Chapter 6

NATUFIAN USE OF THE ENVIRONMENT

Data concerning the use of the environment by the Early Natufian inhabitants of el-Wad can be gathered from two main sources: palaeoenvironmental studies of the Late Glacial period in the area, and direct evidence concerning the use of faunal and vegetal resources and mineral raw materials in the cave itself.

Palaeoenvironmental Studies

Palaeoenvironmental information regarding the Early Natufian, which coincides largely with the European Late Glacial, can be derived from several disciplines. The principal avenues explored in our case will be palynology and archaeobotany, geomorphology and sedimentology, and archaeozoology, while the more general information provided by the oxygen isotope curves of the eastern Mediterranean deep-sea cores will also prove useful. Because each of these disciplines has its inherent limitations, one occasionally runs up against contradictions in their interpretations, which means that in certain cases it may not be possible to arrive at a general reconstruction. The possible biases in the faunal assemblages, resulting from selective hunting, or the major gaps in the sedimentological data come readily to mind. Furthermore, analyses carried out in the various disciplines are indicative of discrete aspects of the palaeoenvironmental data. While the oxygen isotope curve can give us a general idea of changes in global temperatures, the palynological, faunal and probably also the sedimentological/ geomorphological evidence is more suitable if we want to reconstruct changes in humidity. Only rarely do such factors as changes in animal body size (Bergmann Rule: Bergmann, 1847; Mayr, 1956; Davis, 1981; Tchernov, 1979a), or peaks in *Cedrus* or the occurrence of *Utricularia* pollen (Weinstein-Evron, 1990) point to changes in temperature. Thus, we can correlate the various approaches and characterize a specific climatic fluctuation as, e.g., cold/humid or warm/humid, with some confidence only when we have sufficient absolute dates, and when the general picture is detailed enough.

Another difficulty arises from the lack of uniformity we encounter in the nature of data from different geographic regions (Fig. 70). Most of the palynological data come from the Rift Valley cores and not from the archaeological sites themselves. As for sites of northern Israel, the palaeoecological reconstructions here are based chiefly on faunal evidence whereas in the semi-arid regions, such as the Negev and Sinai, these are more often interpreted on the basis of sedimentological and geomorphological data.

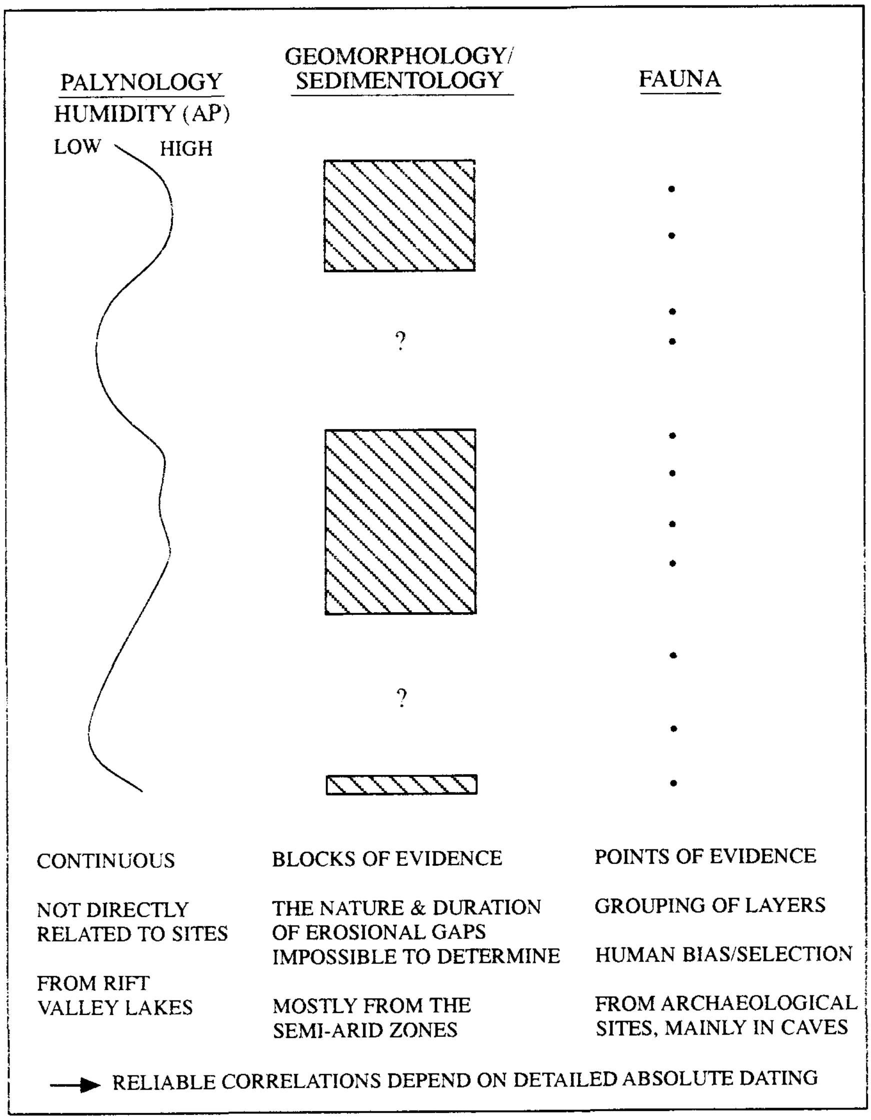

Fig. 70. Schematic representation of the nature and interpretational difficulties of data derived from various disciplines.

Also, there seem to be variations in the "coverage" the different disciplines provide. While palynological data give us more or less continuous curves (Fig. 70), only "blocks" of evidence can be extracted from the geomorphological/ sedimentological data. These "blocks" are often separated by gaps of indeterminable duration for which it is impossible to reconstruct climatological conditions and fluctuations (see also Fellner, 1995). Faunal data are the most sporadic (and probably the most biased) and can be best described as "data points", since they are usually related to specific sites or layers only. The same holds true for pollen assemblages from archaeological sites. Again, for a correlation of the different sets of data and reconstruction of palaeoenvironmental conditions for a specific site or phase to be reliable depends largely on dating.

Given the above, it is in our favour that the Natufian is relatively short: not only is it well covered by analyses of usually rich faunal assemblages, which makes their data more reliable than in earlier periods, but the general picture, too, is well known, especially because of the palynological studies that are available for this period. The latter will be discussed here in some detail, while additional, corroborative data from other disciplines will be cited in a more general way. Moreover, since we are dealing with the Natufian of el-Wad, our discussion focuses on the geographic area of present-day Israel, and information from neighbouring countries will be mentioned only in passing.

Palynology

Two distinct sets of palynological data are available: data obtained from cores in lacustrine deposits and data recovered from archaeological sites. While the former have the advantage of being better preserved and of providing us with larger sample size and greater chronological depth and continuity, the latter are on the whole more narrowly associated with a particular period and more likely to reflect only the local environment or to be biased in other ways.

A palynological sequence from the Hula covering the Natufian was recently published by Baruch and Bottema (1991). The presented Hula curve (Fig. 71) is securely dated with four uncalibrated ^{14}C dates, and can be divided roughly into three main sections. The lower part, from the base of the core to a depth of c. 14.5m (samples 11-12), is characterized by low arboreal pollen (AP) levels, mainly *Quercus ithaburensis* type (deciduous oaks) and some *Pinus,* Gramineae (Poaceae), and relatively abundant Chenopodiaceae and *Artemisia*. The middle part, from c. 14.5 - 11.5m (sample 34), exhibits high AP ratios, mainly deciduous oaks, but with a small rise in *Quercus calliprinos* (kermes oak), *Pistacia* and some *Olea*. Gramineae pollen are still the most abundant, decreasing gradually with the rise in AP. Chenopodiaceae and especially *Artemisia* exhibit pronouncedly lower ratios than before, the latter practically disappearing towards later parts of the sequence. In the upper part of the core, AP levels decrease again, with *Quercus ithaburensis* type pollen as the main element. *Pistacia* and especially *Quercus calliprinos* pollen are more abundant than in the earlier parts of the sequence. Decreases in AP values are compensated for by temporary increases in the Gramineae, with the Chenopodiaceae curve exhibiting similar trends. *Artemisia* pollen has by now disappeared almost entirely.

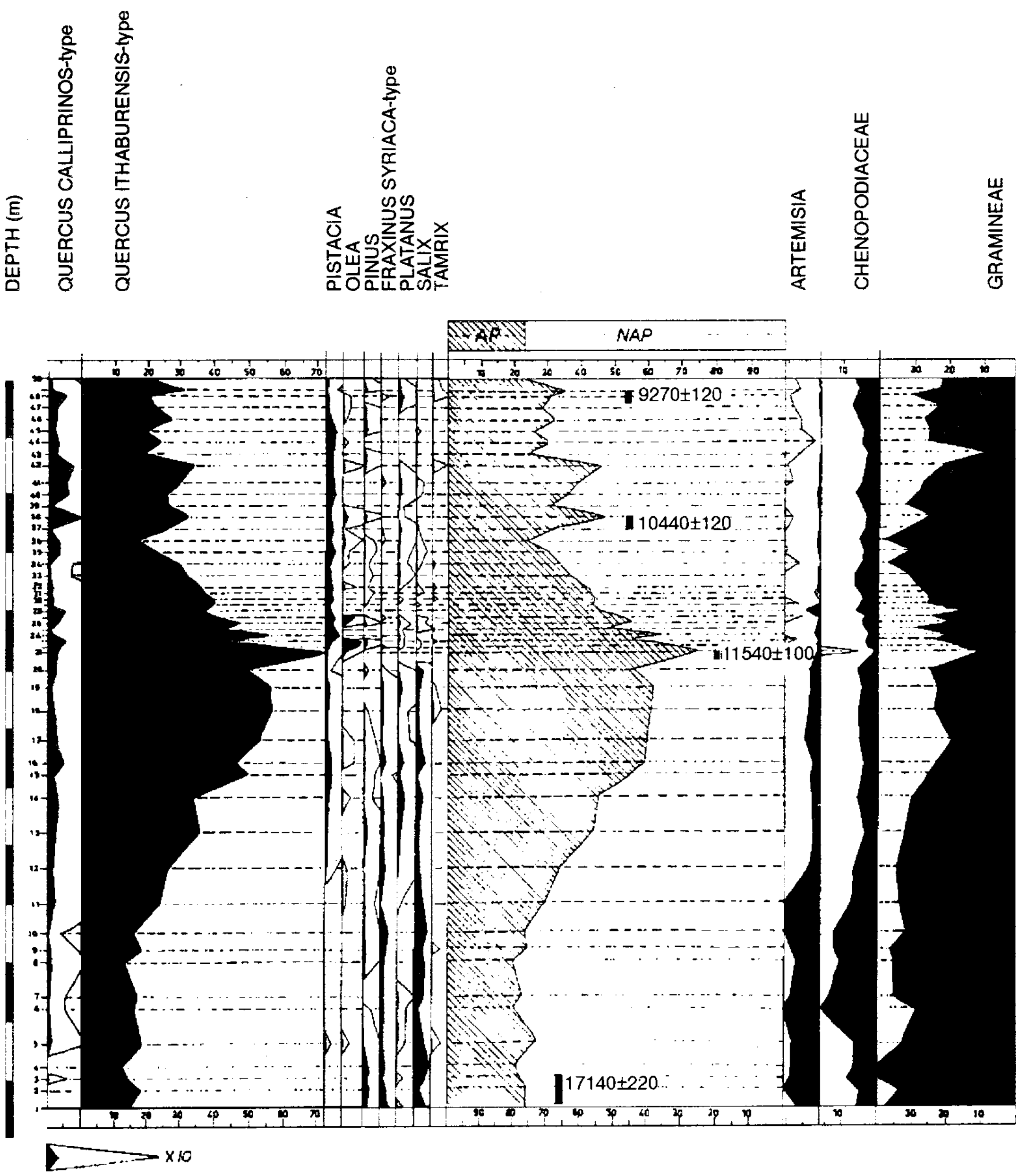

Fig. 71. Baruch and Bottema's Hula pollen diagram.

The earlier phase of Baruch and Bottema's sequence corresponds to the end of the European LGM (Pleniglacial maximum), with the driest spectra of the sequence, as evidenced by the low AP values, coupled with high values of Chenopodiaceae and *Artemisia*. That is, the climate was dry. That this time-span coincided with the Pleniglacial maximum (isotope stage 2) means that it was also cold, as the deep sea cores indicate (e.g., Ryan, 1972; CLIMAP, 1976; Thunell, 1979; Luz, 1982; Nesteroff et al, 1983; Bard et al., 1990; Broecker, 1992; Rossignol-Strick, 1993; Walker, 1995; Cheddadi and Rossignol-Strick, 1995), and as has been corroborated recently by a detailed isotope analysis of Israeli speleothems (Bar-Matthews and Ayalon, 1997). The humid Late Glacial followed, characterized by a marked increase in AP and a clear withdrawal of desert vegetation, especially the *Artemisia*. It was these favourable conditions, i.e., more humidity and warmth than in the earlier phase, that were enjoyed by the Early Natufians. A change to drier conditions came at the end of the Early Natufian and the transition to the Late Natufian. The peak of this dry phase was around 10,500 BP. Baruch and Bottema (1991) relate this dry phase to the cold, European Younger Dryas (see also Bottema, 1995). Slightly more humid fluctuations followed, but the high humidity of the Early Natufian was never regained in the period under discussion. Of course, it would be preferable to correlate the various palynological sequences in due course using calibrated rather than uncalibrated dates. Still, as we showed earlier (Chapter 5, "Dating"), this will have but a minor bearing on the relative antiquity of, and interrelationships between, Natufian sites. For example, if we calibrate the two available dates for the Natufian in Baruch and Bottema's curve (11540±100 BP and 10,440±120 BP; Fig. 71), the resulting calendaric ages (11,660-11,380 BC and 10,570-10,180 BC respectively), when related to those of Natufian sites (Table 1), are hardly such that they will influence our views regarding the palaeoecological background or the onset of specific climatic fluctuations during the "calibrated Natufian".

Significantly, the sub-division proposed here takes into account the older Hula sequence, as represented by Tsukada (Fig. 72b; see below), which suggests that the lower part of Baruch and Bottema's Hula curve should be regarded as an independent phase, coming at the end of an earlier fluctuation. In this it differs somewhat from the sub-division suggested by Baruch and Bottema (1991), who located the boundary between the two earlier sections at sample 14 (a depth of *c.* 13.5m). According to them, the resulting lower part of the sequence is characterized by gradually rising AP values and is taken to represent a mere transitional stage to the very humid, middle section.

Very similar trends are seen in an earlier analysed Hula core (Tsukada, unpublished, cited in Bottema and Van Zeist, 1981) and in a core taken from the Ghab Valley, 300km north of the Hula (Niklewski and Van Zeist, 1970). This correlation (Fig. 72) is based on a modified, chronological framework for the Ghab, earlier put forward by Weinstein-Evron (1990). In all three cores, the humid Late Glacial follows a very dry phase, with the lowest AP levels in the sequence and with many Chenopodiaceae and *Artemisia*. The latter two can be seen clearly in the new Hula (Figs. 71, 72a) and the Ghab (Fig. 72c) curves, but they are not specified in the less detailed old Hula curve (Fig. 72b). The low *Quercus calliprinos* values, and the similar trends in *Pinus*, *Pistacia* and *Olea* in the two curves, strongly suggest that they may have been contemporaneous.

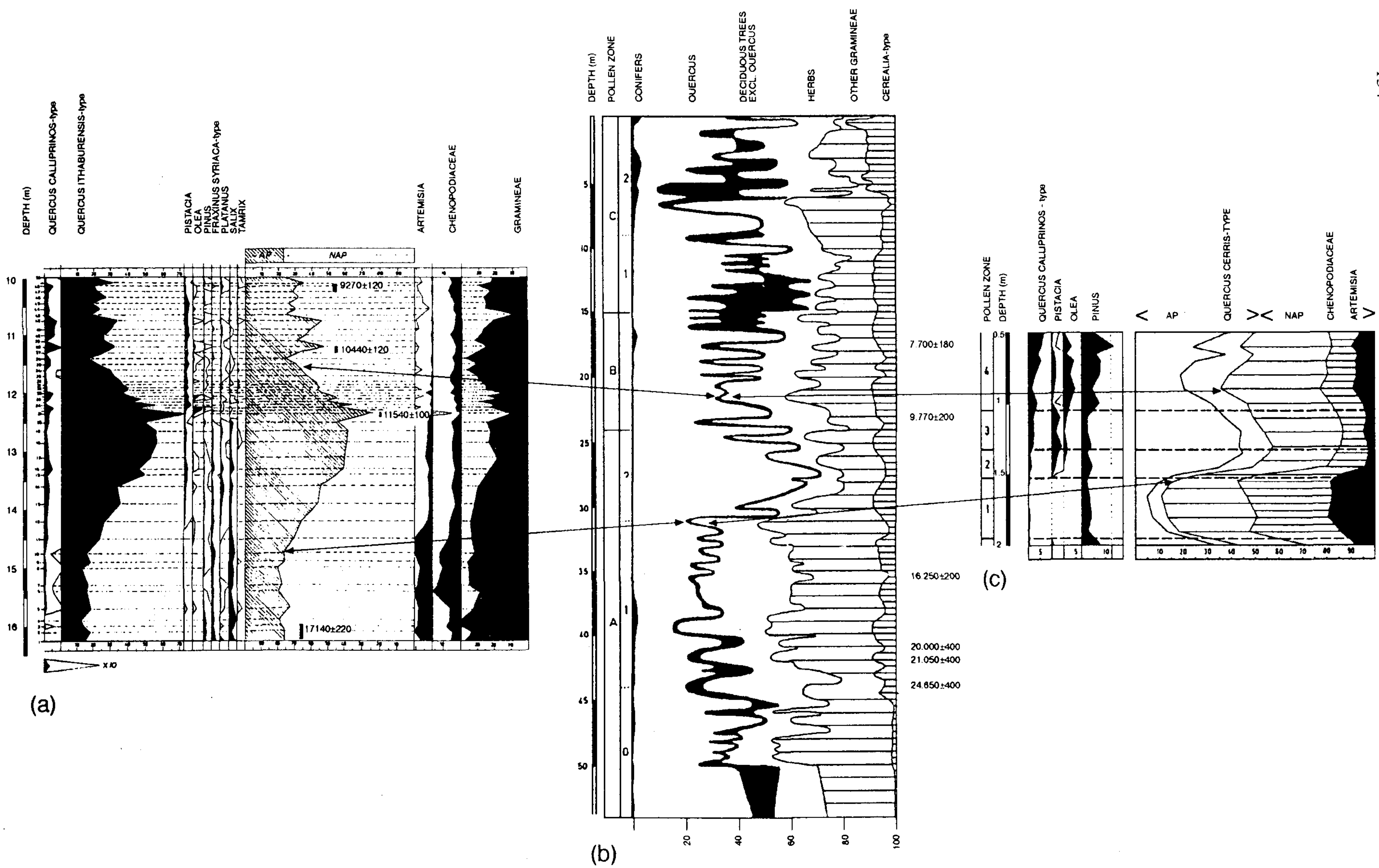

Fig. 72. Correlation of curves representing the LGM – Lateglacial sections of the Ghab (a) and Hula (b and c) palynological sequences: (a) after Baruch and Bottema (1991); (b) after Tsukada (unpublished), in Bottema and van Zeist (1981); (c) after Niklewski and van Zeist (1970) and van Zeist and Woldring (1980).

The humid Late Glacial sequence of the two sites is characterized chiefly by high values of *Quercus ithaburensis* type pollen, indicating that the forest was dominated by deciduous oaks. Unfortunately, it is impossible to distinguish palynologically between the various candidates from amongst the deciduous oak species in the region, which include *Quercus ithaburensis, Q. boissieri, Q. libani* (in the Hula area), *Q. boissieri, Q. cerris, Q. brantii* and *Q. libani* (in the Ghab area). In other words, there seems to be no ground to suggest that the most common species in the Hula was *Q. ithaburensis*, which is the most xeric (Baruch and Bottema, 1991). The long-lasting, very humid conditions could easily have encouraged rather the spread of the other deciduous oaks in the area.

A drier climate prevailed in the upper part of the sequence. AP levels are considerably lower than in the Late Glacial, and their composition in the two sites, with *Quercus calliprinos, Pinus, Pistacia* and *Olea*, indicates the occurrence of some sort of mixed maquis in the Mediterranean pyhtogeographic zone of the region.

Much the same picture emerges from palynological studies of Natufian sites (Fig. 73), especially in the Lower Jordan Rift Valley (Leroi-Gourhan and Darmon, 1987; Darmon, 1987, 1988). A long dry phase between ca. 19000-15000 BP (the LGM) was followed by a relatively humid Late Glacial, as represented by the short Early Natufian sequence of Salibiya XII. The long, increasingly drier Late to Terminal Natufian series of Salibiya I, Fazael IV and Salibiya IX ended the Natufian sequence in the area. A similar trend can be seen in the Early Natufian occupation at Wadi Judayid, southern Jordan (Emery-Barbier, 1988, 1995), where, following a short, dry phase (layer C), humid conditions prevailed (layer B). The difference between the picture derived from these archaeological sites and the clearer Hula curve can be explained by the more fragmentary nature of their data, their poor (often inadequate) dating, the possible over-representation of ruderal and disturbed habitats near the sites, and the various biases at play, especially those related to selective preservation of pollen (Weinstein-Evron, 1986, 1994). The high Asteraceae (Compositae) values in the samples indicate the importance of the latter factor (Bottema, 1975). Palynological data from two other Natufian sites, Eynan (Leroi-Gourhan, 1984) and Hayonim Terrace (Henry et al., 1981), are even more difficult to fit within the general curve (but see Leroi-Gourhan and Darmon, 1991).

Similarly, the pollen assemblages from the Early Natufian of el-Wad are most probably biased due to human activity at the site (Weinstein-Evron, 1994; see above Chapter 5, "Organic Material"). The analysed pollen samples were collected from Chamber III, i.e., the inner part of the cave, since no Natufian sediments have been preserved in the outer chambers of the cave. There is good ground to suspect, however, that pollen spectra from the outer part would have been skewed by the orientation of the opening of the cave, i.e., as the cave opens to the NW, the vegetation of the coastal plain west of Mount Carmel would have been over-represented as compared with that of the mountain itself making general palaeoenvironmental reconstruction unreliable. This phenomenon has already been discussed regarding the adjacent Tabun Cave (Horowitz 1979), as well as other sites in the area (Weinstein, 1981; Weinstein-Evron, 1994). Still, the archaeobotanical data suggest the occurrence of typical Mediterranean vegetational formations in the area,

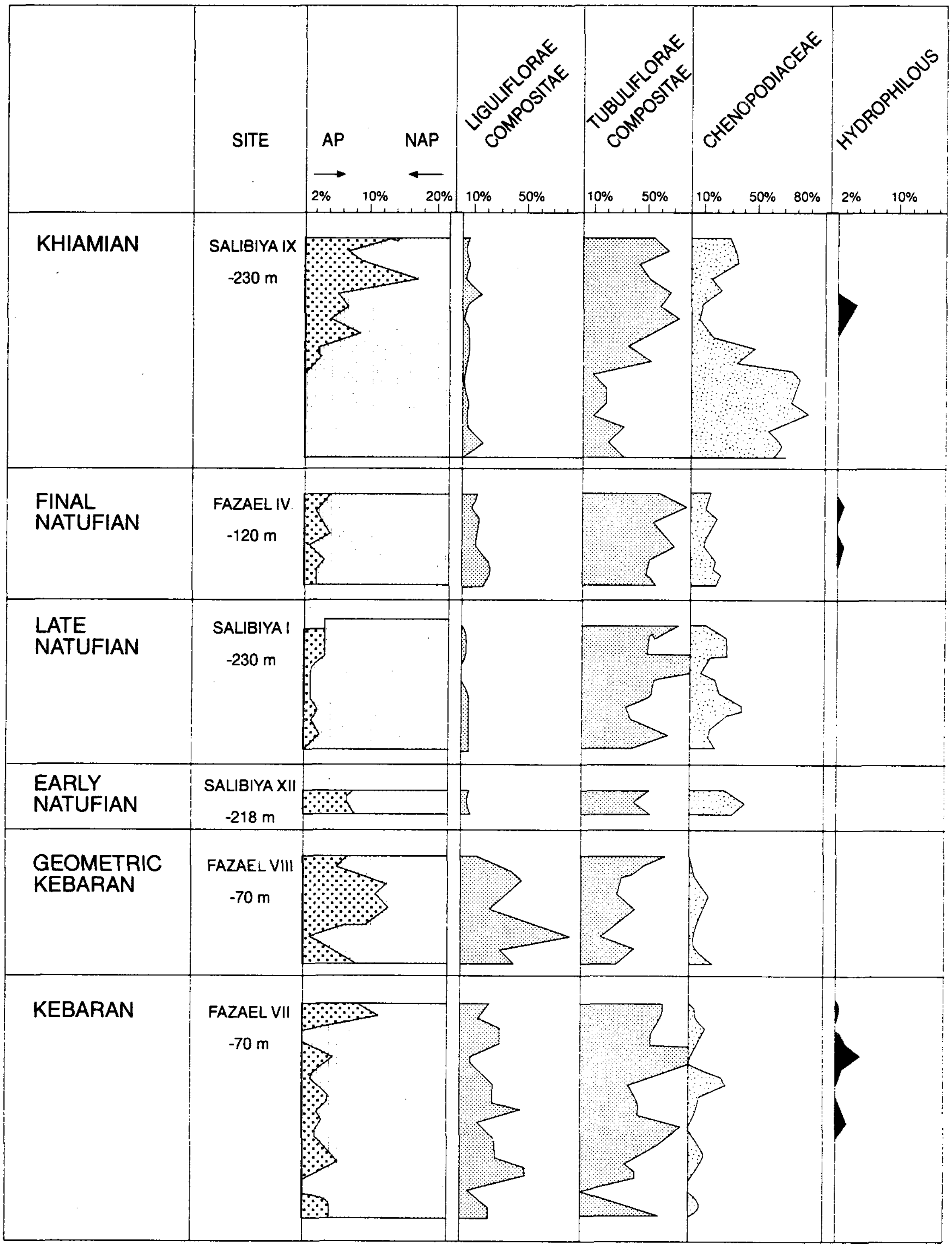

Fig. 73. Simplified pollen diagram of Fazael-Salibiya sites.

but the exact nature and extent are impossible to gauge on the basis of pollen samples from the site alone.

Geology and Geomorphology

As already mentioned, most of the available sedimentological data come from the semi-arid zones of the Levant. Here, palaeoenvironmental changes can be traced through an interpretation of geomorphological data from a series of geological sections, mainly by identifying alluvial/depositional (= humid) and colluvial/erosional (= dry) phases, and with the help of, e.g., processes such as pedogenesis and sand incursion (e.g., Besançon, 1981; Goldberg, 1977, 1981, 1986, 1994; Goldberg and O. Bar-Yosef, 1982; Goldberg and Brimer, 1983; Goring-Morris and Goldberg, 1990; Phillips, 1988; Phillips and Gladfelter, 1989; Gladfelter, 1990; Schuldenrein and Goldberg, 1981; Garrard et al., 1987, among others; see also a recent review by Sanlaville [1996] and references therein). The chronological framework arrived at depends on the presence of relatively or absolutely dated sites or artefacts. That such information is rarely available for all parts of a depositional sequence, and that the sections themselves show many gaps, means that dating successive sedimentological phases will always remain rather vague. This is particularly critical for the boundaries between phases, since here the evidence for the onset and/or end of specific conditions will often have eroded away, inevitably leading to slightly differing versions of chronological reconstructions for the same sections and processes (e.g., Fellner, 1995; Weinstein-Evron, 1993b). However, the overall picture that emerges corresponds rather well with the palynological data. A dry phase, between 22,000/20,000 and 17,000/14,500 BP, broadly coinciding with the LGM (Weinstein-Evron, 1993b), was followed by a humid Late Glacial, with a peak in precipitation between 13,000 and 11,000 BP (Baruch and Bottema, 1991).

A similar picture emerges from the isotopic analysis and dating of well-developed calcic horizons within palaeosols contained in the northern Negev loess sections (Magaritz, 1986; Goodfriend and Magaritz, 1988). The relatively humid conditions during the periods centred around 29,000 and 13,000 BP, are also related to a southward displacement of the desert boundary (Magaritz, 1986, Magaritz and Goodfriend, 1987). Further evidence for the existence of a wet period at this time comes in the form of fresh-water lacustrine sediments that can be found in the present-day desert areas of the northern Sinai (e.g., Goldberg, 1977, 1984). A similar trend is indicated by the reconstructed high Lisan Lake levels (Begin et al., 1985), but opinions still vary as to the amplitude and exact chronology of variations in lake levels (Goldberg, 1994 and references therein; Sanlaville, 1996 and references therein). An increase in the number of human occupation sites in the present-day semi-arid zones is also indicative of relatively moist conditions (Goldberg and Bar-Yosef, 1982).

That, similar to the scenario implied by the palynological evidence (Baruch and Bottema, 1991), there was a short, dry interval between c. 11,000 - 10,000 BP is here indicated by dune migration (Magaritz, 1986; Magaritz and Enzel, 1990), and by the desert boundary extending northward (Magaritz and Goodfriend, 1987), as can be gathered from, e.g., land-snail studies (Magaritz and Heller, 1980), the deposition of a thick layer of halite, recorded in boreholes in the Dead Sea area (Yechieli et al., 1993), and various data from Mediterranean (e.g., Rossignol-Strick, 1993, 1995) and Red Sea (Almogi-Labin et al., 1991) cores.

Fauna

Based on her studies in Mount Carmel showing the relative changes between *Dama mesopotamica* and *Gazella gazella* representations, Bate (1937) was the first to suggest that Natufian faunal assemblages, which are typically rich in gazelles, indicate a relatively dry climate. This is supported by the composition of microfaunal assemblages (Tchernov, 1979b). Significantly, the Natufian was then discussed "en gros", and no evidence for changing trends during this period was available. Moreover, in the case of the el-Wad Layer B assemblage, for example, some cross-site grouping was employed, and "[a]lthough no remains of *Capreolus*, *Cervus elaphus*, or *Alcelaphus* were actually present in the collection from Level B of M. Wad, specimens representing each of these species were obtained from the corresponding Level of the neighbouring cave of Kebara, and may therefore be justifiably included in the faunal assemblage of this time" (Bate, 1937: 153). When deeper Natufian sequences were studied and sub-phases and chronology were defined and refined, a significant decrease in numbers of *Dama mesopotamica* as compared to *Gazella gazella* was observed in most sites. This shift apparently coincides with the change from the Early to Late Natufian (Davis, 1982, 1987), suggesting aridification and decrease of woodland through time.

Several questions are still to be resolved regarding this apparent palaeoecological change: (1) was this apparent decrease in woodland and concomitant rise in numbers of gazelles climatically (as suggested by the palynological and other palaeoenvironmental data) or humanly induced (Garrard, 1982); (2) does it reflect demographic pressure intensified by environmental deterioration (Davis, 1982, 1987, 1991) or, (3) does it reflect selective hunting or culling, possibly even herding, of gazelles (Legge, 1972b; Davis, 1982, 1983, 1991; Cope, 1991, but see Dayan and Simberloff, 1995). The faunal evidence from the el-Wad terrace (Valla et al., 1986) seems to indicate some humidification towards the end of the Natufian, but the assemblage is too small for a reliable trend to be established. As with many other Natufian faunal assemblages, the el-Wad data exhibit a large variety of species, indicative of a wide range of habitats exploited (see also below, Appendix III).

Subsistence

Since el-Wad is located in an ecotonal setting where the slopes of Mount Carmel meet the open expanses of the coastal plain, a variety of locally available resources from different ecotypes could be exploited, including hills, mountain slopes, mountain inner valleys, the coastal plain, the wadi itself, and near-by springs. The Mediterranean sea and shore also provided raw material and food resources. This picture conforms to the model suggested by Henry (1989) for major Natufian sites, or hamlets, in general, according to which each such site enjoys a number of different habitats and proximity of important resources (i.e., wadi channel and springs, plant and animal resources, and flint), and whose integration results in a viable economy. While no springs are reported from the vicinity of el-Wad today (Inbar and Ayal, 1980), two are specified on Mandatory maps of the area (Survey of Palestine, 1942): one on the mountain, some 1.5km north-east of the cave, and another in the coastal plain, 0.8km to the south-west of the site. Much of the water from springs has been since captured and water production from new bores (Inbar and Ayal, 1980) have necessarily resulted in a lowering of the groundwater level in the area.

Over-representation of gazelles (*Gazella gazella*) among the faunal assemblages recovered from the site (Bate, 1937; Garrard, 1982; Valla et al., 1986; and see below, Appendix III) is generally seen as indication of the exploitation of local fauna, especially from the coastal plain; the good pasturing grounds that stretched along the foothills (see above, Chapter 3, "Use of the Cave in the 20th Century"), could have encouraged the grazing of gazelles. The relatively large, flat inner valleys that can be found within the Carmel area (e.g., Emeq Maharal, some 2.5km south-east of el-Wad; Fig. 7) raise the possibility that at least some of the hunted gazelles may have originated from such ecological settings (see also Bökönyi, 1982). Gazelles could also have been hunted on the Eocene hills of the southern Carmel and the Ramat Menashe area, some 5-15km to the south-east (Figs. 6, 7), with their characteristic *Quercus ithaburensis* deciduous park forest (Eig, 1933; Zohary, 1955), where they are found roaming till today (Salman Abu-Rukun, personal communication, 1997). Other animals, especially Cervidae (*Dama mesopotamica*, *Capreolus capreolus* and *Cervus elaphus*), were probably hunted in the more densely wooded Mount Carmel, or, e.g., in the forested areas of the coastal plain. The two former may also adjust to grassland and open landscapes (Putman, 1988). Together with the various deers, wild cattle (*Bos primigenius*) show that, besides open landscapes and grassland (Bökönyi, 1982), there were "localities with woods or thickets and an available [permanent] supply of water" (Bate, 1937: 154). The rodents found at el-Wad (Bate, 1937; Valla et al., 1986; below, Appendix III) also suggest the existence of more wooded areas (with e.g., *Sciurus anomalus*) alongside drier patches of open landscape (*Mesocricetus auratus*) and stands of grassland (*Microtus guentheri* and *Spalax ehrenbergi*) around the site. The latter may be a result of human activity in the immediate vicinity of el-Wad.

The Natufians of el-Wad made use of a variety of other mammals, amphibians, reptiles and birds (Valla et al., 1986; below, Appendix III), characteristic of various biotopes. That there were marshes or bodies of water is shown by the remains of *Pelobates syriacus* within the faunal assemblage (Valla et al., 1986). The use of the shore area itself is implied by the *Columbella rustica* shells found at the site (identified by D. E. Bar-Yosef), and by the occurrence of sandstone "beads" the Natufian inhabitants brought back with them (Fig. 62). Marine fish bones of littoral species (belonging to the Sparidae, Mullidae, Mugilidae and Serranidae families), together with marine shells (*Dentalium* sp., *Conus mediterraneus* and *Arcularis gibbosula*), were reported by Valla et al. (1986). While *Dentalium* shells were abundantly found at the site, and especially within the decorated burials where they "were used for making caps and circlets, and also for garters, capes, &c." (Garrod and Bate, 1937: 40), a list of some 15 other Mediterranean Mollusca species, identified by Connolly and Tomlin, is given in Bate (1937).

The ecotonal setting of the site, together with an abundance of vegetal resources, is further indicated by the botanical data (see above, Chapter 5, "Organic Material"). Both the charcoal remains (Lev-Yadun and Weinstein-Evron, 1993, 1994) and the pollen assemblages (Weinstein-Evron, 1994) suggest a local, typical Mediterranean environment, with many oaks and pistachio, and extensive use of tamarisk, most probably derived from the coastal marshes, whose existence for the period under discussion, besides the faunal evidence, is supported by ^{14}C dates for marshy clays in the Mount Carmel coastal plain (Galili and Weinstein-Evron, 1985).

Even though the same habitats and vegetal resources occur in the area today, they are only of limited use if we want to try to determine their exact distribution during the Early Natufian. Any attempt at reconstruction should take into account a good many factors, for example that the climate was more humid, that the coastal plain was wider, that the topographical setting of the cave (at *c.* 140m above msl) was different, and that there have been many thousands of intervening years of land use and abuse. Inevitably, any such attempt is bound to remain partial and tentative.

The faunal and botanical data gathered at el-Wad indicate clearly the existence of wooded areas, grassland or open park forests, as well as wadi banks and marshes, near the site. Based on geomorphological, botanical and lithological/ pedological data, it seems logical to assume that wooded areas (with *Quercus calliprinos – Pistacia palaestina* as the main association) covered the mountain near the cave, and probably rather densely occupied the north-facing slopes of the hills in the area (Fig. 74a,b; Weinstein-Evron, 1981; Nevo 1995), as also indicated by the Arabic term "El Wa'r" (= "thicket" or "bush") that appears on the Mandatory maps (Fig. 15). Since stands of these trees can be found today on the aeolianite ridges west of the cave, it is possible that this association was much more extended, covering larger areas of the coastal plain in front and to the north of the cave, where the plain narrows considerably (Fig. 7). Again, Arabic names for various spots in the area (Survey of Palestine, 1942) imply the occurrence of other species, typical of the Mount Carmel maquis, such as *Laurus nobilis* ("El Ghara") and *Pistacia lentiscus* ("Es Sarris"). The latter suggests that parts of these areas were covered by a more open *Ceratonia siliqua – Pistacia lentiscus* formation, typical of low elevations in the area today. This association would have also covered the warmer and drier hill slopes that face to the south (Fig. 74,a,c), creating a relatively open, "El Farsh" landscape (Fig. 15). The facing of slopes undoubtedly influenced differential exploitation of micro-habitats in the area. As indicated by its distribution today, *Quercus ithaburensis* park forest may have also existed not far from the cave (Fig. 12; Fig. 74d).

The Mount Carmel maquis has a large potential for vegetal resources, as indicated by a detailed botanical survey around Sefunim Cave, some 8km north of el-Wad (Naveh, 1984). Since the Sefunim area is less disturbed than Nahal Me'arot itself, results of the botanical survey carried out there may be taken to represent the el-Wad area too. Clearly, about half of the identified plant species (117 out of 237) are exploitable by humans (Table 13) either directly or indirectly, through browsers and pasturing animals.

Table 13: Exploitable plant species of the surroundings of Nahal Sefunim (after Naveh, 1984). Determination for human consumption according to Dafni (1984). Species names updated according to Feinbrun-Dothan and Danin (1991).

WOODY PLANTS					
Trees		**Shrubs**		**Dwarfshrubs**	
Arbutus andrachne	F W	*Calicotome villosa*	Fl Br W	*Cistus salviifolius*	L
Ceratonia siliqua	F! P! Br W	*Genista fasselata*	W	*Cistus creticus*	L
Cercis siliquastrum	Fl F Br W	*Pistacia lentiscus*	Br W	*Coridothymus capitatus*	L
Crataegus aronia	F Br W	*Rhamnus alaternus*	Br W	*Majorana syriaca*	L
Laurus nobilis	L Br W	*Rhamnus palaestina*	F Br W	*Melissa officinalis*	L
Olea europaea	F! Br W!	*Ruscus aculeatus*	L	*Micromeria fruticosa*	L
Phyllirea latifolia	Br W!	*Asparagus aphyllus*	Sh	*Salvia fruticosa*	L
Pinus halepensis	W	*Smilax aspera*	Sh	*Sarcopoterium spinosum*	Br W
Pistacia palaestina	F Br! W	*Tamus communis*	Sh	*Satureja thymbra*	L
Styrax officinalis	W			*Teucrium capitatum*	L
Quercus calliprinos	F Br! W				

HERBACEOUS PLANTS					
Geophytes		**Legumes**		**Miscellaneaous herbs**	
Arisarum vulgare	L	*Anthyllis tetraphylla*	P	*Alcea acaulis*	L S
Arum dioscioridis	L	*Coronilla cretica*	P	*Alcea setosa*	L S
Asphodelus ramosus	B	*Hippocrepis unisiliquosa*	P	*Anagallis arvensis*	L
Crocus hyemalis	B	*Hymenocarpos circinnatus*	S P	*Caspella bursa-pastoris*	L
Cyclamen persicum	L Fl	*Lathyrus blepharicarpus*	S P	*Convolvulus caelesyriacus*	P
Ophrys umbilicata	B	*Lotus peregrinus*	P	*Daucus carota*	R
Ophrys bornmuelleri	B	*Medicago orbicularis*	P!	*Erodium gruinum*	P
Ophrys israelitica	B	*Medicago scutellata*	P!	*Erodium moschatum*	P
Ophrys galilaea	B	*Medicago polymorpha*	P!	*Foeniculum vulgare*	L
Ophrys transhyrcana	B	*Onobrychis squarrosa*	P	*Geranium molle*	P
Orchis caspia	B	*Pisum elatius*	S L P	*Geranium purpureum*	P
Orchis galilaea	B	*Scorpiurus muricatus*	P!	*Geranium rotundifolium*	P
Orchis tridentata	B	*Tetragonolobus paleastinus*	P!	*Isatis lusitanica*	L
Serapias levantina	B	*Trifolium campestre*	P!	*Kicksia spuria*	P
Tulipa agenensis	B	*Trifolium clusii*	P	*Mandragora autumnalis*	F
		Trifolium clypeatum	P!	*Nigella arvensis*	S
Grasses		*Trifolium stellatum*	P	*Papaver carmeli*	S
Aegilops ovata	S P	*Vicia hybrida*	S P!	*Plantago cretica*	L
Brachypodium distachyon	P			*Plantago afra*	L
Andropogon distachyus	P!	**Asteraceae**		*Salvia hierosolymitana*	L
Avena sterilis	P!	*Calendula arvensis*	L P	*Salvia pinnata*	L
Bromus alopecurus	P	*Carduus argentatus*	L	*Sanguisorba minor*	L P
Bromus syriacus	P	*Carlina involucrata*	L	*Sinapsis arvensis*	L
Catapodium rigidum	P	*Catananche lutea*	P		
Dactylis glomerata	P!	*Cichorium pumilum*	L S P		
Hordeum bulbosum	S B P!	*Gundelia tournefortii*	C		
Hordeum spontaneum	S P!	*Hedypnois cretica*	P		
Hyparrhenia hirta	P	*Inula viscosa*	L C		
Lopochloa phleoides	P	*Notobasis syriaca*	P		
Phleum subulatum	P	*Rhagadiolus stellatus*	P		
Piptatherum miliaceaum	P!	*Scorzonera papposa*	B P		
Piptatherum blancheanum	P!	*Senecio vernalis*	P		
Stipa bromoides	P	*Tolpis virgata*	P		
		Thrincia tuberosa	P		

F- fruits, S-seeds, B- bulbs, corms, etc., Fl - flowers, L- leaves, Sh- shoots, R- roots, C-capitulum. P- pasture for livestock and browsers (Br). W-wood. (!- high value).

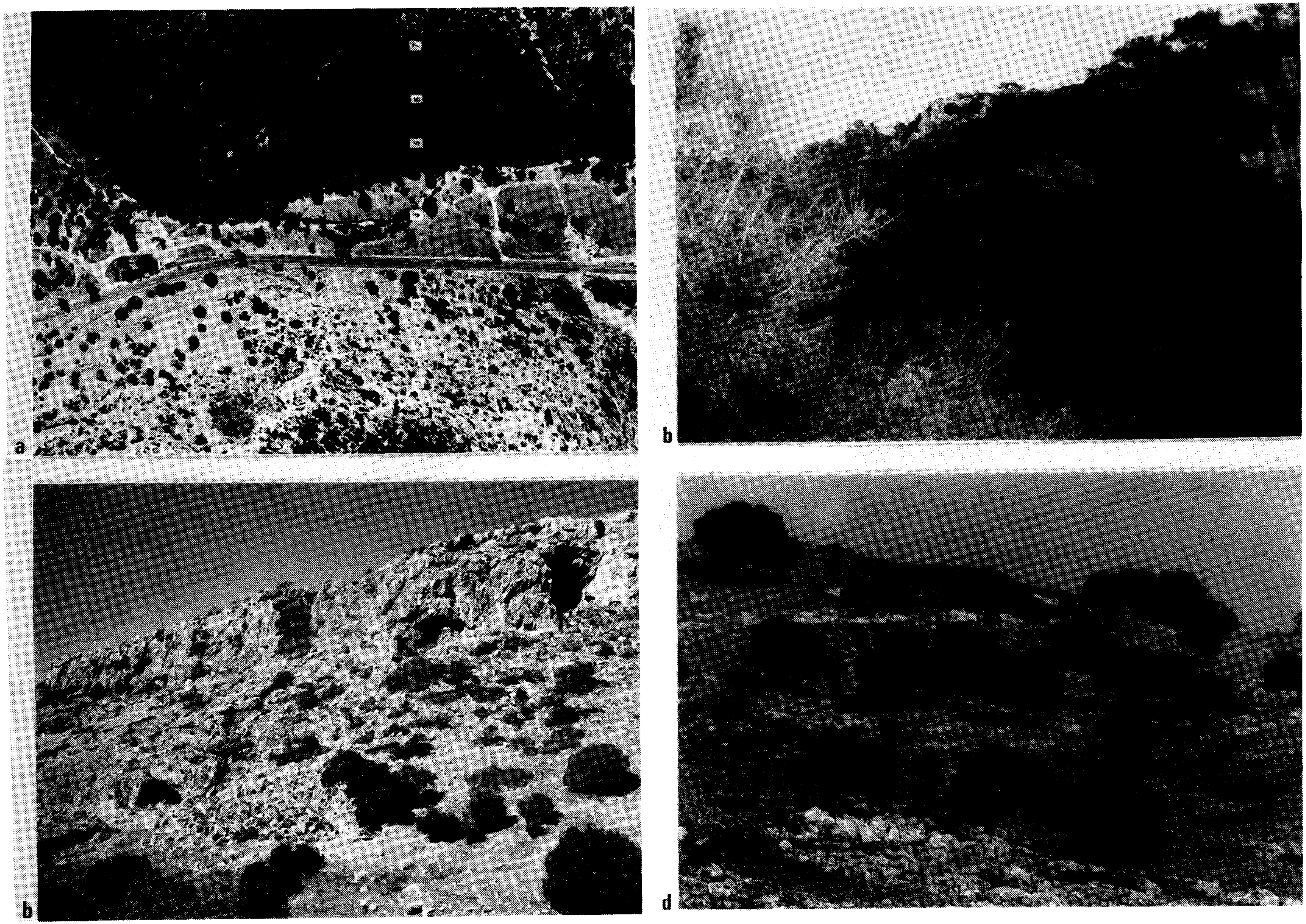
a
b
b
d

Fig. 74. Present-day plant formations in the Mount Carmel area: (a) north-facing (above) and south-facing slopes in Lower Nahal Oren: the more humid, north-facing, slope supports *Quercus calliprinos-Pistacia palaestina* maquis (b) while the drier, south-facing slope is characterized by the open landscape of the *Ceratonia siliqua – Pistacia lentiscus* association (c); (d) *Quercus ithaburensis* open park forest in the eastern Carmel; (e) freshwater marshes near Hadera, with large *Tamarix tetragyna* trees; in the water float plants of *Lemna minor*; (f) coastal kurkar ridge near Hadera, with typical dwarf shrubs of *Coridothymus capitatus*.

While Naveh (1984) regards the Nahal Sefunim vegetation as a valid representative of the natural Mount Carmel vegetation, he stresses the intensive human use for food, wood, fuel and pasture which have possibly reduced greatly "the stature of the sclerophyll phanerophytes ... by burning, cutting and browsing, especially during periods of greater population pressures, both in prehistoric and historic times" (Naveh 1984:42). He argues further that "all woody plants occurring in Nahal Sefunim surroundings and on Mt. Carmel ... are well adapted to fire by efficient regeneration mechanisms and the same is true for many, if not all, herbaceous plants" (Naveh, 1984:44), and that even the Carmel Natufian may have employed a rational use of fire, and modified their vegetation structure and composition "from natural into semi-natural and "semi-agricultural" ecotopes" (Naveh, 1984:54).

Marshes constitute an important addition to these wooded habitats. Today, marshy areas are relatively widespread in the southern Carmel and, to the south of it, in the northern Sharon coastal plain, where they are fed by fresh water springs and/or high ground waters, or occur along the coastal wadis. In many of these *Tamarix* sp. is dominant (Fig. 74e), which seems to have been the case for the Natufian as well, as indicated by the charcoal assemblages from el-Wad. Undoubtedly, marshes are an important potential source for plant and animal foods and resources, as corroborated by the impressive list of species reported for the coastal marshes of the area even today (Berliner, 1977 and references therein). In addition to some 200 hydrophilous and water-plants species, an incomplete list of some 70 animal species from these marshes (ibid.) includes Crustaceae (e.g., *Potamon potamios*), various gastropods and Bivalvia (e.g., *Unio* sp. and *Cardium edulis*), many fish (e.g., *Clarias lazera, Salaria fluviatilis, Garra rufa, Tilapia* sp., *Anguilla anguilla*), amphibians (e.g., *Rana ridibunda, Hyla arborea* and *Bufo viridis*), and various mammals (*Microtus guentheri, Lutra lutra, Herpestes ichneumon, Felis chaus, Sus scrofa*) and reptiles (e.g., *Trionyx triunguis, Mauremys caspica* and, until the turn of the century, *Crocodylus nilotica*). The rich avifaune is described in detail by, e.g., Paz (1986) and Zoaretz (1977). Eleven species of marshy habitats were reported from the Middle Palaeolithic avifauna assemblages of the nearby Kebara cave (Tchernov, 1959, 1962).

As for the area near el-Wad, such marshes probably occurred in the troughs in front of the site, east of the coastal kurkar ridge (Fig. 74f), mainly along the wadi and in areas where there was poor drainage. This is also suggested by the old maps of the area (Survey of Palestine, 1942), which indicate an alluvial (= "El Juruf") area north of the wadi course, and an "El Wa'r" ("thicket"), possibly of reeds, at the point where the wadi traverses the eastern sandstone ridge, and which presumably resulted from poor drainage. A small marsh can also be found on a British Admiralty map of the area in 1862 (Rosen, 1992), located south of the Atlit Crusader fortress. In general, the area in front and especially for the north of the el-Wad cave is relatively high and composed of colluvial sediments derived mainly from the near-by mountain, as shown by their high contents of red-brown terra rossa soils and the many limestone blocks and angular stones (Fig. 24). Artificial outlets (Nir, 1959), usually following pre-existent natural troughs (Butrimovitch, 1988), were dug through the eastern kurkar ridge in historical times to solve the problem of poor drainage of the Carmel wadis. Dark, deep alluvial soils are restricted to the low depressions. However, given the more humid climate during the Natufian, and the Late Glacial sea level rise, marshy habitats in the area would have been more widespread than today.

When reconstructing the carrying capacity of the area the importance of temporary waterbodies for the well-being of human as well as animal populations should not be underestimated (see above, Chapter 3, "Use of the Cave in the 20th Century"). Many wintering and migrant birds rely on marshes and long-lasting temporary water bodies for their food supply and, occasionally, for nesting (Paz, 1986). Several species of wintering and migrant birds were reported from e.g., the Natufian layers of Hayonim and Eynan (Pichon, 1989) and from Hatoula (Pichon, 1994).

Evaluations of Late Pleistocene-Early Holocene sea levels are based on global changes (Shackleton, 1987) and take into account local variations, especially when these are due to tectonics (e.g., Neev et al., 1987; Lambeck, 1996). The number of ways in which sea-level curves can be reconstructed, not ignoring small, local variations, is probably unlimited. For the purpose of our discussion it seems reasonable to adopt the global curve published by Fairbanks (1989), especially as it accords well with the picture suggested for Greece by Van Andel (1989, 1990). According to this curve (Fig. 75), the Early Natufian sea level lay some 100-70m below present-day msl. Given the available topographical, geological and batimetric data, the coastal plain near el-Wad was between c. 12-14km wide during this period, which, even if we allow for some variation, means that there was at least one additional aeolianite ridge (or chain of ridges) between el-Wad Cave and the Natufian Mediterranean, probably separated from the ridges more to the east by a trough where alluvial and marshy sediments accumulated over the years (Figs. 76, 77). This of course also meant a considerable increase of the available resources and an obvious greater economic potential as compared with later periods.

The wider coastal plain may have resembled the present-day Sharon plain, south of the Carmel coastal plain. If we take our cue from today's distribution, a mosaic of habitats can be envisaged for the coastal plain, each with its consumable plants (Dafni, 1980). These include the sea shore (with *Crithmum maritimum* and *Mesembryanthemum crystallinum*), wadi and marsh banks (with *Phragmites* sp., *Arundo* sp., *Nasturtium officinale*, *Apium nodiflorum*) and kurkar and hamra hills (*Quercus calliprinos, Q. ithaburensis, Ceratonia siliqua, Pistacia lentiscus*, grasses). Even when constantly available, *Crithmum maritimum* does not constitute a large supply of food and may have been used as a spicy addition only. Its importance lies, however, in its high vitamin C content (Franke, 1982). *Phragmites* and *Arundo* of the bank vegetation, on the other hand, are an important food source, as use can be made of various parts of the plant (root-stocks, pith, shoots and even capitula). Even with repeated harvesting, because of their vegetative multiplication, they supply large masses of vegetal material for use in handicraft activities (e.g., basketry, matting, weaving or net-making) which are indirectly deduced from the study of Natufian bone tools (Campana, 1989). *Nasturtium officinale* and *Apium nodiflorum* are also edible year-round.

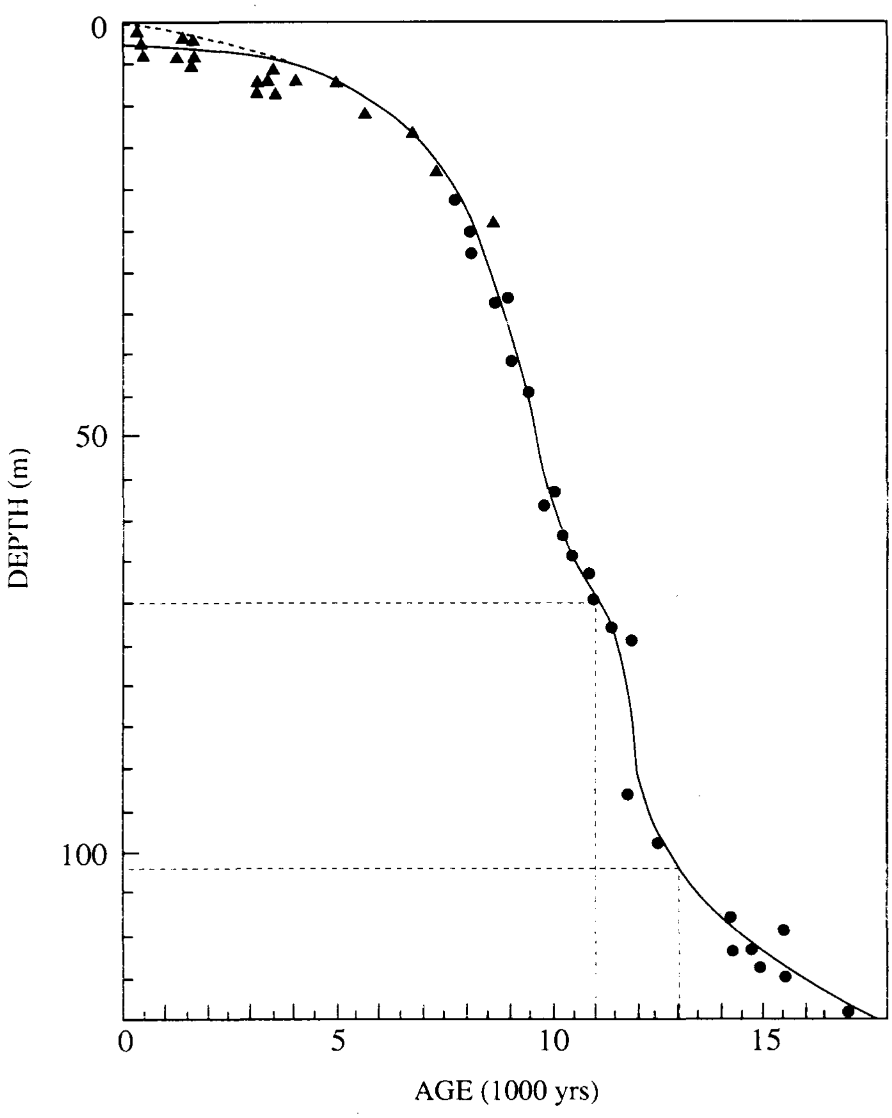

Fig. 75. A simplified Fairbanks Barbados sea level curve (Fairbanks, 1989). Circles are data from Barbados corrected for estimated uplift; triangles are data from four other islands in the Caribian (after Van Andel, 1990). During the Early Natufian, between *c.* 13,000-11,000 years BP, the sea rose by 35m.

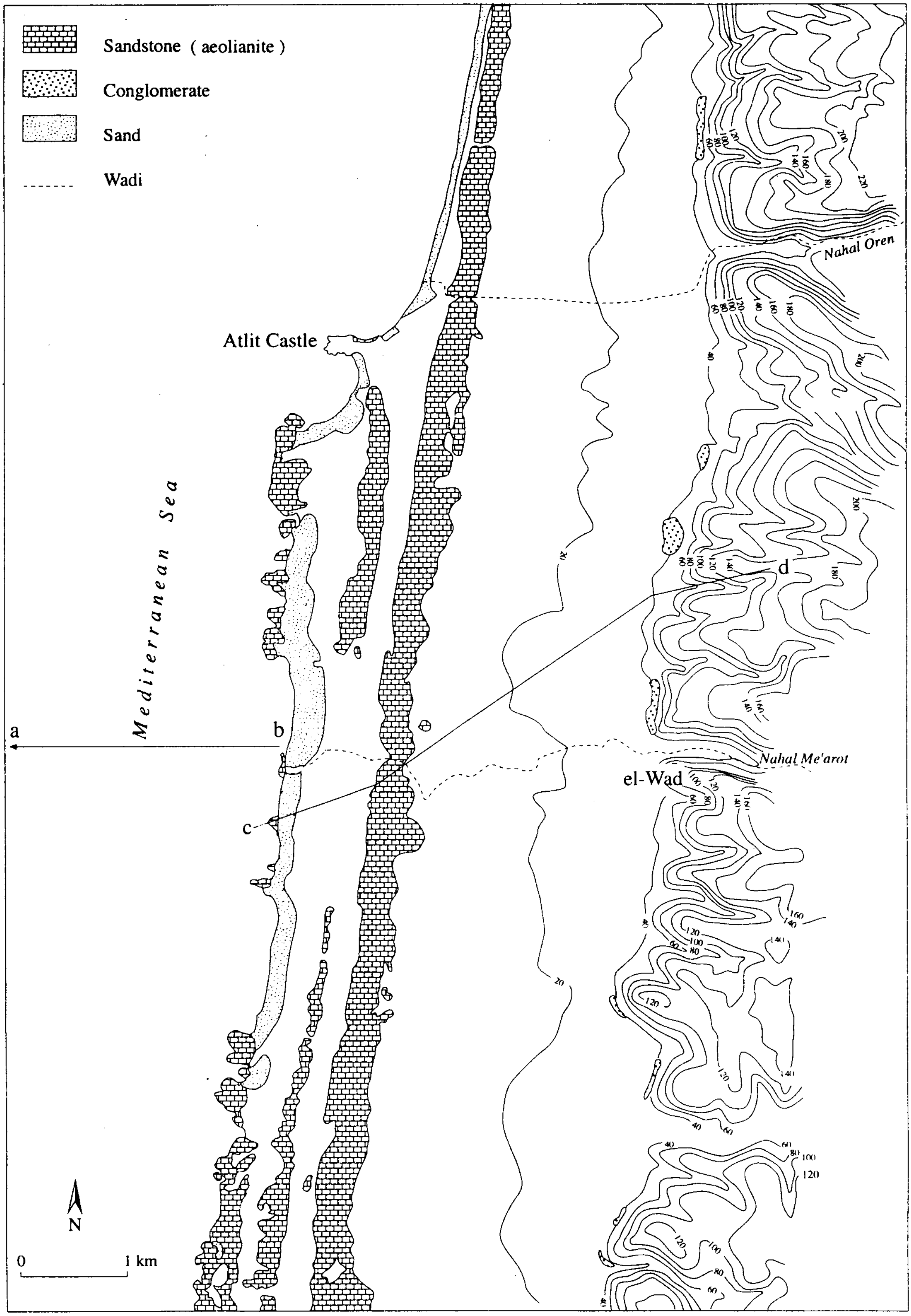

Fig. 76. The foot of the hills and coastal plain near el-Wad. Note the three aeolianite ridges in the west. a-b and c-d mark the location of the sections given in Fig. 77.

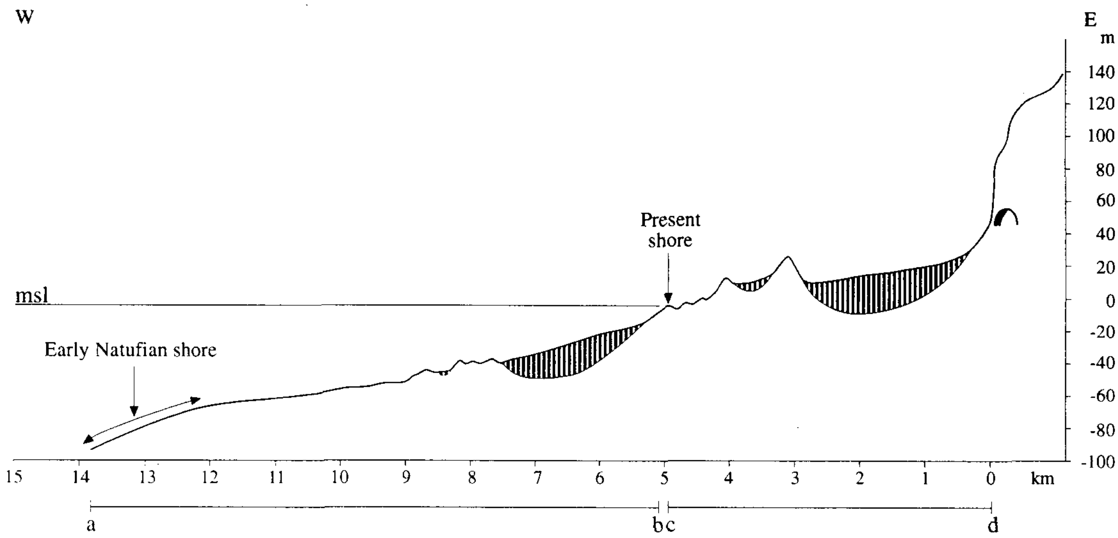

Fig. 77. Theoretical east-west section along the Carmel coastal plain in front of el-Wad Cave, during the Early Natufian. For location see Fig. 76. a-b based on batimetric maps (Survey of Israel, 1971) and complemented with the interpreted data of an eco-sounder profile effectuated by U. Galili at the mouth of Nahal Me'arot. c-d after Michaelson (1970).

The kurkar-hamra hills are another important source of vegetal food, especially *Ceratonia siliqua* and *Quercus ithaburensis* fruits. *Quercus ithaburensis* acorns were used as staple food until the turn of the century. They are better tasting than those of *Q. calliprinos*, keep well for long periods, and can be consumed roasted or ground into "porridge". *Ceratonia siliqua* fruits are also preservable, and have high contents of sugars and proteins. *Pistacia lentiscus* fruits may have been used as a secondary source of food. The apparent dominance of *Quercus calliprinos* in the archaeological charcoal assemblages of the Israeli coastal plain (Liphschitz et al., 1987) could, at least to some extent, have resulted from human bias. People may have preferred the wood of *Quercus calliprinos* for fires and building activities, and spare the *Quercus ithaburensis* since it was rich in edible acorns, which may explain the over-representation of the former in the charcoal assemblages. Ruderal plants (e.g., *Malva* sp., *Gundelia tournefortii*, *Silybum marianum*, *Notobasis syriaca*, *Urtica* sp., *Sonchus* sp., *Foeniculum* sp., *Chrysanthemum* sp.) also constitute an important element. These could be utilized from autumn to spring, but not in summer (Dafni, 1980). Malvaceae and Dipsacaceae pollen are found within the pollen spectra of the cave, indicating the possible occurrence of ruderal habitats near the site. Edible corm and bulb plants (e.g., *Crocus hyemalis, Cyclamen persicum, Asphodelus ramosus, Tulipa aegensis*, Araceae), with their various exploitable parts, can also be found in all habitats (Dafni, 1980, 1984).

Of all the formations discussed, it is the forests and the wet habitats that are especially important. The importance of wet habitats lies in the year-round availability of resources. The *Quercus ithaburensis* open forest is the richest and most varied source for plant foods (Amots Dafni, personal communication, 1996). As already mentioned, its acorns constituted a major traditional staple food in the area, available throughout the year, because of their preservability. With its open landscape and plentiful herbaceous vegetation this type of forest is especially attractive for roaming herds of gazelles, the most prominent of the animal species hunted by the Natufians.

Furthermore, wild cereals, especially wild *spontaneum* barley, are massively distributed and constitue an important annual component of open herbaceous formations, such as deciduos oak park forersts, as well as segetal, man-made habitats (D. Zohary and Hopf, 1994). An increasing reliance on plant resources, probably cereals, is indirectly inferred from the many groundstone implements, sickle blades and sickle hafts within the el-Wad Natufian material culture, as well as from dental studies (Smith, 1972, 1991; Smith et al., 1984) and strontium/calcium analysis (Sillen and Lee-Thorp, 1991) of Natufian (including el-Wad) skeletal remains.

The above theoretical discussion is supported by the analysis of Middle Palaeolithic archaeobotanical data from Kebara Cave (Lev, 1992; Baruch et al., 1992), situated 15km south of el-Wad (Figs. 2, 7) in a rather similar ecotonal setting. Only two groups of consumable plants — wood and fruits/seeds — are represented in the Kebara assemblage, and our discussion focuses on these only, since the use of other plant parts cannot be ascertained. Still, the available evidence suggests that the inhabitants of the cave exploited a large variety of vegetal resources. The most important of the seeds are large and medium-sized-seeds legumes, including *Lens* sp. and *Lathyrus* sp. (chiefly *L. cicercula*), and small grained Fabaceae. Trees are represented by many *Pistacia atlantica* shell fragments and *Quercus* sp. nut shell fragments. The other groups are much less important: the ruderal plants are represented mainly by *Mercurialis annua* and *Chenopodium murale*. The contribution of grasses, Asteraceae and other, miscellaneous herbs, is negligible. Among the wood material *Quercus* sp. (including *Quercus calliprinos* and *Quercus ithaburensis*) is the most dominant (Baruch et al., 1992). The maquis is further represented by *Crataegus* sp., possibly *Crataegus aronia.* The occurrence of *Pistacia* sp. accords with the present-day vegetation of the area. One of the specimens was of *Pistacia atlantica*, which is a typical companion of certain variants of *Quercus ithaburensis* park forests (M. Zohary, 1973). As already mentioned, its occurrence in the area is also attested to by the many shell fragments recovered (Lev, 1992).

The hydrophilous plants are represented by isolated finds of *Salix* sp. and *Ulmus* sp. *Cyperus* sp. pollen was retrieved from an hyaena coprolite (Weinstein-Evron, 1988), together with pollen of *Quercus calliprinos, Pinus* sp., *Olea europaea, Pistacia* sp., and various herbs (Poaceae, *Plantago* sp., Lamiaceae, Fabaceae, Brassicaceae and Asteraceae), which accords well with the multi-habitat picture suggested by the other archaeobotanical data.

Comparison between the archaeobotanical data of both el-Wad and Kebara and the list of present-day exploitable plants (Table 13) indicates clearly that plant resources must have been significantly richer than the archaeological evidence suggests, mainly due to selective preservation of various vegetal parts and the heavy bias towards fruits/seeds and wood. Legumes, which are an important protein source, were intensively consumed by the Kebara people (Lev, 1992).

In summary, in spite of the fragmentary evidence, the archaeobotanical and archaeozoological data, coupled with an analysis of present-day habitats, suggest that a variety of biotopes and many food resources must have been available for, and exploited by, the el-Wad Natufians, who did not "négliger aucune sorte de proie [et de nourriture végétale], même petite" (Valla et al., 1986: 37).

Procurement of Raw Material

By "raw material" we refer to any "material on which a particular manufacturing process is carried out" (Hanks et al., 1979). In its broadest sense, it includes practically all the materials the Natufian inhabitants of the site made use of, whether retrieved from various minerals (flint, basalt and ochre) or from faunal (bone, horncore, leather and hides, molluscs) and vegetal (wood, reeds) resources.

Identifying what kind of raw materials were used by prehistoric people is of crucial importance if we want to arrive at some understanding of the mode of exploitation of the environment and reconstruct the connections and interrelationships that may have existed between sites and populations, including trade ties. While evidence for earlier periods is sporadic, definite trade/exchange systems in the Levant can be attributed to the Upper Palaeolithic (Runnels and Van Andel, 1988; D.E. Bar-Yosef, 1989). Prior to the Natufian, the evidence suggests transport consisted mainly of "nonessentials", such as Mediterranean and Red Sea gastropods, the shells of which were used as ornaments (Mienis, 1977, 1987; D.E. Bar-Yosef, 1989, 1991; Reese, 1991). The long-distance transport of the latter (up to 200km in the Geometric Kebaran) may be explained by the high degree of mobility typical of hunter-gatherers, whereas long-distance exchange becomes evident with the Natufian and the first sedentary or semi-sedentary communities, *c.* 13,000-10,500 BP (D.E. Bar-Yosef, 1989). Others have argued that the widespread distribution of gastropods points to a broadening of social and economic interaction and/or the maintenance of social ties between geographically displaced groups (O. Bar-Yosef, 1990; O. Bar-Yosef and Belfer-Cohen, 1989; Henry, 1989; Kaufman, 1992). It may also be that these exchange/trade networks should be regarded as a major factor in the adoption and spread of agriculture (Runnels and Van Andel, 1988).

Determining what these interactions consisted in calls for a reconstruction of the exchange/trade networks used. Generally, such reconstructions rely on sourcing the raw materials that were exchanged. Unfortunately, apart from the above-mentioned shells and the occasional pieces of flint (Frachtenberg, 1992; Frachtenberg and Yellin, 1992; O. Bar-Yosef, 1991a; Christophe Delage, personal communication, 1997) and basalt for later prehistoric periods (e.g., Amiran and Porat, 1984; Gilead and Goren, 1989; Philip and Williams-Thrope, 1993), sourcing of mineral raw materials in the Levant is only in its very early stages.

Identifying and reconstructing the provenance and procurement of the raw material can be done in a number of ways, depending on the materials discussed. While for the characterization and consequent provenance-determination of the various mineral resources detailed geochemical and mineralogical analyses are required, other methods need to be employed for the vegetal and faunal materials. Here a reasonable "en gros" reconstruction of possible provenances can be arrived at if we are familiar with contemporary resources within the area under discussion and a detailed palaeoenvironmental reconstruction is in place.

As already argued, the Carmel area seems to have been rather self-contained as to faunal and vegetal resources. The most common plants and animal types found in the Natufian assemblages were readily available within the immediate surroundings of the cave or at least within its 5km-radius exploitation territory. The variety of habitats the area offered ensured the procurement of various animals, among them some large and small mammals, fish and turtles, as well as vegetal material such as wood, branches, reeds and straw, that could be used for constructions, as bedding and kindling materials or for the manufacturing of various tools, including containers. A growing body of indirect evidence, mainly based on wear-pattern analysis of bone implements (Campana, 1989, 1991), suggests the Natufians made widespread use of vegetal material (for instance, reeds in basketry manufacture). Thus, even if we cannot ascertain the exact provenance of the raw material used in the manufacturing of each artefact found at the site, the abundance of resources within the Carmel area makes it highly probable that they were autochthonous to the region. As already mentioned, the rare instances of allochthonous species of, e.g., molluscs of *Dentalium elephantinum* (Valla et al., 1986) and *Cypraea moneta* (Bate, 1937) were derived from the Red Sea area through some kind of trade/exchange mechanism.

Mineral raw materials included limestone and dolomite, flint, ochre and basalt. Limestone and dolomite were rarely used at el-Wad (mainly for the manufacturing of mortars; Garrod and Bate, 1937), but are readily available in an area that contains many geological calcareous formations, ranging from the Albian to the Neogene (Fig. 8). Flint was clearly the most widely used, as indicated by the rich lithic assemblage. Most of the flints used by the Natufians of Chamber III were in various shades of grey (from 10YR 7/1 to 10YR 4.5/1; Munsell, 1929-1942), followed by considerable amounts of yellowish to greyish brown (10YR 5.5/2 to 10YR 5.5/3.5) pieces. Dark grey (7.5YR 3.5/0) to veritable black (10YR 2/1), as well as red (2.5YR 4.5/2), and white (10YR 8/1-1.5) occur occasionally. The flints also differ as to homogeneity, external smoothness, translucency and whether or not they contain fossils. The Mount Carmel area is relatively rich in geological formations which contain layers or lenses of flint (Frachtenberg, 1992). These include the Cenomanian (Isfiya, Khureibe and notably Shamir) and the Turonian (Um ez-Zinat) formations (Fig. 8), outcrops of which can be found today no farther than 1.5km of the cave (Karcz, 1959; Kashai, 1966). Eocene flints are also quite at hand as they can be found in abundance along the southern limits of the mountain and in the nearby Ramat Menashe (Figs. 6, 7). In spite of this large variety of sources, it is Cenomanian flints that seem to have been the type most frequently used by the Natufians of Chamber III (Shimon Ilani, personal communication, 1996). A detailed provenance study is still under way, and exact sources of flint await identification. It was shown (Frachtenberg, 1992; Frachtenberg and Yellin, 1992; Delage, 1997) that visual inspection can serve as a preliminary step in classifying flints, and can give us a very large definition of their potential sources, but it is not sufficient for a reliable differentiation and provenance determination of flints of local facies, especially within specific geological formations or when individual artefacts are concerned.

Attempts at determining flint types and their provenance have been carried out for other Mount Carmel sites, e.g., Middle Palaeolithic Kebara (Frachtenberg, 1992) and Middle Palaeolithic to Neolithic Sefunim (Ronen, 1984). Flints originating from an area which extends from Kebara in the south to Nahal Oren in the north (= some 15km) were apparently used at the site (O. Bar-Yosef et al., 1992), alongside raw material that had originated in the Eocene Ramat Menashe, c. 4km to the east of the cave. A few specimens, made of Turonian banded flint, apparently came from further afield, that is, the more southern part of the country (the Judean Desert, the northern Arava and the Negev; Frachtenberg and Yellin, 1992), at least 120km from the site. The validity of this latter source still needs to be established by testing it against other, less remote flint sources, e.g., at the Um el-Fahem area, located only 25km from Kebara, in spite of Frachtenberg's contention that they do not to belong to the same type discussed by him (Frachtenberg, 1992).

Only minor changes through time have been shown in flint-type utilization for the Sefunim Cave, Middle Palaeolithic to Neolithic sequence (Ronen, 1984). Again, the conclusion was that the inhabitants of the site apparently used local flint sources, though their exact provenance was impossible to determine. The exception forms a rare, very distinctive Neolithic flint type, that may have originated from as far as 7km to the south of the cave, a locality where a Neolithic workshop has been identified (Ronen and Davies, 1970). A study done at Hatoula, in the Judean Shephela (Ronen et al., 1994), also indicates that the use of local resources is the most common.

No results of provenance determinations of Natufian flint assemblages have as yet been published regarding the Carmel area. Only for tabular flint, Garrod states that it "occurs abundantly, both in the limestone and weathered out on the surface, between the villages of Jeba and Ain Ghazal, two miles to the south of Wady el-Mughara" (Garrod and Bate, 1937:41). A detailed study is under way for Hayonim (Mousterian and Natufian) and for the Natufian at Eynan (Delage, 1997). For the Early Natufian of Hayonim, it could be demonstrated that for the manufacturing of certain tools the inhabitants of the site made a clear selection towards specific flint types, which are not derived from local, nearby sources, even though the latter are of good quality for flintknapping (Delage, 1997; and personal communication, 1997).

Whatever the exact sources of flint at el-Wad, it is most likely that it originated from the area around the cave. The Natufians apparently invested but little effort in collecting flint, and even less in the manufacturing of their tools, let alone their standardization, suggesting some "regression" in this regard *vis-à- vis* earlier cultures at the same location, especially the Aurignacians and the Acheulo-Jabrudians, almost as though the Natufians lacked the kind of regard for their tools as shown by these other cultures. Such form of "disrespect" can also be seen in the widespread re-use of older blanks or cores, as shown by the double-patination on numerous artifacts. The same holds true for the many tools done on primary blanks, the many exhausted cores and the use of older (Upper Palaeolithic?) endscrapers as sickle blades (see above Chapter 5, "The Lithic Assemblage"). As already mentioned, the "flint bones" used for the figurines may have originated from outcrops some 1.5-2.0km from the cave (see above, Chapter 5, "Decorative and Art Objects").

At this stage of research it is impossible to decide whether this apparent attitude of "disrespect" is cultural, i.e., could be explained by developments in other aspects of their material culture, whereby flint-tool manufacturing was somewhat left behind, with the emphasis on the fabrication of specific tools (e.g., lunates and sickle blades) and artefacts made of other raw materials (e.g., basalt, bone, hides, wood, reeds and straw). It could also have been the result of temporary difficulties in flint procurement, following some kind of environmental change (e.g., a dense vegetational cover?), or have been caused, at least partly, by a density and intensity of occupation and the larger amounts of flints used by the inhabitants of the site during a relatively short period of time. The possible impact of raw material shortage on the manufactured artefacts of other Natufian sites has been discussed, e.g., by Belfer-Cohen (1988) and Valla (1984; but see Delage, 1997). This discussion, of course, is based on my own subjective impressions of the quality of the lithic artefacts. Detailed comparative studies are required in order to verify these informations.

As for ochre, following an in-depth characterization of the archaeological samples through mineralogical and geochemical analyses (see above, Chapter 5, "Ochre Remains"), and in order to identify the provenance of the materials used by the Natufian inhabitants of the el-Wad Cave, a geological survey was conducted of ochre outcrops in the Mount Carmel area, together with mineralogical and geochemical comparisons between geological and archaeological samples (Weinstein-Evron and Ilani, 1994). Common sense dictates, again, that such sources from within the Carmel area itself had served for the procurement of raw material found at the site.

Eight sites of epigenetic iron-oxide mineralizations were found in the Mount Carmel area (Figure 67), all within a range of 0.3 to 10km from el-Wad (see above, Chapter 5, "Ochre Remains"). Based on detailed mineralogical and geochemical studies of both the archaeological ochre remains and ochre from the Mount Carmel outcrops, it has been concluded that the iron mineralization sites in the Mount Carmel area and the ochre fragments from the cave are quite close from a mineralogical point of view and have a similar elemental range of contents suggesting that local sources, from outcrops and alluvium within a distance of c. 10km from the cave, unidentifiable individually, provided the ochre used by the Natufians of el-Wad (Weinstein-Evron and Ilani, 1994; and see above, Chapter 5, "Ochre Remains").

Red haematite is the most common within the ochre fragments in the cave, and was also more often ground than goethite which, in turn, is the common iron oxide in the Mount Carmel mineralizations and thus more readily available. Based on our heating experiments, it has been suggested that the haematite found at the site could have been produced through controlled heating of geothite. This cannot be ascertained, however, in the absence of geochemical markers distinguishing between the collected and the heating-manufactured haematite and so long as no hearths containing both haematite and goethite fragments, in various heating stages, have been unearthed.

As already mentioned, the many fragments of quartzolite and jasperoid-type found in the cave suggest that these are the discarded waste of raw material that proved too hard to grind. It is also possible that these red stones were collected for their aesthetic value rather than for the extraction of pigments. Pieces of ochre may have been brought home, as they were found during hunting or foraging in the mountain or by more task-oriented trips to the mountain outcrops.

Basalt was another raw material widely used by the Natufians. Its exact provenance is not known. Based on geological maps of the area, it has long been held, at least for more northern sites such as Hayonim, that basalt must have originated from areas as far afield as the Lower Galilee and Mount Carmel (e.g., O. Bar Yosef, 1991a). During our iron-oxides survey in the Mount Carmel area we have located a few exposures of large, hard and unweathered basalt blocks at a distance of only 5-10km from the cave (Weinstein-Evron et al., 1995). The blocks, the largest of which attain 50cm in diameter and weigh tens to hundreds of kilograms, could easily have served as raw material for the manufacturing of utensils, including bowls and mortars. This has come as a surprise as the Mount Carmel volcanism was generally believed to include primarily tuffs, with only a few, usually weathered, basalt flows. Again, common sense rules that the available local basalts must have been used by the Natufians of Mount Carmel. Consequently, we have hypothesized that the el-Wad basalts originated from these, recently found, local Mount Carmel sources.

Detailed petrographic, mineralogical or chemical finger-printing of Levantine basalts is not available yet, in spite of the occasional chemical mapping of basalt flows (Goren-Inbar et al., 1986), and though there have been several successful attempts concerning Chalcolithic and Early Bronze groundstone implements (Amiran and Porat, 1984; Gilead and Goren, 1989; Philip and Williams-Thrope, 1993). A more straightforward way may well be to use the unique geological setting of the Mount Carmel basalts to source the archaeological implements and then to show that they originated from these local exposures.

The uniqueness of the Carmel basalts is due to their stratigraphical position. Basalts of varying ages are distributed differentially throughout the Levant. Volcanic rocks of late Cenomanian-Senonian (Upper Cretaceous) age are known only in the Mount Carmel region (Sass, 1980). While in other regions, Tertiary and Quaternary basalts are widespread (Mor, 1993), basalts of these relatively younger ages were not found on the Carmel. This suggests that through K-Ar dating of basalt implements from el-Wad and samples of locally occurring basalts it ought to be possible to determine whether the raw material used in the manufacturing of the el-Wad groundstone implements originated in the Carmel area itself. Results of the dating are summarized in Table 14.

The Mount Carmel fresh basalts yielded ages ranging between 88-77 million years (My) in accordance with their Cenomanian-Senonian stratigraphic position. The dates of the basalt tools from el-Wad, however, are of Late Tertiary to Quaternary age. This clearly excludes the nearby Mount Carmel area as the source of the raw material for these tools. That the occupants of the site ignored locally available basalts is surprising in view of the emphasis we found on the utilization of local foods and mineral resources, especially if we recall that the iron oxides used by the inhabitants of el-Wad are to be found locally in close proximity to exposures of volcanic rocks.

Table 14. K-Ar ages of Carmel basalts and basalt artefacts from el-Wad (Weinstein-Evron et al., 1995). In the cases of duplicate measurements, the value given by the measurements with the higher ^{14}Ar rad is more reliable. For the last sample, the determinations indicated (<250 My) are minimum dates and should be taken as approximations only as they are close to the laboratory limit of detection.

SAMPLE	K (%)	^{40}Ar rad (%)	AGE (My)
Fresh basalt	1.17	91	82.4±1.7
Fresh basalt	1.10	94	77.6±1.6
Fresh basalt	0.90	94	88.0±1.8
Fresh basalt	0.84	88	83.7±1.7
Basalt pestle	1.10	13	1.3±0.1
Basalt pestle	0.80	15	3.7±0.2
		6	1.6±0.3
Basalt grinding stone	0.90	6	2.6±0.5
		24	1.6±0.1
Basalt pestle	0.70	-	<0.250
			<0.250

Where, then, did the el-Wad basalts originate from? Extensive K-Ar dating of basalt occurrences in northern Israel has been carried out in a number of studies over the last two decades (Mor, 1993; Feraud et al., 1983; Heimann, 1990; Shaliv, 1991). Results of these studies help identify more specifically the possible sources of basalt utensils found at el-Wad. The nearest Late Tertiary basalts (2.5-1.8 My) can be found in the Dalton area, north-eastern Galilee (Fig. 78), some 60km from the site. Pleistocene basalts (<2My) occur in the Jordan Valley (e.g., on the western fringes of the northern Golan, Gesher Benot Ya'aqov and along the Yarmuk River) and in the northern Golan (e.g., Birket Ram). Basalts of similar or younger ages are also reported from Syria, some 80-100km away (Mor, 1993; Coleman et al., 1983). The raw material for the manufacture of the Natufian basalt tools thus originated at least 60km east of the Mount Carmel area.

The range of the K-Ar ages suggests the exploitation of different, perhaps widely spread, basalt sources, none of them local. The younger dates indicate that at least one potential source was situated at a distance of at least 60km from Mount Carmel. Alternatively, the possibility that all the basalts originated in a relatively limited area should not be ruled out, in which case one ought to look for regions in which the whole range of the measured dates can be found. The nearest locations where recent (<0.250 My) basalts occur alongside Late Tertiary/Pleistocene basalts within a relatively restricted area are to be found east of the Jordan Valley (Heimann, 1990; Mor, 1993), suggesting the material travelled some 60-100km to reach el-Wad (Fig. 78).

No basalt flakes or waste pointing to on-site manufacturing have been found at the site. Moreover, basalt blocks large enough for the manufacturing of bowls and mortars would be too heavy to carry over such long distances. This suggests that the tools were finished at or near the raw material source, probably at a site specializing in the production of such tools, and then transported to the site. The identification of potential source or sources requires comprehensive dating and sourcing of implements from other Natufian sites. Indeed, dating of basalt implements from Hayonim and Eynan (Weinstein-Evron et al., 1997, n.d.1.) indicate a similar trend, namely, a potential basalt source east of the Jordan Rift Valley. Interestingly, even today the Golan basalts are considered the best, i.e., the strongest, toughest and thus the fittest for sculpturing and for the manufacturing of tombstones, for example (Ya'aqov Mamman, personal communication, 1997).

What may have been the exact nature of these long-distance contacts, whether trade, exchange or gift making, etc., and what the underlying social and economic systems and mechanism, is yet to be determined (Weinstein-Evron et al., n.d.2). At the same time, it is not known what goods may have been traded for the basalt implements. With the easy access the occupants of el-Wad had to the Mediterranean, that shells were used in exchange is highly probable. Significantly, Mediterranean shells are abundant within both Hayonim and Eynan mollusc assemblages (Tchernov, 1974; Mienis, 1987).

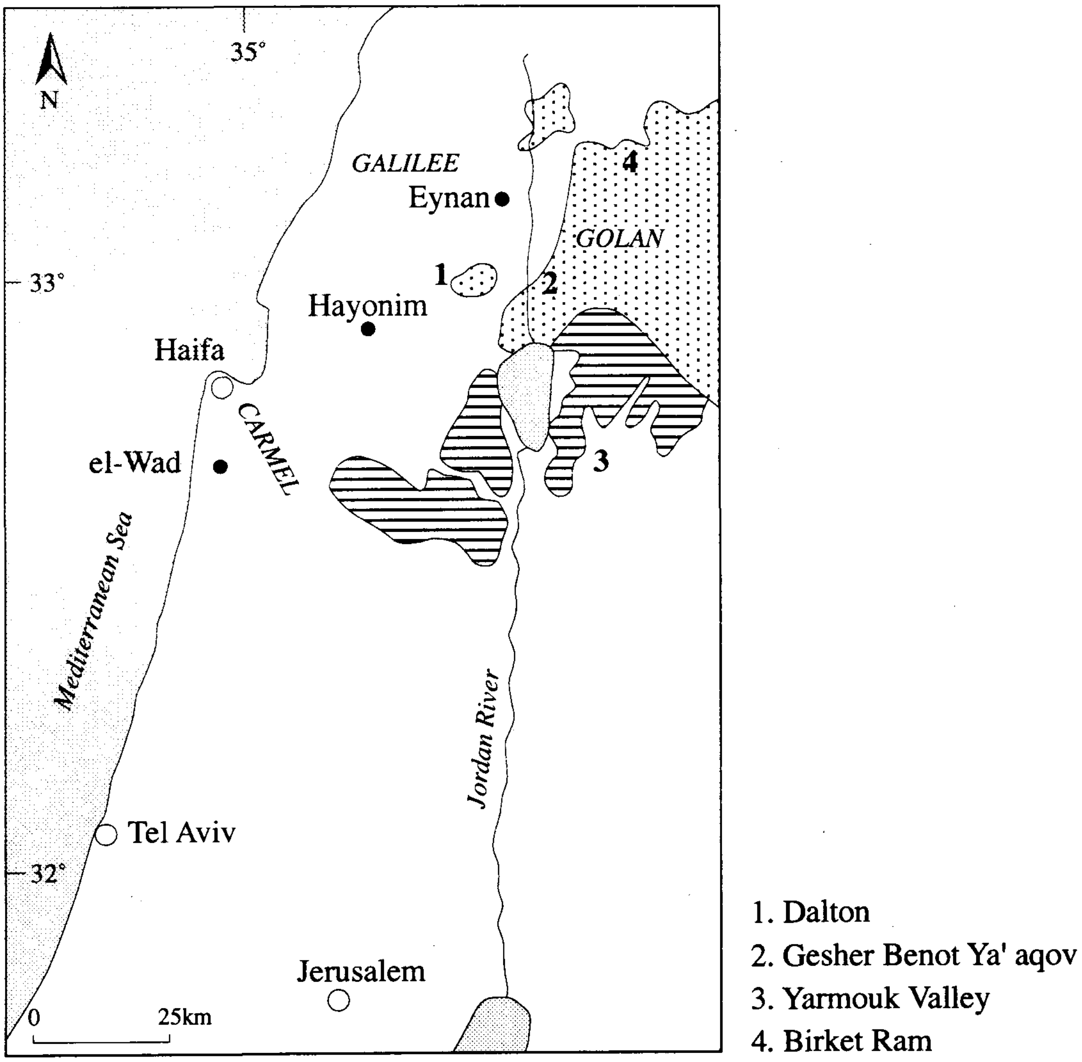

Fig. 78. Distribution of Tertiary – Quaternary basalts in the southern Levant and sites referred to in the text. Pointed areas: basalts younger than *c.* 4 My. Hatched areas: basalts older than *c.* 4 My.