

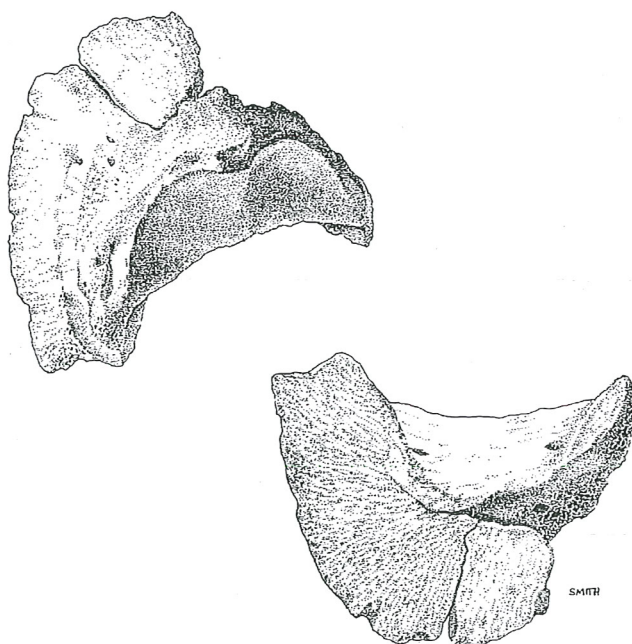


# ARCHAEOZOOLOGY OF THE NEAR EAST III

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

edited by

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



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Cover illustration: Dorsal and palmar aspects of a  
Bronze Age horse phalanx from Arslantepe, Turkey,  
identified by Sándor Bökönyi.  
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## Preface

This publication is the result of the third international symposium on archaeozoology of southwestern Asia and adjacent areas, held in Budapest, Hungary from 2 - 5 September 1996. The editors would like to thank all colleagues of the Working Group who helped with the translation of abstracts. Financial support for the publication was given by the Acker Stratingh Stichting, Groningen, The Netherlands.



Participants of the 3rd ASWA Conference, Budapest 1996  
(Photo: Péter Komjáthy, Aquincum Museum)

Standing, left to right: B. De Cupere (Belgium), G. Bar Oz (Israel), H. Buitenhuis (The Netherlands), R. Rabinovich (Israel), L. Leblanc (New Zealand), N. Benecke (Germany), H. Hongo (Japan), N. Russell (USA), J. Speth (USA), A. Patel (India), E. Stephan (Germany), C. Cavallo (The Netherlands), W. Van Neer (Belgium), A.T. Clason (The Netherlands), T. Dayan (Israel), L. Van Es (The Netherlands), C. Becker (Germany), R. Meadow (USA), M. Mashkour (France), F. Poplin (France), E. Vila (France), Mrs. Poplin (France), L. Bartosiewicz (Hungary), E. Pellé (France), P. Ducos (France).

In front, left to right: E. Tchernov (Israel), L. Martin (Great Britain), A. Choyke (Hungary), I. Zohar (Israel).

Participants not shown in picture: D. Carruthers (Great Britain), D. MacHugh (Ireland), S. Whitcher (Great Britain).

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# “DROWNING IN NUMBERS” - GAZELLES DOMINANCE AND BODY SIZE GROUPS IN THE ARCHAEOZOOLOGICAL RECORD

Rivka Rabinovich<sup>1</sup>

## Résumé

Étude taphonomique de plusieurs collections du Paléolithique Supérieur (40,000 - 18,000): Qafzeh, Hayonim D et de l'Épipaléolithique (18,000 - 12,000): Ohalo II et Hayonim C. L'analyse des restes osseux, comprenant d'innombrables éclats d'os long pas toujours parfaitement déterminables, conduit à la répartition de cette faune d'après le gabarit (Body Size Group= BSG). Cette répartition d'après l'ordre de grandeur des animaux, aide à reconstituer en partie les modes de dépeçage, d'équarissage et de transport pratiques par l'homme préhistorique.

## Introduction

Whenever a faunal assemblage is examined, we are left with a large quantity of bones that are difficult or impossible to identify to species level. These fragments can be ignored or allocated to body parts and body size groups only. In most cases long bone shafts/splinters tend to dominate in these categories, in addition to vertebrae and ribs. Why use bone fragments at all? The main question was and remains: 'what does the distribution of body parts indicate?' The implications have served mostly in endless discussions about scavenging *versus* hunting (Binford, 1981, 1984; Blumenshine, 1986a, 1986b, 1988; Brain, 1981; Bunn, 1981, 1983; Bunn and Kroll, 1986; Stiner, 1991; Gaudzinski, 1995); carcass processing, carcass transport, base camps *versus* butchery stations, spatial organization, food preparation, food sharing etc. (see Hudson (ed.), 1993, for representative references). Even following the main wave of studies and publications related to proving or disproving one of the hypotheses (e.g., scavenging vs. hunting) during the 1980's, the method of publication is still not uniform. It has nevertheless become standard in faunal analysis studies to report bone fragments as well. Although a great quantity of data has lately been accumulated, there are still some obstacles when using this information (Lyman, 1994). Even with a better understanding of the body part frequencies issue, some of the same problems need to be considered:

1. Post-depositional effects. Body parts are often used to explain this process. If post-depositional effects, however, acted in a way that leaves no traces, the data are then interpreted on a false basis.
2. Human behavior. We assume that humans behave in a logical fashion. We therefore turn to the lives of recent hunter-gatherers for analogies.
3. Carnivore behavior. Since animals (like humans) are part of an ecological setting, we have to know as much as possible about all animal species and environmental conditions in order to infer their behavior in prehistoric times.

Element abundance data are used to investigate hominid butchery practices, bone transport decisions, hominid nutritional needs, activity specialisation, etc. (Marean and Spencer, 1991). One of the main applications of element abundance was in the various utility indices. Binford (1978) developed a number of quantitative indices of nutritional utility, such as the MGUI, the Modified General Utility Index, a combined measure of the meat, marrow and fat, associated with each bone. Such indices were translated into diagrams that could distinguish between types of sites, such as kill sites and base sites. These ideas have led to many archaeological studies applying utility diagrams. Some have come up with less complicated ones (e.g. Jones and Metcalfe, 1988), while others have criticised

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their lack of complexity (Bartram, 1993; Lyman, 1985). The distribution of body characteristics is not only family dependent but also species dependent (Blumenschine and Madrigal, 1993; Emerson, 1993).

These indices should be considered in conjunction with the possibility of more complex behavior, related to the ecological setting, prey density, climate and seasonality (Speth, 1983). An ethnoarchaeological study of an eastern Kalahari group for example, discovered that the procedure of meat drying - biltong -, was the main method of dealing with heavy transportation, and that the need to carry long bone shafts from the kill site was avoided by extracting marrow on the spot (Bartram, 1993). See also other studies on body part transport among the Hadza (O'Connell *et al.*, 1988, 1990, 1992).

Since the use of only limb bone epiphyseal ends leads to the underrepresentation of the number of limb elements actually present, shafts should also be considered. Carnivore destruction can also be traced, using this method (Marean and Spencer, 1991).

Quite often these various aspects lead to a circular argument since most of the behaviour related to a body parts profile is merely assumed and no rigid framework is available to explain and combine all of the surrounding circumstances (e.g. body part preference, modes of transport and discard, etc.). This is not to imply that the method itself should be abandoned, but rather to suggest that conclusions should be drawn on the basis of converging evidence from various methods and fields. There is, however, no quantitative method that would satisfy all requirements (Grayson, 1984).

Modified general utility indices (MGUI) are not yet available for gazelle. Some information however - on tissue distribution in gazelles, and differences between males and females - have already been published (Cope, 1994; Cope and Horwitz, pers. comm.). These results appear typical of a cursorial species adapted to open country: 47% of total body weight was found to be muscle tissue. Recent studies on gazelle segment weight (Cope, 1994; Cope and Horwitz, pers. comm.) have shown, that the general distribution of the weight in the male concentrates in the neck, shoulder and upper forelimb as well as the hip and upper leg. In females on the other hand, a homogeneous meat distribution was found between the neck, shoulder, and upper forelimb, as well as the hip and upper leg. Internal organs are the heaviest parts of the female body. The general distribution of meat, fat and marrow resembles that of other ungulates: the hip and upper leg for example, being one of the "meatiest" areas (e.g. high MGUI, Binford, 1978, 1981). By and large, the distribution of long bone flesh resembles that of male and female bovids, as opposed to the head and axial units (Blumenschine and Caro, 1986; Cope, 1994; Cope and Horwitz, pers. comm.).

As with any other archaeological find, animal bones found during the course of excavations represent only a part of the actual residues. Time-dependent post-depositional effects and other destructive factors reduce the actual assemblage. Moreover, most excavations by definition only sample the actual site. Modern studies have tried to numerically express this destructive process. Taphonomic studies are a major tool in assessing pre- and post-depositional influences. Whenever studying a faunal assemblage, we must assume and test, how representative the sample actually is.

Excavation methods greatly affect this issue, particularly sieving and precise mapping of the finds (Payne, 1975). Both sieving and mapping are regularly practiced at prehistoric excavations. Therefore, using assemblages recovered using different methods can result in a biased conclusions. Studying assemblages from excavations conducted a long time ago, and usually stored in museums, are of very little value for taphonomic studies, i.e. the reconstruction of behavioural patterns, both animal and human (Rabinovich and Tchernov, 1995).

Animal size is always mentioned in relation to transportation and butchery. Small carcasses are often transported whole, while large carcasses are reduced to smaller parts (O'Connell *et al.*, 1988, 1990; Lyman, 1985, 1992; Yellen, 1991a, 1991b). The survival of skeletal parts by animal size is a very crucial point in the lengthy process of understanding patterns of human subsistence. Body size related to different body parts distribution was discussed by Klein (1989), *inter alia*: "...in general, the smaller bovids are more evenly represented by various skeletal parts, or conversely, that the larger bovids tend to exhibit more discrepancies in abundance among parts". (Klein, 1989: 370); and "...in the archaeological faunas I have studied, skeletal parts tend to be more complete (less frag-

mented) than those of larger animals. ... skeletal part representation differs between smaller and larger bovids at least because smaller bones are more likely to retain their integrity during butchering and food preparation or during kicking and trampling across the surface of repeatedly occupied sites." (Klein, 1989: 374).

The problem of estimating the number of individuals represented in an assemblage lies along an uncertain hypothetical line between the NISP (XNI - "Maximum Number of Individuals", Gilinsky and Bennington, 1994) and MNI: "...However we caution, as we did earlier, that the number of individuals of a species that are represented in an assemblage is not the same thing as the number of individuals in the once-living community, except under special circumstances..." (Gilinsky and Bennington, 1994: 256).

The practice, whereby the total number of identified bones is presented, has a major influence on the interpretation. The way in which the bone units are calculated, and the MNI results estimated, has a major effect on the results of bone assemblage interpretations. Bone fragments are overrepresented by the NISP but underrepresented by the MNI's. Correlations between these two measures can provide a glimpse into the degree of fragmentation.

During a taphonomic study of several assemblages from the Upper Paleolithic (40,000 - 18,000 BP; UP): Qafzeh, Hayonim layer D, and the Epi Paleolithic (18,000 - 12,500 BP; EP): Ohalo II and Hayonim layer C of Israel (Fig. 1), the role of body size groups, calculated according to bone fragments, was observed. The body size groups will be considered in the following study, in an attempt to demonstrate their relevance to archaeozoological studies. The characteristics of the sites and their fauna were described in other publications (Rabinovich, nd; Rabinovich *et al.*, 1996; Rabinovich and Tchernov, nd).

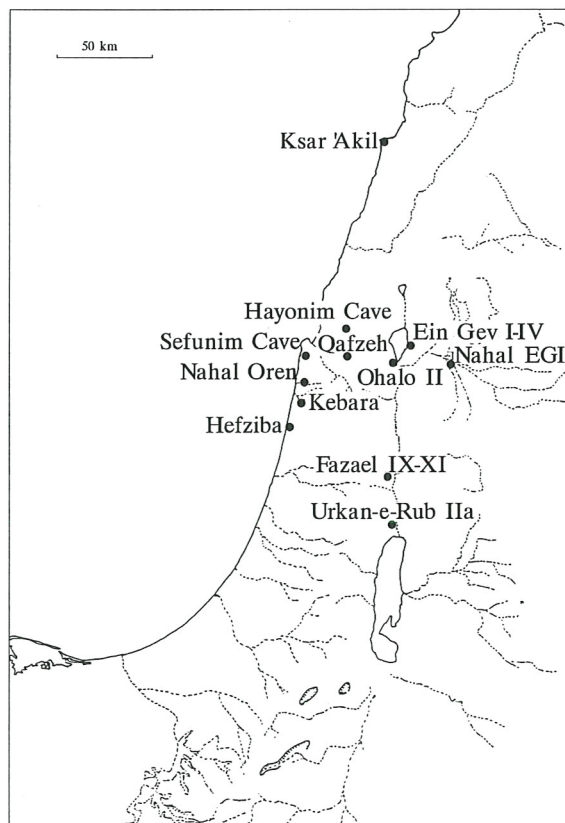


Figure 1. Map of the Upper Paleolithic and Epi-Paleolithic sites in the Levant, mentioned in the text.

## Archaeological Background

Several hunter-gatherer societies existed in the territory of Israel during the Upper Palaeolithic (UP, 40,000-18,000 BP) and Epi-Palaeolithic (EP, 18,000-12,500 BP) epochs. Sites occur mainly in the Mediterranean core area, although their distribution also extends southward in the latter part of the period (late Epi-Palaeolithic), probably due to climatic fluctuations. These groups have been interpreted as being small bands of hunter-gatherers (Gilead, 1991, 1995; Bar-Yosef and Belfer-Cohen, 1988).

The Upper Palaeolithic in Israel is characterized by several different technological traditions, the relationship between which is unclear. These differences have been interpreted as reflecting cultural or micro-chronological phases (Gilead, 1991; Bar-Yosef and Belfer-Cohen, 1988). Information available to date suggests a hunting-based economy focused primarily on mountain gazelle (Cope, 1994; Davis, 1982, 1983). The reconstruction of the subsistence pattern is, however, incomplete as few faunal assemblages have been studied in detail.

## Qafzeh (UP - Ahmarian)

The Qafzeh cave (Fig. 1) is located on the left bank of Wadi el-Haj, 220 m above sea level, about 7 meters above the wadi channel. The site includes occupation layers inside the cave, on the terrace in front of the cave, and the corridor inbetween. The site was excavated by Neuville, assisted by Stekelis (1932-1935; Neuville, 1951:179-184), and more recently by Vandermeersch (1969-1979, 1981). The excavators encountered remains of many human adult and child skeletons, which have been classified as anatomically modern human (*Homo sapiens*; Vandermeersch, 1981).

The stratigraphic accumulation in the cave interior includes archaeological remains from several periods: Medieval - Byzantine (A-B), Upper Palaeolithic (UP; layers C-E), and Middle Palaeolithic (MP; layers F-L). Vandermeersch (in Ronen and Vandermeersch, 1972) excavated at the cave, and exposed remains from the Neolithic and Bronze Ages (2-4), Upper Palaeolithic (5-9), mixed layers (10-11), and a Mousterian industry (12-13). It was the Upper Palaeolithic assemblage which was studied here.

The Upper Palaeolithic sequence comprises several layers:

- Layer 9 - Hearths, reddish clayey silt with small calcareous fragments, slightly weathered. The calcareous elements disappeared in part of the layer (9b).
- Layer 8 - Reddish-brown compact clayey silt with heavily weathered calcareous fragments.
- Layer 7 - Heavily weathered calcareous fragments with a compact clayey silt interfilling.
- Layers 9, 9b and 8 seem quite homogeneous in terms of the flint analysis.

The absence of Aurignacian elements is worth noting. The UP industry is very different from any other known assemblage. It is characterised by blade and bladelet production, attributed to the Ahmarian tradition. There seems to be no continuity between the MP and the UP layers at the site (Ronen and Vandermeersch, 1972; Boutie, 1989). Qafzeh UP is considered to be an early site within the UP sequence of the southern Levant, ca. 43/40-36 ka (Bar-Yosef and Belfer-Cohen, 1988; Bar-Yosef and Vandermeersch, 1993; Belfer-Cohen and Bar-Yosef, 1981).

## Hayonim D (UP - Aurignacian)

Hayonim Cave (Fig. 1) is located in Western Galilee, on the right bank of Nahal Meged. It is composed of a cluster of intact and collapsed chambers, formed by karstic activities. The excavations were carried out in one of these chambers, measuring 230 m<sup>2</sup> beyond the drip line. The exposed stratigraphy consists of layers A-E, separated by unconformities:

- Layer A - the end of the Natufian as well as material mainly from the 2nd century AD to the present.
- Layer B - Natufian remains (ca. 12,350 - 11,000 BP).
- Layer C - Early Kebaran underlies the Natufian layer in the area of the cave's current entrance. The deposit lies at a depth of 1-2.3 meters. The lithic assemblages are dominated by retouched bladelets with micropoints, and with increasing frequency, by obliquely truncated bladelets at the top of the deposit (Bar-Yosef, 1991).
- Layer D - A Levantine Aurignacian industry was identified in the inner part of the cave in a 0.35-0.40 m thick layer within an area measuring 15-18 m<sup>2</sup> and. This layer was accumulated in a lower basin created by dripping water, truncating the top of the Mousterian deposits.
- Layer E - Mousterian deposits probably covered the entire cave.

A detailed study was conducted on the spatial distribution, material culture, and geological setting of the Aurignacian layers of Hayonim D (excavated before the new excavations began in 1991) divided into three layers from the earliest D4, D3, and D1/2 (Belfer-Cohen 1980, Belfer Cohen and Bar-Yosef 1981).

The succeeding Natufian activities obscured the spatial organization of the Aurignacians at Hayonim Cave. The knapping was done elsewhere. Refittable pieces are therefore rare. Due to the large area of refuse, it would seem that a living zone is not present. In spite of the massive evidence for a

bone tool industry, only a few bone tool fragments could be pieced together from the same sub-layer. The various layers comprise:

- Layer D4 - probably includes more than one occupation. The three aligned hearths seem too close to each other. A fireplace with stones and slabs, as well as another three hearths have been assumed to resemble facilities for smoking hides (Belfer-Cohen and Bar-Yosef, 1981).
- Layer D3 - two dumping zones contained the largest game residue in the Cave (“kitchen midden”). Micromorphological analysis indicated that the accumulation was due to the deterioration of organic matter. Even the ground stone artifacts and bone tools seem to have a distribution which encircles the main dump (J20).
- Layer D1/2 - repeated occupations that were very much diffused. The midden area is still in use (J20).

#### Hayonim C (EP - Kebaran)

A small area was exposed in the cave of Hayonim, where Kebaran cultural remains were identified (see layer C above). No detailed archaeological report is available as yet, although a separation into 5 arbitrary layers has been compiled (Bar-Yosef and Tchernov, 1966; Belfer-Cohen, pers. comm.). The size of the faunal assemblage is not very large, but still consists of a variety of bones, both in terms of species and body part.

#### Ohalo II (EP - early Kebaran)

The site of Ohalo II (Fig. 1) is situated on the western shore of the Sea of Galilee, 9 km south of Tiberias, at an elevation of 212.5 m. The site is ca. 1500 m<sup>2</sup> in area. The archaeological deposits lie directly on the Lisan Formation (Nadel, 1991, 1995). A series of <sup>14</sup>C dates yielded an age of ca. 19,000 BP (Carmi and Segal, 1992).

The excavated part of the site (370 m<sup>2</sup>) contains three structures, two of which were sounded and one of which was excavated; *Locus* 1: an oval hut, *Locus* 2: a smaller hut and *Locus* 3: a third pear-shaped structure. In addition, a round stone installation (*Locus* 4), and a series of hearths were discovered (*Locus* 7, and *Locus* 9). Another series of large charcoal fragments and fire remains was revealed to the west of *Locus* 1 (*Locus* 6). A small pit (*Locus* 8), as well as another hearth were found north of the excavated area (*Locus* 11). A burial site with a skeleton of a male (*Locus* 5) lying in a flexed position, was exposed west of the structures, near the surface. An area interpreted as a waste dump was identified along the eastern edge of the camp (*Locus* 10). This burial site contains the most complete representative human remains from the Upper Palaeolithic/Early Palaeolithic (Nadel and Hershkovitz, 1991).

The most unique finds are the charred floral remains. Many species have been identified, among them grains of barley and wild wheat. The wild wheat is to date the oldest recorded from an archaeologically dated site. On the basis of the cereals and wild fruits it was suggested that the site was occupied during spring and autumn (Kislev *et al.*, 1992).

Beads, cut from Mediterranean and/or Red Sea *Dentalium* shells were also found at the site. Twisted fibers were interpreted as fragments of cordage used as bags or nets. Furthermore, their presence was correlated with possible evidence of above-ground storage (Nadel *et al.*, 1994).

### Archaeozoological Background

Most studies on faunal assemblages from the UP and EP periods have not included taphonomic aspects with which to compare our data. The few exceptions include Urkan E-Rub (Hovers *et al.*, 1988) and Neve David (Bar-Oz, this volume). The most detailed studies on sites from the UP and EP were published by Davis (1974a, 1974b, 1977a, 1977b, 1982, 1983). These included the identifications of species, age, sex, size, comparison of species between periods and relative abundance of

species, but did not include a report on damage patterns or modifications (except Davis, 1974b). Gazelle outnumber any other species in all of the sites from the UP: Kebara, Nahal EG I, Fazael IX, Fazael X and Fazael XI (Davis, 1982, Table 2; Fig. 2). The fallow deer is in most cases the next most common species. A similar distribution has been noticed in such Kebaran (EP) sites as Nahal Oren, Ein Gev I, Ein Gev II and Fazael IIIa, and Geometric Kebaran sites such as Ein Gev III and IV and Fazael VIII (*ibid.*). The presence of many cervids was noted from the site of Nahal Ein Gev (*ibid.*).

### Qafzeh

A preliminary study of the macrofaunal remains from Qafzeh was done by Bouchud (1974). His analysis included the material from the 1965-1969 excavations, as well as the remains from Neuville's excavations. The microvertebrates have been studied by Haas (1972) and by Tchernov (1981).

### Hayonim Cave (Layers D and C)

Hayonim D and Hayonim C layers were examined by Davis and published in several articles (Davis, 1974b, 1981, 1982, 1983). The Kebaran layers (Hayonim C) from the first excavation seasons (e.g. until 1966) were examined by Tchernov (in Bar-Yosef and Tchernov, 1966).

Tchernov (1984) examined the relative frequency of commensal animals and noted the significant increase in mice during the Aurignacian (Hayonim D), reflecting an increase in the intensity of occupation, while a decrease was observed in the relative frequency of all commensal species during the Kebaran (Hayonim C).

The Hayonim D faunal assemblage is very prolific, and served as the "type" group for the present study. Detailed methods were tested first on this assemblage in order to identify any pattern that could be used later on for faunal materials from other sites.

### Ohalo II

The fauna had not been studied before the present study. The excavated material was wet-sieved through a 2 mm mesh during the first two seasons, and a 1.2 mm mesh during the third season. As observed in the field and during the first stages of sorting, the mammals are only part of the faunal assemblage from Ohalo II. Bird (Simmon and Nadel, pers. comm.) and fish bones seem to be very abundant as well.

## Methods

Each bone fragment was recorded in a data file and analysed using SAS (Statistical Analysis System; data analysis package). The details specified for every bone item included:

- Stratigraphic location according to the archaeological definitions.
- Anatomical characteristics: body part, side, species, state of fusion at the epiphysis, part of bone.
- Taphonomic modifications: striations, cut marks, hammer stone percussions, scratches, gnawing marks, tooth pits, burnt elements.

Part of the bone recording procedure was adopted from 'Animals', a microcomputer based program, developed by D.V. Campana and P.J. Crabtree (1987). According to their scheme, the relative portion of preserved bone is recorded for each element. A complete bone equals 1, less than half a bone equals 4, half equals 5, and more than half equals 6. This method was used to collate information about the completeness or incompleteness of the bone elements.

### Species Identification

Identification was carried out at the Department of Evolution, Systematics and Ecology, at the Heb-

rew University of Jerusalem, using their comparative osteological collections (HUJ). Because of the emphasis on behavioural aspects in this analysis of faunal remains, even the bones that could not be identified as belonging to a certain species were included in the analysis. Long bone shafts without epiphyses, and other bone fragments (e.g. vertebrae and ribs), were assigned only to body size group category (BSG):

- Aurochs (*Bos primigenius*), rhinoceros (*Rhinoceros hemitoechus*), (A, BSGA; live weight > 1000 kg).
- Red deer (*Cervus elaphus*), fallow deer (*Dama mesopotamica*), wild boar (*Sus scrofa*), hartebeest (*Alcelaphus buselaphus*), (B, BSGB; live weight = 80-250 kg).
- Wild goat (*Capra aegagrus*), (C, BSGC; live weight = 40-80 kg).
- Gazelle (*Gazella gazella*), roe deer (*Capreolus capreolus*), (D, BSGD; live weight = 15 - 40 kg).
- Mammals the size of hare (*Lepus capensis*), common red fox (*Vulpes vulpes*), (E, BSGE; live weight = 2 - 7 kg).

### Body parts

Body parts were identified including shaft fragments as well, thereby facilitating taphonomic analysis in particular. Skeletal elements were presented in the context of three methods, termed: Level 1, Level 2 and Level 3 respectively (Fig. 2):

1. Detailed identification, whereby each preserved part of each bone was recorded (e.g. proximal femur, femur shaft, etc.).
2. Association of skull and tooth parts (skull fragments, maxillary teeth, mandibular teeth, maxilla

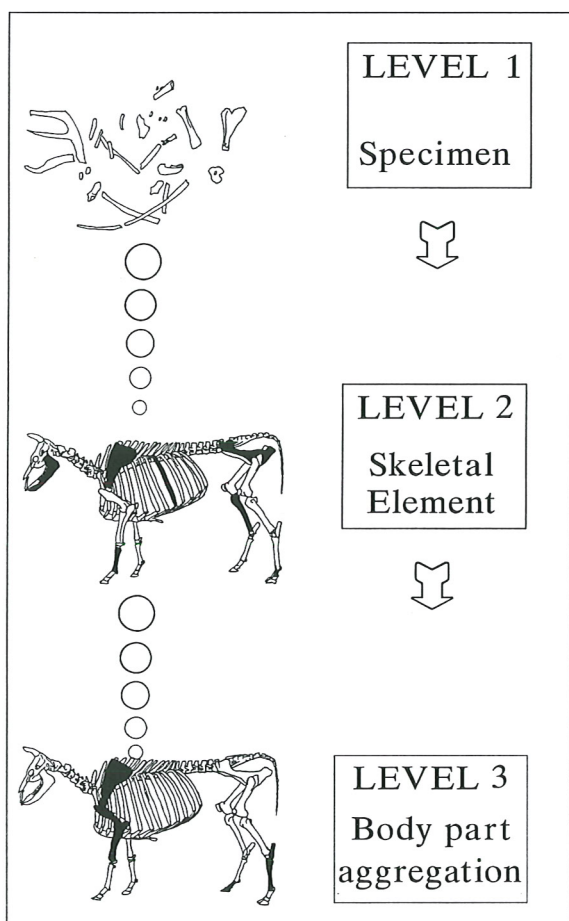


Figure 2. Description of the levels of faunal analysis (Level 1,2,3)

- fragments and mandible fragments) in one group, and of remaining fragments according to skeletal element (femur, humerus etc.).
3. Association of all body parts in eight groups according to anatomical provenance:
  - Skull (SKMX) - skull fragments, maxilla teeth and maxilla fragments.
  - Lower jaw (LJAW) - lower jaw teeth, and teeth fragments.
  - Trunk elements (TRUNK) - vertebrae, pelvis, and ribs.
  - Forelimb (FORELIMB) - humerus, radius, ulna, and scapula.
  - Foreleg (FORELEG) - carpals and metacarpals.
  - Hindlimb (HINDLIMB) - femur, tibia, and fibula.
  - Hind leg (HINDLEG) - tarsal, astragalus, calcaneum, and metatarsal.
  - Others (OTHERS) - metapodials, phalanges, sesamoid.

Using the most detailed level, Level 1, for describing the various species per archaeological layer, was not found to be very useful, therefore only the distribution of the most abundant species, i. e. that of the gazelle, was applied. This method is less appropriate for analysing layers poor in faunal remains. In the present study we will apply the third Level (3) of association for all the bone assemblages.

Species	Qafzeh UP	Qafzeh - %	HD4	HD4 - %	HD3	HD3 - %	HD1/2	HD1/2 - %	HC	HC - %	Ohalo II	Ohalo II - %
<i>Equus</i> sp.	5	1			2	0	1	0				
<i>Rhinoceros hemitoechus</i>			1	0					1	0		
<i>Sus scrofa</i>	15	2	5	0	22	0	25	0	38	1	19	0
Cervidae			5	0	30	0	16	0	11	0	14	0
<i>Cervus elaphus</i>	43	6	27	2	97	1	112	2	39	1	11	0
<i>Dama mesopotamica</i>	57	8	90	6	309	4	399	8	57	2	413	5
<i>Capreolus capreolus</i>	5	1	10	1	43	1	24	0	15	1		
<i>Bos primigenius</i>	29	4	8	1	30	0	39	1	30	1	2	0
<i>Alcelaphus buselaphus</i>					7	0	5	0	3	0		
<i>Gazella gazella</i>	140	20	763	52	3006	43	2484	49	989	33	2059	27
<i>Capra aegagrus</i>	15	2	8	1	59	1	36	1	37	1	4	0
<i>Canis aureus</i>	3	0			1	0			1	0		
<i>Canis lupus</i>									5	0		
<i>Vulpes vulpes</i>	7	1	19	1	90	1	38	1	55	2	118	2
<i>Martes foina</i>			1	0	2	0	2	0	1	0		
<i>Vormela peregusna</i>	1	0					1	0	1	0		
<i>Hyaena hyaena</i>	3	0			1	0					2	0
<i>Crocuta crocuta</i>	29	4										
<i>Felis silvestris</i>			6	0	28	0	33	1	11	0	18	0
<i>Panthera leo</i>	2	0										
<i>Panthera pardus</i>	1	0										
<i>Lepus capensis</i>			3	0	9	0	10	0	22	1	77	1
BSGA	46	6	18	1	88	1	69	1	42	1	18	0
BSGB	102	14	8	1	193	3	94	2	326	11	617	8
BSGC			5	0	36	1	13	0			10	0
BSGD	170	24	488	33	2903	41	1645	32	1265	42	4036	53
BSGE	6	1	14	1	56	1	31	1	73	2	193	3
Carnivore non-ident.	3	0									12	0
Unidentified mammals	34	5									55	1
Total	716	100	1479	100	7012	100	5077	100	3022	100	7678	100

Table 1. Species distribution at all sites (HD4 - Hayonim layer 4, HD3 - Hayonim layer 3, HD1/2 - Hayonim layer 1/2, HC - Hayonim layer C).

## Statistical Methods

As the main issue was to examine the differences between sites representing different cultures, and the different stages within the sites, the statistical analysis has concentrated on this aspect. For the examination of differences between the layers/sites I have purposely used residual analysis (after Sharon, 1996), in order to test homogeneity or heterogeneity in the relative frequency of species, body parts, and modifications within the different layers and/or sites. If the expected values were less than 5 in 20% or more of the tabulated correlation cells, the approximation of the test was considered insufficient. When the alpha value was less than 5% the result is significant, the null hypothesis concerning homogeneity should be rejected. This was decided using Pearson's chi-square test (*ibid*).

## Results

### Qafzeh

The combined relative distribution in UP layers (Table 1) shows the mountain gazelle to be the most common species (N=140, 20%), and the small mammal group (BSGD) to be the largest (N=170, 24%). Aurochs are not very frequent (N=29, 4%), and neither are wild goats (N=15, 2%) or wild pigs (N=15, 2%). Each species of cervid contributes over 6%: fallow deer (N=51, 7%), red deer (N=44, 6%), and roe deer (N=44, 6%). Medium size mammals (BSGB - fallow deer size), moderate the rarity of fallow deer in the UP of Qafzeh (N=102, 14%). Carnivores were in general quite common in the UP, comprising 7% (N=49) of the UP faunal remains. Analysing the UP sequence by layer is very problematic, since the sample size per layer is quite small.

Body size category A (BSGA; N=46, 6%) consists mainly of foot and trunk elements. Body size category B (BSGB) mitigates the rarity of fallow deer bones (N=102, 14%). This group comprises fragments of metapodials, phalanges and sesamoids, as well as trunk elements (N=26, 26%), hind legs, forelimbs and hindlimbs. Body size category D (BSGD) strengthens the tendency toward mountain gazelle abundance (N=170, 24%). Long-bone splinters, foot- and trunk elements were frequent. Long-bone splinters could be identified from both the hind- and forelimbs. The possibility of roe deer bone fragments being present in this category should not be ruled out entirely, although only a few splinters from bones, probably belonging to body size category E (BSGE, N=6, 0.8%), were found.

When examining the distribution of gazelle and the BSGD category in layer 8 and Layer 9, an interesting pattern appeared: while trunk parts are mainly present in the body size group, hind leg elements occur more frequently in Layer 9. Lower jaw parts are more frequent in Layer 8 (Fig. 3). Even detailed body part data for Layer 8 - the most prolific layer of the Qafzeh UP - do not display a

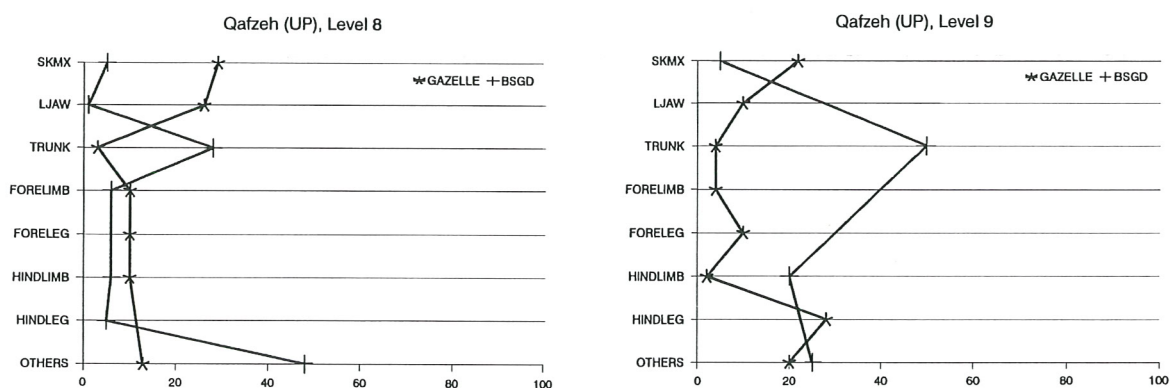


Figure 3. Qafzeh (UP), distribution of body parts association (Level 3) of gazelle and the BSGD category by layer (Layer 8 and 9).

clear distribution pattern due to the diffusion of elements per species. General comparisons between the three most prolific layers from the UP sequence seem to reflect a similar trend, whereby the group body size categories comprise the less complete bone elements and the teeth are not a major factor in the portion distribution per species.

The portion method helped in understanding additional aspects of faunal element distribution. The size groups consist almost entirely of elements less than half preserved. Elements belonging to species represented by few bones tend to be more complete, and not necessarily due only to the presence of teeth, but also because of other identifiable bones (e.g. phalanges).

## Hayonim D

In Layer D4, more than 80% of the 1479 bones (NISP) under study consisted of gazelle remains (N=763, 52%) and the BSGD category (N=488, 33%). The rest of the fauna is represented by fallow deer, red deer, roe deer, aurochs, wild goat, wild boar and rhinoceros (Table 1). Among the carnivores: fox, cat and marten were identified. According to body size, in addition to the predominant BSGD category, the BSGA and BSGE categories are also represented. When compared with the other Aurignacian layers, we observe a slight difference in the distribution of the less dominant species, while the most common species are present in all the layers (Table 1). *Rhinoceros* is present only in Layer D4 - a tooth, identified by Davis (1982), while equid remains are missing from Layer D4, but occur in layers D3 and D1/2. *Alcelaphus buselaphus* is also absent from this layer, as well as *Canis aureus*, *Vormela peregusna* and Hyaenidae. Note that all species missing from Layer D4 appear in very low relative abundance in the other layers (e.g. between 0.01-0.03%).

The most frequently encountered species in all layers is gazelle, followed by fallow deer (*Dama dama*). Other species are present in very low percentages (Table 1). Red fox (*Vulpes vulpes*) is the most common carnivore, followed by wild cat (*Felis silvestris*).

## Body Part Distribution

Many of the skulls were broken, and although some of the pieces might have belonged to the same skull, piecing them together was almost impossible. Several skull parts were so fragmented that they could not be identified. The quantification of the skull parts is therefore rather doubtful.

Most of the horn cores are broken, but the actual reason is unclear. It seems that the more "narrow" horn cores tended to be preserved. Some of the horn cores seemed to have been broken in the past and in many cases were found attached to the skull.

## Distribution of Body Parts to Level 3

In Layer D4 the quantity of bones per species was quite small (Table 1, Fig. 4). Since gazelles outnumber any other species and appear in reasonably great numbers, their body part distributions can be discussed. Both skull-maxilla and mandible fragments outnumber all other body parts, except phalanges. Mandible parts are less common than maxilla parts. Most of the trunk parts are represented in the body size category BSGD (Fig. 4).

When divided slightly different, with the carpals, tarsals, metapodials and long bone splinters set apart, we notice a correlation between the foreleg and hindleg parts. The other species - aside from fallow deer - are represented by a few bones each. Very few phalanges of fallow deer were discovered in comparison to those of gazelle (gazelle phalanges - 26%, fallow deer - 8%).

Gazelle teeth outnumber those of other species. Teeth from the maxilla outnumber teeth from the lower jaw. In fact, very few teeth belong to other species, reflecting the general NISP per species, where gazelle contributes at least 50% to the assemblage.

Rhinoceros is represented by only a single tooth, although it is possible that some of the elements from the BSGA category originate from this species.

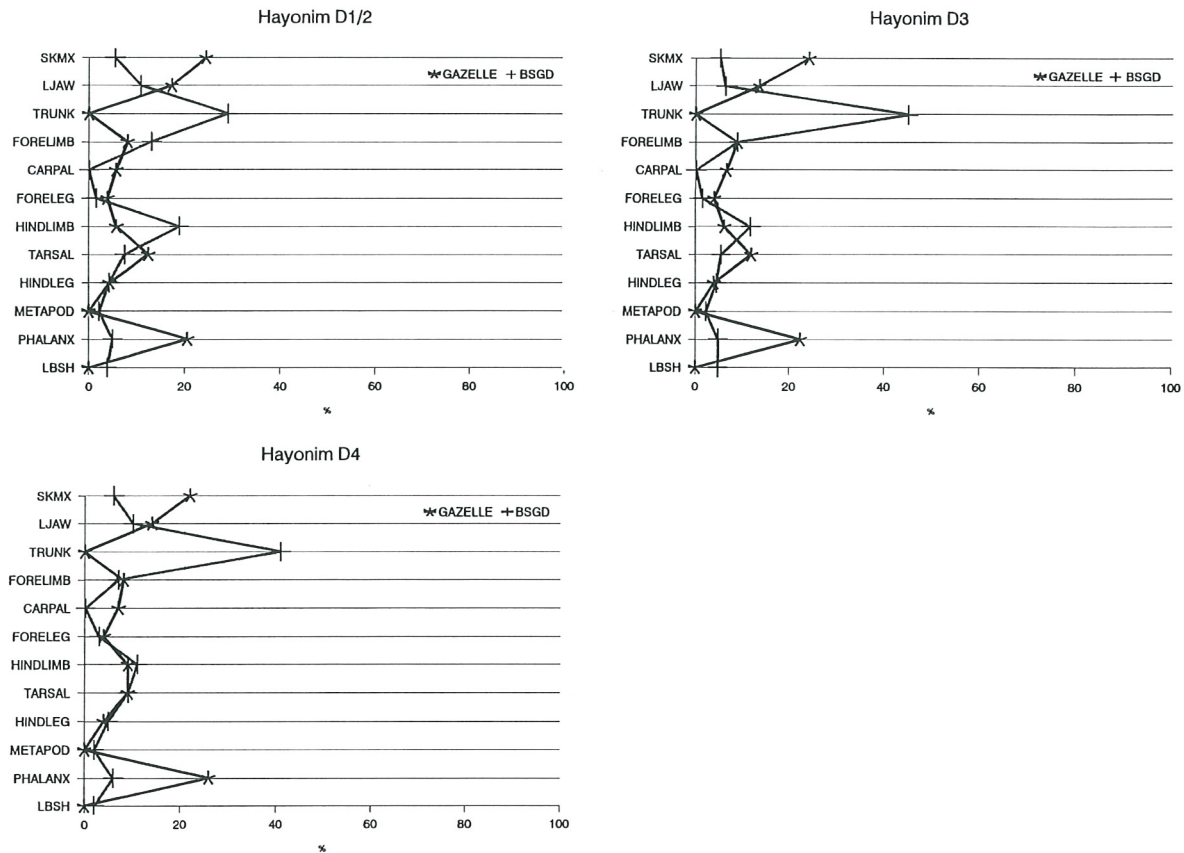


Figure 4. Hayonim D, distribution of body part association (Level 3) of gazelle and the BSGD category by layer.

In Layer D3 (Table 1) the forelimb and hindlimb of gazelle are similarly distributed, and tarsal bones are relatively numerous. BSGD category bones include mainly trunk elements (Fig. 4).

Numerous hindlimb parts are present in this category as well. In the case of gazelle, parts and teeth from the maxilla outnumber lower jaw fragments and teeth. Bones from the forelimbs of fallow deer are less numerous than those from the hindlimbs, and BSGD comprises trunk and long bone shafts.

Bones from the remaining species in Layer D3 and Layer D1/2 fall mainly into the skull, lower jaw and phalanges categories. Roe deer trunk elements could easily be present in the BSGD cluster of bones, while the trunk elements of aurochs belong to BSGA.

In Layer D3, forelimbs and hindlimbs are quite numerous in the BSGA category, probably due to breakage. Wild goat bones are mostly represented by limb parts rather than skull and mandible fragments. Fox elements comprise mainly skull, lower jaw and forelimbs, whereas trunk and tarsal parts are present in BSGE, and lower teeth outnumber upper teeth.

In Layer D1/2, forelimbs outnumber hindlimbs among the gazelle remains, and vice versa for BSGD remains (Fig. 4). Upper jaw teeth - isolated or in the maxilla - outnumber lower jaw teeth and mandibles for gazelle, while mandibular teeth, on the other hand, outnumber maxillary teeth in other species represented in the residues of this layer. Trunk and long bone splinters comprise most of the bones from the BSGD category. Fallow deer remains are distributed between all body parts, while - as in other layers - bones from hindlimbs outnumber those from forelimbs (Fig. 4). Roe deer remains consist mainly of teeth and several phalanges. Red deer remains are distributed through all categories. There are no teeth from goat in this layer, only limb bones. Fox remains are less numerous in this layer, consisting mainly of forelimb bones. Wild cat was present mainly in the form of tooth remains.

## Hayonim C

The species distribution is not very different from the Aurignacian layers of Hayonim. From a total of 3022 bones, gazelle and BSGD make up more than 70% of the faunal assemblage. Meanwhile fallow deer (N=57, 2%), fox (N=55, 2%), wild pig and red deer (N=38 and 39, 1%) each comprise less than two percent of the bones. Other species account for less than 1% (Table 1), with the most infrequent species not appearing in all layers. The body size categories are distributed in a similar way as the species from which they probably originate: BSGB (N=326, 11%), BSGD (N=1265, 42%) and BSGE (N=73, 2%). The only missing species in comparison to Hayonim D layers are the equids and hyaenas, while wolf (*Canis lupus*) is present only in Layers C1 and C5 at Hayonim Cave.

When the distribution of species is examined per layer a picture very similar to that of Hayonim D appears, i.e. an abundance of gazelle bones. Gazelle remains comprise between 27-46% by layer, and a BSGD proportion between 29-49%.

### Distribution of Body Parts to Level 3

Detailed distribution of body parts per layer concentrated on the more abundant species: gazelle, fallow deer and their related body size categories (BSGD and BSGB). As expected, trunk parts such as vertebrae and ribs as well as long bone splinters are represented in the body size group categories. Long bone splinters comprise more than 50% per layer of the BSGD category. The rest are distributed between trunk, lower jaw fragments and limbs. Lower jaw remains include mandible fragments and isolated broken teeth. Hindlimb parts, both upper and lower, are more common than forelimb parts (e.g. in Layers C2, C3/4, and C5). Fallow deer remains are very few, mainly teeth from the upper and lower jaws and phalanges, while the BSGB category includes representatives of almost every body part size (e.g. in Layers C2, C3/4).

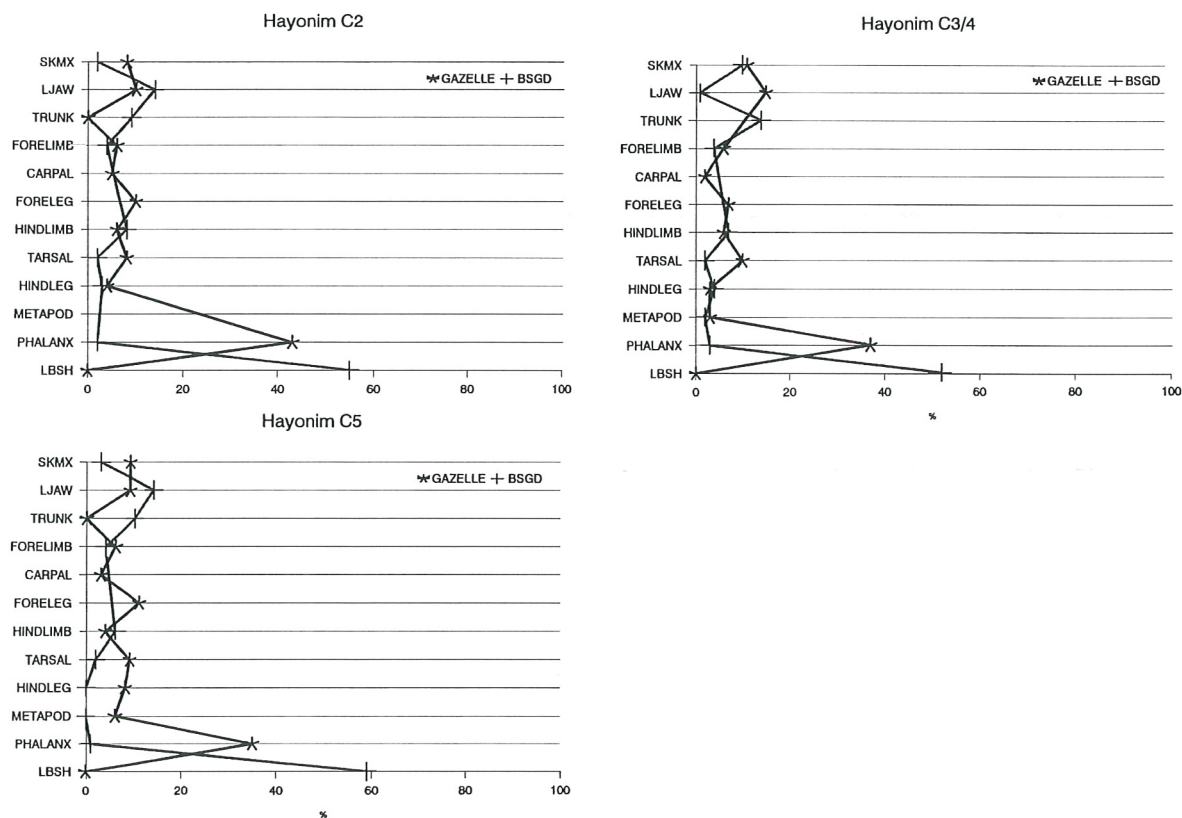


Figure 5. Hayonim C, distribution of body part association (Level 3) of gazelle and the BSGD category by layer.

Species	Surf	L1	L1 S	L2	L2 S	L3	L3 S	L4	L4 S	L5	L6	L6 S	L7	L7 S	L8	L8 S	L9 S	L10	L10 S	Nort
<i>Sus scrofa</i>	4					6	4							3					2	
Cervidae	5	1			1	4							1	1				1		
<i>Cervus elaphus</i>	6					1	1							3						
<i>Dama mesopotamica</i>	194	50	13	5	14	39	19			1			8	19	2	1		9	23	16
<i>Bos primigenius</i>														1	1					
<i>Gazella gazella</i>	1004	40	59	59	101	2863	59	3	4	10	1		59	120	15	9	5	30	100	94
<i>Capra aegagrus</i>	1	1								1				1						
<i>Vulpes vulpes</i>	52	4	4	6	4	21	2					1		17				4	1	2
<i>Hyaena hyaena</i>	2																			
<i>Felis silvestris</i>	9	1	1		3	1				1			2							
Carnivore sp.	4	1				5		1												1
<i>Lepus capensis</i>	17	10	1	4		29		1					9	3					1	1
BSGA	6		1			2	1						1	4					2	1
BSGB	299	29	32	5	25	60	24			5	1	1	8	32	6	1		6	50	33
BSGC	3					5	1												1	
BSGD	2085	78	118	109	173	469	137	12	1	57	9	6	75	191	45	11	10	57	214	176
BSGE	75	9	5	5	4	51	8			2	1		8	10	4		2	1	2	6
Unidentified	14	12				9				1			4					5	9	1
Total per loci	3780	236	234	193	325	988	256	17	5	78	12	8	175	405	73	22	17	113	405	331

Table 2. Ohalo II, distribution of species per loci (Surf= Surface; L1 ... 10 - Locus 1 - Locus 10, L1s - Locus 1 surface etc.).

When layers are compared (Fig. 5), the body part distribution seems very similar, with minor fluctuations. The small sample size has a major effect on the comparison between layers. The marked abundance of long bone splinters is very conspicuous and will be discussed further.

Only teeth of rhinoceros were found in Layer C5 although other bones, mainly long bone splinters, metapodials, ribs and vertebrae, might be present in the BSGA category. Aurochs bones were present in all layers in the form of several bones, including teeth, phalanges, metatarsal and sesamoid bones. Wild pig remains, absent only in Layer C1, include teeth, phalanges, metapodials and tarsalia. Red deer remains consist of phalanges, teeth, carpals and scapulae. Unidentified cervid elements include mainly antler fragments that could not be identified to a particular cervid species. Roe deer remains consist mainly of teeth, a metacarpal fragment, and a distal humerus fragment. Hartebeest (*Alcelaphus buselaphus*) is represented only by teeth. Wild goat elements, apart from teeth, include phalanges, metapodials, horn cores, astragali, and tarsalia. Fox, the most frequently encountered carnivore species, is represented in all layers by various body parts, including femora, humeri, tarsalia and atlas vertebrae. The BSGE category includes: ribs, metapodials, scapulae, radii, vertebrae, tibiae, atlas vertebrae and femora.

## Ohalo II

When the site as a whole is examined, the most commonly occurring species is mountain gazelle, comprising almost one third of the faunal remains (27%), while remains in the BSGD category comprise about 50% of the assemblage. Fallow deer (*Dama mesopotamica*) is the next most abundant species, although on a smaller scale (N=413, 5%), while the BSGB category is better represented (N=617, 8%). Red fox (*Vulpes vulpes*) comprise 2%, hare (*Lepus capensis*) 1%, and bones in the BSGE category make up 3% of the fauna at Ohalo II. Other species represented by several bones each, comprising less than one percent of the total assemblage, are: wild pig (*Sus scrofa*), red deer (*Cervus elaphus*), aurochs (*Bos primigenius*), wild goat (*Capra aegagrus*), Hyaenid, wild cat (*Felis silvestris*).

As previously mentioned, the relative distribution of body size groups correlates quite well with the range of species included in them. For example at Ohalo II, the relative abundance of these categories in descending order is: BSGD, BSGB, BSGA, BSGE and BSGC.

When species distribution is examined per *locus* (Table 2), a similar distribution is noticed: gazelle and the BSGD category are present in all *loci*, and are the dominant remains in all the *loci* at Ohalo II. The rarest species are absent in some of the *loci*. For example, fallow deer is present in all of the *loci*, except for *Locus 4* and *Locus 6*. Both red deer and wild pig are present only in *Loci 3, 7* and *10*. Aurochs are present only in *Locus 7*. Red fox remains are absent in *Loci 4, 5, 6, 8* and *9*.

As expected, gazelle and the BSGD category provided the most detailed information on body part distribution. When the distribution of gazelle is compared with that of the BSGD category, a pattern emerges: reverse relative frequencies of trunk and long bone splinters (LBSH), which are more abundant in the BSGD category; and phalanges are more abundant among the gazelle remains. The rest of the body parts are very similarly distributed with a slight dominance of gazelle remains in most *loci*.

The other species are very poorly represented when divided by body part association (Level 3) per *locus*. Several bones per *locus* for most species is the common distribution in Ohalo II fauna. Fallow deer for example, being the next most abundant species after gazelle, are represented mainly by teeth and phalanges in all *loci*, while the frequency of other body parts varies between *loci*. In general, hindlimb and hind leg parts are more abundant. In *Locus 1* fallow deer is more abundant than gazelle (noteworthy despite the problematic analysis of this sampled *locus*). Fallow deer is represented in every body part category in *Locus 1*, except metapodials, while *Locus 3* remains lack carpal and foreleg bones. Fox remains are rare per *locus*, and include several bones from almost all body part groups. Hare remains in *Locus 1* and *Locus 3* lack teeth and skull fragments.

Long bone splinters are very frequent, probably as a result of wet sieving and the special conditions of preservation at the site, although behavioural factors should also be considered.

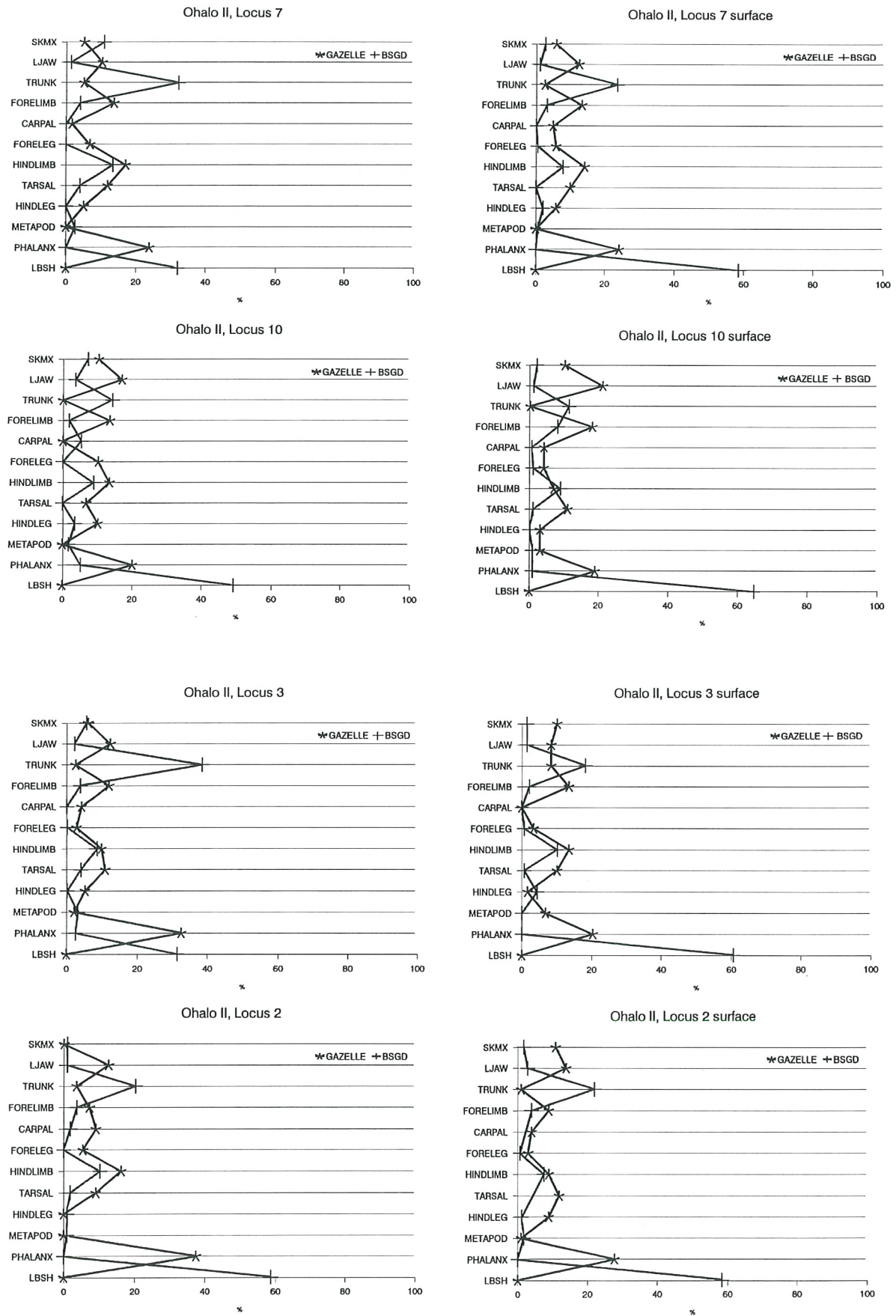


Figure 6. Distribution of body part association (Level 3) of gazelle and the BSGD category per *loci* (Loci: 3, 3 surface, 2, 2 surface, 7, 7 surface, 10, 10 surface).

The body size groups (BSGB, BSGD and BSGE) include mainly trunk and long bone splinters, although fore- and hindlimb bones are also present.

Though the total sample is large (NISP=7678), per *locus* it is actually quite small. Half of the faunal remains come from the surface of the site, collected in areas measuring one to five square metres. As was observed in other aspects of the archaeological record at Ohalo II, "surface" collection is an integral part of recovering the site remains. In order to better understand its nature we have examined the spatial distribution of animal bones. We distinguished between the surface above the *loci*, and the *loci* proper. The faunal remains were therefore described per *locus* and per surface area of each *locus*.

In general, the huts (*Loci* 1, 2 and 3), the large hearth (*Locus* 7) and the waste dump (*Locus* 10) contain the most faunal remains. Consequently, we assume that the nature of the surface faunal deposition is not very different from that of the site itself. It probably originates from the same process and has a similar history of deposition. This does not, however, help in reconstructing the rate of deposition, and requires further examination.

### *Distribution of Body Parts to Level 3*

The relative abundance of long bone splinters (in the BSGD category) is most pronounced in the surface area of *Locus* 1 (Fig. 6). Mandibular teeth and fragments are more frequent than maxilla parts and radius is more frequent than humerus. A very similar distribution was observed at *Locus* 2, but with more carpals and equal distribution of forelimbs (e.g. humerus, radius). Long bone splinters comprise more than half (n=64, 59%) of remains in the BSGD category. In this group, beside trunk elements (ribs and vertebrae), pelvis parts are also common. More hindlimbs than forelimbs were discovered among gazelle and BSGD bones at *Locus* 2. The surface distribution of *Locus* 2 is very similar to the surface distribution of *Locus* 1. Vertebrae are more frequent on the surface of *Locus* 2 than on the surface of *Locus* 1. The presence of a gazelle maxilla fragment is worthy of note, considering the absence of this skeletal element at the *locus* itself.

At *Locus* 3 the distribution of body parts is slightly different from those from other huts (*Loci* 1 and 2). Among the remains in the BSGD category, fewer long bone splinters, and more skull, vertebrae and ribs were identified. The first phalanx is more abundant than the other phalanges. Relatively more long bone splinters came from the surface of *Locus* 3. A typical distribution of gazelle bones is present at *Locus* 7, where mandible parts outnumber skull parts, and the first phalanx outnumbers other phalanges. BSGD category remains comprise long bone splinters, vertebrae, ribs and skull fragments. The surface of *Locus* 7 includes relatively more long bone splinters (59%). The distribution of body parts in *Locus* 10 resembles that of the other *loci*, with a group of slightly larger long bone splinters (BSGD category) on the surface of the *locus*.

Several general conclusions can be drawn from an examination of the distribution of body parts for gazelle and in the BSGD category. Gazelle remains: most *loci* mandible teeth and fragments outnumber maxilla teeth and parts, the first phalanx is more common than other phalanges, all limb bones are present in varying frequencies, and there is a slight tendency toward more hind- than forelimb remains to be found. BSGD category remains: long bone splinters constitute at least 30% and up to 70% of bone specimens 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, but fore- and hindlimb bones are present as well. Femur is one of the long bones represented at each *locus*.

## **Summary and Discussion**

### Intra site variability

In all the assemblages under study, except for Qafzeh, gazelle remains constitute at least 40% of the mammalian bones, and when combined with the remains represented in the relevant body size group

Species	QAF UP	HD4	HD3	HD1/2	Ohalo II	HC	
<b>BSGA</b>	14%	3%	3%	4%	0%	2%	<b>281</b>
<b>BSGB</b>	31%	1%	6%	5%	13%	19%	<b>1337</b>
<b>BSGC</b>	0%	1%	1%	1%	0%	0%	<b>64</b>
<b>BSGD</b>	52%	92%	89%	89%	83%	74%	<b>10504</b>
<b>BSGE</b>	2%	3%	2%	2%	4%	4%	<b>373</b>
	<b>324</b>	<b>527</b>	<b>3276</b>	<b>1852</b>	<b>4874</b>	<b>1706</b>	<b>12559</b>

Table 3. Percent comparison of body size groups between sites.

(BSGD category), account for at least 60% of the bones per site. The other species had a varied abundance, significantly differing across sites ( $\chi^2=842.37$ ,  $df=30$ ,  $\alpha=0.00\%$ ). The next most frequent species is fallow deer. A decrease is observable in the relative abundance of red deer remains between Qafzeh and the other assemblages. This trend is valid even when the unidentified cervid remains are included in the comparison. Meanwhile gazelles are far more abundant at all sites, except Qafzeh (Table 3).

When only the distribution of body size groups (BSGA, BSGB, BSGC, BSGD, BSGE) is compared, a significant difference appears between the sites ( $\chi^2=873.38$ ,  $df=15$ ,  $\alpha=0.00\%$ ), although the BSGD category is the most frequent group at all sites (Table 3). The BSGB category is the next most frequent group in the assemblage of Qafzeh (14%), at Hayonim D3, D1/2, Hayonim C and Ohalo II, but with very low abundance rates (3-8%). Remains in the BSGE category account for less than 1% in all assemblages except Ohalo II and Hayonim C, where they form more than 2% of the assemblage. The BSGC category remains are quite rare. The largest body size group, the BSGA category, is present in all the assemblages at the rate of 1% or less (Ohalo II), except at Qafzeh where it has a relative value of 6% (Table 1).

The body part distribution was examined at all of the sites for gazelle+BSGD category remains and for fallow deer+BSGB category remains, and was found to be significantly different both with and without teeth for both groups. Even when sites closer in chronological/cultural terms were examined separately, such as Hayonim D and Qafzeh, or Ohalo II and Hayonim C, the same trend could be observed.

## Inter site variability

### *Qafzeh*

The UP layers of Qafzeh are problematic, due to the small sample size. General comparisons between the three richest layers from the UP sequence (Layers: 9, 8, 7), seems to repeat a similar pattern, where the group body size categories consist of the less complete bone elements, while teeth do not make a major contribution to the relative distribution by species. The portion distribution of species represented by more bones, however, includes more categories. Might this be connected to the mode of processing by humans or other agents, interfering with natural bone accumulation?

The body part distributions of gazelles+BSGD category bones and fallow deer+BSGB category remains were examined by layer and between the layers for statistical homogeneity (e.g. Layers: 9, 8, 7). Unfortunately, due to the small sample size, this inter- and intra-layer comparison could not provide sufficient information for statistical tests (e.g. expected values less than 5%; see Methods).

Based on the carnivore remains, Dayan (1989) suggested that the cave served as a den for a certain period of time, because of the presence of spotted hyaena (*Crocuta crocuta*) cubs that denned periodically at the cave. Carnivores were generally more frequent in the UP than in the MP at Qafzeh (Rabinovich and Tchernov, 1995). When the spotted hyaena remains were examined by layer at Qafzeh, unworn teeth were present only in Layer 8, the rest deriving from adult animals (e.g. worn down teeth and fused epiphyses). Layer 8 is the most abundant layer in terms of animal remains. A

few bones with cut marks were present in this layer (N=3, 1%), as well as some burnt bones (n=8, 3%). Body part distribution shows very scarce remains in each category, with a slight tendency toward upper hindlimbs in fallow deer bones. A more even distribution is noticeable in gazelle bones. The bulk of the material is represented by splinters/diaphyses and long bone splinters.

In Layer 8, carnivore modified bones constitute four percent (n=10) of the faunal remains, including six gnawed and scratched bones and four digested ones. Animal modification is represented in all body size groups (e.g., BSGA, BSGB, BSGD), as well as in fallow deer, gazelle and bovines. If we assume that spotted hyaena do not bring many bones to the den (Mills, 1990), we might hypothesize that this layer represents a hyaena den and that there is no relationship with the flint industry. The presence of hearths was not mentioned in Layer 8 (Ronen and Vandermeersch, 1972), as in Layer 9b for example. Out of a total of 34 burnt bones, eleven bones originate from layer 9b.

Since little is known about the rate of accumulation, two possible scenarios for the faunal accumulation in the Ahmarian layers of Qafzeh are suggested:

1. Short term accumulation resulting from sporadic human occupation. This might have been on a seasonal basis, with hyaena denning in the interim.
2. Long term human occupation, or repeated visits to the sites. Hyaena denning/usage would then have been a single event, probably in Layer 8.

Carnivore modification on the remains, although not very frequent, left a clear pattern of carnivore accessibility to animal bones. The sex and age distributions provided only a very vague idea of age profiles, but the presence of young animals should be mentioned.

#### *Hayonim D*

Within the Aurignacian of Hayonim D, Artiodactyla species distribution differed significantly between the layers, even when the rare species of Perissodactyla (e.g. rhinoceros, equid) were excluded. The main difference concerned the fallow deer distribution in Layers D3 and D1/2. When the homogeneity of the body size group is examined, a significant change is observed across the layers, due to the distribution of the BSGB category (the fallow deer body size group; Table 4). Even when the body size groups are combined with the relevant species (e.g. fallow deer+BSGB remains, gazelle+BSGD remains), the main dissimilarity remains within the fallow deer group. Red deer distribution is also significantly different throughout the same layers of Hayonim, D3 and D1/2 (Table 4).

The body part distributions of gazelle and fallow deer were examined between the layers and by layer for statistical homogeneity, and have produced surprising results. When examined across layers, the gazelle+BSGD category body part distribution differed significantly ( $\chi^2=261.18$ ,  $df=22$ ,  $\alpha=0.00\%$ ), but not the fallow deer+BSGB distribution ( $\chi^2=27.01$ ,  $df=22$ ,  $\alpha=21.1\%$ ). When teeth are excluded this same trend remains, moreover the homogeneous nature of the fallow deer+BSGB category across layers increases ( $\chi^2=13.81$ ,  $df=18$ ,  $\alpha=74.1\%$ ). A search for the source of the difference in gazelle+BSGD category distribution points toward the upper body parts, while the lower body parts - carpals, foreleg, hind leg and metapodials - are more evenly distributed. Since the pattern of butchery is repetitive across the layers this sort of body part distribution is surprising (Table 5).

The body part distribution of gazelle and fallow deer was examined per layer, with significant differences appearing in all layers. Unfortunately, due to the small sample size, Layer D4 did not yield sufficient information for statistical tests (e.g. expected values less than 5%; see Methods). Even if the same examination is performed with relevant body size groups (e.g. fallow deer+BSGB, gazelle+BSGD) included, or teeth from both lower and upper jaws excluded, gazelle and fallow deer body part distributions remained different by layer.

It is interesting to see which body parts are responsible for the variation. For example when bones of gazelle and fallow deer are examined in Layers D3 and D1/2, trunk parts are one of the main causes of variability, as well as upper and lower jaw parts, and limb parts - mainly hind and lower limbs (Table 5).

When body size groups are included in this comparison, in Layer D3, the significant difference is caused by the jaws (upper and lower), metapodials and long bone splinters. When jaws are excluded,

Species	Residuals			
	D4	D3	D1/2	
BSGA	0.4	-1.3	1.6	175
BSGB	-3.8	1.7	-0.3	295
BSGC	0	0.8	-1.1	54
BSGD	0.6	-0.2	-0.1	5036
BSGE	1.5	-0.3	-0.4	101
	533	3276	1852	5661
26.1 with 8 degrees freedom 0.10 %				
Species	Data			
	D4	D3	D1/2	
<i>Equus sp.</i>	0	2	1	3
<i>Rhinoceros</i>	1	0	0	1
<i>Sus scrofa</i>	5	22	25	52
<i>Cervus elaphus</i>	27	97	112	236
<i>Dama mesopotamica</i>	98	502	493	1093
<i>Capreolus capreolus</i>	10	43	24	77
<i>Bos primigenius</i>	26	118	108	252
<i>Alcelaphus buselaphus</i>	0	7	5	12
<i>Gazella gazella</i>	1251	5909	4129	11289
<i>Capra aegagrus</i>	13	95	49	157
	1431	6795	4946	13172
Species	Expected			
	D4	D3	D1/2	
<i>Sus scrofa</i>	5.6	26.8	19.5	52
<i>Cervus elaphus</i>	25.6	121.7	88.6	236
<i>Dama mesopotamica</i>	118.7	563.8	410.5	1093
<i>Capreolus capreolus</i>	8.4	39.7	28.9	77
<i>Bos primigenius</i>	27.4	130.0	94.6	252
<i>Alcephalus buselaphus</i>	1.3	6.2	4.5	12
<i>Gazella gazella</i>	1225.9	5823.7	4239.4	11289
<i>Capra aegagrus</i>	17	81.0	59.0	157
	1430	6793	4945	13168
8 % of the cells in table have expected values of less than 5				
Species	Expected			
	D4	D3	D1/2	
<i>Sus scrofa</i>	-0.3	-0.9	1.2	52
<i>Cervus elaphus</i>	0.3	-2.2	2.5	236
<i>Dama mesopotamica</i>	-1.9	-2.6	4.1	1093
<i>Capreolus capreolus</i>	0.6	0.5	-0.9	77
<i>Bos primigenius</i>	-0.3	-1.1	1.4	252
<i>Alcelaphus buselaphus</i>	-1.1	0.3	0.2	12
<i>Gazella gazella</i>	0.7	1.1	-1.7	11289
<i>Capra aegagrus</i>	-1.0	1.6	-1.3	157
	1430	6793	4945	13168
56.39 with 14 degrees freedom 0.00 %				

Table 4. Hayonim D, statistical results of species distribution per layer.

Hayonim D3													
Residuals													
Species	Skmx	Ljaw	Trunk	Forelimb	Carpal	Foreleg	Hindlim	Tarsal	Hindleg	Metapod	Phalanx		
<i>Dama mesopotamica</i>	-4.5	-2.2	6.6	2.3	0.9	1.5	5.7	-0.9	-2.5	-0.3	-0.7		309
<i>Gazella gazella</i>	1.4	0.7	-2.1	0.7	-0.3	-0.5	-1.8	0.3	-0.8	0.1	0.2		3006
	742	427	7	307	222	136	231	382	140	1	720		3315
129.33 with 10 degrees freedom 0.00 %													
Residuals													
Species	Skmx	Ljaw	Trunk	Forelimb	Carpal	Foreleg	Hindlim	Tarsal	Hindleg	Metapod	Phalanx	Lbs	
Dama + BSGB	-4.5	-3.1	1.6	1.4	1.8	1.1	0.5	0.8	0.2	-2.4	-0.8	3.6	502
Gazella + BSGD	1.3	0.9	-0.5	-0.4	-0.5	-0.3	-0.1	-0.2	-0.1	-0.7	0.2	-1.0	5909
	893	609	1421	579	225	179	570	559	270	78	861	167	6411
64.24 with 11 degrees freedom 0.00 %													
Residuals (without skull parts and teeth)													
Species	Trunk	Forelimb	Carpal	Foreleg	Hindlim	Tarsal	Hindleg	Metapod	Phalanx	Lbs			
Dama + BSGB	0	0.4	1.0	0.4	-0.5	-0.2	-0.5	1.9	-1.9	2.8			444
Gazella + BSGD	0	-0.1	-0.3	-0.1	0.2	0.1	0.2	-0.6	0.6	-0.9			4465
	1421	579	225	179	570	559	270	78	861	167			4909
18.6 with 9 degrees freedom 2.90 %													
Hayonim D1/2													
Residuals													
Species	Skmx	Ljaw	Trunk	Forelimb	Carpal	Foreleg	Handlim	Tarsal	Hindleg	Metapod	Phalanx	Lbs	
Dama + BSGB	-2.6	-3.1	-5.1	-0.2	2.8	-0.8	-0.3	-1.1	0.8	2.4	-1.3	4.6	493
Gazella + BSGD	0.9	1.1	-1.8	0.1	-1.0	0.3	0.1	0.4	-0.3	-0.8	0.5	-1.6	4129
	735	636	573	447	171	132	487	463	200	45	637	86	4622
90.91 with 11 degrees freedom 0.00 %													
Residuals													
Species	Skmx	Ljaw	Trunk	Forelimb	Carpal	Foreleg	Handlim	Tarsal	Hindleg	Metapod	Phalanx		
Dama + BSGB	-3.9	3.7	16.5	0.8	1.4	-1.0	4.8	-0.8	1.6	7.3	-2.4		399
Gazella + BSGD	1.6	1.5	-6.6	-0.3	-0.5	0.4	-1.9	0.3	-0.6	-2.9	1.0		2484
	644	452	55	227	169	106	191	343	131	10	555		2883
451.33 with 10 degrees freedom 0.00 %													
Residuals (without skull parts and teeth)													
Species	Trunk	Forelimb	Carpal	Foreleg	Hindlim	Tarsal	Hindleg	Metapod	Phalanx	Lbs			
Dama + BSGB	3.7	-1.1	2.0	-1.3	-1.2	-1.9	0.1	1.9	-2.3	3.9			396
Gazella + BSGD	-1.4	0.4	-0.7	0.5	0.5	0.7	0.0	-0.7	0.9	-1.4			2855
	573	447	171	132	497	463	200	45	637	86			3251
57.23 with 9 degrees freedom 0.00 %													

Table 5. Hayonim D, statistical results of body parts distribution per layer, between gazelle and fallow deer with and without body size groups (a,b).

the variation is reduced, but still significant, and results mainly from the long bone splinters. In Layer D1/2 the combined groups of animal size categories (e.g. fallow deer+BSGB, gazelle+BSGD), also show significantly different distributions. Trunk remains a major source of variability, while the remainder are the same as in Layer D3. This body part area remains the chief source of variability together with phalanges and long bone splinters, even when jaws were excluded.

The quantity of fallow deer bone specimens introduced to the site occasionally, and not necessarily in an intact state, differ between the layers. However, the mode of processing as reflected in the body part distribution, is the same across the stratigraphic range. While gazelles seem to have been processed at the site in a very systematic way, a certain variability did occur in their body part distribution. It seems to have had very little meaning in terms of the general butchery scheme and is more

probably related to the type of occupation in each layer. As variations do exist, it might be assumed that it was consumption on a family basis which took place (Rabinovich *et al.*, 1996).

### *Hayonim C*

Species homogeneity between the layers could be only partially examined in statistical terms because of the sample size. The artiodactyles' expected distribution of species per layer, showed that variability is mainly present in the less abundant species (e.g. wild pig, red deer, fallow deer, roe deer, aurochs and wild goat), and in fact in all species but gazelle. The carnivore species distribution was too insufficient in size for changes between layers to be tested.

Body size groups were significantly different in their distribution by layer ( $\chi^2=42.85$ ,  $df=15$ ,  $\alpha=0.00\%$ ). Most of the variability was observed in both the smallest body size group (BSGE), and in the largest (BSGA; Table 6). When gazelle body part distribution (Level 3) is compared between layers, a significant difference may be observed. Metapodials, tarsals and skull parts are the source of this variation (Table 6). A significant difference is also observed in the body part distribution of the BSGD category through the layers, with the following parts causing the variation (in descending order): the skull, lower jaw, hind leg, trunk and metapodials (Table 6).

The presence of extremities, skull parts, teeth and phalanges, might suggest that the animals were even brought into the cave complete, but were "heavily" processed there, in a manner that left very few whole elements, but increased the number of splinters in the long bone category. Vertebrae and ribs are not very abundant among the remains identified to body size group categories, indicating selective transport to the site, or heavy processing. It is difficult to conclude whether post depositional processes had a major influence on the body parts distribution. The possibility that subsequent trampling was an important factor in this history of deposition should not be ruled out.

### *Ohalo II*

Gazelle remains are not many per *loci* - one to three animal bones at most. The distribution of body parts and the part present from each bone is very small in terms of quantity (1-3 specimens), and therefore conclusions drawn from body parts distribution are very limited, even if at a certain point they do reflect the finds. Statistical tests are therefore possible only for the more prolific *loci*, and for a limited number of variables. For example, we have tested the relative frequencies of fallow deer and gazelle between *Loci* 1, 2, 3, 7, 8, 10, and found it to be significantly different ( $\chi^2=63.28$ ,  $df=5$ ,  $\alpha=0.00\%$ ). The relative frequency of body size groups between these *loci* was also found to be significantly different ( $\chi^2=84.35$ ,  $df=14$ ,  $\alpha=0.00\%$ ). At the site of Ohalo II, at almost all *loci*, the long bone splinters are more prolific on the surface than in the *locus* itself (Fig. 6).

It is difficult to believe that fallow deer were brought to the site intact. It is more reasonable to suggest that they were butchered or dismembered outside the exposed parts of the site, and selected parts were transported into the site. When the faunal analysis is completed for the other faunal groups (birds, reptiles, fishes), we believe that the detailed picture will become clearer. Because of the relatively low number of cut marks ( $N=79$ ), it is difficult to draw conclusions regarding butchery patterns. At this stage of research we suspect that the frequent occurrences of broken long bones at the site, are due to the method of processing. According to a recent analysis of the site, several very important conclusions have been drawn (Nadel *et al.*, 1995) that correlate with the faunal analysis:

- The site represents the remains of a camp visited several times by the same group.
- The material remains in the structures and hearths are very similar.
- Probably the same method of core reduction was used, and the same tool types were disposed of or stored in the *loci*.
- No *in situ* remains from any other period were found at the site.

".. the site represents several occupation episodes, lasting altogether several years or maybe several tens of years" (Nadel *et al.*, 1995).

Body size distribution between layers													
Data													
Layers HC	BSGA	BSGB	BSGD	BSGE									
C1	3	46	154	5	208								
C2	5	67	307	29	408								
C3/4	19	126	383	25	553								
C5	11	64	321	8	404								
C6	0	16	56	4	76								
C7	4	6	36	1	47								
	42	325	1257	72	1696								
Residuals													
Layers HC	BSGA	NSGB	BSGD	BSGE									
C1	-0.90	1.00	0.00	-1.30	208								
C2	-1.60	-1.30	0.30	2.80	408								
C3/4	1.40	1.90	-1.30	0.30	553								
C5	0.30	-1.50	1.20	-2.20	404								
C6	-1.40	0.40	0.00	0.40	76								
C7	2.60	-1.00	0.20	-0.70	47								
	42	325	1257	72	1696								
42.85 with 15 degrees freedom 0.00 %													
Expected													
Layers HC	BSGA	BSGB	BSGD	BSGE									
C1	5.2	39.9	154.2	8.8	208								
C2	10.1	78.2	302.4	17.3	408								
C3/4	13.7	106.0	409.9	23.5	553								
C5	10.0	77.4	299.4	17.2	404								
C6	1.9	14.6	56.3	3.2	76								
C7	1.2	9.0	34.8	2.0	47								
	42	325	1257	72	1696								
17 % of cells in table have expected values of less than 5													
Body parts distribution of gazelle and BSGD													
Residuals													
BSGD	Skmx	Ljaw	Trunk	Forelimb	Carpal	Foreleg	Hindlim	Tarsal	Hindleg	Metapod	Phalanx	Lbs	
C1	-0.10	-1.70	3.50	-0.10	-0.40	1.00	1.10	-1.60	-1.30	-0.40	-1.70	-0.60	154
C2	-2.80	3.30	-1.90	0.20	-0.50	0.20	0.80	0.40	0.90	-1.70	0.20	0.10	307
C3/4	4.00	-5.20	0.70	-0.40	1.20	0.00	-0.40	0.70	2.00	2.80	1.90	-0.60	383
C5	1.50	3.60	-1.40	0.30	-0.50	-0.90	-1.10	-0.10	-2.20	-1.20	-1.20	1.00	321
	63	99	152	47	1	3	85	19	25	11	21	639	1165
142.86 with 33 degrees freedom 0.00 %													
Gazelle	Skmx	Ljaw	Forelimb	Carpal	Foreleg	Hindlim	Tarsal	Hindleg	Metapod	Phalanx			
C1	4.70	-0.70	0.40	-1.50	-1.90	0.30	-0.20	1.70	-1.20	-1.30	83		
C2	-1.10	-0.60	0.10	1.90	0.60	-0.50	-0.90	-2.40	1.20	208			
C3/4	0.00	1.90	0.30	-0.40	-1.00	0.70	0.30	-1.50	-0.90	-0.10	307		
C5	-0.90	-1.00	0.00	0.10	1.50	-0.90	-0.20	1.60	2.30	-0.60	248		
C6	-0.70	-1.20	-0.50	-0.50	-0.20	-0.20	2.10	-0.20	1.10	0.20	64		
C7	-0.90	1.10	-0.80	-0.40	0.50	-1.20	-1.40	0.00	2.00	0.60	57		
	104	107	59	26	82	51	89	51	35	363	967		
90.17 with 45 degrees freedom 0.00 %													

Table 6. Hayonim C, statistical results of species distribution between layers, body parts distribution of gazelle and the BSGD category.

Sharing can be considered between the groups using the huts or other areas of the site, to explain the variability that exists. As far as the representation of spatial distribution of body parts by occupation/site/residential place is concerned (when sharing of meat is practiced), it is much more complex and unpredictable than originally thought (Bartram *et al.*, 1991; Marshall, 1994).

Ethnographic studies have shown that great variability in body part distribution may exist between households when sharing is practiced on a regular basis (Bartram *et al.*, 1991; Marshall, 1994).

A single animal can be divided between many households. Thus, large animal carcasses will be less complete than small animal carcasses, and successful hunters will accumulate better "chunks" of meat, resulting in a wider range of body parts and/or parts of higher nutritional value (Marshall, 1994).

#### MNI Counts - indication of fragmentation?

Since MNI counts are problematic, we examined them only in order to get an approximate idea of the probable number of individual animals from which the bones might have derived in each of the assemblages. For example, the MNI counts of the faunal assemblage of Hayonim C have very little meaning, due to the breakage pattern, which is either of natural, animal or human origin, allowing only a very small part of the elements to be assigned to side and hence identified to Minimum Number of Individuals.

When the log correlation is examined, a certain relationship is observed between the NISP and MNI, and as expected, when the samples were larger more MNI's were estimated (Pearson correlation  $r=0.608$ ). When the NISP and MNI were tested across sites, a significant difference was found ( $\chi^2 = 24.40$ ,  $df=5$ ,  $\alpha=0.00\%$ ). The major differences have been associated with the results from Layer D3, where a relatively low MNI was calculated, and the UP of Qafzeh where a relatively high MNI was obtained.

#### Summary

The nature of any archaeozoological assemblage is quite complex in its origins, history of deposition, and preservation. When taphonomic patterns form the major research goals, quantification of the faunal material depends on the mode of collection. Bone shafts, long bone splinters and other fragments, difficult to identify to species level, are part of the faunal record. They may have been broken by one or several taphonomic agents: human, carnivore and natural processes, before or after deposition. Furthermore, when we examine archaeological finds, such as bones, they represent a selected sample from the complete site (e.g. habitual occupation, functional occupation, village and town, etc.), resulting in a sample from within a sample. By ignoring a large chunk of information, our study does not become more accurate. In paleoclimatic studies precise identification to species is related to the reconstruction of typical habitats and relative distributions of species, reflecting the paleoecological setting. But when patterns of behaviour are examined, exclusion of fragments does not help in reconstructing their accumulation. For example, the increase in long bone splinters at Hayonim C and Ohalo II, in comparison to the other sites, might indicate the existence of a different pattern of subsistence/animal exploitation, starting in the Upper/Epi Paleolithic ca. 19,000 BP.

Gazelle is considered a small animal - class size I in many reports (< 25 kg, e.g. Yellen, 1991a, 1991b). Small animals, however, often make up a substantial part of hunter-gatherer meat diet, and are usually consumed within a relatively short time following acquisition. According to the general distribution of meat, fat and marrow in gazelle, the hip (femur) and upper leg may be considered the best areas. The difference between sexes could not be seen in bone fragments, although more effort should be invested in the study of dismemberment and filleting of the male neck, shoulder and upper forelimb. While the percentage of meat is not necessarily the same as the distribution of bone, in *sensu lato* we can assume that gazelle were the main source of meat during the occupation phases of the sites at Hayonim and Ohalo II, while in Qafzeh, cervids filled this role. From this point of view, body size groups (BSG) very clearly reflect the relative distribution of species. In spite of their uncertain paleontological identification such bones may be valuable to other aspects of research.

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## References

- Bar Oz, G., T. Dayan and D. Kaufman, this volume. *Taphonomic analysis of the faunal remains from Neve David*.
- Bartram, L.E., 1993. Perspectives on skeletal part profiles and utility curves from eastern Kalahari ethnoarchaeology. In: J. Hudson (ed.), *From Bones to Behavior*. Center for Archaeological Investigations. Southern Illinois University at Carbondale, Occasional Paper No.21: 115-137.
- Bartram, L.E., E.M. Kroll and H. Bunn, 1991. Variability in camp structure and bone food refuse patterning at Kua San hunter-gatherer camps. In: E. Kroll and D. Price (eds.), *The Interpretation of Archaeological Spatial Patterning*. New York, Plenum: 77-148.
- Bar-Yosef, O., 1991. The archaeology of the Natufian layer at Hayonim Cave. In: O. Bar-Yosef and F.R. Valla (eds.), *The Natufian Culture in the Levant*. Ann Arbor, Michigan, International Monographs in Prehistory.
- Bar-Yosef, O. and E. Tchernov, 1966. Archaeological finds and the fossil faunas of the Natufian and Microlithic industries at Hayonim Cave (Western Galilee, Israel). *Israel Journal of Zoology* 15: 104-140.
- Bar-Yosef, O. and A. Belfer-Cohen, 1988. The early Upper Paleolithic in Levantine caves. In: J.F. Hoffecker and C.A. Wolf (eds.), *The Early Upper Paleolithic, Evidence from Europe and the Near East*. Oxford, BAR International Series: 23-41.
- Bar-Yosef, O. and B. Vandermeersch, 1993. Modern humans in the Levant. *Scientific American* 268(4): 94-99.
- Belfer-Cohen, A., 1980. *The Aurignacian at Hayonim cave*. M.A. thesis, The Hebrew University of Jerusalem, Jerusalem (in Hebrew).
- Belfer-Cohen, A. and O. Bar-Yosef, 1981. The Aurignacian at Hayonim cave. *Paléorient* 7(2): 19-42.
- Binford, L.R., 1978. *Nunamiut Ethno-Archaeology*. New-York, Academic Press.
- Binford, L.R., 1981. *Bones: Ancient man and modern myths*. New-York, Academic Press.
- Binford, L.R., 1984. *Faunal remains from Klasies River Mouth*. Orlando, Academic Press.
- Blumenshine, R.J., 1986a. *Early hominid scavenging opportunities*. Oxford, BAR International Series, 283.
- Blumenshine, R.J., 1986b. Carcass consumption sequences and the archaeological distinction of scavenging and hunting. *Journal of Human Evolution* 15: 639-659.
- Blumenshine, R.J., 1988. An experimental model of the timing of hominid and carnivore influence on archaeological bone assemblage. *Journal of Archaeological Science* 15: 483-502.
- Blumenshine, R.J. and T.M. Caro, 1986. Unit flesh weights of some East African bovids. *African Journal of Ecology* 24: 273-286.
- Blumenshine, R.J. and T.C. Madrigal, 1993. Variability in long bone marrow yields of East African ungulates and its zooarchaeological implications. *Journal of Archaeological Science* 20: 555-587.
- Bouchud, J., 1974. Étude préliminaire de la faune provenant de la grotte du Djebel Qafzeh, près de Nazareth, Israel. *Paléorient* 2(1): 87-102.
- Boutie, P., 1989. Étude technologique de l'Industrie Moustérienne de la grotte de Qafzeh (près de Nazereth, Israel). In: O. Bar-Yosef and B. Vandermeersch (eds.), *Prehistoric Investigation of the Southern Levant*. Oxford, BAR, International Series 497: 213-230.

- Brain, C.K., 1981. *The Hunters or the Hunted? an Introduction to African Taphonomy*. Chicago, University of Chicago Press.
- Bunn, H.T., 1981. Archaeological evidence for meat eating by Plio-Pleistocene hominids at Koobi Fora, Kenya and Olduvai Gorge. *Nature* 291: 574-577.
- Bunn, H.T., 1983. Evidence on the diet and subsistence patterns of Plio-Pleistocene hominids at Koobi Fora, Kenya, and Olduvai Gorge, Tanzania. In: J. Clutton-Brock and C. Grigson (eds.), *Animals and Archaeology: 1. Hunters and their Prey*. BAR International Series 163: 21-30.
- Bunn, H.T. and E.M. Kroll, 1986. Systematic butchery by Plio-Pleistocene hominids at Olduvai Gorge, Tanzania. *Current Anthropology* 27: 431-452.
- Campana, D.V. and P.J. Crabtree, 1987. Animals. A C language computer program of the analysis of faunal remains and its use in the study of Early Iron age fauna from Dun Ailinne. *Archaeozoologia* 1(1): 57-68.
- Carmi, I., and D. Segal, 1992. Rehovot radiocarbon measurements IV. *Radiocarbon* 34(1): 115-132.
- Cope, R.C., 1994. *The Evolution of Natufian Megafaunal Economics*. Ph.D. thesis. The Hebrew University of Jerusalem.
- Davis, S., 1974a. Animal remains from the Kebaran site of Ein Gev I, Jordan Valley, Israel. *Paléorient* 2: 453-462.
- Davis, S., 1974b. Incised bones from the Mousterian of Kebara cave (Mount Carmel) and the Aurignacian of Ha-Yonim cave (Western Galilee), Israel. *Paléorient* 2(1): 181-182.
- Davis, S., 1977a. The ungulate remains from Kebara cave. *Eretz Israel* 13: 150-163.
- Davis, S., 1977b. Size variation of the fox, *Vulpes vulpes*, in the palaeartic region today, and in Israel during the late Quaternary. *Journal of Zoology* 182: 343-351.
- Davis, S., 1981. The effects of temperature change and domestication on the body size of Late Pleistocene to Holocene mammals of Israel. *Paleobiology* 7(1): 101-114.
- Davis, S., 1982. Climate change and the advent of domestication: the succession of ruminant artiodactyls in the Late Pleistocene-Holocene period in the Israel region. *Paléorient* 8(2): 2-16.
- Davis, S., 1983. The age profiles of gazelles predated by ancient man in Israel: possible evidence for a shift from seasonality to sedentism in the Natufian. *Paléorient* 9(1): 55-62.
- Dayan, T., 1989. *The succession and community structure of the carnivores of the Middle East in time and space*. Unpublished Ph.D. dissertation, Tel-Aviv University. (in Hebrew, with English summary).
- Emerson, A.M., 1993. The role of body part utility in small-scale hunting under two strategies of carcass recovery. In: J. Hudson (ed.), *From Bones to Behavior*. Center for Archaeological Investigations. Southern Illinois University at Carbondale, Occasional Paper No.21: 138-155.
- Gaudzinski, S., 1995. Wallertheim revised: a re-analysis of the fauna from the Middle Palaeolithic site of Wallertheim (Rheinhausen/Germany). *Journal of Archaeological Science* 22: 51-66.
- Gilead, I., 1991. The Upper Paleolithic in the Levant. *Journal of World Prehistory* 5(2): 105-155.
- Gilead, I., 1995. The foragers of the Upper Paleolithic period. In: E.T. Levy (ed.), *The Archaeology of Society in the Holy Land*. Leicester University Press, London.
- Gilinsky, N.L. and J.B. Bennington, 1994. Estimating numbers of whole individuals from collections of body parts: a taphonomic limitation of the paleontological record. *Paleobiology* 20(2): 245-258.
- Grayson, D.K., 1984. *Quantitative Zooarchaeology: topics in the analysis of archaeological faunas*. New York, Academic Press.
- Haas, G., 1972. The microfauna of Djebel Qafzeh cave. *Palaeovertebrata*, 5: 261-270.
- Hovers, E., L.K. Horwitz, D.E. Bar-Yosef and C. Cope-Miyashiro, 1988. The site of Urkan-E-Rub IIa: a case study of subsistence and mobility patterns in the Kebaran period in the Lower Jordan valley. *Mitekufat Haeven* 21: 20-48.
- Hudson, J. (ed.), 1993. *From bones to behavior*. Center for Archaeological Investigations. Southern Illinois University at Carbondale. Occasional Paper No. 21.
- Jones, K.T. and D. Metcalfe, 1988. Bare bones archaeology: bone marrow indices and efficiency. *Journal of Archaeological Science* 15: 415-423.

- Kislev, M.E., D. Nadel, and I. Carmi, 1992. Epipaleolithic (19.000 BP) cereal and fruit diet at Ohalo II, Sea of Galilee, Israel. *Review of Palaeobotany and Palynology* 73: 161-166.
- Klein, R.G., 1989. Why does skeletal part representation differ between smaller and larger bovids at Klasies River Mouth and other archaeological sites? *Journal of Archaeological Science* 6: 363-381.
- Lyman, R.L., 1985. Bone frequencies: differential transport, in situ destruction, and the MGUI. *Journal of Archaeological Science* 12: 221-236.
- Lyman, R.L., 1992. Prehistoric seal and sea-lion butchering on the southern northwest coast. *American Antiquity* 57(2): 246-261.
- Lyman, R.L., 1994. *Vertebrate taphonomy*. Cambridge, Cambridge University Press.
- Marean, W.C. and L.M. Spencer, 1991. Impact of carnivore ravaging on zooarchaeological measures of element abundance. *American Anthropologist* 56(4): 645-657.
- Marshall, F., 1994. Food sharing and body part representation in Okiek faunal assemblages. *Journal of Archaeological Science* 21: 65-77.
- Mills, M.G.L., 1990. *Kalahari Hyaenas*. Academic Division of Unwin Hyman Ltd, Great Britain.
- Nadel, D., 1991. Ohalo II - the third season (1991). *Journal of the Israel Prehistoric Society* 24:158-163.
- Nadel, D., 1995. The organization of space in a fisher-hunter-gatherers camp at Ohalo II, Israel. In: M. Otte (ed.), *Nature et Culture*, Liège, Colloque de Liège (13-17 December 1993), E.R.A.U.L 68: 373-388.
- Nadel, D. and I. Hershkovitz, 1991. New subsistence data and human remains from the earliest Levantine Epipalaeolithic. *Current Anthropology* 32(5): 631-635.
- Nadel, D., A. Danin, E. Werker, T. Schick, M.E. Kislev and K. Stewart, 1994. 19.000 - Year old twisted fibers from Ohalo II. *Current Anthropology* 35(4): 451-458.
- Nadel, D., I. Carmi, D. Segal, 1995. Radiocarbon dating of Ohalo II: archaeological and methodological implications. *Journal of Archaeological Science* 22: 811-822.
- Neuville, R., 1951. *Le Paléolithique et le Mésolithique du Désert de Judée*. Paris, Archives de l'Institut de Paléontologie Humaine.
- O'Connell, J.F., K. Hawkes and N. Blurton-Jones, 1988. Hadza hunting, butchering, and bone transport and their archaeological implications. *Journal of Anthropological Research* 44(2): 113-161.
- O'Connell, J.F., K. Hawkes and N. Blurton-Jones, 1990. Reanalysis of large mammal body part transport among the Hadza. *Journal of Archaeological Science* 17: 301-326.
- O'Connell, J.F., K. Hawkes and N. Blurton-Jones, 1992. Patterns in the distribution, site structure and assemblage composition of Hadza kill-butchering sites. *Journal of Archaeological Science* 19: 319-345.
- Payne, S., 1975. Partial recovery and sample bias. In: A.T Clason (ed.), *Archaeozoological Studies*. Amsterdam: 7-17.
- Rabinovich, R., nd. *Patterns of Animal exploitation and subsistence in Israel during the Upper Palaeolithic and Epi-Palaeolithic (40,000-12,500 BP), based upon selected case studies*. Ph.D. Thesis. The Hebrew University of Jerusalem.
- Rabinovich, R. and E. Tchernov, 1995. Chronological, paleoecological and taphonomical aspects of the Middle Paleolithic site of Qafzeh, Israel. In: H. Buitenhuis and H.-P. Uerpmann (eds.), *Archaeozoology of the Near East II*. Leiden, Backhuys Publisher: 5-44.
- Rabinovich, R., O. Bar-Yosef and E. Tchernov, 1996. "How many ways to skin a gazelle" - butchery patterns from an Upper Palaeolithic site, Hayonim cave, Israel. *Archaeozoologia* VIII, No 1(2): 11-52.
- Ronen, A. and B. Vandermeersch, 1972. The Upper Paleolithic sequence in the cave of Qafzeh (Israel). *Quaternaria* XVI: 189-202.
- Sharon, I., 1996. Appendix D: analysis of homogeneity of the distribution of figurines in strata 13-10. In: T.A. Donals and A. De Groot (eds.), *The City of David*. Qedem 35, Jerusalem, Institute of Archaeology, The Hebrew University of Jerusalem: 100-108.
- Speth, J. D., 1983. *Bison Kills and Bone Counts*. Chicago, University of Chicago Press.

- Stiner, M.C., 1991. Food procurement and transport by human and non-human predators. *Journal of Archaeological Science* 18: 455-482.
- Tchernov, E., 1981. The biostratigraphy of the Middle East. In: P. Sanlaville and J. Cauvin (eds.), *Prehistoire du Levant*. Paris, Colloques Internationaux du C.N.R.S. No. 598: 67-97.
- Tchernov, E., 1984. Commensal animals and human sedentism in the Middle East. In: J. Clutton-Brock and C. Grigson (eds.), *Animals and Archaeology*: 3. Early herders and their flocks. BAR International Series 202: 91-115.
- Vandermeersch, B., 1981. *Les hommes fossiles de Qafzeh (Israel)*. Paris, Centre National de la Recherche Scientifique.
- Yellen, J., 1991a. Small mammals: !Kung San utilization and the production of faunal assemblages. *Journal of Anthropological Archaeology* 10:1-26.
- Yellen, J., 1991b. Small mammals: post-discard pattering of !Kung San faunal remains. *Journal of Anthropological Archaeology* 10: 152-192.