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**PATTERNS OF ENVIRONMENTAL CHANGE IN THE NEAR EAST
DURING LATE PLEISTOCENE AND EARLY HOLOCENE TIMES**

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About 20,000 years ago continental glaciers covered much of Europe and North America. In all, approximately 30% of the earth's land surface was covered by ice. As paleoclimatic evidence continues to accumulate from a variety of disciplines, the magnitude of environmental change becomes increasingly apparent. Well beyond the ice sheets periglacial conditions with permafrost applied, and the Würm–Wisconsin faunas of Eurasia and North America attest to ecological conditions radically different from those of today. In the highlands of lower mid-latitudes the last Pleistocene glaciation was recorded by cirque, valley, and piedmont glaciers; or by screes, talus, and solifluction mantles. Elsewhere, in the lowlands of the subtropics, there are a variety of alluvial terraces, colluvial beds, and dunes. And in the innertropical zone, the available evidence now suggests that the tropical rain forest and forest-savanna were drastically modified and, at times, almost eliminated.

Although the broad lines of glacial phenomena have been known since the early 1900s, understanding of environmental changes in nonglaciated areas of the planet has proceeded at a rapid pace only since about 1950. Radiocarbon, potassium-argon, uranium series, and paleomagnetic dating now provide estimates of real time and, as a result, many fundamental stratigraphic concepts of Pleistocene glacial and interglacial sequences are either obsolete or in serious need of revision (see Butzer and Isaac, 1974).

Paleotemperature data, derived from deep-sea cores, indicate that ocean surface-water temperatures were appreciably different in the middle and tropical North Atlantic, the Mediterranean and Red Seas, as well as the tropical Pacific. Palynological evidence is rapidly becoming available from several sectors of the Mediterranean Basin. The accumulating pollen results from Africa are fascinating if enigmatic, while even in midlatitude Europe the interpretation of full-glacial vegetation continues to advance rapidly (see Butzer, 1971, pp. 287 ff.). Aided by these auxiliary sciences and refined by new techniques or revised theoretical concepts, geomorphological studies have found new and challenging problems in periglacial, desert, and tropical environments. Finally, both the number and sophistication of faunal and prehistoric studies have made a quantum jump in several areas.

Pleistocene studies are, consequently, in a state of flux and any synthesis is soon rendered obsolete by more recent findings. Under these circumstances any regional review can be little more than an assessment of currently available information. It renders the work of synthesis ephemeral and often thankless, but nonetheless vital if future work is to be directly along meaningful lines.

A review of late Pleistocene and early post-Pleistocene environmental changes in southwestern Asia and Egypt, written in 1973, faces these very same difficulties. For a critical discussion of the key late Pleistocene and Holocene sequences of the central and western Sahara, see Butzer (1971, pp. 312-34), and for the Sudan, see Butzer and Hansen (1968, pp. 254-58, 323-27) and Whiteman (1971, pp. 109-54). Furthermore, field work in most of this area has lagged, compared with research in many other regions of the Old World. Remarkably few stratigraphic events have been radiometrically fixed outside of Israel and the Nile Valley. In addition, the various episodes of the Late Pleistocene as well as the minor climatic variations of the Holocene are no easier to discern or interpret than are the gross changes of glacial and interglacial stages. It is generally difficult to pinpoint minor climatic variations, and in an intermediate environment such as the subtropical woodlands they are doubly difficult to recognize.

By the standards of northern Europe and the northeastern or northwestern United States, the Pleistocene and the Holocene of the Near East are poorly understood. Evidence is fragmentary and frequently of variable quality, and chronological data are inadequate for the purposes of a regional stratigraphy. At best we can outline the present status of information from different categories of evidence—glaciological, geomorphological, and biological. The broad, generalized impressions that obtain for the major physical provinces will then be presented by way of a tentative synthesis. The results, with the exception of a few areas, are unsatisfactory and, although we have attempted to take a positive approach wherever possible, it must be emphasized that the patterns suggested by the present evidence are best considered as working hypotheses.

Some fifteen years ago the writer assembled the available evidence on Pleistocene and Holocene climatic variation in the Near East (Butzer, 1958), attempting to organize the scattered data into a stratigraphic framework analogous to that of northern Europe. Despite a modest proliferation of field studies since that date, the evidence remains fragmentary for the late Pleistocene, and either nonexistent or next to incoherent for earlier time ranges. However, the results now available suggest that climatic changes within the Near East do not necessarily follow the same pattern from region to region; hence, broad interregional correlations are precluded. It is also apparent that, whatever environmental trends may be recorded in the Holocene, these cannot be simply fitted into the postglacial chronology of northern Europe. Similarly, no clearcut sequence of pluvials and interpluvials has emerged in any region, and glacial-pluvial

correlations are as untenable in the Near East as elsewhere in the Mediterranean Basin and Africa (Butzer, 1971, chaps. 19-20). This same picture of complexity, wherever adequate detail and absolute dating become available, also reduces the stratigraphic value of sea-level fluctuations (Butzer, 1974). In effect, although climato-stratigraphic concepts such as "early," "full," or "late" glacial, or last glacial (Würm) and last interglacial, retain a qualified value in the Near Eastern Highlands, chronometric frameworks offer the only means of realistic, interregional correlation.

GLACIAL-GEOMORPHOLOGICAL EVIDENCE

Glaciation in the Near East is today confined to a few of the highest peaks in the mountain ranges of Turkey, the Caucasus, and northern Iran.

Small glaciers have been reported from Turkey in the Kackar Dag (3,937 m) and Karagol (3,095 m), both in the Pontic Ranges; in the Ak Dag (3,024 m), the Bolkardagh (3,585 m), Ala Dag (3,900 m), Erçiyas Dag (3,916 m), Artos Dag (3,475 m), and Çilo Dag (4,168 m) of the Taurus Ranges, and on the Suphan Dag (4,434 m) and Mt. Ararat (5,165 m), among the summits of the Armenian Plateau (Messerli, 1967, pp. 166 ff.). From this evidence Messerli (1967, p. 167) estimates that the contemporary snowline rises inland from 3,200-4,000 m in the Pontic Ranges while also increasing from 3,500-4,000 m toward the interior within the Central and Eastern Taurus.

In Transcaucasia there currently are important glaciers along the crestline of the High Caucasus (Gora Elbrus, 5,633 m; Gora Shkhara, 5,201 m; Gora Kazbek, 5,047 m; Gord Bazar-Dyuzi, 4,480 m) (Klebensberg, 1949, pp. 787 ff.), with a snowline provisionally estimated at 4,000-4,300 m (Frenzel, 1959, Map 2).

Finally, although there is a perennial snow patch or firn ice on Mt. Lebanon (3,088 m), it responds very rapidly to minor changes in precipitation and appears to be unsuitable for a snowline determination (Messerli, 1966). Highlands located at more southerly latitudes in southwestern Asia and northeastern Africa lie well below the snowline.

At the height of the Würm glaciation, existing glaciers expanded considerably and a great number of new glaciers came into existence, both in the peripheral zones of western Turkey, Lebanon, and the Zagros Ranges of Iraq and Iran, as well as among the lower ranges of eastern Turkey, northern Iran, and Transcaucasia. In Turkey the snowline depression of the Würm full glacial varied between 800 m and 1,200 m (Messerli, 1967, pp. 167 ff.), while in the Iraqi Zagros (Algurd Dag, 3,730 m) this value was at least 1,200 m (Wright, 1962a). The snowline depression in northern Iran may have been little more than 800-900 m (Schweizer, 1970), with slightly or moderately greater values reported from older work in the Caucasus (Klebensberg, 1949, pp. 747 ff.). Both the High Lebanon (2,088 m) and Mt. Hermon (2,814 m) were glaciated, with a snowline estimated at 2,700 m—at least 1,000 m below that of today (Messerli, 1966, also 1967, p. 166, with critique of Kaiser, 1963).

Information for the late Würm Glacial and for the post-Würm is rather more scanty. Reinhard (1925) identified three retreat stages of the Caucasus glaciers, marked by successive snowline depressions of 800-900 m, 550-600 m, and 300-400 meters. The last of these was tentatively correlated with the terminal phase of the Würm.

In the eastern Pontic Ranges, Leutelt (1935) and Gall (1966) refer to three widespread retreat stages but give few details, while de Planhol and Bilgin (1964) describe similar "recessional" moraines from the Karagol. Work by Birman (1968) indicates the presence of moraines of probably late Würm and early post-Würm age, together with definite evidence of post-Würm ice activity, both in the Pontic Ranges (south of Rize) and in the Bolkardagh of the Central Taurus. In the Ulu Dag (2,543 m) of the western Pontic Ranges there are two successive moraines of probable late Würm or early post-Würm age together with evidence of a later, minor advance (Birman, 1968). Moraines postdating the Würm Pleniglacial are found on Ak Dag (3,024 m), Western Taurus (Messerli, 1967, pp. 148 ff.). In the Erçiyas Dag, Central Taurus, Birman (1968) suggests the presence of early post-Würm moraines although Messerli (1967, pp. 120 ff.) believes that an even younger rock glacier may still be of late Würm age. In the Ala Dag, Spreitzer (1958) identified several minor morainic stages, which he believed to pertain to readvances of the seventeenth to nineteenth centuries A.D. A rock glacier, similar to that described by Messerli from the Erçiyas Dag, was ascribed to the nineteenth century.

In the Eastern Taurus, Bobek (1940) noted a complex of "recessional" moraines in the Çilo and Sat Dag, suggesting a snowline depression of 350 meters. In the northern Zagros there are also small upper-story cirques at 3,000 m in the Algurd Dag, which suggest a snowline depression of at least 300 m in fairly recent times (Wright, 1962a); Desio (1934) reported recessional moraines of possible late Würm age in the Zardeh Kuh (4,286 m), southern Zagros. On the slopes of Mt. Ararat, Birman (1968) suggests the presence of late Würm or post-Würm moraines, while minor moraines postdating the Würm full glacial are fairly common in the Elburz Range of northern Iran (Bobek, 1937). The presence of these moraines seems to imply successive snowline depressions of 700 m, 450-500 m, 300 m, 250 m, 170 m, 100 m, and 50 m in the Tacht-i-Suleiman and of 700 m and 450-500 m in the Tochal group (3,970 m).

Seen in overview there is considerable, although highly fragmentary, evidence for late and post-glacial fluctuations of glaciers in the Near Eastern Highlands. Unfortunately, dating techniques are based on indirect geomorphic criteria or weathering phenomena that lack geochronological precision, and Birman (1968) was hampered in establishing a relative stratigraphy of moraines by a lack of suitable rocks for weathering criteria. Under these circumstances no definite chronology is possible. However, it seems reasonable to assume one or more readvances of the highland glaciers during the late Würm glacial, and at least one if not several stages of minor reglaciation or glacial advance in Holocene

times. Messerli (1967, p. 207) estimates a summer temperature depression of 6° – 7° C. for Asia Minor during the Würm Pleniglacial; and, presumably, conditions were still noticeably cool during late glacial times.

High mountain geomorphological processes of "periglacial" type are still so poorly understood in the Near East (see reviews and discussion by Tuzer, 1958, pp. 48 ff.; Bobek, 1963; and Messerli, 1966, 1967, pp. 122, 138 f., 148, 152, 199 ff.; also de Planhol and Bilgin, 1964, and Besançon and Hours, 1970–71) that they are of limited value for the present discussion.

Kaiser (1963) states that late Pleistocene cryoturbation phenomena, "ice wedges," and ice-wedge-like networks occur at elevations of 750–1,000 m in Lebanon and Syria. The writer saw these features illustrated by color slides at a colloquium (Geological Institute, University of Cologne, November 30, 1960). They are remarkably similar to colluvial or "solifluctoidal" phenomena studied in detail by the writer in Spain (Butzer, 1964a), where they are not even remotely connected with cryoturbation or ice wedges, and where it is only rarely necessary that soil frost be invoked for their genesis. The ice-wedge-like networks may be simple frost cracks, but they may possibly be dehydration fissures instead. Similar confusion exists concerning the interpretation of possible periglacial features in Sinai (see Butzer and Hansen, 1968, p. 427), the Sahara (see Butzer, 1973b), Ethiopia (see Butzer and Hansen, 1968, p. 450, and Butzer, unpublished), and southern Africa (see Butzer, 1973a).

LACUSTRINE EVIDENCE FROM THE INTERIOR BASINS

Fossil lake beds and high shorelines are common in semiarid, lower middle latitudes. The interiors of Turkey, Iran, and the Levant are no exception.

Broad, shallow lakes, possibly of seasonal type, existed in some of the extensive alluvial basins of central Anatolia. From such evidence Wenzel (1935, pp. 40 ff.) concluded that the regional drainage had once been integrated, although it lacked an outlet to the sea. Alluvial fans appear to have been deposited during or after the recession of these lakes, and the hydrography has subsequently deteriorated into a number of minor, isolated basins.

A second type of nonoutlet lake can be found in many small tectonic basins of considerable relief, and the literature contains frequent references to high shorelines, at elevations of as much as 100 m above present lake level, in such basins (Louis, 1938; Ardel, 1938, 1954; Lahn, 1951). In no case did external drainage develop, although, on occasion, some of these lakes overflowed into an adjacent, nonoutlet basin. Such older studies offer no stratigraphic frameworks and lack sedimentological analyses.

The lacustrine beds of Anatolia may some day provide substantial evidence for late Pleistocene and Holocene climatic changes. This can be inferred from the results obtained by de Planhol (1956, pp. 39 ff.), from the Burdur Basin. Early observations had indicated the presence of

shorelines at 45 m, 80 m and 90–95 m above the modern lake. These surficial beds are characterized by abundant shells of *Dreissensia burdurensis*, and an overflow threshold was recognized at the highest level, at ca. 947 meters. Louis (1938) found "microliths" on dune sands blown up from this lake, presumably during its ultimate recession, and considered them as Mesolithic. (Needless to say, small stone artifacts—when not precisely identified—have a potential time range of at least 15,000 years in the Near East.) In view of the freshness of the shorelines, he consequently concluded that the high lake levels were of late Pleistocene age and that the level dropped rapidly in early post-Pleistocene times. However, de Planhol (1956) discovered massive lake travertines to an elevation of 980 m (+125 m), which are disconformable under the younger shorelines. Paleobotanical examination of the uppermost travertine beds by G. Depape and J. Arènes (de Planhol, 1956, p. 41) showed the presence of warm-temperate species such as the trees *Quercus cf. pedunculata* and *Salix babylonica*, and the mesic grass *Glyceria cf. fluitans*. Considering that the absolute elevation of the travertines is 980 m and that a lowering of temperature would exclude such species from interior Turkey, they can hardly be of glacial age. They should tentatively be assigned to the early post-Pleistocene warm-up. Implicitly, the younger shorelines could be of Holocene age. Without radiometric dating a definite chronological position can hardly be suggested. But de Planhol's work serves to show how inadequate earlier studies have been, and how promising future investigation will be. The detailed geomorphological, sedimentological, and isotopic studies of similar lacustrine phenomena in southern California and in the Great Basin (see Morrison, 1965, with references) provide good examples.

In the interior of Iran, Bobek (1937) described shorelines at 45 m, 55 m, and 60–70 m above Lake Rezaieh (Urmia), which today has a maximum depth of only 16 meters. This enlarged lake covered an area twice the size of the modern one. Bobek computed a simplified hydrological budget for this former lake and concluded that a 5° C. lowering of mean annual temperatures could adequately explain a water volume almost 10 times as great as that of the present. The age of the high shorelines is uncertain.

Evidence of lacustrine deposits has long been discussed for the great salt pans or kavirs of Iran (Sedlacek, 1955; Gabriel, 1957; Stratil-Sauer, 1957; Bobek, 1959, 1963, 1968; Huckriede, 1962), but the age and paleoclimatic significance of these sediments has remained controversial until the more comprehensive study of Krinsley (1970). Although there is generally no absolute dating, the sedimentary sequences of the intermontane basin floors (Qum Playa, Great Kavir, Lut and Seistan Basins, Lakes Shiraz and Neirz) indicate overall semiarid conditions that were periodically ameliorated by lower temperatures, reduced evaporation ratios, and increased spring runoff from expanded mountain snowpacks. Existing shallow lakes were deeper and greatly expanded; present salt flats harbored shallow sheets of water during winter and spring, while

higher water tables inhibited wind erosion. The last lacustrine phase thus appears to date from the full Würm glacial, although "dating" of the 60 playas Krinsley studied is limited to early Upper Paleolithic artifacts associated with the high shorelines of Lake Neriz. Maximum aridity is indicated in early Holocene times.

More informative are the lacustrine marls and peaty beds described by Huckriede (1962) from a subdesert environment at Kerman (1,760 m). Over 3 m thick, these deposits include a rich mushroom flora, abundant ferns of the species *Pteridium aquilinum* (now confined to the rain forest of the southern Caspian littoral), a host of mollusca requiring permanently moist conditions, as well as the "northern" snail *Valvata piscinalis pulchella*—today found at over 4,000 m elevation in the Zagros Mountains. Saline soils with a completely different, xerophile molluscan fauna are present today. The radiocarbon age of these uncontested pluvial beds is "greater than 25,000 years" (Huckriede, 1962), suggesting an early Würm glacial date.

This evidence from Kerman is compatible with the results of Wright (1966) and his associates, obtained at Lake Zeribar (1,300 m) in the Zagros. From about 22,500 (the base of the longest core) to 12,000 years ago the climate was drier than today at this mountain locale, as shown by the aquatic flora and microfauna, as well as by the nature of the chloride and carbonate precipitates. Higher lake levels, with development of a floating sedge mat, were established during the terminal stages of the late Würm glacial or at the very beginning of the Holocene. These inferences are corroborated by the pollen profiles discussed further below.

From the Kerman and Zeribar data in particular it becomes apparent that generalizations concerning pluvial and nonpluvial periods in the high country of southwestern Asia require far more extensive radiocarbon dating before the apparent parallelisms with high glacial age lakes in the American Southwest (Morrison, 1965) can be confirmed.

The pattern of a moist early glacial followed by a dry full and late glacial appears to be corroborated along the southern shores of the Caspian Sea. A recent study by Ehlers (1971a) identifies three high levels of the Caspian Sea at 45–50 m, 25 m, and 0 m above sea level—or +73–78 m, +53 m, and +28 m above the modern Caspian level—and known as the Early, Middle, and Late Chvalyn Transgressions respectively. The highest level corresponded to an overflow of the Early Chvalyn Sea into the Black Sea during early Würm times (Frenzel, 1959, p. 103; 1960, pp. 45 ff.), apparently in response to a cool, moist climate in mid-latitude Russia. Considerable fluvial activity in northern Iran is indicated by delta fans contemporary with this shoreline (Bobek, 1937; Ehlers, 1971a), and this shoreline is also directly linked to a glacio-fluvial terrace. Ehlers (1971a) was also able to correlate stream alluvia with the late Chvalyn shorelines, although as the Caspian receded in late glacial times, primarily eolian loess was deposited in what is now the Hyrcanian rain forest. Bobek (1937) rightly emphasizes that the lack of any soil development in

the lower 6–7 m of the loess near Asterabad indicates an arid climate. But the youngest loess is much older than Bobek supposed—in the neighboring Belt Cave the uppermost loess has a radiocarbon date of 10,320 B.C. \pm 825 years (Ralph, 1955), while a loess-like sediment was being deposited in the Kara Kamar Cave near Haibak, Afghanistan, from before 30,000 B.C. to about 9000 B.C. (Coon and Ralph, 1955). The exact age of a Caspian Sea level 22 m below the present is uncertain.

Although there are lake beds of early Pleistocene age in the interior basins of Syria and Iraq, lacustrine deposits of late Pleistocene or Holocene age are poorly developed (Van Liere, 1961; Voute and Wedman, 1963), except for the Damascus Basin, where there are extensive lake marls, chalks, and gyttjas (at 610–620 m elevation), dating from a little before 22,000 B.C. to a little after 16,000 B.C. (Kaiser et al., 1973). These lacustrine beds of the lower Barada drainage are correlated with piedmont terraces. The mollusca and ostracods suggest shallow, standing waters of eutrophic character, with abundant vegetation; a temporary recession of palearctic forms midway in the sequence coincides with evidence of increased salinity. The pollen (see below) does not support a major shift of vegetation. Of further interest are massive spring tufas on the mountain flanks (1,100 m), with one terminal C14 date of 1530 B.C.; the pollen includes substantial quantities of oak, pine, and walnut or cedar. If these 80 m-thick tufas are indeed all of Holocene age, as unconvincingly claimed by Kaiser et al. (1973), they would imply a somewhat wetter climate.

The Jordan–Dead Sea Valley shows a massive suite of finely laminated silts, marls, and gypsum, deposited by a great lake 300 km in length and with a volume of 325 km³ water, compared with 136 km³ for the modern Dead Sea (Neev and Emery, 1967). Known as the Lisan Marls, these beds are primarily of late Pleistocene age, and Ben-Arieh (1964a) computed that a 200 mm increase in annual precipitation would be necessary to explain the hydrological budget of this lake, not taking into account any temperature changes.

A series of C14 dates extending back to "greater than" 40,000 years, with extrapolation from the varve-like laminae of the Lisan Marls, indicate that the typical, deep-lake beds were laid down ca. 50,000–17,000 years ago (Neev and Emery, 1967; Huckriede and Wiesemann, 1968; Horowitz, this volume). Shallow-water salt units were deposited from before 100,000 to ca. 70,000 years ago, and intermediate conditions with increasing water depth are indicated ca. 70,000–50,000 years ago by alternating clays and salts. Lake level was temporarily low ca. 13,000 B.C., due at least in part to major tectonic changes, then moderately high ca. 10,000–5000 B.C. and again for a short while ca. 3000 B.C. Related lake shorelines have been studied by Bowman (1970) but are not dated. Conditions similar to those of today prevailed ca. 4500–3500 B.C. and again after 2500 B.C. These results show that the last interglacial was by and large as dry as or drier than the present, while the full glacial was relatively wet, with an optimal runoff-

evaporation ratio ca. 20,000 B.C. coincident with the maximal, Würm glacial advance. Part of the late glacial may have been dry, while undisputable early to mid-Holocene "subpluvial" conditions are shown for a time range with temperatures at least as warm as today.

The Dead Sea evidence finds corroboration in the Hula-Tiberias region where lake chalks and peats were laid down, providing key pollen evidence (see below), in conjunction with spring travertines along the Hermon foothills. Horowitz (this volume) evaluates the total evidence to suggest a rainfall increase of 30–40%, and a temperature decrease of 4–5°C. for the early last glacial, with rainfall still 30% higher during the interstadial. If, however, the temperature depression was twice as great, as is suggested for other parts of the Mediterranean Basin (Butzer, 1971, chaps. 18-19), then there would be no need to postulate a full glacial increase of rainfall (see Haude, 1969; also Galloway, 1970, for similar views on interpretation of "pluvial" lakes in the American Southwest).

The Lisan Lake of the Jordan–Dead Sea Basin finds a parallel in the Jafr depression of southeastern Jordan. Here a lake as much as 1,800 km² in area led to the accumulation of over 25 m of marls, silts, and limestones, with a rich freshwater snail fauna, that includes Palearctic species (Huckriede and Wiesemann, 1968). This lake turned shallow and brackish a little after 24,450 B.C. ± 870 years, with a *Melanoides*, *Hydrobia* and *Corbula* fauna, and increasing proportions of sand and gravel. Ultimately the lake disappeared, and the deposits were covered with fanglomerates, later deflated. A last moist interval, attributed to the terminal Würm glacial, led to deep solution of the older lacustrine limestones; the associated mud flats deposits contain Upper Paleolithic implements. There is no evidence for substantial Holocene climatic changes.

Finally, in Egypt and elsewhere in the eastern Sahara, extensive lacustrine deposits are relatively rare. A notable exception is the case of the Fayum Depression, where deep lakes, considerably larger than the modern Birket Qarun, can be verified for late Pleistocene to mid-Holocene times (Said et al., 1972; Butzer, 1974b). However, these lake fluctuations reflect changes of Nile floodplain elevation and Nile influx. At no time were they controlled by local rainfall variation (Butzer, 1958, pp. 68 ff., 109 ff.). Other contemporary lacustrine beds in Egypt are essentially wadi ponds, such as those of Kurkur (Butzer and Hansen, 1968, chap. 7), or oasis floor deposits, such as those currently being studied from southwestern Egypt by Fred Wendorf and others.

The presence of mid-Holocene lake beds and fossil spring deposits in South Arabia (McClure, 1968; el-Masry, 1973) suggests the possibility that the Arabian record may be analogous to that of Egypt.

The evidence of Near Eastern high shorelines and lacustrine sediments reviewed here is unsatisfactory. Nonetheless there are strong indications for significant changes of climate during the broad time span of the Würm glacial and the Holocene. The patterns and nature of these climatic

changes remain to be elucidated by detailed, radiometrically-controlled studies such as have been published from the American Southwest. At the moment, however, the evidence appears to show that the highlands of Anatolia and northern Iran were cold and dry during the last glacial, with reduced evaporation permitting some enlargement of lakes, whereas the southern Levant and possibly the southern sectors of Iran were apparently wetter and certainly cooler. This dichotomy finds support in other lines of evidence.

ALLUVIAL AND COLLUVIAL PHENOMENA: SOUTHWESTERN ASIA

The evidence of river terraces and other alluvial or colluvial deposits in the Near East is of variable quality from region to region. In some areas, such as Turkey, Iraq, and Iran, data are limited to scattered reports of an exploratory nature. In the Levant somewhat more systematic observations are available, but there are few or no isotopic dates. In Egypt and Nubia the chronology of alluvial deposits is fairly reliable. In Transcaucasia and Arabia, there is almost no published information. A discussion of late Würm and early Holocene alluvial deposits must therefore be selective and uneven.

TURKEY

In Turkey general terrace studies have been made by Pfannenstiel (1940) in the Ankara Valley and by Izbirak (1962) and by Erdbrink and van Heekeren (1965) in the Kizil Irmak Valley.

In the Ankara Valley there appear to be four alluvial terraces at relative elevations of 20–23 m, 65 m, 80 m, and 100–110 m, each composed of coarse, angular, and relatively little-rolled gravel. The lowest terrace gravels include artifacts of late Levalloiso-Mousterian type, and have therefore been ascribed to accelerated frost-weathering and detrital transport during the Würm glacial.

The Kizil Irmak terraces are little more informative for the time range in question. The present floodplain is recognized at 5 m above mean low-water, and consists of clayey material, intercalated with coarse to cobble gravels near the fans developed at the mouths of tributary streams. Dissected gravels and sands, at relative elevations of 7–10 m and at about 20 m, occur at intervals along the river, particularly in basin areas. These and other alluvial deposits from Turkey discussed by Vita-Finzi (1969a) record Holocene and late Pleistocene aggradations of tectonic or climatic origin, but both age and interpretation are uncertain.

IRAN

A detailed study of alluvial deposits in Iran has been made in the Meshed Basin of Khorassan by Scharlau (1958). The terrace suite present there suggests several periods of accelerated erosion and deposition, with development of coarse, well-rounded valley fills and lateral solifluction mantles. The youngest terrace complex is thought to be of late Pleistocene age. Scharlau (1958) suggests that

older observations by Bobek (1940) of alluvial terraces and associated solifluction deposits, found along the southern slopes of the Elburz Range, should be interpreted in a similar manner, a view substantiated by Ehlers (1971a) and Vita-Finzi (1969b).

IRAQ

In the Zagros Ranges of Iraq a variety of alluvial deposits, primarily of glacio-fluvial origin, have been referred to by Bobek (1940) and Wright (1962a), and 60 m of initial gravels and younger silts, intercalated with lacustrine beds, occur in the Iraqi foothills of the Zagros. Wright (1952) considers these as late Pleistocene, reflecting a more humid climate. Similar observations of alluvial terraces, scree and solifluction mantles, or massive landslide phenomena, have been made in the Zagros foothills by Wirth (1958) and Voute and Wedman (1963). The same authors postulate a period of accelerated geomorphologic activity and greater moisture, presumably in late Pleistocene times.

The Tigris Valley, upstream of Baghdad, shows a well-developed terrace suite that extends into the lower courses of the major tributaries (Buringh, 1960, pp. 123 ff.). The "low" or Mahdy terrace, with a general elevation of 10–15 m above floodplain, may possibly correlate with terraces in Syria that Van Liere (1961) considers as late Pleistocene. The basic components of this Tigris terrace are fine sands or silts, capped by 2–4 m of clayey beds and a reddish-brown soil (Buringh, 1960, pp. 123 ff.). On the Jezira Plain, between the middle Tigris and Euphrates, as well as along the larger wadis of the Syrian Desert, Wirth (1958) noted two alluvial terraces. The younger of these consists of gravels, sands, and silts, forming a 3–5 m terrace above the modern gravel channel. Above this lower fill, thought to be of Holocene age, older gravels form a slightly higher surface that grades smoothly onto the surrounding plains. The rather extensive, older fill is attributed to greater discharge and detrital transport in late Pleistocene times. Significantly, these wadis lack hills or mountain terrain in their catchment areas, so that greater runoff rather than a greater supply of weathering detritus seems to be the best explanation. Only locally have minor tributaries dissected the younger fill.

THE LEVANT

The alluvial terraces of Syria and Lebanon are better understood. The middle Euphrates has a broad, well-developed gravel terrace, with abundant derived artifacts of both Acheulean and Levalloiso-Mousterian typology. Some 5–8 m of stratified silt generally terminate this aggradation unit, which typically lies up to 20 m above modern floodplain. A late Pleistocene age is assumed (Van Liere, 1961, pp. 44, 46 f., 59). This silt is indirectly attributed to a greater supply of valley fill.

The results of Van Liere are a little difficult to reconcile with de Heinzelin's (1965) observations on the middle Euphrates. The latter author defines two formations representing a single alluvial complex of pre-Neolithic and pos-

sible late Pleistocene age. The Shajara Formation has a relative elevation of 20–30 m above modern floodplain and incorporates rolled Paleolithic artifacts. Well-patinated, unrolled Middle Paleolithic artifacts occur on the surface. The Mureibat Formation varies from 1–10 m above modern floodplain and is older than a series of Neolithic tells found on its surface. In a broad way the Mureibat fill corresponds to Van Liere's 5 m Holocene silt terrace, while the Shajara deposits probably can be correlated in part with the Main Gravel Terrace as well as with some of Van Liere's older alluvia. More detailed publications on the middle Euphrates will be necessary before satisfactory conclusions can be drawn.

In the Orontes system a "Main Gravel Terrace" is ascribed to the late Pleistocene (Van Liere, 1961, pp. 32, 42 f.). Gravels are again overlain by several meters of stratified silt or fine sandy loam, and a broad floodplain, four times the size of the modern alluvial valley, suggests greater runoff. More detailed facies changes have been recorded from the Ghab depression, where the Orontes once deteriorated into a swampy or lacustrine environment. Here, pollen data (see below) imply appreciable environmental changes during late Pleistocene times, and further radiocarbon dating should provide valuable insights into late Pleistocene and, perhaps, early Holocene environments and tectonic history of central Syria. Holocene fill terraces are not now recognized in the Orontes system.

In the areas of interior drainage near and south of Damascus there are a variety of late Pleistocene alluvial and colluvial deposits. The Wadi Midaneh, a major tributary of the Yarmuk, has a gravel terrace, with rolled Acheulean and fairly fresh Levalloiso-Mousterian artifacts, capped by 5–6 m of stratified clay (Van Liere, 1961, pp. 49 ff.). The silty cap is pre-Neolithic. Similar gravels take the form of alluvial fans adjacent to the Damascus Basin (Van Liere, 1961, pp. 52 ff.; Kaiser et al., 1973). They are overlain by colluvial brown clays, which may be broadly synchronous with black fluvial clays that line the floor of the Damascus Basin. The exact age of these late Pleistocene to early Holocene beds is uncertain. Analogous basin sediments have been described from different parts of the Jordanian desert (Van Liere, 1961, p. 55; Zeuner, 1957; Vita-Finzi, 1964; Huckriede and Wiesemann, 1968). On the other hand, contemporary alluvial deposits appear to be absent from the great wadis that drain the Syrian Desert toward the Euphrates Valley (Wirth, 1958).

A succession of late Pleistocene to Holocene alluvial sediments has been described from the Jordan graben and the adjacent tributaries, particularly those of the eastern bank (Picard, 1963; Vita-Finzi, 1964; Nir and Ben-Arieh, 1965; Horowitz, this volume). During late Pleistocene times a complex of massive gravels was transported through the tributary systems both east and west of the Jordan. As much as 30 m thick, and including the Nakhsholim Conglomerate of Judea, these alluvia are at least locally interdigitated with the Lisan Marls, and have been observed to overlie scarp-edge tufas. They typically form broad, shallow

evidence in later time ranges, and Bate (1940) concluded that there was a significant faunal change during early Holocene (Natufian, ca. 9550–7500 B.C.) times. A half-dozen species of gazelles, a hedgehog, and a species of hyena became extinct, possibly suggesting the oncoming of a more humid phase. Less securely dated than the Natufian is the "early Neolithic" of the Abu Usba Cave, also of Mt. Carmel, where Stekelis and Haas (1952) suggest an appreciably moister environment on faunal grounds. Typical steppe species were absent, but numerous thrushes, reptilian types such as *Chameleo chamaeleon*, *Agama stellio*, *Ophisaurus apus*, as well as the snail *Cyclostoma olivieri* would presume a dense vegetation with more bountiful moisture.

In the interior highlands of Israel, long sedimentary sequences are evident in the caves of Umm-Qatafa (551 m elevation, Judea) and Qafzeh (220 m, near Nazareth). The alternating strata of angular rubble, clays, and calcareous enrichment suggest repeated environmental changes, but modern analytical studies still remain to be reported (Farrand, 1971). The fauna of the last glacial levels at Qafzeh is uniformly dominated by *Cervus*, *Dama* and *Bos* (Bouchud, 1971). Elsewhere in Judea, the cave of el-Khiam (Gonzalez and others, 1966) shows that the late glacial and Holocene (Kebaran, Khiamian, and Tahunian levels, ca. 12,000–5500 B.C.) environment of that area was not unlike that of today. The sediments are rich in carbonates, with uniformly high pH values (over 8.0), and no evidence of weathering. The terrestrial and fluvial mollusca include *Helix*, *Helicogena*, *Eupharypha*, *Pyramidula*, and *Theba*, indicating a dry, warm environment. The megafauna, with *Gazella* sp., boar (*Sus scrofa libycus*), fox (*Vulpes vulpes*), donkey (*Equus asinus* cf. *somaliensis*), and domesticated goat (*Capra hircus*), is compatible with this interpretation, as is the palynological evidence, which suggests a treeless setting of steppe or desert vegetation, dominated by *Chenopodiaceae*.

In the interior of Syria, the cave of Jabrud I (1,427 m elevation) has been studied in unique detail by Farrand (1970, 1971) and Brunnacker (1970). The bottom stratum D, at -8.8 to 11 m (Acheulean and Jabrudian), consists of frost-weathered *éboulis* and travertines, suggestive of a cold and moist climate. The next unit C, at -5 to 8.8 m (Jabrudian), contains only a few horizons of finer and less angular *éboulis*, with eolian lenticles, inferring a drier and less cold climate. Unit B, at -2.3 to 5 m (Jabrudian, Acheulean, Pre-Aurignacian) is more comparable to D, while the uppermost stratum A, at 0 to -2.3 m (Levalloiso-Mousterian), is another fine frost-weathered *éboulis* horizon; both B and A also suggest a cold, moist climate. The relative age of C and D is uncertain, whereas B and A suggest the first half or mid-part of the last glacial. The fauna is dominated by equids throughout, with minor components of gazelle, fallow deer, and goat (Lehmann, 1970).

Equally interesting is the Jerf Ajla cave in the Palmyra foothills at 550 m elevation. The sequence is as follows (Farrand, 1971):

1. 1 m of frost-weathered rubble, with Levalloiso-

Mousterian, capped by weathering horizon (corrosion of rubble, partial decalcification of matrix).

2. 2 m as before.

3. 1.75 m of frost-weathered rubble, with Levalloiso-Mousterian, and date of 43,000 years. Secondary calcification.

4. 1.25 m of frost-weathered rubble, with Upper Paleolithic. Secondary calcification. The entire sequence may span some 50,000 years prior to 30,000 B.C., and again records a colder climate during much or most of the early and full Würm glacial; the early Würm horizons of increased chemical weathering are of considerable interest.

In effect, Jabrud and Jerf Ajla summarize the total import of the Near Eastern cave sequences, both in terms of their implications for glacial cold and their equivocal record of moisture fluctuations.

Although various caves in the Zagros Mountains have been excavated over the years, sites such as Shanidar, Palegawra, Warwasi, Hazar Merd, etc., have not yet produced even rudimentary geological descriptions. For a discussion of the Caspian littoral caves, see Butzer (1958, pp. 107 f.).

POLLEN DATA

LAKE ZERIBAR

At the moment one of the most detailed and continuous records of late glacial and Holocene environmental changes in western Asia is provided by the studies of Lake Zeribar, located at 1,300 m elevation in the Zagros Ranges, 160 km northwest of Kermanshah. Three overlapping piston cores with a total depth of 26 m were subject to meticulous pollen analysis (van Zeist and Wright, 1963; van Zeist, 1967; Wright et al., 1967), while microfaunal and chemical changes within the same sediments were also studied in detail (Hutchinson and Cowgill, 1963; Megard, 1967; Wasylikowa, 1967; Wright, 1966). The deposits in question range from silt and clay to gyttja and peat, laid down in a small lake basin within mountainous terrain (to 2,100 m). Modern rainfall is estimated to vary locally from 600 to 800 mm, with mean January and July temperatures of about 2° and 28° C., respectively.

Three major pollen zones are recognized. Zone A shows next to no arboreal pollen, but is dominated by *Chenopodiaceae* (about 70%) and *Artemisia* (about 30%). The closest analogy is provided by the intermontane steppes of Tabriz, in northwestern Iran, with similar elevations but only 300 mm precipitation. The modern vegetation here is dominated by *Artemisia herba-alba*, with *Chenopodiaceae* in poorly drained areas with saline soils, and local prominence of *Ephedra*. The modern pollen rain near Tabriz includes some oak, 25% *Artemisia*, and 45% *Chenopodiaceae*. The pollen rain of the somewhat restricted modern alpine zone in Iran or Turkey was not sampled, a fact that leaves an element of uncertainty in the application of modern analogues to an interpretation of the cores. Since Lake Zeribar is now located in the Zagros oak-woodland belt, Wright et al. (1967) suggest that Zone A reflects a depression of the altitudinal treeline by at least 1,000

meters. Increased aridity is corroborated by abundant carbonates with chlorides in the mineral sediments of this time, while greater cold is indicated by the presence of two "northern" cladoceran species. Three C14 dates of 20,650 B.C., 12,850 B.C., and 11,700 B.C., are available, and by interpolation and extrapolation Zone A can be dated from before 20,500 to about 10,000 B.C. It therefore appears to record the later full glacial and part of the late glacial.

Zone B marks a transition period with *Quercus* present and increasing irregularly from an initial value of about 15%. While *Artemisia* fluctuates around 10%, the *Chenopodiaceae* decrease from about 70% to 50%, *Plantago* averages near 10%, with *Salix*, Gramineae, and Compositae present in addition. Wright et al. (1967) indicate that there is no good regional analogue for this type of pollen spectrum. The modern pollen rain in the Zagros oak woodland (800–2,000 m elevation) includes 35% *Quercus*, 15% *Artemisia*, with abundant Gramineae, *Plantago*, and some *Pistacia*. In the almond-pistachio (*Amygdalus-Pistacia*) savanna of the Zagros foothills (700–800 m), *Quercus* is limited to 1 or 2% and *Artemisia* to 5%, with *Plantago* dominant. This suggests closer analogies with the oak woodland than with the piedmont savanna or the plateau steppe, and conditions were obviously warmer than during Zone A. Northern species of *Cladocera* phase out in Zone B, and southern species make their first appearance in significant numbers. Carbonates and chlorides decrease steadily in the sediments. A C14 date of 6,150 B.C. allows interpolation for a time span of about 10,000 to 4000 B.C. (?Alleröd, Younger Dryas, Boreal, early Atlantic). The second half of Zone B, broadly corresponding to the middle Holocene, has appreciably higher *Quercus* values, while evaporites average no higher than they do in more recent sediments.

Zone C, with a basal date of 3510 B.C., suggests that conditions have remained similar to those of today during the last 6,000 years. *Quercus* averages near 60%, *Artemisia* and *Plantago* about 10% each, and some *Pistacia* is generally recorded from the organogenic sediments.

The Zone A spectrum suggests arid conditions in the Zagros during the second half of the Würm glacial. This finds strong confirmation in the contemporaneous pollen record of southern Europe (see discussion in Butzer, 1974c), as well as in more recent pollen spectra from Syria and Lebanon. The Zeribar diagrams are, furthermore, regionally representative, since unpublished results from two other Iranian cores are comparable (van Zeist, 1967). Therefore it appears that most of Turkey, northeastern Iraq, and Iran were treeless during the Würm full glacial and during most of late glacial time. However, the lacustrine and glaciological evidence precludes truly arid climate even if absolute precipitation was significantly reduced (compare Messerli, 1967, pp. 204, 209 ff.; Wright, 1962a; Butzer, 1971, chap. 19). In other words, we are confronted with evidence of physiological rather than climatic aridity, such as in many parts of mid-latitude Europe (see Butzer, 1971, pp. 285 ff.). Mountain tundra, steppe, and scrub-steppe were almost certainly the dominant vegetation of the Near

Eastern highlands during the full and late glacial. This is compatible with the evidence of accelerated frost-weathering, solifluction, and alluviation from these areas. Similarly it would explain the full and late glacial loess deposits of northern Iran and Afghanistan.

The interpretation of Zone B is more difficult. Wright et al. (1967) implicitly suggest that the local environment was drier than at present, tentatively drawing analogies from the almond-pistachio savanna of the Zagros piedmont. However, on the basis of the evidence presented, the similarities of upper Zone B with the pollen rain of the modern oak-woodland belt are conspicuously stronger. In conversation and correspondence both Jack R. Harlan and Marvin W. Mikesell have expressed the opinion that degraded oak scrub produces more pollen than an undisturbed oak forest, since there are many more flowering shoots. Daniel Zohary, on the other hand, believes that fully-developed, undisturbed oaks of the *Quercus persica-Quercus ithaburensis* group will produce more flowers and pollen than heavily-cropped oaks or a fully degraded oak scrub. With such differences of opinion, this question requires further study in the field. As an alternative hypothesis, it is therefore possible that the marked increase in oak pollen between Zones B and C reflected intensive cultural disturbance (browsing, cropping, charcoaling), initiated in late prehistoric times. The sediment chemistry does not substantiate a drier environment for the upper half of Zone B. Similarly, pollen profiles from northwestern Turkey suggest that the first half of the Holocene was slightly moister and possibly cooler than the second part (Beug, 1967). On the available evidence it would therefore seem that essentially modern conditions had been established by the beginning of the Holocene, and that there may have been few significant changes since.

THE ORONTES VALLEY, COASTAL LEBANON, AND LAKE HULA

The overall implications of the Zeribar profile find corroboration in a 12 m core from the Ghab depression of the central Orontes Valley, at 190 m elevation (Niklewski and van Zeist, 1970). A rudimentary chronology is provided by interpolation and extrapolation from two finite C14 dates, and several reconstructions in time are given by the vegetation cross section of Figure 2. Superimposed fluctuations complicate but do not obscure a progressive opening of the vegetation during the course of the late Pleistocene. During the early Würm the 500–800 m Jebel Zawiye to the east was an open woodland of deciduous and live oak; the 500–1700 m Jebel Alaouite a deciduous oak forest with some pine, cedar, and juniper; and the Mediterranean coastal plain a live oak–pistachio woodland. By the late Würm the mountains and coastal plain were chenopod–*Artemisia* steppes with a mixed, temperate woodland confined to the intermediate level, windward slopes of Jebel Alaouite. In detail, the Würm interstadial time spans were notable by increased woodland vegetation, while the glacial maxima saw an increasingly open vegetation (fig. 2).

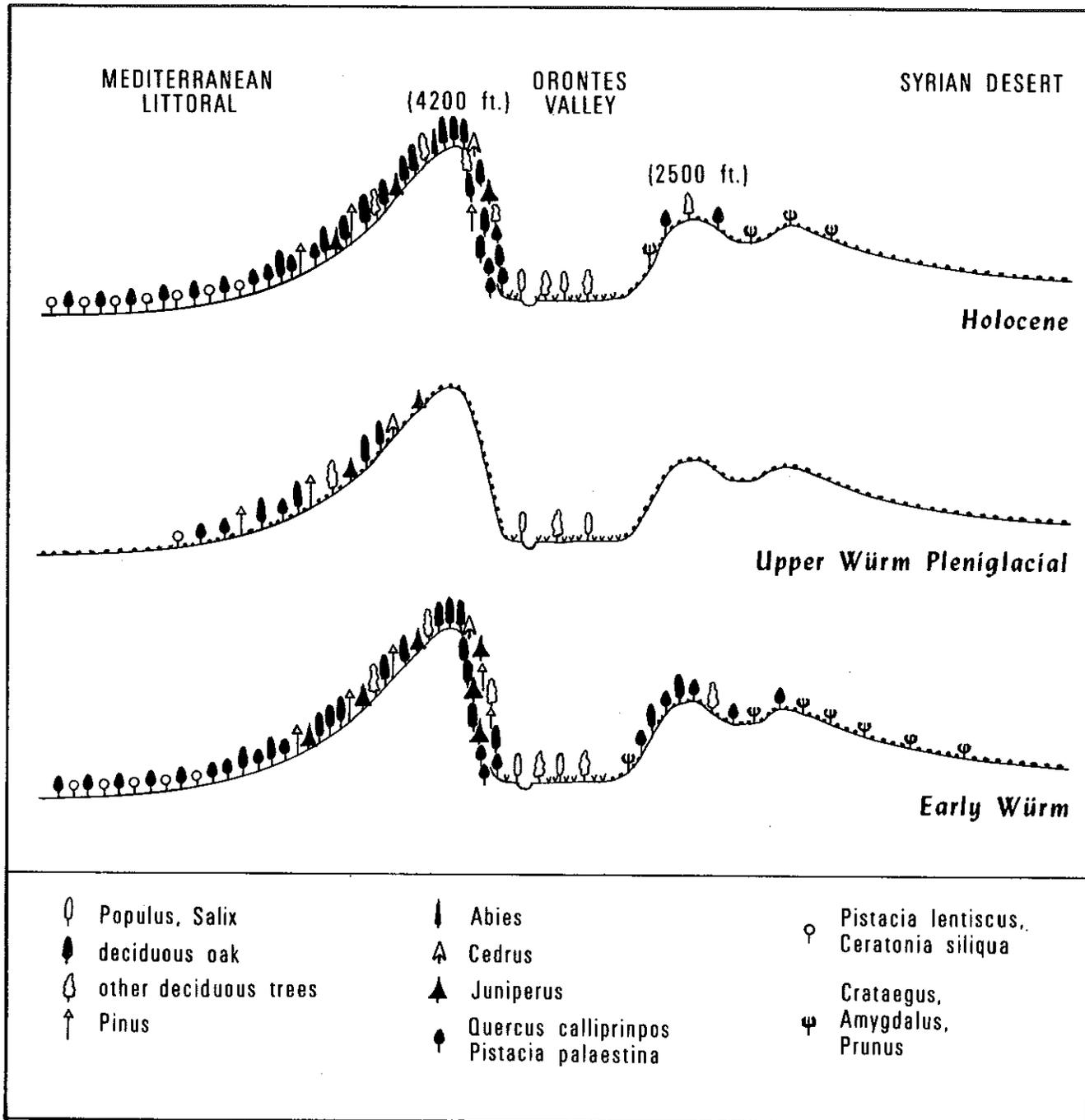


FIG. 2—Reconstruction of vegetation during the Würm in the Khab Depression, Orontes Valley, from a 12 m core.

The Ghab profile and its interpretation are verified by 14 well-chosen pollen spectra from several late Pleistocene substages recorded by sediments along the Lebanese coast (Leroi-Gourhan, 1971). The last interglacial, +1.8 m *Strombus* beach was next to a mediterranean woodland of live oak, pistachio, wild olive, and carob, with a minor representation of hornbeam, *Celtis*, walnut, and wild grape. By contrast, late interglacial or early glacial deposits suggest a forest steppe, with wild olive and pine the dominant trees. Nonarboreal pollen vary from 42 to 94% in the full glacial

spectra, reflecting a predominantly open vegetation. This picture of coastal vegetation promises to be complemented by pollen from Mt. Carmel, where the Tabun sequence includes a high proportion of temperate trees in the early Würmian levels (Horowitz, this volume). It is also compatible with Leroi-Gourhan's pollen spectra from the Damascus Basin (Kaiser et al., 1973), where arboreal pollen in the full glacial deposits accounts for only 3 to 36%. However, the presence of *Pterocarya* and *Tilia tomentosa*, now found in the Caucasus, as well as cedar and walnut, now found at

more mesic elevations and exposures, suggest a cooler and slightly less xeric regional environment.

The 123 m Hula profile, from below sea level at the northern end of the Jordan graben, is essentially dated by extrapolation from a single C14 date (Horowitz, 1971, 1973; see also Cowgill, 1969, for other dates and a discussion of the variable sedimentation rates). For the Holocene, several other dated profiles are available from Hula and Lake Tiberias. The early Würm was marked by a maximum of live oak and wild olive, probably representing an open mediterranean woodland, not substantially different from that prevalent in the relatively moist mid-Holocene. Another period of open oak forest is indicated ca. 25,000 B.C., with a return to almost equally mesic conditions during part of the late glacial. Nonarboreal pollen dominated during the last interglacial, the mid-Würm interstadial, for a short while ca. 18,000 B.C., and during early Holocene times.

These Levantine pollen profiles, seen as an ensemble, show that some woodland persisted in the coastal hill country throughout the late Pleistocene, unlike the open vegetation of Anatolia and Iran. Nonetheless, with possible exception of the early Würm, the last glacial can hardly have enjoyed greater rainfall than the Holocene. Most of the apparent pluvial phenomena must therefore be attributed to lower temperatures and reduced evaporation, possibly combined with greater seasonal periodicity of precipitation and runoff. However, there is an apparent zonal change from north to south within the Levant, whereby late Pleistocene vegetation was generally denser in Israel—where open woodland extended into the northern Negev for a while (Horowitz, this volume)—than in Syria and Lebanon; similarly, the Würm interstadial time-range saw an increase of woodland in the north, a decrease in the south. These regional contrasts presumably document a real zonal trend from glacial aridity in the latitude of Anatolia to increasingly moist glacial conditions in Israel. By extension, substantial increases of absolute precipitation during much of the late Pleistocene should be expected in the latitude of Sinai and Egypt, which is consonant with the geomorphologic record of the Nile Valley.

SYNTHESIS: TURKEY AND IRAN

In concluding and attempting to synthesize the Near Eastern evidence for environmental conditions from the late Pleistocene to mid-Holocene time range, it is necessary to review our information within broad regional contexts: (1) the highlands of Anatolia, Armenia, Kurdistan, and Iran; (2) the hill country and plains of the Levant and Mesopotamia; and (3) the lower Nile Valley and the adjacent deserts.

The evidence from the highland belt can be summarized as follows:

1. Widespread glacial features in Turkey, Transcaucasia, Iran, the adjacent parts of Iraq, as well as in the high Lebanon, all indicate a colder climate during the Würm full glacial. Mean summer temperatures may have been in the

order of 6–7° C. lower than at present. The existence of multiple minor (“recessional”) moraines in association with most of these late Pleistocene glaciers suggests one or more readvances during the late glacial as well as one or more stage of temporary readvance or reglaciation during the Holocene.

2. The Lake Zeribar pollen diagram and associated evidence suggests that an open vegetation of steppe and mountain tundra, perhaps with scrub-steppe in more favored localities, characterized Turkey, northeastern Iraq, and most of Iran during the full glacial. The warmup during the Alleröd and particularly during the early Holocene appears to have been accompanied by an increase in precipitation, leading to gradual reforestation of the highlands.

3. The remaining categories of geomorphologic evidence from the highlands do not appear to contradict the Lake Zeribar interpretation. Few lacustrine deposits have been dated, and many but not all seem to be of early Würm or of Holocene date. In no case do the higher lake levels indicate a very appreciable increase in rainfall, and those of glacial age are readily explained by reduced evaporation alone. The alluvial deposits of the high highlands are all dated, on rather indirect criteria, as late Pleistocene. Some or even the majority may turn out to be of early Würm age. Others may pertain to the full glacial, reflecting seasonally concentrated stream discharge and accelerated morphogenesis under a more severe climate. Although dissected Holocene alluvia appear to be infrequent or lacking, there is at least a strong possibility of higher lake levels during some parts of the Holocene (e.g., Lake Burdur).

4. The data now available show clearly that the Near Eastern Highlands, north of about latitude 35°, did not experience “pluvial” conditions during the last 50,000 years or so. The full and late glacial were conspicuously cold and comparatively dry. The Holocene environment appears to have remained fairly constant, with conditions similar to those to be expected today without human disturbance. Perhaps the only significant post-Pleistocene changes in this regional setting have been those accompanying and following intensive or rapacious land-use. Under any circumstances, considerable environmental change must have accompanied the Pleistocene-Holocene transition. Unfortunately, the exact nature of these changes can only be conjectured at the moment.

SYNTHESIS: THE LEVANT AND MESOPOTAMIA

In the hill country and plainlands of Syria, Lebanon, Israel, Jordan, and Iraq, the climatic vicissitudes of the late Pleistocene and early Holocene are documented by several categories of evidence:

1. There are no imposing lake deposits outside of the Jordan Valley, and geomorphologic changes appear to be most manifest in fairly widespread alluvial fills that accompany many larger and smaller streams. The implications of these now-dissected alluvia are not unequivocal, and they may be a result of one or more of the following factors: (a) more torrential rains, (b) more concentrated discharge

and/or precipitation, (c) greater precipitation, (d) more detritus as a result of accelerated weathering, and, in areas with an effective vegetation mat today, (e) changes of the vegetative cover reflecting on differing temperatures and evaporation rates. Until more detailed work has been done and isotopic dating has become available, the geomorphic environment of the Levant and Mesopotamia in recent geological times must remain somewhat enigmatic. An important exception is provided by the Damascus Basin and particularly by the Jordan Valley, where several moist interglades can be clearly recognized in the late Pleistocene to Holocene time range. Interpretation of at least the lacustrine beds and massive spring deposits seem to be clear in this area, although further sedimentological study of the alluvial terraces will be necessary.

2. The available cave sequences show that most of the early Würm, and parts of both the full and late Würm, were sufficiently cold (and moist) to generate significant frost-weathering. The resulting angular rubbles are interrupted by horizons reflecting on chemical weathering or fine-grained sedimentation under more temperate conditions. The state of cave sedimentological studies leaves a great deal to be desired, however.

3. The biological evidence from the Levant and Mesopotamia now includes both faunas and some pollen. Although the full glacial cave deposits of the Levant show a number of intrusive Palearctic forms (see Howell, 1959, and Hooijer, 1961), the glacial age faunas everywhere suggest ecological conditions remarkably similar to those of today. Far more impressive are the pollen data, which show that forest vegetation was generally diminished during the glacial periods, except for the Negev. This trend to relatively diminished vegetation is far more evident in northern Syria and Lebanon, where absolute rainfall must have decreased markedly during the full glacial, than in Israel where rainfall amounts did not decline appreciably but where reduced evaporation favored expansion of existing woodlands. There may also be some biological evidence for moister conditions during part of the early and middle Holocene in Israel and the Damascus Basin, but elsewhere the paucity of evidence for change should be evaluated in a positive light, namely that there has been little ecologically significant change in post-Pleistocene times north of perhaps 32° latitude.

4. In view of the evidence there is absolutely no support for once current theories that agricultural origins must be explained by post-Pleistocene desiccation. There is no evidence for a deterioration of suitable agricultural lands in the Levant or Mesopotamia during the Pleistocene/Holocene transition. Instead, the close of the Pleistocene opened up extensive arable lands and lush pastures in the high country. Similarly, there is no reason whatsoever to believe that agricultural dispersals were motivated or aided by progressive desiccation of the nuclear agricultural area in southwestern Asia. These problems have already been outlined and discussed elsewhere (Butzer, 1971, chaps. 32-33).

SYNTHESIS: EGYPT

In a hyperarid environment such as Egypt even very modest increases of precipitation have had disproportionately great effects on geomorphologic equilibrium as well as on ecological conditions. Yet even here true "pluvial" conditions were last experienced during the first half or so of the Würm. The later full glacial was as dry as today in Egypt. The more recent evidence can be summed up as follows:

1. Wadi discharge in Egypt and Nubia was more significant during much of the period between 15,000 and 3000 B.C., except for three major dry interludes centered at approximately 9500 B.C., 5500 B.C., and 4500 B.C. The geomorphologic evidence is substantiated by fragmentary biological data and, altogether, suggests that rains were more frequent and perhaps of greater duration during much of this time. A reddish paleosol, with distinctive evidence of biochemical weathering, can be dated 5000 B.C. The existence of one or more mid-Holocene moist spells appears to be borne out by the lake beds and spring deposits of Arabia as well.

2. The impact of subpluvial intervals on the fauna of Egypt during late prehistoric times has been studied in some detail (Butzer, 1959*a*) and the significance of these moister spells elsewhere in the Sahara has been frequently discussed in the literature. There is no evidence, however, that episodes of late Pleistocene desiccation in Egypt led to enforced concentration of prehistoric settlement in the Nile Valley, as was once claimed. Lower and Middle Paleolithic habitation seems to have already been confined to the vicinity of reliable water sources, and the late Paleolithic settlers of the Nile Valley did not expand into the nearby deserts during moister intervals (see Butzer and Hansen, 1968, chap. 4). However, the biomass and diversity of game resources outside of the riverine zone would have varied significantly, with potential implications for at least some activities of certain prehistoric groups.

3. Contemporary ecological conditions were finally established in Old Kingdom times and a long arid phase with accelerated dune activity, accompanied by comparatively low Nile floods had begun by the end of the Fifth Dynasty (ca. 2350 B.C.).

GENERAL CONCLUSIONS

In final overview, it is apparent that the available evidence allows several general conclusions.

1. The last interglacial period, although poorly recorded in most areas, more often than not experienced environmental conditions similar to those of today. Nonetheless, wherever there is detailed information it becomes equally evident that climates changed through time.

2. The last glacial allows characterization of three distinct paleoclimatic provinces in the Near East: (a) the highlands of Anatolia and Iran, intensely cold most of the time, were also very dry during the full glacial, with next to no tree growth possible; (b) the Levant, moderately cold

and relatively dry in the north, cool and comparatively moist in the south—this dichotomy possibly extending eastwards across Mesopotamia and southern Iran; (c) Egypt, experiencing long periods of increased rainfall, except for the Würm glacial maximum—a pattern possibly repeated in Sinai and Arabia. Different trends again are apparent in the southern Sahara and East Africa (Butzer, Isaac, et al., 1972).

3. The mid-Holocene saw repeated moister trends in Egypt and Arabia, comparable to those in sub-Saharan Africa, that affected Israel but are not evident farther north.

4. The early to middle Pleistocene, although not the subject of this review, is next to intangible in view of the

fragmentary evidence, and above all in view of the almost total lack of radiometric and palynological criteria that proved to be essential to any realistic unravelling of the late Pleistocene and Holocene of the Near East.

5. All of the climatic changes recorded were of relatively short wave length, and none exceeded the duration of the standard late Pleistocene substages utilized in the European chronology. This makes direct correlations with the European chronology difficult if not undesirable, particularly in default of radiometric dating.

6. Except for Egypt, there is no sound evidence for pluvials as such in the Near East, even though the term "pluvial" is useful as an adjectival form to describe particular phenomena (see also Butzer, 1971, pp. 350 ff.).

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