



# The Epipalaeolithic Faunal Sequence in Israel: A View from Neve David

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We carried out a detailed taphonomic, palaeoeconomic and palaeoecological analysis of the faunal remains from Neve David, a major Geometric-Kebaran open air site at the foot of the slope of Mount Carmel. The bone assemblage comprised 15 mammal species, two reptile species and seven genera of molluscs of the Mediterranean Sea. Bone fractures, cut marks and burned bones reflect human activity. The major prey species, as in other Epipalaeolithic sites from Israel, are gazelle and fallow deer (at 60 and 30%, respectively). It is possible that male fallow deer were selectively hunted. Neve David does not differ appreciably from the general Epipalaeolithic faunal sequence. Our attempt to compare the faunal remains of Neve David to other fossil assemblages from the Epipalaeolithic sequence revealed no significant difference between pre-Natufian and Natufian fossil assemblages in the economic characteristics studied, putting in question the basis for various hypotheses regarding the development of early domestication.

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## Introduction

The transition from hunting and gathering, nomadic societies to true farming communities, took place during the Levantine Epipalaeolithic. The Epipalaeolithic sequence of Kebaran, Geometric-Kebaran and Natufian cultures in the Mediterranean region is generally considered a developmental continuum (Bar-Yosef, 1981, 1990; Bar-Yosef & Vogel, 1987; Bar-Yosef & Belfer-Cohen, 1989, 1992; Henry, 1989). It begins with Kebaran nomadic hunter-gatherers, proceeds with the Geometric-Kebaran and ends with the Natufians inhabiting at least semi-sedentary communities (Bar-Yosef, 1983; Tchernov, 1984, 1992; Henry, 1985, 1989), exploiting wild cereals (possibly even carrying out small scale cultivation (Unger-Hamilton, 1989)) and beginning the process of animal domestication (Davis & Valla, 1978; Valla, 1990; Dayan, 1994a; Tchernov & Valla, 1997). The transformation during the Natufian is striking, and has led some researchers to view the shift as “revolutionary” (e.g., Henry, Leroi-Gourhan & Davis, 1981; Gilead, 1988). Other researchers (e.g. Kaufman, 1992), prefer to emphasize the concept of a gradual change within the Epipalaeolithic.

Whether defined as steady, directional evolution or as a revolution, the causes for the shift are still poorly understood and much remains to be understood about the development of Natufian economies. However, some patterns in Natufian faunal exploitation have been suggested in recent years:

- A shift to a wide spectrum economy featuring an increased number of small game species (e.g., Henry, Leroi-Gourhan & Davis, 1981; Tchernov, 1992).
- An increase in the percentage of gazelle (*Gazella gazella*) exploited (e.g., Legge, 1972; Davis, 1982; Henry, 1985, 1989; Tchernov, 1992, 1993), coupled with an increase in the percentage of young gazelles (Davis, 1983), a high percentage of male gazelles hunted (Cope, 1992; Tchernov, 1992, 1993) and a diminution in their body size (Davis, 1981; Cope, 1992).

The shift to a broad spectrum economy (Flannery, 1969) has been interpreted later as a manifestation of food stress, resulting from either rising population pressure on available resources (Cohen, 1977; Henry, 1985) or from the shift to sedentism and over-exploitation of the prey resources in the vicinity of sites (Henry, 1989; Bar-Yosef & Belfer-Cohen, 1992;

Tchernov, 1992). It has sometimes been suggested that food stress was the trigger for domestication; a sound indication of food stress during the Natufian may support this hypothesis (Dayan, 1997).

Increased gazelle hunting has been ascribed to a cultural change (Henry, 1975) or to a climatic change that made gazelle herds more abundant as compared with those of fallow deer (*Dama mesopotamica*) (Bate, 1937; Davis, 1982). Various explanations have been forwarded to account for the increase in juvenile gazelles during the Natufian (see Davis, 1983). The increase in male hunting has been interpreted as resulting from herd management (Legge, 1972), and the body size diminution has been interpreted as a result of this practice (Cope, 1992), indicating "proto-domestication" or as a result of climatic change (Davis, 1981). Thus, patterns of the Natufian economy have been ascribed variously to climatic and cultural events.

Do the preceding Kebaran and Geometric-Kebaran cultures foreshadow this exploitation pattern? Can a directional trend be perceived during the Epipalaeolithic, which merely culminates during the Natufian period? Or is the Natufian culture indeed revolutionary? Zooarchaeological research of Epipalaeolithic remains is the key to resolving these questions. So far, only a very limited number of pre-Natufian Epipalaeolithic excavations have yielded good faunal collections (e.g., Bar-Yosef & Tchernov, 1966; Noy, Legge & Higgs, 1973; Davis, 1974; Saxon, 1974; Heller, 1978; Saxon, Martin & Bar-Yosef, 1978; Hovers *et al.*, 1988) and many of these have been published as merely faunal lists. Natufian remains are more abundant and have been subject to relatively more research (e.g., Bate, 1937; Bar-Yosef & Tchernov, 1966; Noy, Legge & Higgs, 1973; Saxon, 1974; Henry, Leroi-Gourhan & Davis, 1981; Davis, 1982, 1983; Valla *et al.*, 1986; Bouchud, 1987; Cope, 1992; Crabtree, Campana & Belfer-Cohen, 1992; Tchernov, 1992, 1993; Davis, Lernau & Pichon, 1994).

The Natufian culture replaced the Geometric-Kebaran in the Mediterranean region of Israel. Understanding the economic structure of the Geometric-Kebaran is therefore crucial for understanding this process (see also Bar-Yosef & Belfer-Cohen, 1992). We carried out detailed taphonomic, palaeoeconomic and palaeoecological analyses of the faunal remains from Neve David in order to gain insight into the development of the Epipalaeolithic subsistence strategies. Our search was for economic characteristics of the Geometric-Kebaran that may have been the precursors of the Natufian "Revolution". In order to do so we also re-examined some of the features of the Natufian economy as they are described in the literature (e.g., Noy, Legge & Higgs, 1973; Saxon, 1974; Henry, Leroi-Gourhan & Davis, 1981; Valla *et al.*, 1986; Bouchud, 1987; Campana & Crabtree, 1990; Cope, 1992; Crabtree, Campana & Belfer-Cohen, 1992; Tchernov, 1993; Davis, Lernau & Pichon, 1994).

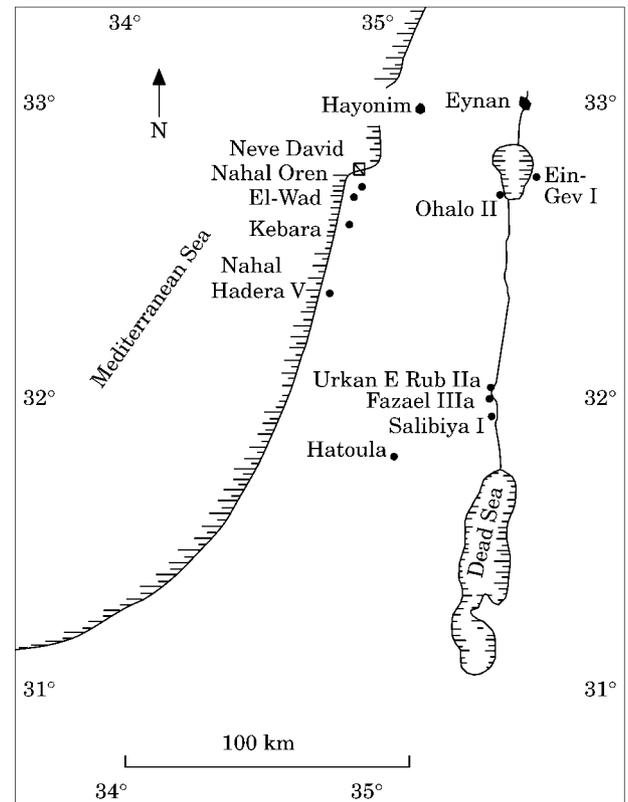


Figure 1. Map showing location of Neve David and other Epipalaeolithic sites analysed.

## Neve David

The site of Neve David is situated at the foot of the western slope of Mount Carmel on the north bank of Nahal Siah at its outlet to the coastal plain, 60 m above sea level and approximately 1000 m from the present shoreline (Figure 1). This is an ecotonal setting allowing easy access to two primary environmental zones: the slopes of Mount Carmel and the broad coastal plain which, during the time of occupation was some 10–13 km wider than today (Weinstein-Evron, 1997). Water was available from springs located along the wadi and abundant flint sources could be found in the limestone bedrock of Mount Carmel.

Stratigraphically, the Geometric-Kebaran is overlain by a series of deposits approximately 1.5 m thick containing finds from the Chalcolithic/Early Bronze Age to recent (20th century) periods. Some features from these late occupations, such as pits and structures, intrude into the underlying layer.

The Geometric-Kebaran is within a dark reddish-brown colluvium which attained a maximum thickness of 1.4 m. No sedimentological changes were observed throughout the depth of deposit which would be suggestive of post-depositional changes or deflation. Its contact with the overlying sediments, though, is quite sharp indicating an erosional episode. The implementiferous horizon within this sediment is approximately

60 cm thick. With depth, the number of artefacts decreases rapidly and the sediment eventually becomes sterile. The areal extent of the Geometric-Kebaran occupation is somewhat difficult to determine. However, the reddish-brown colluvium, with artefacts, is observable for a distance of at least 30 m within a north-south section created by a road cut which destroyed a considerable portion of the site. Assuming that the east-west dimension was similar, the occupation would approach some 1000 square metres.

The Geometric-Kebaran horizon is marked by a very high density of artefacts and faunal remains. This can be explained, in part, by the rapid covering of the site by the colluvium. In addition, these high densities also indicate a relatively prolonged stay at the site and it has been proposed that the occupation represents a period of aggregation of a relatively large group (Kaufman, 1986, 1989, 1992). This is in accordance with the size of the site and is further supported by the occurrence of two burials (Kaufman, 1986, 1987, 1989; Kaufman & Ronen, 1988), which also suggest an extended temporal connection to this particular setting.

Two radiocarbon determinations were made on charred bone yielding dates of  $12,610 \pm 130$  BP (OxA-892) and  $13,400 \pm 180$  BP (OxA-859). Both of these dates fall within the accepted range for the Geometric-Kebaran, but are somewhat problematic in that there is an 800 year gap between them and no overlap even at two standard deviations. However, the dates, together with the characteristics of the lithic assemblage, suggest that Neve David can be attributed to the latter stages of the Geometric-Kebaran (Kaufman, 1988) just prior to the appearance of the Natufian.

The sample analysed in this study comes from an excavated area of 55 square metres and includes only those materials which came from undisturbed areas of the Geometric-Kebaran horizon. The excavation grid was based on one metre squares, each of which was further subdivided into 0.25 square metre units. Vertical control was maintained through the excavation of 5 cm spits. All matrix removed during excavation was dry screened through 3-mm mesh.

Over 21,000 complete and fragmentary bones were recovered from the excavated area. Of these, 2496 (12%), representing 24 vertebrate and invertebrate taxa, were identified to species. Bone density at the site is 860 bone fragments per  $m^3$ . The relative abundances of the different taxa were quantified using the number of identified specimens (NISP) for each taxon together with the minimum number of individuals (MNI) from which the remains could have originated (Table 1). These values were calculated using the assumptions described in Klein & Cruz-Urbe (1984).

### Taphonomic Considerations

Analysis of skeletal part frequencies enables us to assess the amount of possible taphonomic disturbances

caused by pre- and post-depositional processes, which reduce our ability to interpret human subsistence patterns and palaeoecological conditions (Klein & Cruz-Urbe, 1984). The probability that skeletal parts will survive various taphonomic processes is at least partially a function of their structural density (e.g., Lyman, 1994).

We found a significant relationship ( $R^2=0.258$ ;  $P<0.001$ ) between gazelle (*Gazella gazella*) bone survivorship (based on proportional frequency of elements observed in Neve David (%MNI)) and bone density (based on domestic sheep bone densities (Lyman, 1984)), which accounts for 26% of the observed variance. The regression line obtained ( $MNI=0.8187 \times (\text{bulk density}) - 0.0016$ ) suggests differential loss of gazelle bone fragments relative to their density owing to taphonomic disturbances.

A similar significant relationship ( $R^2=0.401$ ;  $P<0.001$ ) was found also between fallow deer (*Dama mesopotamica*) bone survivorship (based on proportional frequency of elements observed in Neve David (%MNI) and bone density (based on *Odocoileus* spp., (Lyman, 1984)), which accounts for 40% of the observed variance. However, the regression line obtained ( $MNI=0.8831 \times (\text{bulk density}) - 0.0412$ ) differs significantly from that of gazelles (ANCOVA;  $F=7.49$ ;  $P<0.05$ ). Klein (1989) previously demonstrated that in South African bovids, density and abundance tend to be much more closely related in larger bovids than in the smaller ones, and hypothesized that differential selective destruction is at least partly responsible for the observed contrast in skeletal part representation between smaller and larger bovids. Our regressions on the other hand indicate that the larger species (fallow deer) apparently underwent more selective destruction. However, we note that bone density accounts for only a small part of the variation.

Analysis of the ratio of proximal humeri (low density elements) to distal humeri (high density elements) of gazelle and fallow deer bones from Neve David (6:58 and 4:29, respectively) supports these results. These ratios place the Neve David bone assemblage among assemblages that suffered various attritional processes (according to Binford, 1981). In order to explain the taphonomic bias related to bone density, we examined the influence of the processes that may have affected the Neve David bone assemblage.

To determine whether fluvial transport has significantly altered the Neve David faunal assemblage, we grouped bones according to their surface-volume ratio as suggested by Shipman (1981). We found that the various transport groups are well represented at the site's faunal remains, making it unlikely that the assemblage has been strongly biased by moving water (Bar-Oz, Dayan & Kaufman, 1997). Chewing, gnawing and scratch marks of rodents and carnivores (see Fisher, 1995 for description and references) are totally absent from all identifiable bone elements. A further possible taphonomic agent is chemical decomposition. This, however, was not studied during the excavation, so we

Table 1. Number of identified specimens/minimum number of individuals by which each taxon is represented at Neve David

	<i>Gazella gazella</i>	<i>Bos primigenius</i>	<i>Alcelaphus bus.</i>	<i>Dama mesop.</i>	<i>Capreolus cap.</i>	<i>Cervus elapus</i>	<i>Sus Scrofa</i>	<i>Lepus capensis</i>	<i>Vulpes vulpes</i>	<i>Canis lupus</i>	<i>Herpestes ich.</i>	<i>Martes foina</i>	<i>Sciurus anomalus</i>	<i>Hystrix indica</i>	<i>Erinaceus euro.</i>	<i>Testudo graeca</i>	<i>Ophiosaurus sp.</i>	
Antler				3														
Horn	46																	
Skull fragments	64			22														
Mandibules	14			17				2	2	1		1	3				2	
Teeth	177			117	10		1	10	10	1				1				
Atlas	4			1						1								
Axis	5			3														
Cervical Ver.	45	3		41	1				2									
Thoracic Ver.	49		1	26	3													
Lumbar Ver.	35	1	1	46					1	1								
Proximal Rib	72	3		27														
Sacrum	3			1														
Sternum	2			1														
Scapula	70	1		22	3			10	3									
Prox. Humerus	7																1	
Dis. Humerus	57			29				4	4	1								
Dis. Radius	12			13					1									
Prox. Radius	23			7														
Ulna	19			15			2	3	1						1			
Dis. Metacarpus	10			6														
Prox. Metacarpus	8			4		1												
Acetabulum	53			33		1		2	1		1							
Dis. Femur	6			4			1		3	1							1	
Prox. Femur	25			8					2								10	
Dis. Tibia	29			27														
Prox. Tibia	4			7														
Patella	1			1														
Navicular	2			1														
Astragalus	74	1	1	36	2		1											
Calcaneum	51		2	28	2		3	2										
Coboid	14			8														
Dis. Metatarsus	5			12														
Prox. Metatarsus	7			14														
Phalanx I	154	1	1	60	1	1		4	6		1							
Phalanx II	133	2		44	2	4	1	2	5	2	1							
Phalanx III	64			19	1					2								
Seasamoid	11			6														
Tarsal	14			9														
Metapod Condyle	171	1		62	1	1												
<b>NISP</b>	1540	13	6	780	26	8	9	39	41	10	3	1	3	1	1	12	2	2495
<b>MNI</b>	45	1	1	21	2	1	2	7	3	1	1	1	2	1	1	4	1	95

cannot attempt to quantify its role in the taphonomy of this site. However, bone surfaces are well preserved, suggesting that major loss by decay is not very likely.

We studied bone fracture angle and breakage outline of the Neve David bone assemblage in search of evidence for green (fresh) bone fracture and/or dry bone fractures indicating trampling. The angle formed by the fractures can be oblique, right, or a combination of both. An oblique angle indicates green bone fracture, while a right angle indicates dry bone fracture (Villa & Mahieu, 1991). The outline formed between the surface of the fracture and the cortical bone can be

transverse, curved or V-shaped, or intermediate. A curved or V-shaped outline indicates green bone breakage, while a transverse fracture indicates dry bone breakage (Villa & Mahieu, 1991). We examined these characteristics on all epiphyses and compared them to those of bones from two Neolithic sites in southern France, in which the taphonomic history is known, based on other characteristics (Villa & Mahieu, 1991). Neve David and Fontbregoua are similar with 54.1% and 65.5% of oblique angles while Sarrrians differs with only 8.2% (Figure 2).  $\chi^2$  tests reveal a highly significant difference between Neve David and Sarrrians ( $\chi^2=87.8$ ;

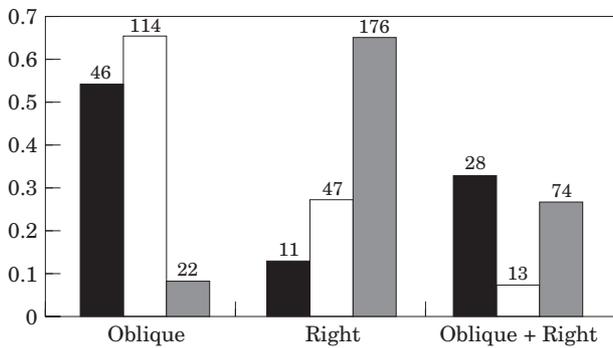


Figure 2. Relative frequencies of fracture angles from Neve David (■) compared to Fonbregoua (□) and Sarrians (▒) (after Villa & Mahieu, 1991).

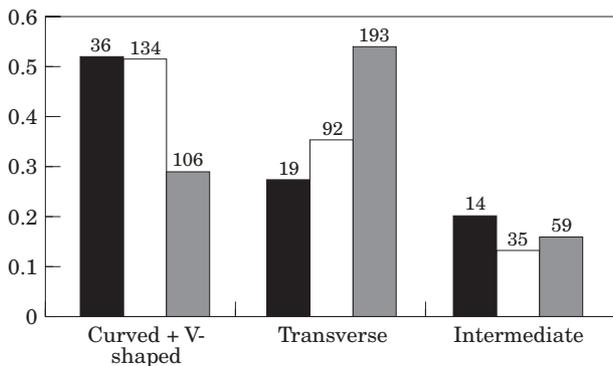


Figure 3. Relative frequencies of fracture outlines from Neve David (■) compared to Fonbregoua (□) and Sarrians (▒) (after Villa & Mahieu, 1991).

$P < 0.001$ ), and no significant difference between Neve David and Fontbregoua ( $\chi^2 = 3.14$ ;  $P = 0.08$ ). Neve David and Fontbregoua on one hand, exhibit a majority of curved fractures, and Sarrians on the other, exhibits a majority of transverse fractures (Figure 3).  $\chi^2$  tests reveal a highly significant difference between Neve David and Sarrians ( $\chi^2 = 13.27$ ;  $P < 0.001$ ), and no significant difference between Neve David and Fontbregoua ( $\chi^2 = 0.02$ ;  $P = 0.9$ ). Thus, the mode of bone fracture found in Neve David shows low representation of dry bone fractures resulting from bone trampling, as observed in Sarrians, and indicates that fractures were made on fresh bones, probably for marrow extraction, as was found in the site of Fontbregoua. In addition, we found no typical signs of surface modifications (as in Fiorillo, 1989) indicating pre-depositional bone trampling.

Thus we suggest that bone fractures at Neve David reflect human activities during occupation (see also Bar-Oz, Dayan & Kaufman, 1997), an action that produced a large number of fragments with green bone fractures and accounts for their high density at the site. Unfortunately, because of the absence of similar information from other Epipalaeolithic sites, a comparative study cannot yet be carried out.

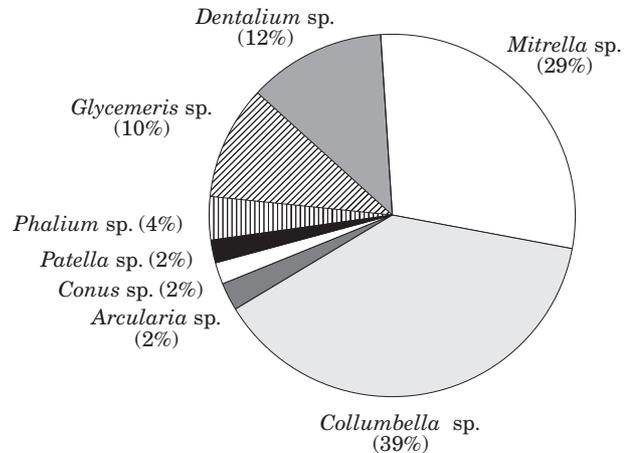


Figure 4. Relative frequencies of marine shell genera ( $N = 51$ ).

### The Economy of the Site

The faunal remains from the site enable us to reconstruct the subsistence economy and hunting preferences of a group of Geometric-Kebaran hunter-gatherers. The Neve David faunal assemblage comprises 15 mammal species, two reptile species (Table 1) and seven genera of gastropods and bivalves of the Mediterranean Sea (Figure 4). The small number of shells found in the site and their frequent conversion into ornaments (some of the shells bore regular piercing on the vertex of shell), suggest that the collectors were interested in the shells of molluscs rather than in their edible flesh (see D. E. Bar-Yosef, 1989, 1997).

The major prey species at Neve David (based on NISP), as in other pre-Natufian Epipalaeolithic sites in the area, are gazelle (*Gazella gazella*, 60%) and fallow deer (*Dama mesopotamica*, 31%). Similar proportions of these species were found in Hefzibah (Bar-Oz, unpubl. data), Nahal Hadera V (Saxon, Martin & Bar-Yosef, 1978; Bar-Oz, unpubl. data), Kebara C (Saxon, 1974) and Nahal Oren (Noy, Legge & Higgs, 1973), four other nearby Epipalaeolithic pre-Natufian sites (see discussion).

Few remains of small mammals, such as fox (*Vulpes vulpes*) and hare (*Lepus capensis*) are found in Neve David (3%). This is considered typical also of other Epipalaeolithic pre-Natufian assemblages (Davis, 1974; Saxon, Martin & Bar-Yosef, 1978; Hovers *et al.*, 1988; and see discussion).

Among the 15 species of mammals, cut marks and burned bones indicate use for consumption of at least nine species. Signs of burning were found on some of the bone remains of wild boar (*Sus scrofa*, 11% (based on NISP excluding teeth)), red deer (*Cervus elaphus*, 25%), and the tortoise (*Testudo graeca*, 30%). Cut marks were observed on the remains of six species: gazelle, fallow deer, hartebeest (*Alcelaphus* sp.), wolf (*Canis lupus*), fox and hare.

The gazelle and fallow deer remains bore marks from all stages of preparation: skinning, dismemberment

Table 2. Sum of cut marks on gazelle bones and their related activities (after Binford, 1981)

Dismemberment	N	Filleting	N	Skinning	N
Astragalus	9	Thoracic vertebrae	2	Metacarpus	2
Scapula	8	Vertebrae	1	Horn	1
Humerus	4	Calcaneum	1		
Cervical vertebrae	2	Metacarpus	1		
Metapod	1				

Table 3. Sum of cut marks on fallow deer bones and their related activities (after Binford, 1981)

Dismemberment	N	Filleting	N
Tibia	9	Thoracic vertebrae	2
Scapula	4	Tibia	1
Femur	2	Calcaneum	1
Humerus	2	Metacarpus	1
Rib	2		
Astragalus	1		
Mandible	1		

and filleting (Tables 2 & 3, for gazelle and fallow deer, respectively) (after Binford, 1981). The hartebeest, wolf, fox and hare, represented by small samples, each bore single cut marks related to dismemberment.

The little evidence of butchering found may suggest that foxes and wolves were eaten, but sample sizes do not permit a serious assessment of the nature of cut and burn marks on these species. In addition, these bones were dispersed and not found in articulation, much the same as the bones of other species. Similar findings were reported by Clutton-Brock (1979) for foxes in Jericho.

### Skeletal Parts Representation

The fauna of Neve David is heavily dominated by gazelle and fallow deer; therefore, they are the principal species in which skeletal part representation can be analysed. We did so by grouping gazelle and fallow deer bones of similar densities into five parts of the carcass: head, represented by the skull bones; body, represented by the thoracic and lumbar vertebrae; fore and hind limbs, represented by long bones (the latter two groups were united for the fallow deer analysis because of small sample size); and toes, represented by phalanx I and II.

Some of the bones that are not identifiable to species level were included in this analysis. These are mainly vertebrae and head fragments, which were identified only to 4 size classes (small; small-medium; medium-large; large). Fallow deer are in the medium-large size class as are red deer and hartebeest. However, red deer and hartebeest are so rare that their share in this

Table 4. Skeletal parts representation of fallow deer pooled into 4 carcass parts

	Head <sup>1</sup>	Body <sup>2</sup>	Limb <sup>3</sup>	Toes <sup>4</sup>
<b>Observed</b>	24	43	36	35
<b>Expected</b>	29	46	24.2	38.7
<b>Obs./Exp.</b>	0.83	0.93	1.48	0.9

<sup>1</sup> Occipital, sphenoid, parietal.

<sup>2</sup> Thoracic and lumbar vertebrae.

<sup>3</sup> Femur, humerus, radius, scapula, tibia, ulna.

<sup>4</sup> Phalanx I and II.

Table 5. Skeletal parts representation of gazelle pooled into 5 carcass parts

	Head <sup>1</sup>	Body <sup>2</sup>	Forelimb <sup>3</sup>	Hindlimb <sup>4</sup>	Toes <sup>5</sup>
<b>Observed</b>	60	69	61	59	59
<b>Expected</b>	89.6	78.4	33.6	44.8	44.8
<b>Obs./Exp.</b>	0.67	0.88	1.82	1.32	1.32

<sup>1</sup> Occipital, sphenoid, parietal.

<sup>2</sup> Thoracic and lumbar vertebrae.

<sup>3</sup> Humerus, radius, scapula, ulna.

<sup>4</sup> Femur, tibia.

<sup>5</sup> Phalanx I and II.

size class is negligible and we can view the entire class as representing fallow deer. The same is also true for gazelles and the extremely rare bones of roe deer (*Capreolus capreolus*) in the small-medium size class.

In order to factor out the preservation bias related to bone density, only post-cranial bones with similar density values (in the range of 0.2–0.35 g/cc) were used in this analysis (fallow deer bone densities based on *Odocoileus* spp., and gazelle bone densities based on *Ovis aries* (Lyman, 1984)). Unfortunately, there are no published density values for cranial elements. Since we did not want to ignore them altogether we added to our analysis skull bones of similar structure and developmental history (Romer, 1970) (i.e., occipital, sphenoid, parietal). This implies a probable similarity in density among the skull bones, but does not necessarily imply a similarity in density between the cranial and post-cranial elements used in this analysis.

Analysis of the skeletal part distribution of fallow deer recovered from the site reveals a representation of all body parts that does not differ from the expected (Table 4) ( $\chi^2=3.189$ ;  $P=0.363$ ). Thus, it may be inferred that entire fallow deer carcasses were brought to the site. In contrast, the skeletal part distribution of gazelles reveals a significantly different representation from that expected (Table 5) ( $\chi^2=17.58$ ;  $P<0.001$ ), with low occurrence frequencies of head and body parts and high counts of limb and toe bones. Moreover, comparison between gazelle and fallow deer skeletal part elements shows a significant difference

between the two species ( $\chi^2=9.389$ ;  $P<0.05$ ), which suggest that these animals were subjected to different kinds of treatment.

The difference between gazelle remains and those expected should be interpreted with caution, however. There are many problems associated with the analysis of vertebrae from archeological sites (Stiner, 1994). The scarcity of gazelle cranial elements could conceivably be explained in part by a possibly lower density of the cranial bones relative to the other skeletal elements used in this analysis. However, we find this explanation unlikely, since such a bias is not evident in fallow deer. Fallow deer are larger, so their bones could conceivably be more resistant and better represented, but this fact should not be reflected in a bias towards certain skeletal elements, and not others.

If the pattern of missing cranial and body bones is not related to bone densities, then two explanations may account for it. First, the pattern may indicate special treatment of some skeletal elements, but not others. For example, smashing the skull in order to consume the brain could have decreased the proportion of identifiable gazelle cranial elements in the bone assemblage. Speth (1983, 1987, 1990) suggested that during lean seasons, fat levels in ungulate species may drop with fat deposits remaining primarily in the brain, in the marrow of the distal limbs and ventral mandibular border, and within the cancellous tissue of the vertebrae and limb epiphyses. So one could speculate that the pattern at Neve David may reflect intensive use of gazelle brains that reflects hunting during a lean season at the end of the summer, and this may also bear on the season of occupation of the site. Possibly, fallow deer and gazelles were hunted at different seasons. Alternative hypotheses may be differential treatment of gazelle and fallow deer carcasses in terms of cooking, which would make the remains less attractive to carnivores (Lupo, 1995), and time of occupation during the hunting season, which may affect the availability of the remains to carnivores (Yellen, 1991; Bunn, 1993). While these hypotheses cannot be refuted or supported by the currently available data, we note that no gnaw marks were found on bone remains from the site.

Alternatively, it could be suggested that the differences in body part distributions between gazelles and fallow deer reflect differences in food transport behaviour. Food dispersion and prey body size exert roughly similar effects on the quantities of food transported by foragers; fewer body parts may be moved as either factor increases (Stiner, 1994). There is some evidence that modern humans will do more field processing for larger prey (e.g., O'Connell & Marshall, 1989). Fallow deer weigh *c.* 80–100 kg while gazelles weigh only *c.* 20–25 kg (Mendelsohn & Yom-Tov, 1987), so we would expect the opposite pattern to occur at Neve David. However, it is possible that the two species were hunted at different distances from the site.

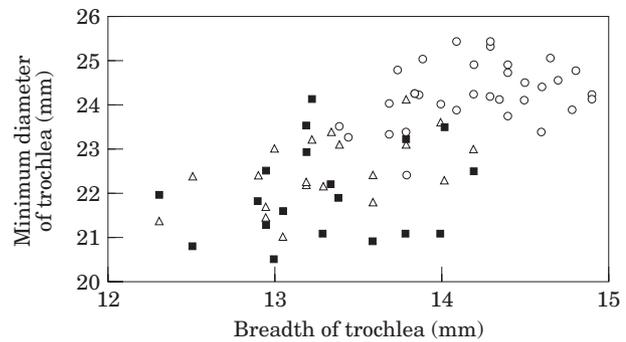


Figure 5. Scatter plot of distal humerus measurements (breadth of trochlea versus minimum diameter of trochlea) of recent sexed gazelles (female =  $\circ$ ; male =  $\triangle$ ) and fossil gazelles from Neve David ( $\blacksquare$ ).

### The Hunting Pattern

It has previously been suggested that a stage of selective culling served as a crucial step towards human control over wild herds, culminating in actual domestication (Zeuner, 1963). Therefore, it is important to determine the hunting pattern of gazelle and fallow deer at Neve David.

We analysed the sex ratios and age structure of gazelle and fallow deer remains at the site, and then compared them to those of recent populations. The gazelle fossil assemblage was compared to a recent gazelle population from the Lower Galilee, Israel (Baharav, 1974). Fallow deer are now extinct in our region, and therefore the herd structure was compared to that of the European subspecies (*Dama dama dama*) (Putman, 1988; Chapman & Putman, 1991).

Davis (1977) suggested that, in ungulates, distal epiphysis measurement of the humerus (breadth of trochlea versus the minimum diameter of trochlea (Driesch, 1976)) shows some separation of the sexes, in particular among highly dimorphic species. Distal humerus measurements of a sample of recent gazelles (32 males and 20 females), however, show some overlap between the sexes (Figure 5). A discriminant functional analysis failed to place 20% of the recent individuals in their proper sex group. Of the 19 fossil specimens, a discriminant functional analysis placed 13 individuals within the female measurements (at  $P<0.05$ ), and failed to place the remaining six individuals within a sex.

The mean of the fossil specimens is significantly lower than the mean for those of the recent specimens (32 males and 20 females), for both our measurements ( $t=4.34$ ;  $P<0.001$  for breadth of trochlea and  $t=5.21$ ;  $P<0.001$  for minimum diameter of trochlea). This could reflect either a smaller sized population or a large number of females in the fossil sample (females are significantly smaller than males ( $t=7.08$ ;  $P<0.001$  for breadth of trochlea and  $t=8.35$ ;  $P<0.001$  for minimum diameter of trochlea)). We carried out a Student's *t*-test to compare the fossil specimens with our sample of 20

recent females, then we compared them to the 20 recent females plus one randomly drawn recent male, then to the 20 recent females plus two randomly drawn males, etc. The fossil sample was not significantly different in size from the recent females sample, and not significantly different when we added first one, then two, then three and then four randomly drawn males to the 20 recent females sample. A significant difference was detected when we reached the comparison with 20 recent females plus five recent males ( $t=2.09$ ;  $P<0.05$  for breadth of trochlea and  $t=2.68$ ;  $P<0.05$  for minimum diameter of trochlea). Thus, if the fossil gazelles were of the same size as those of the recent, then the fossil assemblage structure must include the ratio of 20 females to four males, at the most. Of our fossil sample of 19, this implies no more than three males to 16 females.

Baharav (1974) estimates on the basis of monthly drive counts and counts taken from fixed observation sites that, in the lower Galilee, for each 100 females over 18 months of age, there are 81 males. A comparison of the recent herd of gazelle with the hunted specimens from Neve David (three males, 16 females) shows a significant difference in sex ratio between the fossil and the recent populations ( $\chi^2=5.92$ ;  $P<0.05$ ) suggesting selective culling of female gazelles, the opposite of the pattern reported by Cope (1992) for Natufian hunting practices.

Horn cores are the only abundant skeletal element which can be used for sexing the Neve David gazelles reliably. In Neve David we found 21 horn core bases of male gazelles, but only three of female gazelles. This result may reflect, in part, the fact that male horn cores are more robust. However, it certainly indicates also that many more than three male gazelles were brought to the site. Thus, we must also consider the alternative hypothesis, that the Neve David gazelles may simply be significantly smaller than the recent ones, as has previously been suggested for Natufian gazelles (Davis, 1981; Cope, 1992). If this is the case, then we cannot sex the Neve David herd with any certainty.

The age profile of the gazelle fossil population was examined using two methods: (1) Juvenile-adult distinction, based on epiphyseal fusion. Fusion occurs at a particular age for each skeletal part, and the age at which each epiphysis fuses is known for gazelles (Davis, 1980). (2) Continuous distinction, based on dental age classes through comparison to rate of tooth wear of recent gazelle skulls in the Tel-Aviv University Zoological Museum whose age at death was recorded (following Deniz & Payne, 1982 for goat).

Age distribution according to mode of dental wear suggests random hunting of gazelles. The percentage of young individuals (under 18 months of age) in the recent herd is estimated at approximately 35% (Baharav, 1974). Of course, these results are merely suggestive since not only do percentages of young in the field vary considerably from year to year in natural herds, but also the effect of time-averaging on a "fossil

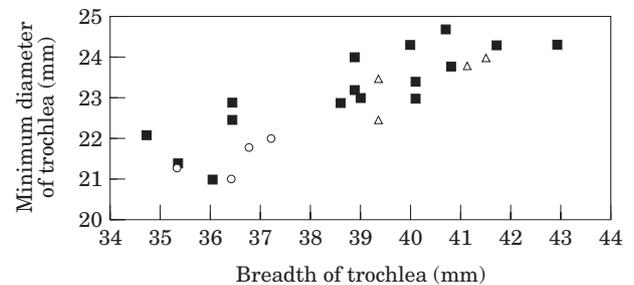


Figure 6. Scatter plot of distal humerus measurements (width versus minimum diameter of trochlea) of recent sexed fallow deer (female = O; male =  $\Delta$ ) and fossil fallow deer from Neve David ( $\blacksquare$ ).

herd" may be significant as well. In Neve David, the percentage of the young individuals, under the age of 18 months, according to dental wear rate is also 35%. The identity between the recent and the fossil population suggests no age-selective culling. The percentage of young individuals based on epiphyseal fusion of several skeletal elements (radii, metapodia, femora, tibiae, calcanea) whose fusion ages range from approximately 10 to 15 months of age (method developed by Davis, 1983) is 29%. Thus the epiphyseal age profile resembles the dental profile quite closely. These findings are similar to other Epipalaeolithic sites, including Natufian sites from Israel (Davis, 1983; Davis, Lernau & Pichon, 1994; and see discussion).

In contrast to gazelles, distal humerus measurements on recent sexed individuals of fallow deer (*Dama mesopotamica*) from Israel reveal two clusters of measurements representing males and females. The 16 measured fossil bones fall clearly into these two groups (Figure 6): smaller measurements, which probably represent females (31%), and larger measurements, which probably represent males (69%). This finding is also supported by a Discriminant Functional Analysis on recent sexed specimens (four males and four females) which clearly distinguished between the sexes ( $P=0.01$ ).

For comparison, sex ratio in natural death of fallow deer (*Dama dama*) from Richmond Park, England is 60% females and 40% males (Chapman & Putman, 1991). This ratio was also found among red deer herds (Lowe, 1969). Comparing the fallow deer herd found in the site to these data shows that selective male hunting of fallow deer at Neve David was practiced.

The percentage of young individuals, based on epiphyseal fusion, according to the calculation used by Davis (1983) for gazelles, is 31%. Focardi, Toso & Pecchioli (1996) found that fawns (under 1 year of age) constituted 23.6% of a wild herd of European fallow deer (*Dama dama dama*) in a Mediterranean forest near Rome. This herd has no natural predators, but regular culling is practiced for management, complicating potential comparison. Moreover, since no data are available for epiphyseal fusion ages of fallow deer, we cannot determine the age class of "young individuals"

at Neve David properly, and can only note that the above figures do not seem to clash.

### Seasonality

A clue concerning the season of occupation was found in the form of an embryonic pelvis fragment of fallow deer. The reproductive season of fallow deer is constant and is regulated by the circadian rhythm (Braza & San-Jose, 1988; Putman, 1988). After a pregnancy of 230 days the doe gives birth at the beginning of the spring (Bar-David, pers. comm.). Therefore, the hunting of the pregnant doe must have taken place towards the end of the winter. Although this is a single finding, and should be treated as such, it suggests a late winter–early spring occupation. This result is in accordance with Lieberman's (1993) analysis of seasonal bands in dental cementum of 16 gazelle specimens, which indicates seasonal hunting of gazelles at Neve David during the winter.

### Palaeoecological Reconstruction

The faunal remains recovered at Neve David represent the local fauna hunted in the vicinity of the site. Therefore, they can be taken as a reflection of the Geometric-Kebaran fauna of Mount Carmel and the coastal plain area during the last glacial, a period with a cooler and more humid climate than reigns today (e.g., Horowitz, 1989; Baruch & Bottema, 1992; Bar-Mattheus, Ayalon & Kaufman, 1997). Ecological analysis of the faunal remains shows species that inhabited different habitats.

Some species found in the site require open country landscape. Among them are gazelle, wild cattle (*Bos primigenius*) and hartebeest. The hartebeest, probably *Alcelaphus buselaphus* adapted to savannah woodland, is the only species in the genus found north of the Sahara belt (Dorst & Dandelot, 1970) and has also been found in other Epipalaeolithic sites in Israel (e.g., Davis, 1994). Other species found in the site require wooded landscapes, such as the Syrian squirrel (*Sciurus anomalus*) and red deer (Harrison & Bate, 1991). Other palaeoartic woodland mammals found in the site are fallow deer and roe deer.

Evidence for a cooler, more humid environment is furnished by the large size of the hare at Neve David, in accordance with Bergmann's (1847) rule (see Dayan *et al.*, 1991 for alternatives). This rule was found to apply to the hare (Yom-Tov, 1967; Raanan, 1980; Dayan *et al.*, 1986), among other species (Davis, 1981). Comparison of scapula-glenoid-fossa lengths (Driesch, 1976) between the fossil hare of Neve David and a recent population from the Hula basin shows that individuals of the fossil population are significantly larger ( $P < 0.05$ ) (Table 6). This diminution is most probably due to processes of post-glacial warming and desiccation. This finding is in accordance with the

Table 6. Length of scapula GLP of the hare from Neve David in comparison to recent specimens

	Range of variability	Mean	S	N	Student's <i>t</i> -test
Neve David	12.45–13	12.65	0.242	4	$t=3.86$
Recent	10.6–12.05	11.4	0.463	8	$P < 0.05$

exceptionally large wolf (*Canis lupus*) found in the site (Dayan, 1994a).

### Discussion

The faunal remains from Neve-David, a Geometric-Kebaran occupation site, represent 15 mammalian species, at least nine of which bear signs of human exploitation. Cut marks representing all stages of activity, lack of direct evidence of carnivore activity and representation of all elements of fallow deer skeletons in the site suggest that Neve David served as a base camp, occupied for prolonged periods of time. This finding is supported by the lithic assemblage (Kaufman, 1989).

Does the Neve David faunal assemblage bear Natufian characteristics? And how does it add to our understanding of the Epipalaeolithic economic sequence? In order to discuss these issues we re-examined the published Epipalaeolithic faunal assemblages from Israel.

#### *Testing the broad spectrum economy of the Natufian*

It has often been suggested that, in the Natufian, we witness a shift to a wide spectrum economy featuring an increased number of small game species, in particular birds and fishes (e.g., Henry, Leroi-Gourhan & Davis, 1981; Tchernov, 1992). This wide spectrum revolution has been suggested by Flannery (1969) as the precursor to the beginning of food production. It entails the intensified use of small resources which are readily and predictably available in some quantity at certain seasons of the year: waterfowl, fish, mussels, snails and plants (Flannery, 1969). The broad spectrum economy in the Levant has been widely discussed for many years but remains essentially untested. Intensification and diversification of the use of plants remains to be analysed quantitatively. Limited studies have attempted to test this phenomenon in faunal remains. Henry, Leroi-Gourhan & Davis (1981) and Davis, Lernau & Pichon (1994) compared two strata of a single site. Edwards (1989), carried out a broad temporal analysis, and found no support for such economic changes. However, his study included species of no economic value (Neeley & Clark, 1993), pooled a large number of sites from the entire Levant, combined published reports based on either MNI or NISP and used both open air and cave sites without consideration of possible taphonomic differences. Moreover, Edwards

(1989) used diversity indices, which confound the actual number of species (richness) and their relative abundance (evenness) (Pielou, 1975). Neeley & Clark (1993) reanalysed most of the same data base, but made an a priori distinction between economic and non-economic faunas (by excluding rodents, raptors, insectivores, songbirds, some carnivore species and reptiles, except for tortoises) and excluded all molluscs (because of inconsistent reporting and because they had a largely ornamental value). Their within-period simulation provided tentative support for a broad spectrum pattern of exploitation, since patterns indicating greater richness and evenness occurred in the Kebaran, Natufian and Neolithic periods, followed by predicted declines (Neeley & Clark, 1993). However, this study did not point to a difference between the pre-Natufian and Natufian Epipalaeolithic. As a whole, these studies suffer from being at a scale too coarse to test adequately between alternative models of subsistence change (see Miracle, 1996).

Statistical analysis of most of the currently published faunal assemblages from the Epipalaeolithic of Israel is not possible. Even after narrowing our list down to sites which were excavated using modern recovery techniques, various problems prevented us from using much of the published data. The faunal assemblage at Ein Gev I (Davis, 1974) was published with mention of the presence of various bird species, tortoise, fox and hare, but without quantitative data. The Hayonim Terrace (Henry, Leroi-Gourhan & Davis, 1981) and El-Wad Terrace (Valla *et al.*, 1986) faunal assemblages were published without analysis of the bird remains, and the faunal remains from Salibiya I were published with mention of 115 terminal phalanges of raptors, but without specific identification of these or other skeletal elements (Crabtree, Campana & Belfer-Cohen, 1992). Hayonim Cave layers B and C (Bar-Yosef & Tchernov, 1966) and Iraq E Zigan (Heller, 1978) were published with species lists, but without data on frequencies of occurrence. For Nahal Oren (Noy, Legge & Higgs, 1973) and Fazael IIIa (Davis, 1982), only the artiodactyls were published. Kebara B and C (Saxon, 1974) were published with MNI data alone and no total bone counts. Relatively complete data sets (except for fish at Mallaha) are available only for Mallaha (Eynan) (Bouchud, 1987), Hatoula (Davis, Lernau & Pichon, 1994), Urkan E Rub IIa (Hovers *et al.*, 1988), Nahal Hadera V (unpubl. data, of which seven bird bones remain unidentified) and Neve David. Only four of these sites (excluding Urkan E Rub IIa) are from the Mediterranean zone of Israel.

Four sites are hardly adequate for statistical analysis of diversity. However, since this is the best available, we carried out two analyses (using NISP as a basic measure of taxonomic abundance, and see Grayson, 1984) excluding species of no economic significance based on the criteria of Neeley & Clark (1993) (see Miracle, 1996 for an alternative approach). First, we calculated Shannon-Weaver indices (Shannon &

Weaver, 1949),  $H' = -\sum p_i \log p_i$ , where  $p_i$  is the percentage of individuals in the  $i$ th species. The results are: 0.407 for Nahal Hadera V (Kebaran); 0.452 for Neve David (Geometric Kebaran); 0.228 for Hatoula (Natufian); and 1.088 for Eynan (Natufian). These diversity indices are all significantly different from one another ( $P < 0.001$ ) (Zar, 1984; 146). Judging by these results Eynan is the most diverse assemblage and Hatoula the least diverse, so no temporal pattern can be discerned.

Diversity indices confound the actual number of species (richness) and their relative abundance (evenness), both of which should be defined precisely and examined separately before communities are compared (James & Rathbun, 1981). Thus, identical diversity values of the index can result from various combinations of values of these variables (Pielou, 1975). If richness *per se* is what the broad spectrum revolution implies, then clearly Shannon-Weaver indices are misleading. However, equitability may also be a related factor. Low equitability implies that the economy is based largely on a single or few species (gazelle and fallow deer in this case), and this should be considered when discussing the anthropological and ecological implications of a broad economic base.

We performed a Mann-Whitney U-Test (Sokal & Rohlf, 1995), comparing the ratios of gazelle and fallow deer, pooled together, from seven pre-Natufian versus seven Natufian faunal assemblages and found no significant difference ( $U_{[7,7]} = 21$ ;  $P = 0.654$ ). Similarly, Henry (1989) pointed out that even in those Natufian excavations where all minute faunal remains were recovered through fine mesh water sieving and froth-flotation, the quantity of the remains of small species implies that, relative to the large species, they contributed less than 1% of the meat to the diet. Flannery (1969) specifically addressed this point, and asserted that "it would be oversimplified to view the broad spectrum revolution as a shift from large to small game, and that even at late Palaeolithic sites ungulates contributed over 90% of the meat supply. The trend is rather from exploiting a more narrow spectrum of environmental resources to a more broad spectrum of edible wild products". Nevertheless, if gazelle plus fallow deer continue throughout the Epipalaeolithic at the same ratio, one may question the economic significance of a shift to a broad spectrum economy, if such a shift occurs.

Hayden (1981) suggested that there was a non-random order in which major types of resources were added, determined by the perceptions of people as to the species that would be most worthwhile to exploit next (given resource stress) and the technological basis. Similarly, Miracle (1996) points out that the relative abundance of high- versus low-ranked resources should give a direct index of diet breadth since diet breadth is predicted to change through the inclusion or exclusion of low-ranked resources (Broughton & Grayson, 1993). Therefore, "average prey package size

Table 7. Sample size (N), species number (S), estimated number of species based on rarefaction analysis (E(S)) and standard deviation of rarefaction results (SD) for four Epipalaeolithic faunal assemblages

	N	S	E(S)	SD
Neve David	2125	15	45-24	3-318
Nahal Hadera V	2143	13	45-39	3-318
Hatoula	2733	23	49-94	3-26
Eynan	2900	62	51-08	3-23

or a ratio of high- versus low-ranked species may be powerful indicators of diet breadth" (Miracle, 1996). A general gradual shift from large to smaller prey has been reported by Straus (1977) for Upper Palaeolithic sites in Cantabrian Spain, but while he suggests that both patterns of increased specialization and increased resource diversity may be discerned during this period, he points to the significance of spatial geographic differences in specialization (Straus, 1983), as well as to the importance of discerning between settlement types and seasons of settlement. The stable representation of gazelle plus fallow deer indicates no change in this ratio in the Epipalaeolithic sites studied.

As an alternative analysis, we also compared species richness among the assemblages using rarefaction, a technique developed by Sanders (1968), to compare species richness between collections of different size. This method enabled us to ask how many species a given sample would include, were that sample restricted (rarefied). The diversity of these species in nature in the recent is unknown. Eynan, the largest assemblage is also the richest, but the other assemblages also include species not represented in Eynan. Therefore, we could use neither the recent nor the Eynan assemblage for drawing out the smaller samples. Our tentative solution to this problem was to pool all four assemblages and to draw the sample sizes of our known assemblages from them (Table 7). For the rarefaction analysis we assume interdependence is minimal (Dayan, 1994b), an assumption that also underlies the use of NISP as an abundance measure. We incorporated Simberloff's modification to Sanders method (Simberloff, 1972). None of the four assemblages could likely have been drawn from the pooled assemblage, as their actual richness is several standard deviations each from the expected (Table 7). However, interestingly, while the two Kebaran sites (Neve David and Nahal Hadera V) and Hatoula were significantly less rich than expected, Eynan is significantly richer than the expected. Possibly, the real difference lies not between the Natufian and the Kebaran, but between Eynan and the other sites.

Although all four sites are in the Mediterranean region, they represent different subregions and habitats. Of the 62 species of economic value at Eynan, c. two-thirds are waterfowl. Eynan's situation at the Hula Basin may account for this large diversity of waterfowl,

rather than a cultural economic development. For example, in Ohalo II, an early Kebaran site at the edge of the Sea of Galilee, over 60 species of waterfowl were identified (Simmons & Nadel, 1997). Ohalo II and Eynan are from the same general region and share a similar habitat type; so, possibly, habitat may be the overriding factor. Many fish remains were also found in Ohalo II (Nadel *et al.*, 1994) and, although they are not yet identified to species level, it is clear that fish and waterfowl were intensively exploited already by the Early Kebaran. Pichon (1992) found that waterfowl formed part of the Natufian diet, in particular in sites along the Jordan Valley, and it appears that fishing activity, significant at Eynan (Desse, 1987), may have been of less importance along the Mediterranean Coast, although this impression may also be confounded by the use of earlier excavation methods (Bar-Yosef & Meadow, 1995). It is true that in both Kebaran sites (Neve David and Nahal Hadera V) there are few bird species and no fish, but at this point and in view of the findings of Ohalo II, we cannot rule out the possibility that this is a localized or regional phenomenon. Moreover, a new excavation at Nahal Hadera V that is currently underway has already yielded fish remains (Bar-Oz, unpubl. data).

Another aspect of intensification of resource use is the extraction of a larger fraction of energy out of existing resources. This should be reflected in more intensive use of the hunted species including, for example, more intensive use of bone marrow or of less desirable body parts. For want of taphonomic analyses in the overwhelming majority of published reports, we were unable to address this issue.

The bottom line is that at present the scope of published data does not enable a rigorous testing of a broad spectrum pattern of exploitation during the Natufian. Even the sites we used were analysed differently from one another. For example, Davis, Lerner & Pichon (1994) identified only a specific set of gazelle and fallow deer skeletal remains, while in Neve David and Nahal Hadera V we analysed all skeletal elements and also used size categories. This should enhance the equitability in Hatoula as compared to the Kebaran sites in this study.

Moreover, we follow Neeley & Clark's (1993) criteria for non-economic faunas, but alternative approaches are also possible (see Miracle, 1996). Differentiating between economic and non-economic fauna should be based also on taphonomic analyses (such as analysis of wing to non-wing ratios), which have not been carried out.

Clearly, more detailed research is required in order to discuss the occurrence and origins of the broad spectrum economy. A diachronic study of Epipalaeolithic assemblages from a single region and habitat, considering sources of taphonomic bias and employing the same research protocol, must be carried out in order to elucidate the evolution of patterns of faunal exploitation in the Epipalaeolithic of Israel.

Table 8. Relative frequency of gazelle and fallow deer remains analysed in this study

	Gazelle	Fallow deer	Reference
Nahal Oren (Kebaran)	0.77	0.15	Noy, Legge & Higgs, 1973
Ein Gev I (Kebaran)	0.44	0.28	Davis, 1982
Hayonim C (Kebaran)	0.82	0.06	Davis, 1982
Fazael IIIa (Kebaran)	0.73	0.18	Davis, 1982
Urkan E Rub IIa (Kebaran)	0.95	0.03	Hovers <i>et al.</i> , 1988
Nahal Hadera V (Kebaran)	0.74	0.2	Unpubl. data
Neve David (Geometric-Kebaran)	0.6	0.31	
Hayonim B (Early Natufian)	0.584	0.257	Cope, 1991
Eynan (Early Natufian)	0.658	0.179	Bouchud, 1987
El Wad Ter. (Early Natufian)	0.897	0.089	Valla <i>et al.</i> , 1986
Salibiya I (Early Natufian)	0.894	0.022	Crabtree, Campana & Belfer-Cohen, 1991
Hayonim Ter. (Late Natufian)	0.83	0.14	Davis, 1982
Nahal Oren (Late Natufian)	0.833	0.026	Noy, Legge & Higgs, 1973
Eynan (Late Natufian)	0.655	0.188	Bouchud, 1987

### Gazelle exploitation in the Epipalaeolithic

Another suggested characteristic of the Natufian subsistence economy is the increase in gazelle hunting relative to fallow deer hunting (e.g., Legge, 1972; Henry, 1985, 1989; Tchernov, 1992, 1993), coupled with increased specialization of gazelle hunting: a higher proportion of juveniles (Davis, 1983), a higher proportion of males (Cope, 1992; Tchernov, 1992, 1993) and diminution and increased variability that have been ascribed to “proto-domestication” (Cope, 1992). How strong are these patterns?

We searched for these patterns using data from published analyses of the faunal remains from 14 assemblages of 11 sites from central and northern Israel for which NISP data were published. Table 8 and Figure 7 present the ratios of gazelle and fallow deer to the total faunal assemblage in these sites, based on NISP. No clear pattern emerges. We performed a Mann-Whitney U-Test comparing the ratios of gazelles in pre-Natufian and Natufian assemblages and found no significant difference ( $U_{[7,7]}=20$ ;  $P=0.565$ ). The same test comparing the ratios of fallow deer among the two periods also revealed no significant difference

( $U_{[7,7]}=17$ ;  $P=0.338$ ). We note, however, that the ratios of gazelle and fallow deer are not entirely independent of each other.

The sites listed and analysed represent several regions in Israel (e.g., Davis, 1982), so pooling the data may bias the results of our analysis. We divided the sites into four general regions: Mount Carmel and northern coastal plain region (Nahal Oren, Hadera V, Neve David, El-Wad), Galilee (Hayonim Cave and Terrace), Jordan Valley (Fazael IIIa, Urkan E Rub IIa, Salibiya I), Lake Kinneret and Hula Basin (Ein Gev I and Mallaha). We compared pre-Natufian to Natufian gazelle and fallow deer hunting patterns within the Mount Carmel and northern coastal plain only (since the assemblages of the other regions comprised too few data points for statistical analysis). In this region we found a marginally significant difference in gazelle ratios between pre-Natufian and Natufian assemblages ( $U_{[3,2]}=0$ ;  $P=0.08$ ), with gazelles more common in the Natufian. For fallow deer, we found a similar marginally significant difference ( $U_{[3,2]}=0$ ;  $P=0.08$ ), with fallow deer less common in the Natufian. Neve David, with 60% gazelle and 30% fallow deer, has the lowest percentage of gazelle among all assemblages of this region, but statistical analysis with the current sample size is pointless. Clearly, dividing the sites into geographical regions limits the number of sites and the sizes of the assemblages, and weakens the power of our test. Again, a detailed diachronic study of several bone assemblages from the same general region is required. Such an analysis should also consider possible economic differences between base camps and ephemeral camps (see Straus, 1977; Bar-Yosef & Meadow, 1995).

Davis (1983) noted an increased juvenile cull of gazelles beginning in the Early Natufian and suggested several possible explanations to this pattern, one of which he favoured: that the increase reflected year-round hunting of gazelles which included the Spring peak of juveniles in the natural population. Alternatively, it was suggested that this shift reflects new

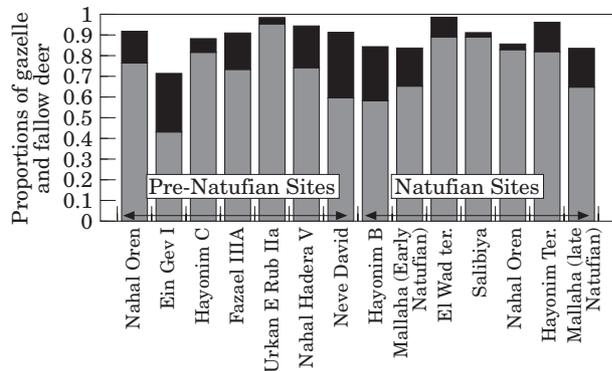


Figure 7. Proportions of gazelle (□) and fallow deer (■) in Natufian and pre-Natufian assemblages.

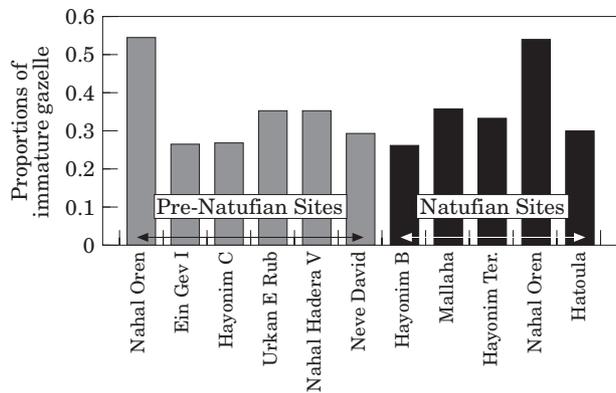


Figure 8. Proportions of juveniles in the gazelle remains of Natufian and pre-Natufian assemblages.

hunting methods, which may even contribute to a broad spectrum economy (Campana & Crabtree, 1990). We re-examined the ratio of juvenile to adult gazelles from the published reports from 13 assemblages of nine sites with NISP data, including new data that were not available for Davis's (1983) study (Table 9, Figure 8). We note that this is a fairly rough analysis, since in different studies different methods were used to age the gazelles and, in others, the methods were not specified. We used a Mann Whitney U-Test to compare the ratios of immature gazelles in Pre-Natufian versus Natufian assemblages and found no significant difference ( $U_{[7,6]}=16$ ;  $P=0.475$ ). Could a shift have occurred during the Natufian period? Bar-Yosef & Belfer-Cohen (1992) suggest that there are major differences between Early and Late Natufian phases that were likely the result of significant social changes. Pooling the Early Natufian assemblages with the pre-Natufian ones and comparing them with later Natufian assemblages did not reveal a difference either ( $U_{[10,3]}=8$ ;  $P=0.237$ ), nor did the exclusion of Nahal Oren where possibly the assemblages have been mixed ( $U_{[6,5]}=11$ ;  $P=0.465$ ). Thus, there appears to be no pattern in age-selective culling of gazelles in the Epipalaeolithic. Neve David,

with 29% immature gazelles, does not differ from the general sequence.

Cope (1992) suggested a pattern of increasing proportions of male gazelles hunted, morphological size diminution previously noted by Davis (1981) (and interpreted by him as a climatically induced phenomenon) and increased morphological variation in the Natufian gazelles. She ascribed these patterns to intensive sex culling practiced by the Natufian people and suggested the term "proto-domestication" for this stage when cultural control on a prey species reaches the level of producing measurable phenotypic aberrations. However, Dayan & Simberloff (1995), who carried out statistical analyses of Cope's (1992) published sample statistics, failed to confirm the morphological patterns and also questioned her method of sexing gazelles. Neve David gazelles may have been smaller than the recent ones, but a detailed morphometric study of size trends in Epipalaeolithic gazelles is required in order to resolve this point. We note, however, that both suggested hypotheses for gazelle diminution during the Natufian, climatic change (Davis, 1981) and "proto-domestication" (Cope, 1992), seem hardly relevant to the Geometric-Kebaran. In the meantime, with this question open, it is difficult to sex the Neve David gazelles with certainty. Cope (1992) found no other ungulate species to exhibit any form of sex bias for any site sampled throughout the Natufian. Interestingly, in Neve David we found a significantly higher percentage of male fallow deer than would be expected by chance. This could arise from either conscious male preference as a herd management practice, as has been suggested for other deer species (Zeuner, 1963), from some difference in the susceptibility of males and females to hunting, as has been reported for other ungulate species (e.g., Fitzgibbon, 1990), or from some seasonal selection to target males when they were in best condition (for discussion, see Speth, 1983, 1987, 1990). Data from other pre-Natufian sites are limited, so we cannot tell if this is an isolated phenomenon or a general pattern. Detailed studies of other Epipalaeolithic faunas are required to resolve this question.

Table 9. Relative frequency of immature gazelle analysed in this study

Gazelle immature	Reference
Nahal Oren (Kebaran)	Noy, Legge & Higgs, 1973
Ein Gev I (Kebaran)	Davis, 1983
Hayonim C (Kebaran)	Davis, 1983
Urkan E Rub IIa (Kebaran)	Hovers <i>et al.</i> , 1988
Nahal Hadera V (Kebaran)	Saxon <i>et al.</i> , 1978
Neve David (Geometric-Kebaran)	
Hayonim B (Early Natufian)	Davis, 1983
Eynan (Early Natufian)	Tchernov, 1993
Hayonim Ter. (Late Natufian)	Davis, 1983
Nahal Oren (Late Natufian)	Noy, Legge & Higgs, 1973
Hatoula (Late Natufian)	Davis, Lernau & Pichon, 1994

## Summary

The Epipalaeolithic faunal sequence from Israeli prehistoric sites may be the key to understanding the cultural, economic and palaeoecological processes that led to animal husbandry. Here we presented the faunal analysis of Neve David, a major Geometric-Kebaran site. However, our attempt to compare this assemblage with other pre-Natufian and Natufian sites revealed that the frequently suggested distinguishing characteristics of the Natufian economy cannot be substantiated using the currently available published data.

A diachronic study of Epipalaeolithic assemblages from a single region and habitat, considering sources of taphonomic bias and employing the same research protocol must be carried out in order to elucidate the evolution of patterns of faunal exploitation in the Epipalaeolithic of Israel. Such a study will enable us to formulate a clear picture of the Epipalaeolithic subsistence economy and to substantiate or refute the different scenarios. At the current stage of research, the key question is not “Natufian revolution” versus “Natufian evolution”, but rather—is the Natufian economy at all different from that of preceding cultures?

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