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Holocene changes in the Fayum: Lake Moeris and the evolution of climate in Northeastern Africa

Introduction

In the years 1979 - 1981 the authors of the present study conducted excavations at the northern boundary of the Fayum Oasis in the region of Qasr el-Sagha which were described in several earlier reports. The research was carried out jointly by the Jagiellonian University in Cracow and the German Archaeological Institute in Cairo. The investigations focused primarily on the reconstruction of palaeogeographical conditions during the Older and the Middle Holocene and the evolution of climate in these periods. Moreover, the influence of ecological conditions on the formation of Pre-Dynastic settlement was traced, as well as its development and transformations. That after several years we are coming back to what seemed to have been a closed subject, has been prompted by new investigations in the region of Lake Birket Qarun conducted by the expeditions of R.J. Wenke (Wenke *et al.* 1983) and F.A. Hassan (1986). These investigations have partially confirmed our earlier findings, and in part yielded new data not always supporting our earlier conclusions. All this has compelled us to take up the issue again. In addition our considerations on the subject of the variability of climate in the region of the Fayum Oasis can now be confronted with the results of investigations conducted in the Nile Valley in the Western Desert and in the areas south of Sahara. This confrontation has revealed certain regularities in climatic changes and provided grounds to propose new, more general formulations.

Holocene lacustrine events in the Fayum Depression

After several seasons of investigations in the northern part of the Fayum Depression, Caton-Thompson and Gardner concluded that the large Pleistocene lake filling the center of the depression (up to the level of 40 m a.s.l.) gradually lowered until the Neolithic when the shore of the lake was at the level of + 10 m a.s.l. Subsequently the lake continued to shrink and remained low during the whole historical period. This view was common among researchers of the prehistory of Egypt, although already before WW II Little (1936) suggested that in the Pharaonic period the lake level reached + 22 m a.s.l.

The paradigm of the successions of increasingly lower levels of the lake was finally abandoned owing to the investigations of the Combined Prehistoric Expedition (Wendorf and Schild 1976). Its findings revealed, on the northern side of the shore, a number of Holocene fluctuations of the lake, preceding not only historical times but even the Neolithic. The oldest high Holocene level of the lake has been dated to about 9,000 years B.P. – based on the interpolation of dates. To this level are ascribed "fluvial sands" and "diatomites" from the site E29G1 area F presenting deep water sediments of the so-called Palaeo-Moeris Lake.

The next stage in the evolution of the lake is represented by desiccation cracks in the top of the diatomite unit, which mark the low level of the lake.

The next transgression, the so-called Pre-Moeris Lake, is better documented. Sediments from this period were recorded on the sites: G1, area A and B, G3, area A and H1, area A. The level of this lake was more than 17 m a.s.l. It is placed by the radiocarbon dates between 8,100 and 7,500 years B.P. During the recession the level of the Pre-Moeris Lake lowered to + 12 m a.s.l. At that time deep erosional wadi channels formed, pointing to fairly heavy rainfall in the desert.

Subsequent transgression is associated with the Proto-Moeris Lake. Its high level (+ 19 m a.s.l.) on the site E29G1 area E is dated at 7,140 years B.P. If we take into consideration the sediments on site H1 area C the level may have been even higher.

Another lowering of the lake level is marked by red soil on the level of + 9 m (in the so-called basin X).

The Middle Holocene transgression phase is identified by Wendorf and Schild as Lake Moeris and dated from the Neolithic (Fayum A) until Dynasty IV when, they believe, the lake reached its maximum level in that transgression (+ 25 m a.s.l.). Subsequently the lake lowered to about 18 m in the period of the Middle Kingdom to remain stable until the time of Herodotus.

While Wendorf and Schild based their investigations first of all on the exploration of the northern side of the Birket Qarun Lake, R. Wenke and F. Hassan carried out their investigations on the south-western side of the lake. Here F. Hassan recorded diatomites associated with the Palaeo-Moeris Lake, at + 11 - 12 m a.s.l., overlain by a weak gypsiferous reddish-yellow palaeosoil. Near Gisr el Hadid, F. Hassan recorded the sediments of the Pre-Moeris Lake of the sandy beach type and swampy silts. In addition sediments of the Proto-Moeris Lake occurred at locality 64 represented by sandy-silt series with lacustrine snails, interbedded by sand and gravel sediments containing fresh water snails. In the region of Bahr Wadi Quta wadi activity was observed consisting of wadi deposits intercalated with cross-bedded aeolian sand from the period which post-dates the Pre-Moeris Lake and predates the Proto-Moeris Lake.

The Mid-Holocene transgression is represented – Hassan claims (1986: 489) – by the sandy sediments of the beach facies on site FS-1 (Wenke *et al.* 1983). On the basis of the data obtained in our investigations Hassan comes to the conclusion that the lake began to rise as early as 6,500 B.P., whereas the lacustrine sediments on site FS-1 on the southwestern side of the lake, + 20 m a.s.l., can be dated at *ca.* 5,160 ± 70 B.P. As to the further evolution of the lake, F. Hassan shares the views of Butzer (1984) *viz.* that after the lake level lowered in the Early Dynastic period, it rose to 18 - 22 m in the period of the Old Kingdom, lowered again in the first Intermediate Period to rise up to 15 - 18 m in the period of the Middle Kingdom. For the last period of transgression there is evidence of F. Hassan's observations on the pedestal of two colossi of Byahmu where traces have been preserved of the high level of the lake from the times of Amenemhat III (1,940 - 1,793 B.C.).

In order to better illustrate our further considerations let us refer to the sequence of lithostratigraphic changes and the curve of changes in the lake level reconstructed on the basis of the field investigations we conducted and the analysis of obtained materials.

The oldest part of the Holocene sediments on the northern side of the Birket Qarun lake starts with the lacustrine sediments of marls and diatomites (LMD) which are associated with several fluctuations in the lake level. In the profiles the bottom part of LMD can be seen with the evidence of the lake getting bigger. The middle part of this formation displays distinct features of lake recession such as: the occurrence of humic levels, desiccation cracks, fires of vegetation, and crystals of gypsum. Subsequent part of LMD reveals another transgression of the lake, also evidence of fresh water supplies by the Nile. The top part of LMD is connected with another recession of the lake. As a consequence a wide near shore zone was revealed. Lithological observations have been fully confirmed by the results of investigations of malacofauna by S. Alexandrowicz (1986).

In-between the top of LMD and the bottom part of the next sediment of hard grey silts (GHS) there is, in all likelihood, a short period without sedimentation. It is also possible that partial erosion of the top of LMD took place – which is suggested by surfaces of unconformity observable in the profiles. The beginning of the GHS sedimentation is marked by a distinct transgression of the lake connected with the inflow of masses of water from the Nile carrying with it a group of malacofauna typical of the Nile Valley. The middle part of GHS shows a tendency towards a recession of the lake particularly well visible in the top part of the GHS. The top of the GHS is cut by erosional processes which created differing conditions of sedimentation of consecutive series of sediments easily recorded even over a relatively small area.

The complex of white sands and silts (CWSS) in the eastern part of the investigated area, shows the occurrence of sediments of the supralittoral beach type, whereas in the western part deltaic sediments such as cross-bedded sands, sometimes coarse-grained. It should be explained that the terms "white silts and sands" are used for the purposes of reference while in fact CWSS series is considerably varied in color, both vertically and horizontally, from whitish, yellow-grey to orange-brown coloring.

The CWSS sedimentation began in the period of a transgression of the lake which was gradually becoming deeper. In the middle part of CWSS a new short-event of the recession can be seen, followed by another transgression. Particularly in the western part of the region of Qasr el-Sagha this new transgression is marked by the presence of remains of miocene malacofauna in the deltaic formations on secondary deposits. They confirm intensive transport of materials from the north, from the desert, caused by periodical torrential rains supplying the lake with water.

The CWSS top itself falls at the period of another lowering of the lake level. In effect fairly large areas were uncovered on which developed humic soil at some distance from the shore. This soil was overlain by brown sands (BS) deposited during another lake transgression. The maximum of this transgression is connected with the top of BS and is at least partly of anthropogenic character. Therefore it can be associated with large-scale hydraulic works carried out in the period of the Middle Kingdom. The chronological table (Table 1) shows radiocarbon dates obtained for each lithostratigraphic unit and the corresponding lake events.

Table 1

Radiocarbon dates from the region of Qasr el-Sagha collected by the expedition of the Jagiellonian University.

Site	C-14 date B.P.	Laboratory
Brownish sands (BS)		
QS VIIC/80	3,890 ± 45	Gd-1372
QS VIIA/80	4,820 ± 100	Gd-976
QS VIIA/80	5,000 ± 60	Gd-1496
QS VIIA/80	5,000 ± 110	Gd-916
Fossil soil		
QS VIII/80	5,010 ± 120	Gd-904
Complex of white sand-silts (CWSS)		
QS VIIA/80	5,070 ± 110	Gd-895
QS VIIG/80	5,120 ± 110	Gd-874
QS VIIA/80	5,160 ± 110	Gd-915
QS X/81	5,330 ± 100	Gd-978
QS VID/80	5,410 ± 110	Gd-903
QS VIIA/80	5,450 ± 100	Gd-977
QS I/79	5,540 ± 70	Gd-1140
QS I/79	5,555 ± 60	Bln-2333
QS I/79	5,645 ± 55	Bln-2334
QS VIE/80	5,650 ± 70	Gd-1495
Grey hard silts (GHS)		
QS V/79	5,990 ± 60	Gd-693
QS I/79	6,035 ± 650	Gd-708
QS V/79	6,075 ± 50	Bln-2335
QS X/81	6,290 ± 100	Gd-979
QS X/81	6,290 ± 110	Gd-980
QS X/81	6,320 ± 60	Gd-1497
QS IX/81	6,380 ± 60	Gd-1499
QS XI/81	6,480 ± 170	Gd-2021
Lake marls-diatomite (LMD)		
QS II/79	7,440 ± 60	Bln-2336
QS I/79	8,835 ± 890	Gd-709

An attempt at a synthesis of lacustrine events

The results of the investigations we have discussed above enable us to attempt a synthesis of the Holocene lacustrine events (Fig. 1). The hypothesis put forward by Wendorf and Schild about three pre-Neolithic transgressions of the Early Holocene lake has been fully confirmed. Certain discrepancies in comparison with the results obtained in our investigations as well as those of Hassan occur in the chronology of the maximum of the last transgression (Proto-Moeris Lake). Wendorf and Schild date it to about 6,800 years B.P., the corresponding lacustrine event is placed by F. Hassan at about 7,200 years B.P., whereas our investigations date it to about 7,400 years B.P. As a consequence of this disparity there is disagreement as to the dating of the deep recession which postdates the Proto-Moeris Lake and predates the Neolithic Lake. According to Wendorf and Schild this event should fall at the second half of the 7th millennium B.P. Hassan places it at the first half of the same millennium, whereas our observations date the deep recession at the end of the 8th millennium B.P.

Unfortunately, we have no radiocarbon determinations that would directly pertain to this important recession episode. Its lower boundary has the date of 7,140 ± 120 obtained from site E29G1 area E from the sediments of the Proto-Moeris Lake on the level of + 19 m. This date was obtained on burnt *Pila ovata* shells (Wendorf and Schild 1976: 179) and for that reason may not be wholly comparable with other dates obtained on charcoal. Moreover, the date in question corresponds to the level of the Qarunian for which the remaining dates are within 8,220 ± 105 from site FS2 level 2 (Wenke *et al.* 1983) and 7,440 ± 60 from our site QS II/79 (*Qasr el-Sagha* 1983: 114). The date of 8,835 ± 890 from our site QS I/79 is disregarded since the standard error is too large. The upper boundary of the episode of the deep recession is demarcated only by dates from the top levels of the sediments of the first transgression of the Neolithic lake. These dates are at the same time the oldest determinations for the Fayumian: 6,480 ± 170 from site QS XI/81, and 6,380 ± 60 from site QS IX/81 (Dagnan-Ginter *et al.* 1984). Thus, they do not allow us to place the recession episode with greater precision. It seems most likely that it can be ascribed at the first part of the 7th millennium B.P. as Hassan suggested (1986a).

Serious disagreements appear among the views of the Middle Holocene transgression of the lake. As we have said, Wendorf and Schild distinguished one transgression *viz.* the Moeris Lake which started in the Neolithic, reached its maximum in the period of the IV Dynasty, to lower again in the period of the Middle Kingdom. All the data that we have obtained disprove the thesis about the high level of the lake in the period of the Old Kingdom. This thesis was mainly based upon erroneous dating of the temple at Qasr el-Sagha and associated sediments to the period of the IVth Dynasty. In fact, the investigations of D. Arnold first and then J. Śliwa ascertained that these are the sites from the Middle Kingdom period. This chronology has been further confirmed by radiocarbon date from the Western Settlement (QS VIA-2/81) of 3,580 ± 60 B.P.

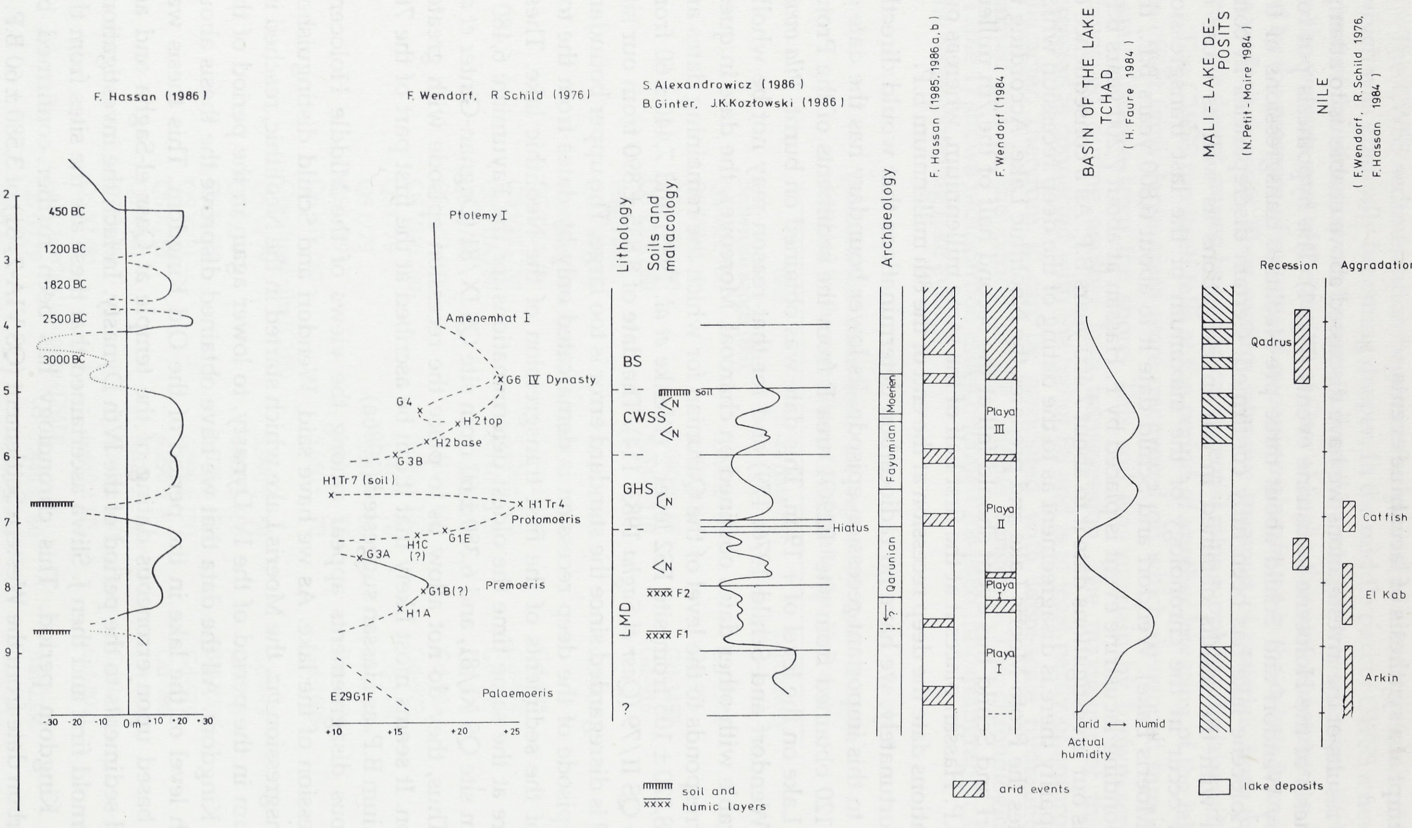

Fig. 1. Lacustrine events in Fayum Depression in comparison with Western Desert arid and dry intervals, other Saharian lakes fluctuations and with Nile aggradations and recessions during the Holocene.

F. Hassan's thesis which distinguishes separate transgressions: one Neolithic and three consecutive Dynastic ones partially concurs with our observations concerning major recession of the lake between the Neolithic and the Dynastic times. We cannot accept, however, for reasons mentioned above, F. Hassan's assumption – who follows K. Butzer on this issue – that in the period of the Old Kingdom the lèvel of the lake was high. Besides, none of the arguments presented by Hassan refer to his own investigations and the results confirming only the high level of the lake in the period of the Middle Kingdom – which is also our thesis.

There are also some differences between our and F. Hassan's views on the evolution of the Neolithic Lake. Hassan claims only one insignificant fluctuation, whereas we believe that there were at least three transgressions separated by fairly deep recessions. For this there is the evidence of the lithostratigraphic data as well as three instances of recurrence of Nilotic fauna (S. Alexandrowicz 1986).

Changes in the level of Lake Moeris and the evolution of climate in the Western Desert

The starting point for our considerations of the evolution of climate in the Western Desert in the Holocene are the investigations conducted by Wendorf and Schild (1980; 1984) and F. Hassan (1984; 1985; 1986a; 1986b; 1986c). On the basis of these investigations we can distinguish three wet phases in the Early Holocene (Selima, El-Beid, Nabta) separated by dry phases (9,400 - 9,300 and 8,800 - 8,600 B.P.). A dry phase (7,100 - 6,900 B.P.) occurred between the Early Holocene wet phase and the Middle Holocene wet events (El-Heiz, Khraga I and II). The latter are, in turn, separated by dry episodes dated to 6,100 - 5,900 and 5,000 - 4,800 B.P. Starting from the period after 5,000 B.P. – according to Wendorf (1984), 4,500/4,000 – according to Hassan (1986c), began the last dry phase, with slightly moist intervals, which lasted till modern times. The dry episodes we have enumerated here correspond approximately to the periods of recession of Lake Moeris, especially the curve of changes of the lake level we have proposed is taken into account. These observations are in apparent disagreement with clear traces of wadi activity in some periods of lake recession, which indicate rainfalls in the desert. In reality the periods of lake recession were usually longer than the dry episodes in the desert. This fact supports Hassan's thesis that local rainfalls did not basically influence the fluctuations of the lake level. For the same reasons we should verify an earlier view which associated some of the changes in the level of the Holocene lake with variations in local precipitations (Caton-Thompson and Gardner 1934; *Qasr el-Sagha* 1983). On the other hand, the overlap of deltaic sediments and sediments from transgression phases of the Neolithic lake seem to confirm some role of local rainfall in the rising of the lake level, especially in erosional processes which was suggested earlier by K.S. Sandford and W.J. Arkell (1929: 68). A different rhythm of wet and dry phases is observed in the southern zone of the Sahara where wet events seem to correspond to the recessions of Moeris Lake rather than to its transgressions. A situation like this has been recorded in the basin of Lake Chad (Williams and Faure 1980; Faure 1984).

Lake Moeris and the Nile

The periods of the aggradation of the Nile correlate well with the Early Holocene evolution of Lake Moeris. The three Early Holocene aggradation of the Nile: Arkin, El Kab and Catfish (Wendorf and Schild 1976; Hassan 1984; Kobusiewicz 1976) correspond closely to the three Early Holocene phases of the lake: Palaeo-Moeris, Pre-Moeris and Proto-Moeris. Regretfully, sufficient information about the levels of inundations of the Nile for the period of the Neolithic Lake is not available. It is likely that the Qadrus recession may corespond to the recession of the lake in the Proto-dynastic period and the Old Kingdom. It seems that the Nile played an important role in the changes of the level of the Holocene lake which means that at least periodically there must have been a free flow of water between the Nile Valley and the Fayum depression. This is indicated by, among others, malacological data confirming the presence of Nilotic species particularly in the waters of the Early Holocene lake. The occurrence of the Nilotic malacofauna in the younger phases of the Neolithic lake cannot be unequivocally interpreted because of – as we have already pointed out – considerable importance at that time of lateral transport and erosional factors destroying older sediments (Ginter and Kozłowski 1986: 12 - 13). There is no data about the level of the Nile in the 6th and 5th millennium B.P. and for this reason lacustrine events cannot be correlated with the situation in the Nile Valley.

Archaeological implications

The Early Holocene settlement of the Qarunian is associated both with the recession as well as transgression phases of Lake Moeris as the hunting-fishing economy compensated for different conditions of the access to the lake. The Qarunian shows links with contemporaneous taxonomic units known from the Nile Valley such as the Shamarkian and the El-Kabian (Schild *et al.* 1986; Kobusiewicz 1976; Vermeersch 1970; 1978) and with the cultures of the oases of the Western Desert (Hassan and Gross 1977). A chronological and typological hiatus separates the Qarunian from the oldest Neolithic settlement in the Fayum Depression. Depending on the interpolation of dates this hiatus may have lasted from 500 to 1,500 radiocarbon years. Such a hiatus corresponds to the recession of Lake Moeris and the dry episode in the desert. This episode may have created a critical situation for Epipalaeolithic communities who inhabited the northern zone of the Western Desert at the time when in the south there was already settlement of Saharo-Sudanese Neolithic.

The appearance of the oldest population of a typically Neolithic character is associated with the period of the first transgression of the "Neolithic Lake". This population is represented by the Fayumian identified with the Fayumian A culture according to the terminology used by G. Caton-Thompson. Seasonal fluctuations of the lake level and seasonal torrential rains in the desert shaped a seasonal model of economy with a variable participation of agriculture and breeding on the one hand, and fishing and, possibly, hunting on the other, practiced in different ecological zones, depending moreover on the distance from the lake shores. The Fayumian is a culture which shows distinct links with the cultures distributed in the Nile Valley and in the Delta.

The increasing aridity of the climate in the Sahara, especially in the second half of the 5th millennium B.P. caused a complete cultural change in the Fayum depression whereby the Fayumian was replaced by the Moerian culture with typical north-Saharan connections. The Moerian appeared in the ascending phase of the last Neolitic transgression of Lake Moeris and continued until the beginning of the next recession of the lake.

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