LATE GLACIAL AND POSTGLACIAL CLIMATIC VARIATION IN THE NEAR EAST

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Mit 5 Bildern

Spät- und nacheiszeitliche Klimaschwankungen im Vorderen Orient

Zusammenfassung: Verf. unternimmt den Versuch, die Klimaschwankungen seit der letzten Eiszeit für einen Teil der suptropischen Breiten, den Vorderen Orient, zu rekonstruieren. Für diesen Raum liegen verhältnismäßig brauchbare Ergebnisse vor, wenn diese auch nicht die Genauigkeit erreichen wie in höheren Breiten, da die Pollenanalyse hier nicht anwendbar ist. Auf Grund stratigraphischer, morphologischer, archäologischer und historischer Befunde können folgende Perioden ausgegliedert werden:

1. Postpluvial I (anschließend an die letzte Pluvialzeit). Trockener und ein wenig kühler als heute mit ausgeprägter Windabtragung. Höhepunkt wahrscheinlich im 11. Jhrtsd. v. Chr.

2. Subpluvial I (wahrscheinlich im 9. Jhrtsd.). Ziemlich feucht mit Niederschlägen, die sich etwa auf halber Höhe zwischen denen eines Pluvials und denen der Neuzeit bewegen. Niedrigere Temperaturen mit einem letzten Vorstoß der kleinen Würm-Kargletscher des Hochlandes.

3. Postpluvial IIa (ca. 8000—6500 v. Chr.). Wieder trockener als heute und anscheinend wärmer als während der vorhergehenden Phase.

4. Postpluvial IIb (ca. 6500—5500 bzw. 5000 v. Chr.). Etwas feuchter, ähnlich dem jetzigen Klima.

5. Subpluvial II (ca. 5000—2400 v. Chr.). Diese zweite postpluviale Feuchtzeit ist ihrer Intensität nach etwa dem Subpluvial I zu vergleichen, dauerte aber länger und war— zusammen mit der folgenden Periode — durch etwas größere Wärme (Klimaoptimum!) gekennzeichnet. Kurzfristige Niederschlagsverminderungen kurz vor und kurz nach 4000, sowie um 3000 v. Chr. zeichnen sich ab.

6. Postpluvial III (2400—850 v. Chr.). Nach einem plötzlichen Klimaumschwung treten erneut aride Verhältnisse — mit ähnlichen Temperaturen wie vorher — auf. Mindestens einmal (im 12. Jhrhdt.) läßt sich ein feuchteres Intervall feststellen.

7. Postpluvial IVa (850 v. Chr.—700 n. Chr.). Im großen und ganzen gleich dem heutigen Klima, nur ein wenig trockener mit etwas wärmeren Wintern. Merkwürdig ist eine ausgeprägte Dürre ca. 590—645 n. Chr.

8. Postpluvial IVb (Seit 700 n. Chr.). Von etwa 650 n. Chr. macht sich eine zunehmende Zahl kälterer Winter bemerkbar, besonders während der frühislamischen Zeit. Das Intervall 700—1000 n. Chr., sowie das späte 13., frühe 15. und frühe 17. Jahrhdt. waren relativ feucht. Das 12. Jahrhdt. etwas trockener. Seit 1900 ist eine Niederschlagsabnahme von vielleicht 10—15% spürbar, die anscheinend mit der "recent climatic fluctuation" zusammenhängt. Geringe örtliche Temperaturzunahmen sind vorhanden, dürfen aber nicht für den Vorderen Orient verallgemeinert werden. Seit etwa 1938 deutet sich jedoch ein erneuter Umschwung zu etwas feuchteren Verhältnissen an.

General Problems associated with the Chronology

Climatic variation as a field of serious investigation is rapidly assuming a role of fundamental importance, and the prodigous amount of literature devoted to the subject in recent years, indicates the universal interest shown both by geographers, meteorologists and geologists. Frequent references to supposed climatic changes in the eastern half of the classical world can already be found in the Greek and Arabic authors, and similar speculations have continued into the twentieth century. Climatic variation was only considered as a means to an end, either to substantiate or refute the deterministic theories abounding at the time. Consequently this fretting speculation by travellers and other non-specialized observers was disastrously affected by the introduction of new and less fallible methods of investigation in northern Europe, leading to the triumph of the historical possibilistes and those vehement adherents of a theory of static climate "since glacial times". However, little observed by the cognate fields, a new and less circumstantial technique, the intensive geomorphologic study of select type areas, was beginning to accumulate a great number of unintegrated and often obscure contributions to this theme of climatic variation, often only focused upon the pluvials of the Pleistocene epoch. Largely neglecting this newer literature and often based only upon that highly disputable criterion of nomadic migrations, *C. E. P. Brooks* (1926) presented a general survey of Near Eastern climatic fluctuations. Only the more profitable although still quite scetchy syntheses of *D. M. A. Bate* (1940) and *S. A. Huzayyin* (1941) marked the first great step to a new inauguration of palaeoclimatological study in the desert margins of the Old World. Subsequently, *G. W. Murray* (1951) and *H. Bobek* (1954) have attempted to give a regional outline of climatic evolution in Egypt and Persia respectively, but both of these outstanding explorers were hampered by the impossibility of comparing overall data from the wider base area essential to to such a study, and were almost obliged to consider the Holocene as an appendage to their valuable treatment of the last pluvial-glacial phase.

Those familiar with the extensive specialized literature on the postglacial chronology of Europe will probably find the methodology employed in this treatise rather different and probably even less definite and not sufficiently quantitative, but this is inavoidable through the difference of the geographical factors, and thereby of the climatic indicators involved. Although the penetration of cold air masses effects cyclogenesis to no inconsiderable degree, and temperature conditions regulate the rate of evaporation, the direct morphological evidence of temperature variation in the Near East, in contrast to Europe, is very secondary to that of rainfall fluctuations. Yet the effects of increased precipitation and decreased evaporation are largely identical, and often reflect an identical primary cause, so that one can draw no sharp distinction between these two processes in the Near East. Undoubtedly the lack of botanical evidence is of the greatest hindrance and inconvenience since pollen-analysis, the foundation of the European climatic succession, is almost inapplicable under the existing conditions of oxidation. The preservation of the pollen requires constant immersion and therefore a constant watertable, something that is very rarely achieved in the Near East except in the vicinity of the great exotic rivers *(H. Gross)*. Furthermore, neutral or alkaline water is fatal for their preservation. Since the stratigraphical profile can never supply the precise chronological dating of the pollen profile, resort must be made to the new technique of radiocarbon dating, and such dates as are assigned in the climatic succession established below are largely provided by C_{14}. The last great advantage of pollen diagrams comes from the relatively good quantitative estimates that can be made of existing climatic conditions according to the movements and relative percentage of well-known, botanical species. Morphological processes in themselves are continually the subject of strong controversy, and too little unamity has been acieved in regard to the climatic environment associated with them.

In this paper a first attempt will be made to establish a parallel to the European chronology within a section of the northern margins of the great Afrasian Steppe, the necessity of maintaining unity of variation confining us to the ancient historical lands of the Near East: Egypt, Syria, Mesopotamia and Persia. This geographical area composes the southeastern quadrant of the Mediterranean climatic province, with its westerly circulation and rainy season in winter, its tradewind, subtropical desert climate during summer. Southwards and eastwards the climate grades into desert and eventually into the peripheral sphere of the great monsoonal provinces, northwards into regions with rainfall maxima during the summer or during the transitional seasons. It is hoped that the detailed climatic succession established here independently of, but so curiously alike, that of Europe will stimulate further wide and non-deductive regional studies of Holocene climatic variation in the horselatitudes, for only then can we establish that transitional link vital for a satisfactory reconstruction of the general atmospheric circulation patterns of the Pleistocene.

Temperature and Rainfall during the Late Glacial Period

The existence of periods of considerably greater rainfall during the Near Eastern Pleistocene has been known for many years, and it was to account for these fossil traces of former climates that the term pluvial was introduced as early as 1889. The contemporaneity of these lower middle latitude pluvials with the world-wide glaciations has been repeatedly confirmed and accepted in the contemporary literature by *P. Woldstedt, C. Troll, R. F. Flint, M. Pfannenstiel, S. A. Huzayyin, J. Büdel, H. Mensching* and many others. Consequently we are free to refer to the last phase of glaciation as the 'Last Pluvial' in the Near East, and we may speak of a 'postpluvial' as well as a 'postglacial' period. However is the significance of the last two terms identical? Chronologically there appears to be need of a distinction. The postglacial period is usually regarded as beginning with the drainage of the Baltic ice-lake about 8000 B. C., while the last Würm pluvial subphase had probably ceased several thousand years earlier, apparently with the end of the last glacial maximum. In fact, it looks as if the general characteristic of the Late Glacial period in the Near East was an arid climate, with a rainfall considerably less than today in view of the prevailing temperatures still a little below those of the present.

In Egypt, the Nile undercut and degraded its bed, to 46m below the modern alluvium at Asyut and to at least 30m below sea level in the Delta (*Fourtau* 1915, *Sandford* & *Arkell* 1939, p. 75–6), as a response to the glacio-eustatic lowering of world sea level during the Würm glacial maximum when large masses of the oceans' waters were held in the great continental ice sheets. As a result the free communication of the river and the last Nile- controlled Fayum pluvial lake was interrupted in Upper Palaeolithic times after the Nile level dropped below a certain threshhold value, somewhere between 18m and sea level according to Miss *Caton-Thompson* and Miss *Gardner* (1934, p. 14) on the grounds of peculiarities of the molluscan fauna and great precipitations of lime in the shoals of the Idwa bank. The lake, left to itself, shrank rapidly and almost or completely dried up permitting aeolian agents to attack the exposed lacustrine sediments severely. This shrinkage implies a low rainfall since the subsequent Neolithic lake built up impressive beaches during protracted halts under identical circumstances of isolation and with somewhat higher temperatures. Further, since wind denudation of these Neolithic and Dynastic beach formations of the Fayum has been negligible, it appears that aeolian deflation was particularly pronounced in Upper Palaeolithic times. Similarly in Libya, where *G. W. Murray* (1951) points to the striking absence of surface finds of Upper Palaeolithic and microlithic flint implements in Cyrenaica, *C. Rathjens* (1928) was able to ascribe the deposition of the Tripolitanian loess to an arid period with more frequent and stronger southerly winds than are known to-day, somewhere between pluvial and historic times.

After the last, weak 'Pluvial C' of the Jordan Valley (probably to be identified with the last Würm Pluvial subphase) *L. Picard* (1929) notes that the Jordan and its tributaries cut deeply into the soft Pleistocene sediments, leading to the isolation of the 'upper terrace' and aggradation gravels of Pluvial 'C'. The vertical incision proceeded to below the present alluvial plain by at least 9m, and after the subsequent aggradation of the 'lower terrace' or modern floodplain, degradation has only been able to excavate a shallow channel since Neolithic times. Similarly in the Chemchemal Plain of Kurdistan, *H. E. Wright, Jr.* (1952) points out that the site of Jarmo was occupied about 5000 B. C. (earliest occupational layers radiocarbon dated 4756 B, C. ± 320 by *Arnold* and *Libby*, 1951) when the postpluvial erosion had already incised the small river valley to four-fifths its present depth.

The extensive loess deposits on the southern shore of the Caspian Sea, reaching a depth of 10m north of Astarabad, offer further substantiation of early postpluvial aridity. *H. Bobek* (1937) believes this deposition of loess would not have been possible had the present moist Caspian forest then existed here, and he concludes that the lower treeline against the steppe must have lain several hundred meters higher upon the mountain slopes. The origin of the Asterabad loess is to be found, at least in part, in the exposure of the old sea floor sediments of the shrinking pluvial (Chvalyn) Caspian Sea to wind-attack during early postpluvial times. From the Kara Kamar Cave near Haibak, Afghanistan, we may conclude that the bulk of the loess deposition had stopped before 9000 B. C. but had been proceeding for at least 25,000 years before that date (*Coon* & *Ralph* 1955). The deflation of the 'younger sediments' (or Seelöß = lacustrine loess) of the southern Lut Basin of Iran necessarily implies a great fall of the water table or water level of the kavir, as the basis of aerial denudation is only then achieved when the newly exposed sediments lie close above this water-saturated horizon (*G. Stratil-Sauer* 1952). As these younger sediments were deposited subaerially and to some extent 'subaqueously' to some 150m (*Stratil-Sauer* 1952, *A. Gabriel* 1942) and then excavated to well below the level of the present Namakzar Kavir, we must suppose a great decrease in moisture since the last local pluvial and a water table somewhat below that of the present, prior to the subsequent recreation of the present kavir or salt pan.

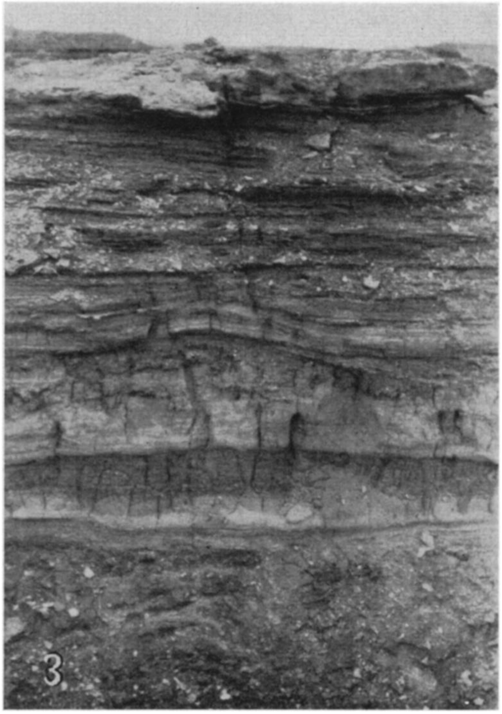
The persistance of lower temperatures even in latitude 33 °N until c. 8000 B. C. can be deduced from the Haua Fteah Cave, Cyrenaica, where angular limestone fragments, due to frost weathering of the roof and walls of the cave, are most plentiful in radiocarbon dated horizons of older date (*C. B. McBurney* and others 1953, *H. E. Suess* 1954). Similarly a last horizon of angular limestone fragments due to thermoclastic weathering occurs at —1.5m in the cave deposits at Ksar Akil, Lebanon, compared with Würm I and Würm II archaeologically dated horizons indicating greater cold and moisture at —15 and —10m respectively (*J. F. Ewing* 1951). The last suggests the last world-wide glacial readvance leading to the formation of the Salpausselkä and Mankato end-moraines, (dated at 8800—8100 B. C. by *H. Gross* (1954) taking a mean of the geochronological and radiocarbon dates), and there is ample indirect testimony of a similar phenomenon in the montane regions of the Near East. *A. v. Reinhard* (1925) identified three stages in the retreat of the Würm glaciers of the Caucasus, which he even ventured to designate as Bühl (Schlern), Gschnitz and Daun in reference to the Alpine chronology. More important is that these stadia were characterized by snowline depressions of 8—900, 550—600 and 3—400m. *R. Leutelt* (1935) also recognized stadial moraines in Lazistan which he considered of Daun. and some possibly of Gschnitz age on account of similar snowline depressions. In Hakari, *Bobek* (1940) identified at least one distinct early post — Würm maximum stage with a snowline depression of 350m, i. e. half that of the Würm, which he suggested may represent Gschnitz. The retreat stadia of the Elburz are even less distinct and general so that *Bobek* (1937) can only tentatively suggest stages with snowline depressions of 700, 450—500, 300, 250, 170 and 100m, compared with a Würm depression of 800m. Lastly, *A. Desio* (1934) recognized a stadial in the retreat of the Zardeh Kuh glaciers in Southwest Iran with a snowline depression of 300m compared with 600—650m for the last glacial maximum. We cannot conclude too much from these details, other than that it appears most probable that the world wide temperature relapse of the 9th millenium was also characterized by a temporary readvance of the already much smaller Würm glaciers in the highlands of Anatolia and Iran, with a minimum snowline depression of somewhere between 100 and 300—400m.

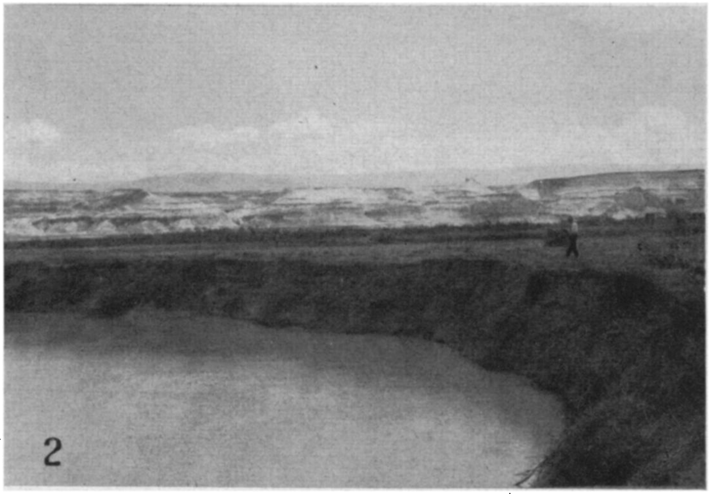
However this last glacial relapse does not seem to have passed unnoticed in the precipitation curve of the Near East, just as the terraces at 9—10, 7—8 and 3—5m of the eastern Kharga Scarp (*Caton-Thompson* 1952, p. 3—11) seem to indicate a series of minor, temporary improvements of local moisture conditions subsequent to the last, pluvial subphase with tufa formation (early Upper Palaeolithic). Firstly in the Hagfet et Tera Cave, Cyrenaica, a stalagmite horizon overlying a considerable depth of Upper Palaeolithic material indicates a quite humid phase antedating a fairly evolved Capsian-type blade-industry associated with remains of *CERVUS SP.* (*C. Petrocchi* 1940, p. 8—34). Similarly *G. Knetsch* (1950) has identified a short phase of 'pluviation' during Capsian times in the Djebel es Soda of Libya, where erosion and deposition of angular gravels took place, possibly accompanied by the local formation of red earths in the Central Sahara. Thanks to the radiocarbon dating of events in Northwest Africa and teleconnection with equatorial varves in East Africa (c. f. *H. Alimen* 1955, Table XI), the Capsian sensu lato seems dated at about 7000 to 13,000 years ago, so that a 9th millenium date would not be improbable as a first estimate. Further, at Heliopolis in Egypt, *S. A. Huzayyin* (1952b) notes a pre-microlithic, Upper Palaeolithic industry with noticeable Neolithic tendencies found in a 30cm thick bed of gravels brought down during some 'semipluvial' phase by local torrents.

In Palestine a similar interruption of the characteristic early postpluvial aridity of the Near East can be noted. Miss *Bate* (1940) points to a faunal change in Palestine among species with widely differing biological requirements in Natufian [1]) times, where the disappearance of a half dozen species of gazelles, a hedgehog and a species of hyaena suggests the oncoming of a more humid phase. In the Jordan Valley, degradation ceased at the beginning of the Holocene (to be considered in a broader sense of the word), and at first some 2m of sand were deposited by a swifter river able to carry a greater load than at present, remarkable since only the finest materials can be transported to this particular point to-day (*Picard* 1929). Perhaps the 80cm horizon of well rounded gravels at the base of the 'lower terrace' exposed at Eddesiye at the Jarmuk estuary (*Picard* 1932) was also contemporary. *Picard* mentions a 2m strandline of Lake Tiberias, and the author has noted numerous comparatively recent terraces on the northwestern end of the Dead Sea. Aneroid determinations gave approximate elevations of 10, 12—15, 20, 25, 35, 45 and 50m above the present Dead Sea level (392m below m.s.l. in 1948) for these minor abrasional terraces cut into the seasonally-banded, varve-like Lisan sediments possibly connected with the older (constructional?) terraces described by *G. S. Blake* (1928, p. 24—5). It is not possible to date the younger terraces by cultural associations as it is next to hopeless to find prehistoric sites close to this sterile and forbidding body of water, yet on comparison, we suggest that the terraces from 10 to 50m are morphologically as fresh and as well-preserved as the Neolithic terraces of the Fayum, so that a Holocene date does not seem improbable.

Lastly the Ghar i-Khamarband (Belt) and Hotu Caves near Ashraf on the Caspian coast of Iran offer dating possibilities for the temporary humid interval noted earlier for Libya, Egypt and Palestine. In the Belt Cave (*Coon* 1951) an early Mesolithic layer of cave earths is separated from the overlying horizons by a 30cm layer of loess, which we believe represents one of the oscillations to an arid climate recorded in the upper 3—4m of the Mazanderan loess by 3—4 alternating layers of light-coloured loess and dark, clayey transformed loess beds (*Bobek* 1937). The early ('Seal') Mesolithic has been radiocarbon dated at 9525 B. C. ±550 by *Ralph* (1955) and at 6150 B. C. ± 900 by *Arnold* & *Libby* (1951). Further the overlying loess beds gave a date of 10,320 B. C. ± 825 (*Ralph* 1955) so that there appears to have been some contamination, alteration or redeposition here. The nature of the Seal Mesolithic deposits suggests a moister climate which is substantiated by the occurrence of a small species of seal, likewise found in a horizon dated at 9905 B. C. ± 840 in the Hotu Cave, which suggests the close proximity of the Caspian shore. The base of the entrance to the Belt Cave being 15.4m above the 1951 level of the Caspian, it seems quite likely that the post-Chvalyn 10—12m 'Dagestan Stadium' shoreline identified

[1]) The Natufian appears to have begun some 12,000 years ago according to the latest excavations by *J. Perrot*, see „Der Fortschritt", Düsseldorf, 14. 6. 1956.





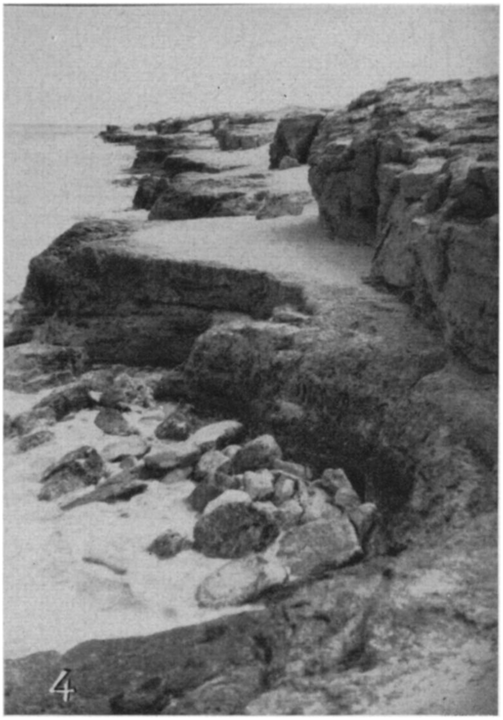


Abb. 1: Postpluvial Dead Sea terraces (with embankment of Jericho road in left foreground)

Abb. 2: Postpluvial incision of the Jordan: 'upper terrace' scarp (55 m) with 'lower terrace' alluvium and river meander in foreground

Abb. 3: Upper Pleistocene varve-like annual layers of gypsum or calcium carbonate alternating with silt or clay (1,5 m vertical section: the seasonally-banded layers average 2—3 mm in thickness)

Abb. 4: 2 m raised beach of the Mediterranean probably dating from 1—2000 years B.C. (between Sidi abd el Rahman and El Alamein)

Abb. 5: Shoreline of the Neolithic 'B' Fayum lake at 4 m dating from c. 4000 B.C. (North of Kom Aushim)

Photos by the author.

by *Leontyev* & *Fedorov* (1953) was contemporary. Similarly a brown cave earth layer in the Kara Kamar cave, dated at 8625 B. C. ± 300 (*Coon* & *Ralph* 1955) suggests a moister period in comparison to the previous loess deposition.

From the above evidence one may, for the Near East, deduce a temporary moist phase, which indirectly seems to be associated with the last glacial relapse of the 9th millenium. It must be emphasized however that all postpluvial humid fluctuations cannot be compared with the pluvials proper, being relatively insignificant geologically. Their importance lies rather in the ecological environment they provided during the rapid development of the earlier Near Eastern cultures at this time. From all indications we believe an identification with the Makalian phase of East Africa may one day be possible, but pending more conclusive evidence to the contemporaneity of 'tropical' and 'subtropical' pluvials we prefer to adopt a quite independent terminology here, not limited by regional or cultural designations. Consequently we shall simply and arbitrarily call those periods with a rainfall similar to or less than that of to-day by the term 'Postpluvial' phase, with a suffixed number for purposes of identification. Similarly the moister intervals shall be designated 'Subpluvial' phases, so that the original arid period from perhaps 16,000 or at latest 13,000 B. C. 'Subpluvial I', and the succeeding drier phase, 'Postpluvial II'.

Climatic Variation during the Early Holocene (until 2400 B. C.)

The Postpluvial II phase. The moist phase described above and designated as 'Subpluvial I' only represented a temporary amelioration of moisture conditions, a prolonged interruption of the general trend of earlier postpluvial aridity which from all indications seems to have continued at least a millenium or two after the close of the Subpluvial I.

Throughout the Near East a lack of evidence to the contrary suggests that temperatures rose to their present values during the 8th and 7th millenia, while the waters of the world oceans rose rapidly in the so-called 'Flandrian Transgression' as the continental ice masses rapidly disintegrated during the Preboreal and early Boreal. In response to this rising sea level the Nile will necessarily have begun to aggrade its bed, raising its level till it overflowed across the Hawara Canal into the Fayum a second time, giving rise to a new lake at 18m of local pre-Neolithic date (*Caton-Thompson* & *Gardner* 1929, 1934 p. 15—7). The lack of any associated cultural sites or in fact of any 'Mesolithic' implements per se suggests to us that the climate and vegetation of the unsubmerged parts of the oasis cannot have been very inviting to man. The Survey of Egypt (*O. H. Little* 1936) contended that the Fayum lake had a shoreline at 22—24m somewhere between the 12th and 18th Dynasties, basing themselves on the typology of a single pot found in situ for the date. Such archaeological evidence is all but convincing, and *Caton-Thompson, Gardner* & *Huzayyin* (1937) have refuted these contentions, suggesting that the 22—24m beach appears to be the storm-beach of the 18m Neolithic lake. However *N. M. Shukri* & *N. Azer* (1952) have been able to show indisputably on mineralogical grounds that the 22—24m 'Gisr' beach formations are of Palaeolithic date, as the mineral content does not compare favourably with that of more recent Nilotic sediments. Consequently a free connection with the Nile at more or less its present level at Beni Suef will already have provided the necessary gradient for the establishment of the 18m lake, which however was not of long duration. Great climatic or hydrographic changes seem to have been taking place in Abyssinia at this time as a second great phase of silt deposition began in Lower and Middle Egypt during the Mesolithic, blocking the mouths of the wadis and apparently the Hawara Canal as well (*Huzayyin* 1952a), so that the Fayum was isolated a second time and the 18m lake began to fall. The isolation of the lake is obvious as the Nile aggraded its bed to 20 m above its present level at Turah during Neolithic times (*Huzayyin* 1952a) while the Fayum lake dropped continuously in successive stages, becoming increasingly brackish as is witnessed by the first appearance of the brack-water mollusc *HYDROBIA PERAUDIERI* after the fall from the 18m beach (*Caton-Thompson* & *Gardner* 1934).

A similar return to more arid conditions in Palestine after the Subpluvial I is possibly indicated by a lower level of Lake Tiberias, where *R. Köppel* (1932b) found innumerable silex implements of pre-Ceramic date to a depth of 1—2m below the present water level and to a distance of 20—30m out from the present shore. Three primitive 'quais' built at such a lower level suggest a post-Palaeolithic date. Further, more conclusive evidence comes from the Belt Cave in Persia where the 20 cm Seal Mesolithic horizon dated in the 10th millenium or later by radiocarbon is overlain by 30 cm of loess which apparently represents one of the final alternating layers of the southern Caspian loess which *Bobek* (1937, 1953) has shown to be an evidence of sizeable climatic oscillations. The overlying Gazelle Mesolithic horizon dated at 6615 B. C.

± 380 by radiocarbon (*Ralph* 1955) is dominated by a steppe form *GAZELLA SUBGUTTEROSA* but also contains *BOS PRIMIGENIUS* and *CERVUS ELAPHUS* which with the absence of loess suggest an unmistakable trend to moister conditions, probably with a climate not much different than that characterizing the present.

Briefly, following the Subpluvial I there was apparently a relapse to more arid conditions for possibly some 1500 years which were gradually replaced by a climate closer to that of the present during the first half of the 7th millenium, something further substantiated by the relatively slow fall of the isolated 18 m Fayum lake which seems to have taken place some 7—8000 years ago judging by the Egyptian cultural sequence.

The Subpluvial II Phase or Neolithic Moist Interval. The climatic improvement already noticeable during the later stages of the Postpluvial II stage took on an important character in the following centuries and deserves recognition as a second 'Subpluvial Phase' which was characteristic of the Near Eastern Neolithic par exellence, and probably this relaxation of the 'climatic crisis' was intimately associated with the rapid spread of the earliest food-producing economy and the establishment, or rather the resumation of widespread cultural contacts and intercommunications during the Neolithic (*Huzayyin* 1941 p. 319). The existence of such a prehistoric moist phase has been suspected for many years now (*Caton-Thompson* & *Gardner* 1929, *Bate* 1940) but no systematic study of the overall evidence has been made to date so that its duration and character were quite differently assessed by the individual authors. So does *S. A. Huzayyin* (1941), for example, give a date of c. 5500—2500 B. C., *G. W. Murray* (1951) c. 8000—4000 B. C. while *H. Bobek* (1953) even speaks of a pronounced arid phase from c. 9000—4000 B. C.

In Northern Egypt, the silts deposited to some 20 m during high and unusual floods reaching the outer borders of the Nile Valley were eventually interbedded with angular wadi gravels along the sides of the valley indicating a return to local fluviatile activity and a moister climate (*Huzayyin* 1952a). In all eventuality the increase in local rainfall leading to the protracted halt of the falling 18m Neolithic lake at the 10m shoreline (*Caton-Thompson* & *Gardner* 1929, 1934) was contemporary. After the establishment of this beach the Fayum was colonized by Neolithic peoples. Radiocarbon dates of this Neolithic 'A' industry have yielded figures of 4440 B. C. ± 180 and 4144 B. C. ± 250 (*Arnold* & *Libby* 1951, *Libby* 1951), and since the earliest Neolithic of the Haua Fteah Cave, Cyrenaica, which should be a little later than the Egyptian Neolithic in general, has been dated at 4850 B. C. ± 350 by *Suess* (1954), a date of about 5000 B. C. for the beginning of the Subpluvial II with its greater rainfall should not be too far from the truth. At the close Neolithic 'A', the prehistoric Fayum lake began to fall again, temporarily regained an equilibrium at 4m and then dropped further to -2m (m. s. 1.) at which level the formation of an impressive salient beach, as well as the archaeological evidence, suggest a very constant level of perhaps 1700 years, remaining static throughout predynastic times, and extending at least into the period of the 4th Dynasty (c. 2400 B. C.) whose settlements were found along the shoreline (*Caton-Thompson* & *Gardner* 1934). A greater rainfall than today must again have counterbalanced evaporation both during the brief halt at 4m and during the long functioning of the -2m beach, something that is nicely shown by the lagoons, isolated by successive drops of the eventually several kilometer distant lake, which were able to persist as rain-fed lakes into the Early Dynastic period. The absence of landshells in the beach deposits, however, indicates that either there was insufficient rain to give rise to a continuous mat of vegetation or that the drainage was only short and intermittent (*Caton-Thompson* & *Gardner* 1934, p. 16–17). *M. Amer* & *Huzayyin* (1952) have identified several 'cycles' of gravel disposition by lateral wadis interrupted by limited local erosion at the site of Ma'adi. Possibly there may be a justification to attempt a correlation of these periods of fluviatile activity to the fluctuations of the Fayum lake, and we suggest that the aggradation of the Wadi Diglah characterized by the deposition of coarse gravels before the earliest Middle Predynastic settlement at Ma'adi and again during Early Dynastic times coincided with the -2m Fayum lake.

Even in the more elevated areas of the Sahara there was apparently a relative increase in precipitation at the time. The artifacts of the Khargan 'Beduin Microlithic' (Haua Fteah 'Microlithic' dated 5350 B. C. ± 300 by *Suess* (1954) are not found near the mound springs but are lightly embedded in the silt pans collected by rain wash and run-off on the Kharga Scarp, suggesting that the intervals between rain were less prolonged at the time (*Caton-Thompson* 1952, p. 34—5). The oldest class of rock pictographs incised upon the exposed boulders and scarps throughout the now utterly barren Libyan Desert and the Fezzan, as far south as latitude 22° N in Egypt, are most probably Mesolithic to early Neolithic in date

(*H. Breuil* 1928). These rock drawings variously depict giraffes, ibex, oryx, gazelles, lions, ostriches and even people in the apparent posture of swimming (Djebel Uweinat, Gilf Kebir), and to this list must be added the elephants, rhinoceros, crocodiles and buffaloes appearing on the Fezzan drawings (Wadis Issaghen and In Habeter) (*L. Frobenius,* 1937). In later Neolithic times the elephant, rhinoceros, crocodile, buffalo and some of the antelope species have become locally extinct as they are absent from the pictographs, or, presented in such a conventionalized and primitive fashion as if the artists were merely carrying on a tradition drawing animals long disappeared from their environment as *P. Graziosi* (1951) has described it. To-day all these steppe animals are gone and even jackals are a rarity, so that one need not hesitate to suggest a more abundant vegetation, something possible here only through a somewhat greater precipitation. However the exact chronological position of the Bushmen and Libyan series, as *Breuil* has called the earlier and later groups of drawings, is not certain. *Frobenius* (1937, p. 72—3) associates the older drawings with a Capsian-type industry, while *Graziosi* identifies the earliest 'Berguig hunters' group as 'Neolithic'. It is, all in all, well possible that a part of the oldest group depicting the characteristic tropical fauna are actually older and belong to the Subpluvial I, but at the present state of our knowledge it is advisable to defer judgement. Elsewhere in Egypt there is further substantiation of greater humidity until c. 2400 B. C. The author noted wall-reliefs of 5th Dynasty date in tombs at Sakkara depicting *ADENOTA KOB, CERVUS ELAPHUS, ONOTRAGUS MEGACEROS, ORYX ALGAZEL, IBEX* and *FELIS LEO,* animals which are first encountered in the Central Sudan to-day. These species are largely steppe animals and would not have favoured the riverine zone, rather they would have lived in adjacent patches of grassland, However Egyptian wall-reliefs of later date seldom depict these animals again, while to-day the desert gravels encroach right upon the irrigated fields of the Nile floodplain, practically without a single shrub existing on the west bank above the highest flood levels.

The main period of aggradation of the 'lower terrace' of the Jordan Valley is connected with a grey-black marshy loam, well seen overlying the gravel horizon and a 70 cm light grey loam to a depth of 1 m in the Eddesiye profile (*Picard* 1932). The further occurrence of this grey-black soil to a depth of 1 m between Jenin and Affule in Samaria, reaching to the bottom of the wadis and containing mollusca which cannot live in any of the dry wadis of the area to-day, suggest a meso-neolithic period of greater rainfall and greater warmth to *Picard.* Similar black earth layers have also been found in the Wadi Musrawa and at Tel Aviv, as well as at Ksar Akil and Tripoli (*Ewing* 1951), where one contained Mesolithic tools at its base.

From a study of the zoological biotypes found in the post-Natufian or early Neolithic level of the Abu Usba Cave, Mount Carmel, *Stekelis* and *Haas* (1952) have suggested a period of somewhat greater rainfall that the present, possibly amounting to 70—80 cm or over (compared with 55—60 today). Typical steppe species are absent, and reptilian types such as *OPHISAURUS APUS, AGAMA STELLIO,* and *CHAMAELEO CHAMAELEON,* numerous thrushes, and the mollusc *CYCLOSTOMA OLIVIERI* all favour a quite dense vegetational cover and usually exist under somewhat more bountiful rainfall conditions. In Arabia, *H. Philby* (1933) found gravel spreads and other lacustrine deposits containing fresh-water shells. These deposits in the northern fringes of the Rub al-Khali contained innumerable stone implements classified as 'Neolithic'. In the Hasa, *P. B. Cornwall* (1946) found a chalcolithic site situated beside lacustrine sediments likewise abounding in fresh-water shells near Uquair. This former lake bed remained dry even after a 100 mm rainfall in December 1940, the influx of drainage barely able to form small channels in the overlying sediments. In general there is much evidence in favour of a numerous Neolithic population in the Syrian Desert, living with an abundance of water, pasture and game (*S. Passarge* 1951, p. 473—4). In Baluchistan and the Makran, Sir *A. Stein* (1934) found numerous chalcolithic sites marked by great stone barrages intended to serve as reservoirs and secure irrigation for valleys which are now utterly desolate, which fact he can only explain by a substantially moister climate some four millenia ago.

Lastly, the biblical references to the Deluge are confirmed in ancient Babylonian tradition, and, the Gilgamesh Epic found in Assurbanipal's library as well as the legends from Bambyce reconded by Pseudolucian, seem to suggest a catastrophic storm both in Mesopotamia and in Syria accompanied by strong winds, unusually great electricity, and much rainfall extending over a period of several days and causing large areas adjacent to the Euphrates to be temporarily inundated. Stratigraphical profiles have confirmed this controversial legend, in particular since *L. Woolley* (1954, p. 31—35) was able to find an 8—11 ft. thick uniform layer of water-lain mud, material brought down from the middle reaches of the Euphrates and deposited in water at least

25 ft. deep upon the Neolithic site at Ur. If we assign an average of 35 years per reign, as is the case of the more credible king-list of the Ist Dynasty of Ur, we can calculate a date of somewhere between c. 3500 and 4500 B. C. from the Babylonian royal chronology, depending upon whether we consider the Ist Dynasty of Erech and the Ist Dynasty of Kish contemporary or not. These traces of a unique, great flood are not isolated and can be encountered at Erech (Warka), as well as at Dar-i-Khazineh on the Karun River. One may at least speculate on the meteorological implications of the phenomenon. At the present time major floods occur on the Euphrates when exceptionally great quantities of winter snow in Anatolia are suddenly melted by strong, warm and moist southwesterly winds which add their own precipitation to the swollen rivers. However permanent snow was at a lean minimum during these millenia, as *S. Erinç* (1952) was able to show that the present cirque glaciers of Anatolia are generally recreations following an almost total disappearance, most probably during the 'Climatic Optimum'. Consequently an extraordinary rainfall appears to have been mainly responsible.

In retrospect, the return to arid conditions after the close of the Subpluvial I of the 9th millenium lasted until perhaps 5500 or 5000 B. C. but as was seen, the last millenium or so of its duration was more like the present and a little moister than the earlier climatic subphase. Consequently a Postpluvial IIa from perhaps roughly 8000—6500 B. C. and a Postpluvial IIb from c. 6500—5000 B. C. can be tentatively identified, of which the former was somewhat more arid. Subsequently there was a definite climatic improvement characterized by an appreciable increase in moisture in the southeastern quadrant of the Mediterranean climatic province, and apparently accompanied by a local increase in temperature as well. This period which lasted from c. 5000 to 2400 B. C. is designated as Subpluvial II and represents the Neolithic humid phase as already recognized by *Huzayyin* (1941) and others. Geologically speaking, the Subpluvial II was again fairly insignificant, but the increase in precipitation was sufficiently great to permit the flourishing of a more exubriant fauna and flora in areas climatically unsuitable to-day, and was thereby of great significance to the human habitat. From the fluctuations of the Fayum lake as well as from the physiographic cycles at Ma'adi (*Amer* & *Huzayyin* 1952) there were at least three temporary decreases in rainfall during the Subpluvial II, two of them a little before and a little after 4000 B. C., and the third at the close of the predynastic period about 3000 B. C.

Chronologically the Postpluvial II a and b would coincide approximately with the Preboreal and Boreal periods respectively in Europe, while the Subpluvial II clearly was almost synchronous with the Atlantic phase. From a meteorological standpoint this chronology and climatic succession prove to be of considerable interest, as it has long been a popular theory that the postglacial Climatic Optimum corresponded to an extensive period of maximum aridity in lower middle latitudes. Further below it shall be noted that the Postpluvial III phase, which coincides more or less with the European Subboreal, was more arid than the present day, so that there appears to be a curious parallelism between moisture trends in Europe and in the Near East. However the individual meteorological problems associated with this climatic succession deserve a more detailed attention, and must therefore be reserved to a subsequent paper.

A recent arid phase c. 2400—850 B. C.

The climatic fluctuations of the last 4000 years have not been of sufficient duration or magnitude to leave much physiographical evidence, and it becomes necessary to resort more and more to archaeological evidence and literary sources. Following upon the Subpluvial II the climate, or rather, the rainfall of the Near East deteriorated very severely and during the maximum of the short but arid period, the Postpluvial III as we shall call it, the average annual precipitation of the Near East was less than that of any other time since c. 9000 B. C.

It appears that the ancient Fayum lake began to fall after c. 2400 B. C. stopping briefly at a level of —11m and this fall continued to at least —13m, at the time when Ptolemy Philadelphus (285—247 B. C.) began the systematic project of reducing the lake to its present low level at —45m (*Caton-Thompson* and *Gardner*, 1934). There appears to have been a general exodus from the Libyan Desert in VIth Dynasty times, whereafter the rock paintings of the abandoned Neolithic sites ceased, and the archaeological evidence of the immigration of the Nubian C-group from the Sahara in VIth Dynasty times is substantiated by the historical records referring to the first appearance of the Tehennu Libyans in the Nile Valley during the reign of Pepi II (*O. H. Myres* 1939). In other words, a pronounced reduction of rainfall and pasturage in Egypt and the Libyan Desert quite certainly took place after 2400 B. C.

As a first literary source, the Old Testament may be cited, since the biblical references to severe droughts and catastrophic famines have a definite bearing upon rainfall conditions in ancient Palestine. Particular attention should be drawn to the fact that of over eleven specific references to severe and prolonged droughts or famines found in the Bible[2]), only two belong to the period after 850 B. C. We find reference to such droughts in the days of Abraham (c. 1800 B. C.), Isaac and Jacob, during the rule of the Judges, and the reigns of David (c. 1010—970 B. C.) and Ahab (876—853 B. C.). Furthermore *R. Köppel* (1932a) describes a Dead Sea level of —8m on the grounds of a submerged marine erosional bench for which he suggests a date of c. 2500—1200 B. C. on account of a specific Bronze Age type implement nearby.

M.E.L.Mallowan (c.f. Bobek 1954) points out that the number of known Neolithic and Bronze Age sites from the steppe of Mesopotamia are in the ratio of 5 : 1 and he concludes that many settlements had to be abandoned after the middle of the 3rd millenium B. C. due to a declining rainfall. In the Asterabad loess area, *H. Bobek* (1937) notes that the numerous Bronze Age tepehs of the area were obviously occupied at a period when the luxuriant forest was replaced by steppe and loess deposition, probably recorded in the final oscillating layers of the upper loess. And in the Karakum Desert, *A. Schultz* (1927) identifies a period of recent desert conditions during which the mobile dunes, found especially in the vicinity of the Amudarya, came into existence at a time corresponding to the European Subboreal.

At Enkomi-Alasia, Cyprus, *C. F. A. Schaeffer* (1952, p. 358—9) identified six gravel beds alternating with sand, which he assigns to six consecutive years of particularly abundant precipitation. An alluvial layer of almost 1m depth accumulated after this, which he stratigraphically dated at 1150—1100 B. C.

All in all the existence of a dry period between c. 2400—850 B. C. seems relatively certain, although the indications of a temporary fluctuation in the late 12th century B. C. from Cyprus suggest that the maximum aridity had been reached before that date, possibly midway in the 2nd millenium. But, that the Postpluvial II phase was by no means over until at least 850 B. C. is borne out by the repeated biblical references to very severe droughts in the early 1st millenium B. C. Chronologically this Postpluvial III period corresponds well with the European Subboreal, just as the Subpluvial II was contemporary to the Atlantic of Europe. The climatic relationship as regards a pattern of general atmospheric circulation is not quite so obvious, and presents an inviting problem for further research.

[2]) I Gen. 12; I Gen. 26; I Gen. 43; I Gen. 47; Ruth 1; II Sam. 21; I Kings 17, 18; II Kings 4; II Kings 6; Joel 1; Jeremiah 14.

The climate of the historical period since 850 B.C.

Perhaps our best evidence to show that a period of moister conditions of greater permanency had set in comes from *H. E. Wright Jr.*'s (1952) geological study of the archaeological sites of the Chemchemal Plain in Kurdistan, where alluvial fill deposited to a depth of almost 10m in a deep erosional gully of the Quadhai Chai contained pottery tentatively identified as late Assyrian (750—600 B. C.). However none of the other rivers nearby were sufficiently advanced in their cyle of erosion to go over from degradation to aggradation, a process absent in the general area since the pluvials. Probably this isolated and temporary exception records a fluctuation to moister conditions. Confirmation is available from the Karakum where a renewed phase of dune-fixation took place contemporary to the onset of the European Subatlantic (*Schultz* 1927).

From this time onwards climatic conditions in the Near East seem to have approached a norm resembling that of the present in all respects. One may deduce this largely from a lack of evidence to the contrary. From the scanty historical information available from literary sources we can do little more than suggest that the last five centuries B. C. were very similar to the first half of the 1st millenium A. D. In later Roman times and especially in Byzantine and Islamic times we know considerably more. However it is not necessary to go into detail at this point, and the reader is referred to the readily accessible work of *C. E. P. Brooks* (1926, 1931) on the Nile levels, *E. Brückner*'s (1890) invaluable study of the Caspian Sea fluctuations in historical times, and lastly to the detailed weather chronology assembled by *R. Hennig* (1904) with further references in *A. Wagner* (1941). However it will not be superfluous to discuss these weather criteria themselves briefly, and to outline and discuss the short-term climatic fluctuations of the last millenia on the basis of the above sources.

Although *Brückner* believed the Caspian Sea level fluctuates in direct proportion to the high-water level of its chief tributary the Volga, *L. S. Berg* (1934) has pointed out that whereas the rainfall of the Volga drainage basin increased after 1881, and especially after 1900, the Caspian has fallen steadily, alone by 3.5m during 1900—1925. Evidently the evaporation over the Caspian or over the whole watershed increased considerably. *A. Wagner* believes that since only the winter rainfall of Russia had increased, the evaporation over the northern watershed remained the same, and he concludes that evaporation over the Caspian itself, in all probability over the southern half of its great expanse, must have increased. A good proof that the Caspian Sea fluctuations reflect Near Eastern moisture trends can be obtained by a comparison of the recorded variations of the annual maxima of the Dead Sea (*M. R. Bloch)* and the Caspian *(W. Köppen* 1936, *G. A. Taskin* 1954) for the only comparable, 19-year period 1928—1946. The linear correlation of the relative movements of both non-outlet lakes is very good, yielding a coefficient of correlation of $r = +0.70$, wherefrom, considering the large distances and local features involved, as well as the poor correlation coefficients obtained between tree-ring curves in various localities of the American Southwest, it will be seen that the we may consider the historical fluctuations of the Caspian Sea as an invaluable criterion of Near Eastern climate.

The curious pattern of Nile levels has long proved to be a perplexing problem, which is by no means simplified by the doubtful reliability of so much of the data. However as a first point a clear distinction must be drawn between total volume, and high and low-water levels. Very interestingly the total Nile waterflow 1870—1900 was 10 % above average while that of 1900—1920 was 14.5 % below normal, which is in full accord with the mean annual precipitation of Jerusalem amounting to 736 mm in 1880—1900 and 660 mm in 1900—1915, not to mention the 3.5m fall of the Caspian during 1900—1925. This again lends support to the theory that rainfall trends north and south of the Sahara are very similar. However the problem of high and low-water level patterns is a little more complicated, and other than that we know that the flood-level is solely determined by the Blue Nile and its tributaries in Abyssinia, while the equatorial drainage entering through the White Nile above the mouth of the Sobat makes up less than 5 % of the Nile volume (*Pietsch* 1910), we do not as yet understand this pattern of maxima and minima. *J. Hövermann* (1954) has shown that seasonal distribution and absolute amounts of precipitation in Ethiopia, as well as the historical fluctuations of the lower limit of snowfall all play their part to make the problem rather complex.

The Nile floods of the 1st century A. D. were high and there is evidence of a great drought lasting many years in Central Asia about A. D. 80. However the Nile floods became considerably lower during the 2nd century and the traveller Cosmas refers to perennial snowfields in Ethiopia at the time (*Hövermann* 1954). The year 145 is signalled out by catastrophic flood throughout the Mediterranean. It is no mere coincidence that *C. E. P. Brooks* with Miss *L. D. Sawyer* (1931) after investigating the weather record of Claudius Ptolemy (observabat A. D. 127—151) taken at Alexandria, should arrive at the conclusion that occasional rare depressions interrupted the steady fine summer weather of the Eastern Mediterranean at this time. All in all the early 2nd century appears to have been quite moist, in contrast to the 1st century A. D. which was apparently drier.

There are records of great heat and drought around A. D. 260, and about the year 310 Cyprus suffered from 36 years of extraordinary drought. In A. D. 333 the level of the Dead Sea, which *J. Enge* (1931) has shown to be in proportion to the local rainfall, was the same or probably a little lower than that of the present. Between 360 and 363 there are further indications of droughts in Asia and Africa, but by the close of the century, a period of moister and cooler conditions set in. There was an abnormally great rainfall in A. D. 395, and the winters 400/01 and 418 or 421 were extremely cold. In 400/01 the Black Sea was supposedly covered in its entirety (surely exaggerated!) by a sheet of ice for twenty days. This more humid phase was cut off about A. D. 450, and the years 454 and 484 were very dry. During the reign of the Sassanid Firuz (A. D. 459—484), and during the 6th and 7th centuries the Caspian Sea seems to have hovered around the —4m 'Derbent Stadium' of *Leontyev* and *Fedorov* (1953). Following another severe drought from A. D. 512—517 in Palestine, moister conditions prevailed until the late 6th century when we can point four phenomenally critical years 591, 593 or 594, 598 and 605 or 606 when a period of almost uninterrupted drought and heat lasted nine consecutive months in the Mediterranean world! Arab legends further record a seven-year drought 'in the days of Muhammad', a severe drought is recorded in A. D. 630, and during the nine month long drought of the 'Year of Destruction' in 640, the heat 'burnt the soil of Arabia to ashes' as the Arabic authors have put it. All indications show that there was an extremely dry snap between about 590 and 647 which latter date marks the gradual beginning of a long series of seldom interrupted records of very cold winters or wet years in Asia Minor such as 673, 717/18, 763/64, 800/01, 829, 859/60 and 1010/11, which are curiously paralleled by exceptionally low Nile floods between A. D. 700—1000, which reached an absolute minimum A. D. 750—800.

When Istakhri visited Derbent between 915 and 921, the Caspian seems to have stood at 10.5m above the present level, but during the 12th century seems to have fallen to —2.5m Perhaps this temporary low level occurred at the time of the accentuated dry years 1158—60 in the Mediterranean world, since the years 1099/1100 and 1129 were still cooler and humid in the Near East. After this drier interval, the Caspian rose very rapidly at the end of the 13th century and attained a maximum of 13m before it began to fall again in A. D. 1307, althoug *L. S. Berg* (1934) would discount this and the 915/21 maximum on the grounds that the indicating mollusc, *CARDIUM EDULE,* of the modern Caspian does not occur continuously above 6m over the present level, However such very temporary high levels cannot be expected to produce wholesale movements of the mollusca, while the excuse of 'sheer accidents' cannot explain the numerous exceptions to this 6m 'continuous' occurrence of *C. EDULE.* Neither can the mediaeval inflow of the Amudarya be called upon to account for this high level, since newer Russian on the Sarykamish Depression (*Tolstov, Kess* and *Shdanko,* 1954) has revealed that there has been no recent noteworthy or sustained flow of of water in the Uzboi Channel, as the Bronze Age sites of the lowest Uzboi terrace have not been disturbed.

During the early 15th century the Caspian rose once again to a level of 6m and simultaneously the Nile flood-levels were so low as to cause severe famines in Egypt. The next information comes from the first half of the 17th century, when we note a new Caspian level of 7m, some very cold winters in Asia Minor such as 1608 and 1621 when the Bosporus was icebound, as well as a lowering of the climatic snowline with a readvance of the Near-Eastern glaciers. *H. Bobek* (1940, 1937) identifies numerous moraines of Fernau age in Kurdistan, implying a considerable advance of the Cilo and Sat Dag glaciers, while similar moraines occur in the Tacht e Suleiman group of the Elburz. *S. Erinç* (1952) has assigned a major advance to the Anatolian glaciers during the 17th century, confirming the observations of *R. Leutelt* (1935) in Lazistan. The snowline depression appears to have been between 50 and 100m in both Iran and Turkey. Whereas the Ethiopian highlands enjoyed little or no snowfall in the 16th century, the snowline apparently hovered at about 4200—4400m in the early 17th century according to many detailed travel descriptions of contemporary Europeans (*Hövermann* 1954).

After dropping to +2.3m by 1715/20, the level of the Caspian rose rapidly c. 1740 to reach a maximum 1742/43, falling to a new low level 1765/66; correspondingly the winter of 1709 was very mild in Istanbul while that of 1742 was quite severe in Syria. In the 1780's the Caspian began to rise once more, this time achieving a new maximum of about 5m in 1809/15, but falling back to +2.4m by 1830, about which level it fluctuated for the remainder of the century. Another general advance of the Anatolian and Elburz glaciers before 1850 was paralleled by advances in the Caucasus where the Azau or Baksan glacier advanced rapidly in 1849, only to retreat by 1.5 km during 1873—1911. Again from a number of travel descriptions from Ethiopia (*Hövermann* 1954, *Werdecker* 1955) it appears that while the lower limit of snowfall was at about 3300m during the years 1830—50, little or no snow fell in Abyssinia during the last half of the 18th century, as has been the case since about 1880.

With regards to the well-known 'recent climatic fluctuation' experienced in higher middle latitudes during the last century or so, some remarks can be made from a study of some of the few longer meteorological records of the Near East (*H. H. Clayton* 1927, 1934, 1947). In the case of temperature there appears to be no outspoken trend, although a slight tendency towards higher temperatures can be noticed. The period 1911—1940 in Alexandria had a mean annual temperature of 0.4 °C higher than that of 1870—1910. Similar results can be cited for Beirut with an increase of 0.8° between 1884—1913 and 1911—1914, but there was no change whatever in Bushire, while in Krasnovodsk a bare increase of 0.1 °C occurred between 1883—1910 and 1911—1940. An the whole the trend between mean annual temperatures and mean winter temperatures was identical. Different is the picture presented by the precipitation records. Alexandria received an average annual precipitation of 220 mm for the period 1887—1910, 173 mm for 1911—1940; Beirut 932 mm for 1876—1910, 858 mm for 1911—1940; Quetta 246 mm for 1878—1910, 218 mm for 1911—1940. In other words there was a general and considerable decrease in precipitation, and if we average the decrease from the four long-term records of Alexandria, Beirut, Bushire and Quetta for the years 1881—1910 and 1911—1940 we obtain an approximation of 10—15 % decrease on the 60 year mean.

The testimony of the weather records is borne out in many other ways. The water-table fell by many meters in Syria, Egypt and the Sahara during the present century, and from the description of many travellers one can note a rapid extinction of organic life and increasing desolation in the Libyan Desert and in Tibesti (*W. Thesiger* 1939). A sharp decrease in rainfall in Syria between 1920—1934 resulted in a series of bad crop failures. However as the well-known temperature trend of higher latitudes was definitely interrupted since 1938 by the repeated occurrence of very cold winters, so too has the decline in Near Eastern precipitation apparently been reversed, the cold winters of higher latitudes accompanied by bountiful rainy seasons in the eastern Mediterranean Basin. It does appear likely that the present climatic fluctuation, and thereby the menacing desiccation of the Near East has been halted or at least interrupted.

Reviewing the climate of the historical period, it is clear that there has been no long-term desiccation 'since Roman times', rather we may divide the associated climatic phase, for which the name Postpluvial IV is suggested, into two subphases of which the first or IVa period c. 850—B.C.—A.D. 700 was generally characterized by lake levels equal to or lower than those of the present, by numerous records of warm summers and severe droughts and very few references to cold winters or wet years; the subsequent Postpluvial IVa phase, except for two intervals in the 12th and 20th centuries, was characterized by Caspian Sea levels well above those of the present, by many cold winters and other indications of a greater rainfall or lower evaporation. In short, the earlier IVa subphase was a little warmer than and also drier than the later IVb subphase. Within this latter period we can identify distinct but temporary maxima of humidity from A. D. 700—1000, during the late 13th, the early 15th, the first half of the 17th and the beginning of the 19th centuries[3]).

Summary and Conclusions

The results of the above investigation may be briefly summarized below the headings of the different climatic phases identified for the Near East in the course of the discussion:

Postpluvial I. During this period of unknown duration following the Last Pluvial, wind-erosion was particularly pronounced, temperatures apparently a little lower, and the rainfall of the Near East was somewhat less than that of the present, probably reaching a minimum during the 11th millenium B. C.

Subpluvial I. (probably during the 9th millenium B. C.) A marked, but temporary improvement of moisture conditions is evident in te Near East, with a mean precipitation perhaps halfway between that of the Last Pluvial and modern conditions. It appears that a last readvance of the disappearing Würm glaciers took place during this time, accompanied by lower temperatures effective to at least as far south as latitude 33 °N.

Postpluvial IIa. (perhaps 8000—6500 B. C.). Following the temporary humid phase probably associated with the last glacial relapse of the 9th millenium, temperatures rose and typical postpluvial conditions of aridity set in with a rainfall a little less than that of the present.

Postpluvial IIb. (c. 6500 to 5500 or 5000 B. C.) marked an improvement in precipitation, characterized by moisture conditions closely resembling those os the last century of our era.

Subpluvial II. (c. 5000—2400 B. C.) This Neolithic moist interval, as it has already been called, enjoyed a rainfall somewhat greater than that of the present despite indications of higher local temperatures. A higher rate of evaporation consequently implies that the increase in precipitation was appreciable, again probably on a plane halfway between that of a pluvial and modern conditions. There appear to have been temporary decreases in rainfall shortly before and after 4000 B. C. and again about 3000 B. C.

Postpluvial III. (c. 2400—850 B. C.). A renewed decrease in precipitation during the late 3rd millenium led to a longer period of arid conditions probably accompanied by greater warmth, with an average rainfall below that of the present, interrupted by at least one moister interval (in the 12th century B. C.).

Postpluvial III. (c. 2400—850 B. C.) 700.) Ushered in by a short interval of quite moist conditions, the period was characterized by a rainfall about the same as, or rather a trifle less than to-day. In general the winters still appear to have been a little warmer. A very severe drought between perhaps A. D. 590—645 can actually be determined, which however, only represents a minor climatic fluctuation prior to a change to slightly different conditions of rainfall and temperature.

Postpluvial IVb. (A. D. 700 —.) After about A. D. 650 an increasing number of quite cold winters were recorded in the Near East, during which the Black Sea was apparently frozen over on two occasions (in A. D. 673 and 800/01), and ice even formed on the Nile (in A. D. 829 and 1010/11). The rainfall was a little higher on the average, but marked by continuous short-term fluctuations over a fairly wide range.

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Only since 1900 can one speak of a certain climatic deterioration which has been destructive to organic life in such marginal pastures as the elevated plateaus of the Libyan Desert. This very recent climatic fluctuation is associated with a 10—15 % decrease in rainfall, a fall of level in lakes with interior drainage, a decreased Nile volume and a retreat of the peripheral zone glaciers. There seems to be no overall tendency to higher temperatures and one is inclined to see a major cause in the retreat of the glaciers in a decrease in precipitation, in itself largely confined to the winter season, and not so much in a temperature amelioration.

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SOZIALGRUPPEN ALS FORSCHUNGSGEGENSTAND DER GEOGRAPHIE

Gedanken zur Systematik der Anthropogeographie

Helmut Hahn

Social groups as subjects of research in geography

Summary: German geography has recognised only relatively late the bearing that social groups have on the shaping of the cultural landscape. During the last few decades, however, a good deal of preliminary work has been done, and it seems that the time has now come to give social geography its logical place within the field of geography as a subject in teaching and research. A brief review of the development of human geography since *Ratzel* and an analysis of the content and task of social geography shows that it is by no means identical with human geography as is claimed here and there in more recent publications.

Like all geographical research social geography must be pursed analytically and synthetically. Since man shapes the cultural landscape almost exclusively merely as a member of a group, as a social being, synthetic human geography can, however, only be pursued in the form of social geography. The established branches of analytical human geography, i. e. population, settlement, economic and commercial geography, geography of communications and in particular physical and psychical anthropogeography (as understood by *Ratzel*) completely retain the justification of their existence beside the analytical social geography. (In order to make the distinction clearer it should rather be called socio-geography.) The different manifestations of human activity are materially so closely tied to the laws of the inorganic and biological spheres, that we should not cut ourselves off from the possibility of a penetrating analysis by a onesided emphasis of the social sphere.

Social geography merely aims to juxtapose to the causally determined complex of physical nature a cultural spatial complex shaped by human forces and thus to facilitate deeper penetration into the interrelationship existing within the cultural landscape (habitat *and* human society).

Kürzlich hat *H. Overbeck* einen Überblick über die Entwicklung der Anthropogeographie veröffentlicht, der in übersichtlicher und klarer Darstellung die methodischen und sachlichen Fortschritte dieses Zweiges der Geographie beleuchtet, aber auch zur Besinnung anregt[1]). Gilt es doch, die Leistungen und Irrtümer von drei Forschergenerationen zu beherzigen, wenn wir selbst bestehen wollen. Wie notwendig eine solche Besinnung ist, wird allein schon durch die Tatsache bewiesen, daß z. B. die niederländische Geographie eine ganze Generation früher als die deutsche die landschaftliche Gestaltungskraft sozialer Ord-

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[1]) *Hermann Overbeck,* Die Entwicklung der Anthropogeographie (insbesondere in Deutschland) seit der Jahrhundertwende und ihre Bedeutung für die geschichtliche Landesforschung, aus: Blätter für deutsche Landesgeschichte, 91. Jg. 1954, S. 182—244.

Auf ein umfangreiches Literaturverzeichnis soll hier aus Raumgründen verzichtet werden. Die in den Fußnoten zitierten Autoren — insbesondere *Overbeck, Winkler, Houston, Hottes* und *Lautensach* — bringen Schrifttumsverzeichnisse, welche die wesentliche einschlägige Literatur erfassen.