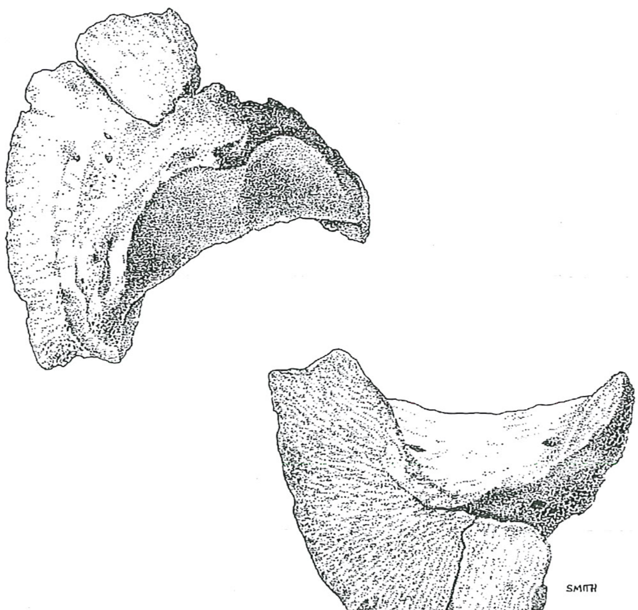
ARCHAEOZOOLOGY OF THE NEAR EAST III

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



ARC - Publicaties 18
Groningen, The Netherlands, 1998

Cover illustration: Dorsal and palmar aspects of a
Bronze Age horse phalanx from Arslantepe, Turkey,
identified by Sándor Bökönyi.
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Printing: RCG -Groningen

Information: Centre for Archeologicl Research and Consultancy
Poststraat 6, 9712 ER Groningen, The Netherlands

ISBN 903670791-9
NUGI 644/821/835

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).

Contents

AN ATTEMPT TO SYNCHRONIZE THE FAUNAL CHANGES WITH THE RADIOMETRIC DATES AND THE CULTURAL CHRONOLOGY IN SOUTHWEST ASIA

Eitan Tchernov[1]

Résumé

Il est aujourd'hui clairement admis que le Paléolithique moyen du Levant Sud à dure plus longtemps que ce que l'on pensait, et que plusieurs éléments importants pour l' évolution humaine se sont produits alors dans cette region. En intégrant ce que l'on sait des microfaunes aux géo-chronologies des établissements en grottes et de leurs séquences d'industries lithiques, et compte tenue des nouvelles datattions radiométriques, il est possible de présenter une chronologie plus complète pour le Paléolithique moyen, et de proposer de manière plus claire de rélations entre éléments abiotiques ou biotiques et ces mêmes évènements.

Les changements biotiques et les évènements concernant l'évolution des Hominidés sont généralement considérés comme des résponses aux fluctuations climatiques at aux accidents écologiques, et la question poséedans cette article est précisément de savoir si l'on peut affirmer qu'il en est toujours ainsi.

Il est montré que si le passage rapide pour les groupes humains, d'une grande mobilité à un état sédentaire, du Kébarien Géometrique au Natoufien ancien, peut être directement lié à des facteurs d'environnement, il n'en est pas de même pour les changements intervenus au Paléolithique ancien ou au PPNA. Sédentarité et domestication sont les deux faces d'un même phénomène: la domestication est une conséquence directe de la vie sédentaire. L'émergence d'une véritable société sédentaire avec un haut degré d'organisation sociale, une économie stratifiée et une division du travail, a ainsi déclenché, à l'image d'une chaine de réactions autonomes, une séries d'évènements dont le resultat final fut la "food production".

I. Introduction

The nature of ecological events is that, in spite of being extremely complicated, they are essentially an indirect reflection of the environment. The more vigorous the action of the elements is, the more simple and direct will be the ecological response. Using the same Darwinian logic then, under a low level of environmental change, there is only a blurred reflection of the physical environment, as in that case the interplay will be mainly between and within the biotic components, and not with the elements. The amplitude of climatic fluctuations (as indicated by deep-sea oxygen-isotope $\partial^{18}O$) increased during the last 5 m.y., but in particular over the past one m.y., followed by evermore extreme repeated shifts in the ecological belts. Understanding the response of biotic communities to environmental fluctuations is fundamental to modeling the climatic changes during human history. In spite of the indirect and complicated response of mammal communities to climatic fluctuations, the relative rapidity and high frequencies that occurred during the Pleistocene, the rich fossil record and the relatively detailed radiometric data permit a much more rigid and specific correlation between biotic changes, abiotic parameters and socio-cultural events. When dealing with the southern Levant we have to consider that in comparison with higher latitudes, the magnitude of Quaternary environmental changes was not severe enough to cause large scale biotic turnovers. Hence, the large mammals of this province can scarcely be used for biostratigraphic correlations. It is mostly the micromammals that have displayed dynamic changes and therefore may be more efficiently used for more comprehensive paleoecological consideration and biochronology.

The question whether there is any causal relationship between cultural events and environmental changes is a central one in archeobiology. The question is amplified when dealing with Southwest Asia where significant socio-economical transformations and hominine interchanges took place during the

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Period	Major Stages or Units	Site	Radiometric Dates (ka BP)				References
			ESR (tooth enamel)		TL (flint)	U-Series	
UPPER MOUSTERIAN (Tabun B type)	B (N)	Amud	42±3	49±4			1
		Bi'qat Kuneitra	39±6	54±6			2
	VI-IX	Kebara	?	?	48±3 - 58±4		3,4
	X-XIII (N)				60±4 - 62±4		
	B (N)	Tabun	76±11 - 86±11	85±18 - 103±16		50.7±0.2	5,6
MIDDLE MOUSTERIAN (Tabun C type)	XV-XXIII (AMH)	Qafzeh	100±10 - 105±2	115±8 - 125±22	88±9 - 92±5	89±3 - 106±2	1,6,7,8
	C (Garrod's layer)	Tabun	102±17 - 118±5	119±11-127±10	134 - 184	101.5±2.9	1,6,9,10
	I (=17-26) Jelinek's beds				171±17		
	(AMH Tabun II Jaws)						
	B (AMH)	Skhul	81±15 - 88±13	101±12-102±18	119±18	79±4 - 80±0.6	6,9,10,11,12
EARLY MOUSTERIAN (Tabun D type)	D (Garrod's layer)	Tabun	93±12-122±20	152±24-166±20	263±27	110±0.9	1,6,9,10
	IX (=62-69) Jelinek's beds						
	E	Hayonim Cave	c. 130 -170		c. 125 - 230	163±60	12,13
ACHEULO-YABRUDIAN	Ea-Eb (Garrod's layer)	Tabun	154±34-167±42	158±56-196±57	306±33	159±1 - 168±2	5,6,9,10
	(XI = 73-77) Jelinek's beds						
	Ed (Garrod's layer)	Tabun	186±61	213±46	331±30		5.9.10
	(XIII = 81-85) Jelinek's beds						
		Zuttiyeh				148±6 - 164±21	12
		Yabrud	177±20	231±19	195±15		9.13
LATE ACHEULIAN		Oumm Qatafa					

Table 1. ESR, TL and U-Series dating of Middle Paleolithic faunal bearing sites and key sites in the southern Levant. (N) = Neanderthal remains; (AMH) = Anatomically modern human remains.

References: 1 = Grün and Stringer, 1991; 2 = Ziaei *et al.*, 1990; 3 = Valladas *et al.*, 1987; 4 = Schwarcz *et al.*, 1989; 5 = Grün *et al.*, 1991; 6 = McDermott *et al.*, 1993; 7 = Valladas *et al.*, 1988; 8 = Aitken and Valladas, 1992; 9 = Mercier and Valladas, 1994; 10 = Mercier *et al.*, 1995; 11 = Stringer *et al.*, 1989; 12 = Schwarcz *et al.*, 1980; 13 = Valladas, in verbis; Schwarcz, 1994.

Quaternary; a region where the climatic fluctuations were relatively mild. One of the most conspicuous yet highly debatable events in Southwest Asia concerns the emergence of anatomically modern humans and Neanderthals. During the last 12 years, sufficient anthropological evidence has been accumulated to indicate that probably two types of humans alternatively, or sympatrically, occupied the region: 'Proto-Cro-Magnons' and 'Western Asian Neanderthals'. At present, the main disagreements are centered around the dating of the fossils, the definition of the various morphotypes, in terms of phylogenetic relationships, and the place of the fossils within the evolutionary and cultural sequence. Yet, until recently the correct sequence of their appearance and disappearance, or whether they were sympatric or excluded each other, has not yet been resolved. Thus the efforts to create a reliable bio-cultural chronology for the southern Levantine Middle Paleolithic became inseparable from the efforts to understand the evolution of modern humans. Another problem revolves around the possible coincidence between a particular climatic fluctuation and the emergence of the Upper Palaeolithic entity and modern humans in Europe. Other debatable issues concern the emergence of sedentary societies at the end of the Epipaleolithic, and ultimately the advent of food production. One of the most difficult issues centers around the problem of whether sedentism and food production were driven by climatic changes or driven by "internal" causes when humans became already sufficiently detached from environmental factors? To what extent and until when did hominids play an integral part in natural ecological events? Are hominid dispersal's and faunal changes part of the same phenomenon? And, in general, to what extent are cultural associations reflective of biological relationships, and if so, when was it during the history of man that he became independent of the elements, and detached from environmental parameters?

From which period must we stop explaining historic events as reflections of the physical world? During the history of humans we witness unidirectional changes in their bio-social structure and a widening of their niche space, that eventually became detached from environmental factors, or biological causes, and recently turned to be the main force for changes in both the biotic and abiotic environments. However, during the major part of the human history their impact on the ecosystem was negligible. Indeed, hominids constituted an integral component of their community system, but in particular they played an important role within the large-mammal communities (Brain, 1981; Foley, 1984; Isaac, 1980, 1983; Turner 1984). As such, hominids were certainly susceptible to approximately the same ecological selective pressures as all other members of their community, and hence to any ecological shift or dispersal event. It has been more specifically shown by Turner (1984) that migration of carnivores occurred in the same direction as the major dispersal of the hominids and within the same general time-span. However, a dispersal event is never limited to one group, as all members of the community are ecologically interwoven within the system and its trophic levels. Hence, changes in the ecology of hominids, probably until the later part of the Upper Pleistocene, constituted a natural component of any ecological phenomena. Nonetheless, the relationship between the abiotic factors, the biotic pattern and human behavior is never simple. To counterbalance such views I argue that even when there is a strong effect of climate on the biota, we must remember that organisms do not merely receive a given environment, but actively seek alternatives, or very often may alter the surrounding condition. The biotic and abiotic relationship is a reciprocal process.

While the mis-interpretation of the morphological, taxonomic and evolutionary status of the southern Levantine Middle Paleolithic hominids was essentially due to the inadequacy of the fossil record and its scanty samples, it is the reliance on insecure stratigraphic frameworks, and samples taken from insecure stratigraphic levels, as well as counting on non-matching radiometric methods, that caused poor comprehension and unclear insight into the real sequence of biotic and anthropological events during this period in Southwest Asia. But in particular, it is still the difficulties in correlating the biotic changes with the geochronological and archeological succession which prevents the establishment of a more solid framework between the different chronologies, faunal turn-over and anthropological events. In this domain the mammalofaunal spectra together with the newly established radiodatings, mainly ESR and TL, in spite of the discrepancy of their results, offered some preliminary clues to a basic sequence in which late Acheulian, Acheulo-Yabrudian and Mousterian periods are ordered according to faunal turn-over, and correlated with the cultural chronostratigraphy. Relative dating of the mammalian fauna also

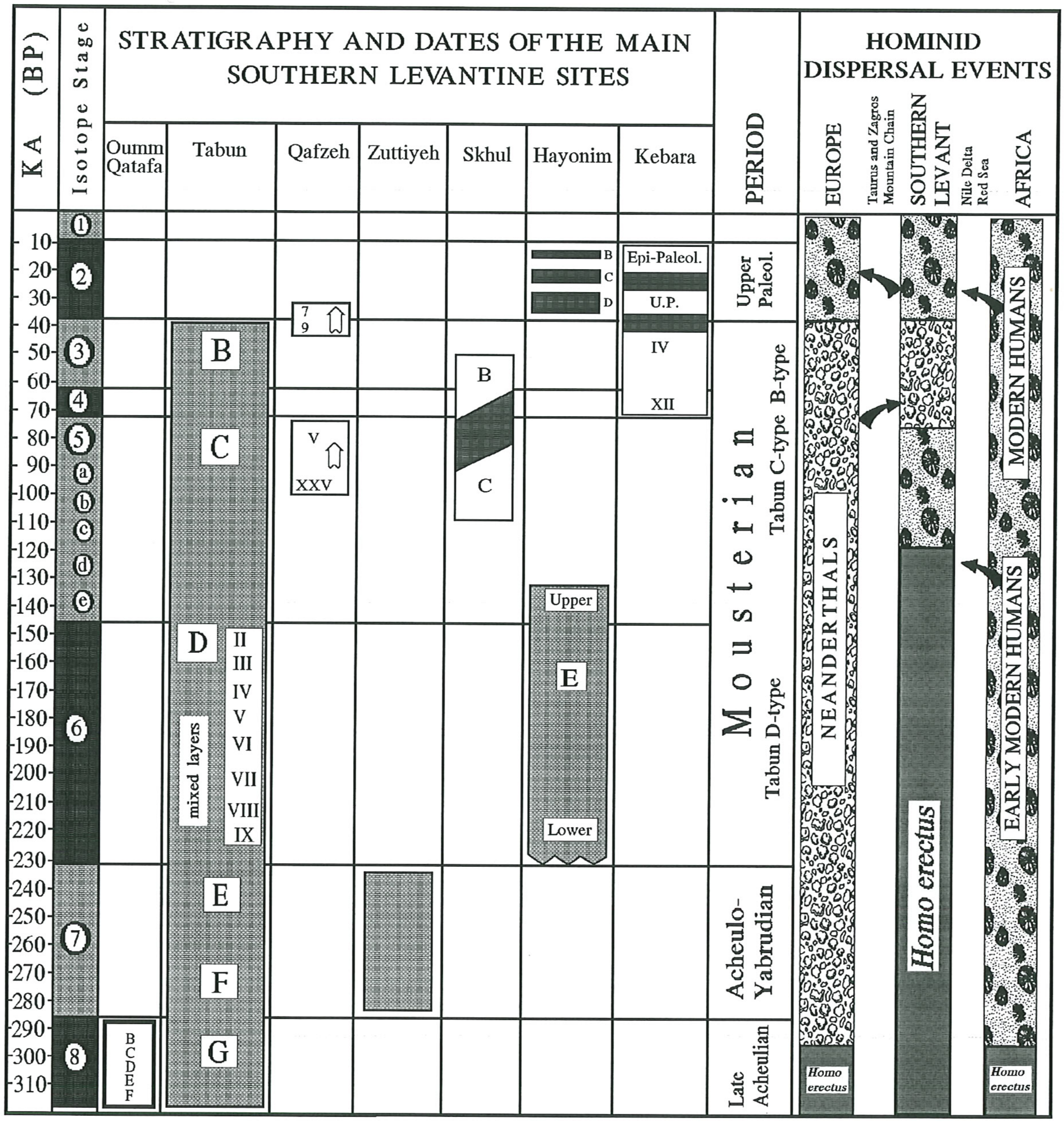

Figure 1. Hominid dispersal events correlated with the main cultural units in the main Late Acheulian and Middle Paleolithic sites of Southwest Asia.

permitted a general reconstruction of the southern Levantine environment. It is in particular useful for periods for which the pollen spectra and geochemical analyses are not compatible.

As for later periods, inter-laboratory inconsistencies and difficulties raised by the conventional ^{14}C dating of old wood may have biased the chronostratigraphy of the late Upper Pleistocene. Furthermore, dates from a defined cultural sequence may display a broad overlap between phases. Bar-Yosef and Kra (1994:8) have pointed out that "*...Difficulties in matching events in ocean and pollen records to a well-founded ^{14}C time scale inhibit better understanding of complex relations between temperature change, precipitation and vegetational response intervals of abrupt climate change. Our inability to reach a sound chronological framework for the eastern Mediterranean impacts on the interpretation of archaeological studies and his torical documents of the Holocene...*" However, the accumulation of many dates for numerous southern Levantine sites sheds more light on the basic sequences for the eastern Mediterranean region, for which a reliable biostratigraphy and cultural-historical chronology now begins to emerge. They also complained that there is still no complete palynological record for the past 20,000 years, and the impact of the Younger Dryas on the region is not yet well known. Yet, we do have a good sequence of faunal remains for these periods (last 20-10 ka) from which the basic ecological conditions can be outlined, whereas the conditions prevailing during the Younger Dryas did not have a significant impact on the animal life. In this article the faunal turnovers and the biotic exchanges during the Levantine Pleistocene will be correlated with the composite hominine history during the late Middle and Upper Pleistocene within this biogeographically dynamic region, and examined for an understanding of hominine evolution and emigration, as well as socio-economic changes, which can be separated from climatic fluctuations and ecological accidents.

II. The Middle Paleolithic

A. Dating the Cultural Sequence

It is now clearly understood that the Middle Paleolithic of the eastern Mediterranean actually lasted for a much longer period that previously thought, especially if we rely on TL-based chronology. Yet, we have to be aware that it is not only this series of datings which is far from being complete, as for some critical layers we do need more reliable dates, but there is a substantial disagreement between ESR, TL and U-series based chronologies. Moreover, confusion was raised for some important strata due to unreliable sampling of bones, mainly for ESR dating. The stretch of time suggested at present for the southern Levantine Middle Paleolithic is spread out from circa 45 to 260 ka (Mercier *et al*., 1995; Valladas *in verbis*), if based on TL chronology. The ESR based chronology suggested a time-span between 45 to 170 ka (Grün *et al*., 1991). It seems that the older the dated period is, the greater the discrepancy in dates (Table 1).

Estimation for Middle Paleolithic and earlier Middle Pleistocene sites in the southern Levant were mainly based on ESR (using tooth enamel), TL and U-series. The reliability of early uptake *vs*. linear uptake models of ESR age determination has been argued at length in many recent publications (Bar-Yosef and Kra, 1994; Farrand, 1994; McDermott *et al*., 1993; Mercier *et al*., 1995; Schwarcz, 1994). What essentially seems to emerge from the discussions is that the local environment and the micro-environment (climatic fluctuations, ground water levels, U concentration in teeth) may critically change the estimation of the gamma dose rate. As for U-series, dating of calcite concretions and encrustations of artifacts were applied at some of the sites, using thermal ionization mass spectrometry. The level of contamination may sometime be too high to allow the dating of even carefully selected samples (Schwarcz, 1994).

The sequence of the Middle Paleolithic industries that emerges for the Levantine Middle Paleolithic seems now to be more clearly divided into three complexes. The later one, known as 'Tabun B-type' (Fig. 1) is well represented at the caves of Amud, Kebara and level B of Tabun (as well as Sefunim and Geula cave in Mt. Carmel), and was dated with more confidence by both the ESR and TL methods to ca 45 to 65 ka. The current excavations in Kebara (Bar-Yosef *et al*., 1986) exposed a successive and intensive occupation of humans, with an increased rate of sedimentation and an industry that very much resembles 'Tabun B-type' (Meignen and Bar-Yosef, 1988, 1989). A series of TL dates indicates that Units XII through VI spans the range of 60 to 48 ka (Valladas *et al*., 1988). ESR dates suggest (Grün *et al*., 1991; Schwarcz *et al*., 1988) a range of 60-64 ka for Units X-XI. If the estimated age of the first Neanderthal occupation is around 65 ka then the occupation of Kebara site started at the end of stage 4, when Neanderthals probably dominated in the region.

'Tabun C-type' industrial assemblages are mainly represented in Skhul, Tabun and Qafzeh (Fig. 1). As microfaunal remains from the 'Tabun C-type' industry are mainly known from Qafzeh, and not from Skhul, and the list of mammals from layer C of Tabun is only known from Bate's publications (1937a,b, 1942, 1943). We can only rely on the community of Qafzeh for this time period! The small rockshelter of Skhul (Garrod and Bate, 1937) actually contains two complexes: a lower unit C, uncomformably overlaid by Unit B that contained the hominid burials. The erosion phase between B and C was correlated by Bar-Yosef (1989) to the erosion phase that truncated the top of Tabun D. ESR datings for this site (Grün *et al.*, 1991; Stringer *et al.*, 1989) gave an average age of 81±15 ka (linear uptake), and 101±12 ka (early uptake), and hence may be partially contemporaneous with Qafzeh; but no microfauna was described from Skhul.

The 'Tabun D-type' (Fig. 1) industry is known from Tabun D, Rosh Ein Mor, Nahal Aqev 3, Abu Sif, Duara 3, and a few other sites. As for Hayonim E it is worth indicating that while the industrial assemblage of 'Lower E' was associated with 'Tabun D-type', and the industry of 'Upper E' with 'Tabun C-type', the faunal assemblages of the whole complex of Hayonim E, which stretches over a relatively long span of time, antedates all the faunal assemblages of Qafzeh.

The Acheulo-Yabrudian macrofauna of Zuttiyeh cave (Bate, 1932) might be correlated with, at least, part of Tabun F and E. However, the paucity of the faunal remains does not permit finer correlation. The industry displays some similarity with Tabun E (Gisis and Bar-Yosef, 1974).

The layers above the Acheulo-Yabrudian in Zuttiyeh cave provided dates of 95±10 and 97±13 ka, while two dates were recorded by Schwarcz *et al.*(1980) from below these layers: 148±6 and 164±21 ka, and thus area not in concert with any of the recent dates from Hayonim E. This layer was associated with a hominine remain of intermediate affinities.

B. The Climatic Changes

1. Stages 8 and 7 (ca 300-190 ka)

Temperate belt glacial conditions (a mixture of wet and cold, cold and dry periods) were followed by an interglacial climate which in this region is often wet in its early part. Upper Acheulian sites occur in numerous localities, including northern Sinai, the Transjordanian plateau and El Kowm basin, mainly in wadi and river terraces. Stage 8 is best represented by the faunal assemblage from the cave of Oumm-Qatafa (Judea), and stage 7 by the assemblage of Zuttiyeh, which may be correlated with Tabun F-E (Farrand, 1994; Tchernov, 1994). The marine transgression Enfean I is dated to Stage 7.

2. Stage 6 (ca 190 - 130 ka)

Fluviatile terrace accumulations in Nahr el Kebir and the Orontes river, as well as the sedimentation of lacustrine or palustrine layers in interior basins such as El Kowm and the Jordan Valley, indicated a prevalence of pluvial conditions over most of the Levant including the desert margins. No Acheulo-Yabrudian sites are known from the well-surveyed Negev.

3. Stage 5e (ca 130 - 118/115 ka)

A rise in sea level resulted in the Enfean II formation (Gvirtzman *et al.*, 1983/4) which contains *Strombus bubonius* shells. Dunal accumulations from the previous sea retreat along the Israeli coast were stabilized and formed the westernmost sandstone (kurkar) ridge. The sandy deposits in the lower part of the Tabun cave sequence (layers F, E) were originally related to this stage or to the time of a subsequent sea regression (Farrand, 1979; Jelinek, 1982a), stage 5d or 5b. An alternative interpretation relates this important accumulation to Stage 6 (Bar-Yosef and Goren, 1981). As for Europe, Roebroeks *et al.* (1992:556; see also 1994) argued that the Eemian must have been an interglacial "*...with a high sea level and an oceanic climate similar to or warmer than the present one, with vegetation and climate rather uniform over large areas...*".

4. Stage 5d-5a (118/115 - 73 ka)

Due to increasing aridity, sea levels reached heights similar to Enfean I, originally named Enfean II and Naamean by Sanlaville (1988). According to Goldberg (1986) and Horowitz (1979), damper periods caused the deposition of fine-grain sediments upstream and gravel downstream in the various wadis hat made the early Levantine Mousterian occupation in the Negev possible. The faunal assemblage of Qafzeh does not support the notion of a damp climate in the Mediterranean region during this period.

5. Stage 4 (73 - 61 ka)

A major sea retreat caused the expansion of the coastal plain mainly between Mt. Carmel and the Nile delta. Intensive dunal accumulations along the shoreline are evidenced by the kurkar ridges. Fluviatile terrace accumulations were interrupted by an event or events of major down-cutting in wadis and rivers (Besançon, 1981; Goldberg, 1986).

6. Stage 3 (early part) (61 - ca 40 ka)

Stage 3 marks a return to moderate climatic fluctuations between wetter and somewhat drier conditions. Red soil (hamra) was formed under thick vegetation on the kurkar ridges. There is a re-deposition of loessial (siltic) accumulations in the northern Negev.

7. Stage 3 (later part) (ca 40- 22 ka)

Wetter and slightly drier spells continued to fluctuate with each other. A damper phase is evidenced in caves where Mousterian layers were eroded (e.g. Shukbah) and the deposition of early Upper Paleolithic industries was interrupted (e.g. El Wad, Kebara, Rakefet). A somewhat later, wetter period was radiocarbon dated mainly in the Negev and Sinai to 34-30 ka BP. The following millennia became cooler and finally also drier, culminating in the maximum of the Late Glacial (Stage 2). Abundant geomorphic evidence for this period demonstrates continuous siltic/loessic accumulations, increased dunal activity, and the retraction of inland lakes was followed by a phase of increased erosion and lake shrinkage (Bintliff, 1982; Goldberg, 1986).

C. The Faunal Sequence of the Southwest Asian Middle Paleolithic

On the basis of the relative antiquity of its micromammalian assemblage (Fig. 2), *Rattus haasi, Arvicanthis ectos, Mastomys batei* (Muridae), *Myomimus judaicus* (Gliridae), and in particular the unique appearance of *Ochotona* sp. (Ochotonidae, Lagomorpha), some of which never have been recovered from later lithic deposits (Tchernov, 1994), it seems that the osseous beds of Oumm-Qatafa (Judea) predate all Acheulo-Yabrudian lithic accumulations in the Levantine region. Some Palearctic species such as *Lepus* (Leporidae, Lagomorpha), *Talpa* (Talpidae, Insectivora), *Sciurus* (Sciuridae, Rodentia), are not yet represented in the southern Levant. The assemblage of Oumm-Qatafa may be best correlated with Tabun G (Farrand, 1994, Jelinek, 1981, 1982a,b, 1992) to which a stage 8 may be assigned. Therefore Oumm-Qatafa may delineate a biostratigraphic base-line for all of the later Acheulo-Yabrudian and Mousterian faunal sequences.

A post-Acheulian replacement of *Ochotona* by the genus *Lepus* (Lagomorpha; Tabun F+E; Tchernov, 1994), and the disappearance of other ancient rodent forms such as *Myomimus judaicus* and *Rattus haasi,* and the first appearance of new elements such as *Lepus capensis, Sciurus anomalus* and *Myomimus qafzensis* (Daams, 1981; Haas 1972, 1973), places the complex of Tabun F+E, but in particular layer E (from which most of the microfaunal material was retrieved), within the Acheulo-Yabrudian (Fig. 2). Whatever the dates of Hayonim E are, the early Mousterian of 'Tabun D-type' fauna still includes earlier Pleistocene elements, such as the representative of the fossil cricetid genus *Allocricetus* (*A. jesreelicus* and *A. magnus*), predominance of Palearctic mammals (such as *Talpa chthonia,* Insectivora), all of which were abruptly replaced in the assemblage of Qafzeh, mainly by Afro-Arabian elements (Fig. 2). Biostratigraphically and ecologically the fauna of Hayonim E can be best fitted to isotope stage 6, which in this case more or less confirms the ESR based chronology, but correlates less with the TL based chronology. Hence, we suggest that Tabun D (unit IX) and Hayonim Upper and

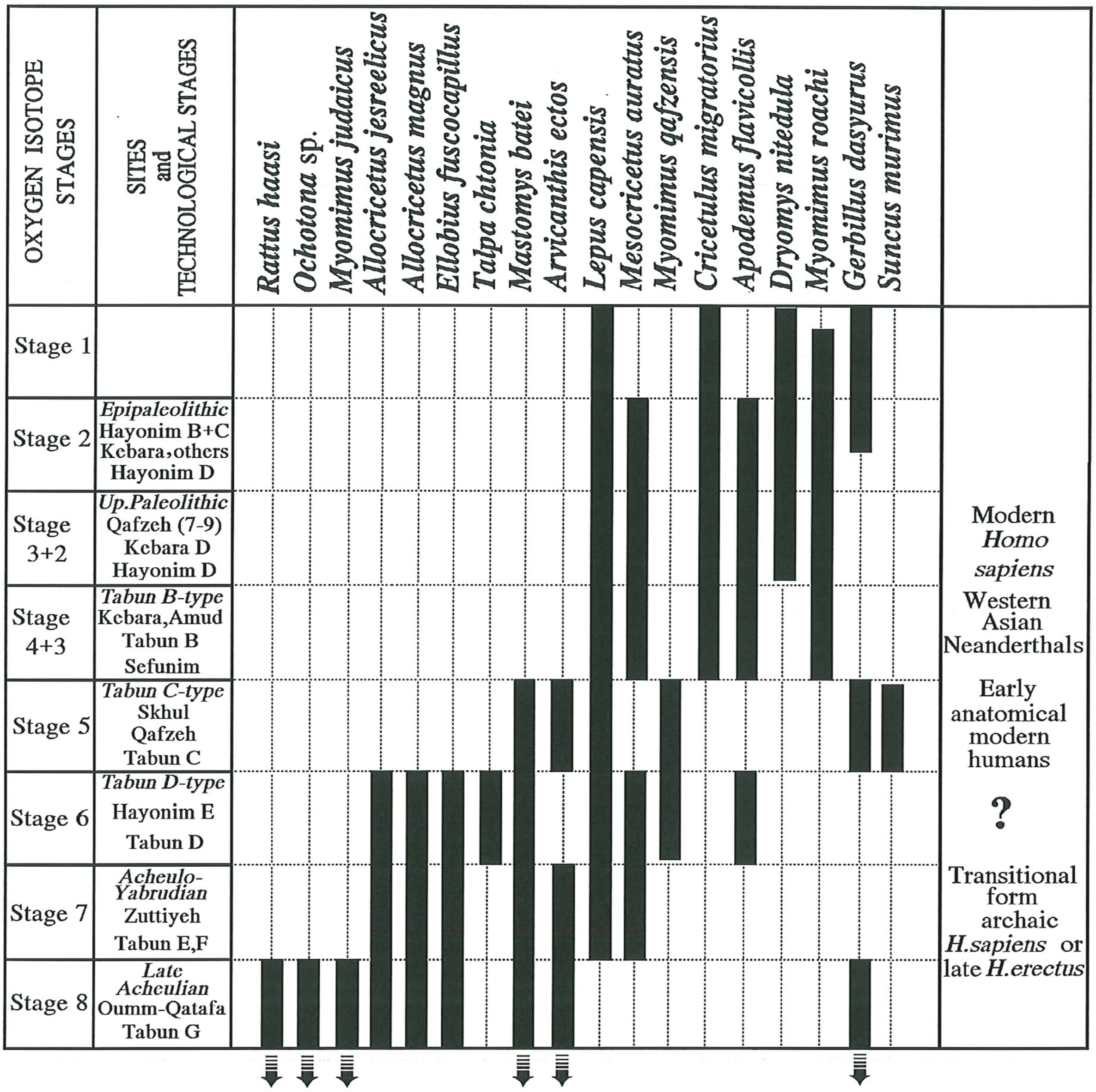

Figure 2. Microfaunal turnover, ^{18}O‰ stages and hominine dispersal events during the southern Levantine Late Middle and Upper Plesitocene.

Lower E antedates the complex of Qafzeh. While comparing the assemblage of Hayonim E with that of Qafzeh a significant faunal change can be shown. The total absence of cricetines (all of which are of Palearctic origin) is most obvious. This is the only known site in the Mediterranean region of the southern Levant where cricetines were never retrieved. *Ellobius fuscocapillus* (an Euro-Siberian Microtinae) and *Talpa chthonia* (a typical northern Palearctic insectivore) are also missing from this micromammalian community of Qafzeh. The Microtinae and the Cricetinae of the Old World have never developed any adaptations to withstand arid conditions and are completely absent from the Saharo-Arabian arid belt. The complete absence of these Palearctic elements from the assemblage of Qafzeh can only be explained by the unique ecological circumstances that prevailed during this period in this area (Rabinovich and Tchernov, 1996). This impression is reinforced by the salient increase of East African savanna and Arabian elements: *Arvicanthis ectos, Mastomys batei, Gerbillus dasyurus* and *Suncus murimus* (Insectivora). Both of these latter species are unknown in Acheulo-Yabrudian material. The faunal assemblage of Qafzeh is dominated by open country steppe or savanna species: the Arabian

Gerbillus dasyurus; the giant Indo-Arabian shrew, *Suncus murimus*; the typical savanna rodents *Mastomys* and *Arvicanthis,* which are associated with the African antelope *Alcelaphus buselaphus*, and possibly an African ass *Equus africanus* (Eisenmann, 1992; details in Rabinovich and Tchernov, 1996), a North African Equid, *Equus* cf. *tabeti* (Eisenmann 1992), *Gazella gazella*, *Dicerorhinus hemitoechus* as well as *Camelus* cf. *dromedarius* (according to Bouchud, 1974) and *Struthio camelus*. This is made manifest by the complete absence of all the cricetines as well as *Ellobius fuscocapillus* and *Apodemus flavicollis*. There is hence a strong Afro-Arabian stamp upon the fauna of Qafzeh, indicating that savanna conditions prevailed during this period.

As far as the microfauna and its paleoecological implications are concerned, there is a distinct faunal change between the assemblage of Qafzeh and that of Kebara (and other 'Tabun B-type' sites like Amud, Geula and Sefunim). A total elimination of almost all the Afro-Arabian micromammals, and a significant decrease in the predominance of large open-land mammals is very clear in the fossil record. The sharp faunal turnover and the ecological shift between the faunal assemblage of Qafzeh and those of Kebara and Amud correlate both with the ESR and TL radiometric datings, and fits the transition from isotope stage 5 to stage 4. At the dawn of stage 4, associated with the appearance of Neanderthals in the Levant, a conspicuous faunal turnover took place in the region, when a swarm of Palearctic-European elements invaded the region. During the dawn of stage 4 several archaic species of mammals became extinct or were eliminated from the Levantine scenario: *Myomimus qafzensis, Mastomys batei, Arvicanthis ectos, Suncus murimus* and temporarily also *Gerbillus dasyurus* and *Camelus* cf. *dromedarius*. On the other hand, the cricetines reappear in the southern Levant, together with new Euro-Siberian species such as *Myomimus roachi*. This significant faunal break between stage 5 and 4 is associated with a large scale southward dispersal of Palearctic elements and the first introduction of Neanderthals in this region, pushing many of the Afro-Arabian species southward (Figs. 1,2).

It still remains to be shown by enriching the fossil documentation that this emigration phenomenon was associated with the first introduction of Neanderthals into this region. The southward dispersal of Neanderthals may be correlated with the onset of the cold and dry conditions of Stage 4 in western Europe, which evidently caused drastic biotic changes. Bar-Yosef and Kra (1994:4) noted that *"... it is highly probable that the so-called Mediterranean Neanderthals prevailed in the Levant during the entire sequence of the Late Mousterian..."*. The southward and eastward expansion of continental glaciers as well as the advent of mountain glaciers enlarged the surface of periglacial lands, and shifted the boundaries of vegetational belts. If this reconstruction is verified, then the arrival of Neanderthals in Southwest Asia occurred around 70 ka ago. Early stage 4 and its faunal turnover was associated in the Levant by a lowering of the sea level, and dunal activity which resulted in the development of kurkar ridges along the coast.

D. The Upper Paleolithic

a. Chronology and Dates

The earliest Upper Paleolithic assemblages in the Levant were found in the present arid belt of the southern Levant (the Negev and Sinai; Boker Tachtit and Abu Noshra II in the south, as well as Qafzeh and Kebara caves in the north of Israel within the present Mediterranean belt; Table 2). These sites belong to the Ahmarian complex, and appeared ca. 8000 yr earlier than the Levantine Aurignacian at Ksar 'Akil, Lebanon (Phillips, 1994). The transition from Late Mousterian to the early Upper Paleolithic can be traced to the site of Boker Tachtit in the Negev (Marks, 1983; Phillips, 1994), where the earliest ^{14}C dates for the beginning of the Upper Paleolithic technological change in lithics were found to be ca. 48-40 ka BP (Schwarcz *et al.*, 1980). The site of Ein Avdat, in the Negev Desert, is particularly interesting in this context. It is located near the site of Boker Tachtit where its travertine was also found to contain artifacts of similar typology to the lithic industry of Boker Tachtit. The travertine, which was quite pure, gave a well-defined U-series date of 47 ka (± 3000 yr). Similar dates were obtained by ^{14}C analysis of ostrich eggshells at Boker Tachtit: ca 43.5, 33 and 43 ca (± 2000) yr.

Period	Tradition: Mediterranean	Tradition: Arid Zone	Site	Major Units	Radiometric Dates (ka)	Materials	References
	Natufian		Rakefet Cave		10.6 -11.0	bone	1
	Natufian		Salibiya I		11.5	charcoal	1
E	Natufian		Jericho	E	9.8 - 11.2	charcoal	2, OxA
P	Natufian		Ain Mallaha		11.3 - 11.7	charcoal	2
I	Natufian		Hayonim Terrace		10.0 - 11.0	charcoal	
P	Natufian		El-Wad Cave		1.9	bone	3
A	Natufian		Hayonim Cave	B	12.0 - 12.4	*Lupinus* seeds	2, 4, OxA
L	Natufian		El-Wad Terrace		10.0 - 11.9	bone	3
E					10.7 - 12.9	charcoal	
O		Mushabian	Shunera	IV, XXI	11.0 - 12.1	charcoal	1
L		Mushabian	Mushabi	V	12.7	charcoal	5
I	Geometric Kebaran		Neve David		12.6 - 13.4	charred bone	OxA
T		Geometric Kebaran	Mushabi	XIV,XVI,XVIII	13.0 - 14.3	charcoal	5
H		Geometric Kebaran	Urkan-e-Rabb	horizons 1+2	14.4 - 15.7	charcoal	OxA, 6
I	Early Kebaran		Hayonim Cave	C	c. 15 - 16		
C	Early Kebaran		Ohalo II		17.5 - 20.1	charcoal	5
					18.7 - 19.3	wild barley	
UPPER		Levantine Aurignacian	Shunera	XVI	15.8 - 16.1	eggshell	1
					16.2	ash	
P		Levantine Aurignacian	Ein Aqev (D31)	5, 7, 9, 11, 12	16.9 - 20.0	charcoal	8
A		Levantine Aurignacian	Jilat 9		21.2	bone	9, 10
L		Ahmarian	Boker BE		24.6 - 27.5	charcoal	8,11
E	Levantine Aurignacian		Hayonim Cave	D	20.0 - 29.0	bone	12
O	Levantine Aurignacian		Ksar 'Akil	3-7	21.1 - 23.2	charcoal	13
L				8-13	26.9 - 32.4	charcoal	
I		Ahmarian	Boker A		33.4 - 37.9	charcoal	8, 11
T	Ahmarian		Qafzeh		c. 35		12, 14
H		Ahmarian	Boker Tachtit		35.0	charcoal	11
I	Ahmarian		Kebara	D V	42.1 - 42.5	charcoal	15
C				D III	43.5 - 43.8	charcoal	
				D II	34.0 - 36.0	charcoal	
		Transitional Ahmarian	Boker Tachtit		45.6 - 47.3	charcoal	11

Table 2. ^{14}C dating of fauna bearing sites and key sites in the southern Levant. The Mediterranean zone is defined as regions with a minimum 250 mm isohyete at present; the desert zone is defined as regions with less than 250 mm isohyete at present.
References: OxA = Oxford Radiocarbon Accelerator Unit A; 1= Goring-Morris, 1987; 2= Valla *et al.*, 1987; 3= Valla *et al.*, 1986; 4= Hopf and Bar-Yosef, 1977; Sillen, 1984; 5= Bar-Yosef and Phillips, 1977; 6= Hovers *et al.* , 1988; Hovers and Marder, 1991; 7= Nadel and Hershkovitz, 1991; 8= Marks, 1976: 230; 9= Garrad and Gebel, 1988: 319; 10= Phillips, 1994; 11= Marks, 1983: 37; 12= Bar-Yosef, 1991; 13= Mellars and Tixier, 1989; 14= Bar-Yosef and Belfer-Cohen, 1988; Bar-Yosef and Kra, 1994.

Other dates from a somewhat later context in Kebara cave, where the transitional industry or 'Emiran' (Gilead, 1988) produced ages in the range of 43-47 ka BP and hence support the dates from the Negev.

Although the TL dates for Kebara are not available for Unit V, the latest Mousterian deposits in the site (= Unit VI) was dated to (TL) 48 (±3.5) ka, indicating that the MP/UP transition took place ca. 47-45 ka BP. These dates show that the MP/UP transition occurred in the southern Levant a few thousand years earlier than in Europe, where the transition from Mousterian to Aurignacian was ^{14}C dated to ca 40 ka (Bischoff *et al.*, 1989).

The Levantine Aurignacian, on the other hand, first appeared at Ksar 'Akil, (Lebanon) at ca. 32 ka BP where a good series of dates follow the stratigraphic sequence (Table 2). At this site, the Aurignacian is followed by the Proto-Kebaran at ca. 23 ka. In the Negev and Sinai, the Ahmarian continues up to ca. 24 ka. (Phillips, 1994). In the Mt. Carmel area, the Ahmarian is replaced by the Levantine Aurignacian at ca. 32 ka BP. The Levantine Aurignacian is characterized by rockshelter habitations in the northern Levant, with retouched, generally thick and irregular blades, and a variety of burins and steep end scrapers making up the majority of the lithic tool assemblages. Phillips (1994) pointed out that some Levantine Aurignacian assemblages overlap dated Epipaleolithic Kebaran sites, such as Ohalo II (Sea of Galilee), and hence could have continued in the southern Levant (like Ein Aqev in the Negev) while the Kebaran was already developing in the north. This is a question that needs to be clarified.

b. The Fauna

Older phases of the Upper Paleolithic are represented in Kebara (Mt. Carmel;Schick and Stekelis, 1977; Ziffer, 1978), and Qafzeh (Lower Galilee;Ronen and Vandermeersch, 1972). Aurignacian fossiliferous beds were exposed in Sefunim cave (Mt. Carmel) and in layer D of Hayonim cave (western Galilee), where a wealth of mammalian remains was uncovered. Upper Paleolithic faunal remains were recovered from Avedat/Aqev and Har Harif in the Negev (Marks, 1975; Tchernov, 1976). The importance of these sites is their present location in this area, offering an opportunity for an insight into the climatic and ecological nature of this region during this period.

The excavations in Kebara Cave in the 1950's and 1960's by M. Stekelis and the recent excavations (1982 to 1990) have yielded an immense collection of faunal remains. The mammalian bones from the Stekelis excavations were studied by Davis (1977), who identified the following species from the Mousterian deposits: *Gazella gazella, Alcelaphus buselaphus, Capra aegagrus, Bos primigenius, Capreolus capreolus, Dama mesopotamica, Cervus elaphus, Sus scrofa, Rhinoceros hemitoechus, Equus caballus* and *Equus hydruntinus* (the specific identifications of the Middle Paleolithic equids are still in dispute). Eisenmann has identified *Equus hydruntinus* as the most common equid species at Kebara, but *Equus* cf. *tabeti* and *Equus caballus* might also be represented within the local equid fauna. Carnivore remains in Kebara are relatively rare, and include hyaena, canid, fox, and several others (Dayan n.d.). In Kebara the hyaenids are represented by *Crocuta crocuta,* which had been present in the region since the Villafranchian but disappeared from the entire region during the Epipaleolithic; and by *Hyaena hyaena,* which still exists in the southern Levant.

It seems that during the later part of the Mousterian the faunal communities in the southern Levant became stabilized (Saxon, 1974; Davis, 1977; Tchernov, 1981, 1984). The few ossiferous beds from the early Upper Paleolithic, such as Qafzeh 7-9 and Kebara, indicate that no significant faunal change took place during the MP/UP transition. What did occur was an abrupt change in the relative frequencies of the rodent communities and most probably in the ungulates as well. The main paleoecological change that seems to be shown by the micromammals in the Levantine Upper Paleolithic, in comparison with the Late Mousterian (of Kebara) is the increase in the relative number of arboreal species of rodents (namely *Sciurus anomalus,* the appearance of the glirid *Dryomys nitedula* (Fig. 2), the re-appearance of *Apodemus flavicollis* and a decrease in the relative abundance of *Microtus guntheri*; an open landscape species (Tchernov, 1984). It is worth noting, that the increase in arboreal species of rodents is recorded both from the earlier Upper Paleolithic deposits (the Ahmarian in Kebara and Qafzeh; Table 2), as well as from the later part of the UP in Hayonim layer D and Sefunim (Tchernov, 1984). This phenomenon coincides with the palynological picture of the late Würm, as given by Horowitz (1979), which expressed a dominance of oak forests under levels of cool and humid pluvial vegetation in the Hula region and in other places in the southern Levant. *Bos primigenius, Sus scrofa, Gazella, Capra, Vulpes, Felis,* fish and bird remains were uncovered at Abu Noshra (southern Sinai; Phillips, 1994). The transition to the UP is associated with a gradual disappearance of faunal elements from the region during the U.P. rather than any faunal break.

That this was a relatively wet period is clearly shown by the faunal list recovered from Upper Paleolithic sites in the southern Sinai (Gladfelter, 1990), where not only the large diversity of fresh-water species of molluscs that have been identified, as well as freshwater Teleostei, but typical mesic Palearctic species such as *Bos primigenius* and *Sus scrofa* were found at these sites. Gladfelter (1990:117) concluded: *"...The sedimentary record preserved around the oasis indicates that in the mountainous interior of southern Sinai the last glacial was wetter and cooler than the contemporary conditions..."*. Hence it is still amazing that within the present Mediterranean belt of the southern Levant relatively so few Upper Paleolithic sites have been recovered.

E. Faunal Changes and Human Emigrations - Concluding Remarks

There is a general agreement, but certainly not a complete consensus, that Neanderthals and modern humans were genetically isolated. Our working hypothesis is that modern humans and Neanderthals are the product of vicariant evolution of *Homo erectus*; the former evolved in Afro-Arabia (the remains from Qafzeh may represent one of the oldest paleodemes of a seemingly indigenous *Homo sapiens*), the latter in western Europe. No solid and indisputable evidence is as yet at hand to show that Neanderthals predated stage 4 in Southwest Asia, as long as the dates from Tabun are not accepted as final. Some 100 ka ago, however, a more evolved form of *Homo sapiens*, or Proto-Cro-Magnons, were already present in Southwest Asia, and hence, may have occupied this region before any Neanderthaloid type first appeared here. That Neanderthals could have been late immigrants to the Levant as a direct consequence of the abrupt and severe climatic change during early stage 4, is still ill-appreciated by many scholars. Proving the possibility that these two forms of hominids coexisted or overlapped each other during a certain period in this region is utterly dependent on the fossil record (Figs. 1,2).

The regional sequence, although poor in fossils in its early part, demonstrates that most Neanderthal remains are relatively late in the Mousterian sequence (e.g. Tabun C, Kebara, the earlier group in Shanidar). A cautious age estimate will be around 70-50 ka. Thus, the arrival of the Neanderthals into Southwest Asia could be explained as resulting from a swift dispersal into the Mediterranean regime, originating from European populations. This population expansion could have happened with the onset of stage 4 in western Europe, which evidently caused drastic changes in the availability, reliability and accessibility of basic food resources. The southward and eastward expansion of continental glaciers as well as the advent of mountain glaciers enlarged the surface of periglacial lands, and shifted the boundaries of vegetational belts, when regions such as Belgium turned into polar deserts (Cordy, 1984). Environmental changes, such as in Southwestern France led to the replacement of red deer, wild horse and roe deer by mainly reindeer herds in the area of Combe Grenal (Chase, 1986; Delpech and Prat, 1980), challenging the abilities of Mousterian people to adapt to a more precarious resource of meat (Burch, 1972). A somewhat similar faunal change is also observed in Central Europe (Gabori, 1976). In conclusion, the new environmental configuration in Europe challenged the foraging technologies, the social structure and the spatial organization of Mousterian populations, forcing them to move into the Mediterranean lands. We know very little about the vague transitional period when the replacement of Neanderthals and Cro-Magnon's took place, as no faunal replacement was recorded during the two profound cultural alterations.

The exodus of modern *H. sapiens* at the dawn of the Upper Paleolithic may be considered a unique event, as this was the first time that we witness a large scale human dispersal that is completely detached from the behavior of the biota. During late stage 3, climatic conditions (Fig. 2) in the Levant seemed to be cooler and wetter, with a wider cover of Mediterranean woodland, as indicated by the relative frequencies of mammals (particularly of arboreal *Sciurus anomalus*), and the re-appearance of *Apodemus flavicollis* (Tchernov, 1979), and the southward expansion of a European species *(Dryomys nitedula)*. The expansion of modern humans ('Cro-Magnon's') was rapid, and the impact of their new tradition is already visible in the arid zone (which was mostly much wetter during this period) 46 ka years ago.

Sherratt (1996) argued that human populations were repeatedly sucked into the great land mass of North Africa in correlation with climatic fluctuations or across the Levant between Africa and Eurasia. Until late in the Pleistocene this phenomenon was an integral part of a natural ecological event, but human behavior in the Upper Paleolithic seems to be already driven by internal anthropogenic stimuli.

IV. The Epipaleolithic and Neolithic

A. Climatic Changes During the Epipaleolithic and Early Neolithic

The climatic fluctuations in the temperate zone were relatively mild, but can be clearly traced along the Mediterranean-Eremian suture lines (Tchernov, 1982, 1988; Tables 2,3). The southern Palearctic biota had shifted northward and southward over large regions, due to global and local climatic changes alternately enriching and impoverishing those marginal areas. Palynological studies by Roberts and White (1993) and van Zeist and Bottema (1982, 1991), in correlation with lake levels and deep sea cores, provided a general paleoecological picture of Southwest Asia. The following climatic fluctuations may be claimed for the Levant:

a. During the Late Glacial Maximum (24-16/14 ka BP) the climate of the southern Levant was colder and drier than today (see Bar-Yosef and Meadow, 1995);(Tables 2,3). Due however, to the influence of the Mediterranean, the coastal region and the western slopes of the north-south mountainous backbone enjoyed a wetter condition and hence a denser vegetational (forest) cover. In no way is it possible to compare the climate of this region with the more continental or northern Levantine domains.

b. During most of the Epipaleolithic period (20-14 ka BP) the forests along the coastal ranges in Syria, Lebanon, and Israel became more open in the south. Lakes (such as Lake Lissan; Begin *et al.*, 1985) were reduced in size. Only a narrow strip of open forest or a parkland stretched along the Transjordanian plateau. The Saharo-Arabian belt expanded westward into Syria and Jordan and northward into the Sinai and Negev region.

c. An increase in precipitation is said to affect the whole region (Baruch and Bottema, 1991; Bar-Yosef and Meadow, 1995) during the post LGM period (14-11.5 ka BP; the later part of the Epipaleolithic), and was followed by expansion of forests in the hilly regions, of the Irano-Turanian deep into the desert belt, appearance of temporary small lakes, and restored size sof larger lakes (such as the Dead Sea; Begin *et al.*, 1985). The last recognizable paleosol was formed during this period. Studies of succeeding pollen zones in some southern Levantine sites have shown (Baruch, 1994:118) that the forest experienced its largest expansion in the Allerød, 12-11 ka BP. Thus, the southern Levant departed from the general pollen spectrum of the northern Levant (van Zeist and Bottema, 1982, 1991; van Zeist *et al.*, 1975), where at least periodically, aridity characterized the general climatic conditions of the Late Glacial period. The remarkable expansion of Mediterranean forests during the Late Glacial in the southern Levant explains the significant southward shift of the Mediterranean belt deep into the Arabian desert. This phenomenon actually commenced at the dawn of stage 4, as shown by the faunal changes in the transition from stage 5 to stage 4. Since most pollen diagrams do not exceed 15-20 ka however, the pollen spectra of earlier periods are vague. There is also enough evidence to show that the Indian Ocean monsoonal system penetrated the southern and eastern portions of the eastern Mediterranean during the period from 12-9 ka BP (Tables 2,3).

d. The decrease in rainfall (from ca. 11-10 ka BP) was associated with a dry and cold period (ca. 10,800-10,000 BP), and can be correlated with the global phase of the Younger Dryas. The 'Younger Dryas' event of the North Atlantic region was recognized in the Red Sea cores (Almogi-Lubin *et al.*, 1991).

Period: Mediterranean	Period: Arid Zone	Site	Radiometric Dates (ka BP)	Material	References
PNA		Jilat 13	7.870 - 7.920	charcoal	1
	PNA	Jericho			
	PPNB	Basta	7.900 - 8.100	charcoal	1
	PPNB	Ujrat-el-Mehed	8.220	charcoal	2
PPNB		Ain Ghazal	7.800 - 9.200	charcoal	3, 4, 5
PPNB		Abu Gosh	c. 8.200 - 8.400		
PPNB		Iftahel	8.570 - 8.890	seeds	6
	PPNB	Nahal Hemar	8.100 - 9.000	charcoal	7
	PPNB	Jericho	8.600 - 9.000	charcoal	8, 9
PPNB		Munhatta	c. 8.600 - 8.800		
	PPNB	Beidha	8.500 - 9.100	charcoal, nuts	10, 11, 12, 13
	PPNB	Wadi Tbeik	10.350	charcoal	14
	PPNA	Jericho	8.700 - 10.200	charcoal	8, 9
	PPNA	Netiv Hagdud	9.400 - 10.600	charcoal, seeds	15, 16
PPNA		Iraq-ed-Dubb	9.950	charcoal	17
PPNA		Mureybet (I-IV)	8.800 - 10.600	charcoal	11, 18
	PPNA	Gilgal I	9.700 - 9.950	charcoal	19
PPNA		Gesher	9.790 - 10.020	charcoal	20
PPNA		Hatoula	9.400 - 9.700	charcoal	21
	PPNA	Abu Madi I	9.790 - 10.110	charcoal	16

Table 3. ^{14}C dating (based on uncalibrated radiocarbon dates BP, Bar-Yosef and Kra, 1994; Bar-Yosef and Meadow, 1995) of the main fauna bearing sites and other key sites in the southern Levant. The Mediterranean zone is defined as regions with a minimum 250 isohyet at present; the desert zone is defined as regions with less than 250 mm isohyet at present.

References: 1= Garrard *et al.*, 1994; 2= Weinstein, 1984; 3= Rollefson and Simmons, 1988; 4= Hedges *et al.*, 1989; 5= Rollefson *et al.*, 1992; 6= Garfinkel *et al.*, 1987; 7= Hedges *et al.*, 1990; 8= Burleigh, 1981; 9= Burleigh, 1983; 10= Barker and Mackey, 1968; 11= Stuckenrath and Lawn, 1969; Vogel and Waterbolk, 1972; 13= Weinstein, 1984; 14= Gopher, 1985; 15= Gowlett *et al.*, 1986; 16= Bar-Yosef, 1991; 17= Kuijt *et al.*, 1991; 18= Cauvin, 1987; 19= Noy *et al.*, 1980; 20= Garfinkel and Nadel, 1989; 21= Lechevallier and Ronen, 1985.

The $\partial^{18}O$ record pointed to a marked increase in the salinity of the Red Sea by 3-5ä, indicating the occurrence of an arid phase in the region.

e. The recovery of wetter (pluvial) conditions around 10-8 ka BP was recorded in pollen cores from the southern Levant (Baruch and Bottema, 1991), but probably never reached its previous peak and coincides with the global climatic model (COHMAP, 1988). The monsoonal front could have reached the southern corner of the southern Levant before shifting southward post-8 ka (terminal PPNB). The terminal date approximates 8.3-8 ka, and marks the end of the PPNB. This period could have still enjoyed a significant amount of summer rainfall, as all the PPNB faunal assemblages show.

f. A sharp shift to warmer conditions, decrease in the influence of the monsoonal system (summer rains) and development of dry Mediterranean conditions with a northward shift of the arid Arabian belt, characterize the later Neolithic phases (late PPNA and PPNB).

1. The Hula Region and the Mediterranean Belt

According to Baruch and Bottema (1991), in the earlier part of the Epipaleolithic (ca. 17-15 ka BP) the forest cover in the Hula area was rather limited, whereas the cover by steppe and desert plants must have been quite extensive. The climate was dry, and since this timespan coincides with the pleniglacial maximum, it may be assumed that it was also rather cold. Indeed, the Aurignacian assemblage was followed by a significant decrease in open-land species (particularly *Microtus guentheri*). The relative abundance of arboreal elements (*Sciurus* and *Apodemus*) decreased and open-land species (*Microtus*) increased. This phenomenological trend is also expressed by the fact, that for the first time typical arid to semi-arid species, *Acomys cahirinus* (a North African element) and *Gerbillus dasyurus* (an Arabian element) both stenoecious species which specifically occupy bare rocky slopes, abruptly appeared within the Mediterranean region of Israel.

During the Natufian a drastic shrinkage of *Microtus* distributions occurred, and arboreal elements became more abundant. *Mesocricetus auratus, Apodemus flavicollis* and *Sciurus anomalus* became extinct in Israel during the later part of the Neolithic, when *Microtus* greatly increases its relative frequency and the rest of the arboreal species are less common. From about 15 ka BP onwards more humid conditions must have gradually developed in the Hula region, resulting in a gradual expansion of the forest. More specifically, an increase in precipitation between roughly 14 and 13 ka (=Geometric Kebaran) was shown using different methods. This resulted in an expansion of continuous evergreen oak forests into the hilly regions between the coastal plain and the Jordan Valley and along the margin to the Transjordanian plateau. It also led to an expansion of the steppic Irano-Turanian vegetational belt both southwards and eastwards into formerly desert areas (Baruch and Bottema, 1991; Henry, 1989; Rognon, 1987). This may be reflected by the wider distribution of Geometric Kebaran sites, which are not only found in the core Mediterranean region of the southern Levant, but also in more marginal areas such as the Negev, Sinai, and the Transjordanian Plateau (Bar-Yosef and Goren, 1981). Starting about 13 ka BP this process accelerated, with humidity attaining its maximum value, and the forest its maximum extent, at about 11.5 ka, but it does not explain the large scale withdrawal of PPNA sites from the southern Levant. The later slight decrease in arboreal pollen in the Hula basin possibly represents the Younger Dryas and a slight increase in arboreal pollen marks the onset of the wetter early Holocene conditions probably ca. 10 ka.

2. The arid Zone

Following the dry period of the last glacial maximum at ca.18 ka BP a wet period is recorded at various localities. The widespread development of a soil profile during the period of ca. 15-11 ka BP is indicated by ^{14}C-dating of the top calcic horizon in the northern Negev (Magaritz, 1986) and in the coastal plain of Israel (Magaritz *et al.*, 1981), as well as by an archeologically-dated calcic horizon in the northern Sinai (Goldberg, 1986), where a freshwater lake occupied a large region at Gebel Moghara. An increase in the number of human occupation sites in the present-day desert of the Negev and Sinai

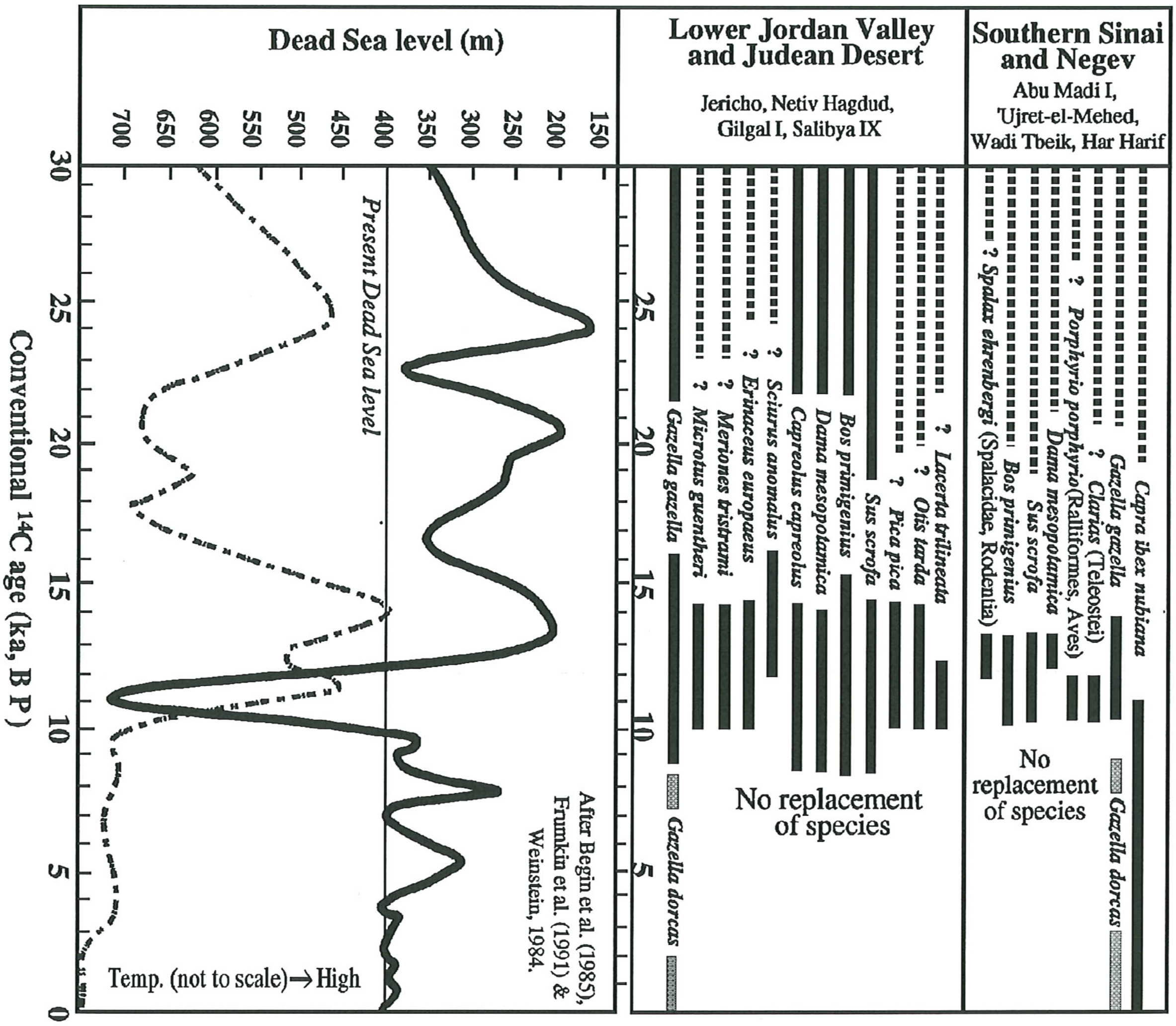

Figure 3. Late Epipaleolithic and neolithic f aunal elements in the present arid zone of the southern Levant. The Palearctic and aquatic species are dominant in this region at least during the later Glacial period. There is evidence that some of tlhe larger mammals were continuously present during the late Middle and Upper Pleistocene in Israel.

was documented by Goldberg and Bar-Yosef (1982) and reinforced the suggestion of relatively moist conditions.

Magaritz and Heller (1980) have shown that snail shells from archeological sites provide evidence for shifts in the desert boundary. They argued for arid conditions at ca. 11-10.5 ka (Late Natufian = Younger Dryas) in what is presently a moist area of Israel, as indicated by the enrichment of the shell carbonate and by the smaller size of the shells. Analysis of pollen from a Late Natufian site in the semi-arid region of Syria also indicates relatively dry conditions from 10.5-10.2 ka, with a slight increase in moisture between 10.5-10 ka (Leroi-Gourhan, 1982).

Pollen spectra for the PPNB and the Late Natufian settlements in the central Negev highlands (Horowitz, 1976, 1992) show considerably higher percentages of arboreal components as compared with the present day, including oaks, cypress, olive, pistachio and almond trees, and contradict the suggestion of dry conditions in the region during the Younger Dryas.

The data from both southern Sinai PPNB sites (Wadi-Tbeik and ’Ujrat el-Mehed (Dayan *et al.*, 1986; Tchernov and Bar-Yosef, 1982) imply a significantly wet climate during the earliest Holocene that could have supported typical Palearctic elements. The freshwater elements recovered from Wadi-Tbeik (*Porphyrio porphyrio* and *Clarias anguillaris*);(Fig. 3), the remains of *Gazella gazella* and *Bos primigenius* from both sites, the existence of *Lepus capensis* and *Alectoris chukar,* are some of the northern

species that characterized the fauna in the southern Sinai during the PPNB. The PPNA faunal assemblage of Abu Madi I (southern Sinai) shows much the same composition of species which also includes typical Palearctic elements, among which very surprisingly the mole rat (*Spalax ehrenbergi*, Spalacidae) was found to occur south of the southern Mediterranean coastal line. The faunal assemblages of the late Natufian and the PPNA (=Younger Dryas) (Figs. 3,4), as well as during most of the PPNB, do not support cold and dry conditions, nor any degradation in species diversity. It is still to be shown, that there is a correlation between
the small number of PPNB and PPNA sites in the southern Levant and climatic effects.

3. The Lower Jordan Valley

According to Horowitz (1992), the present day values for arboreal pollen north of the Dead Sea, within continental sediments, are around 1-2%. The arboreal pollen spectrum obtained from Kebaran sediments at the same locality, 18-14.5 ka BP, are in the range of 5-12%. The Geometric Kebaran, 14 - 12.5 ka BP yielded values in excess of 10%, while the early Natufian (12- 11 ka) showed values of 8-10%. The late Natufian (11-10.75 ka) yielded 2-4%, while during the terminal Natufian (ca. 10.5 ka) the values of arboreal pollen spectra dropped down to zero. Following this stage of the PPNA (10-9.2 ka), when arboreal pollen showed values of 10-15%, an increase up to 20% during the PPNB, (9.2-8 ka; Darmon, 1988) was shown.

Horowitz (1992) also argued that the environment was only slightly more humid compared with present. Humidity increased during the following Geometric Kebaran, until approximately 12.5 ka. The Natufian period shows gradual desiccation, attaining a peak during its terminal phase, in which arboreal pollen are entirely absent from the sites' deposits (Table 2). It was shown by Begin *et al.* (1985) as well as Magaritz and Goodfriend (1987), that during the arid spell of the 11 th millennium (BP) the Lissan lake greatly receded (Fig. 4), leaving behind a track of a flat muddy-marly lake bottom and a trail of small leftover water bodies (Tchernov, 1994).

Magaritz and Goodfriend (1987:173) argued that following relatively wet conditions during the period between 12-11 ka, *"...a short (ca. 1000 years) period of extremely dry conditions..."* prevailed in the Levant. This claim is not in concert with any of the biological evidence that was accumulated from all the PPNA sites in the southern Levant. Yet Magaritz and Goodfriend (1987) agree that the evidence for this period *"...is meager since it represents a time of erosion and non-deposition of sediments..."*. No ^{14}C dates for this period have been obtained from sediments in the northern Negev. Around 10.3 ka. a return to a wetter phase, although not as wet as in former Upper Pleistocene phases, took place (Magaritz and Goodfriend, 1987; Bar Yosef, 1990; Bar-Yosef and Meadow, 1995).

It was during this period that a trail of some refreshing water bodies appeared in the area, which may explain the considerable enrichment of the local biota. This trail of fresh- to semi-freshwater bodies could have been further enlarged, as argued by Bar Yosef (1990), during the wetter conditions that prevailed in the PPNA period, and dispersed from Fazael, the northern part of the Lower Jordan Valley, southward to Netiv Hagdud and Jericho area (Tchernov, 1994). This phenomenon goes far to explain the abundance of aquatic plants and animals in all the PPNA sites. This wetter phase could have lasted during the PPNA and the PPNB periods, greatly affecting the southern Levantine ecosystems, and explains the existence of Palearctic and Mediterranean elements in much lower latitudes within the present Sinai desert (Dayan *et al.*, 1986; Tchernov, 1981, 1982, 1994; Tchernov and Bar Yosef, 1982).

In their reconstruction of the vegetational belts according toh the palynological record for ca 10 ka, Bar-Yosef and Belfer-Cohen (1989) indicate that the Lower Jordan Valley and other sites in the Sinai and the Negev were well within the Mediterranean belt. Whatever the magnitude of the Younger Dryas in the southern Levant was, no real traces of it are reflected in the local flora (Baruch, *in verbis*) and fauna of the region.

It is indeed difficult to reconcile the claim for extremely dry conditions in these regions when the biotic evidences for all the PPNA sites show much the opposite, as does the existence of Harifian people (10.6-10.2 ka) in the central Negev (Gorring-Morris, 1987). The disagreement between Magaritz and Goodfriend's (1987) speculation concerning the existence of an arid phase, and the completely different

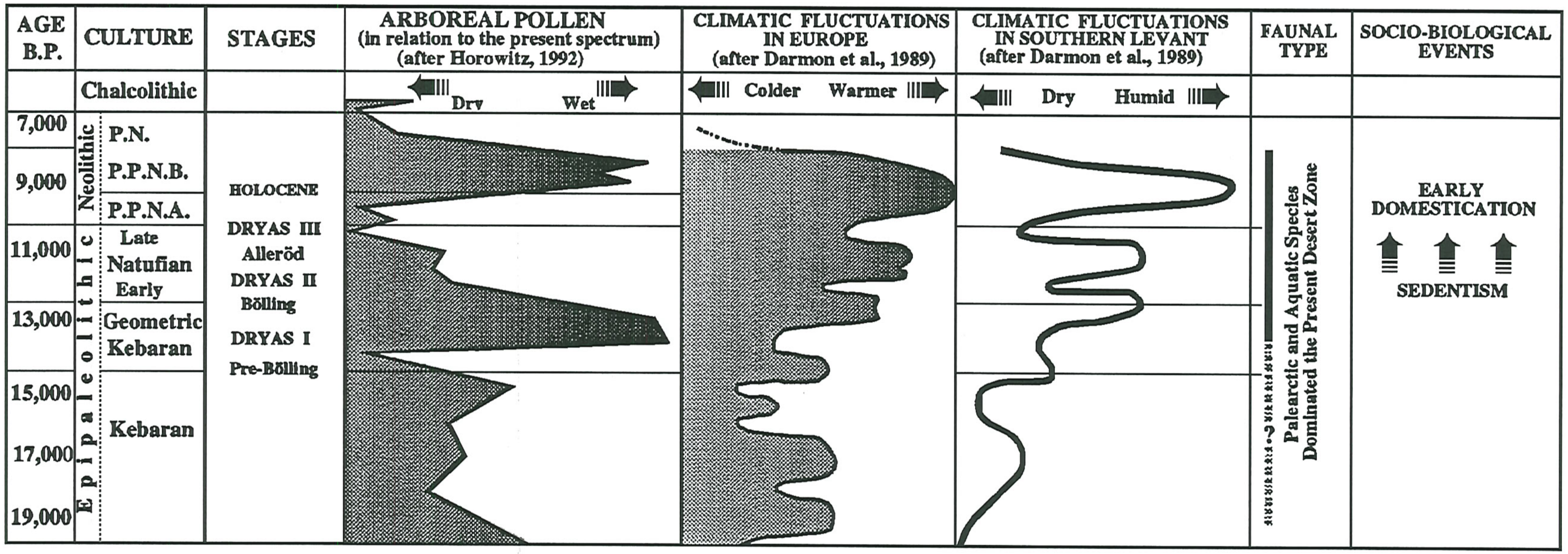

Figure 4. Climatic fluctuations in the southern Levant during the Epipaleolithic and Neolithic periods, correlated with the general European curve. The faunal assemblages of the southern Levant did not show any after-effect compared to the Younger Dryas, or other late Pleistocene climatic fluctuations. The linear process of sedentism to domestication developed s a self-generating process, independent from climatic changes.

picture shown by the species composition of the PPNA communities, may reside in the imprecision of dating the abiotic non-anthropogenic factors (sediment characteristics, dune movements, lake levels, as well as the discontinuous sedimentary record in the Negev) as conceded by Magaritz and Goodfriend (1987) themselves, compared to the much better dated anthropogenic sites and their deposits. The other possibility is that this 'dry episode' was not as dry as speculated by Magaritz and Goodfriend, or that the period does not exactly match coincide with the Khiamian - PPNA periods, but preceded them.

There could have been no depletion of resources during the late Natufian and early PPNA (=Younger Dryas) in the southern Levant, as argued by Bar-Yosef and Meadow (1995). As it is clearly shown by the biogeographical distribution of birds (Pichon, 1984, 1987, 1989, 1991) species with a present distribution of some 800-1000 km north of Israel, were resident in this area during the late Natufian (Mallaha and Mureybet). The existence of three species of *Apodemus* (Tchernov, 1979), the presence of typical Palearctic species in the PPNA of Netiv Hagdud (Tchernov, 1994) and Abu Madi I contra-indicate dry conditions in this region. Moreover, the carrying capacity of the semi-steppic Irano-Turanian phytogeographic regions may have been higher than Mediterranean forests; at least the herbivore biome (with herds of *Alcelaphus*, Gazelles, *Dama mesopotamica* (Fig. 3) and in particular medium size mammals, is much higher in open landscapes.

The recorded faunal assemblages of the later Natufian and the PPNA sites within the Lower Jordan Valley (Gilgal I, Salibiya IX and the PPNA layers of Jericho and Abu Madi I in the southern Sinai), revealed the existence of an ecosystem that is completely different from the present one. None of the recorded species of reptiles live any longer in the area, and represent a typical Mediterranean pattern of distribution, with preference for moist habitats. The distribution of most of them is limited by the minimum 300 mm isohyete. *Lacerta trilineata* (Lacertidae, Reptilia) and the eastern subspecies *Chameleo chameleon rectristrictus* (Chamelionidae, Reptilia) are wood dwellers, while the large legless lizard *Ophisaurus apodus* and the common tortoise *Testudo graeca* are limited mainly to Mediterranean *batha* and *garrigue* landscapes. The presence of *Rana ridibunda*, an obligatory aquatic frog, together with a large quantity of the freshwater crustacean *Potamon fluviatilis*, and the opisthobranch mollusc *Melanopsis praemorsa* (Tchernov, 1994);(Fig. 3), the faunule of fishes and the rich assemblage of aquatic birds, indubitably indicate that freshwater bodies were abundant during this period in the vicinity of the PPNA sites in the Lower Jordan Valley.

Similarly, the micromammal community underwent profound changes in their pattern of distribution. Out of the nine recorded species seven no longer exist in the region (Tchernov, 1994), and are found only within the Mediterranean belt. One became extinct in the southern Levant (*Arvicola terrestris*). *Paraechinus aethiopicus* (Erinaceidae) is rare in the Lower Jordan Valley, while two other species of hedgehogs (*Hemiechinus auritus* and *Erinacaeus europaeus*) withdrew from the region during the Holocene. Except for *Psammomys obesus* (Gerbillidae, Rodentia), all the recorded rodent species from Netiv Hagdud (Tchernov, 1994) are restricted at present to the Mediterranean belt, as is clearly exemplified by the present distribution of *Microtus guentheri* (Microtinae).

A few types of trees were mentioned by Kislev (in Bar-Yosef *et al*., 1991; Kislev, *et al*., 1986; Kislev and Bar-Yosef, 1988) which may support some of the Mediterranean faunal elements recorded from the region:*Amygdalus* sp., *Pistacia* sp., *Quercus calliprinos* and *Ficus carica*. To these forms we may add *Ceratonia siliqua*, *Fontanesia* and *Tamarix* spp. as known from the pollen record (Leroi-Gourhan and Darmon, 1987; Darmon, 1988; Darmon *et al*., 1989). Leroi-Gourhan and Darmon (1987) identified the following trees: *Quercus calliprinos*, *Fontanesia* (Oleaceae), *Ceratonia*, as well as representatives of aquatic Nympheaceae. In Salibiya IX, *Ficus carica* was also identified and in Netiv Hagdud (Bar-Yosef 1989; Bar-Yosef *et al*. 1991), the arboreal pollen amounts to 21% (Darmon, 1988, Darmon *et al*., 1989, Leroi-Gourhan and Darmon, 1987). Very similar to the vertebrate remains, all plant species belong to Mediterranean flora with dominating Oleaceae, while aquatic plants (Nympheaceae) notably increased.

The sharp and brief biotic impoverishment that took place after the PPNB, was mainly expressed by a considerable attenuation of the local communities that had remained within the swiftly desiccating belt, which was rapidly occupied by Eremian, mainly Arabian elements, (Tchernov, 1988), but the total diversity greatly declined and could have been caused by climatic change of catastrophic magnitude, or in some places, by anthopogenic causes as well.

B. Major Socio-Economical Events - Sedentism and Domestication

1. Different Models of Early Domestication

Very few human remains have been uncovered in the Levantine Upper Paleolithic: in Qafzeh; in Ksar 'Akil 17, in El Wad (McCown and Keith, 1939) and in Hayonim layer D, which included at least three individuals; and at Nahal Ein-Gev I (where a skeleton of a female was found);(Arensburg *et al.*, 1990). Morphometric parameters of Upper Paleolithic and Kebaran skeletons have shown a close similarity with the Natufian ones (Smith, 1991). Arensburg (1977:214) stated that *"...The metric and morphological characteristics of the Nahal Ein-Gev I skeleton are close enough to Proto-Mediterranean Natufians to enable the statement that no radical changes occurred in the anthropological composition of the area from the end of the Aurignacian to the beginning of the Neolithic. The Kebaran skeleton of Ein-Gev I may only reinforce this view.."*. Thus, if no population replacement took place during the Epipaleolithic and early Neolithic, we may assume that all the cultural transformations which took place in this region were *in situ*.

Horwitz (1993) has already pointed out that the PPNB is not and should not, be viewed as a single entity, either in terms of chronology, architecture or material culture. It should be borne in mind that as noted by Rollefson (1989) and Rollefson and Köhler-Rollefson (1989), the vertical and horizontal divisions for the PPNB probably fluctuated during the sequence. The temporal step by step development of the PPNB in each region in the Levant has not yet been defined, and hence the development of ovicaprine domestication cannot be clearly related to any specific site. A common problem one has to face when dealing with the fauna recovered from the PPNB sites, is the multiple phases of this period, which in many instances are published together as a single socio-economical unit. This is certainly an oversimplification of a complex reality. Subdividing this period is essential, because referring to a site as coming from the 'PPNB period' becomes non-informative (Horwitz, 1993).

The Natufian period was the brewing period of the PPNB. Sometime during the 2,000 years of this period active food production emerged, but it also sowed the seeds of the appearance of social, religious, and economic complexity that we can already observe toward the end of the PPNB. This is why it is of utmost importance to subdivide the PPNB into socio-economic cultural levels, mainly based on the existence or non-existence of domesticated animals. One of the central arguments concerning these periods is whether there was a cultural continuity from the Natufian to the PPNA. Despite the undeniable biological persistence of the same indigenous population, both culturally and economically, the PPNA marks a cultural change, but an autochthonous one (Bar-Yosef and Belfer-Cohen, 1989). Yet, the basic concepts and techniques of animal exploitation may possibly demonstrate an indigenous, unilinear continuity from the Natufian tradition (Henry 1989). It does seem plausible that there is a traditional cultural and practical continuum in the exploitation of biotic resources, which goes all the way from the early Natufian through the PPNB in the southern Levant. With only insignificant changes in animal exploitation during the PPNA, this tradition was still employed in the early phase of the early PPNB populations in those areas, where caprovid (whether domesticated or not) exploitation was still relatively low (Yiftahel, Abu Ghosh, Nahal Oren).

At the eve of the Pleistocene of the southern Levant, an irreversible transformation of small nomadic bands into sedentary social units took place, while acquiring new properties, such as labor division, intergroup identification, intensive harvesting of wild cereals and wide usage of storage facilities. This event came to full realization during the later part of the Epipaleolithic (or the Natufian period). The sedentary settlements of the Natufian communities developed out of the Epipaleolithic hunter-gatherer way of life with its ephemeral nature and high residential mobility. The abrupt replacement of many small Kebaran seasonal sites, which were scattered throughout the southern Levant into a few relatively large long-term sites, took place without traces of intermediate stages. This socio-economic transformation could have taken place either by the agglomeration of several sites into a large sedentary village, or through exclusion of part of the sites, and an increase in the others. This phenomenon is perhaps the most astonishing example of an increase in the level of complexity of social organization manifested by the human family, with an everlasting profound impact on all later stages of human evolution.

There were many attemps to simulate the impact of climatic changes on the Levantine cultural events. But obviously, the rapid shift from high mobility to sedentism in the transition from Geometric Kebaran to the Early Natufian cannot be directly linked, or related, to environmental factors. Climatic shifts, as harsh as they were, cannot explain a major change from one level of organization to a more complex one! Vice versa, it could cause collapse of complex structures.

According to Valla (1987, 1988) ^{14}C dates show that the most ancient period of the Natufian would be dated from 12,500 BP up to 11,000 BP; the recent phase would last up to about 10,500 BP, followed by the final phase up to about 10,200 BP. It seems that the extent of the Natufian territory increased in time, so that later Natufian sites are also known from marginal areas, and even within the desert belt (Henry, 1985, 1989; Bar-Yosef and Meadow, 1995). Yet, these peripheral sites were much smaller in size (Bar-Yosef and Belfer-Cohen 1989), and were probably inhabited by populations with a higher mobility pattern. Bar-Yosef and Meadow argued (1995:70) that *"...The impact of the Younger Dryas is attested by the abandonment of early Natufian sites and the establishment of late Natufian settlements often in new localities..."*. Abandonment (or collapse) of sites (human communities) during this period (as so often occurred in later periods; Lamberg-Karlowski, 1989) could have been the result of over-exploitation of resources (see Rollefson, 1989, 1992; Rollefson and Köhler-Rollefson, 1989 for Ain Ghazal), or other social causes, and not necessarily changes in climate. A prolonged occupation of a site by a group of people will cause an enormous drain on the vicinity areas, which ultimately will turn it into a barren land.An intensive exploitation of resources, killing-off of game, and spending more time just to maintain a constant level of food intake within the limited area available to the people, will utterly alter the natural habitats around sites (Tchernov, 1992).

There are various works that try and simulate the impact of climatic changes on the Levantine environment as well as various models offered as explanation for the cultural transitions, which led to the establishment of farming communities by about 10,000 BP. According to Bar-Yosef (1989), it was the onset of wetter conditions around 10,000 BP that enabled the well-established Natufian settlements within the Mediterranean phytogeographic belt to expand their knowledge as intensive users of wild cereals and successfully practice cultivation. Such an abrupt climatic change together with a period of social stress was suggested as a logical explanation for the 'decision' made by Geometric Kebarans to become sedentary, or considerably less mobile, than their predecessors. Bar-Yosef and Belfer-Cohen (1989, 1991) suggested that before shifting to sedentary life, hunter-gatherers needed to maintain their population size below the level of mean carrying capacity of the region *"...as monitored by the living memory of the band.... If they fail to do so, they must have moved to neighboring territories, and change their subsistence base, or die..."* It has very often been shown (Hassan, 1981; Yellen, 1977), that a direct relationship exists between the size of the site and the size of the group. On this basis Bar-Yosef (1987) and Bar-Yosef and Belfer-Cohen (1991) argued that the rapid and instantaneous population growth of the Natufians into a higher stage of socio-economic level was an event that took place within a relatively restricted geographical area. For Bar-Yosef and Meadow (1995) the abrupt *"..emergence of the Natufian from a population of hunter-gatherers was a threshold event that took place in the 'Levantine homeland', to be followed by another threshold event, namely, the establishment of early farming communities..."*. They argue, that such swift cultural changes could have been triggered by climatic shifts. As for the sudden appearance of sedentary societies in the Natufian period, the 'combined model' is based on other interrelated phenomena, such as abundance and predictability of plants, seeds, and animal resources, heavy demographic pressure. All these lead to the necessity for a territorial rearrangement with marked demarcation between the different groups. Bar-Yosef and Meadow (1995) claim that rapid environmental changes resulting from abrupt climatic shifts are seen as the triggers for cultural changes. They argue that the *"...behavior of the common local game (e.g., the "sedentism" of Gazella dorcas) and the predictability of vegetal resources within small territories of the coastal Levant encouraged greater sedentism, i.e., smaller exploitation territories and sites occupied for longer periods of time each year..."*. Also they claimed that demographic pressure being a relative measure can be invoked by noting that from ca 14,500 BP, *"...people occupied every ecozone within the Near East. Under conditions of subsistence stress, territorial rearrangements and shifts in settlement pattern were necessary..."* (p. 70). For Bar-Yosef and Meadow (1995:70), the emergence of farming communities is hence

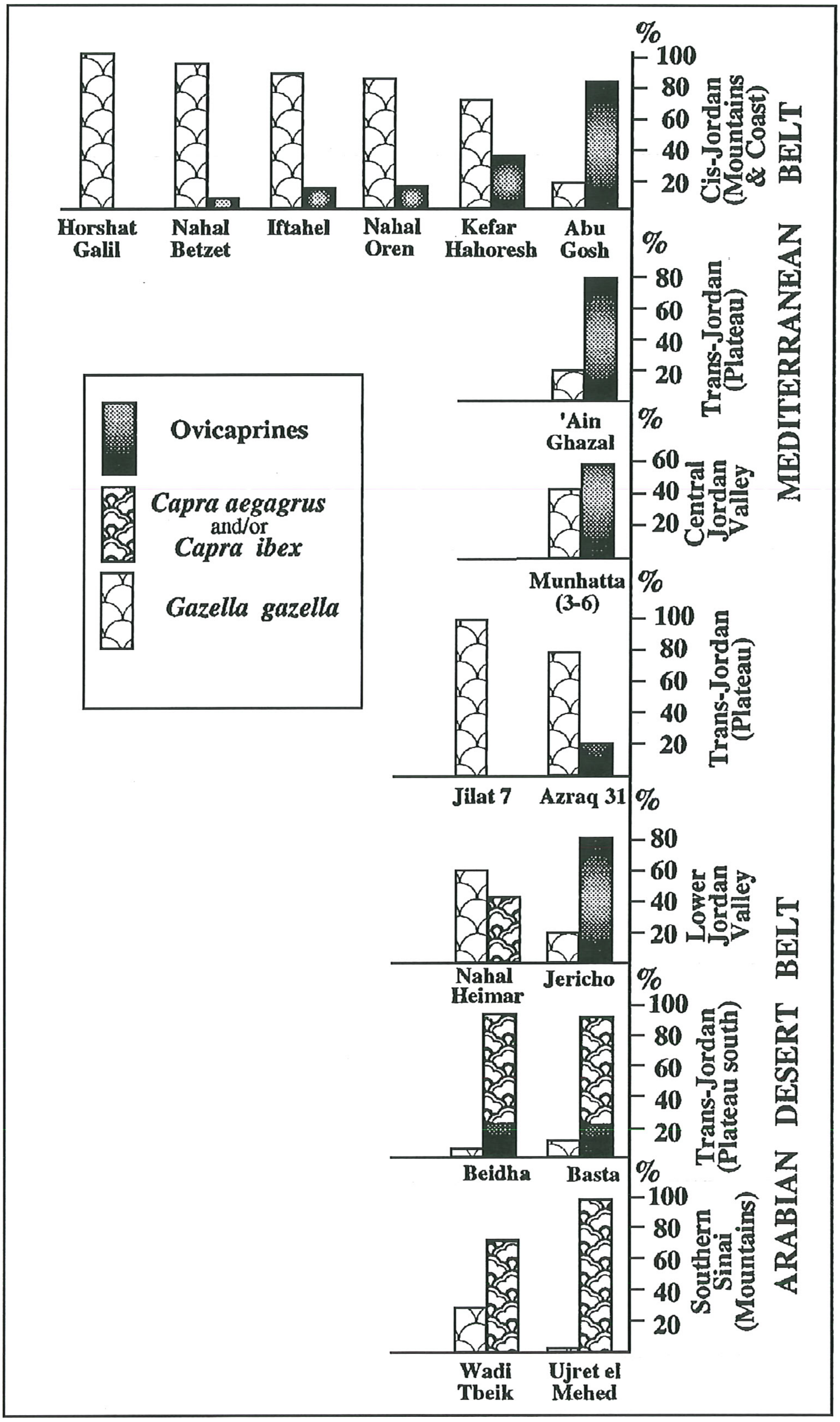

Figure 5. Relative representation of ovicaprines and gazelles at various PPNB sites from different climatic zones in the southern Levant.

seen as a socio-economic response to the forcing effects of the Younger Dryas on the Late Natufian in the Levantine Corridor. They postulate that the cold and dry Younger Dryas caused yields of natural cereal stands to decrease and, under the existing territorial restrictions, created the motivation for increasing intentional cultivation.

Another way to explain the sharp shift to higher levels of organization, or aggregation of a group of components to a higher (social) structure, which emerged with completely new properties, is through a swift fluctuation in the energy absorption of the late Geometric Kebaran people, which demanded at least an improvement in the environment rather than impoverishment.

The shift from ephemeral and/or seasonal occupation to a prolonged habitation of relatively large communities, had a far-reaching and profound impact on the proximate biotic environment. Such effects could have happened only under a long period of intensive occupation of a certain place, and not from recurrent usage of a site:

1. due to the need of a sedentary community to exploit its resources within a geographically limited area, its subsistence became evermore restricted, forcing the people to become more specialized in the way they exploited the environment, resulting in a broad spectral array of animal remains, including small-sized mammals, birds, reptiles, fishes, as well as large pulmonates ('broad spectrum exploitation'; Flannery, 1969, 1972).
2. Cultural control of wild populations of gazelles, is expressed by the highly selective culling of males, resulting in phenotypic deformation of body proportion and sizes, mainly towards a drastic disproportional allometric size diminution, and a highly skewed curve of the population structure (Cope, 1992; Horwitz *et al.*, 1990).
3. Appearance of commensal animals around and within Natufian habitations (Tchernov, 1984, 1991, 1992).

Following the chronological sequence of Ain Ghazal as outlined by Rollefson (1989) and Rollefson and Köhler- Rollefson (1989), a clear sequential pattern is obtained. In the Early PPNB sites, gazelle dominate the assemblages in extremely high frequencies, with concomitant low ovicaprine frequencies. In the Middle PPNB, one gets an increase in the frequency of ovicaprines, but with a wide range of intersite variability, while in the latest phase ('PPNC'), the ovicaprine frequencies are well over 70-80%.

The model proposed by Horwitz (1989) shows that the earliest Phase (Stage B1) is associated with intensive hunting. The late PPNB (Stage B2 in the model) is characterized by a population isolation phase, and the final phase, Stage C, marks the beginning of domestication. By the onset of the final PPNB, the ovicaprines already exhibit both metric and morphological features characteristic of domestic animals.

As a working hypothesis it may be argued that along the 'Levantine Corridor' (Bar-Yosef, 1989; Horwitz, 1989) the reliance on caprovids was more progressive than within the montane Mediterranean belt, or the coastal plains (Yiftahel, Munhatta, Abu Ghosh, Nahal Oren). If PPNB sites, which we try to compare, were not contemporaneous, those within the 'Corridor' could belong to the latest phase of the PPNB, where domestication was already practiced, while other PPNB sites outside the 'Corridor' may have been from earlier phases, when hunting was still the essential tradition. It is noteworthy that the "Corridor" sites (Ain Ghazal, Beidha and Jericho) have the highest frequencies of ovicaprines. However, if PPNB sites outside the 'Corridor' belong to Stage A, there is no unequivocal support for this hypothesis. Also, the middle PPNB sites lie outside this ''Corridor' and do contain large ovicaprine remains (Ujret-el-Mehed and Wadi Tbeik in southern Sinai; Dayan *et al.*, 1986; Tchernov and Bar-Yosef, 1982), yet these caprines have not all been assessed as morphometrically domestic (Horwitz, 1989). The large differences in the exploitation of caprovids may have also been due to the critical attrition of the gazelle populations along the Jordan Valley, compelling people to rely on the more difficult hunting of *Capra* to compensate for the growing scarcity of gazelles (Rollefson, 1989, 1992). A complete reliance on hunting of wild (small and large) game during the PPNB is well-known from the desert areas of southern Sinai such as Wadi Tbeik and 'Ujret el Mehed (Dayan *et al.*, 1986; Tchernov and Bar-Yosef, 1982). During this period these regions were still much more mesic and allowed intensive hunting. The increase in the relative frequency of *Capra* vs. *Gazella* during the PPNB is obvious. Yet, there is no convincing anatomical evidence that these goats were already domesticated anywhere in the southern Levant during the PPNB (Fig. 5). On the contrary, it seems that they were mostly wild. However, if we will be able to follow the fine stages we may find out that there was an obvious shift during the PPNB, particularly along the Jordan Valley or the 'Corridor', from extensive gazelle hunting to sometimes an exclusive reliance on goat. The reason for such a acute shift of preference from *Gazella* to *Capra* could also have been a direct consequence of an 'overkill' of gazelles during the PPNA and the beginning of the PPNB due to prolonged sedentism. Legge (1969) pointed out, that most PPNB sites south of Syria (Beidha, Basta, Ain Ghazal, Azraq) contained *Capra* only. Sensu Legge (ibid.), most of these sites seem to be from later phases in the PPNB. He claims (1966:259) that *"... the absence of sheep... suggest that their origin as domesticates lay to the north or east..."*.

The final phase of the PPNB coincides with an increased severity in the environment in the southern Levant, and could have been the main cause of the large scale abandonment of most of the southern Levantine PNA sites. In peripheral regions like Ain Ghazal the ecological impact of both plant and animal domestication that continued ,was facilitated by herding the caprines in regions far away from the sites (such as in the steppe/desert areas), as well as by technological changes in agriculture (Rollefson, 1989, 1992 and Rollefson and Köhler-Rollefson, 1989). The presence of domestic animals, enabled Neolithic populations to use more favorable areas (Rollefson, 1992), or to take up a nomadic/semi-nomadic life style. Exceptions would have been sites situated in areas adjacent to perennial water sources, those situated in fertile regions.

Goat and sheep have made up most of the hunted game in the Zagros mountains since Mousterian times (Uerpmann, 1987, 1989). There is ample evidence to indicate that the domestication of these herd mammals took place during the Early Neolithic period in the Zagros region and perhaps in the eastern Taurus. The exchange networks which enabled the incorporation of domesticated cereals into the Zagros economy may have been responsible for the introduction of goat and sheep into the Levant. Thus, the shift in the faunal spectra is reflected at PPNB sites which in the southern Levant are located within the 'Corridor' which runs from the Damascus basin through the Jordan Valley. It is only in later times that both the western hilly slopes of Cis- and Trans-Jordan and their desert fringes acquired domesticated species. According to Garrard *et al.* (1996:220) *"...there is no evidence from Jordan and elsewhere in the Levant to support models that propose that plant and animal domestication first developed in the Marginal Zone..."*

Contrasted to the diffusion model is the idea of *in situ* domestication. Intentional manipulation of wild populations in the PPNB as shown at several southern Levantine sites within the Arabian desert belt. In Beidha (Hecker, 1975, 1982), in 'Ujrat el Mehed (Dayan *et al.*, 1986) and in Wadi Tbeik (Tchernov and Bar-Yosef, 1982). In all these cases, human intervention in the population structure mainly through sex selective culling was carried out on *Capra* (Fig. 5). The idea of differential culling was already practiced by the Natufians, and hence could have been transmitted traditionally through the local PPNA populations. Our difficulty rests in the unfortunate situation that there are too few PPNA sites with large enough samples of ungulates to allow detailed studies of this period in this region. Garrard *et al.* (1996) argued that there was a time lapse between the earliest appearance of crop cultivars and domestic livestock in the 'Levantine Corridor' and the arid zone. Our present limited knowledge of these periods in the southern Levant allows us only to say that autochtonous domestication has not yet been properly demonstrated in the region of the Jordan Valley during the PPNB, nor is it even possible to say that caprovids were indeed morphogenetically domesticated. The inhabitants of the desert regions of the southern Levant did not appear to have either practiced or adapted animal domestication until a much later (Pottery Neolithic, or even Chalcolithic) period.

2. Domestication: A self organization process or environmental aftermath

Blumler (1996: 28) has already stressed that *"...climatic change occurs at all time scales, can be very rapid, and was particularly dramatic across the Pleistocene/Holocene boundary..."*, that is coinciding with the transition to agriculture. Quite a few scholars have related, although to different extent, cultural transformation, such as domestication, to climatic events (Bar-Yosef, 1991; Bar- Yosef and Belfer-

Cohen, 1991; Henry, 1989; Hillman, 1996; Sherratt, 1996; McCorriston and Hole, 1991; Moore and Hillman, 1992). Bar-Yosef and Kra argued (1994:8) that *"...Ample evidence implies that environmental deterioration and resource depletion began with the establishment of farming communities. However, this was not a linear trend..."*. Bar-Yosef's (1990) argument that the onset of the wetter conditions around 10.3-10 ka, following the 11th millennium later Natufian drier period, related to the 'Younger Dryas', is relevant, as it was significant enough to trigger an expansion and establishment of the early Neolithic settlements, with their successful practice of hunting, technology, herd culling and cultivation in areas that are at present within the arid belt.

That the origin of agriculture was tied directly to increased sedentism was emphasized by Harris (1977a). But for him sedentism developed gradually, and the 'broad spectrum' economy triggered an uncontrollable increase in population that consequently exerted pressure on the ever-shrinking resources. This process inevitably led to increasingly specialized exploitation of pro-agricultural resources.

For Reed and Perkins (1984) the origin of agriculture and domestication should be regarded as a part of evolution of behavior, with emphasis on the increasing use of energy by different living groups of organisms. For them domesticated animals are an example of cultural symbiosis, with each partner being a secondary energy-trap for the other. Such symbiotic relationships must have developed during a long period to allow the development of such (or any) biological interspecific relationships. The 'incubation' period from early sedentism to incipient domestication could have allowed the development of this kind of symbiosis. Reed and Perkins (1984) accepted the idea that sedentism caused an increase in population which led to over-hunting, reduction in meat resources and domestication. Yet they (ibid.) agreed that the behavioral shift from hunting to herding is not clear.

For Köhler-Rollefson *et al.* (1988) and Köhler-Rollefson and Rollefson (1990) the domestication of goat, of all other potential animals, might have seemed like an ideal answer to the growing scarcity of faunal resources, but while their availability undoubtedly contributed to human population growth, their rising numbers exerted strains on the environment.

For Rindos (1984) there was an early encouragement for consumption of low valued resources; a process that occurred *"...before domesticates had began to make any substantial contribution to the diet.."*. Yet again it should be emphasized that the first domesticates appeared more than 2,000 years after the abrupt shift to a broad spectrum dietary logistic. Rindos (1984), however, agrees that the development of sedentism and agroecology are directly connected with domestication. The question is why such a long period elapsed between the time the earliest sedentism of the Natufians which emerged in a limited region of the southern Levant and the appearance elsewhere of the earliest domesticates much later (northern Mesopotamia).

Cauvin (1989) pointed out that it is the lengthy sociological and cultural maturation which emerged within the Natufian domain of sedentism that led man to food production. Neolithisation for Cauvin (1989) appears as a progressive and overall transformation, in which the food production is more the consequence of a cultural and mental change than the true cause of other changes.

The idea that the Natufians may have been the earliest farmers was suggested by Garrod in 1932 and, in spite of later criticism, was revived by others and supported by the experimental studies on sickle blades (Unger-Hamilton, 1991). Other researchers have also argued that incipient agriculture may have first occurred even as early as the late Natufian (Cauvin, 1977, 1987; Moore, 1989). To date there is no substantial evidence for incipient cultivation of cereals during the Natufian, which can be due to scarcity of plant material preservation (Bar-Yosef and Meadow, 1995), but it must be acknowledged that traces of plant-husbandry would be difficult to verify (Hillman *et al.*, 1989). Unger-Hamilton (1989, 1991) has argued, that the evidence for harvesting of cereals grown in loose soil, suggests that some cultivation of cereals could have been practiced in the Natufian (see, however, Anderson, 1991; Bar-Yosef and Meadow, 1995). In any case, the Natufian and PPNA periods can be regarded as an incubation period for the beginning of food production. Systematic cultivation, however, would have rapidly resulted in the domestication of wheat and barley (Hillman and Davies, 1992a,b). However, even in the Early Neolithic (=PPNA), the state of domestication of cereals is still debated.

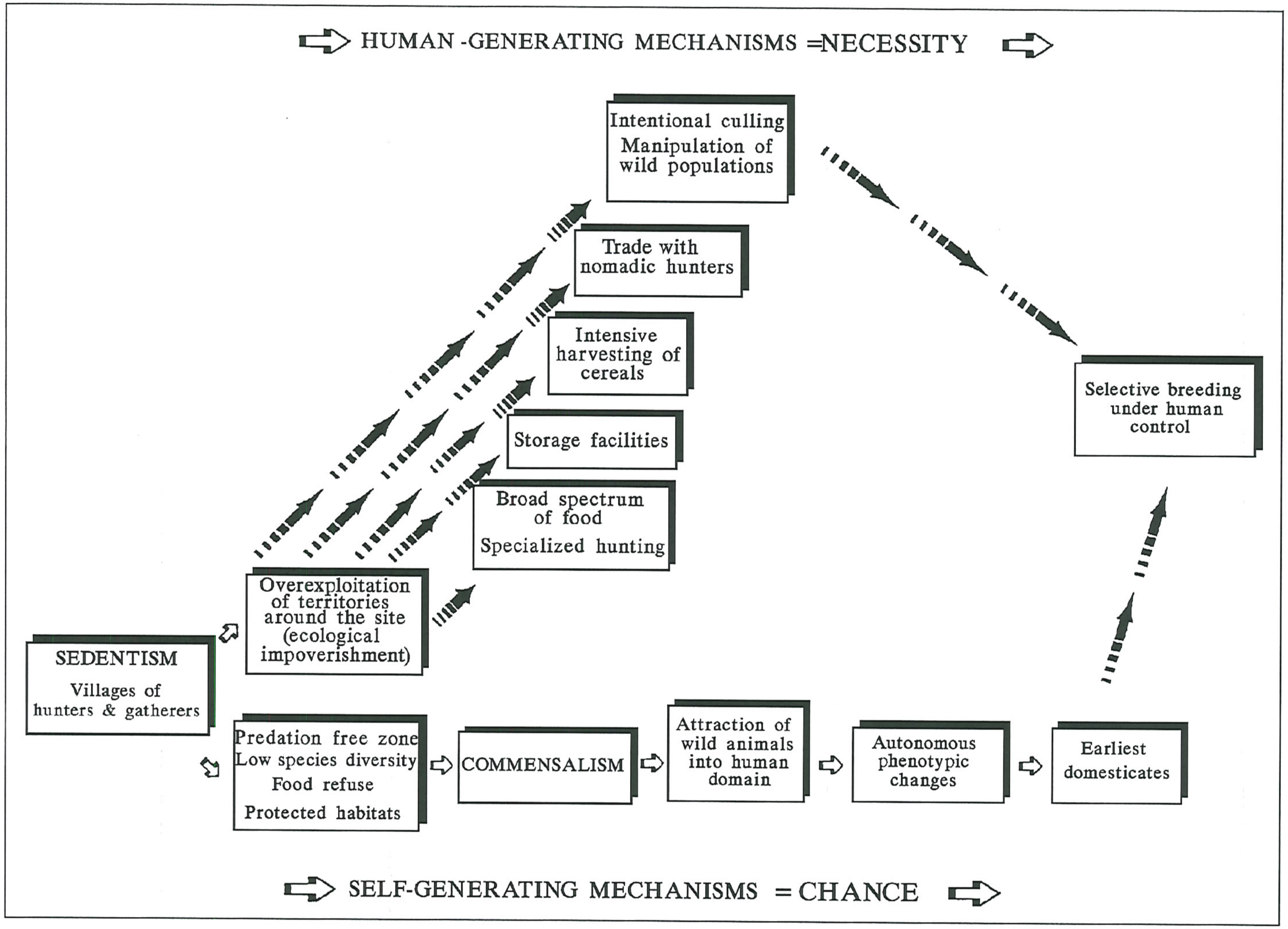

Figure 6. The appearance of domestication was initiated as a self-generating process due to new selection pressures on the quasi-isolated populations around anthropogenic habitats. A parallel, multi-stage process leading to domestication simultaneously developed, ending up with intentional culling and selective breeding.

After hundreds of millennia of Pleistocene hominid evolution, small groups of hunters and gatherers, ephemeral in nature and with high residential mobility, suddenly gave rise in the Mediterranean belt of the southern Levant to larger, functionally interdependent groups, hierarchically organized along economic and social lines. This phenomenon is perhaps the most astonishing example of an increase in the level of complexity of social organization manifested by the human family. No wonder that sedentism had a profound impact on later stages of human evolution. During this swift transition between the latest Geometric Kebaran to the earliest Natufian we do not witness any significant climatic change in this region.

During the late Kebaran (Bar-Yosef and Belfer-Cohen, 1989; Byrd, 1989) there was no way for expansion, dispersal or immigration, as the number of settlements and the distribution density of occupational sites was too high to permit any population movement. Any attempt to overcome resource shortages by migration would be doomed to failure, as territoriality and competition with all the other communities around would have prevented any violation of their territorial range and any attempt at dispersal. Territorial behavior practices by various groups is inferred from the spatial distribution of the sites and the stylistic differences in their lithic assemblages (Hovers *et al.*, 1988). We do not have any evidence that the abrupt sedentism of the Natufians and the punctuational increase in their socio-economic status was indeed the outcome of the agglomeration of small settlements into larger ones, or occurred through the extinction of many small settlements and an *in situ* growth of a few small settlements into much larger societies.

There were many that tried to simulate the impact of climatic changes on the Levantine cultural events. Obviously however, the rapid shift from high mobility to sedentism in the transition from Geometric Kebaran to the Early Natufian cannot be directly linked, or related, to environmental factors. Climatic shifts, as harsh as they were, cannot explain such a major and sharp change from one level of organization to a more complex one.

Tchernov (1992) has argued, that sedentism originated abruptly through a marked shift which cannot yet be explained either by biological or anthropological approaches. It is the high level of social organization, the creation of social hierarchy and economical stratification, that mentally prepared and economically led a sedentary society toward food production. It is the new and far more complex and sophisticated pattern of interaction of humans with the environment that enabled the newly emerged sedentary populations to cope more efficiently with the biotic world, as well as with the elements through a new mental insight into the world around them.

A fluctuation in a societal complex that brings it far from thermodynamic equilibrium and, following Prigogine's theorem (1961, 1978; Prigogine *et al.*, 1972) of minimum entropy production, will reach a point beyond a critical threshold where more stable choices are available. Any choice that a socio-system shifts into, will be more stable than the former stage, and hence will stay there. In the situation that can arise when the societal equilibrium becomes unstable enough to bring it to the bifurcation point of higher stability, this can simply be expressed by an increase in the number of individuals, as well as the input/output of energy. Yet cultural and biological adaptations to new environments, or selection for higher fitness, both in its biological and cultural meanings, is a constantly ongoing gradual process, always within a certain level of organization. However, a transitional event to a higher level of organization (biosocialization) is not an outcome of Darwinian selection forces, and it does not take place through adaptive equilibria within a given level of organization, but through a marked self-organization process into a higher level. Climatic changes have nothing to do with it. Hence, another way to explain the punctuational shift to a higher level of organization, or aggregation of a group of components to a higher (social) structure, which emerged with completely newproperties, is through a swift fluctuation in the energy absorption of the late Geometric Kebaran people, which demands at least an improvement in the environment rather than its degradation.

I argue that the emergence of a true sedentary society with a high level of social organization, economic stratification, and division of labor, triggered, like an autonomous chain reaction, a series of events that ended up in food production. What actually happened when a close and long-term natural association developed between humans and wild animals, is a sequence of changes in the phenotypes of wild species caught within the special quasi-isolated anthropogenic habitats in response to some special selective pressures. The changes and their consequences that occurred in a wild population under persistent anthropogenic conditions, took place with a minimum intervention by people. This natural selection will be sufficient to eventually unconsciously bring about a domesticated breed (Fig. 6). The essential idea of this figure is, that the phenotypic changes observed in primeval domesticates, were initially due to spontaneous responses of the animals to the special anthropogenic habitats. No rational decision was involved in this process in its initial stages.

The shift in the ecology of some wild populations seems to be enough to considerably affect the fitness of several major adaptations vital in the wild, and to automatically initiate selection for numerous new traits which characterize the domestic caprines (Uerpmann, 1996). Unconscious selection has been largely responsible for molding the morphology, behavior and physiology of sheep and goat under domestication (Fig. 6). Several adaptations, vital for survival in the wild, lost their fitness under the new conditions and broke down. New traits (which characterize domestic caprines) were unconsciously and promptly selected for. Protection from predators, culling of young males, protection from the elements, and changes in land utilization and in food and water supplies, are considered the main ecological factors introduced by man at the start of caprine domestication. This was even more so at the beginning, i.e. soon after the founder herds were assembled and controlled by humans (Fig. 6). In this respect caprine domestication seems to resemble closely the mode of domestication already proposed for the principal cultivated cereals of the Near East (Hillman and Davies, 1992a,b; Zohary and Hopf, 1993: 16-18). Indeed, the consequences of the introduction of culling of young males and the breakdown of the α-male mating system in the caprines is no less spectacular than the outcome of the introduction of tilling, sowing and reaping and the breakdown of the wild-type mode of seed dispersal in wheat and barley.

Even during the period when domestication was already under way, the earliest agriculturists never had preconceived ideas on the end products they wished to attain through intentional selection. Rather, morphogenetic changes associated with domestication were essentially the result of unconscious or indirect selection by humans, and appeared as a natural by-product of induced environmental conditions created during a long period of sedentism.

Rational decisions concerning how to improve the end product; intentional sought to improve cultivation and manipulation of domesticates, preconceived selective breeding under human control, are all a secondary later stage in food production. A long 'incubation' period was mentally, socially and economically obligatory in order to reach the point of intentional management of wild populations of just the right species. Figure 6 is an attempt to summarize the idea that the emergence of domesticated animals (and plants) is essentially a consequence of an evolutionary process, which appeared by chance. Intentional manipulation of animals (whether already domesticated or wild) emerged only later on, after a long period of sociocultural maturation. By then, food production was the product of a profound mental change in human beings; a strict matter of necessity.

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