1	Filleting
	329	*Bos taurus*	Horn	S-4	Skinning/tool manufacturing
	342	*Bos taurus*	Horn	S-4	Skinning/tool manufacturing
	343	*Capra/Ovis*	Horn	S-4	Skinning/tool manufacturing
	356	*Ovis aries*	Humerus	?	?
	361	*Capra/Ovis*	Vertebra-Axis	CV-3	Dismembering (Stiff body)
	362	*Gazella gazella*	Metapod	MTd-3	Dismembering
	364	*Sus scrofa*	Humerus	?	?
	371	*Sus scrofa*	Pelvic-Ischium	PS-8	Dismembering
	377	*Capra/Ovis*	Horn	S-4	Skinning/tool manufacturing
	378	*Capra/Ovis*	Horn	S-4	Skinning/tool manufacturing
	381	*Capra/Ovis*	Horn	S-4	Skinning/tool manufacturing
	385	*Capra/Ovis*	Tibia	Td-4	Filleting
	396	*Gallus gallus*	Tibio-Tarsus	?	?
	397	*Bos taurus*	Horn	S-4	Skinning/tool manufacturing
	405	*Capra/Ovis*	Humerus	Hd-2	Dismembering
	408	*Capra/Ovis*	Radius	?	?
	409	*Capra/Ovis*	Scapula	S-2	Dismembering
	473	*Capra/Ovis*	Horn	S-4	Skinning/tool manufacturing
	477	*Gazella gazella*	Horn	S-4	Skinning/tool manufacturing
	480	*Bos taurus*	Horn	S-4	Skinning/tool manufacturing
	481	*Capra/Ovis*	Radius	?	?

Fig. 3. Horns from the Ottoman stratum: (1–3) sheep/goat sawn and cut to half horn cores; (4) cattle sawn and cut to half horn core; (5, 7, 9, 11) cattle sawn horn cores; (6, 10) sheep and goat sawn horn cores; (8) mountain gazelle sawn horn core.

fragments of pelvis, Cat. No. 291) and fowl (distal tibio-tarsus, Cat. No. 396). Burning was observed on only five animal bones, three from the Crusader/Mamluk deposits (cattle-size rib, sheep/goat astragalus, and wild boar 4th metatarsal), and two from the Ottoman deposits (sheep/goat axis and pubis acetabulum, the latter highly calcined).

The Ottoman bone assemblage comprises 23 worked bones, the majority of which are sawn. In addition, a single sheep/goat worked astragalus was found in the Crusader/Mamluk deposits. The majority of the worked bones are horn cores of sheep/goat (n = 8) and of cattle (n = 6). The horn core of a mountain gazelle was also sawn (Cat. No. 477; Fig. 3:8). Notably, horns

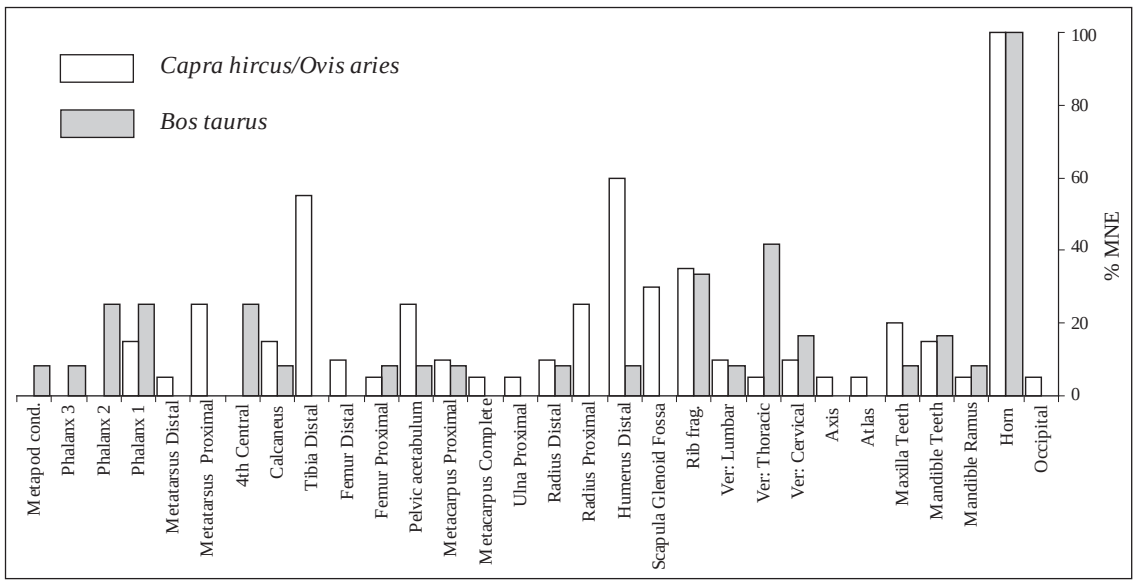

Fig. 4. Distribution of bone elements of cattle, sheep and goat from the Ottoman period. Note that horn cores are the most frequent element for both taxa.

of cattle, sheep and goats are the most frequent body parts in the Ottoman faunal assemblage (Fig. 4; Table 2). The MNI of the sheep/goat in the Ottoman stratum, according to horns, is ten, while the next most abundant bone is the distal humerus (MNI = 6). In cattle, the MNI based on horns is six and the next most abundant bone is the 4th central tarsal (MNI = 2).

The horns derive from many different loci, but worked/sawn horns were found only in Loci 118, 120 and 125, in the building's foundation and in fills under its floor (Tepper 2009: Plan 1). Loci 120 and 118 are located along the western, shorter side of the building, and L125 is at its northern end. An Ottoman coin (IAA 106088) from the time of 'Abd al-Majid (1841 CE) was found in L125 as well (Tepper 2009). The distribution pattern of horns at the site does not reveal further information on the accumulation and the depositional processes of the leftovers and it seems most likely that the zooarchaeological remains are part of a fill.

Discussion

Horns were used in Europe until the nineteenth century CE for many different purposes and were commonly utilized in bone-tool manufacturing. Horn working was usually connected with the production of a variety of objects, including combs and tool handles (Ryder 1984). The tools were made of horn sheath that was softened and shaped by heat and pressure. Common refuse from such activities are horn cores that were sawn at their base, while the horn sheath was still attached to them. Then the sheath was separated, producing a short cylindrical piece and a core, which has largely been left intact, but may exhibit a right-angled cut on its base (e.g., Batey 2001; MacGregor and Mainman 2001; Maldre 2001). It appears that this was the procedure largely followed at Shihab ad-Din (cf., for instance, Fig. 3:1–3). Furthermore, removal of the horn was carried out by sawing off the solid tip of the horn first, before separating the core from the sheath (Fig. 3:9–11). Thus, it is tempting to interpret the high representation of sawn horn cores at Shihab ad-Din as reflecting the waste of a horn workshop that must have been active nearby.

Other bones that were identified as waste from bone tool manufacture (Table 5; Fig. 5) include long bone epiphyses that had been

Table 5. Distribution of Worked Bones from Shihab ad-Din, Nazareth according to Period, Species, Bone, and Portion. Catalog Number is Given for Each Bone

Period	Cat. No.	Species	Bone	Portion	Note
Crusader/Mamluk	102	*Capra/Ovis*	Tarsal-Astragalus	Lateral+Medial	
	34	*Camelus dromedarius*	Femur	Distal	
	168	*Camelus dromedarius*	Ulna	Proximal	
	184	*Bos taurus*	Horn	Proximal	
	203	*Capra/Ovis*	Horn	Proximal	
	204	*Capra/Ovis*	Horn	Proximal	
	207	*Capra/Ovis*	Pelvic-Ilium	Acetabulum	
	223	*Capra/Ovis*	Horn	Proximal	
	246	*Camelus dromedarius*	Central 4th Tarsal	Distal	
	272	*Ovis aries*	Scapula	Distal	
	299	*Bos taurus*	Horn	Proximal	
	315	*Equus sp.*	Metapod	Distal	
	378	*Capra/Ovis*	Horn	Proximal	
	380	*Bos taurus*	Horn	Proximal	
	397	*Bos taurus*	Horn	Proximal	
	399	*Bos taurus*	Horn	Distal+Proximal	
	472	*Capra/Ovis*	Horn	Proximal	
	473	*Capra/Ovis*	Horn	Proximal	
	474	*Capra/Ovis*	Horn	Distal	
	475	*?*	?	?	Botton
	477	*Gazella gazella*	Horn	Proximal	
	479	*Capra/Ovis*	Horn	Proximal	
Ottoman	480	*Bos taurus*	Horn	Distal+Proximal	

Fig. 5. Worked bone elements other than that of cattle, sheep and goat found in the Ottoman stratum: (1) sawn distal femur of camel; (2) sawn proximal ulna of camel; (3) sawn 4th central tarsal of camel; (4) sawn distal metapod of equid.

Fig. 6. Bone button found in the Ottoman assemblage (L125, B1063).

severed from the bone shafts at an initial stage of the bone tool manufacturing process. Although they are usually long bones of large mammals, the artifacts found show little coherent patterning in both species and bone elements selected, suggesting that exploitation of animal bones was opportunistic and ad hoc in nature. Only a single finished bone tool was found, identified as a button (Cat. No. 475; Fig. 6). It is plain, without decoration or design, with five holes drilled in its center and was a commonly used household item.[2]

CONCLUSIONS

The bone assemblages of Shihab ad-Din are primarily based on domestic sheep and goats and to a lesser extent on cattle. Wild animals were exploited only in low frequencies and include the remains of wild boar and mountain gazelle. Other species represent draft animals: viz. ass, horse and camel. The presence of camel remains reflects on the location of Nazareth along trade routes. The same applies to the presence of donkey and horse remains at the site; both animals served as pack animals at the time.

A major part of the Ottoman bone assemblage consists of bone waste, including several horn cores and long bone epiphyses of large mammals. The high frequency of sawn horn cores most probably indicates that they represent the waste of horn-working that apparently had been practiced in this part of the site. It should be remembered that horn sheath was the earliest forerunner of plastic and served as an important product for making essential daily-life items, such as combs, spoons, knives and tool handles.[3] In addition, Ayalon (2005: 6–7) suggests that sawn or chopped epiphyses are common in archaeological sites and usually represent the remains of a bone workshop. Sawing off the long bone epiphyses is generally the first step in the manufacturing process, and it seems likely that long bones of large mammals were preferred (Ayalon 2005:133, 154). Thus, the presence of both horn core fragments and severed epiphyses at the site demonstrate that a horn and bone workshop existed in Nazareth in the early nineteenth century CE. It is, however, difficult to estimate the size of the industry at the time from the present finds.

This pattern might suggest that the bone industry in the Ottoman period was carried out locally by professional craftsmen (as described by Ayalon 2005:139–140). As most of the retrieved artifacts are bone waste, rather than final products, it seems reasonable to assume that the finished bone tools at Shihab ad-Din found their way to the city market, most probably in the vicinity of the craftsmen's workshops.

APPENDIX 1: MAMMAL BONE MEASUREMENTS (MM) ACCORDING TO SPECIES AND ELEMENT[i]

Species	Bone	Element							Period	Cat. No.
		Bd	BT							
Capra/Ovis	Humerus	33.86	33.93						Ottoman	166
Capra/Ovis	Humerus	32.77	32.31						Ottoman	348
Capra/Ovis	Humerus		34.90						Ottoman	357
Capra/Ovis	Humerus	34.95	33.05						Ottoman	425
Ovis aries	Humerus		35.11						Crusader/ Mamluk	231
Ovis aries	Humerus		27.33						Ottoman	133
Ovis aries	Humerus	34.79	33.46						Ottoman	187
Ovis aries	Humerus		34.02						Ottoman	273
Ovis aries	Humerus	33.25	31.83						Ottoman	356
Ovis aries	Humerus	35.97	33.16						Ottoman	404
		Bp	GL	Bd	SD					
Capra hircus	Metacarpal	27.63	121.59	30.57	18.43				Crusader/ Mamluk	458
Capra hircus	Metacarpal	24.09	113.98	29.06	16.09				Ottoman	127
Capra/Ovis	Metatarsal	22.08							Ottoman	175
Capra/Ovis	Metatarsal	21.48							Ottoman	238
Capra/Ovis	Metatarsal	22.49							Ottoman	264
Ovis aries	Metatarsal			25.55					Ottoman	35
		Bp	GL	Bd	SD					
Capra hircus	Phalanx 1	14.73	44.19	14.47	11.69				Ottoman	2
Capra hircus	Phalanx 1	14.79	39.87	14.78	13.42				Ottoman	3
Capra hircus	Phalanx 1	14.81	44.84	13.76	12.73				Ottoman	365
Capra/Ovis	Phalanx 1			13.53					Crusader/ Mamluk	101
		Bp	Bd							
Capra/Ovis	Radius		33.58		249.00				Ottoman	
Capra/Ovis	Radius	32.85			358.00				Ottoman	
Capra/Ovis	Radius	32.61			392.00				Ottoman	
Ovis aries	Radius	34.32			138.00				Ottoman	
		GLP	LG	BG	SLC					
Capra/Ovis	Scapula	31.94	26.00	21.91	19.58				Ottoman	241
Capra/Ovis	Scapula		30.77	25.00	23.78				Ottoman	409
Ovis aries	Scapula	36.26	30.68	24.05	23.32				Ottoman	272
		GL	GB							
Capra/Ovis	Tarsal-Calcaneum	61.23	23.18						Ottoman	276
Capra/Ovis	Tarsal-Calcaneum		23.71						Ottoman	284
Capra/Ovis	Tarsal-Calcaneum		27.20						Ottoman	330

[i] All measurements and abbreviations are based on von den Driesch 1976.

APPENDIX 1: (cont.)

Species	Bone	Element							Period	Cat. No.
		Bd	Dd	SD						
Capra/Ovis	Tibia	30.24							Crusader/ Mamluk	453
Capra/Ovis	Tibia	28.72							Crusader/ Mamluk	466
Capra/Ovis	Tibia	31.64							Ottoman	21
Capra/Ovis	Tibia	26.71							Ottoman	128
Capra/Ovis	Tibia	27.18							Ottoman	176
Capra/Ovis	Tibia	27.51							Ottoman	216
Capra/Ovis	Tibia	25.76							Ottoman	217
Capra/Ovis	Tibia	30.67		16.62					Ottoman	328
Capra/Ovis	Tibia	30.45							Ottoman	366
Capra/Ovis	Tibia	27.82							Ottoman	412
		SBV	H							
Capra/Ovis	Vertebra-Axis	50.65	30.33						Ottoman	361
		Bp	GL	Bd	SD					
Bos taurus	Metatarsal			50.39					Crusader/ Mamluk	306
		Bp	GL	Bd	SD					
Bos taurus	Phalanx 1		58.96	25.72					Crusader/ Mamluk	112
Bos taurus	Phalanx 1	24.82	54.95	24.45	20.99				Ottoman	37
Bos taurus	Phalanx 1	31.38	57.61	28.61	24.85				Ottoman	287
		Bp	GL	Bd	SD					
Bos taurus	Phalanx 2	31.88	38.46	27.61	26.15				Ottoman	1
Bos taurus	Phalanx 2	24.33	34.51	21.88	20.06				Ottoman	211
Bos taurus	Phalanx 2			17.19					Ottoman	212
		DLS	Ld	MBS						
Bos taurus	Phalanx 3	45.62	39.42	13.97					Crusader/ Mamluk	469
Bos taurus	Phalanx 3	63.61	50.19	17.52					Ottoman	172
		Bone	GB							
Bos taurus	Ottoman	Tarsal-4th Central	49.48						Ottoman	247
		Bp	GL	Bd						
Equus sp.	Metapod			29.94					Ottoman	315
Equus sp.	Metatarsal		222.38	33.25					Ottoman	121
		DLS	Ld	MBS						
Bos taurus	Phalanx 3	45.62	39.42	13.97					Crusader/ Mamluk	469
Bos taurus	Phalanx 3	63.61	50.19	17.52					Ottoman	172

APPENDIX 1: (cont.)

Species	Bone	Element							Period	Cat. No.
		GB								
Bos taurus	Tarsal-4th Central	49.48							Ottoman	247
		Bp	GL	Bd						
Equus sp.	Metapod			29.94					Ottoman	315
		DLS	Ld	MBS						
Bos taurus	Phalanx 3	45.62	39.42	13.97					Crusader/ Mamluk	469
Bos taurus	Phalanx 3	63.61	50.19	17.52					Ottoman	172
		GB								
Bos taurus	Tarsal-4th Central	49.48							Ottoman	247
		Bp	GL	Bd						.
Equus sp.	Metapod			29.94					Ottoman	315
Equus sp.	Metatarsal		222.38	33.25					Ottoman	121
Equus sp.	Metatarsal	33.73							Ottoman	171
		LA								
Equus sp.	Pelvic-Ilium Ischium	42.51							Ottoman	432
Equus sp.	Pelvic-Ilium Ischium Pubic	40.77							Crusader/ Mamluk	228
		Bp	BFp	GL	Bd	SD				
Equus sp.	Phalanx 2	49.53	45.62	42.54	48.29	43.38			Ottoman	169
Equus sp.	Phalanx 2	34.51	30.30	33.07	29.99	28.86			Ottoman	170
		Ld	GL	GB	BF	LF				
Equus sp.	Phalanx 3	53.53	73.66		53.44	27.23			Ottoman	129
Equus sp.	Phalanx 3	32.56	38.83	39.62	34.37	19.13			Ottoman	367
Equus sp.	Phalanx 3					22.51			Ottoman	426
Equus sp.	Phalnax 3	51.12	58.59		51.00	26.07			Ottoman	354
		Bp	BFp							
Equus sp.	Radius	68.16	61.91						Ottoman	191
		GH	LmT	GB	BFd					
Equus sp.	Tarsal-Astragalus	44.66	45.41	45.28	39.77				Ottoman	119
Equus sp.	Tarsal-Astragalus	59.05	57.31	58.57	51.10				Ottoman	136
Equus sp.	Tarsal-Astragalus	41.87	37.01	41.82	35.12				Ottoman	213
Equus sp.	Tarsal-Astragalus	52.36	51.75		41.17				Ottoman	353
		GL	GB							
Equus sp.	Tarsal-Calcaneum	110.24	54.24						Crusader/ Mamluk	455

APPENDIX 1: (cont.)

Species	Bone	Element							Period	Cat. No.
Equus sp.	Tarsal-Calcaneum		38.67						Ottoman	120
Equus sp.	Tarsal-Calcaneum		33.34						Ottoman	214
Equus sp.	Tarsal-Calcaneum	78.72	38.98						Ottoman	314
		22C	P2L	P2B	P3L	P3B	P4L	P4B		
Equus sp.	Teeth-P2↑		37.32	26.87					Ottoman	336
Equus asinus	Teeth-M3↓		20.04	12.90					Ottoman	337
Equus sp.	Teeth-P2…P4↓	48.21	30.18	17.65	25.37	18.79	27.36	16.41	Ottoman	27
Equus sp.	Teeth-M3…P2↓		29.95	15.03					Ottoman	28
Equus sp.	Teeth-P2↓		25.13	12.58					Crusader/ Mamluk	304
Equus asinus	Teeth-M3↓		30.63	16.09					Ottoman	198
Equus asinus	Teeth-P3↓				23.19	15.18			Crusader/ Mamluk	305
Equus asinus	Teeth-P3…P2↓		22.56	13.24	24.22	17.01			Crusader/ Mamluk	226
Equus sp.	Teeth-P4↓						25.89	17.00	Ottoman	288
Equus sp.	Teeth-P4↓						21.74	18.46	Ottoman	340
		M1L	M1B	M2L	M2B	M3L	M3B			
Equus caballus	Teeth-M1↑	24.09	27.57						Crusader/ Mamluk	103
Equus sp.	Teeth-M1↑	26.34	25.01						Ottoman	124
Equus sp.	Teeth-M1↓	22.96	16.05						Ottoman	339
Equus sp.	Teeth-M2↑			26.42	24.33				Crusader/ Mamluk	459
Equus sp.	Teeth-M2↓			21.48	11.91				Ottoman	338
Equus sp.	Teeth-M2↓			25.42	17.87				Ottoman	430
Equus sp.	Teeth-M3↓					24.35	11.22		Crusader/ Mamluk	461
Equus sp.	Teeth-M3↑					21.20	22.99		Ottoman	13
Equus sp.	Teeth-M3↑					23.25	23.57		Ottoman	125
Equus sp.	Teeth-M3↑					28.74	22.17		Ottoman	151
		Bd	Dd							
Equus sp.	Tibia	63.14	42.56						Crusader/ Mamluk	98
		Bpacd								
Equus sp.	Vertebra-Axis	86.64							Ottoman	382
		Bd								
Camelus dromedareus	Femur	113.03							Ottoman	34

APPENDIX 1: (cont.)

Species	Bone	Element							Period	Cat. No.
		Bp	GL	Bd	SD					
Camelus dromedareus	Phalanx 1	41.89	96.65	37.14	22.49				Ottoman	26
		GB								
Camelus dromedareus	Tarsal-4th Central	64.23							Ottoman	246
		SDO	DPA	LO						
Camelus dromedareus	Ulna	71.54	78.89	84.61					Ottoman	168
		GL	BFcd	BFcr	LAd					
Camelus dromedareus	Vertebra-Atlas	92.44	82.50	91.94	36.16				Ottoman	428
		BT	SD							
Sus scrofa	Humerus	39.32							Crusader/ Mamluk	97
Sus scrofa	Humerus	38.05							Crusader/ Mamluk	303
Sus scrofa	Humerus	46.66	39.93						Ottoman	364
		Bp	GL	Bd	SD					
Sus scrofa	Metacarpal III	20.10	86.88	20.89	16.90				Ottoman	162
Sus scrofa	Metacarpal IV	18.87	85.78	17.62	13.27				Ottoman	283
Sus scrofa	Metapod	41.34		20.82					Crusader/ Mamluk	46
Sus scrofa	Metatarsal II		66.22	10.88	6.42				Ottoman	390
Sus scrofa	Metatarsal IV	18.19	103.61	19.10	14.61				Crusader/ Mamluk	230
		18	10	13	14	19				
Canis sp.	Teeth-M2… M1↓	49.89	32.64	19.68	19.38	21.55			Ottoman	153
		Bp	GL	Bd	SD					
Canis sp.	Tibia		159.43	20.41	11.20				Ottoman	17
Canis sp.	Tibia	29.81	177.69		11.13				Ottoman	389
		GB	GL	BFcd	BFcr	LAd	H			
Canis sp.	Vertebra-Atlas	82.41	40.75	28.71	39.91	10.98	28.15		Ottoman	387
		LCDe	LAPa	BPcd	Bpacd	BFcr	SBV	H		
Canis sp.	Vertebra-Axis	49.47	54.72	17.34	33.28	30.14	20.46	34.90	Ottoman	19

APPENDIX 2: ABBREVIATIONS (AFTER VON DEN DRIESCH 1976)

Long bones and Phalanges	Bd	Breadth of distal end
	BT	Breadth of trochlea
	Bp	Breadth of proximal end
	GL	Greatest length
	SD	Smallest breadth of diaphysis
	GB	Greatest breadth
	BFd	Breadth of facies articularies proximalis
	BFp	Breadth of facies articularies distalis
	Dd	Depth of distal end
	SDO	Smallest depth of olecranon
	DPA	Depth across processus anconaeus
	LO	Length of olecranon
Scapula	GLP	Greatest length of glenoid foss
	LG	Length of glenoid cavity
	BG	Breadth of glenoid cavity
	SLC	Smallest length of collum scapula
Vertebra	SBV	Smallest breadth of vertebra
	H	Height
	BPacd	Breadth across processus articularis caudales
	BFcd	Breadth of facies articularis caudalis
	BFcr	Breadth of facies articularis cranialis
	LAd	Length of arcus dorsalis
Astragalus	DLS	Diagonal length of sole
	Ld	Length of dorsal surface
	MBS	Middle breadth of sole
	GH	Greatest height
	LmT	Length of medial part of trochlea
Pelvic	LA	Length of acetabulum
Cranial	22C	Length of cheek tooth row
	P2L	Length of P2
	P2B	Breadth of P2
	P3L	Length of P3
	P3B	Breadth of P3
	P4L	Length of P4
	P4B	Breadth of P4
	M1L	Length of M1
	M1B	Breadth of M1
	M2L	Length of M2
	M2B	Breadth of M2
	M3L	Length of M3
	M3B	Breadth of M3
	18	Dental length
	10	Viscerocranium length
	13	Parietal length
	14	Frontal length
	19	Entorbitale

NOTES

[1] The trial excavations were directed by Yotam Tepper on behalf of the Israel Antiquities Authority (Permit No. A-3953; map ref. NIG 228166–83/734058–75; OIG 178166–83/234058–75) and financed by the Ministry of Construction and Housing. The authors thank Hadas Mutro for her assistance in identifying the equid specimens and the anonymous reviewer for the thoughtful comments and significant contribution to the narrative and structure of this paper.

[2] For the various stages in the carving of bone buttons, see Wapnish 1991; 1997; see also Ayalon 2005.

[3] For a recent review of horn-working history, see Schaverien 2006.

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