

## **Rodent faunas, chronostratigraphy and paleobiogeography of the southern Levant during the Quaternary**

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**Abstract.** Due to its geographical location the southern Levantine region has been intermittently used as a land bridge between Eurasia and Africa. The kaleidoscopic admixture of Palaearctic, Palaeotropic and Saharo-Arabian elements in the Levant during the Quaternary is primarily the product of Afro-Eurasian biotic interchanges resulting from the drawing up of the northern edge of the Afro-Arabian continent against the margin of the Eurasian continental body by subduction along the present Anatolian-Iranian tectonic suture line. With the ever increasing aridity during the Quaternary, the southern Levant became sufficiently isolated to hamper gene flow with other regions, and while undergoing provincialization endemism was encouraged. Therefore, intrusion of new elements into this region should be associated with major geological and climatological fluctuations. Minor environmental changes would not have been effective enough to thrust organisms either over the northern Levantine mountain chain or across the arid zones. Apart from the known microfaunal assemblages, the geochronologies of many of the bone bearing sites and cultural sequences concerned and evidence from sea level fluctuations along the Mediterranean coast, there are at present more radiometric dates available for some of the problematic assemblages. Combining these dates with the known bio- and chronostratigraphies enable us to suggest a somewhat more complete reconstruction of the Levantine Pleistocene faunal sequence, and correlate it with the main events in Eurasia and Africa. The faunal spectra of micromammals were used to build up a sequence in which the most important bone-bearing beds are ordered according to faunal events. It also enables a better understanding of the paleoecological conditions that prevailed in this region.

**Key words:** Ubeidiya, Erq-el-Ahmar, Evron, Latamne, Gesher-Benot-Yaakov, Qafzeh, Hayonim, Kebara, southern Levant, African-Eurasian biotic exchange.

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### **I. INTRODUCTION**

The Alpine orogeny in the northern Levant is mainly due to the docking of the north-west edge of the Afro-Arabian crustal plate along the present Anatolian-Iranian suture line. This event not only established a connection between Africa and Eurasia and thus triggered Afro-Eurasian biotic exchanges, but is also responsible for the constant elevation of the Zagros-Taurus mountain chain, which eventually became a severe barrier between Palaearctica and southeast Asia (TCHERNOV 1988). The extensive tectonics of the Arabian plate are the main cause of the fragmentation of the southern Levantine region into smaller units, which constantly modified the internal biotic configuration of the region. Thus, free biotic connections with the northern Palaearctic were

hampered by the Taurus-Zagros orogeny, while severe disjunction with the African continent took place by the widening of the Red Sea and the break up of the Bab-el-Mandab Afro-Arabian landbridge already in the late Neogene. The development of the Saharo-Arabian desert belt set a new frontier between Palaearctica and Palaetropica. It is thus obvious that the southern Levant virtually became a peninsular-like regime intermittently isolated from Africa and Europe during the late Pliocene and Quaternary (AZZAROLI & GUAZZONE 1979/80; AZZAROLI et al. 1982; TCHERNOV 1991). Thus, the establishment and obliteration of barriers occasionally shut and opened the southern Levantine gates for northern (European), eastern (Asiatic) and southern (Afro-Arabian; including hominids) invasions.

## II. EARLY PLEISTOCENE SITES

The advent of the Levantine Pleistocene is distinguished by a combination of simultaneous events, two of which, severe climatic fluctuations and eustatic sea-level changes, are part of a global phenomenon. An endemic event is distinguished during the Plio-Pleistocene transition by tectonism, mainly faulting and upwarping that molded the contemporary topographic, climatic and biotic configuration of southwest Asia. The onset of the Pleistocene finds the southern Levant already divided into several morphotectonic domains. Later tectonic and climatic events, however, continued to play an important role in reshaping the area, causing constant changes in the dispersal behaviour of plant and animal groups, sometimes affecting the rate of biotic turnover (TCHERNOV 1984) and extinction, but always within an already well established biogeographic framework.

### The Site of Ubeidiya

Early Pleistocene faunal communities are extremely rare in the southern Levant. An exception is the rich fossiliferous beds of 'Ubeidiya Formation in the Jordan Valley (Figs 1, 2). Ubeidiya predates the Yarmouk Basalt, which has been K/Ar dated to  $0.79 \pm 0.17$  myr (MOR & STEINITZ 1985). It was deposited after the Erq el-Ahmar Formation, as was demonstrated by the molluscan assemblages (SCHÜTT & ORTAL 1993; TCHERNOV 1973, 1975, 1988). The Erq el-Ahmar Formation comprises lacustrine and fluvial deposits accumulated within the central Jordan Valley immediately after the major tectonic activity (Fig. 3) that shaped the Jordan Rift Valley, dated to  $3.11 \pm 0.18$  myr (MOR & STEINITZ 1982). Thus, Plio-Pleistocene lithographic and geophysical sequential events in the central Jordan Valley set minimum and maximum age limits on the Ubeidiya Formation, which lies within the Matuyama reversed polarity epoch.

The mammalian community of 'Ubeidiya consists of 45 genera (excluding Chiroptera) originating from many different biogeographical provinces (Table I). This community shows the strongest affinity and best correlation with the lower Biharian of Europe, being somewhat younger than the 1.7 m.y. of Sèneze (France) (following OPDYKE et al. 1983), and well within the Tamanian Faunal Complex (Russia), which is dated to the Jaramillo (about 0.9 my) (TCHERNOV 1986, 1988), An-Hanech (North-Africa), and Olduvai Upper Bed II (East Africa). The rich lithic assemblage of 'Ubeidiya demonstrates the closest affinity with Olduvai Upper Bed II (BAR-YOSEF & GOREN 1993). Considering the geological minimum-maximum limit, the biochronological agreement with well-dated fossil communities in Eurasia and East Africa and the striking similarity of its lithic industry with Olduvai Upper Bed II, 'Ubeidiya can be dated to 1.4 m.y. (Fig. 3) (TCHERNOV 1988; TCHERNOV et al. 1994).

Due to the increasing aridity of the Saharan belt, the biogeographical connections between North Africa and the Levant were limited throughout the rest of the Pleistocene; faunal exchanges occurred at a very slow pace and very selectively. Elements that did cross this "Rubicon" in the Early Pleistocene were, for instance, *Equus cf. tabeti*, *Mus macedonicus* and *Macaca sylvana*. The *Paraethomys* lineage, which survived the entire Maghreb Pleistocene, and other long-lasting North

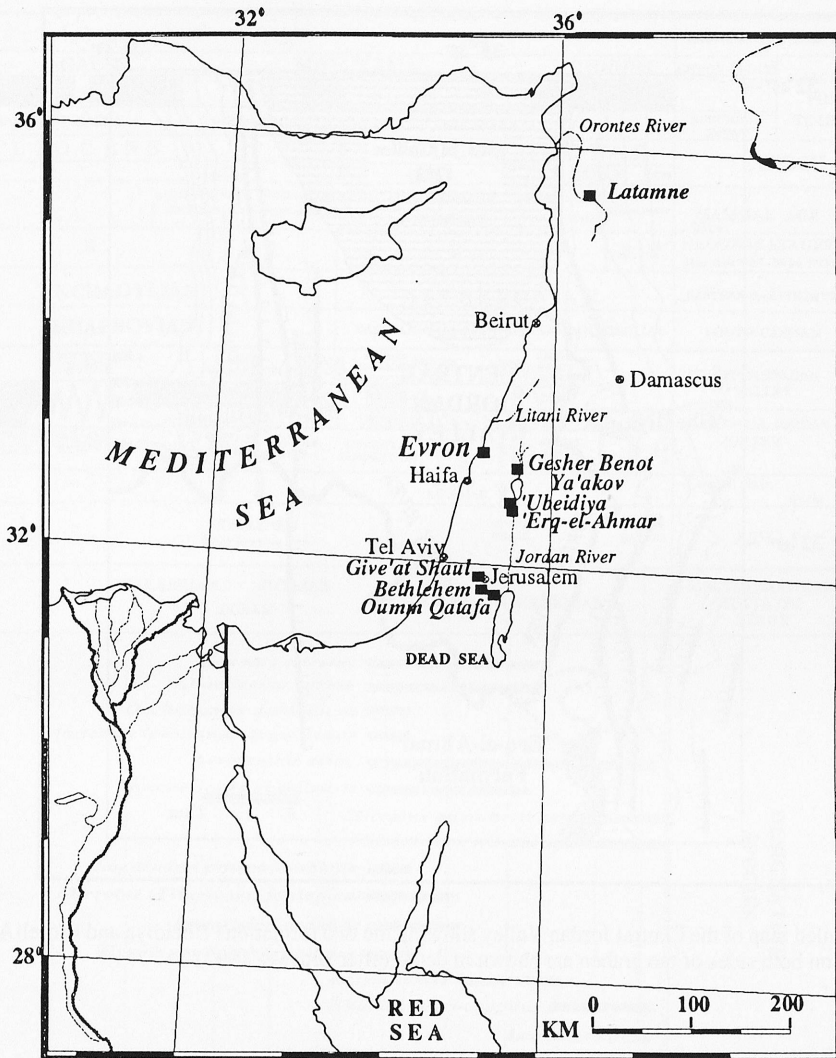


Fig. 1. Map of the southern Levant showing Lower Palaeolithic sites in this region (closed rectangles). Givat Shaul is not mentioned in the text, but see TCHERNOV (1988).

African rodents, have never invaded the Levant. On the other hand, species of Asiatic origin such as *Ellobius fuscicapillus*, *Eliomys quercinus*, and, later on, *Spalax ehrenbergi* and *Microtus guentheri*, dispersed into the North Africa only much later in the Pleistocene. Many other eastern Mediterranean species, even those with a very wide Holarctic distribution (like *Canis lupus*) found it difficult to introduce themselves on the African terrain.

With regard to rodents and lagomorphs the list of species (Table I) indicates that the great majority are endemic to the southern Levant. The genus *Paramerion* and the subgenus *Tibericola* (KOENIGSWALD et al. 1992) exemplify the extent to which endemism occurred in this region. Seven species of rodents are endemic (Table I), as well as a few species of large mammals like *Hippopotamus behemoth* (FAURE 1986), *Gazella gazella* and *Kolpochoerus evronensis* (GERAADS 1986). The unusual amount of endemism within this small province indicates that speciation took

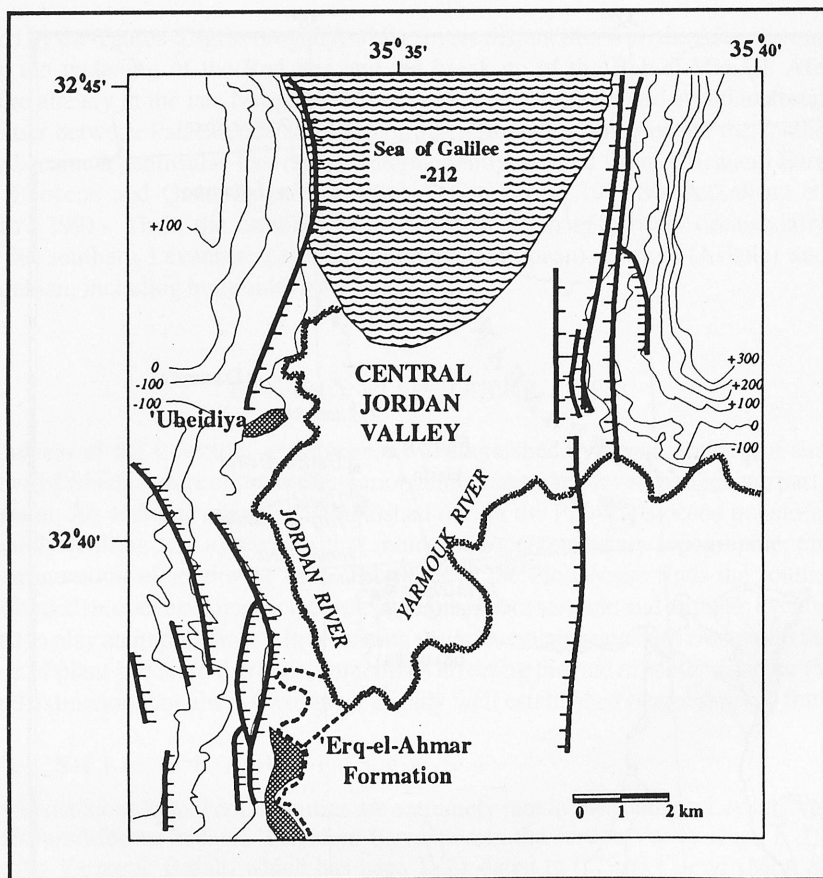


Fig. 2. A detailed map of the Central Jordan Valley showing the two formations Ubeidiya and Erq-el-Ahmar. The faults on both sides of the graben are shown in detail (after BROWN, 1992).

place more or less in situ. Hence, the direct ancestors of the local species should have arrived earlier than the Ubeidiya period. The exchange of elements between the Levant and other regions (Africa, Eurasia) took place before the deposition of Ubeidiya, and the whole region became biogeographically virtually isolated already during the Early Pleistocene. Only a few of the species continued into later Early Pleistocene periods (*Paramerion*, *Tibericola*, *Lagurodon arankae*). Most of the other species either disappeared or continued to speciate in situ (*Mastomys*) (Table II).

### The 'Erq-el-Ahmar Formation

Following the formation of the Dead Sea transform, its central portion became occupied by freshwater lakes. The earliest lacustrine deposits in the central Jordan Valley are those of the 'Erq-el-Ahmar Formation. The type locality of this formation is 10 km south of lake Kinnereth (Figs 1, 2). The deposits of the type locality unconformably overlie the Cover Basalt (HOROWITZ 1979) and are overlain in sharp unconformity by the horizontal Lisan Formation of Würmian age (BEGIN et al. 1980). In other places it may be overlain by the Naharayim and Gesher Benot Ya'akov Formations (Fig. 3). Some layers are rich in molluscs and plant and fish remains are also abundant (TCHERNOV 1975). Assuming that the whole formation is overlain by the better known 'Ubeidiya



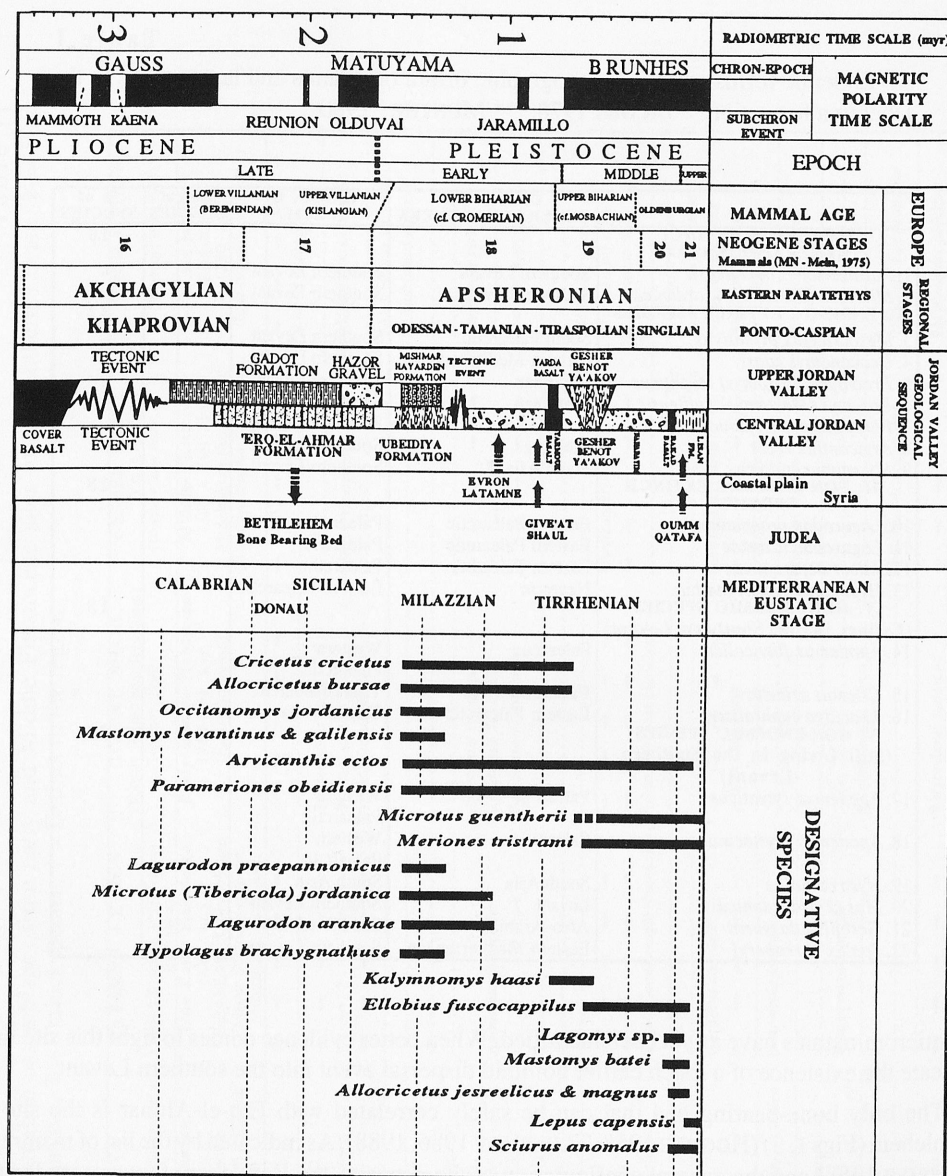


Fig. 3. The main Lower and Middle Palaeolithic sites and geological events along the Mediterranean coastal plain, Dead Sea Rift and Judean mountains, indicating the main chronological position of the late Neogene – Early Pleistocene formations and their correlations.

Formation (TCHERNOV 1986; TCHERNOV & GUERIN 1986; TCHERNOV et al. 1994), the sequence was correlated with the absolute polarity time scale (BROWN 1992). VEROSUB & TCHERNOV (1991) suggested that the upper section of normal polarity either correlates with the Olduvai subchron, or with the upper Reunion subchron (Figs 3, 4). The time separating them is short in either case.

A few artifacts have come to light in the Erq-el-Ahmar Formation. Some of these are in association with large mammals, but mainly with freshwater molluscs (SCHÜTT & ORTAL 1993).

Table I

Endemic forms and the biogeographic origin of rodents and lagomorphs in the Ubeidiya formation. \* JACOBS 1978. \*\* MUNTHE 1980

	ORIGIN OF GENERA/SUBGENERA	ORIGIN OF SPECIES	No. of SPECIES	% of SPECIES
<b>I. ENDEMIC EXTINCT GENERA/SUBGENERA</b>			<b>2</b>	<b>10</b>
1. <i>Parameriones obeidiensis</i>	Southern Levant	Southern Levant		
2. <i>Microtus (Tibericola) jordanica</i>	Southern Levant	Southern Levant		
<b>II. ENDEMIC EXTINCT SPECIES</b>			<b>7</b>	<b>32</b>
3. <i>Mesocricetus primitivus</i>	South Palearctic	Southern Levant		
4. <i>Occitanomys haasi</i>	Circum-Mediterranean	Southern Levant		
5. <i>Praomys (Mastomys) levantinus</i>	Ethiopian	Southern Levant		
6. <i>Praomys (Mastomys) galilensis</i>	Ethiopian	Southern Levant		
7. <i>Parapodemus jordanicus</i>	South Asia*	Southern Levant		
8. <i>Arvicanthis ectos</i>	Ethiopia	Southern Levant		
9. <i>Myomimus judaicus</i>	South Asia**	Southern Levant		
<b>III. NON-ENDEMIC EXTINCT SPECIES</b>			<b>4</b>	<b>18</b>
10. <i>Lagurodon praepannonicus</i>	Eastern Palearctic	Palearctic		
11. <i>Lagurodon arankae</i>	Eastern Palearctic	Palearctic		
12. <i>Allocrietus bursae</i>	Eastern Palearctic	Palearctic		
13. <i>Hypolagus brachygnathus</i>	Nearctic	Eastern Palearctic		
<b>IV. NON-ENDEMIC SPECIES (Extinct in the Southern Levant)</b>			<b>3</b>	<b>13</b>
14. <i>Apodemus flavicollis</i>	Palearctic	Western Palearctic		
15. <i>Cricetus cricetus</i>	Palearctic	Trans-Palearctic		
16. <i>Allactaga euphratica</i>	Eastern Palearctic	Central Asia		
<b>V. NON-ENDEMIC SPECIES (Still Living in the Southern Levant)</b>			<b>6</b>	<b>27</b>
17. <i>Apodemus sylvaticus</i>	Palearctic	Western Palearctic		
18. <i>Apodemus mystacinus</i>	Palearctic	Western Palearctic		
19. <i>Hystrix indica</i>	South Asia	South Asia		
20. <i>Mus cf. macedonicus</i>	Levant	Southern Levant		
21. <i>Gerbillus dasyurus</i>	Afro-Arabian	Saudi-Arabia		
22. <i>Spalax ehrenbergi</i>	Eastern Mediterranean	Southern Levant		

No micromammals have as yet been identified. When better evidence comes to light this site may indicate the existence of a much earlier hominid dispersal event into the southern Levant.

The only bone-bearing bed that can be safely correlated with Erq-el-Ahmar is the site of Bethlehem (Figs 1, 3) (HOOIJER 1958; TCHERNOV 1986, 1988). As indicated by the list of mammals (HOOIJER 1958) and the general configuration of the deposits, the Bethlehem fauna preceded the main tectonic event of the Dead Sea rift (HOROWITZ 1979). The assemblage of Bethlehem consists mainly of lower Villafranchian species (HOOIJER 1958): *Nyctereutes megamastoides*, *Homotheurium* sp., *Elephas planifrons*, *Sus strozzi*, *Giraffa* sp., *Gazellospira torticornis*, *Hipparion* sp. The absence of *Equus* and cervids is probably due to a quasi-isolation of the southern Levant from Eurasia already during this period (TCHERNOV & GUERIN 1986). The early Pliocene of Turkey is commonly occupied by cervids, while south of the Taurus-Zagros range, and in North Africa, cervids and other typical Palaearctic elements are unknown until the Pleistocene.

## The Sites of Evron and Latamne

The Evron Quarry site is located on the coastal plain of western Galilee (Fig. 1) and has yielded in situ Acheulian deposits. The major stratigraphical units seen in the site were outlined by RONEN

Table II

Comparison of micromammalian assemblages from early and Middle Pleistocene sites in the southern Levant.  $\blacklozenge$  = First appearance,  $\blacklozenge$  = continue to survive,  $\dagger$  = Extinct species,  $\dagger$  = Extinct in the region

*UBEDIYA	LATAMNE + EVRON	GIVE'AT SHAUL (Fissure Filling near Jerusalem) (Tchernov, 1968)	GESHER BENOT Y'A'AKOV (Tchernov, new data)	OUMIM QATAFA (Tchernov, 1968; 1986)
(Tchernov, 1986; v. Koenigswald et al., 1992)	(Mein & Besançon, 1993; Tchernov et al., in press)			
<b>Early Pleistocene</b> (1.4 m.y.) <b>Early Pleistocene</b> Olduvai Upper Bed II (Lower Biharian)	<b>Late Early Pleistocene</b> (1.0 m.y.) Early Middle Acheulian (late Lower Biharian; between Milazian & Tirrhenian)	<b>Early Middle Pleistocene</b> (900-800 kyr.) (Early Tirrhenian)	<b>Middle Pleistocene</b> (500 - 600 kyr.) Middle Acheulian (Upper Biharian; middle Tirrhenian).	<b>Late Middle Pleistocene</b> (250 kyr.) Late Acheulian (Stage 7)
<i>Hystrix indica</i>				
♀ <i>Cricetus cricetus</i>	→ → → → →	♀ <i>Cricetus cricetus</i>	→ → → → → ?	→ → → → → ♂ <i>Sciurus anomalus</i>
♀ <i>Mesocricetus primitivus</i>	? → ? → ? →	♀ <i>Mesocricetus</i> sp.	♀ <i>Mesocricetus</i> sp. ? →	♀ <i>Mesocricetus auratus</i>
♀ <i>Allocricetus bursa</i>	→ → → → →	♀ <i>Allocricetus bursa</i>	→ → → → → ?	♀ <i>Allocricetus jessericus</i> ♀ <i>Allocricetus magnus</i>
♀ <i>Occitanomys haasi</i>	→ → → → →	→ → → → →	→ → → → →	→ → → → →
♀ <i>Parapodemus jordanicus</i>	? →	♀ <i>Apodemus sylvaticus</i>	→ → → → →	♀ <i>Apodemus sylvaticus</i>
♀ <i>Apodemus sylvaticus</i>	♀ <i>Apodemus flavicollis</i>	♀ <i>Apodemus flavicollis</i>	? →	♀ <i>Apodemus mystacinus</i>
♀ <i>Apodemus flavicollis</i>	? →	♀ <i>Apodemus mystacinus</i>	→ → → → →	→ → → → →
♀ <i>Mastomys levaninus</i>	→ → → → →	→ → → → →	→ → → → →	→ → → → →
♀ <i>Mastomys galileensis</i>	→ → → → →	→ → → → →	→ → → → →	→ → → → →
♀ <i>Arvicanthus ectos</i>	→ → → → →	→ → → → →	♀ <i>Arvicanthus ectos</i>	♀ <i>Mastomys baiei</i> ♀ <i>Arvicanthus ectos</i> ♀ <i>Mus macedonicus</i>
♀ <i>Mus cf. macedonicus</i>	→ → → → →	→ → → → →	→ → → → →	→ → → → →
♀ <i>Parameriones obeidensis</i>	♀(=Meriones maghrebianus)	♀ <i>Parameriones obeidensis</i>	→ → → → →	→ → → → → ♀ <i>Meriones tristrami</i> ♀ <i>Psammomys obesus</i> ♀ <i>Gerbillus dasyurus</i> ♀ <i>Spalax ehrenbergi</i> ♀ <i>Arvicola terrestris</i> ♀ <i>Microtus guentheri</i>
♀ <i>Gerbillus dasyurus</i>	→ → → → →	→ → → → →	→ → → → →	→ → → → →
♀ <i>Spalax ehrenbergi</i>	→ → → → →	♀ <i>Spalax ehrenbergi</i>	→ → → → →	→ → → → →
♀ <i>Microtus (Tibericola) jordanica</i>	(=Arvicola jordanica)	→ → → → →	→ → → → →	→ → → → →
♀ <i>Lagurodon praeparannonicus</i>	→ → → → →	→ → → → →	→ → → → →	→ → → → →
♀ <i>Lagurodon arankae</i>	♀ <i>Lagurodon arankae</i>	♀ <i>Kalymnomys haasi</i>	→ → → → →	→ → → → →
♀ <i>Allactaga euphratica</i>	→ → → → →	→ → → → →	→ → → → →	♀ <i>Ellobius fuscicapillus</i>
♀ <i>Myomimus judaicus</i>	→ → → → →	♀ <i>Myomimus judaicus</i>	→ → → → →	♀ <i>Myomimus judaicus</i>
♀ <i>Hypodagus brachygnathus</i>	→ → → → →	→ → → → →	→ → → → →	♀ <i>Lagomys sp.</i>

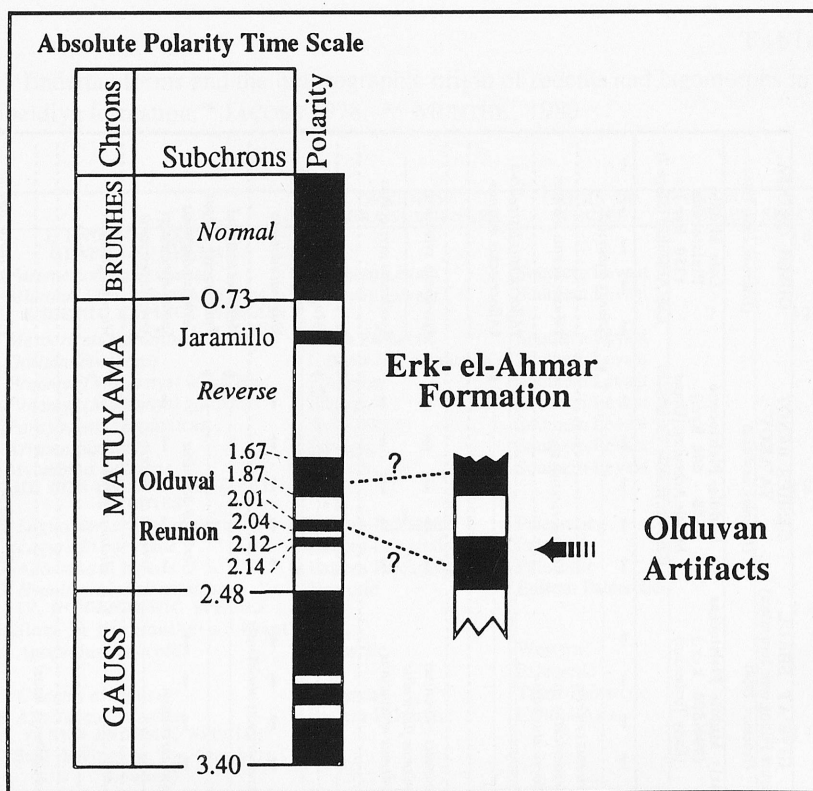


Fig. 4. The sequence of Erq-el-Ahmar was correlated with the absolute polarity time scale (BROWN 1992; VEROSUB & TCHERNOV 1991) suggesting that the upper section of normal polarity either correlates with the Olduvai subchron or with the upper Reunion subchron. The time differential between these is slight.

(1991). The Evron Quarry assemblage is composed of quartz/limestone pebbles, flint artifacts (nodules, cores and debitage) and faunal remains.

Evron Quarry includes only 12 species of large mammals (TCHERNOV et al. 1994) and has a strong Oriental stamp in the presence of *Stegodon* sp. and *Elephas (hysudricus - maximus)*. *Kolpochoerus*, *Alcelaphus* and *Trionyx* sp., on the other hand, are typical Ethiopian elements. *Bos* cf. *primigenius* and cervids are of Palearctic origin, while cf. *Gerbillus* (cf. *dasyurus*) is an Arabian species. Some of the species are endemic to this region (*Kolpochoerus evronensis*, and possibly *Stegodon* sp. and *Hippopotamus* sp.). The genus *Stegodon* is found in only three sites in the southern Levant (Latamne, Evron and Gesher Benot Yaaqov).

The most important site along the Orontes Valley, 39 km north of Hama, Syria (LIERE & HOOIJER 1961), is a 60 m fluvialite deposit of the Latamne Formation (QfIII) (BESANÇON et al. 1978; COPELAND & HOURS 1979, 1993; SANLAVILLE et al. 1993). An archaeological horizon was located in the sequence of what was later defined as the Latamne Formation (CLARK 1967, 1968), and contained an in situ living floor". Most of the well-preserved and identifiable faunal specimens came from the gravels underneath the archeological horizon. The species represented were initially identified by HOOIJER (1962) but more recently the fauna has been revised by GUERIN et al. (1993) and MEIN & BESANÇON (1993) (Table II). This revision enables a better comparison with other Lower Palaeolithic sites in the southern Levant. The Middle Acheulian industry of the Latamne



living floor resembles Evron in some respects (TCHERNOV et al. 1994). Latamne has large handaxes similar to Evron but they are better retouched. The handaxes of Sitt Markho are quite rolled but seem to have been shaped mainly by large removals, similar to those at Evron (RONEN 1991). COPELAND & HOURS (1979, 1993) and HOURS (1981) re-analysed and redated the site of Latamne, and placed it far below the Tyrrhenian and just above the Cromerian. The overall assemblage was assigned by HOOIJER to the "Mindel-Riss" Interglacial, but SANLAVILLE et al. (1993) assumed that the date of Latamne was around 0.7 myr. This date, however, would place the lithic assemblage of Latamne as closer to Gesher Benot Yaakov (TCHERNOV et al. 1994) (see below). The completely different tool kits of these sites (BAR-YOSEF & GOREN-INBAR 1993; COPELAND & HOURS 1993) excludes the possibility of contemporaneity.

The presence at Evron of Early to early Middle Pleistocene elements like *Kolpochoerus*, as well as the presence at Latamne of a typical Early Pleistocene representative of the Arvicolidae (*Lagurodon arankae*) as recently described by MEIN & BESANÇON (1993), place these sites chronologically much closer to Ubeidiya than to Gesher Benot Yaakov, which is now reasonably well dated to less than 800 Kyr (GOREN-INBAR et al. 1992), and hence below the Tyrrhenian (Table II). On the basis of the profound differences in the lithic assemblages, the first appearance of some modern mammals (*Palaeoloxodon*, *Microtus*), and the disappearance of some typical Early to early Middle Pleistocene mammals (e. g., *Praemegaceros*, *Sus strozzi*, *Kolpochoerus* and *Lagurodon*), we conclude that the site of Gesher Benot Yaakov (see later) cannot be contemporaneous with Evron and Latamne Formation, as has been argued by MEIN & BESANÇON (1993).

### III. MIDDLE PLEISTOCENE SITES

#### G i v e a t S h a u l

The breccia of this Karst Fissure Filling near Jerusalem (Fig. 1) appears to be the remains of an old cave and is composed of fossil red soil, fragments of stalagmites and stalactites, some irregularly shaped limestone pebbles with an average diameter of 10 cm, and small pieces of non-artifactual flint (5 cm). The paucity of remains of larger mammals, and the large number of small species, mainly nocturnal mammals found in isolated accretions, indicate that the material is a pellet accumulation of owls. The fauna extracted from it comprises 10-11 species of rodents (TCHERNOV 1968) that show affinities with early Middle Pleistocene faunas. The rodent fauna still includes some extinct forms, such as *Allocricetus bursae* and *Paramerion ubiadiensis* (Table II).

The genus and species described by TCHERNOV (1968) as *Jordanomys haasi* from this site was revised by KOENIGSWALD et al. (1992). It was found that *Jordanomys major* from Kalymnos island, *Jordanomys haasi*, and *Jordanomys pusillus* from Ubeidiya represent the new genus *Kalymnomys*.

#### G e s h e r B e n o t Y a a q o v

The Benot Ya'aqov Formation is located in the northern sector of the Dead Sea Rift some 4 km south of Hula Valley, on both banks of the Jordan River (Fig. 1). The presence of "African" characteristics in its lithic industry (high frequencies of cleavers produced by "block on block" technique and a marked preference for basalt in artifact production) mark Gesher Benot Ya'aqov as a unique prehistoric site (STEKELIS 1960; GOREN-INBAR & BELITZKY 1989; GOREN-INBAR et al. 1992).

Due to tectonic activity, some of the strata are strongly tilted along young, NNE-trending, left-lateral faults. The Yarden Basalt (Fig. 3), which is unconformably overlain by the Benot Ya'aqov Formation, was recently dated by K/Ar to 800 and 880 myr (HEIMANN et al. 1987). The formation is therefore not older than 800 myr. The middle, marly horizon was noted to be very rich in shells of the endemic fossil gastropod *Viviparus apameae* and named the "*Viviparus* Beds" (TCHERNOV 1973).

The list of mammals identified from the old exposures (HOOIJER 1959, 1960) was revised by GERAADS & TCHERNOV (1983). The large mammals include *Elephas antiquus/namadicus*, *Stegodon mediterraneus*, *Dicerorhinus* sp., *Equus* sp., *Hippopotamus* sp., *Cervus* cf. *elaphus*, *Dama* cf. *mesopotamica* and *Gazella gazella*. Recently, micromammals were found and identified. This research is still ongoing. The following species have been recorded (Table II): *Mesocricetus* sp., *Arvicanthis ectos*, *Mus* cf. *macedonicus*, *Gerbillus dasyurus*, *Ellobius fuscocapillus*, *Microtus guentheri* and *Arvicola* cf. *terrestris*. The earliest appearance of *Microtus* s. str. and *Arvicola* is recorded from this site.

### O u m m Q a t a f a

Oumm Qatafa is situated in the Judean desert (Fig. 1) and was excavated by NEUVILLE (1951). The faunal assemblage indicates a relatively short period of deposition, at least of the bone bearing beds (HAAS 1951; TCHERNOV 1988). The micromammalian assemblage is comparable (Tables II, III) with the late Acheulian fauna of Tabun G ("Tayacian").

Large scale biotic exchange is represented in the community of Oumm Qatafa, where many Palaearctic elements appear for the first time in this region (*Meriones tristrami*, *Sciurus anomalus*, *Lagomys* and, soon after, *Lepus capensis*).

On the basis of the relative antiquity of its micromammalian assemblage (*Rattus haasi*, *Arvicanthis ectos*, *Mastomys batei*, Muridae; *Myomimus judaicus*, Gliridae) and in particular the unique appearance of *Ochotona* sp. (Tables II, III, IV), some of which have not been recovered from later lithic deposits (TCHERNOV 1984), it seems that the osseous beds of Oumm Qatafa predate all Acheulo-Yabrudian lithic accumulations in the Levantine region. Moreover, several mainly Palaearctic genera (e. g., *Lepus* and *Talpa*) are not yet represented in the southern Levant during this period. This assemblage may be best correlated with Tabun G (JELINEK 1982), or Yabrud rockshelter (COPELAND & HOURS 1983), which may be assigned to Oxygen Isotope Stage 7 (TCHERNOV et al. 1994). Therefore, Oumm Qatafa may form a biochronologic baseline for all the later Acheulo-Yabrudian and Mousterian faunal sequences.

## IV. LATE MIDDLE AND LATE PLEISTOCENE SITES

Several guidelines were used in building up the suggested sequence of mammalian-hominid chronostratigraphy of this region. Apart from the known faunal assemblages, the geochronologies of many of the cave sites concerned, the industrial sequences, and evidence from sea level fluctuations along the Mediterranean coast, there are at present more radiometric dates available for some of the problematic cultural units. Combining those dates with the known stratigraphies enabled us to make a more complete reconstruction of the late Middle and Late Pleistocene sequence.

### T a b u n C a v e

The spatio-chronological distribution of lagomorphs in the southern Levant indicates a short event during late Acheulian time when the genus *Ochotona* was present in the region (the site of Oumm-Qatafa), and a post-Acheulian replacement of *Ochotona* by *Lepus* (Tabun F+E; Table IV) (TCHERNOV 1988). The disappearance of *Ochotona* and a few other ancient forms like *Myomimus judaicus* and *Rattus haasi*, and the first appearance of new elements such as *Lepus capensis* and *Myomimus qafzensis* (DAAMS 1981; HAAS 1972, 1973), places the complex of Tabun F+E, but in particular layer E, well after the faunal beds of Oumm Qatafa and within the Acheulo-Yabrudian range. This is in agreement with BAR-YOSEF's (1989) argument that Tabun F and E are best placed in late stage 7 and 6. From Tabun F no satisfactory fauna was recorded.

Table III

Comparison of micromammalian assemblages from late Acheulian, Acheulo-Yabrudian and Mousterian deposits from Israel. When available, dates and references are added to each site. The assemblages of the late Middle Paleolithic sites, Amund (Galilee), Sefunim and Geula (Mt. Carmel) identical with the Mousterian complex of Kebara

[illegible]



Table IV  
First appearances and last occurrences of micromammals (and relevant large mammals) during the late Middle and Upper Pleistocene in the southern Levant

Age (kyr)	Oxygen Isotope Stage	Principal Cultural Sequence	Reference Locality	Taxa Occurring in the		Reference		Fauna
				Taxa Restricted to the Reference Level	First Appearance	Last Occurrence	Last Intermittent Occurrence*	First Intermittent Appearance*
10		Neolithic	Various sites		** <i>Meriones saharicus</i> ** <i>Gerbillus allenbyi</i> ** <i>Gerbillus pyramidalis</i> ( <i>Gazella dorcas</i> )			
10.5 12.5	Early 1	Epipaleolithic Natufian	Hayonim B Hayonim Terrace (Galilee) Eynan (Huleh Valley)			<i>Apodemus flavicollis</i> <i>Sciurus anomalus</i> ( <i>Capra aegagrus</i> ) ( <i>Equus caballus</i> )		
12.5 22	Late 2	Epipaleolithic Kebaran	Hayonim C		<i>Acomys cahirinus</i>	( <i>Dicerosaurus hemiochus</i> )		<i>Gerbillus dasyurus</i>
22 37	Early 2 Late 3	Upper Paleolithic	Hayonim D Kebara D		<i>Eliomys melanurus</i> <i>Rattus rattus</i>	( <i>Crocota crocota</i> )		
40 60	Early 3	Late Mousterian	Hayonim (Upper E) Kebara E (XI-XII) Tabun C+B; Sefunim (Mt. Carmel)					<i>Apodemus flavicollis</i>
60 75	4	Mousterian	Hayonim (Lower E) #Tabun D (Unit I)	✓ <i>Cricetulus migratorius</i>	<i>Myomimus roachi</i> <i>Suncus etruscus</i> <i>Suncus murinus</i>	<i>Ellobius fuscocapillus</i> <i>Allocricetus magnus</i> <i>Talpa chibonia</i>		
90 110 120 130 140 160	5a-c 5d-e 6	Early Mousterian Early Mousterian Acheulo-Yabrudian	Qafzeh (Galilee) #Tabun D (Units IX) Tabun E	<i>Suncus murinus</i>	<i>Myomimus galensis</i> <i>Suncus etruscus</i> <i>Suncus murinus</i>	<i>Arviculus ecius</i> <i>Suncus murinus</i> <i>Mastomys balei</i>	<i>Apodemus flavicollis</i> <i>Gerbillus dasyurus</i>	
					<i>Lepus capensis</i> † <i>Myomimus</i> (?) <i>galensis</i> <i>Sciurus anomalus</i> <i>Talpa chibonia</i>	<i>Allocricetus jersolensis</i>	<i>Apodemus flavicollis</i> <i>Allocricetus magnus</i> <i>Mesocricetus auratus</i>	
200	7	Late Acheulian	Oumr-Qatafa (Judean Desert)	<i>Ochotona</i> sp. <i>Rattus hazati</i>	<i>Ochotona</i> sp. <i>Rattus hazati</i> <i>Ellobius fuscocapillus</i> # <i>Allocricetus jersolensis</i> # <i>Allocricetus magnus</i> # <i>Mesocricetus auratus</i>	<i>Ochotona</i> sp. <i>Rattus hazati</i> † <i>Myomimus judaicus</i>		

\* A few species of rodents intermittently appear and disappear from the Mediterranean region of the southern Levant in correlation with climatic fluctuations. During cold phases, *Apodemus flavicollis* dispersed southward from the Palearctic region; during and periods *Gerbillus dasyurus* dispersed northward (TCHERNOV 1989); \*\* First appearance of Saharan elements during the early Holocene; a dispersal event that was restricted to the southern Levantine coastal plains (TCHERNOV 1989); V Probably replacing the extinct genus *Allocricetus* in the Levant (an event that occurred much earlier in the Palearctic region outside the Levant (TCHERNOV 1989); # The fauna of the complex layers of Tabun D was hitherto seen treated as a single assemblage and hence much earlier Mousterian communities were mixed together. In this table Tabun D is considered as two separated entities (as was already suggested by JELINEK, 1982). The fauna from Tabun D (units I-II) would have shown a close relationship to the assemblage of Qafzeh, and Tabun D (unit IX) – to Tabun C; † Described by BATE (1937) as a new genus (*Philistomys*), it was later reidentified as a member of the genus *Myomimus*, probably *M. galensis*; # Probably replacing *Allocricetus bursae* (TCHERNOV 1986); § Probably replacing the extinct Lower Pleistocene species, *Mesocricetus primitivus* (TCHERNOV 1986).



Culturally, Tabun D would best be placed in an oxygen isotope stage between the Acheulo-Yabrudian and the Lower Mousterian of Qafzeh (Stage 5+6), or within the earlier phases of stage 5E (Table IV; Fig. 5). The extinct genus *Allocricetus* is of great importance in chronologic correlations. The Early Pleistocene *Allocricetus bursae* continued to survive in the eastern Mediterranean until the Middle Pleistocene (TCHERNOV 1986; TCHERNOV et al. 1994), long after it became extinct elsewhere. During the Middle Pleistocene it probably underwent a swift in situ speciation into two different forms; *Allocricetus magnus* (TCHERNOV 1986; TCHERNOV et al. 1994) and *Allocricetus jesreelicus*, and became extinct during the last Interglacial. *Ellobius fuscocapillus* (Murinae) is known from layers E, D and C of Tabun (= *Ellobius pedorychus*, BATE 1937) and from Oumm Qatafa (HAAS 1951). This species was also recovered from the lower level of layer E in Hayonim cave (Table III) (TCHERNOV 1988).

The Middle Pleistocene *Myomimus qafzensis* is known from Oumm Qatafa, Tabun F+E and Qafzeh and was replaced by the modern species *Myomimus roachi*. *Talpa chthonia* was first described by BATE (1937) from Tabun F+E, and only reappears in Hayonim E (Stage 5) and Tabun C. This species became extinct during the upper phases of the Mousterian (Tables III, IV). The only representative of the Talpidae in the southern Levant is *Talpa chthonia* [first described by BATE (1937)]. This endemic species was identified from Tabun F but was absent from Qafzeh. It reappears in Tabun C.

The Levantine Mousterian is still subdivided on the basis of the stratified deposits of Tabun cave into three phases, originally named by COPELAND (1975) as "Tabun D"-type, "Tabun C"-type and "Tabun B"-type. The stratigraphic complexity of Tabun D as shown by JELINEK (1982) and its long time span is the main reason for the existing uncertainties regarding the faunal composition (as well as the industries) of Tabun D. Following JELINEK (1982) it seems that we must separate Unit IX at the base of Tabun D from Unit II at the top or consider it, as JELINEK suggested in his 1982 paper, as related to early Tabun C. This approach may also clear up much of the confusion regarding the correlation between the Qafzeh, Tabun and Hayonim sequences, as well as the irrational coexistence of Acheulo-Yabrudian survivors with modern newcomers similar to those found in Tabun C. The discrepancy of absolute dating vs. biochronological succession and cultural sequence is due both to some imprecision in ESR and TL dating methods and to bias in the sampling of animal remains for ESR dating from the sequence of Tabun (GRÜN & STRINGER 1991; KLEIN 1994). We argue that Unit IX indeed antedates the early Mousterian complex of Qafzeh (layers XXV through VI) while Unit II of Tabun D postdates Qafzeh, which would explain the arrival of a swarm of Palaearctic species at the beginning of stage 4. Radiometric dates should be produced separately from the different Units of Tabun D and not rely on "GARROD'S collection".

In conclusion, we suggest that Tabun D (units IX) antedates the complex of Qafzeh, and contains all those Afro-Arabian elements which are known from that sequence. Hence, Tabun D (unit IX) is much earlier than Qafzeh, yet within stage 5 (Fig. 5). Unit II of Tabun D, however, postdates the complex of Qafzeh, and includes all the newly arrived Palaearctic elements, which may mark the beginning of the last Glacial, or early stage 4 (Table IV).

### Hayonim Cave

The Mousterian complex excavated at Hayonim cave retains some of the old taxa (*Ellobius fuscocapillus* and, in particular, *Allocricetus magnus*) but thus far none of the Afro-Arabian elements (*Arvicanthis*, *Mastomys*, *Gerbillus dasyurus*) has been found. This assemblage contains typical Palaearctic taxa, including *Talpa chthonia*. None of these species appear in the later part of the Mousterian (=Tabun C+B). It is thus apparent that Layer E of Hayonim antedates all the Mousterian units that seem to belong to a unique climatic stage, biochronologically somewhat older than Qafzeh (Fig. 5).

### Qafzeh Cave

It is of great significance that the two archaic forms of Muridae (*Mastomys* and *Arvicanthis*) still survive in the Qafzeh deposits. *Mastomys* was first recorded from Tabun E and Tabun D (BATE



1942, 1943), and then from Oumm Qatafa (HAAS 1951). TCHERNOV (1968) described *Mastomys batei* as a new species endemic to the southern Levant. *Arvicanthis ectos* was also described by BATE (1942, 1943), from Tabun F+E. This was the first record of the genus outside Africa (apart from *Arvicanthis niloticus naso* from southern Arabia). These two genera have been confined to the Middle East since the Early Pleistocene (TCHERNOV 1986). While *Mastomys batei* is also found in Tabun D (possibly Unit IX), the genus *Arvicanthis* is, however, absent from this layer, and neither of them is found in any of the later Mousterian deposits, or anywhere else in Asia. In Oumm Qatafa, Tabun E and Qafzeh there existed a unique species of glirid, *Myomimus qafzensis*, identified by both HAAS (1973) and DAAMS (1981) as endemic to this area. This dormouse was replaced by a modern Euro-Siberian form, *Myomimus roachi* (TCHERNOV 1986). Of great importance is the unique appearance of the Indo-Arabian *Suncus murimus* (TCHERNOV 1988). This is the only period of the Pleistocene when such an Indo-Arabian element is known from such a northern latitude, and together with other Afro-Arabian elements indicates a large scale northward shift of the desert belt. Complementarily, cricetines, as well as other Palaearctic elements like *Talpa*, *Ellobius* and *Apodemus flavicollis*, are completely absent from the Mousterian deposits of Qafzeh. The community 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 abundant African antelope *Alcelaphus buselaphus*, an African ass, *Equus africanus*, a North African Equid, *Equus cf. tabeti* (EISENMANN 1992), *Gazella gazella*, *Dicerorhinus hemitoechus*, *Camelus dromedarius* and *Struthio camelus* (PAYNE & GARARD 1983). The ESR dates given by SCHWARCZ et al. (1988) reinforced the TL average date of  $92 \pm 5$  kyr (linear uptake) and  $115 \pm 15$  kyr (early uptake) for these layers VALLADAS et al. (1988).

#### T a b u n C + E

As pointed out previously, Tabun C cannot biochronologically and culturally be regarded as an integral cultural stage (JELINEK 1982). The fauna from its upper part seems to belong to Tabun B and that from its lower part to the upper phases of Tabun D. There is a very weak fit between the ESR and TL dates of Tabun C and the regional southern Levantine Middle Paleolithic cultural and biochronological sequence (KLEIN 1994), due to methodological problems with these methods and the biased sampling (much like the sampling of Tabun D) of this layer. Sampling BATE's material from the Natural History Museum for ESR without referring to JELINEK's stratigraphical sequence means dating mixed layers and causes discrepancy in the results. This is why the apparent ages of Tabun sequence widely overlap, suggesting that for the time being it would be unwise to interpret the TL and ESR dates too precisely... (KLEIN 1994, p. 10).

#### K e b a r a C a v e

Early stage 4 and its faunal turnover was associated in the Levant by a lowering of the sea level, particularly from Mt. Carmel south to the Sinai, and dune activity resulted in the development of *kurkar* ridges along the coast. In all later Mousterian deposits in the southern Levant most of the archaic species of micromammals became extinct or were totally eliminated from the Levantine scenario: *Myomimus qafzensis*, *Mastomys batei*, *Arvicanthis ectos*, *Suncus murimus* and temporarily also *Gerbillus dasyurus* and probably *Camelus dromedarius* (Table IV). On the other hand, other species which are associated with more mesic environments or arboreal habitats appear: *Myomimus roachi*, *Apodemus flavicollis* and all the cricetines (Tables III, IV). The appearance of *Cricetulus migratorius* in the southern Levant may be considered a valuable biochronological event at the beginning of Stage 4. It is at present the only surviving cricetine in Israel. This event is post-Qafzeh.

Kebara cave includes a successive and intensive occupation by humans, with an increased rate of sedimentation and an industry that very much resembles "Tabun B-type" (BAR-YOSEF 1989). A series of TL dates indicates that Units XII through VI span the range from 60 to 48 kyr



(VALLADAS et al. 1988). ESR dates (SCHWARCZ et al. 1988) suggested a range of 60-64 kyr for Units X-XI.

## V. TERMINAL PLEISTOCENE AND EARLY HOLOCENE

The Levantine communities seem to be temporarily stabilized during the late Mousterian and the Aurignacian. The transition to Stage 3 can be faunistically represented by the assemblage of the later part of Tabun C and Tabun B, the whole complex of the Mousterian deposits in Kebara cave (Layers XII through VI), Amud, Shovakh, Sefunim and Geula. The few ossiferous beds from the early Upper Palaeolithic such as Qafzeh 7-9 and Kebara indicate that virtually none of the mammalian groups show an accelerated rate of extinction in late and post-Würmian time. What did occur was a significant change in the relative frequencies of the rodents (TCHERNOV 1984) and most probably of the ungulates as well.

Only two species of ungulates became extinct towards the end of the Würm: *Dicerorhinus hemitoechus* and *Equus hydruntinus* (during the Epipalaeolithic). The only other large mammal that shifted its range northward towards the onset of the glacial period is *Capra aegagrus*. It was only during much later historical time that other ungulates and large carnivores were finally eliminated from the local fauna, some of which only after the introduction of firearms into the region. *Cervus elaphus*, *Dama mesopotamica* and *Capreolus capreolus*. *Alcelaphus* sp., *Equus hemionus*, *Hippopotamus amphibius*, *Felis leo* and *Ursus arctos* became extinct in late historical time. It is thus evident that most of the ungulates and larger carnivores withstood the swift postglacial climatic change. However, three species of rodents were eliminated from the local fauna towards the Neolithic but continue to survive further to the north: *Sciurus anomalus*, *Apodemus flavicollis* and *Mesocricetus auratus*. Only during the Iron Age did *Myomimus roachi* become extinct. On the other hand, a swarm of species well adapted to arid environments immigrated into the desiccating Mediterranean region of the Levant, either originating in the Arabian desert (*Acomys cahirinus*, *Gerbillus dasyurus* and *Meriones sacrametni*). *Rattus rattus* first appeared in the area during the Epipalaeolithic period, some 15 kyr ago. When *Dryomys nitedula* and *Eliomys melanurus* (both rare in the fossil record), the two glirid species of the Levant, appeared in the region is not known.

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