Ḥadashot Arkheologiyot—
Excavations and Surveys in Israel 131

Jerusalem, Ras el-ʻAmud: Animal Bones

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Introduction

A salvage excavation in the vicinity of Ras el-ʻAmud recovered a small faunal assemblage from a hewn water cistern in Area A (see ʻAdawi 2019). The assemblage, dated by the associated pottery to the late Iron Age II and the beginning of the Persian period, is unique, as it can provide zooarchaeological information on a period and region that are otherwise not well-known in terms of animal economy.

Methods

The assemblage is held in a single standard carton box, to which it was returned after the study; no specimens were removed or repacked. In preparation for analysis, the bones were washed with tap water to remove adhering soil. Bone identification was facilitated by the comparative collection of the Laboratory of Archaeozoology at the University of Haifa. All archaeological specimens that could be identified to skeletal element were recorded, including long bone diaphysis, vertebral, rib and cranial fragments. Recorded specimens were assigned to a biological taxon or to a size class; size classes consist of mammals of small size (cat, hare), medium size (sheep, goat, pig) and large size (horse, donkey, cattle). Closely related biological taxa were distinguished on the basis of morphological criteria (Johnstone 2004; Zeder and Lapham 2010). The state of epiphyseal fusion and the degree of tooth wear (Grant 1982) were noted when possible. Sufficiently complete specimens were measured following von den Driesch to the nearest 0.1 mm using Vernier callipers (Driesch 1976; Appendix 1).

The quantification of taxonomic frequencies employed raw counts (number of identified specimens, NISP), whereas the quantification of skeletal elements utilized estimates of minimum number of elements (MNE) and minimal number of animal units (MAU) (for definitions, see Lyman 2008). MNE was derived by using a fraction summation approach for long bones, and a diagnostic zone ubiquity count for other elements (Dobney and Rielly 1988).[1]

[1] Fuller details on bone counting methods may be found in Marom 2012.

Age-at-death for sheep and goats was estimated following Zeder (2006). Sex-ratio analysis employed pelvic morphology (Edwards, Marchinton and Smith 1982) and mixture analysis (Monchot, Mashkour and Vigne 2005). The latter technique was carried out on a log-ratio transformation of caprine measurements from the site with reference to an adult male sheep from Chamchamal Valley, Iraq, which was measured by the autohr at the Field Museum of Natural History, Chicago (FMNH 57255; Appendix 1).

Bone surface modifications were sought for by a careful examination with the naked eye of all identified specimens under a strong, oblique light source; a magnifying glass (×2.5) was employed when needed. Burning, carnivore gnawing marks, surface weathering (Behrensmeyer 1978) and fracture morphology (Villa and Mahieu 1991) were recorded. Butchery marks were interpreted with reference to Binford (1981), Isaakidou (2004) and Rixson (1989).

RESULTS

TAXONOMIC FREQUENCIES

The faunal assemblage consists of 225 bones identified to biological taxon and 42 bones identified to size class, making for a total of 267 identified bones (Table 1). A great majority of the specimens are sheep (*Ovis aries*; NISP = 16) and goat (*Capra hircus*; NISP = 2) bones, and together with the specimens identified as 'caprine', which could not be distinguished to one of the two species (NISP = 178), comprise 87% of the NISP assigned to biological taxon. Cattle (*Bos Taurus*; NISP = 22; 10%) are the second most common taxon in the assemblage. Few bones record the presence of donkeys (*Equus asinus*; NISP = 4; 2%) and a large species of deer (NISP = 3; 1%).

Table 1. Taxonomic Frequencies:
Number of Identified Specimens (NISP) by Taxon and Size Class

Taxon	Locus			NISP (N)	NISP (%)
	103	105	107		
Sheep/Goat (*Capra hircus* or *Ovis aries*)	24	146	8	178	87
Sheep (*Ovis aries*)	2	12	2	16	
Goat (*Capra hircus*)	1	1		2	
Cattle (*Bos Taurus*)	6	16		22	10
Equus (*Equus asinus*)	4			4	2
Deer (*Dama dama mesopotamica* or *Cervus elaphus*)	1	2		3	1
Total	*38*	*177*	*10*	*225*	*100*
Small mammal		1		1	2
Medium mammal	8	1	3	12	29
Large mammal	23	6		29	69
Grand Total	*69*	*185*	*13*	*267*	*100*

SKELETAL-ELEMENT FREQUENCIES

The frequencies for skeletal elements could be calculated for sheep, goat and medium-sized mammals, from which minimally sufficient abundance profiles were derive in terms of sample size (Fig. 1; Table 2). Frequency counts by element for cattle, donkeys and deer appear in Appendix 2.

All skeletal parts of caprines are represented in the assemblage, with higher frequencies of limb bones; heads and especially feet are less frequent. There is no correlation between the representation

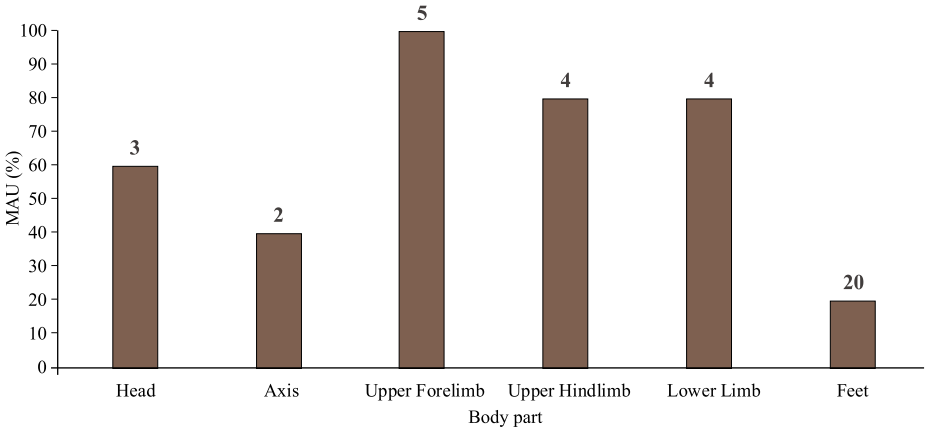

Fig. 1. Minimum Animal Units (MAU) for Skeletal Elements of Sheep, Goats and Medium-Sized Mammals.

Table 2. Skeletal-Element Frequencies by Number of Identified Specimens (NISP), Minimum Number of Elements (MNE) and Minimum Animal Units (MAU)

Body Part	Element	NISP	MNE	MAU
Head	Skull	31	3	2
	Mandible	15	5	3
Axis	Cervical vertebrae	14	7	1
	Thoracic vertebrae	15	14	2
	Lumbar vertebrae	10	6	2
	Ribs	29	18	1
	Pelvis	8	3	2
Upper Forelimb	Scapula	12	7	4
	Humerus	8	3	2
	Radius	12	10	5
Upper Hindlimb	Femur	4	3	2
	Tibia	19	7	4
Tarsals	Calcaneus	1	1	1
Lower Limb	Metacarpus	10	7	4
	Metatarsus	6	6	3
	Metapodial	3	2	1
	Phalanx 1	6	6	1

of various skeletal elements in the assemblage (MNE) and their densities (Spearman's r = 0.19, P = 0.59) or simplified general utility index (Spearman's r = -0.51, P = 0.13; values from Marshall and Pilgram 1991: Table 2). Fragmentation, measured as the NISP to MNE ratio, is likewise not correlated with marrow content (measured as calorific returns from processing; Jones and Metcalf 1988: Table 3).

AGE-AT-DEATH AND SEX RATIOS

A sample of 79 caprine bones (Table 3) was used to construct a survivorship curve for the population represented in the cistern (Fig. 2). The results indicate increased culling during the second year of life (Age Groups C and D), a relatively young adult age. The evidence from tooth wear (Table 4) contradicts this age estimate to some extent, as the medium- to advanced-wear stage exhibited by the specimens would suit better a mature adult population. The sample for cattle is very small (Table 5), but the frequency of the unfused femora hints at the consumption of relatively numerous osteologically immature animals in their fourth year of life.

Table 3. Epiphyseal fusion for sheep and goats (P. = proximal; D. = distal)

Age Group	Element	Fused	Unfused	Total
Group A (0–6 months)	Radius, P.	4		
Total		*4*	*0*	*4*
Group B (6–12 months)	Humerus, D.		1	
	Pelvis	5		
	Scapula	7		
Total		*12*	*1*	*13*
Group C (12–18 months)	Phalanx 1	4	2	
Total		*4*	*2*	*6*
Group D (18–30 months)	Tibia, D.	2	3	
	Metacarpus, D.	1	3	
	Metatarsus, D.	3	2	
	Metapod, D.		2	
Total		*6*	*10*	*16*
Group E (30–48 months)	Calcaneus	1		
	Femur, D.	2		
	Ulna	1		
	Radius, D.	1		
	Tibia, P.	3	2	
Total		*8*	*2*	*10*
Group F (48+ months)	Humerus, P.	3	1	
	Vertebrae	16	10	
Total		19	11	30
Grand Total			79	

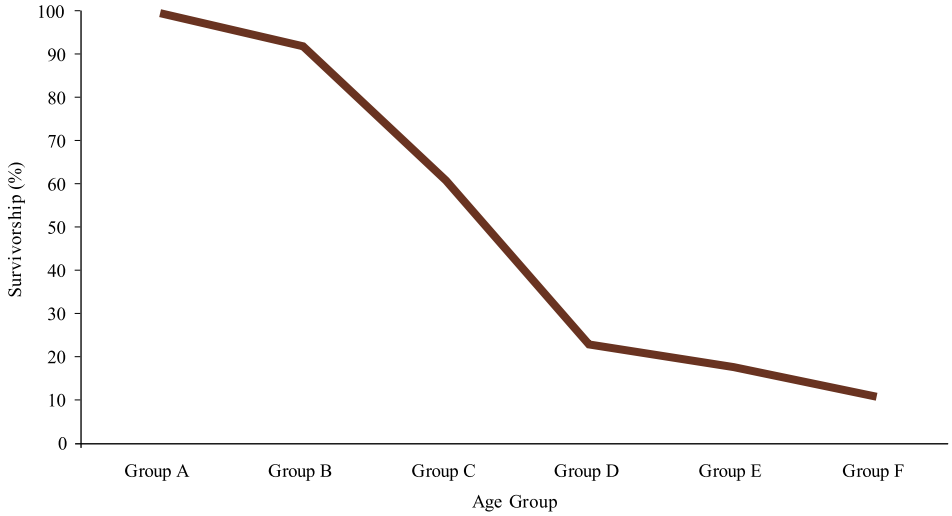

Fig. 2. Survivorship curve for sheep and goats.

Table 4. Tooth-Wear Scores for Caprine's Mandibular Teeth

Mandibular Teeth	Tooth Wear Stage
Mandible (dp3, dp4, M1, M2)	h, g, e
Mandible (M1, M3)	l, g, g
Mandible (M1/2)	I
Mandible (M1/2)	G
Mandible (M3)	G
Mandible (M3)	G
Mandible (M3)	G
Mandible (P3, M2)	j, m, g
Mandible (P4)	g

Sex-ratio reconstruction for the caprine sample shows an overwhelming dominance of males when mixture analysis is employed, but a slight female-biased ratio when pelvic morphology is considered (Fig. 3). Since the morphological method was applied on a very small number of fragments from a single skeletal element, making it more sensitive to element-dependent sex bias, the results of the mixture analysis will be favored in this case.

Table 5. State of Epiphyseal Fusion and Tooth Wear for Cattle (P. = proximal; D. = distal)

Element	Fusion State/Wear Stage
Vertebra, Cervical	Unfused
Pelvis	Unfused
Humerus, P.	Unfused
Femur, P.	Unfused
Femur, P.	Unfused
Femur, D.	Unfused
Femur, D.	Unfused
Femur, D.	Unfused
Tibia, D.	Fused
Tibia, D.	Fused
Phalanx 2	Fused
Phalanx 2	Fused
Mandible M3	g

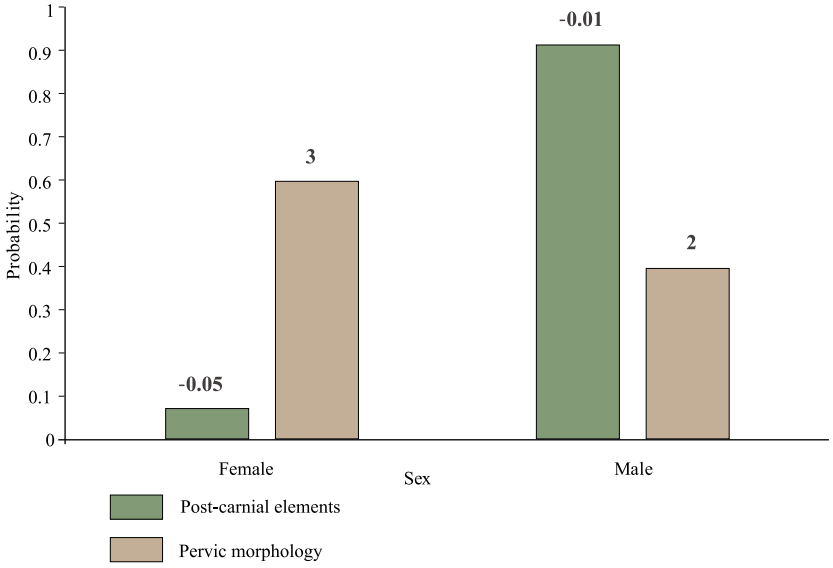

Fig. 3. Caprine sex-ratio estimates by mixture analysis applied to log-ratio transformed measurements of (a) post-cranial elements (N = 20; dark grey); and (b) pelvic morphology (N = 5; light grey). Numbers above the columns are mean log-ratio for the group and NISP, respectively.

BUTCHERY MARKS

The butchery marks on bones from the excavation (Table 6; N = 48) were inflicted by three distinct types of instruments: a metal knife (N = 38), a heavy blade ('cleaver'; N = 9) and a hammerstone (N = 1). The frequency of marks made by the various instruments does not appear to depend on the size of

Table 6. Butchery Activities and Instruments

Taxon	Type	Instrument		
		Knife	Cleaver	Hammerstone
Sheep/Goat	Skinning			
	Dismemberment	3	5	
	Disarticulation	21		
	Defleshing	7	2	
Large Mammal	Skinning			
	Dismemberment		1	
	Disarticulation	2	1	
	Defleshing	5		
	Marrow			1
Total		*38*	*9*	*1*

Table 7. Bone Sample Modification

Bone Modification	Sample size	Modified specimens	
		N	%
Gnaw	268	0	0
Burnt	268	3	1
Weathered > Stage 2	67	18	27
Fresh Fractures	34	21	62
Dry Fractures	34	4	12

the carcass that was processed (Chi-square = 0.07, P. = 0.79). Marks of disarticulation, defleshing and dismemberment are common, and reflect consumption involving pot-sizing and filleting. Skinning marks are missing, although metapodials, on which these marks frequently occur, are present in the assemblage. The single percussion mark, which was made by using a blunt instrument, probably a hammerstone, indicates an attempt to obtain marrow. A complete description of the butchery marks observed in the assemblage appears in Appendix 3.

OTHER BONE SURFACE MODIFICATIONS

Bone surface modifications can often provide information on the depositional history of an assemblage. In Ras el-'Amud (Table 7), it appears that the assemblage was accumulated in a place that was not accessible to scavenging village dogs, as indicated by the complete absence of gnawing marks. Burning is also very rare, suggesting that food preparation was accomplished by cooking rather than roasting. Weathered bones are relatively frequent, comprising about a quarter of the examined sample; these indicate a long post-depositional and pre-burial phase, when the bones were exposed to the elements. Most of the bones were broken when relatively fresh, probably for marrow consumption. Others, however, show breakage typical of older, dry bones, which happened sometime after deposition.

SUMMARY AND CONCLUSIONS

The faunal assemblage from Ras al-'Amud allows us for the first time to glean information on the animal economy of a peripheral settlement of Jerusalem in the late Iron Age II and Persian periods. As the Ras al-'Amud bone assemblage was found in a hewn cistern, taphonomical assessment of its history may also contribute to the archaeological understanding of its depositional context.

The assemblage comprises mainly sheep and goat specimens, with a clear dominance of sheep. The animals appear to be mostly males that were culled during their second or third year of life. All parts of the animals' bodies are represented in the assemblage; however, those making up consumption waste are more prevalent than butchery waste (head and feet). This assemblage, dominated by young male sheep, is typical of a consumer economy, which was supplied with animals by off-site producers. Further support for this economic reconstruction is found in the low frequency of butchery waste. This is an indication that the first stages of carcass processing were carried out in a different location, and that both the butchery and the supply of animals were specialized activities.

The relatively few cattle bones belonged to young adult animals and represent meat-rich body parts. Several head and metapodial fragments of a large deer evince hunting in a wooded environment. A few donkey remains were also found; some of them bear butchery marks.

Carcass butchery employed metal knifes, heavy-edged cleavers and, in a single case, a blunt instrument that was used to fracture the marrow cavity of a large mammal humerus. Most of the attested butchery activity was of carcass disarticulation (separation at the joints) and dismemberment (cutting through the bone), typical of pot-sizing. Defleshing marks are also common, indicating the removal of the meat from the bones. Skinning marks, on the contrary, are entirely absent; these may have been evident on feet, but these are poorly represented in the assemblage. The virtual lack of burning marks indicates that meat was prepared by cooking rather than by roasting—a common feature of Levantine cuisine in all periods. The fracturing of bones when still fresh indicates the consumption of the bone marrow, although a statistical analysis of fragmentation patterns does not indicate intensive and selective breakage of marrow-rich bones. The presence of weathered bones and of fractures on dry bones—presumably resulting from trampling—suggests that the assemblage lay in the open for some time (secondary deposition) before it was deposited within the cistern (tertiary deposition). The absence of carnivore gnawing marks hints that the environment of the secondary deposition had restricted access to dogs, unlike a street or an open area on the outskirts of the settlement.

In summary, the Ras el-'Amud assemblage was found in tertiary deposition in a cistern hewn in a peripheral settlement of Jerusalem in the late Iron Age. It indicates a specialized animal economy, with animal production, butchery and consumption carried out in different locals by different people (Zeder 1991). The result is a sheep-, male- and young-dominated consumer signature. This signature stands in contrast to a rural producer economy, which is characterized by evidence of on-site butchery and by a more balanced mixture of young and adult animals, with many females and a larger proportion of sheep than in the Ras el-'Amud assemblage.

APPENDIX 1. BONE MEASUREMENTS (MM) BY TAXON[1]

Taxon	Element	Fused/Unfused	Bp	Bd/BT	GL/Gll/Glpe
Sheep/Goat	Femur	Fused		39.4	
	Humerus	Unfused		26.9	
	Metacarpus	Fused		29.8	
		Unfused	26.5	29.0	
		Unfused	25.9	29.0	
			30.7		
			28.9		
			22.4	25.8	
	Metapod	Unfused		33.4	
	Metatarsus	Fused		24.5	147.2
		Fused	21.1	25.6	143.0
		Fused		26.2	148.1
		Unfused	22.6	27.6	
		Unfused	23.0	27.6	
	Phalanx 1	Fused	13.3	12.7	36.8
		Fused	13.8	12.9	38.0
	Radius	Unfused		25.3	
		Unfused/Unfused	24.4	26.8	
	Scapula	Fused		36.6	
		Fused		35.1	
		Fused		36.7	
		Fused		36.8	
	Tibia	Fused	43.8		
		Fused	44.6		
		Fused		29.7	
		Unfused		32.5	
		Unfused		30.4	
		Unfused	43.0		
Sheep	Femur	Fused		39.1	
	Phalanx 1	Fused	13.6	12.8	37.6
		Fused	26.1	25.5	45.9
		Unfused		14.0	
		Unfused		14.1	
	Radius	Fused	30.6		
		Fused	36.1		
		Fused	33.7	31.1	169.7
		Fused		32.6	
		Fused	33.5		
		Fused	33.2	32.6	178.7
		Fused	34.1	30.0	170.2
Goat	Radius	Fused	31.8		

[1] Reference values for log-ratio analysis: Scapula Bd = 38.8; Metatarsus Bd = 27.8; Radius Bp = 33.6; Femur Bd = 45.4; Humerus BT = 26.9; Tibia Bd = 31.4.

APPENDIX 1. (cont.)

Taxon	Element	Fused/Unfused	Bp	Bd/BT	GL/Gll/Glpe
Cattle	Phalanx 2	Fused	28.2	23.8	
		Fused	30.2	26.4	
	Tibia	Fused		58.6	
		Fused		58.6	
Deer	Metatarsus	Fused	26.9	30.1	176.9
			26.9		

APPENDIX 2. NUMBER OF IDENTIFIED SPECIMENS (NISP) OF SKELETAL ELEMENTS OF CATTLE, DEER AND DONKEYS (***EQUUS***)

Element	Cattle	Deer	Equus	Total
Maxilla	1	1		2
Mandible	8			8
Vertebra	1			1
Pelvis	1			1
Humerus	1			1
Femur	5		2	7
Tibia	2		2	4
Metacarpus	1			1
Metatarsus		2		2
Phalanx	2			2
Total	*22*	*3*	*4*	*29*

APPENDIX 3. DESCRIPTION AND INTERPRETATION OF BUTCHERY MARKS BY TAXON AND BODY ELEMENT

Taxon	Element	Location	Type	Tool	Interpretation
Sheep/Goat	Femur	Medial aspect of distal articulation	Diagonal cut marks	Knife	Disarticulation
	Humerus	Medial aspect of lateral tuberosity on proximal part	Transverse cut marks	Knife	Disarticulation
		Lateral aspect of proximal shaft	Longitudinal cut marks	Knife	Defleshing
	Mandible	Lateral aspect of ascending ramus (5–6)	Transverse cut marks	Metal knife	Defleshing
	Occipital Condyle		Transverse cut marks	Knife	Disarticulation
	Pelvis	Acetabulum	Transverse chop	Cleaver	Dismemberment
		Ventral aspect of ilium (5)	Transverse cut marks	Knife	Dismemberment
		Ventral aspect of ilium (5)	Transverse cut marks	Knife	Dismemberment
	Radius	Cranial aspect of middle shaft	Diagonal cut marks	Knife	Defleshing
	Scapula	Lateral aspect of blade (7)	Longitudinal cut marks	Knife	Defleshing
		Cranial aspect of neck (4)	Transverse cut marks	Knife	Disarticulation
		Medial aspect of articulation	Transverse cut marks	Knife	Disarticulation
	Tibia	Lateral aspect of proximal articulation	Diagonal cut marks	Knife	Dismemberment
		Lateral aspect of middle shaft	Transverse cut marks	Knife	Defleshing
		Middle shaft	Chop mark	Cleaver	Defleshing
	Vertebra, Atlas	Dorsal aspect of centrum	Transverse cut marks	Metal knife	Disarticulation
		Dorsal aspect of centrum	Transverse cut marks	Knife	Disarticulation
	Vertebra, Axis	Ventral aspect of centrum	Transverse cut marks	Metal knife	Disarticulation
		Ventral aspect of centrum	Transverse cut marks	Metal knife	Disarticulation
		Frontal-sagittal plane of centrum	Cleft	Cleaver	Dismemberment
	Vertebra, Cervical	Ventral aspect of centrum	Transverse cut marks	Knife	Disarticulation
		Frontal-sagittal plane of centrum	Cleft	Cleaver	Dismemberment
	Vertebra, Lumbar	Dorsal aspect of posterior zyapophysis	Transverse cut marks	Knife	Disarticulation
		Ventral aspect of centrum	Diagonal cut marks	Knife	Disarticulation
	Vertebra, Sacrum	Frontal plane of centrum	Cleft	Cleaver	Dismemberment
		Ventral aspect of centrum	Transverse cut marks	Knife	Disarticulation
		Ventral aspect of centrum	Diagonal cut marks	Metal knife	Disarticulation
	Vertebra, Thoracic	Ventral aspect of centrum	Transverse cut marks	Metal knife	Disarticulation
		Dorsal aspect of posterior zyapophysis	Transverse cut marks	Metal knife	Disarticulation
		Ventral aspect of centrum	Transverse cut marks	Knife	Disarticulation
		Lateral aspect of neural spine	Diagonal cut marks	Metal knife	Defleshing
Sheep	Frontal	Anterior aspect of horn base	Chop mark	Cleaver	Dismemberment
	Radius	Cranio-lateral aspect of proximal articulation	Diagonal cut marks	Knife	Disarticulation
		Medial aspect of proximal articulation	Diagonal cut marks	Knife	Disarticulation
		Medial aspect of proximal articulation	Transverse cut marks	Knife	Disarticulation
		Medial aspect of proximal articulation	Transverse cut marks	Metal knife	Disarticulation
		Medial aspect of proximal shaft	Diagonal cut marks	Metal knife	Defleshing

APPENDIX 3. (cont.)

Taxon	Element	Location	Type	Tool	Interpretation
Goat	Radius	Medial aspect of middle shaft	Chop mark	Cleaver	Defleshing/ Marrow
Cattle	Humerus	Proximal shaft	Diagonal cut marks	Knife	Defleshing
	Pelvis	Ventral aspect of pubis	Transverse cut marks	Metal knife	Disarticulation
	Tibia	Transverse plane of distal articulation	Sheared	Cleaver	Disarticulation
Equus	Femur	Around middle shaft	Transverse cut marks	Knife	Defleshing
	Tibia	Middle shaft	Diagonal cut marks	Metal knife	Defleshing
		Middle shaft	Transverse cut marks	Knife	Defleshing
Medium Mammal	Rib	Articulation	Transverse cut marks	Knife	Defleshing
Large Mammal	Humerus	Middle shaft	Percussion mark	Hammerstone	Marrow
	Pelvis	Inside acetabulum	Longitudinal cut marks	Knife	Disarticulation
	Vertebra, Thoracic	Lateral aspect of neural spine	Diagonal cut marks	Metal knife	Defleshing
		Transverse plane of centrum	Cleft	Cleaver	Dismemberment

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