ARCHAEOZOOLOGY OF THE NEAR EAST

V

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Preface

When I participated in the IV^th International Conference of ASWA, held in the summer of 1998 in Paris, I was gratified to learn that the Scientific committee had unanimously agreed to hold the next meeting in Jordan. Thus, on 2 April 2000, the V^th International Conference of the Archaeozoology of Southwest Asia and Adjacent Areas was held for the first time within the region at Yarmouk University in Irbid, Jordan after being held on the past four occasions in Europe.

The themes of this conference were divided into five areas including:

- Paleo-environment and biogeography
- Domestication and animal management
- Ancient subsistence economies
- Man/animal interactions in the past
- Ongoing research projects in the field and related areas

I wish to thank all those who helped make this conference such a success. In particular, I would like to express my appreciation to the Director of the Institute of Archaeology and anthropology at Yarmouk University Special thanks are due to his excellency, the President of Yarmouk University, Professor Khasawneh, who gave his full support and encouragement to the convening of this conference at Yarmouk University and to all those who contributed the working papers which made the conference possible.

I also wish to thank members of the organizing committee who worked very hard for many months in preparing the venue for this conference.

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Note from the editors:
The editors wish to thank Dr. László Bartosiewicz for his excellent assistance in preparing and checking the contributions to this volume.

Participants at the 5th ASWA Conference, held at theYarmouk University in Irbid, Jordan, 2000

Contents

CHOICE CUTS: HOMINID BUTCHERY ACTIVITIES AT THE LOWER PALEOLITHIC SITE OF HOLON, ISRAEL

Liora Kolska Horwitz[1] and Hervé Monchot[2]

Abstract

Butchery marks on animal bones from the open-air Lower Paleolithic site of Holon, situated on the southern coastal plain of Israel, are described. Features discussed are: the breakdown of marks by bone element and species, their number per bone, location on the bone and morphology. In addition, the possible butchery functions with which they were associated is reviewed.

This serves as the first detailed study of butchery damage from a Lower Paleolithic site in the Levant, and offers some insights into early hominid subsistence strategies in the region.

Résumé

Les marques de boucherie présentes sur les ossements d'animaux d'Holon, site du paléolithique inférieur de plein air de la côte méridionale israélienne, sont décrites. Les caractères discutés et analysés sont ainsi la présence des marques par élément anatomique et spécifique, leur nombre, leur localisation et leur morphologie sur l'os. De plus, leurs possibles fonctions dans les activités de traitement des carcasses sont également examinées.

Ce travail représente ainsi la première étude complète de traces anthropiques présentes sur des ossements au paléolithique inférieur dans la région du Levant, offrant ainsi des perspectives de recherches sur les stratégies de subsistance des Hominidés dans cette même région.

Key Words: Acheulean, Southern Levant, Butchery, Early Hominids, Hunting

Mots Clés: Acheuléen, Levant sud, Boucherie, Premier hominidés, Chasse

Introduction

Studies of early hominid sites in East Africa (e.g. Binford *et al.* 1988; Blumenschine 1986, 1988; Selvaggio 1994, 1998) and Europe (e.g. Binford 1981; Diez 1999; Gaudzinski and Turner 1999; Villa and Soressi 2000) have shown that the co-existence of lithics and fauna cannot be taken as clear evidence for the contemporaneity of these features or as proof that they are both the result of hominid activity. World-wide, site formation processes have been shown to be extremely complex and may involve a combination of anthropogenic and non-anthropogenic biological agents, as well as geomorphological and diagenetic processes (e.g. Binford 1981; Fosse 1999; Goldberg *et al*. 1993; Morlan 1984; Nash and Petraglia 1987; Stiner 1994). In many instances, the taphonomic histories of lithic and faunal assemblages found together may differ greatly. Thus, an archaeological assemblage may be the outcome of activities carried out by a variety of agents and processes which have contributed, either synchronically or diachronically, to its accumulation and/or modification in a particular location. Examination of these issues has served as the goal of the taphonomic study of the faunal remains recovered from the Lower Paleolithic open-air site of Holon, located on the southern coastal plain of Israel (Fig. 1).

A total area of 260 m^2 was excavated at the site of Holon during three excavation seasons in the 1960's and 1970 (Yizraeli 1967). A single archaeological horizon, lying in a light grey, sandy matrix, was identified which contained a rich assemblage of both lithic artifacts and fauna (Chazan *et al.* 2001). Recently, the archaeological horizon was dated using thermoluminescence (TL) and ESR dating techniques to 198±22 Ky – 201±17Ky BP, that is, within Qxygen Isotope Stage 7 (Chazan *et al.* 2001; Porat *et al*. 1999).

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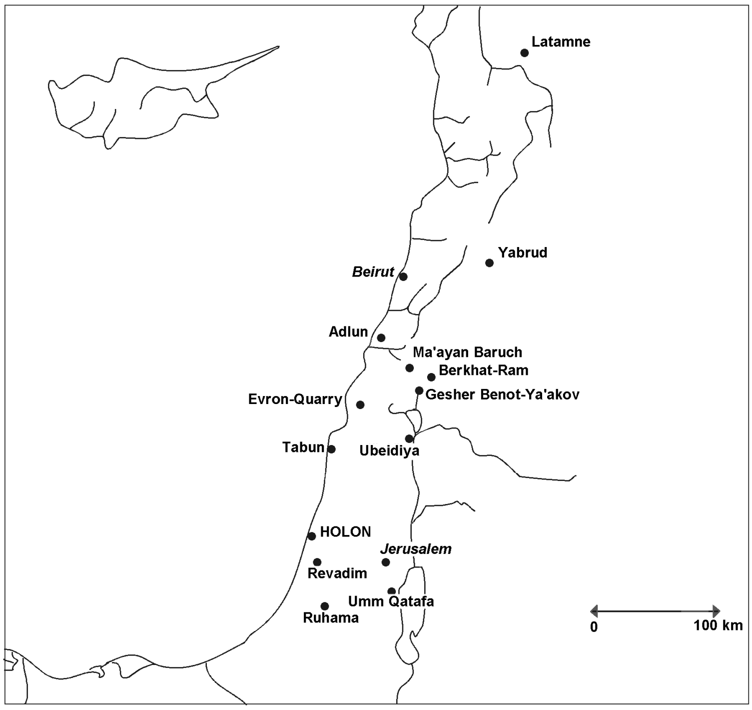

Fig. 1. Map showing location of Holon relative to other Lower Paleolithic sites in the Levant.

The Holon faunal assemblage, which numbered 1,568 bones (identified and non-identified), was subjected to an in-depth taphonomic study aimed at examining age and sex breakdown of species, body part representation, bone breakage and preservation and surface modifications (Monchot and Horwitz in press). Clear evidence was found on 3% of the bones for the action of non-human agents in the form of rodent gnawing and/or carnivore damage. However, the results of the other aspects of the taphonomic investigation indicated that hominids had played a major role in the accumulation of the faunal assemblage. Most importantly, the presence of cut marks on 3.3% of the bones, a feature which directly linked hominid activities (and hence lithic artifacts) to the animal bones at the site, offered the most conclusive evidence that at least part, if not all the bones, are the result of their activities.

As early as the mid-1800's, cut marks were recognized as a reflection of human butchery activities (Lartet 1860; Lartet and Christy 1865-75). In recent studies of the taphonomy of East African Plio-Pleistocene bone assemblages, cut marks have provided the strongest evidence for early human activity in controversial faunal assemblages (e.g. Bunn 1981; Bunn and Kroll 1986; Marshall 1986; Potts and Shipman 1981; Selvaggio 1994, 1998; Sept 1992; Shipman 1981, 1986). Butchery damage has also commonly been used to identify early hominid activity in Pleistocene sites in Europe (Fernandez-Lomana *et al*. 1997; Gaudzinski 1999; Gaudzinski and Turner 1999; Monchot 1996; Patou 1987; Shipman and Rose 1983; Valensi 1991), as well as in late Pleistocene sites in North America (Shipman *et al*. 1984).

This paper describes the evidence for butchery damage in the Holon faunal assemblage, and discusses its implications for early hominid subsistence activities in the Levant. This is the first detailed documentation of butchery damage from a Lower Paleolithic site in this region.

Materials and methods

The faunal assemblage from Holon comprises a total of 1,568 bones of which only 572 (36 %) could be identified to species (Chazan *et al*. 2001). Eight species were identified (Table 1) with remains of fallow deer (*Dama* cf. *mesopotamica*) being most frequent followed by aurochs (*Bos primigenius*). The straight-tusked elephant (*Palaeoloxodon antiquus*) was the third most common species. Scanty remains were found of gazelle (*Gazella* sp.), possibly the mountain gazelle, red deer (*Cervus elaphus*), a suid tentatively identified as *Sus* cf. *scrofa,* and marsh turtle (*Mauremys caspica*). This assemblage reflects the mosaic environment of the landscape around the site and points to the presence of a relatively deep water-source (*Hippopotamus, Mauremys*) as well as the proximity of forest-scrubland and park-forest (*Palaeoloxodon, Dama, Bos*) and grassy steppe (*Gazella*).

Table 1. Fauna represented at Holon.

SPECIES	NISP	% NISP	MNI
Dama mesopotamica	247	43.1	5
Bos primigenius	162	28.3	3
Palaeoloxodon antiquus	120	21.0	5
Hippopotamus cf. *amphibius*	29	5.0	2
Gazella sp.	7	1.2	1
Mauremys caspica	3	0.5	1
Cervus elaphus	2	0.3	1
Sus cf. *scrofa*	2	0.3	1
TOTAL	572	100	19

All identified bones as well as unidentified bone fragments in the Holon faunal assemblage were examined under artificial light for surface modifications using a binocular microscope with magnifications of up to 25 X. For each bone, the element and species were noted as well as the type of damage, its location and number and form of modifications. Anthropogenic damage was observed on 53 (3.3%) bones in the assemblage.

Two categories of damage were identified, those resulting from tool-induced modification, namely cut marks and chop marks, and those due to fracture of bones, namely conchoidal percussion scars and notches:

(1) Cut Marks: These are incisions resulting from the cutting movement of a sharp-edged implement on the bone’s surface. They are elongated, linear striations of variable length and width (Fig. 2). Cut marks are usually V-shaped in section, but cross-sectional area and width have been shown to vary depending upon the pressure applied during tool use and the sharpness of the cutting edge (Fischer 1995; Walker and Long 1977). Bifacially flaked stone tools leave relatively shallow and wide striations that may be irregular in cross-section (Greenfield 2000; Walker and Long 1977). These grooves are uneven in length and thickness and take the form of a series of secondary but parallel striations, lateral to the apex of the cut at the bottom of the groove (Greenfield 2000). One side of the cut mark is steeper and smoother than the other which is rough and forms a series of step-like secondary ridges. Walker and Long (1977) noted that following the application of low pressure, unmodified stone flakes produced V-shaped, shallow grooves while under higher pressure, the edges of the flake tools resulted in broader, irregular striations similar to those made by bifacially flaked artifacts.

In order to distinguish between striations made by carnivore dentition and cut marks resulting from tool use, criteria outlined in Shipman (1981) were followed and several cut-marked bones from Holon were studied using an Environmental SEM. Cut marks usually exhibit fine parallel striations within the main groove of the striation (Fig. 3). This is thought to be produced by the irregular cutting edge of the tool and is absent in carnivore marks which, in contrast, may exhibit small perpendicular ridges along the edges, resulting from the movement of the teeth as they are impelled across the bone surface while the animal applies force.

(2) Chop Marks: These are defined as broad, deep and relatively linear depressions that often have a V-shaped cross-section (Fisher 1995). Internal striations within the main groove may be observed (Fig. 4). Chop marks are the result of a heavy blow to the bone with a sharp implement.

(3) Conchoidal Flake Scars and Notches: Flake scars and notches are produced when a strong force is applied to the bone, usually by a hard object, resulting in the removal of bone fragments due to the impact or the removal of arc-shaped flakes on the edge of the bone (Fisher 1995) (Fig. 5). Arc-

shaped flakes were found on several bones in the Holon assemblage. This damage type was interpreted, even in the absence of clear percussion pits and impact scars, as the result of intentional bone breakage and shaft fracture, probably to facilitate marrow extraction. Similar bone flakes were produced by Stanford *et al.* (1981) in an experiment on fresh elephant bone.

The morphology of the butchery marks were noted as Transverse, Oblique, Parallel (or a combination of features) according to their angle relative to the long axis of the bone following Lyman (1987). Based on their location, morphology and frequency, together with information on the soft tissue anatomy of the relevant species, an attempt was made to interpret the function of the butchery marks. For this purpose reference was also made to criteria outlined in Binford (1981). Three butchery activities are associated with the Holon cut and chop marks: disarticulation which involves the taking apart of the carcass (separating limbs from the carcass), dismemberment which is the division of limbs into joints of meat (cutting limb from limb), and filleting which entails the removal of meat. A further activity, bone breakage by percussion, is responsible for the creation of the bone notches.

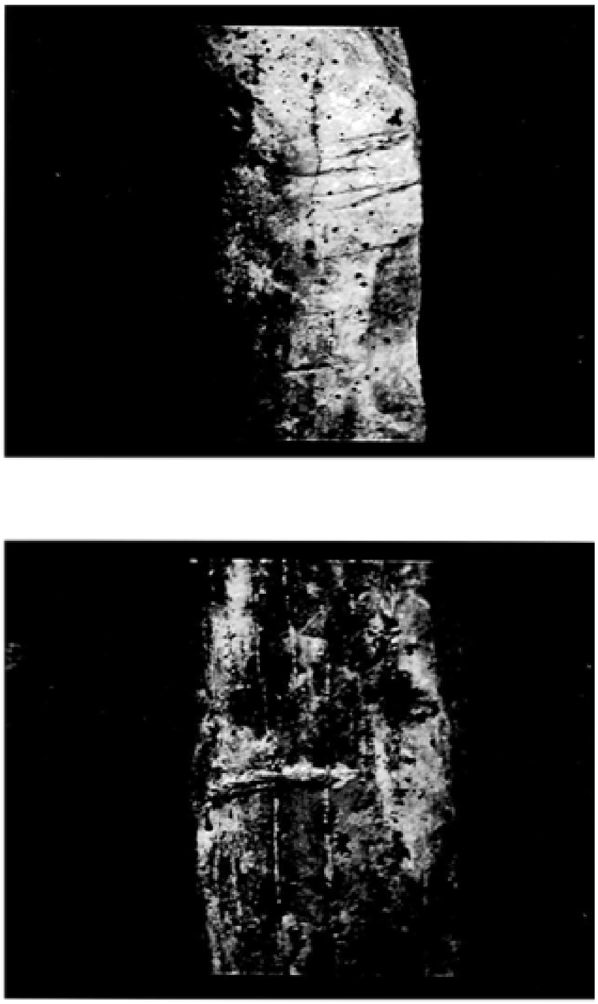

Fig. 2. Two examples of cut marks on bones from Holon taken with a binocular microscope
Multiple cut marks on specimen HN#1031 (10X)
A single cut mark on specimen HN# 1032 (25X)

Findings

Anthropogenic modifications were present on 53 bones (3.3%) in the Holon faunal assemblage. These were broken down into 23 diagnostic bones (4% of the identified sample) and 30 unidentified bone splinters (3% of the splinter sample) (Table 2). In terms of damage type, they comprised 39 cut marks (17 on diagnostic bones and 22 on unidentified bone splinters); 5 chop marks (all on diagnostic bones); and 9 flaked bones (1 on a diagnostic bone and 8 on unidentified bone splinters).

Cut Marks

Cut marks were found on 15 bones of *Dama* out of a NISP of 247 (6%), while 7 cut marks were present on bones of *Bos* from an NISP count of 162 (4%) (Table 1). Thus, the quantity of cut marked bones per species is directly correlated to the relative abundance (NISP counts) of these species at the site. Only one gazelle bone exhibited a cut mark which is a relatively high frequency considering that only 7 bones of this species were identified in the assemblage. This means that some 14% of gazelle bones had cut marks. The absence of cut marks on bones of *Palaeoloxodon* and *Hippopotamus* is related to the fact that these species are almost entirely represented by dentition despite their prominent representation in the NISP counts for the site (Table 1). A chi square test showed that there are no significant differences between species in the frequencies of cut-marked bones ($\chi^2 = 11.179$; d.f. = 6; P = 0.131).

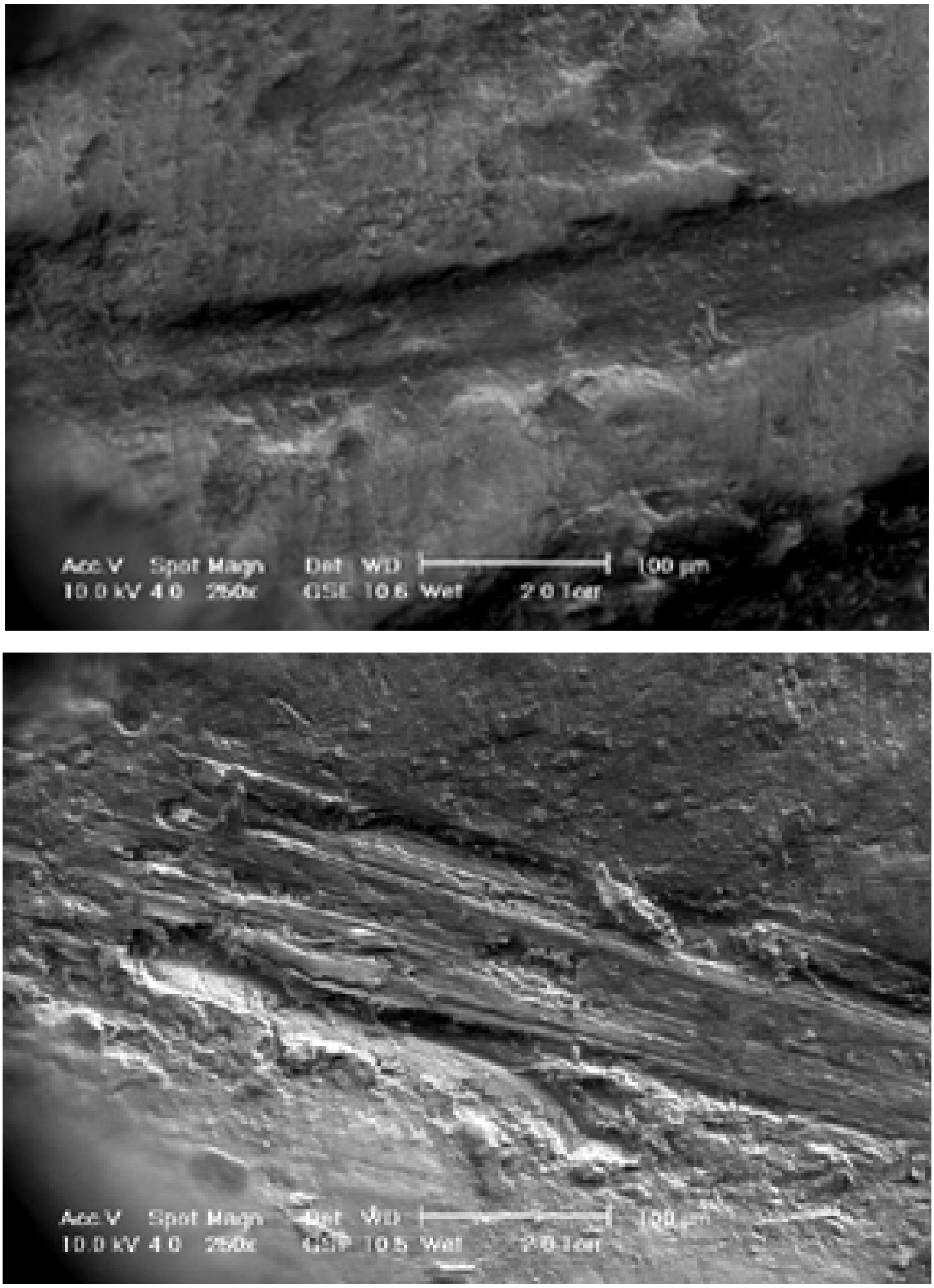

Fig. 3. SEM photographs of cut marks from Holon illustrating the uneven edges of the groove made by a bifacially flaked artifact in (a) HN# 1031, and the presence of typical internal micro-striations within the main groove in (b) HN# 188.
Our special thanks to the UMR 5590 of the CNRS at Tautavel, France for providing us with the SEM photographs.

Fig. 4. An example of a chop mark on an antler fragment (HN#338).

Fig. 5. Example of a flake scar on specimen HN#535.

A total of 24 bone fragments with butchery damage could not be identified to species or bone element and were placed in a medium-sized herbivore category, while a further 6 bones were placed in the large-sized herbivore category (Table 2). Assuming that the fragments from medium-sized herbivores are those of *Dama* and the large ones belong to *Bos*, the total cut-marked bones per species increases to 39 for *Dama* and 13 for *Bos*. Thus, a total of 16% of all *Dama* bones exhibited cut marks, compared to only 8% for *Bos*. When tested using a chi square test, this inter-species difference was found to be statistically significant ($P = 0.001$) indicating that there are proportionally more cut-marked bones in the medium-sized herbivore category than in the large-sized herbivore group. When the frequency of non-diagnostic cut-marked bones was re-calculated as a proportion of all the large and medium-sized herbivore category (661 large herbivore bones and 298 medium herbivore remains) the results were non-significant (4.3% for medium-sized herbivores and 2.8% for large-sized herbivores).

As shown in Table 2, the majority of bones in the Holon assemblage had a single cut mark each; 11 of the 23 identified bones (48%) and 12 of the 30 unidentified splinters (40%). Two cut marks per bone were found on 10 of the identified bones (44%) and only on 4 (13%) of the unidentified splinters (Table 2). Two bone splinters (7%), but none of the identified bones, had 3 cut marks each. The highest number of cut marks was found on an unidentified bone splinter (6 cut marks). Another two splinters had five cut marks each, while a *Bos* cranial bone had the highest number of cut marks ($N = 4$) of the identified bones. These marks have been identified as relating to skinning.

For both species, most of the cut marks appear on the epiphyseal ends of the long bones. For *Dama* these are the distal radius and proximal metatarsal, while for *Bos* the distal humerus was the most commonly cut marked bone.

Table 2. List of anthropogenic marks in the Holon bone assemblage (by body part)
R = Right; L = left; Ind = indeterminate; Ina = inapplicable; MH = medium herbivore; GH = large herbivore

Specimen Number	**Type of Mark**	**Frequency**	**Skeletal Element**	**Location**	**Side**	**Taxa**	**Morphology**	**Function**
HN 2	Chop mark	Single	Antler		Ind	*Dama*	Transverse	??
HN 338	Chop mark	Single	Antler		Ind	*Dama*	Transverse	??
HN 339	Cut mark	Four	Crania		Ina	*Bos*	Oblique and parallel	Skinning
HN 329	Cut mark	Single	Humerus, distal epiphysis		R	*Bos*	Transverse	Dismembering
HN 334	Cut mark	Two	Humerus, distal epiphysis	Lateral	R	*Bos*	Transverse and parallel	Dismembering
HN 89	Cut mark	Two	Radius, distal epiphysis	Medial	R	*Dama*	Transverse and parallel	Dismembering
HN 186	Chop mark	Two	Radius, proximal epiphysis		R	*Bos*	Oblique	Dismembering
HN 209	Cut mark	Two	Femur, distal diaphysis	Anterior	L	*Bos*	Oblique and parallel	Filleting
HN 188	Cut mark	Single	Tibia, proximal shaft	Lateral	L	*Dama*	Oblique	Filleting
HN 276	Cut mark	Single	Tibia, distal epiphysis		L	*Dama*	Oblique	Dismembering
HN 142	Cut mark	Single	Metatarsal,proximal epiphysis	Anterior	Ind	*Dama*	Transverse	Disarticulation
HN 147	Cut mark	Single	Metatarsal, proximal epiphysis	Anterior	Ind	*Dama*	Transverse	Disarticulation
HN 350	Cut mark	Two	Metatarsal, diaphysis			*Dama*	Oblique	Disarticulation
HN 410	Chop mark	Single	Metatarsal, proximal diaphysis	Anterior	L	*Dama*	Oblique	Disarticulation
HN 77	Cut mark	Two	Metapodial, distal epiphysis	Medial	R	*Dama*	Transverse and Parallel	Disarticulation
HN 263	Flake	Single	Metapodial, shaft		Ind	*Dama*		Marrow extraction
HN 426	Cut mark	Two	Metapodial, shaft		Ind	*Dama*	Oblique	Disarticulation
HN 96	Cut mark	Single	Naviculo-cuboid	Anterior	R	*Dama*	Transverse	Dismembering
HN 278	Cut mark	Single	Calacaneus, proximal part		Ind	*Dama*	Oblique	Disarticulation
HN 357	Cut mark	Single	Cuneiform	Posterior	L	*Bos*	Oblique	Dismembering
HN 447	Chop mark	Two	Rib		Ind	*Bos*	Transverse	Disarticulation
HN 1475	Cut mark	Two	Thoracic vertebra		Ina	*Gazella*	Parallel	Disarticulation
HN 161	Cut mark	Two	Thoracic vertebra		Ina	*Dama*	Oblique	Disarticulation
HN 501	Cut mark	Two	Splinter		Ind	MH	Oblique	Filleting
HN 521	Cut mark	Single	Splinter		Ind	GH	Oblique	Filleting
HN 535	Flake	Single	Splinter		Ind	MH		Marrow extraction
HN 561	Flake	Single	Splinter		Ind	GH		Marrow extraction
HN 570	Cut mark	Two	Splinter		Ind	MH	Oblique	Filleting
HN 581	Cut mark	Three	Splinter		Ind	MH	Oblique and incurved	Filleting
HN 606	Flake	Single	Splinter		Ind	GH		Marrow extraction
HN 614	Cut mark	Single	Splinter		Ind	MH	Oblique	Filleting
HN 615	Cut mark	Single	Splinter		Ind	MH	Oblique	Filleting

Table 2. continued

Specimen Number	Type of Mark	Frequency	Skeletal Element	Location	Side	Taxa	Morphology	Function
HN 616	Cut mark	Two	Splinter		Ind	MH	Oblique	Filleting
HN 639	Cut mark	Five	Splinter		Ind	MH	Oblique	Filleting
HN 648	Cut mark	Single	Splinter		Ind	MH	Oblique	Filleting
HN 677	Cut mark	Two	Splinter		Ind	MH	Oblique	Filleting
HN 691	Cut mark	Single	Splinter		Ind	GH	Oblique	Filleting
HN 707	Cut mark	Single	Splinter		Ind	GH	Oblique	Filleting
HN 764	Cut mark	Two-Three	Splinter		Ind	MH	Oblique	Filleting
HN 855	Cut mark	Five	Splinter		Ind	MH	Oblique	Filleting
HN 938	Cut mark	Single	Splinter		Ind	MH	Oblique	Filleting
HN 963	Cut mark	Single	Splinter		Ind	MH	Oblique	Filleting
HN 1008	Flake	Single	Splinter		Ind	MH		Marrow extraction
HN 1018	Flake	Single	Splinter		Ind	MH		Marrow extraction
HN 1019	Cut mark	Two	Splinter		Ind	MH	Oblique	Filleting
HN 1031	Cut mark	Six	Splinter		Ind	MH	Transverse	Filleting
HN 1032	Cut mark	Single	Splinter		Ind	MH	Oblique	Filleting
HN 1038	Cut mark	Single	Splinter		Ind	MH	Oblique	Filleting
HN 1042	Cut mark	Single	Splinter		Ind	MH	Oblique	Filleting
HN 1099	Flake	Single	Splinter		Ind	MH		Marrow extraction
HN 1114	Cut mark	Single	Splinter		Ind	MH	Oblique	Filleting
HN 1150	Flake	Single	Splinter		Ind	MH		Marrow extraction
HN 1235	Flake	Single	Splinter		Ind	GH		Marrow extraction

There is no statistically significant association, for either *Bos* or *Dama*, between the number of cut-marked bones and the NISP of a particular bone element as shown by the results of the Kolmogorov-Smirnov test shown in Table 3 (*Dama*: Z = 0.545 P>0.1; *Bos*: Z= 0.621; P>0.1). Thus, the number of cut bones of a particular bone element is independent of sample size and must reflect differences in butchery activities. The only butchery marks in the mid-shaft region were flakes removed from a *Dama* metapodial which relates to percussion during breakage of the bone for marrow extraction.

When the function of the different cut marks is examined (Table 2), the majority of those found on *Dama* bones are associated with disarticulation i.e. primary division of the carcass. For *Bos* a different pattern is observed, with the majority of butchery marks being those associated with dismembering i.e. division of limbs into smaller parcels of meat (joints). On bones of both species few filleting marks were evident, while only one skinning mark was present on a *Bos* proximal metatarsal. Binford *et al*. (1988) and Binford (1981) noted that the number of butchery marks is highest following filleting. A chi square test for species differences in cut mark type was not found to be statistically significant (χ^2= 6.36; d.f. = 4; P = 0.117). If only the identified elements are tested, the significance level of the results of the chi square tests are borderline (χ^2= 9.772; d.f. = 4; P = 0.059), while if you include the cut-marked bone splinters the results are not statistically significant despite the extra cut-marked pieces, especially in the medium-sized herbivore/*Dama* category.

As illustrated in Table 4, in *Dama* the majority of cut marks are concentrated in the wrist and ankle regions, and may relate to the separation (disarticulation) of the lower extremities, poor in meat, from the upper limb segments which are rich in meat (Blumenschine and Caro 1986; Grand 1991). In contrast, the majority of cuts on *Bos* bones occurred in the elbow region and may relate to the dismemberment of the meat-rich upper limbs into smaller joints. The absence of cut marks on the hindlimbs of *Bos* may be explained by the fact that the forelimb yields markedly less meat than the hindlimb (Blumenschine and Caro 1986; Grand 1991), such that in order to maximize meat removal from the forelimb there will be a greater probability of cutting the bone. In contrast, in the meat-rich hindlimb, one can obtain a significant quantity of meat with less chance of nicking the bone. This is corroborated by data shown in Table 5.

For both *Dama* and *Bos*, it is apparent that there are more cut marks on the meat-rich bones than on the non-meaty ones (Table 5). However, when tested with a chi square test these differences were not statistically significant for *Dama* (χ^2= 2.228; d.f. = 1; P = 0.133) and only slightly significant for *Bos* (χ^2= 4.533; d.f. = 1; P = 0.033). Comparison of cut mark frequencies for meaty bones between species proved not to be significant using Arcsine transformations (Table 5), but the frequency of cut marked non-meaty bones was borderline (P>0.05), indicating differences in the pattern of butchery between the large-sized *Bos* and medium-sized *Dama*.

Chop Marks and Flakes

Chop marks were observed on five identified bones (Table 1). Two of these were on *Dama* antler and may represent damage incurred during antler removal from the cranium. Similarly, the presence of chop marks on a proximal radius and rib of *Bos*, and a proximal metatarsal of *Dama* are probably due to heavy blows aimed at disarticulation of limb segments.

Conchoidal flake scars were rare on identified bones and only found on a metapodial shaft identified as *Dama*. These are clearly identified with activities involving percussion, either for fracturing long bones for marrow removal or for bone artifact manufacture. In addition, eight bone splinters had flake scars.

Discussion

Only a low frequency of bones in the Holon assemblage exhibited cut marks (3%). Based on the data presented here, it is clear that there is no association between the number of cut-marked bones of a particular element and the relative abundance of that element in the assemblage. Thus, the number of cut marks is independent of sample size and must reflect butchery activities.

Table 3. NISP and frequencies of cut-marked specimens at Holon by bone element

	BOS			**DAMA**		
Skeletal Part	**NISP**	**N CUT**	**% CUT**	**NISP**	**N CUT**	**% CUT**
Antler/Horn	7	0	**0**	13	2	**15**
Cranium	10	1	**10**	3	0	**0**
Humerus dist	4	2	**50**	4	0	**0**
Radius dist	0	0	**0**	3	1	**33**
Radius prox	6	1	**17**	5	0	**0**
Femur dist	3	1	**1**	3	0	**0**
Tibia prox	1	0	**0**	4	1	**25**
Tibia dist	3	0	**0**	5	1	**20**
Metatarsal prox	3	0	**0**	9	3	**33**
Metatarsal Shaft	0	0	**0**	24	1	**4**
Metapodial dist	13	0	**0**	13	1	**8**
Metapodial Shaft	1	0	**0**	13	2	**15**
Naviculo-cuboid	1	0	**0**	3	1	**33**
Calcaneus	1	0	**0**	3	1	**33**
Cuneiform	1	1	**100**	0	0	**0**
Rib	1	1	**100**	4	0	**0**
Thoracic Vertb.	0	0	**0**	1	1	**100**

Kolmogorov-Smirnov test between NISP and N Cut:
DAMA: Z = 0.545, P > 0.1; BOS: Z = 0.621, P > 0.1

Table 4. NISP and frequencies of cut-marked specimens at Holon by joints

Species	**BOS**			**DAMA**			**Arcsine**	
Skeletal Part	NISP	N CUT	% CUT	NISP	N CUT	% CUT	t s	*P*
Elbow	10	3	**30**	4	1	**25**	0.082	> 0.5
Wrist	0	0	**0**	12	4	**33**	4.354	< 0.01
Knee	9	0	**0**	7	1	**14**	1.119	> 0.2
Ankle	9	1	**11**	20	6	**30**	0.982	> 0.3

Joint breakdown after Lyman (1987, 1994: 312) where:
Elbow: distal humerus, proximal radius, proximal ulna
Wrist: distal radius, distal ulna, carpals, proximal metacarpal
Knee: distal femur, patella, proximal tibia
Ankle: distal tibia, tarsals, distal fibula, proximal metatarsal

Table 5. Frequency of cut marked meaty versus non-meaty bones

Anatomical Element	**NISP**	**N Cut**	**% Cut**	**NISP**	**N Cut**	**% Cut**	**Arcsine**	
							t s	***P***
HOLON	**DAMA**			**BOS**				
Meaty	24	6	25	17	4	23	0.077	> 0.5
Non-meaty	59	7	12	17	0	0	1.759	> 0.05

Breakdown of meaty to non-meaty bones taken from Lyman (1994, Table 8.5):
Meaty: limbs and shafts of humerus, radius, ulna, femur, tibia.
Non-meaty: metapodials.

There is also no correlation between the number of cut marks per bone and the identified species, bone element type or the butchery activity that the marks are associated with (function).

However, there are differences in the pattern of butchery at Holon between the two most common species at the site, *Bos* and *Dama*, which reflects variation in the manner in which different sized animals were exploited. The medium-sized herbivore bones have significantly more cut marks than those of large herbivores. The majority of these remains are associated with disarticulation of the carcass. Unfortunately, no data for either species was available for the bones of the shoulder or hip. However, as the majority of cut marks for *Dama* were found in the wrist and ankle joints, it suggests disarticulation of the meat-rich upper limbs (shoulder and hip) from the lower extremities (metapodials and feet) which are poor in meat. Thus, complete carcasses of *Dama* were probably butchered on-site, with entire limbs or large joints of meat being removed.

In contrast, the large-sized herbivore group has a lower frequency of cut marked bones, and these tend to be correlated with meat-rich elements. Most of these marks are related to dismemberment i.e. the division of limbs into smaller parcels of meat (joints). For *Bos* the highest frequency of cut marks are in the elbow followed by the knee joints, both of which are primarily comprised of meat-rich elements. It is suggested here that in contrast to *Dama*, the large-sized *Bos* carcasses were being reduced on-site into much smaller parcels of meat. This pattern of butchery clearly takes into account the marked size difference between the species.

Attempts have been made by researchers (e.g. Binford 1981; Lyman 1987, 1994; Marean 1998; Shipman 1986) to apply data on cut mark abundance and their relative position on specific bones to the study of early hominid subsistence strategies, namely hunting versus scavenging. It has been suggested by them that a high frequency of cut marks on meaty bones is generally associated with early access to a carcass and hence more likely to be associated with hunting. In contrast, a high frequency of cut marks on bones poor in meat has been interpreted as associated with late access to a carcass i.e. scavenging. In light of these hypotheses, it may be concluded that both the medium and large-sized herbivores in the Holon assemblage probably represent early access to carcasses, and as such may represent hunted rather than scavenged prey. This interpretation would support other lines of evidence which have led Chazan *et al.* (2001) to suggest that the site of Holon may represent a palimpsest of hunting and butchering episodes. The presence of carnivore damage on 3% of the bones (i.e. as many bones as have cut marks), supports this interpretation.

Having established that the provisioning capabilities of the Lower Paleolithic hominids at Holon were complex and probably involved hunting rather than scavenging, the question to be posed is how did they catch and butcher these animals?

Recent experiments on animal butchery using lithic artifacts (Schick and Toth 1993) have shown that for opening the carcass, sharp, unmodified flakes are the most efficient tools, while for dismembering and defleshing unmodified or retouched flakes are the most efficient. However, unmodified flakes dull within 3-4 minutes of use (Brose 1975) while modified flake tools last longer, can be rapidly resharpened and have been shown to be as efficient as metal tools (Greenfield 2000). For marrow extraction, bones can be cracked open using an unmodified cobble or core (Schick and Toth 1993). Detailed typological and technical studies of the lithics from Holon have recently been published by Chazan (2000a,b). The entire assemblage comprised 1,468 artifacts which is almost as large as that of the fauna (N = 1568). Chazan (2000a) noted that the most frequent lithic artifacts were flake tools, predominantly sidescrapers and raclettes (a total of 44% of the assemblage). A high frequency of retouch was evident on the flakes. In addition 100 handaxes and 39 choppers were recovered that had been manufactured off-site. No projectile points or spears have been found at Holon, but it has been suggested that handaxes may have served as projectiles (O’Brien 1981). Consequently, together with the retouched and unmodified flake tools at Holon, a rich lithic assemblage suitable for hunting and butchery of extremely large species such as elephants and hippopotami through to small ungulates such as gazelle, would have been readily available to its Paleolithic occupants.

Stanford *et al*. (1981) have also suggested that bone flakes may serve as efficient butchering tools for cutting through animal hide. They were however less efficient for butchering muscle as the meat tended to adhere to the edges. As they are difficult to resharpen, such flakes would have been discarded once dull (Stanford *et al.* 1981). The presence of arc-shaped notches on 3 large-sized herbivore bone splinters may reflect the manufacture of such tools. No evidence for more formal bone tools, as described from several European sites (Gaudzinski 1999), was found at Holon.

Tool use, which entails enlisting an unattached object to modify another such object, is no longer considered a uniquely human feature as a wide range of non-human species are both tool-makers and tool-users (Ambrose 2001). However, evidence for a complex method of tool use and hence of developed cognitive behaviour at Holon is reflected in the marked difference in butchery patterns between *Dama* and *Bos,* two different-sized prey. This reflects a systematic plan of action which is the essence of tool use, namely the application of an external object to express a plan. As early as the 1980's several researchers (Bunn 1981; Bunn and Kroll 1986; Potts and Shipman 1981; Shipman 1986) suggested that at least 2 million years ago, East African hominids were capable of efficient butchery activities entailing skinning, dismemberment and meat removal. The earliest dates for percussion and cut marks on bones now stands at 2.5 million years ago (Ambrose 2001). Thus, it is not surprising that the more recent Lower Paleolithic population of Holon, dated to circa 200,000 years ago should reflect such expertise in this field.

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