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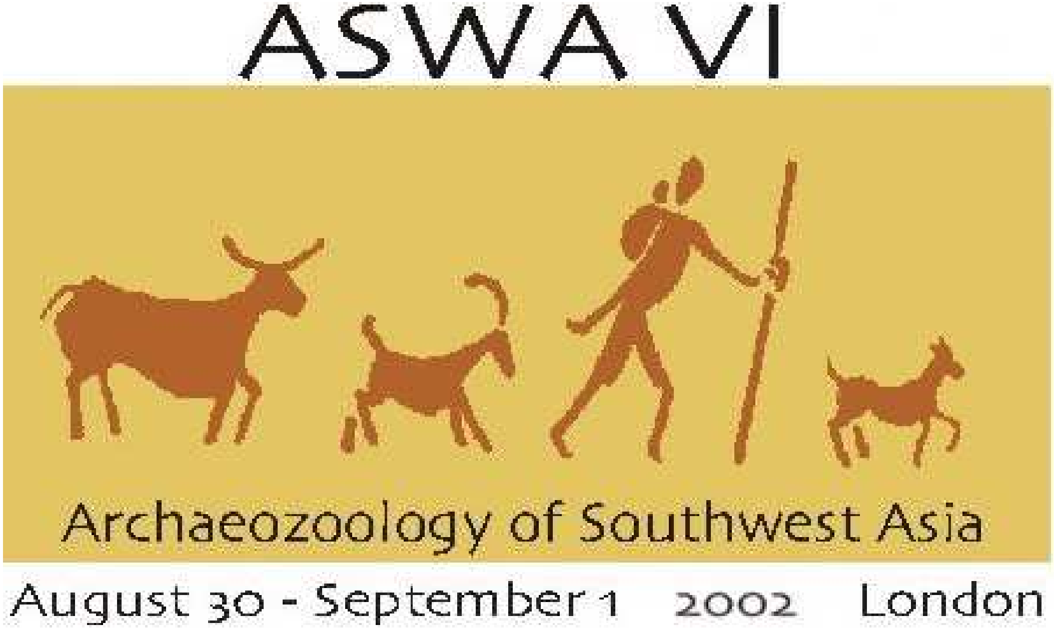
ARCHAEOZOOLOGY OF THE NEAR EAST
VI

Proceedings of the sixth international symposium on the archaeozoology of southwestern Asia and adjacent areas

edited by

H. Buitenhuis, A.M. Choyke, L. Martin, L. Bartosiewicz
and M. Mashkour



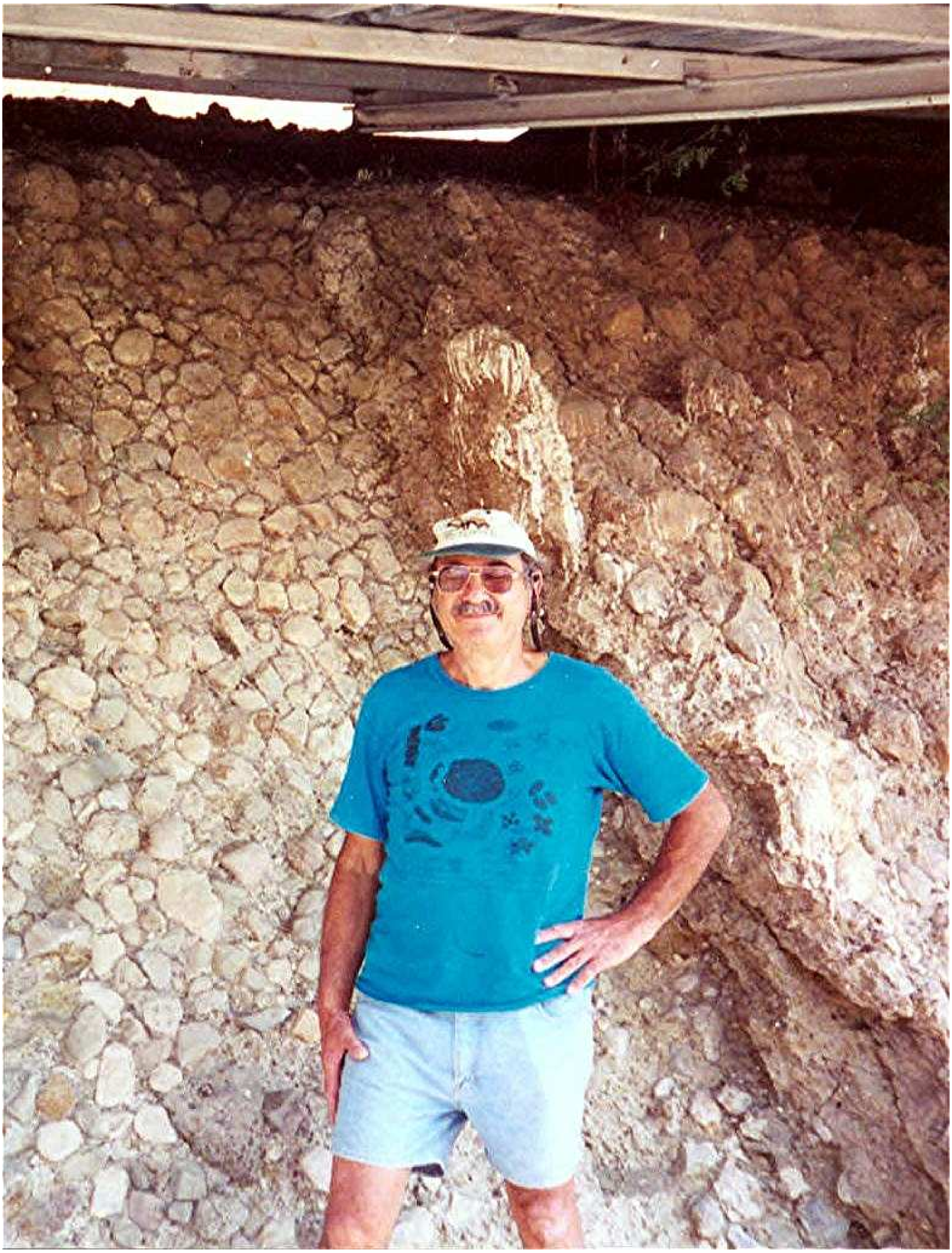
ARC-Publicaties 123
Groningen, The Netherlands, 2005

Cover illustration by Chris Mosseri-Marlio

This publication is sponsored by: ARC-bv and Vledderhuizen Beheer bv

Information and sales: ARC-bv, Koningsweg 48, Postbus 41018, 9701CA Groningen, The Netherlands, Tel: +31 (0)50 3687100, fax: +31 (0)50 3687 199, email: info@arcbv.nl, internet: www.arcbv.nl

ISBN 90-77170-02-2



Prof.Dr. Eitan Tchernov

This volume is dedicated to the memory of Prof. Dr. Eitan Tchernov, in fond memory of his enthusiasm and support to many in the field of archaeozoology**.**

Preface

The ASWA VI meeting was held at the Institute of Archaeology, University College London, from 30th August-1st September 2002, timetabled to follow on the heels of the ICAZ meeting in Durham, UK. Over 55 participants attended the meeting, travelling from 13 countries, bringing the latest research results from our field. As usual, it was a pleasure to see so many doctoral students presenting their research – a sign for a very healthy future for zooarchaeology in south west Asia. It is still unfortunate, however, that colleagues from some Middle Eastern countries were unable to attend due to financial and political constraints.

Presentations were organized into the following six themes, which highlight the scope of the ASWA membership: Animals in Palaeolithic and Epipalaeolithic Levant; Neolithic Patterns of Animal Use; Animals in Neolithic Anatolia; Animals in the Chalcolithic and Bronze Ages; Iron Age, Nabatean and Roman Patterns of Animal Use; Animals in Ancient Egypt. There was also a poster session, and contributors were invited to submit papers to this volume.

As always with the ASWA forum, the meeting served to welcome new scholars to the group, but was also very much a reunion of old friends and colleagues who have been sharing new information and discussing issues of joint interest for many years now. In this vein, it is a great sadness that ASWA VI was the last international meeting attended by Prof. Eitan Tchernov, an original founder of the group and mentor and inspiration to so many. For many of us, it was the last time we saw Eitan, and experienced his usual incisive comment, unstoppable enthusiasm for the subject, and warm friendship. He will be greatly missed.

ASWA VI was supported by the Institute of Archaeology, UCL, who provided facilities and financial and administrative help. In particular, the organizing team was aided greatly by the administrative assistance of Jo Dullaghan at the Institute. ARC bv (Archaeological Research and Consultancy, Groningen, The Netherlands) once again shouldered the finances of the publication of the proceedings, and we are extremely grateful for their continuing support. Many thanks are also due to the postgraduate student helpers from the Institute of Archaeology who made the meeting run so smoothly: Banu Aydinoğlugil, Jenny Bredenberg, Chiori Kitagawa, Peter Popkin, and Chris Mosseri-Marlio (who also produced the logo reproduced on the frontispiece of this volume).

Many thanks to all the participants for making the meeting such a success!

Louise Martin
London 2005

Participants of the 6th ASWA Conference, held at the Institute of Archaeology, University College London.

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Preface

BROKEN MAMMAL BONES: TAPHONOMY AND FOOD SHARING AT THE OHALO II SUBMERGED PREHISTORIC CAMP

Rivka Rabinovich[1] and Dani Nadel[2]

Abstract

The open-air submerged site of Ohalo II (Sea of Galilee, Israel) was occupied during the cold and dry conditions of the last Glacial Maximum (ca. 19,500 BP), on a year-round basis. The well-preserved remains include the floors of six brush huts, hearths, a grave and small installations. Large quantities of food remains were preserved *in situ* on the floors and near the hearths. These provide a detailed picture of the lives of fishers-hunters-gatherers in a resource-rich environment, where fruit, grains, fish, birds and mammals thrived within the immediate surroundings of the camp. Medium-sized mammals were one of the major animal protein sources for the inhabitants. The mode of animal exploitation was traced in detail by studying a sample of 7678 mammal bones. The results indicate preliminary off-site butchering and on-site meat consumption and bone marrow extraction. Food sharing seems to have taken place around open-air fireplaces as well as in the brush huts.

Resumé

Le site de plein air submergé de Ohalo II (Mer de Galilée, Israel) a été occupé durant les conditions climatiques froides et sèches de la dernière Maximum Glaciaire (ca.19,500 BP) sur une base annuelle. Les restes très bien conservés incluent les sols de six huttes, des foyers, une tombe et de petites installations. Sur les sols entre les huttes et proche des foyers, de grandes quantités de restes de nourriture a été préservé *in situ*. Ceux ci offrent une image détaillée de la vie de pêcheurs, chasseurs-cueilleurs dans un environnement à ressources abondantes, où les fruits, les graines, les poissons, les oiseaux et les mammifères prospèrent aux abords immédiats du camp. Les mammifères de taille moyenne étaient l'un des principale source de protéine des occupants du site. Le mode d'exploitation des animaux est décrit en détail par l'étude de 7678 restes osseux mammaliens. Les résultats indiquent un premier abattage hors site en vue de consommation de viande et d'extraction de moelle. Le partage de nourriture se déroule autour du foyer de plein-air de même que la hutte.

Keywords: Upper Palaeolithic, medium-sized mammals, taphonomy, butchery, sharing, hunter-gatherers, Israel.

Mots Clés: Paléolithique supérieur, mammifères de taille moyenne, taphonomie, boucherie, partage, chasseurs-cueilleurs, Israel.

Introduction

Since the end of the Mousterian in the Mediterranean Levant (ca. 45,000 B.P.), the most common medium-sized mammal species found in prehistoric sites have been gazelle (*Gazella gazella,* Bovidae) and fallow deer (*Dama mesopotamica,* Cervidae). Other mammals, which are not found at all sites, include red deer (*Cervus elaphus*, Cervidae), aurochs (*Bos primigenius*, Bovidae), wild goat *(Capra aegagrus*, Bovidae), boar (*Sus scrofa*, Suidae) and equid (*Equus ferus*, Equidae), as well as small numbers of carnivores such as fox (*Vulpes vulpes*, Canidae). Smaller animals such as lagomorphs, rodents, reptiles, birds, fish and snails have also been discovered (Tchernov, 1988; Stiner *et al.* 1999, 2000). The species variability in the Upper Palaeolithic and the subsequent Epipalaeolithic is quite similar, with an increasing dominance of gazelle at most later sites (Davis 1982, 1983; Tchernov 1981, 1988; Bar-Oz and Dayan 1999). The accepted view is that the hunted fauna represents the immediate environments of the sites (*ibid*; Higgs 1967; Garrard 1982; Rabinovich 2003), though no doubt tradition, hunters' choice and other factors affected the range of recovered species as well as their relative frequencies in the archaeological record.

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Faunal assemblages are known from many caves and open-air sites around the southern Levant. Nonetheless, the number of detailed reports from Upper Palaeolithic and early Epipalaeolithic sites is relatively small, and various aspects of the data are not always comparable. Animal remains are a major source of information for reconstructing subsistence and behavioral patterns, though interpretations vary considerably. A large faunal assemblage was recovered from the open-air submerged site of Ohalo II (19.5 ka B.P.), providing an opportunity to conduct a detailed taphonomic analysis of a variety of faunal groups recovered from one site (Simmons and Nadel 1998; Rabinovich 1998a, 1998b; Belmaker 2001). Furthermore, the majority of the finds were retrieved from *in situ* brush hut floors and open-air hearths. Thus, a study of taphonomy, as well as past human indoor and outdoor behavior, is possible.

In this paper we report the main results concerning the medium-sized mammal exploitation patterns at Ohalo II, and discuss several aspects of food processing behavior at the camp.

The Ohalo II site

The Ohalo II submerged site is located on the shore of the Sea of Galilee, and *in situ* on the Lisan marls – the Late Pleistocene precursor of the current lake (Belitzky and Nadel 2002). The camp covers an area of more than 2000 square meters, and the excavated remains include six brush huts, six concentrations of open-air fireplaces, a human grave, a pit, a stone installation, and midden deposits (Fig. 1). Submerged in anaerobic conditions, organic remains were excellently preserved. The brush hut floors were oval in shape, 2.5 – 4.5 meters long, with an area ranging between 5 and 13 square meters (Nadel 2003).

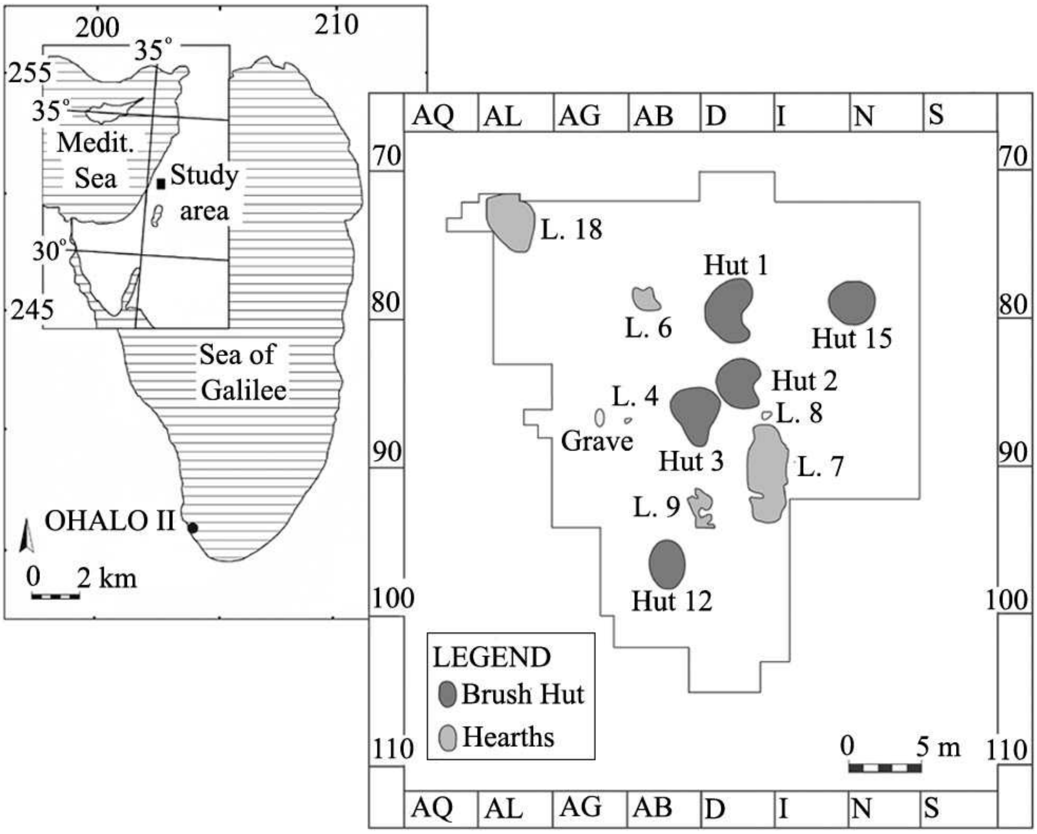

Fig. 1. Location map of Ohalo II and site plan (central area of excavation).

Fig. 2a. Fallow deer mandible *in situ* (Locus 12).

Fig. 2b. Gazelle horn core *in situ* (Locus 10).

The foundations of the brush hut walls were preserved in some cases, and the identified charcoal specimens from them indicate that the walls were made of thick branches of tamarisk and oak, covered by leaves and grass (Nadel and Werker 1999). The floors were dug into the bedrock lacustrine deposits like shallow bowls, and were commonly 20-30 cm deep at the center. The anthropogenic layers were dark and rich in finds, while there were hardly any finds at all in the surrounding sandy, silty layers (Tsatskin and Nadel 2003).

On each floor, and around most hearths were found large quantities of flints, animal bones and plant remains, in many cases in what apparently look like original distribution patterns. A sample of ca. 90,000 charred seeds/fruit (Kislev *et al.* 1992; Kislev *et al.* 2002) was analyzed, and includes many edible species. Animal bones were also very common in most loci, and samples of fish bones (Zohar 2002), bird bones (Simmons and Nadel 1998; Simmons 2002), small mammal bones (Belmaker *et al.* 2001; Belmaker 2002) and medium-sized mammal bones were also studied (Rabinovich 1998a, 2002) (Fig. 2).
Charcoal samples retrieved from most loci provided 45 ^{14}C dates from the archaeological deposits as well as from pre- and post-occupation layers. The average date of the occupation is 22,500-23,500 cal BP. (Nadel 1995; Nadel 2002).

The climate in the southern Levant was colder and drier during the end of the last Glacial Maximum, according to local palynological and speleothem studies (see Weinstein-Evron 1993; Bar-Matthews *et al.* 1999; Bar-Matthews and Ayalon 2003). On a local scale, the Ohalo II remains provide much data regarding the immediate environment. For example, out of more than 100 identified plant taxa, only two are extinct in the Sea of Galilee Basin today (Nadel *et al* 2004a). Furthermore, the bird, micro-mammal and medium-sized mammal species indicate an environment very similar to the current one (*ibid*). It is suggested that even during the cold LGM, the Sea of Galilee Basin fauna and flora were only mildly affected. Apart from local small-scale, geographic shifts of plant and animal communities, no dramatic changes took place. Probably, the most important impact on life in the basin was water level fluctuations (Bartov *et al.* 2002; Belitzky and Nadel 2002).

Methodology

During fieldwork, emphasis was placed on the retrieval of even the smallest and most delicate of remains. Thus, all excavated material was wet-sieved through a 2 mm mesh during the first two seasons, and a 1 mm mesh during the following seasons. A preliminary sample from several loci is presented below (Table 1).

Species identification was conducted in the Department of Evolution, Systematics and Ecology at the Hebrew University of Jerusalem using the comparative osteological collections. Skeletal part was recorded for every possible specimen. Long bone shafts missing the epiphyses and other bone fragments (e.g. vertebrae and ribs) were defined only to body size group category (BSG). The body size categories are based on the animals' weight and body size and serve as a general scale for the size of the animals from which the bones derive. Five categories of body size group have been defined: BSGA-BSGE (from aurochs size to fox size, Table 2).

Every bone fragment was examined under a light microscope (X10-X40), and modifications such as striations, cut marks, scratches, tooth marks, gnawing marks and burning signs as well as pathologies were scored, and their exact location along the bone documented. These aspects are key to understanding the history of animal bones accumulation. Such a detailed method is usually applied to earlier sites (Lower Palaeolithic to Middle Palaeolithic) where human impact on the faunal remains is uncertain. However, the application of these methods to later sites (Upper- and Epi-Palaeolithic) can facilitate the understanding of hunting, butchery, dismemberment, and other relevant activities (Rabinovich *et al.* 1997; Rabinovich 1998c; Munro 2001; Bar-Oz and Dayan 2003; Valla *et al* 2004).

In this study, only the naked eye was used to define burnt bones. We therefore adopted a very strict approach and only grey and yellow bones that were certainly burnt were counted as such[3].

Body part abundance data were used to investigate human butchery practices, bone transport decisions, nutritional needs, activity specializations, etc. (i.e., Marean 1991; Bartram 1993). Human behavior in relation to food choice is assumed to be rational, meaning that people will obtain food in the most profitable manner possible, according to resource availability.

Table 1. Species frequencies at Ohalo II.
(for abbreviations of BSG = Body Size Group: see Table 2).

Species	NISP	%
Sus scrofa	19	0.25
Cervidae	14	0.18
Cervus elaphus	11	0.14
Dama mesopotamica	413	5.38
Bos primigenius	2	0.03
Gazella gazella	2059	26.82
Capra aegagrus	4	0.05
Vulpes vulpes	118	1.54
Canis lupus	2	0.03
Felis silvestris	18	0.23
Lepus capensis	77	1.00
BSGA	18	0.23
BSGB	617	8.04
BSGC	10	0.13
BSGD	4036	52.57
BSGE	193	2.51
Carnivore unident.	12	0.16
Unidentified mammal	55	0.71
Total	**7678**	**100.0**

Species	NISP	%
Sus scrofa	19	0.7
Cervidae	14	0.5
Cervus elaphus	11	0.4
Dama mesopotamica	413	15.1
Bos primigenius	2	0.1
Gazella gazella	2059	75.2
Capra aegagrus	4	0.1
Vulpes vulpes	118	4.3
Canis lupus	2	0.1
Felis silvestris	18	0.7
Lepus capensis	77	2.8
Total	**2737**	**100.0**

BSGA	18	0.4
BSGB	617	12.5
BSGC	10	0.2
BSGD	4036	81.7
BSGE	193	3.9
Carnivore unident.	12	0.2
Unidentified mammal	55	1.1
Total	**4941**	**100.0**

Table 2. Body size groups.

Body Size Group	Main Species Included	Weight range
BSGA	aurochs, rhinoceros	> 1000 kg.
BSGB	fallow deer, red deer, boar, hartebeest	250 - 80 kg.
BSGC	wild goat	80 - 40 kg.
BSGD	gazelle, roe deer	40 -15 kg.
BSGE	hare, common red fox	10 - 2 kg.

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[3] Research carried out on a sample of bones from Hayonim Cave layer D (Upper Palaeolithic) showed that 85% of the black bones were actually burnt. However, in waterlogged sites such as Ohalo II, where most bones are dark in color, it is very difficult to use color as a means by which to identify those bones that were in fact burnt.

Given that each body element has unique values of density, thickness, weight, meat, grease, and marrow, the Ohalo II body element frequencies were compared with the known relevant values. Quantitative indices of nutritional utility were developed to represent a combined measure of the meat, marrow, and grease associated with each bone (i.e., MGUI – the Modified General Utility; Binford 1978). Utility indices provide the theoretical bases for models evaluating strategies of utilization and transport behavior in the past. The less durable elements (e.g., less heavy, less thick, less dense) are sensitive to destructive forces that affect their preservation in the faunal assemblages. Thus, we attempted to record the body part distribution of the two most prolific species (gazelle and fallow deer) by comparing the utility indices[4] (normed utility indices of meat, marrow, grease and MGUI Binford 1978, in Lyman, 1994, Table 7.1) with the average bone mineral densities (photon densitometry; Lyman 1994, Table 7.6). In addition, Thomson's gazelle (Blumenschine and Ca 1986) flesh unit weights were used to see if there was any correlation between gazelle body parts and their relative flesh content.

The Ohalo II mammals

Species distribution

The mammal bones discussed here are a large sample (NISP=7678) from the 1989-1991 seasons of excavation (Table 1). Preservation is good, including complete small elements from various taxa and minute splinters of long bones. The most prolific species is the mountain gazelle (*Gazella gazella*), comprising almost a third of the faunal remains (NISP=2059, 27%), while the BSGD comprises about 50% of the assemblage (Tables 1, 2). In other words, it is most likely that the gazelle bones represent over 70% of the mammal bones, based on this sample. Fallow deer, *Dama mesopotamica*, is the next most abundant species, although on a smaller scale (NISP=413, 5%; BSGB 8%; percentages of all counted specimens). Fox, *Vulpes vulpes* comprises 2%, hare, *Lepus capensis* 1%, and their relevant BSGE is 3%. Other species, represented by several bones each (comprising less than 1% of the total assemblage), include wild boar, *Sus scrofa*, red deer, *Cervus elaphus*, aurochs, *Bos primigenius*, wild goat, *Capra aegagrus*, wolf, *Canis lupus* and wild cat, *Felis silvestris*. Relative frequencies of body size groups correlate quite well with the frequencies of species included in them (Table 1).

When species distribution is examined for each locus (Table 3), a similar pattern is evident. In the current sample, gazelle and BSGD are present and dominant in all loci, comprising ca. 80% of the bones, while fallow deer are present in various frequencies. The rarest species are the most varied ones among the loci. Both red deer and boar are present only in Loci 3, 7 and 10. Aurochs is present only in Locus 7. Fox remains are absent in Loci 4, 5, 6, 8 and 9. Locus 1 is exceptional because there fallow deer is almost as common as gazelle (though only a sample of the locus was examined). Huts (Loci 1, 2, 3), hearths (Loci 6, 7, 9) and other features are undistinguishable based on the relative frequencies of the major species. Two conjoinable old breaks on a long bone shaft from a fallow deer phalanx and a complete tarsalia in its anatomical position (from Locus 3) serve as good examples of the minor post depositional effects on the medium-sized faunal remains.

The surface sand above the huts and hearths remains contained archaeological finds including flints and charcoal. The surface collection is an integral part of the site remains. Consequently, we assumed that the nature of the surface faunal deposition was not very different from that of the *in situ* loci, and probably originated from the same processes. The, medium-sized mammal bones were similar in all observable characteristics such as species distribution (Table 3) and gazelle ageing (Table 4).

Analysis of age

A third of the gazelle and BSGD ageable bones were unfused (N=219, 30%). The unfused elements were divided into six age groups (Davis 1980). Isolated finds from each age group are present (Table 4), but the largest group is of animals between 10-18 months old.

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[4] As gazelle bone densities are not available, we have used deer densities (Lyman 1994, Table 7.6) for both gazelle and fallow deer in spite of the problematic implications of assessing values from other species.

Table 3. Species distribution by locus (Surf = surface; N.A. = North Area).

Species	Loc. 1	Loc. 2	Loc. 3	Loc. 4	Loc. 5	Loc. 6	Loc. 7	Loc. 8	Loc. 9	Loc.10	Surf	N.A.
Sus scrofa			10				3			2	4	
Cervidae	1	1	4				2			1	5	
Cervus elaphus			2				3				6	
Dama mesopotamica	63	19	58		1		27	3		32	194	16
Bos primigenius							1	1				
Gazella gazella	99	160	345	7	10	1	179	24	5	130	1004	94
Capra aegagrus	1				1		1				1	
Vulpes vulpes	8	10	23			1	17			5	52	2
Canis lupus											2	
Felis silvestris	2	3	1		1		2				9	
Carnivore sp.	1		5	1							4	1
Lepus capensis	11	4	29	1			12			1	17	1
BSGA	1		3				5			2	6	1
BSGB	61	30	84		5	2	40	7		56	299	33
BSGC			6							1	3	
BSGD	196	282	606	13	57	15	266	56	10	271	2085	176
BSGE	14	9	59		2	1	18	4	2	3	75	6
Unidentified	12		9		1		4			14	14	1
Total per Loci	470	518	1244	22	78	20	580	95	17	518	3780	331

Representations of all age groups were found only in Hut 3 and Locus 7. Gazelle teeth were examined based on their wear stages (*ibid*; Table 4). The pattern shows the presence of very young specimens - up to one year old - while most of the cases are from specimens two years old and up.

Unfused fallow deer bones are present in most loci. The presence of fetal bones in Huts 1 and 3 should be noted. The rest of the unfused bones are from animals in the age group of 8-18 months, 18-24 months and older. Ageing can be more finely estimated based on tooth eruption and wear. Four mandibles of fallow deer found in Hut 1 were from specimens aged two to four years (according to the eruption and wear stages published by Chaplin and White 1969). Deciduous premolars of another mandible fragment from the surface of the site indicate a possible age at death of two years.

Remains of wild pig bones from a one to two year old animal were found at several locations in the site. In addition, two unfused hare bones, a fox metapodial and a distal femur from a wild goat from Hut 3 were classified as unfused bones.

Thus, fetal bones imply occupation of the site during the birthing season – our current springtime – while male dominance (see below) might imply use of the site during the mating season – our current

Table 4. Counts of elements per age group based on fusion data.

Age class	Surface	Loc. 1	Loc. 2	Loc. 3	Loc. 7	Loc. 10	North Area
fetus	10			3			
0 to 2 months	2				1		
3 to 8 months	6		3	9	1	1	2
8 to 10 months	13			8	2	3	2
10 to 18 months	51	4	7	28	14	6	10
< 18 months	7	1	7	12	3	1	1
Total	89	5	17	60	21	11	15
Age class %	**Surface**	**Loc. 1**	**Loc. 2**	**Loc. 3**	**Loc. 7**	**Loc. 10**	**North Area**
fetus	11	0	0	5	0	0	0
0 to 2 months	2	0	0	0	5	0	0
3 to 8 months	7	0	18	15	5	9	13
8 to 10 months	15	0	0	13	10	27	13
10 to 18 months	57	80	41	47	67	55	67
< 18 months	8	20	41	20	14	9	7

autumn. In addition, the presence of varied age ranges – fawns of up to one year, yearlings, and older specimens from various species, suggests a more prolonged occupation through several seasons.

Analysis of Sex

Morphological characteristics were used on several bones to determine sex, favoring males at all loci. The sexed elements – mostly horn core remains – include representatives of gazelles (2 females, 11 males[5]), fallow deer (2 males) and aurochs (1 male).

Body Part Distribution

As expected, the gazelles and BSGD provided the most detailed information on body part distribution. Correlations of the body parts of the gazelles with the average bone mineral densities of deer was examined. No significant correlation was found between these variables (Fig. 3; i.e. NISP and bone density), suggesting that selective attrition does not explain gazelle bone distribution at the site.

Thomson's gazelle flesh units were used in order to determine whether there was any connection between the gazelle NISP per body part and their relative flesh content. A significant correlation was observed (Table 5; r values range between 0.678-0.844) in all loci but Locus 10, suggesting that meat content was an important issue when animal parts were brought to the site.

The ratio of proximal/distal of fore (humerus, radius, ulna) and hind limbs (femur, tibia) was examined for the gazelle and its relevant body group size (BSGD). When all loci were examined, the ratio of proximal parts versus distal was quite low (0.5). When this ratio was examined separately for each fore and hind limb, the proximal parts of the fore limbs were better represented (ratio prox/dist=1.4), while the proximal parts of the hind limbs were poorly represented (0.2). For most loci the sample size was not sufficient to permit this ratio to be assessed (Fig. 4). In Locus 7 however, relatively more proximal parts of fore limbs were present.

Table 5. Correlation of gazelle remains from Ohalo II vs. unit flesh weight*.

	weight	***Loci***	***Loc 1***	***Loc 2***	***Loc 2 S***	***Loc 3***	***Loc 3 S***	***Loc 7***	***Loc 7 S***	***Loc 10***	***Loc 10 S***
weight	1										
Loci	0.8337	1									
Loc 1	0.6785	0.8901	1								
Loc 2	0.7024	0.6606	0.4792	1							
Loc 2 S	0.7825	0.9763	0.9466	0.5346	1						
Loc 3	0.8444	0.9739	0.7831	0.6940	0.9239	1					
Loc 3 S	0.7649	0.9488	0.8474	0.5676	0.9345	0.8941	1				
Loc 7	0.7013	0.8961	0.9423	0.4575	0.9478	0.8238	0.8908	1			
Loc 7 S	0.8025	0.9916	0.8942	0.6508	0.9644	0.9486	0.9526	0.8691	1		
Loc 10	0.3489	0.5848	0.7603	0.4219	0.6801	0.5126	0.5456	0.7725	0.5476	1	
Loc 10 S	0.3458	0.6867	0.8006	0.1706	0.7393	0.5555	0.6445	0.6341	0.7456	0.4144	1

weight * - Thomson's gazelle unit flesh
Loci - all Loci; S- surface of loci

Table 6. Correlation of fallow deer remains from Ohalo II vs. utility indices.

	Loci	*Loc. 3*	*Loc. 10 S*	*MGUI*	*Meat*	*Marrow*	*Grease*
Loci	1						
Loc. 3	0.9495	1					
Loc. 10 S	0.7466	0.7148	1				
MGUI	0.0527	-0.0215	-0.0618	1			
Meat	0.1093	0.0392	-0.0165	0.9192	1		
Marrow	-0.1728	-0.2626	-0.1587	0.1838	0.0010	1	
Grease	-0.1104	-0.1870	-0.2373	0.5466	0.3019	0.3582	1

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[5] Eight of the eleven sexed elements were horn cores from the surface of the site.

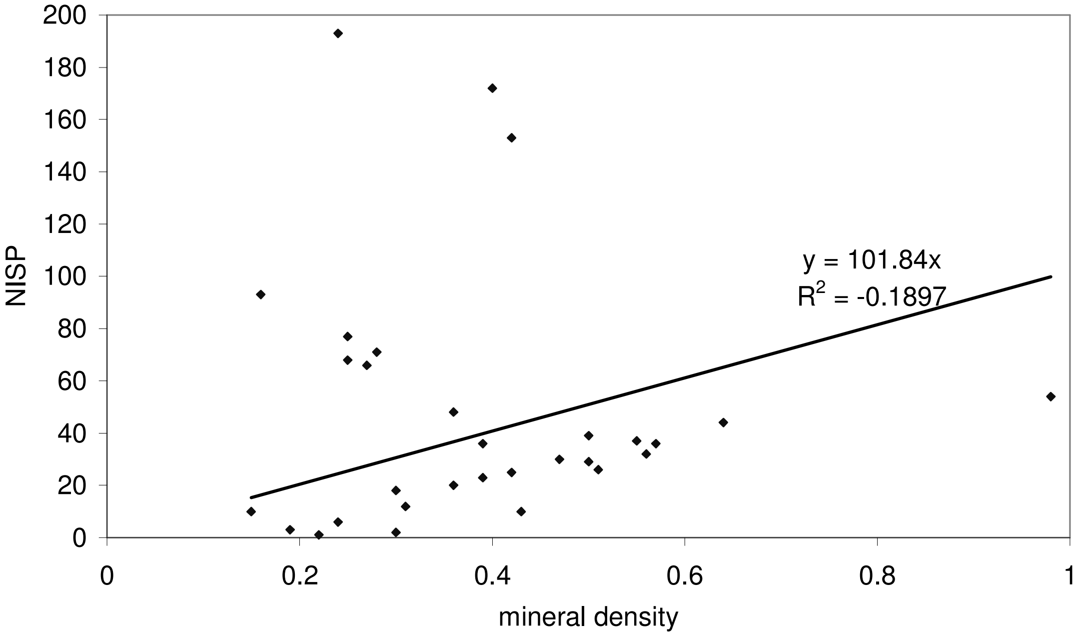

Fig. 3. Mineral density of deer (after Lyman 1994: table 7.6) plotted versus gazelle and BSGD.

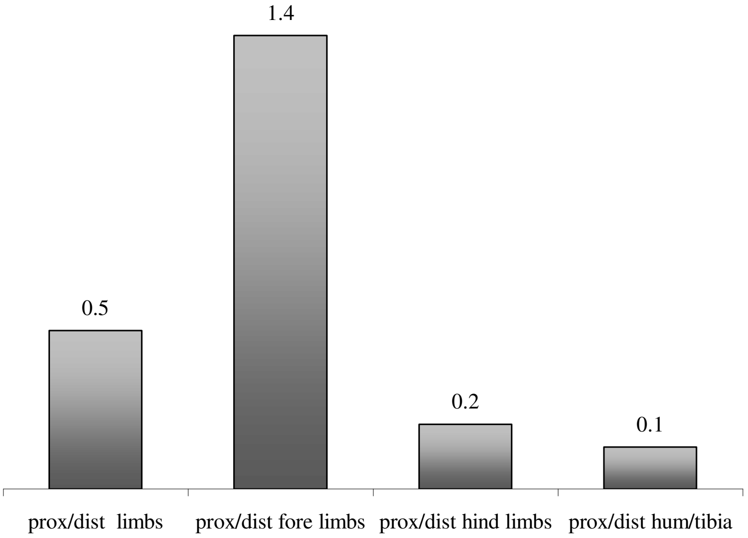

Fig. 4. Gazelle and BSGD, distribution of proximal vs. distal parts

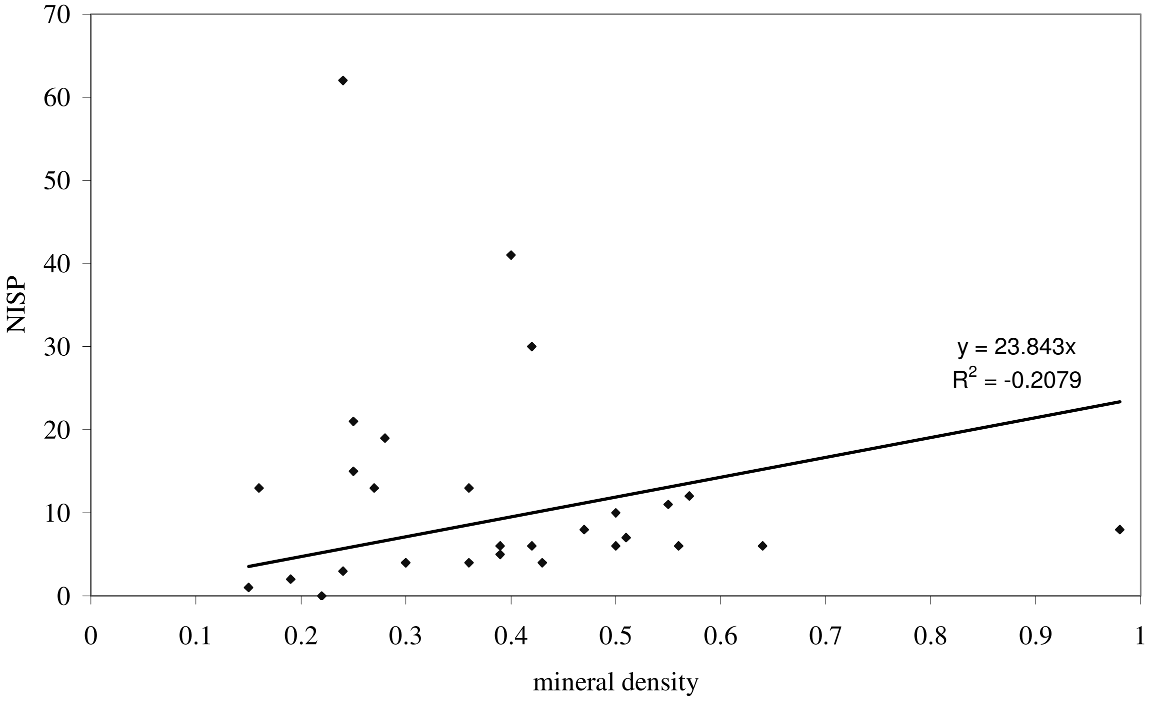

Fig. 5. Mineral density of deer (after Lyman 1994: table 7.6) plotted versus fallow deer and BSGB.

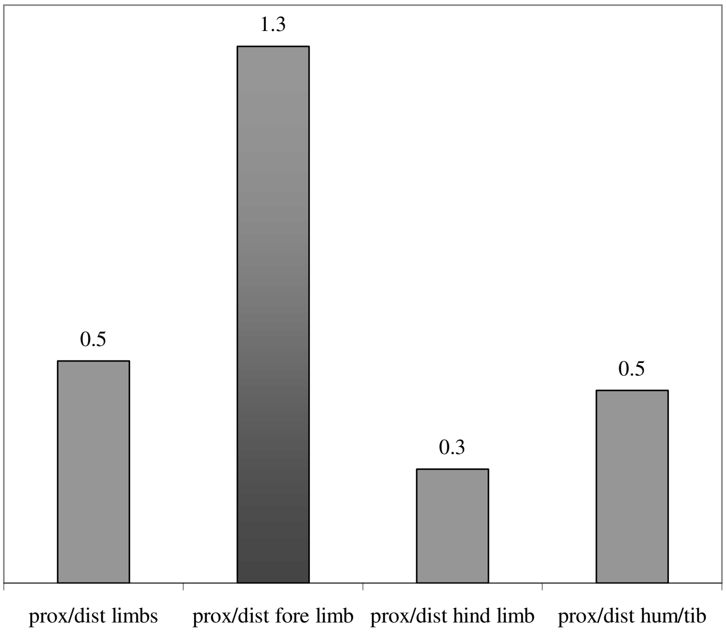

Fig. 6. Fallow deer and BSGB, distribution of proximal vs. distal parts.

Fallow deer, the most abundant species after gazelle, were represented mainly by teeth and phalanges at all loci, while the frequency of other body parts varied among the loci. In general, we noted that hind limb and hind leg fragments were more abundant.

Another way to understand the nature of the accumulation of the fallow deer bones was to examine their average mineral density. This correlation was found to be insignificant (r=-0.111). A scatterplot of bone density and NISP showed no selection of low density or high density bones, while the frequency of bones varied along the density range. Selection due to attrition is therefore not suggested as an explanation for the distribution of fallow deer bones at the site (Fig. 5).

The ratio of proximal/distal of fore (humerus, radius, ulna) and hind limbs (femur, tibia) was examined for fallow deer and its relevant body group size (BSGB). Due to problems of sample size, the remains from all loci were examined together, revealing a picture similar to that of the gazelle. Forelimbs were unevenly distributed with more proximal parts evident (1.3),while proximal parts of hind limbs were underrepresented (0.3) (Fig. 6).

Fallow deer bones from the loci were correlated to their normed utility indices of meat, marrow, grease and MGUI. No correlation was found between the remains of fallow deer bones and their utility indices, either for all of the loci together or for a few selected loci (Table 6; e.g. Locus 3, Locus 10).

For the rest of the mammalian species, body part distribution is quite sporadic (e.g. fox, hare and others), with no indication for any special selection[6].

Burnt Elements

There are hearths and burnt huts everywhere in the camp. However, the issue of identifying burnt bones is more complex because the dark color of most of the bones is typical of waterlogged sites and not necessarily indicative of exposure to fire. Therefore, a very conservative definition of burnt bones was adopted and only grey and yellow bones that were certainly burnt were counted as such. Thus, burnt elements comprise at least 6% of the faunal assemblage (N=464).

When loci are compared, there are marked differences, including a tendency toward an inverse correlation between the number of bones per locus (NISP) and the relative frequency of burnt bones (Fig. 7, as a percentage of the NISP of each species). This phenomenon is especially marked for two hearths, Loci 6 and 9. Although Locus 7 was also defined as a concentration of hearths, the relative number of burnt bones is not distinct from the huts. In all loci, gazelle bones and especially BSGD bones were burnt. Burnt body parts include: long bone splinters, limb bones, phalanges, vertebrae and ribs. Both upper limbs and lower limbs were burnt. There seems to be no difference between the loci in terms of burnt skeletal elements.

Butchery patterns

The studied sample includes 79 modified bones, of which 21 (27%) are the result of the smoothing of long bone shafts during bone tool preparation (Rabinovich and Nadel 1994). Six cases of hammer stone percussion were observed, all save one on long bone shafts: the femur, tibia, and metatarsal. Four of the cases were on fallow deer bones and the other two on gazelle body size (BSGD) bones. The exception was a fallow deer calcaneum from Hut 3 which was broken by hammer stone percussion. As the calcaneum is not very rich in marrow content, it was probably broken for its relatively high grease content (based on utility indices of caribou according to Binford 1978).

The rest of the signs (N=52) are cut marks located along various bones from Loci 1, 2, 3, 4, 6,7 8 and 10[7]. Most of the cut marks were on gazelle bones and BSGD bones (N=32, 62% of the total cut-marked bones). They result from the dismemberment of the fore and hind limbs and the filleting of

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[6] Fox remains are rare per locus, and include several bones from almost all body part groups. Hare remains from Locus 1 and Locus 3 lack teeth and skull fragments (Bar-El and Tchernov 2001).

[7] Cut marks were noticed also in the surface assemblage from the central and northern areas of the excavation.

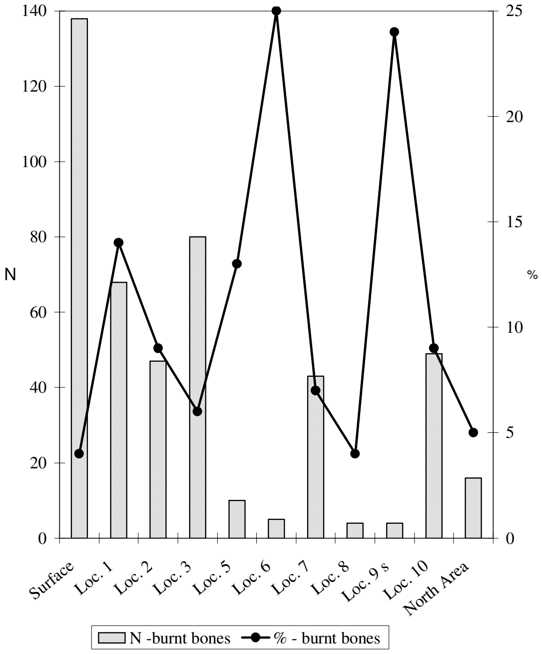

Fig. 7. Burnt bones per locus, N = number of burnt bones per locus, % - burnt bones per locus.

the ribs, vertebrae and femur. A wild cat astragalus from the surface of the site had cut marks on it, apparently from dismemberment.

The presence of an incomplete gazelle calcaneum might provide insight into the mode of consumption, as might the destruction of the first phalanx and the other long bones that appear mainly as shaft fragments. Most bones are broken lengthwise, mainly in the body size groups BSGB, BSGD and BSGE. The body size groups include long bone splinters, trunk parts and some fore and hind limb bones parts. Most of the long bone splinters probably originate from limb bones and are a measure of the degree of breakage in the bone assemblage. Much can be learned through the study of these splinters. For example, extraction of bone marrow and grease results in many splinters of the spongy (epiphyses) and the compact (shaft) parts (Outram 2001). Moreover, it has been suggested that in human-accumulated assemblages, counts of shaft segment, rather than epiphyses counts, are a more accurate measure of bone quantification (Lam *et al.* 1998, see references there).

Although some trampling may have caused long bone fragmentation, most of them likely represent bone cracking to extract marrow. Animal remnants could have been buried in the hut floors and trampled by occupants, crushing the long bones into smaller splinters. However, the complete state of many small bones, coupled with the charred material and flints renders this possibility unlikely. The swift inundation of the site by water and silty sand (Belitzky and Nadel 2002; Tsatskin and Nadel 2003) excludes large-scale, post-depositional breakage of long bones.

Discussion

The Ohalo II people introduced most (if not all) of the mammal species mentioned in the text to the site. Evidence of animal modifications is very rare; only six bones were gnawed (mostly by rodents). Carnivores or other raptors were not a major faunal accumulator, although smaller carnivores such as foxes, cats and wolves might have trampled and consumed the bones after the site was abandoned. To date, the detailed taphonomical study of the medium-large fauna shows no indication of major post depositional processes affecting the accumulation of the animal bones. Therefore, we suggest that if there was any kind of post-depositional process, after or between the site occupation episodes, it is not visible in the mammal bones.

The gazelle is the most common species in the faunal assemblage of Ohalo II and together with BSGD it is the dominant mammalian find in most loci. Based on the mineral density of the gazelle and fallow deer bones, natural selection due to attrition is not suggested as an explanation for the observed body parts' distribution. Post-depositional processes had a minimal effect on the animal bones and their distribution. The same conclusion was reached by studying the distribution of fish vertebrae and flints on one hut floor (Nadel *et al.* 1994; Nadel 2001). Given that organic wall remains and grass bedding were found *in situ,* such observations are not surprising (Nadel and Werker 1999; Nadel *et al* 2004b).

Today, the mountain gazelle bear offspring twice a year, apparently depending on the quantity of available water (Baharav 1981, 1983a, 1983b)[8]. If indeed the timing of births and the ability of female ungulates to conceive while lactating are a matter of short-term adaptation to changing environmental conditions, then it will be very difficult to assess the birthrate in prehistoric times. Thus, several scenarios are possible, depending upon the palaeoecological conditions (Hovers 1988; Horwitz *et al.* 1990; Martin 2000). The gazelle cycle of reproduction could have been different during the colder and drier climate coinciding with the occupation of Ohalo II[9]. Nevertheless, the mountain gazelle is capable of adapting to very diverse biotopes, foraging on a wide variety of plants and tolerating different climatic conditions (Rabinovich 1998a, Martin 2000).

The use of nonselective hunting methods on herd animals (traps, nets, drives) might result in the presence of a catastrophic age profile in the archaeological assemblage, including all age groups, as found in the living population. However, if other methods of hunting were used, for example the targeting of larger specimens, it is more likely that young adults and adults would have been preferred because of their vulnerability[10] when guarding their territory (Baharav 1983a, 1983b). Thus, the predominance of males in the archaeological assemblage for most species might be related to the risk to which males are exposed while engaging in reproductive activities. Consequently, distracted males are an easier prey during the mating season in autumn[11]. However, the presence of fetal bones as well as more varied age groups suggests the multi-season use of the site. Accordingly, hunting methods together with the behavioral characteristics of the gazelle result in adult male dominance in the Ohalo II faunal assemblage.

Evidence of the extent of animal processing at the site, based on body part representation, the quantity of long bone splinters and burnt elements indicate *in situ* processing. The relative rarity of butchery signs might be related to the mode of processing before or after butchery. Bone breakage for consumption of marrow may have considerably reduced the frequency of observable cut marks. The animals were not brought to the studied loci intact, and a butchery site was probably located close to where disarticulation took place. Secondary butchery, filleting and breakage for marrow were most probably done at the site. Thus, cut marks on bones from all studied loci, though few in number originate from both disarticulation and filleting.

At this stage in our research, and despite certain observed variations, it is difficult to clearly identify differences among the loci. The less meaty animal parts were found in the waste dump (Locus 10), cut-marked bones were more common in one of the huts, although the relative number of burnt bones in the concentration of hearths (Locus 7) is not high in comparison with the huts. Furthermore, there

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[8] Both mountain and dorcas gazelle have been examined in detail in ecological and behavioral studies (Baharav 1980, 1981, 1983a, 1983b). Most of the basic information available on the social behavior of gazelles is based on these studies, which are the most lengthy and detailed.

[9] The variability of floral remains at the site suggests that there were no marginal conditions and a wealth of species was available for consumption, for both animals and humans. Either way, there were enough protein sources for the hunter-gather-fishers of Ohalo II.

[10] Variations of flight distances from predators, men and vehicles can be recognized in almost all Antilopini species based on age, sex, and social status.

[11] Cementum-increment data on teeth (Lieberman 1993a; 1993b) is a new, applicable method for reading seasonality that clarifies problems associated with changes in reproductive behavior. While this method may lead us in new research directions, adequate sample sizes from clear archaeological contexts are needed to prevent generalization based on a small sample size. Based on cementum-increment analysis of gazelle teeth, Lieberman (1993a, 1993b) deduced at least two possible seasons of occupation for Ohalo II – winter and spring.

seems to be no preference of burnt elements by species, or by locus. Burnt bones are probably more a result of their use for combustion in the hearths or of the subsequent burning of the huts.

According to the studied samples, gazelle bones in each locus appear to belong to not more than one to three animals (MNI). In most loci, mandible elements of gazelle outnumber maxillary elements; all limb bones are present in varying frequencies; the first phalanx is more abundant than the other phalanges and there is a slight tendency toward more hind than fore limbs. The distribution of BSGD remains per locus is different: long bone splinters constitute at least 30% and up to 70% per locus. In several cases more long bone splinters were detected on the surface of the loci. Long bone splinters and trunk parts (e.g. vertebrae and ribs) constitute most of the remains, although fore and hind limb bones are present as well.

Different treatment of fore and hind limb bones is implied, as is evident in the ratio of proximal to distal parts of gazelle and fallow deer, with destruction of hind proximal parts being higher. We can only speculate on the activities that might have been responsible for this pattern: perhaps breaking the proximal epiphyses to extract grease, marrow extraction from the middle shaft area, or chopping articulations before sucking the marrow out (Kent 1993). The presence of femurs, one of the highest nutrient elements, reinforce the impression that meat was processed at the site at the various loci.

Meat sharing is known from recent hunter-gatherer societies. Scholars of evolutionary processes regard hunting and food sharing as basic hominid behaviors (e.g., Kaplan *et al.* 2000; Hawkes and Bliege Bird 2002). Models of spatial organization of recent hunter-gatherers have been applied to archaeological sites (Goring-Morris 1987, 1988; Enloe *et al.* 1994). Social behavior, such as food sharing, can be tracked based on the spatial distribution of bone residues. For example, the same animal can be shared among several families (hearths), while a certain chunk of highly prized meat could be consumed near the hearth of one family only. However, when meat is shared, the representation of the spatial distribution of body parts per occupation/site/residential place is much more complex and unpredictable (Binford 1980; Bartram *et al.* 1991; Marshall 1994; Bliege Bird *et al.* 2002; Waguespack 2002). Transportation of animal parts to the base camp depends on the size of the animal, the distance from the base camp, the number of participants, etc. (Bartram *et al.* 1991; Kent 1993). Most studies of recent hunter-gatherers note that large animals are commonly shared. For example, the Hadza consume parts of large prey such as giraffes, zebras and impalas on the spot, while other parts of the animal are brought back to the camp (Hawkes *et al.* 2001). There is no archaeological evidence at Ohalo II to indicate whether only meat chunks from large animals (i.e., aurochs and red deer) were distributed among the activity areas.

The gazelle is considered a small animal[12]. Small animals often make up a substantial part of the hunter-gatherers meat diet, and are usually consumed within a relatively short time after acquisition (Yellen 1991a, 1991b). Sharing may have more influence on the body part distribution on the inter-household level, especially with small-medium sized animals (Diab 1998).

If indeed at Ohalo II most of the disarticulation took place outside the known occupation area, chunks of animals were brought into the camp for consumption on a small-scale level – the family level (Kent 1993; Marshall 1994, Diab 1998). The large quantity of long bone splinters may indicate marrow and/or grease processing in all huts and near them, at the hut-household level.

Unfortunately, due to the high percentage of fragmented bones, they seem unlikely candidates for refitting analysis. However, other indications suggest that sharing went on between the inhabitants of Ohalo II. Kent mentioned, that `*…bones tended to remain spatially near the locus where meat was consumed at least for the first few weeks. With the passage of time, bones tended to be scattered as a result of trampling and other taphonomic processes...'* (Kent 1993: 340). In her long-term and detailed study of a Kalahari community, Kent pointed out that most of the NISP (6697; 79.6%) were not associated with a feature, and only 20.4% (1717) were associated with a feature, most of which were ash areas (*ibid*). Where did this activity take place within the Ohalo II camp? If it took place outside the huts, since outdoor activities are very common among humans, then Locus 10 actually reflects activities that took place near the structures.[13]

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[12] Class I size in the African bovids.

[13] More information is available from recent excavations.

Kent (1993) also mentioned the different methods of meat preparation such as boiling in containers or roasting in pits. Although difficult to test, roasting could have been practiced at Ohalo II in pits and baskets.

Thus, at Ohalo II the resemblance between the various loci in the mammalian species, the breakage patterns and the presence of high meat elements, as well as the probable existence of the primary butchery spot in an unexposed location nearby suggest that some sort of similar group activity took place in the various parts of the site, probably related to sharing. In addition, detailed study of the flints clearly indicates no difference between the huts and the hearth concentrations (Nadel 2001, 2003).

Studies of plant remnants, bird bones and mammal remains argue for a multi-seasonal occupation of the site. Medium-sized mammals were probably the major animal protein source for the inhabitants, together with fish. The mode of animal processing suggests food sharing took place between the inhabitants. The relative frequency of species is the same as for other contemporaneous sites (Rabinovich 2003). While the taxonomic richness of medium-sized mammals is not a refined indicator of variability at the end of the Pleistocene, detailed exploitation patterns are.

In terms of return rates, medium-sized animals are one of the most common elements in the diet of hunter-gatherer-fishers (Kelly 1995). As the major protein source, medium-sized mammals comprised an essential part of the diet. The favorable location of Ohalo II near several habitats such as a body of water (lake?), the grasslands and the woodlands, permitted a combination of subsistence strategies using hunting, gathering and fishing. The studied bird bones include a large diversity of species, pointing to anthropogenic exploitation (Simmons and Nadel 1998). Fish, a nutritionally rich resource are now being study. Future research will examine the exact technologies and the relative energy investment expended for obtaining each food component at Ohalo II.

Acknowledgments

The project (fieldwork and lab analyses) was generously supported by the Irene Levi Sala CARE Archaeological Foundation, The Israel Science Foundation (831/00), the Jerusalem Center for Anthropological Studies, the L.S.B. Leakey Foundation, the MAFCAF Foundation, the M. Stekelis Museum of Prehistory in Haifa, the National Geographic Society, the Israel Antiquities Authority and the Zinman Institute of Archaeology (University of Haifa).

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