ARCHAEOZOOLOGY OF THE NEAR EAST
V

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

edited by

H. Buitenhuis, A.M. Choyke, M. Mashkour and A.H. Al-Shiyab

ARC-Publicaties 62
Groningen, The Netherlands, 2002

Cover illustrations:
Logo of the Yarmouk University, Jordan

This publication is sponsored by: ARCbv and Vledderhuizen Beheer bv

Printing: RCG-Groningen

Information and sales: ARCbv, Kraneweg 13, Postbus 41018, 9701 CA, Groningen, The Netherlands
Tel: +31 (0)50 3687100, fax: +31 (0)50 3687199, email: info@arcbv.nl, internet: www.arcbv.nl

ISBN 90 – 77170 – 01– 4

NUGI 680 -430

Preface

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

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

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

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

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

Abdel Halim Al-Shiyab
Yarmouk University
Irbid, Jordan

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

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

Contents

TAPHONOMIC ANALYSIS OF THE FAUNAL REMAINS FROM NAHAL HADERA V (1973 SEASON)

Guy Bar-Oz[1] and Tamar Dayan[2]

Abstract

This study deals with the taphonomic analysis of the faunal remains from the 1973 excavation at Nahal Hadera V (NHV), an early Kebaran open-air site on the Israeli northern coastal plain. Significant relationships between bone preservation and bone density, coupled with low representation of low-density bones, suggest that bone survivorship was affected by selective destruction. It seems that selective destruction was primarily due to intensive bone processing by the inhabitants of the site, possibly for marrow extraction. Surface modifications suggest minor loss of bones due to other post-depositional processes. The use of Behrensmeyer's (1991) multi-variate taphonomic approach to compare NHV and Neve David, a Geometric Kebaran site at the foot of Mount Carmel, suggests a similar taphonomic history for the two sites.

Résumé

Cette étude traite de l'analyse taphonomique des restes fauniques de la fouille de 1973 de Nahal Hadera V (NHV), un site kebaréen ancien de plein air sur les plaines côtières d'Israël. Un rapport significatif entre la préservation des os et la densité des os, associé à une faible représentation d'os de faible densité, suggère que leur conservation a été affectée par une destruction sélective, liée sans doute a une découpe intensive des os par les habitants du site, probablement en vue de l'extraction de la moelle. Les altérations superficielles suggèrent une perte d'os suite à des effets post-depositionnels. L'utilisation de l'approche multivariée de Behrensmeyer (1991) dans la comparaison de NHV et Neve David, un site du kebaréen géométrique au pied du Mont Carmel, indique une même histoire taphonomique pour les deux sites.

Key Words: Density related preservation, Multivariate statistics, Kebaran culture

Mots Clés: Conservation liée à la densité, Statistiques multivarées, Culture kebaréenne

Introduction

Taphonomic research deals with the analysis of preservational processes and their influence on faunal remains through time. It is widely accepted that understanding the depositional history of a site is crucial for detecting potential biases in the zooarchaeological record (see Lyman 1994 for an extensive review of the history of taphonomic research and the wide range of analytical approaches). The working hypothesis of taphonomy is that looking for markers of these processes, while analyzing faunal remains from archaeological sites, enables us to learn about and reconstruct differential depositional histories of archaeological sites (Bonnichsen & Sorg 1989).

We carried out a detailed taphonomic analysis of the faunal remains from Nahal Hadera V - 1973 season (NHV), an early Kebaran open-air site, on the northern coastal plain of Israel. Here, we focus on two types of taphonomic disturbances: pre-depositional processes (the deposit assemblage) and post-depositional processes (the fossil assemblage). The effect of sample assemblage (i.e. due to the addition of shaft fragments and size class bones) and skeletal part representation is described in Bar-Oz and Dayan (2002). Understanding these taphonomic disturbances affect our ability to reconstruct the subsistence economy (the death assemblage) and paleoecological conditions (the life assemblage) (Klein & Cruz-Uribe 1984).

Pre-depositional processes include human subsistence activities, such as food preparation and processing (e.g. Speth & Spielmann 1983; Speth 1989, 1990), resulting in a high number of fresh percussion fractures, together with percussion marks located on the fracture edges (Blumenschine & Selvaggio 1988). It also includes pre-depositional bone trampling (e.g. Fiorillo 1989). Post-depositional processes include the effect of carnivores (Binford 1981; Blumenschine 1988) and rodents (Rabinovitch & Horowitz 1994), bone weathering (Behrensmeyer 1978), root etching (Lyman 1994), abrasion

[1] Harvard University, Dept. Of Anthropology, Peabody Museum 11 Divinity Ave, Cambridge, MA 02138 USA
[2] Department of Zoology, Tel-Aviv University, Tel-Aviv 69978, Israel

(Shipman & Rose 1988), and post-depositional bone trampling (Lyman 1994). These processes affect bones in relation to their size, volume and density (Lyman 1984, 1994). Commonly, these processes leave typical bone surface modifications. Bone modification refers to any form of alteration to individual bones (Bonnichsen & Sorg 1989). Because modification features are expected in certain contexts, their absence is also useful in formulating and testing hypotheses (Behrensmeyer 1991).

The faunal remains from NHV were identified to bone element and species when previously published within a site report (Saxon, Martin & Bar-Yosef 1978), without taphonomic considerations. Bone modification and bone fragmentation were not studied before. In this study we use the same taphonomic research protocol applied to faunal remains from the Geometric-Kebaran site of Neve David (Bar-Oz, Dayan & Kaufman 1998, 1999). We used Behrensmeyer's (1991) multivariate taphonomic approach to compare the depositional histories of the two sites. The method of multivariate taphonomic analysis proposes a graphic solution to compare taphonomic histories of different sites. The resulting graph for each site shows the behavior of different taphonomic variables in relation to one another within the assemblage and encourages standardized representation of data, allowing comparative analyses of different assemblages (Behrensmeyer 1991).

The site

The site of NHV is situated on the northern coastal plain of Israel, on top of the first sandstone ridge overlooking the Hadera River, about 1 km southeast of its outlet to the present shoreline.

The excavation by J. Phillips in 1973 was carried out in a 3 m by 2 m trench located on the highest point of the hilltop. The whole matrix was dry-sieved (0.2 cm), wet-sieved, sorted and stored at the Institute of Archaeology at the Hebrew University in Jerusalem. E. Saxon identified the faunal material. The majority of the Kebaran finds were preserved stratified and restricted to a layer of very dark brown soil ("*hamra*"), 0.2-0.6 m below the surface (Saxon *et al.* 1978).

The faunal remains represent 14 mammal and reptile species (Saxon *et al.* 1978). The bone assemblage is dominated by mountain gazelle (*Gazella gazella*, 70%, based on NISP) and fallow deer (*Dama mesopotamica*, 20%), which formed the basis of the Kebaran economy. Other large mammals from the grassland coastal plain (equids [*Equus hydruntinus*; Eisenman pers. comm.] and hartebeest [*Alcelaphus buselaphus*]) and from the woodland coastal plain (aurochs [*Bos primigenius*] and roe deer [*Capreolus capreolus*]) are represented in small proportions. Small game is represented in small proportions by fox (*Vulpes vulpes*), hare (*Lepus capensis*), and tortoise (*Testudo graeca*) (Saxon *et al.* 1978; Bar-Oz & Dayan 2002).

The taphonomic analysis

We carried out a detailed taphonomic analysis of the faunal remains from NHV along the following lines:

1. Analysis of skeletal part frequencies. The working hypothesis behind this analysis is that the probability of survival of a skeletal part is at least partially a function of that part's structural density. This analysis enables us to quantify the completeness of the bone assemblage and serves as a baseline for comparison between bone assemblages (Lyman 1984). Two methods were used:
2. The relationship between bone survivorship and bone density (Lyman 1984, 1994).
3. The relationship between proportional frequency of proximal (low density) and distal humeri (high density) in comparison to reference assemblages with a known degree of destruction (Binford 1981).
4. Identifying specific attritional processes by observing specific bone surface modifications. All identifiable fragments were immersed in 5% acetic acid in order to remove the patina. This enabled us to observe various surface modifications, by using a 2.5X magnifying lamp. We searched for modifications indicating pre-depositional bone trampling (Fiorillo 1989), bone weathering (Behrensmeyer 1978), root etching (Lyman 1994), abrasion (Shipman & Rose 1988), signs of animal activities (Fisher 1995), and percussion marks (Blumenschine & Selvaggio 1988).

5. Mode of bone fragmentation was analyzed for all epiphyses and a random sample of diaphyses in order to discern between fresh and dry bone fractures. Three variables were checked: fracture angle, fracture outline, and shaft circumference. Fracture angle and outline were assessed in order to determine the stage at which the bones were broken (fresh or dry);(Villa & Mahieu 1991), and shaft circumference was assessed in order to discern the possible effects of carnivore activity (Bunn 1983).

Analysis of skeletal part frequencies

Our first step in analyzing the degree of bone preservation was to examine the relationship between bone survivorship and bone density. The resulting regression line for gazelle bone survivorship (based on proportional frequency of elements observed in NHV [%MNI]) and bone density (based on domestic sheep bone densities [Lyman 1984, 1994]) indicates a significant and meaningful relationship between the two variables (R^2=0.452; P<0.001), which accounts for 45% of the observed variance (Fig. 1). A positive relationship (R^2=0.57; P<0.001) was also found between fallow deer bone survivorship and bone density (based on *Odocoileus* spp. [Lyman 1984]), which accounts for 57% of the observed variance (Fig. 2). The regression line obtained for gazelles (MNI=0.965*[bulk density]-0.12) does not differ significantly from that of fallow deer (MNI=0.927*[bulk density]-0.125) (ANCOVA; F=0.619; P<0.001). These results suggest similar differential loss of gazelle and fallow deer bone fragments relative to their density owing to taphonomic disturbances.

The ratios of proximal (low density) to distal parts (high density) of gazelle and fallow deer humeri from NHV show a similar trend. The similar ratio of these bone parts for gazelle and fallow deer (5:27 and 1:4, respectively; R^2=0.6; P=0.80) provides an index of the degree of attrition suffered by the assemblage in comparison to reported values from a series of control assemblages with a known degree of destruction (Binford 1981). We used the cluster analysis method (Shennan 1997) in order to compare NHV's proximal to distal ratio to Binford's (1981) destructive sites (low ratio of proximal humeri) and non-destructive sites (high ratio). The tree diagram produced (Fig. 3) places the NHV assemblage closer to the destructive assemblages (0.19 linkage distance) than to the non-destructive assemblages (1.23 linkage distance), suggesting differential loss of bones either due to pre-depositional or post-depositional processes.

On the other hand, we found no relationship between bone survivorship and the food utility index (i.e. FUI - Metcalfe & Jones 1988). This result is supported by homogeneous representation of both gazelle and fallow deer skeletal parts, suggesting that complete carcasses were imported to the site (see Bar-Oz & Dayan 2002 for analysis of FUI and skeletal part representation). The absence of a relationship between bone abundance and the food utility index, and the significant and meaningful relationship between bone abundance and density suggests that bone survivorship was affected by selective destruction (density) alone, and not affected by selective transport related to food value (see Klein 1989 for discussion of this method).

Specific attritional processes

- The NHV bone assemblage contained very few modifications related to post-depositional processes (examined on all identifiable elements):
- None of the long bones displayed signs of abrasion. In our analysis we described abraded bones as bones that have rounded or smoothed break surfaces (Shipman & Rose 1988). This result suggests that abrasion due to physical erosion did not affect the NHV bone assemblage.
- The bones contained minor signs of surface weathering. The majority of bones (87% of 136 examined bones) were in the range of low weathering (stages 0-2, according to Behrensmeyer 1978). When exposed to air, bones crack in patterns that tend to follow the original pattern of the bone, and with time these multiply and lead to total disintegration. A low rate of cracking, as found at NHV indicates that bones were buried soon after their deposition. This result suggests that bone weathering was a minor factor in biasing the NHV bone assemblage.

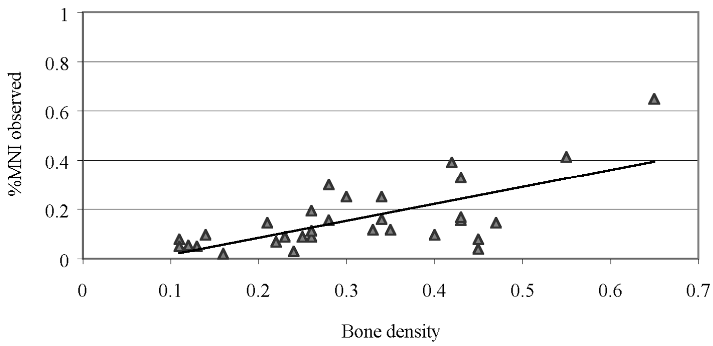

Fig. 1. Relationship between the proportional frequency of gazelle elements observed at NHV (%MNI) and bone density (based on domestic sheep densities, after Lyman 1984).

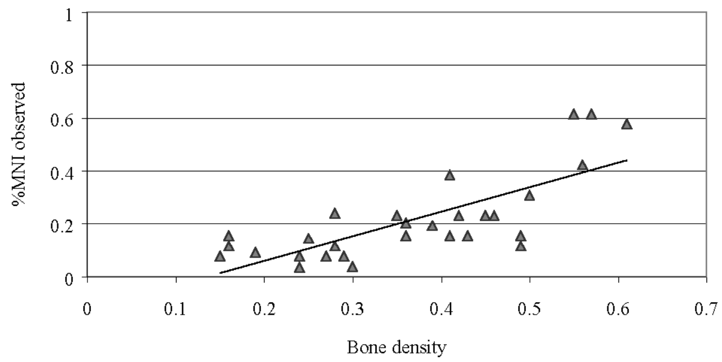

Fig. 2. Relationship between the proportional frequency of fallow deer elements observed at NHV (%MNI) and bone density (based on *Odocoileus* spp. densities, after Lyman 1984).

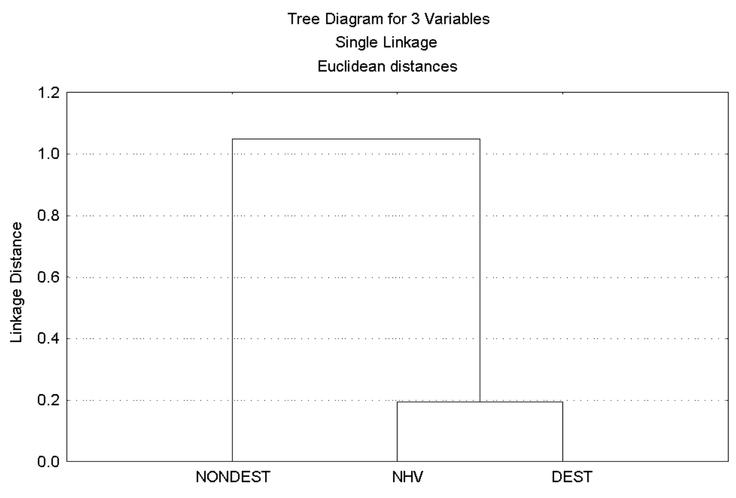

Fig. 3. Tree diagram (based on cluster analysis) for measuring similarity between NHV and Binford's (1981) destructive (DEST) and non-destructive (NONDEST) sites (based on proportional frequency of proximal and distal humerus parts).

- Of all the identifiable elements, 27 (0.87%) contained modification signs of root marks. These marks are easy to define by their dendritic patterns of shallow grooves and are interpreted as the result of dissolution by acids associated with the growth and decay of roots in direct contact with bone surfaces (Behrensmeyer 1978; Lyman 1994). This result suggests that root activity alsoplayed a minor role in biasing the bone assemblage.
- We found none of the typical signs of surface modification (as in Fiorillo 1989), related to pre-depositional bone trampling. Absence of trampling attrition is supported by the mode of bone fragmentation (see below).
- Chewing, gnawing, and scratch marks (see Fisher 1995 for description and references) are totally absent from the assemblage. Thus, it appears that destruction of bone elements by carnivores and rodents at NHV was insignificant.

Mode of bone fragmentation

Fracture angle, fracture outline and shaft circumference in the NHV bone assemblage was studied on all long bone epiphyses and a sample of diaphyses in search of evidence for green (fresh) bone fractures, and/or dry bone fractures (see Bar-Oz, Dayan & Kaufman 1998 for description of the typological character of each fracture; after Villa & Mahieu 1991). A high rate of fresh bone fractures indicates human activity, such as marrow extraction (e.g. Enloe 1993), and a high rate of dry bone fractures indicate either pre-depositional or post-depositional bone trampling. Comparison between the relative frequencies of fracture angle, fracture outline and shaft circumference from NHV to those found at the sites of Fontbregoua and Sarrians (Table 1) suggest that bone trampling did not affect the NHV bone assemblage, a pattern opposite to that observed in Sarrians, and indicates that fractures were made on fresh bones, possibly for marrow extraction, as was found at the site of Fontbregoua. This result is in accord with the small number of percussion marks, found close to the fracture edges, which also may possibly have been made during marrow processing (Blumenschine & Selvaggio 1988). Similar ratios of green bone fractures were found at the nearby site of Neve-David (Bar-Oz, Dayan & Kaufman 1999).

Comparison between the taphonomic history of NHV and Neve-David

We used Behrensmeyer's (1991) multivariate taphonomic analysis to compare the depositional history of the two sites. The multivariate taphonomic analysis provides a visual overview of taphonomic attributes displayed by an assemblage that can be used as a basis for standardized comparisons among different accumulations, and therefore helps to summarize the complex array of taphonomic information available in each bone accumulation (Behrensmeyer 1991).

Table 1. Relative frequencies of fracture angle, fracture outline, and shaft circumference from NHV compared to Fontbregoua and Sarrians (after Villa & Mahieu, 1991).

	Fracture angle			Fracture outline			Shaft circumference		
	Oblique	Right	Intermediate	V shaped	Transverse	Intermediate	Less than 1/2	More than 1/2	Complete
NHV	83 (65%)	30 (23%)	16 (12%)	82 (57%)	38 (25%)	25 (18%)	79 (68%)	24 (20%)	13 (12%)
Fontbregoua	114 (66%)	47 (27%)	13 (7%)	134 (52%)	92 (35%)	35 (13%)	115 (76%)	23 (15%)	13 (9%)
Sarrians	22 (8%)	176 (65%)	74 (27%)	106 (30%)	193 (54%)	59 (16%)	16 (7%)	10 (4%)	200 (89%)

Table 2 summarizes the measured values for the 15 studied taphonomic variables in NHV (the assemblage data are from Bar-Oz and Dayan 2002) and Neve-David (Bar-Oz *et al*. 1998). Figure 4 represents a visual comparison of the data from Table 2. The taphonomic analysis reveals a high level of similarity between the depositional histories of the two assemblages in all the variables studied. These results imply similar depositional histories between the two sites and demonstrate analogous practices of food preparation and processing.

Table 2. Measured values for taphonomic variables in NHV (the assemblage data from Bar-Oz & Dayan 2002) and Neve David (Bar-Oz, Dayan & Kaufman 1998, 1999).

Variable	**NHV**	**Neve David**
Assemblage data		
NISP	2654	2496
MNI	86	95
Richness	14	17
Diversity	0.458	0.452
% Adult	62	65
Fluvial transport	VG III	VG III
Bone modification		
% weathered (> stage 2)	13	8
% abraded	0	0
% carnivore gnaw	0	0
% rodent gnaw	0	0
% burned	4.6	6.6
% butchered	1.7	8
% trampling	0	0
Bone fragmentation		
% Oblique angles	65	54
% V shaped outline	57	52

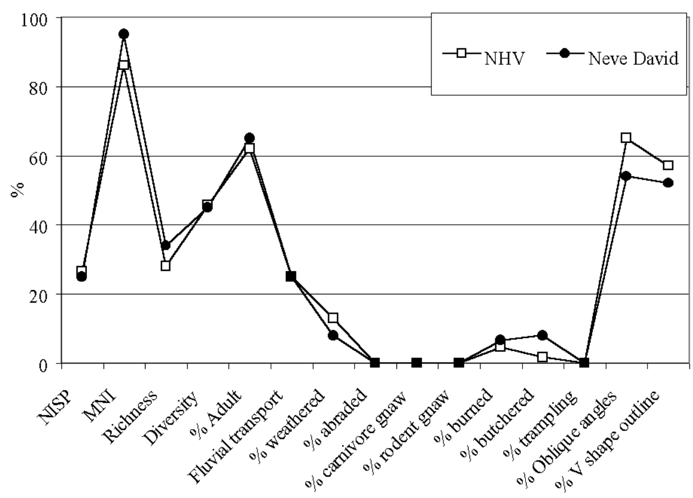

Fig. 4. Graphic representation of data from Table 2, summarizing and comparing 15 different taphonomic variables from the NHV and Neve David bone assemblages (after Behrensmeyer 1991).

Summary

The taphonomic analysis of the NHV bone assemblage reveals the attritional processes which played a role in shaping the faunal assemblage through time. The significant relationship between bone preservation and bone density suggests differential loss of gazelle and fallow deer bone elements as a function of their densities. This result is supported by the low representation of proximal humeri. Modes of bone fracture show low representation of dry bone fractures and indicate that fractures were made on fresh bone, probably for marrow extraction. Surface modifications suggest minor loss of bones due to other pre-depositional and post-depositional forces.

We found much similarity between the taphonomic history of NHV and that of Neve David. Future taphonomic studies from other archaeological sites will enable further comparative studies. Such studies will enable more reliable comparisons between sites and assemblages, bringing about more meaningful conclusions concerning various subsistence strategies practiced by the early human cultures in our region.

Acknowledgements

We thank Vera Eisenman for her help in identifying the equid specimen and Natalie Munro, Anat Haber and Shai Meiri for their comments on an earlier draft of the manuscript. We thank Yarmouk University Irbid, Jordan for the opportunity to present our paper at the 5th ASWA meeting. This research was supported by the Irene Levi Sala Care Archaeological Foundation.

References

Bar-Oz G., Dayan T., and Kaufman D., 1998. Taphonomic analysis of the faunal remains from Neve David. In: H. Buitenhuis, L. Bartosiewicz and A.M. Choyke, (eds) *Archaeozoology of the Near East III. Proceedings of the international symposium on the ArchaeoZoology of southwestern Asia and adjacent areas*, ARC- Publications 18, Groningen, The Netherlands: 72-79.

Bar-Oz G., Dayan T. and Kaufman D., 1999. The Epipaleolithic faunal sequence in Israel: a view from Neve-David. *Journal of Archaeological Science* 26: 67-82.

Bar-Oz G. and Dayan T., 2002**.** "After twenty years": a taphonomic reevaluation of Nahal Hadera V, an Epipaleolihic site on the Israeli coastal plain. *Journal of Archaeological Science* 29: 145-156.

Behrensmeyer A.K., 1978. Taphonomic and ecological information from bone weathering. *Paleobiology* 4: 150-162.

Behrensmeyer A.K., 1991. Terrestrial vertebrate accumulations. In: P.A. Allison and D.E.G. Briggs (eds), *Taphonomy: Releasing the Data Locked in the Fossil record*, Topics in Geobiology Vol. 9. Plenum Press, New York: 291-335.

Binford L.R., 1981. *Bones: ancient men and modern myths*. New York: Academic Press.

Blumenschine R.J., 1988. An experimental model of the timing of hominid and carnivore influence on archaeological bone assemblages. *Journal of Archaeological Science* 15: 483-502.

Blumenschine R.J., and Selvaggio, M. 1988. Percussion marks on bone surface as a new diagnostic of human behavior. *Nature* 333: 763-765.

Bonnichsen R. and Sorg, M., (eds). 1989. *Bone Modification*. University of Maine Center for the Study of the First Americans, Orono.

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*. British Archaeological Report, Oxford: 21-30.

Enloe J.G., 1993. Ethnoarchaeology of marrow cracking: implications for the recognition of prehistoric subsistence organization. In: J. Hudson (ed), *From Bones to Behavior: Ethnoarchaeological and Experimental Contributions to the Interpretation of Faunal Remains.* Center for archaeological investigations, Occasional paper No. 21. Southern Illinois University: 82-97.

Fiorillo A.R., 1989. An experimental study of trampling: implication for the fossil record. In R. Bonnichsen and M.H. Sorg, (eds), *Bone Modification*. Orono: University of Maine Center for the Study of the First Americans: 61-71.

Fisher J.W., 1995. Bone surface modifications in zooarchaeology. *Journal of Archaeological Method and Theory* 2: 7-68.

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* 16: 363-381.

Klein R.G. and Cruz-Uribe K., 1984. *The Analysis of Animal Bones from Archaeological Sites*. University Chicago Press, Chicago.

Lyman R.L., 1984. Bone density and differential survivorship of fossil classes. *Journal of Anthropological Archaeology* 3: 259-299.

Lyman R.L., 1994. *Vertebrate Taphonomy*. Cambridge University Press, Cambridge.

Metcalfe D. and Jones K.T. 1988. A reconsideration of animal body part utility indices. *American Antiquity* 53: 486-504.

Rabinovitch R. and Horwitz L.K., 1994. An experimental approach to the study of porcupine damage to bones: a gnawing issue. *taphonomie* 9: 97-118.

Saxon E.C. Martin G. and Bar-Yosef O. 1978. Nahal Hadera V: an open air site on the Israeli coast. *Paléorient* 4: 253-266.

Shennan S., 1997. *Quantifying Archaeology*. Edinburgh University Press, Second edition.

Shipman P., and Rose J. 1988. Bone tools: an experimental approach. In: S.L. Olsen (ed), *Scanning Electron Microscopy in Archaeology*. British Archaeological Reports, Oxford: 303-35.

Speth J.D., 1989. Early hominid hunting and scavenging: the role of meat as an energy source. *Journal of Human Evolution* 18: 329-343.

Speth J.D., 1990. Seasonality, resource stress , and food sharing in so called "egalitarian" foraging societies. *Journal of Anthropological Archaeology*, 9: 148-188.

Speth J.D. and Spielmann K.A., 1983. Energy source, protein metabolism, and hunter-gatherer subsistence strategies. *Journal of Anthropological Archaeology* 2/1: 1-34.

Villa P. and Mahieu E., 1991. Breakage patterns of human long bones. *Journal of Human Evolution* 21: 27-48.