POZNAŃ ARCHAEOLOGICAL MUSEUM

ENVIRONMENTAL CHANGE AND HUMAN CULTURE IN THE NILE BASIN AND NORTHERN AFRICA UNTIL THE SECOND MILLENNIUM B.C.

Poznań 1993

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ENVIRONMENTAL CHANGE AND HUMAN CULTURE IN THE NILE BASIN AND NORTHERN AFRICA UNTIL THE SECOND MILLENNIUM B.C.

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Co-Editor
WOJCIECH ŚMIGIELSKI

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Dymaczewo near Poznań, 5–10 September, 1988

Cover: Rock engraving depicting a group of females interpreted as statues of the later prehistoric goddesses, discovered recently in the eastern part of the ancient Dakhleh Oasis (after L. Krzyżaniak and K. Kroeper, *Archéo-Nil* vol. 1: 1991, Figs. 2–3).

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From the Organizers and Editors

The Editors regret very much the delay in publishing these Proceedings. Several factors have been responsible, all of them basically resulting from unexpected effects of the fundamental transformation of our part of Europe in recent years.

The idea of the organization of continuous Dymaczewo symposia was obvious to all who attended our 1980 and 1984 conference. In 1984 the Participants decided that these symposia should be held every four years. The subject of the 1988 symposium was discussed during the meeting of the Board of the International Commission of the Later Prehistory of Northeastern Africa in Cologne on the 3rd of November 1986. This was the last day of the memorable international conference on "Chronological Problems of the Eastern Sahara and the Nile Valley" organized by Rudolph Kuper, who had just founded his "Forschungsstelle Afrika", a major research institute of African prehistory at the University of Cologne. The Board of our Commission decided there to devote the following Dymaczewo symposium to the theme "Environmental Change and Human Culture in the Nile Basin and Northern Africa until the Second Millennium B.C." It was felt that after discussing the main lines of cultural development in the later prehistory of northeastern Africa at the two previous symposia, it would now be useful to have a review of recent evidence on the natural environment in this time period – a background to the cultural processes. The symposium was held on 5–10 September, 1988.

That was another successful symposium. The Organizers wish to thank very much those who attended as well as those who submitted their contributions to this volume and have been patiently waiting for their publication. Word of appreciation also go from the Organizers to John Alexander, who has kindly agreed to become a third Editor of these Proceedings.

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GRAEME BARKER

The UNESCO Libyan Valleys Survey: environmental change and human settlement in Tripolitania

Introduction

The project which is the subject of this paper began in 1979 with a direct brief from UNESCO to investigate the nature of ancient farming in the Tripolitanian pre-desert of Northwestern Libya (Fig. 1), to give an archaeological perspective to modern plans for agricultural development in the same region. Fieldwork took place in 1979, 1980, 1981, 1984, and 1989. The project has been directed by Prof. G.D.B. Jones of the University of Manchester and myself. The British contribution to the project has developed under the aegis of the Society for Libyan Studies, whose journal *Libyan Studies* has published detailed progress reports about the project every year since 1979.

The study area, the Tripolitanian pre-desert, is the region which lies between the coastal zone and the true desert. It consists of an undulating rock plateau some 100 kilometers long from north to south, principally of limestone but in places mantled with basalt, dissected by the two main wadi systems of the Sofeggin and Zemzem. The major wadis may be several kilometers wide, but the tributaries are often narrow trenches, a few hundred meters across. Both are floored with a mosaic of flood loams, gravels, and sand dunes. To the north of the pre-desert, in the Gebel hills and the coastal plain, annual rainfall is higher than 200 mm, the minimum for dry farming without irrigation, making these zones the preferred areas for human settlement in antiquity as today. In the pre-desert, however, rainfall decreases very rapidly moving southwards, to only 25 mm or less on the southern boundary with the rock desert and sand seas of the Sahara. The regime consists of sporadic and often highly localized cloudbursts on a few days a year, which cause torrential floodwaters to fill the depressions on the plateau or flow down the wadis, reworking the alluvial sediments and replenishing their nutrient levels.

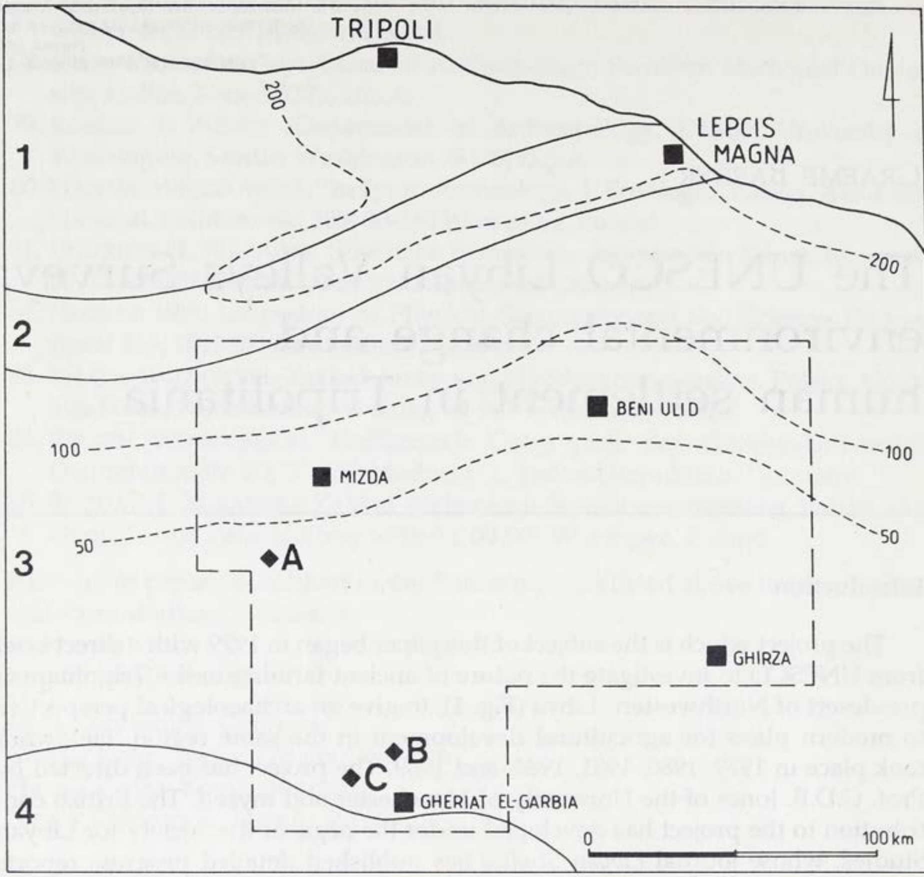

Fig. 1. The study area of the UNESCO Libyan Valleys Survey: the Tripolitanian pre-desert, between the settlements of Beni Ulid and Gheriat el-Garbia (after Barker 1986: Fig. 1);
The location of the three groups of rock carvings
A: Maia Dib; B: Udei el-Ghel/Gaf al-Hetshia; C: al-Tobga
Topography and modern vegetation
1: coastal plain – mixed steppe; 2: Gebel escarpment – steppe; 3: pre-desert plateau – rare vegetation except on wadi floors; 4: Hamada al-Hamra desert – vegetation almost absent.
Dash lines show rainfall isohyets in mm.

Patterns of land use are undergoing major changes today in the social, economic and technological transformations of modern Libya, but the traditional way of life that was evolved by the Bedouin to cope with this hostile environment was characterized above all by low density populations, seasonal mobility, and a reliance on pastoralism. Cereal crops were sown in the floodloams of the pre-desert wadis after the autumn rains, and the Bedouin then moved south with their sheep, goats, and camels to the desert margins for the winter, coming north again with their animals in the spring for the harvest. The summer months were spent on the dry pastures of the pre-desert, the only water available (apart from isolated deep wells) being rainwater collected the previous winter in rock-cut cisterns. Settlements consisted either of tents or drystone walled shelters roofed with timber or tenting, and stock were normally penned in brushwood or thorn enclosures.

The kind of ephemeral archaeology created by this way of life contrasts vividly with much of the archaeology of ancient settlement. The German explorer Heinrich Barth first reported the very large numbers of ancient ruins, particularly the "castles" (in Arabic *qsur*) or fortified farms that are found mainly along the edges of the narrower wadis, noting also that these monuments were frequently associated with systems of low drystone walls running both along and across the wadis (Barth 1857). The *qsur* implied a density and permanence of settlement in antiquity very different from the traditional Bedouin system of settlement, and the wall systems likewise implied an agricultural system with much greater organizational and technological inputs than Bedouin farming. The first systematic archaeological studies of the *qsur* indicated a late Roman date, the consensus being that they represented a frontier defence system of soldier-farmers (*limitanei*) to protect the Romano-Libyan coastal cities and their rich agricultural hinterlands from the desert nomads (Brogan 1964; Brogan and Smith 1957; Goodchild 1950).

Hence the Libyan Valleys Survey was initiated by UNESCO as the first modern study of the archaeology of pre-desert settlement. The fact that we needed to understand not only how the Romano-Libyan agricultural system funcioned but also why it began and why it collapsed has meant that from the outset the project adopted a multi-period approach, as it seemed very unlikely that Romano-Libyan farming could be understood in isolation from earlier and later systems of settlement and land use in the pre-desert. Given the agricultural dimension, too, the project has been characterized throughout by multidisciplinary investigations linking archaeology with the natural sciences, particularly botany, zoology, and geomorphology.

The first phase of the project consisted of primary mapping, with vehicle-based survey teams visiting all the major wadis and recording the range of archaeological monuments visible along the wadi edges (Barker and Jones 1981; 1982; Jones and Barker 1980). We then selected a representative series of wadis in the north, centre and south of the survey area for more detailed study on foot, mapping the full range of the surface archaeology from major upstanding monuments to lit̮nic scatters, and mapping in detail the systems of wadi walls (Barker 1985; Gilbertson *et al.* 1984). The third phase of the project has consisted of the detailed investigation, including by excavation, of individual Romano-Libyan farms and their agricultural systems (Barker and Jones 1984; Barker *et al.* 1991; Hunt *et al.* 1986).

Prehistoric settlement

The preliminary analysis of the surface lithic material (Hivernel 1985) has identified a succession of homogeneous assemblages of Middle Palaeolithic, Epipalaeolithic, and Neolithic styles, with only one assemblage being classified as Upper Palaeolithic in its typology. Whilst it is possible that some of the Aterian material classified as Middle Palaeolithic is in fact late glacial in date, the paucity of evidence for Upper Palaeolithic occupation in the pre-desert is perhaps not surprising given the climatic evidence across North Africa for the intense aridity of the late glacial environment *ca.* 20,000 - 10,000 b.p.

With the climatic amelioration of the Early Holocene, regular utilization of the pre-desert plateau resumed by people with Epipalaeolithic and Neolithic technologies. Further evidence for human occupation at this time consists of a series of rock art sites in the survey area (Barker 1986: Fig. 1). These consist of carvings of the well known bovids at Maia Dib, including one with a disc between the horns (Graziosi 1934; 1941); bovids, equids and ostriches at el-Chel (Graziosi 1937; 1941); and a bovid, antelope- or gazelle-like animals, a giraffe, and human figures at el-Tobga. The close association of the cattle and game motifs at these sites suggests an occupation of the pre-desert by people combining pastoralism with hunting, by analogy with southern Libya perhaps somewhere within the range 6,000 - 3,000 b.c. (*Arte Prehistorica del Sahara* 1986; Barich 1987).

The locations of the Tripolitanian carvings correlate broadly with the locations of the most abundant evidence for surface lithic assemblages of Epipalaeolithic and Neolithic type, on the southwestern margins of the predesert plateau at its border with the Hamada al-Hamra rock desert. In this area the landscape is dominated by undulating terrain interspersed with isolated oases and springs, very different from the dominant landscape of the rock plateau and dry wadi channels. The region has also been the natural corridor north for pastoralists wintering on the desert margins. The area of the pictographs is likely to have been a critical part of the subsistence territories of both hunter-gatherers and pastoralists, the carved boulders perhaps serving as territorial markers for particular social groups. Given that hunter-gatherers and pastoralists tend to define their seasonal territories very elaborately, with access to some resources shared but to others being strictly controlled, the location of the Tripolitanian pictographs near springs and oases must be significant, particularly given the evidence for increasing desiccation during the period represented by the carvings and Neolithic industries.

No prehistoric pottery has been recovered by the project. The principal evidence for pre-desert settlement in the late prehistoric and protohistoric periods consists of a series of rock carvings at el-Togba: small stick figures, mostly four-legged animals, but also humans, palm trees, and a possible wheeled vehicle. As elsewhere in the Libyan Sahara, such late rock carvings showing evidence on the one hand for the existence of desert conditions similar to today and on the other for contact with the protohistoric and historic cultures of Egypt are likely to date to the later second and first millennia b.c.

In addition, the prolific evidence for settlement in the Romano-Libyan period incorporates further indications of small-scale utilization of the predesert in the immediately Pre-Classical period. It quickly became apparent from the detailed surveys of wadi settlement that the archaeology of the Romano-

Libyan period embraced a wide variety of monuments. Apart from the fortified farms or *qsur*, major monuments included enclosed hilltop settlements, open (undefended) courtyard farms, mausolea, small enclosures with one- and two-roomed buildings, single huts, groups of what seem to be tent footings like those of the modern abandoned Bedouin camps, and small burial cairns. Dating monuments by surface artifacts is of course problematical, and the deflated surface of the pre-desert plateau is a palimpsest of the archaeology of very different periods of antiquity. However, there are repeated correlations of sites which are identical to the smallest categories of domestic and funerary sites containing Romano-Libyan pottery but which are associated instead with lithics of Neolithic/Post-Neolithic type. These correlations suggest the very strong possibility that a Bedouin-style pastoralist population was living in the pre-desert in the centuries immediately preceding the Romano-Libyan transformation, perhaps using a simplified version of the wadi-wall technology described in the following section.

Romano-Libyan farming

The transformation began in the first century AD, with the superimposition on the indigenous settlement system of farms comparable in design and architecture to the villa farms of the Gebel hills that provided the principal agricultural wealth for coastal cities such as Lepcis Magna (Mattingly 1985; 1988).

We conducted excavations in the middens associated with the pre-desert farms to recover faunal and botanical residues as direct information on their agricultural systems. The study of the botanical remains (van der Veen 1985) has shown that the new farms grew barley as the principal crop as well as various wheats, together with lentils and pulses, vegetables such as water melons, and tree crops: olive, grape, fig, date, and almond. Many farms had pressing equipment for oil or wine, smaller versions of the presses well known on the Gebel farms (Oates 1953). In one we excavated on a farm in Wadi el-Amud (Barker and Jones 1984), in the southern part of the pre-desert, the main oil tank had a capacity of 3000 litres and two ancillary vats had a combined capacity of 1200 litres. There seems little doubt that these pre-desert forms were substantial enterprises capable of producing oil and wine in surplus for the coastal markets (Mattingly 1986).

Sheep and goats in roughly equal proportions dominate the faunal samples from the farms (Clark 1986). Mortality data indicate the importance of meat production and a husbandry regime in general very similar to the traditional Bedouin system, augmented at the southern farms such as el-Amud by gazelle hunting.

In this marginal environment, the new agricultural system was maintained by sophisticated methods of floodwater farming designed to concentrate runoff from a large catchment into the restricted cultivated land of the wadi floor

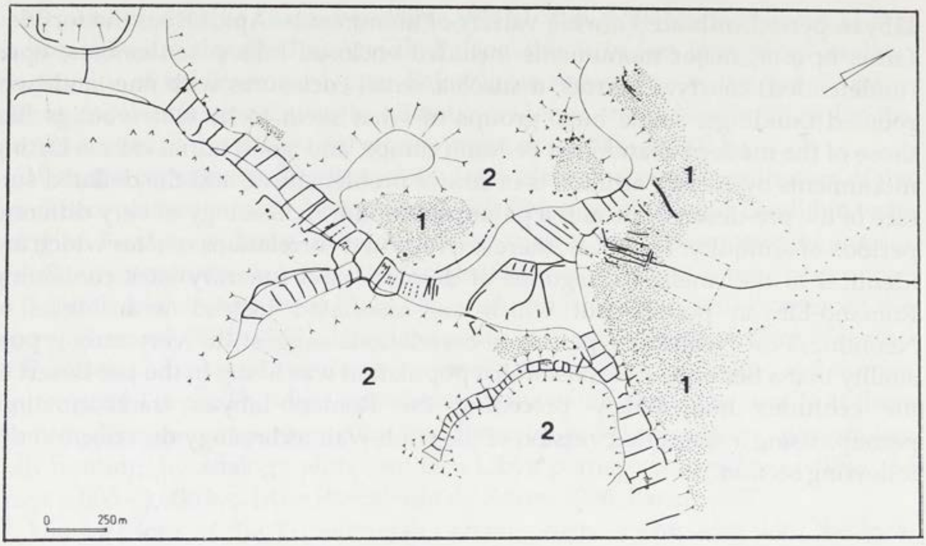

Fig. 2. Field systems in the upper Wadi Gobbeen (after Gilbertson *et al*. 1984: Fig. 3);
1: basalt; 2: limestone.

(Barker 1985: Fig. 2). Most walls were built for controlling and trapping water, with their construction showing detailed local knowledge of runoff characteristics (Gilbertson *et al*. 1984). Others separate arable and pastoral land, others were field boundaries or larger territorial boundaries. Conduit walls fed water into cisterns, or controlled the flow of floodwater into the fields. One of the most impressive systems was mapped around the Wadi el-Amud farm (Fig. 3): floodwaters entered the fields through a series of sluices and excess water could be directed out into the main wadi over stone slipways. In the section of the Wadi Mansur in the northern part of the study area which is illustrated as Fig. 4, our investigations indicated that the area was divided into three farms or "estates", each with 35 - 50 hectares of arable land on the wadi floor (Hunt *et al*. 1986). One also had a subsidiary field system in the tributary wadi on the southern side, which appears to have been divided into a separate area for stock, a nursery area for olive trees, and cereal fields in between.

Inscriptions found at these sites indicate that the farmers were romanized Libyans rather than colonists, a hypothesis supported by the Libyan nature of cult architecture (Mattingly 1986; 1987). The pre-desert phenomenon appears to have been an example of the kind of frontier process found elsewhere on the fringes of the Roman world, whereby Roman pacification positively encouraged rural elites to opt into the Roman market for the accumulation of wealth.

In the second and third centuries A.D., these elites steadily abandoned their open farms in favor of massively fortified farms, the *qsur*. The botanical and faunal residues, pressing equipment and wall systems indicate the continuance of the earlier system of agricultural production without significant change, but

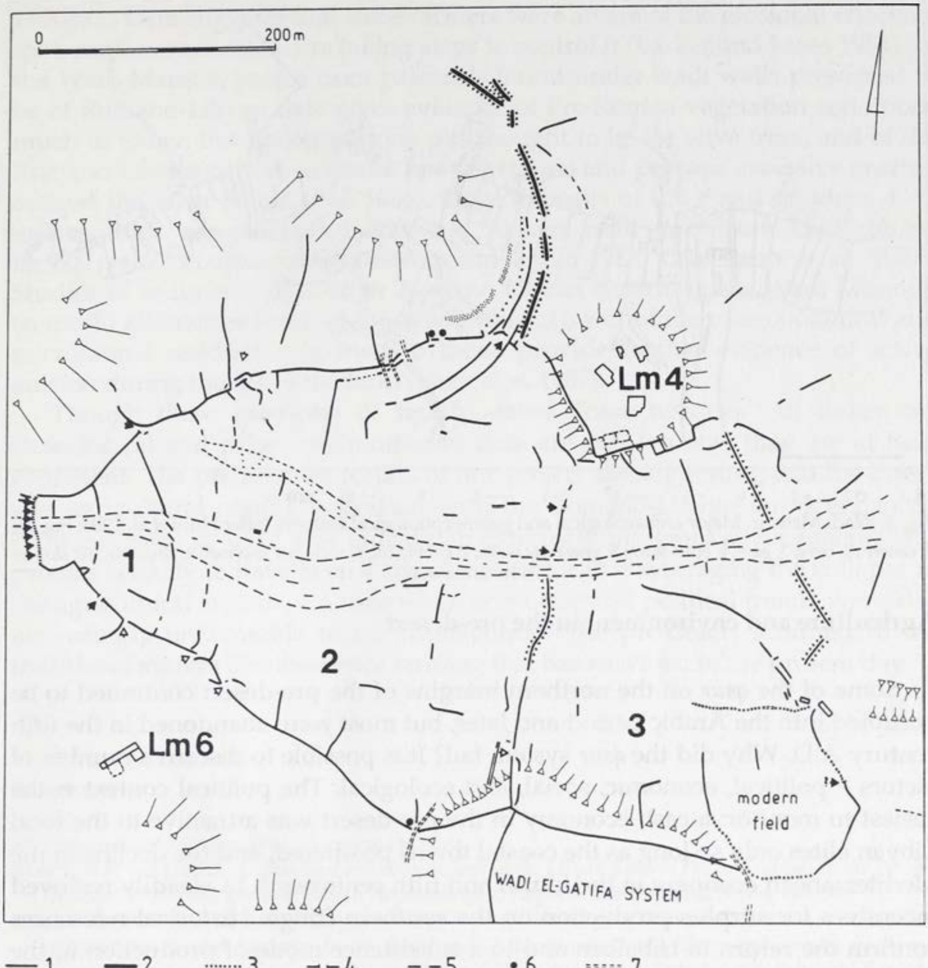

Fig. 3. Wadi el-Amud. The water control system of the Lm4 farm (after Barker and Jones 1984: Fig. 17); Zones: 1: West zone; 2: Central zone; 3: East zone.
Legend: 1: ancient walls; 2: thick battered walls; 3: piled walls; 4: sluices and flow direction; 5: possible water inlets; 6: unclear features; 7: modern tracks.

in general the size of the agricultural holdings decreased as the number of *qsur* increased relative to the number of open farms before. It used to be thought that the *qsur* were occupied by *limitanei*, soldier-farmers, as a system of "defence in depth" separating the rich coastal lands from desert nomads, but it is now clear that the *qsur* were principally the response to local competition for land and prestige, and the resultant internal strains within the indigenous population. Relatively high populations (in the context of such a marginal environment) were competing for severely restricted arable land and runoff opportunities.

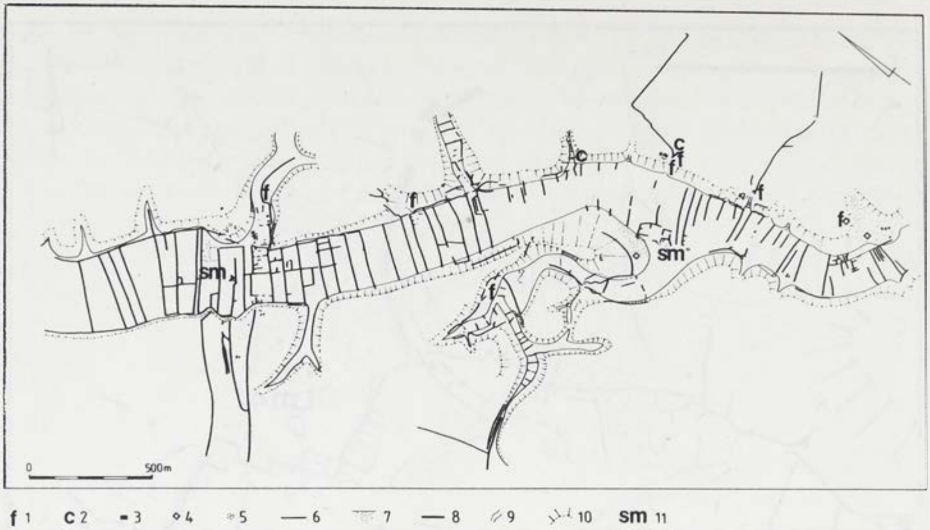

Fig. 4. Wadi Mansur. Major archaeological and geomorphological features (after Hunt *et al.* 1986: Fig. 2); 1: cistern; 2: cave; 3: *gasr*; 4: open farm; 5: graves; 6: walls; 7: cobbly fill; 8: rock cut channel; 9: alluvium; 10: slopes; 11: stone mounds.

Agriculture and environment in the pre-desert

Some of the *qsur* on the northern margins of the pre-desert continued to be occupied into the Arabic period and later, but most were abandoned in the fifth century A.D. Why did the *qsur* system fail? It is possible to discern a number of factors – political, economic, social, and ecological. The political context is the easiest to monitor: a cash economy in the pre-desert was attractive to the local Libyan elites only so long as the coastal towns prospered, and the decline in the Mediterranean economy in the fourth and fifth centuries A.D. steadily removed incentives for surplus production on the southern fringe. Historical references confirm the return to tribalism and to a subsistence mode of production in the pre-desert at this time (Mattingly 1987).

There is a large literature about the climatic context of Roman farming in North Africa, but remarkably little reliable or specific evidence and still less evidence that is tightly related to archaeological data for settlement and land use. The studies by the project's geomorphologists have found no clear evidence for any significant differences in climate between the Romano-Libyan period and the present, though the wetter periods of the earlier Holocene created paleosols on the plateau, the erosion of which might be associated with the Romano-Libyan farming (Barker and Jones 1982; Barker *et al.* 1983; Gilbertson *et al.* 1987; Hunt *et al.* 1986). There is clear evidence for the effect of Romano-Libyan farming on the landscape.

For example, sediments in a Romano-Libyan cistern in the Wadi Mansur demonstrate that plateau erosion was in progress during the life of the farm (Hunt *et al.* 1986). The partial blocking of the principal sluice system in the Wadi el-Amud farm suggests that some farmers were aware of the erosional effects of the runoff system and were taking steps to control it (Barker and Jones 1984). In the Wadi Mansur, pollen from paleosols found under wadi walls presumed to be of Romano-Libyan date gives evidence of Pre-Roman vegetation conditions much as today, but pollen in stone pits thought to be for olive trees, and of the Romano-Libyan period, indicates less vegetation and perhaps excessive grazing around the farm (Hunt *et al.* 1986). Slope deposits of scree and middens 4 - 8 metres thick accumulated below the Abzam farm near Beni Ulid during its 500 year occupation (Gilbertson and Hunt 1988; Gilbertson *et al.* 1987). Studies of sediments in another Romano-Libyan cistern, in the Wadi Mimoun (some 20 kilometres south of the Wadi Mansur), and of the macrobotanical and microfaunal residues contained in them, provide further evidence of active erosion during the life of the farm (Hunt *et al.* 1987).

Though these examples of tightly dated "case histories" of linked archaeological and pelaeoenvironmental data are still too few, they are at least consistent. The preliminary results of our project are suggesting that the intensive agricultural regime associated with the Romano-Libyan farms enhanced erosional rates in what was already an extremely marginal environment. This process is likely to have been a significant factor in encouraging the collapse of the agricultural system at a time when economic and political trends were also increasingly unfavorable to its prolongation. The pre-desert returned to the traditional system of subsistence farming that has survived to the present day.

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Plant macrofossils from the archaeological sites of Uan Muhuggiag and Ti-n-Torha, Southwestern Libya

Archaeological investigations in the Tadrart Acacus range led to the discovery of very rich and interesting remains of Epipalaeolithic and Neolithic habitation. Studies of the environmental conditions included the geology of the area, the remains of wild and domestic animals, pollen and macroscopic plant remains. The results show the great importance of these sites for understanding the subsistence patterns of pastoral tribes which inhabited the Sahara in the Early and Middle Holocene (Barich 1987).

The Ti-n-Torha and Uan Muhuggiag rock shelters contained deposits rich in plant material. Pollen analyses were made of the settlement layers at both sites (Pasa and Pasa-Durante 1962; Schulz 1987). Macrofossils were reported only from the Uan Muhuggiag shelter in which the following species were found: *Acacia albida, Balanites aegyptiaca, Artemisia campestris, Zilla spinosa, Aristida sp.* and *Citrullus vulgaris* (Pasa and Pasa-Durante 1962). Further studies on plant macrofossils from Uan Muhuggiag and Ti-n-Torha/Two Caves were undertaken by the present author in order to supplement the information about the natural environment provided by pollen analysis and to contribute to the discussion on the use of wild plants by prehistoric populations of the Acacus area. Preliminary results are reported here.

Present-day climate and vegetation

Tadrart Acacus is a low mountain range, with the highest elevations of about 900 m a.s.l. in the middle part, situated on the north-east edge of the central Saharan mountains, in the rain shadow of the Tassili-n-Ajjer. The area belongs to the zone of subtropical dry desert climate with extremely irregular precipitation and maximum rainfall in summer. The nearest meteorological data are available from Ghat on the west side of the range, at an elevation of 561 m a.s.l. Mean annual precipitation is 10 mm, and mean annual temperature is 25.3°C (Walter *et al.* 1975). Deeply cut wadis have perennial vegetation in the form of desert savanna with *Acacia-Maerua-Panicum* or *Tamarix-Stipagrostis* communities. Diffuse vegetation is limited to annual herbs which develop only after rain (Schulz 1987). Geological structure and topography of the range enable the ground-water accumulation during the rain season and subsequent slow discharge in the dry season, thus reducing the influence of climatic aridity on vegetation and creating specific microclimates favorable for human habitation (Marcolongo 1987).

Archaeological setting

The oldest occupation levels were found in the northern part of the Tadrart Acacus, in rock shelter located in the Wadi Ti-n-Torha (Fig. 1). Three sites were excavated there, namely East Shelter, North Shelter and the Two Caves Shelter, with the oldest occupation traces with ages between 9,350 ± 110 and 7,990 ± 70 b.p. found in the East and Two Caves shelters (Barich 1987; Barich *et al.* 1984). According to Barich (1987), the earliest habitation had a semi-permanent character, with subsistence based on fishing, hunting and gathering of wild plants; domestic animals were not found. The lithic industry was of typical Epipalaeolithic character but the use of pottery was suggested by the presence of potsherds in the layer dated to 8640 ± 70 b.p. in the East Shelter. Faunal remains from the Two Caves indicated that the shelters were occupied probably in the dry season, *i.e.* during the late autumn, winter or early spring (Gautier 1987). Occupation levels in the Ti-n-Torha North Shelter were of younger age, their C-14 dates ranged between 7,070 ± 60 and 5,260 ± 130 b.p.

More or less at the same time Neolithic population appeared in the central part of the Tadrart Acacus (Fig. 1), where traces of frequent stays of pastoral tribes were found in several shelters in the Wadi Teshuinat. The most interesting of them was Uan Muhuggiag shelter were rock paintings were discovered illustrating, among other things, hunting and pastoral scenes. Two Neolithic horizons were distinguished in this shelter (Barich 1987). The older one started before 6,035 ± 100 b.p. and had the youngest date of 5,350 ± 200 b.p. It represented a non-residential site which was used by pastoral groups several times but for short periods only. Pottery already played an important role, and the lithic industry continued a local tradition. Domestic animals (cattle, sheep, goat) were more important in the diet than the wild game, over 92% of the bones belonged to domestic types (Gautier 1987). According to Barich (1987), grass-seed gathering was probably reduced compared to Ti-n-Torha, because the number of grinding implements was very small. The younger horizon was connected with

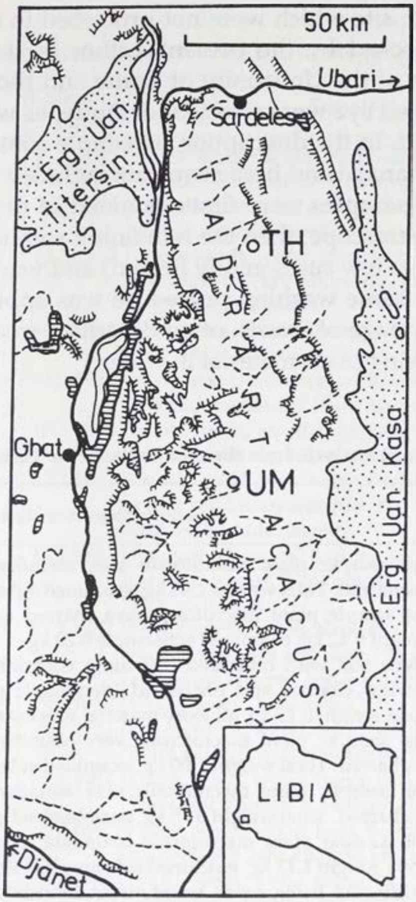


Fig. 1. Location of the Tin-n-Torha (TH) and Uan Muhuggiag (UM) rock shelters (after Schulz 1987).

the dates ranging from 4,730 ± 310 to 2,220 ± 220 b.p. It contained quite different archaeological material and indicated slighter habitation compared to the older phase. Rock paintings were connected with this horizon.

Material and methods

All samples for macrofossil analysis were collected by Barbara Barich during the excavation seasons of 1978 in Ti-n-Torha/Two Caves and 1982 in Uan Muhuggiag. Most of them were small samples composed of isolated large fruits or seeds, lumps of soil, stems of herbaceous plants, leaves, twigs, wood and charcoals. They were picked up in the field either directly from the exposed level or from the sieved portions of earth. In addition, six large soil samples were collected from each site which were not processed in the field. In 1986 all small samples were checked by the present author in the laboratory of the Instituto di Paletnologia of the University of Rome and those containing fruits or seeds visible with naked eye were selected for study, as were the soil samples not processed in the field. In the description of sample content (Tables 1 and 2) the presence of wood, charcoal and herb stems not included in this study is indicated. In Cracow, small samples were first examined in dry condition under a low-power binocular microscope, then the remaining soil lumps and dust were soaked in pure water (in a few cases gently heated) and washed through a sieve with 0.2 mm mesh. The same washing procedure was applied to the large soil samples. No signs of damage of fossils, often described from other desert sites, were observed after soaking plant material in water.

Table 1

List of samples for seed and fruit analysis from the rock shelter Ti-n-Torha/Two Caves.

Sample number	Sector	Layer	Sample characteristics
1		I	Soil sample; plant macrofossils very abundant, charred and uncharred. Total weight 2.45 kg, examined subsample 0.80 kg
2	West	III	Soil sample; plant macrofossils rare, charred and uncharred. Total weight 0.42 kg, examined subsample 0.20 kg
3	Test trench	I	Loose soil with cemented soil lump containing abundant plant detritus, charred and uncharred. Identifiable plant macrofossils rare. Total weight 0.13 kg, all loose material was examined
4	West	I	Soil sample; plant macrofossils very abundant, charred and uncharred. Total weight 1.00 kg, examined subsample 0.20 kg
5	East	IIa	Soil sample; plant macrofossils very abundant, charred and uncharred. Total weight 0.75 kg, examined subsample 0.37 kg
6	mostly Central	surface	Soil sample; plant macrofossils abundant, charred and uncharred. Total weight 1.17 kg, examined subsample 0.40 kg
7	West	I	Uncharred fruits, seeds, wood pieces, branches, herb stems, coprolites, soil lumps
8	East	III	Accumulation of uncharred herb stems, few charcoals (nest?)
9	Central	surface	Twigs, one coprolite, one cocoon, uncharred
10	Central	II	One twig with fruits, fresh in appearance
11	West	II	Few fruits, twigs, one twig with fruits fresh in appearance. All uncharred
12	East	IIa	Twigs with fruits fresh in appearance, one coprolite, uncharred
13	East	II	Twigs with fruits fresh in appearance, one charcoal
14	Central	III	Fragments of herbaceous plant, fresh in appearance
15	West	III	Few uncharred twigs and herb stems, one charred twig, one coprolite
16	East	IIa	Soil sample; plant macrofossils very abundant, charred and uncharred

Due to the procedure of sample collecting, each sample can be ascribed to a definite layer but neither the stratigraphic sequence within a layer nor the position of sample on a horizontal plan are known (Figs. 2 and 3). In the case of a few samples from an individual layer we have only an indication that plant remnants were picked up several times, *i.e.* from different places in the excavated layer. Macrofossil samples were given arbitrary numbers by the present author.

Table 2

List of samples for seed and fruit analysis from the Uan Muhuggiag rock shelter.

Sample number	Sector	Layer	Collecting date	Sample characteristics
1	B	1	11.2.1982	Fruits, seeds, wood, bark, twigs, herb stems, coprolites, insects, soil dust and lumps, plant macrofossils very abundant, charred and uncharred. Lumps of cemented soil with dung and *Citrullus colocynthis* seeds
2	B	1a	13.2.1982	Fruits, seeds, wood, branches, herb stems, loose soil, plant macrofossils very abundant, charred and uncharred, coprolites, one insect
3	B	2d	18.2.1982	Few fruits, wood, bark, twigs, herb stems, coprolite, soil dust. Plant macrofossils rare, uncharred only
4	B	2	14.2.1982	Bark, wood, loose soil with herbacous plant fragments, charred and uncharred. Plant macrofossils very abundant
4a	B	2	15.2.1982	Fruits, seeds, wood, bark, twigs, coprolites, loose soil. Plant macrofossils abundant, charred and uncharred
5	B	2b	17.2.1982	Fruits, wood, bark, twigs, herb stems, bones, coprolites, one insect, soil lumps and dust. Plant macrofossils very abundant, charred and uncharred
6	B	2a	15.2.1982	Fruits, seeds, wood, bark, twigs, charcoals, coprolites, one insect, soil lumps. Plant macrofossils very abundant, charred and uncharred
7	B	2	14.2.1982	Fruits, seeds, wood, bark, twigs, herb stems, coprolites, insects, soil lumps and dust. Plant macrofossils very abundant, charred and uncharred
8	A	3	9.2.1982	Wood, twigs, 3 coprolites, plant macrofossils rare, uncharred
9	A	2	7.2.1982	Fruits, seeds, wood, bark, twigs, herb stems, coprolites. Plant macrofossils abundant, charred and uncharred
10	A	2c	9.2.1982	Fruits, seeds, wood, twigs, herb stems, coprolites, soil dust. Plant macrofossils abundant, charred and uncharred
11	A	2b	8.2.1982	Fruits, seeds, wood, bark, twigs, charcoals, coprolites. Plant macrofossils rare, charred and uncharred
12	A	2a	8.2.1982	Fruits, seeds, wood, twigs, herbaceous stems, charcoals, coprolites, one snail. Plant macrofossils abundant, charred and uncharred
13	A	1a	7.2.1982	Fruits, wood, bark, herbaceous stems, coprolites, one insect, soil lumps. Plant macrofossils rare, uncharred
14	A	1	6.2.1982	Fruits, seeds, coprolites, insects. Plant macrofossils rare, charred and uncharred
15	A	1a	7.2.1982	Fruits, leaves fresh in appearance, coprolites. Plant macrofossils rare, uncharred
16	A	2	7.2.1982	Fruits, seeds, coprolites. Plant macrofossils rare, charred and uncharred
17	A	2a	8.2.1982	Lumps of sediment with "roasted" *Acacia sp.* seeds, coprolites
18	A	2a	8.2.1982	Few seeds
19	A	2c	9.2.1982	Lump of soil with straw and *Urochloa* type spikelets, uncharred
20	A	2		A fragment of uncharred *Balanites* fruit – stone
21	A	1		A fragment of uncharred *Balanites* fruit – stone, charcoals
25	A	2 –143 cm	8.2.1982	Soil sample with charcoal, plant macrofossils very abundant, charred and uncharred
26	A	surface	5.2.1982	A fragment of charred *Balanites* fruit – stone
27	A	2a –160 cm		Soil sample with charred lumps of deposit composed mostly of plant detritus. Plant macrofossils very abundant, charred and uncharred

Table 2 (continued)

Sample number	Sector	Layer	Collecting date	Sample characteristics
28	A	1 –75 cm	6.2.1982	Soil sample plant macrofossils very abundant, charred and uncharred
29	A	2a	7.2.1982	One uncharred large coprolite
30	A	2	7.2.1982	Lumps of cemented deposit from the top of the layer, composed of sand and very abundant plant detritus, mostly uncharred; few charcoals. A small portion of disintegrated deposit was examined
31	A	1 –80/90 cm		Partly charred lumps of soil from the hearth, charcoals, bones. Plant macrofossils rare, charred and uncharred
32	A+B	surface	4.2.1982	Few pieces of cemented soil from the hardened level (crust) on top of the excavated deposit. Uncharred and less numerous charred plant detritus visible on the surface, coprolites

Plant remains were preserved in charred and uncharred (dessicated) conditions, both types of fossils being mixed in one layer. About half of the taxa were represented by charred and uncharred specimens, the other half by uncharred only. On the basis of field observations it was assumed by the excavator that charred and uncharred fossils were of the same age. This assumption was confirmed by C-14 dating of the two kinds of fossils from the layers 1a in sector A and 2b in sector B at Uan Muhuggiag. The discrepancy between charred and uncharred material occurred in the layer 2, sector A. In sector B three samples from the layer 1 gave three different dates pointing to the heterogeneity of plant material in the top layer (Table 3).

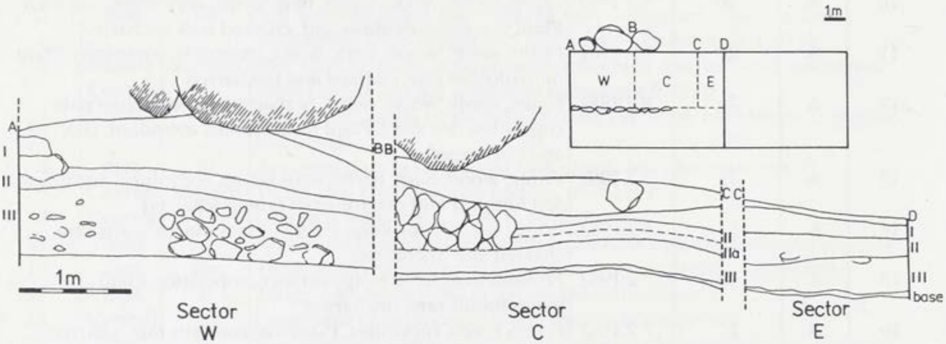


Fig. 2. Tin-n-Torha. Schematic profiles of the West, Central and East sectors (after Barich 1987, simplified);

I - III: archaeological layers.

It should be stressed that in both sites the archaeological layers were numbered by the excavator in each sector independently and the same layer number does not necessarily mean the same age (Tables 3 and 4). Thus, in Uan Muhuggiag layers 1 and 1a in sector A and the layer 1 (but not 1a) in sector B belong to the younger habitation horizon, while the layer 1a in sector B and layers 2 - 2d in both sectors belong to the older one (Fig. 3).

Table 3

^{14}C dates for individual layers in the Ti-n-Torha/Two Caves shelter and numbers of samples available for seed-and-fruit analysis.

Sector	Layer	^{14}C b.p.	Lab. No.	Material	Botanical samples
West	I	8840 ± 60	R-1405	charcoal	4, 7
		8520 ± 60	R-1407	charcoal	
		5210 ± 90	Gd-2855	uncharred plant detritus from sample 4	
West	II	8450 ± 60	R-1408	charcoal	11
West	III	8630 ± 50	R-1404	charcoal	2, 15
		8400 ± 90	R-1404	bis charcoal	
Central	Surface				6
Central	II				10
Central	III				14
East	I	6230 ± 50	R-1403	charcoal	
East	II	8620 ± 50	R-1406	charcoal	13
		8650 ± 105	R-1409	charcoal	
East	IIa				5, 12, 16
East	III	9350 ± 110	R-1402	charcoal	8
Test trench	I				3

R – datings from Barich *et al.* 1984; Gd – from Pazdur, this volume.

Table 4

^{14}C dates for individual layers in Uan Muhuggiag shelter and numbers of samples available for seed-and-fruit analysis.

Sector	Layer	^{14}C b.p.	Lab. No.	Material	Botanical samples
A	Surface				26
A	1				14, 21, 28, 31
A	1a	3770 ± 200	Ud-224	charcoal	13, 15
		3800 ± 140	Gd-4363	uncharred *Balanites* fruits, two	
		3720 ± 90	Gd-2962	measurements of one sample	
A	2	6035 ± 100	Ud-225	charcoal	9, 16, 20, 25, 30
		5290 ± 110	Gd-4362	uncharred *Balanites* fruits	
A	2a	6030 ± 80	Gd-2853	uncharred coprolites	12, 17, 18, 27, 29
A	2b				11
A	2c	5780 ± 80	Gd-4358	uncharred *Balanites* fruits	10, 19
A	3				8
A+B	Surface				32
B	1	2220 ± 220	Gd-4290	uncharred *Citrullus colocynthis* seeds	1
		2770 ± 80	Gd-4288	uncharred coprolites	
		3810 ± 80	Gd-2854	uncharred *Balanites* fruits	
B	1a	4980 ± 70	Gd-2958	uncharred *Balanites*	2
		4980 ± 110	Gd-4357	fruits, two measurements of one sample	
B	2	5340 ± 120	Gd-2959	uncharred *Balanites* fruits	4, 4a, 7
B	2a	5420 ± 100	Gd-2960	uncharred *Balanites* fruits	6
B	2b	5350 ± 200	Ud-226	charcoal	5
		5420 ± 50	Gd-5337	uncharred *Balanites* fruits	
B	2d				3

Ud – datings from Barich 1987; Gd – from Pazdur, this volume.

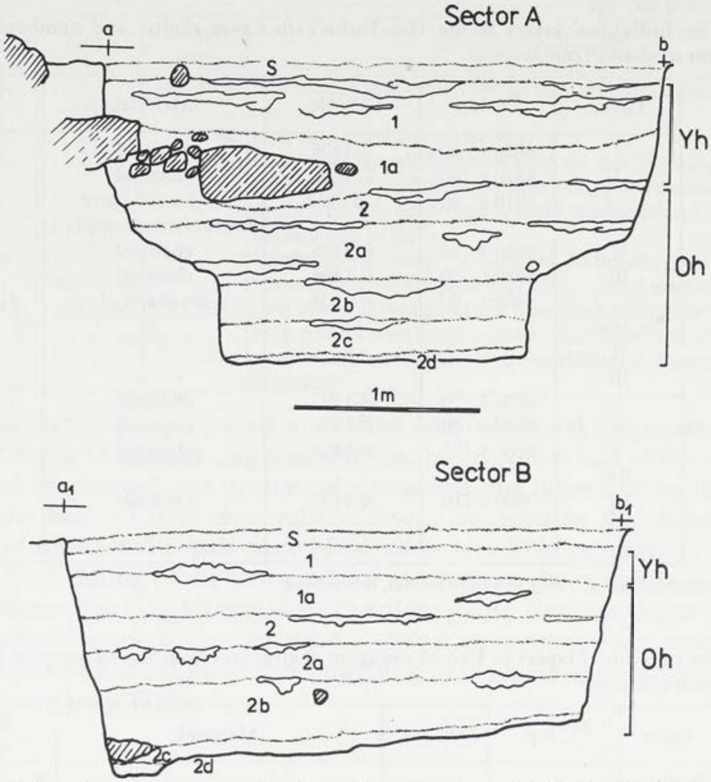


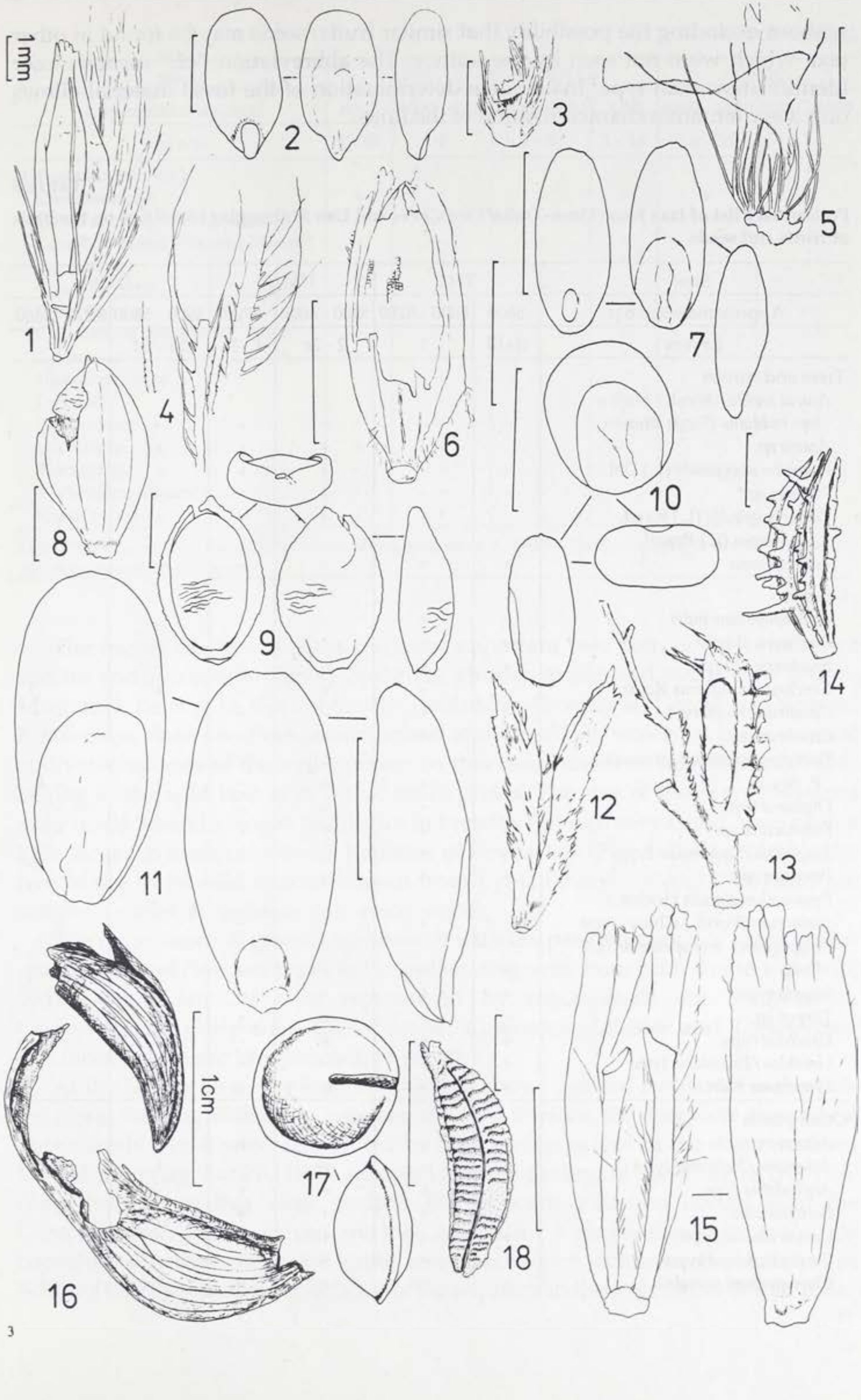
Fig. 3. Uan Muhuggiag. Schematic profiles from the sectors A and B (after Barich 1987, simplified); S and 1 - 2d: archaeological layers; Yh: younger settlement horizon; Oh: older settlement horizon.

Taxonomic composition of the flora

Morphological differentiation of the carpological flora indicates that over 65 taxa are present. About 40 of them could be identified to taxonomic groups of various ranks and only those are listed in Table 5. The qualification "type" following plant name means morphological resemblance to a taxon named but

Fig. 4. Selected plant remains from Uan Muhuggiag (UM) and Tin-n-Torha (TH);

1 - 4: *Pennisetum elatum/setaceum* type, UM sector B, layer 2b, uncharred: 1: spikelet with one fertile floret and bristles; 2: one grain; 3: spikelet base with bristles and pedicel; 4: outer (scabrous) and inner (plumose) bristles; 5: *Cenchrus* cf. *ciliaris*, spikelet base, TH West sector, layer I, uncharred. 6 - 7. *Digitaria* type: 6: uncharred spikelet, UM sector B, layer 2b, 7: one charred grain, UM sector B, layer 2. 8 - 9: *Urochloa* type, TH layer I, uncharred. 8: spikelet with long outer glume, dorsal view; 9: one spikelet without outer and inner glumes. 10: *Echinochloa sp.*, one charred grain, UM sector B, layer 2. 11: *Panicoideae indet.*, one uncharred grain, UM sector B, layer 2. 12: *Polypogon* cf. *monspeliensis*, uncharred spikelet, UM sector B, layer 2b. 13 - 14: *Tragus sp.*, two damaged spikelets, uncharred, TH layer I. 15: *Andropogoneae indet.*, one spikelet, uncharred, TH surface layer. 16: *Acacia tortilis ssp. raddiana*, two odd fragments, uncharred, UM sector B, layer 1. 17: *Chenopodium murale*, one uncharred seed, UM sector B, layer 2. 18: cf. *Picris sp.*, uncharred fruit, UM sector B, layer 2b. Scale lines equal 1 mm except for No. 16.


1mm
1
2
3
4
5
6
7
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10
11
12
13
14
15
16
1cm
17
18

without excluding the possibility that similar fruits/seeds may be found in other taxa which were not seen by the author. The abbreviation "cf." means closer identification than type. Inadequate determination of the fossil material allows only very tentative characterization of the flora.

Table 5

Preliminary list of taxa from Tin-n-Torha/Two Caves and Uan Muhuggiag identified on the basis of fruits and seeds.

Site	TH2		UMA		UMB	
Approximate age b.p.	8600	8600 - 5200	5200 - 6000	3700	4900 - 5400	2200 - 3800
Layers	II+III	I	2 - 2c	1 - 1a	1a - 2d	1
Trees and shrubs						
Acacia tortilis (Forsk.) Hayne *ssp. raddiana* (Savi) Brenan	–	–	–	–	–	+
Acacia sp.			+	+	+	+
Balanites aegyptiaca (L.) Del.	+	–	+	+	+	+
*Phoenix sp.**	–	–	–	–	–	+
Tamarix aphylla (L.) Karst.	–	+	+	+	+	+
Zilla spinosa (L.) Prantl. *ssp. spinosa*	+	+	+	+	–	+
Grasses						
Andropogoneae indet.	–	+	–	–	+	–
Brachiaria B type	+	+	–	–	–	–
Brachiaria C type	+	+	–	–	–	–
Cenchrus cf. *biflorus* Roxb.	–	–	+	–	+	–
Cenchrus cf. *ciliaris* L.	–	+	–	–	–	–
Cenchrus sp.	+	+	+	–	+	–
Dactyloctenium aegyptium (L.) P. Beauv.	–	+	+	–	+	–
Digitaria type	–	–	+	–	+	–
Echinochloa sp.	+	+	+	+	+	+
Eragrostis / Sporobolus type	–	+	–	–	[illegible]	–
Panicum sp.	+	+	+	+	–	–
Pennisetum elatum Hochst. / *setaceum* (Forsk.) Chiov. type	–	+	+	–	+	–
Polypogon cf. *monspeliensis* (L.) Desf.	–	–	–	–	+	–
Setaria type	+	+	+	–	+	–
Targus sp.	–	+	+	+	+	–
Urochloa type	+	+	+	–	+	–
Urochloa / Brachiaria type	+	+	–	–	–	–
Gramineae indet.	+	+	+	+	+	–
Other plants						
Aizoon type	+	+	–	+	–	–
Artemisia / Pulicaria type	+	–	+	–	+	–
Asphodelus type	+	+	–	+	–	–
Boraginaceae	+	+	+	+	–	–
Capparidaceae type	+	+	+	+	–	–
Caryophyllaceae type	+	–	–	–	–	–
Chenopodium murale L.	–	–	+	–	+	–

Table 5 (continued)

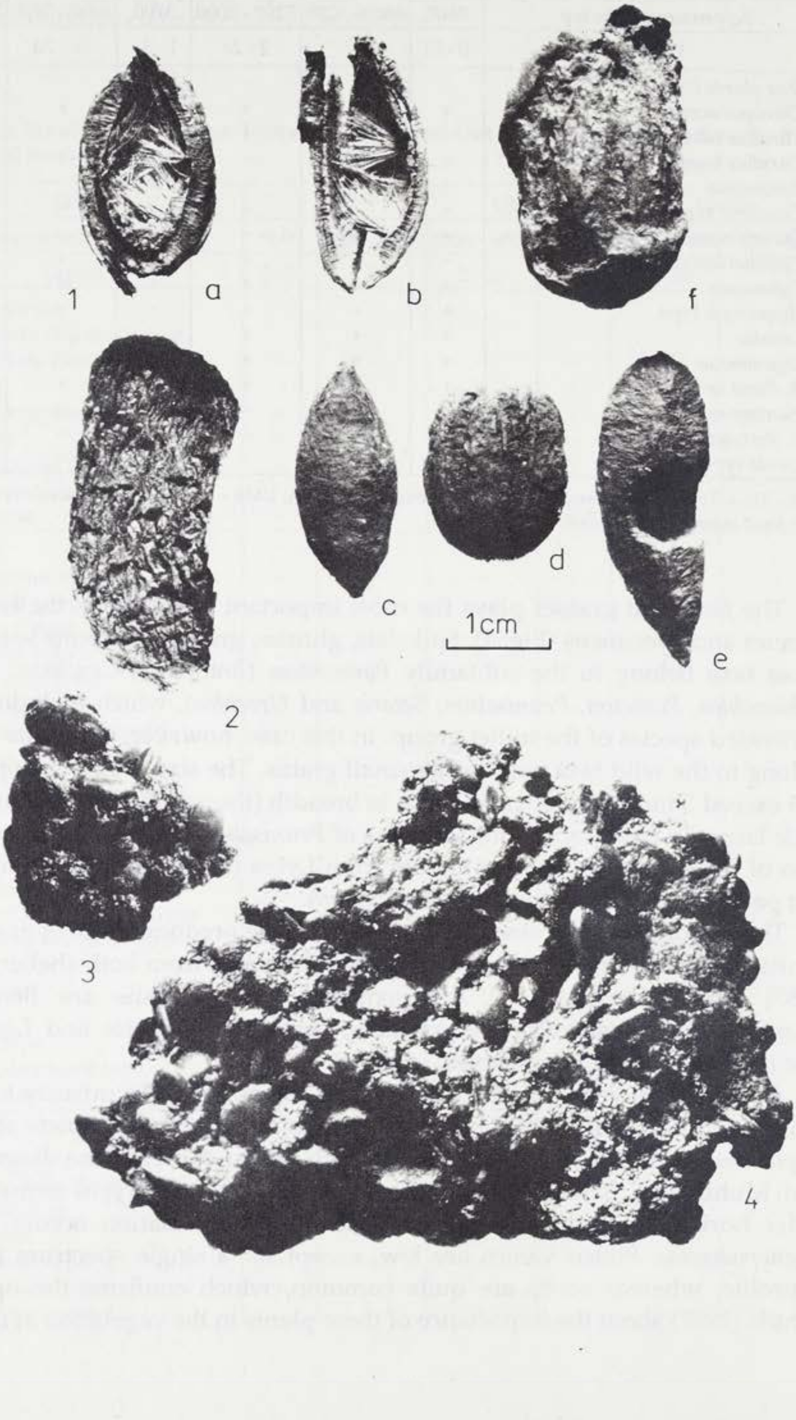
Site	TH2		UMA		UMB	
Approximate age b.p.	8600	8600 - 5200	5200 - 6000	3700	4900 - 5400	2200 - 3800
Layers	II+III	I	2 - 2c	1 - 1a	1a - 2d	1
Other plants (cntd.)						
Chenopodiaceae	+	+	+	+	+	+
Citrullus colocynthis (L.) Schrad.	–	+	+	+	+	+
Citrullus lanatus (Thunb.) Mansf.*	+	–	–	–	+	–
Compositae	+	+	–	+	–	+
Cruciferae type	–	–	+	–	–	–
Cucurbitaceae	–	+	–	–	–	–
Cynomorium coccineum L. type?	–	–	–	–	+	+
Cyperaceae	+	+	+	+	+	–
Hippocrepis type	+	+	–	–	–	–
Labiatae	+	+	+	–	–	–
Leguminosae	+	+	+	–	–	+
cf. *Picris sp.*	+ .	+	+	–	+	–
Plantago sp.	–	–	–	+	–	–
cf. *Portulaca oleracea* L.	–	–	–	–	+	–
Reseda type	+	+	–	–	–	–

TH2 – Tin-n-Torha/Two Caves; UMA – Uan Muhuggiag sector A; UMB – Uan Muhuggiag sector B; * – affiliation with fossil assemblage uncertain.

The family of grasses plays the most important role both as the number of species and specimens (Fig. 4). Spikelets, glumes, grains and stems were found. Most taxa belong to the subfamily *Panicoideae* (*Brachiaria, Cenchrus, Digitaria, Echinochloa, Panicum, Pennisetum, Setaria* and *Urochloa*), which includes several cultivated species of the millet group. In this case, however, all fossils probably belong to the wild taxa with rather small grains. The size of the caryopses does not exceed 3 mm in length and 1 mm in breadth (though they could have been a little larger in fresh condition). Remains of *Pennisetum* (Fig. 4: 1 - 4) resemble the two of the three wild species known from Lybia (Sherif, Siddiqi 1988) and are not pearl millet, *P. typhoides* (=*P. americanum*).

The importance of grasses agrees well with the predominance of grass pollen (particularly of *Panicum* type) in the pollen diagrams from both shelters (Schulz 1987). Other families well represented by macrofossils are *Boraginaceae, Chenopodiaceae, Compositae, Cucurbitaceae, Cyperaceae, Labiatae* and *Leguminosae* (for more details see Wasylikowa, in print).

At the family level, the macrofossil flora shows general similarity to the pollen flora. Striking difference between the two floras is the complete absence of *Typha* seeds which was represented by high pollen values in the diagram from Uan Muhuggiag. Barich (1987) reported also the finding of *Typha* stems from the older horizon in this same shelter. The opposite situation occurs with the *Chenopodiaceae*. Pollen values are low, except for a single spectrum from one coprolite, whereas seeds are quite common, which confirms the opinion of Schulz (1987) about the importance of these plants in the vegetation at that time.


1
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b
f
2
c
d
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1cm
3
4

Remarks on the possible use of wild plants

Few taxa found in the fossil material represent wild plants which are collected for various uses by the inhabitants of the Sahara today. Most interesting is the desert date *Balanites aegyptiaca* (L.) Del. (Fig. 5: 4). It is a small tree or shrub which grows in the *Acacia-Panicum* communities along the wadis in the desert zone (Ozenda 1958) and in the dry savanna zone (Knapp 1973). Its ripe fruits may be eaten raw, its oil is extracted from the seeds, and its fruit pulp has medicinal properties. Due to the saponine content, fruits may be used for cleaning silk and cotton. Different articles of home-use are made of its very hard wood which is also used in fires (Gast 1968; Tubiana and Tubiana 1977). Many fruit-stones were found in all layers from Uan Muhuggiag and only two fragments appeared in one sample from Ti-n-Torha/Two Caves. Most of the very hard fruit-stones were broken, usually split longitudinally, and uncharred; a few were charred or partly charred, many of them filled with fragments of herbs, mainly grass spikelets. It seems probable that the endocarps were crushed by people in order to obtain seeds. The work could have been done inside or outside the shelter. The utilization of *Balanites* fruits is here suggested only for the Neolithic period (and younger times) in Uan Muhuggiag where the stones were abundant (particularly so in the sector B). Two fruit stone-wall pieces of the age of about 8,600 b.p. (layer IIa) found in the Ti-n-Torha/Two Caves may represent quite accidental admixture.

Several other plants could have been gathered for food by the nomads inhabiting the Acacus Mountains but there is no direct evidence. In several samples from Uan Muhuggiag seeds of colocynth *Citrullus colocynthis* (L.) Schrad. were found. This common Saharan species has very bitter fruits but its seeds can be eaten after boiling and drying them (Nicolaisen 1963). A few seeds of water melon, *Citrullus lanatus* (Thunb.) Mansf. were present in one sample from Uan Muhuggiag and one from Ti-n-Torha. They had a badly damaged surface (digested?) and did not look fresh. This widely cultivated plant has also wild races which occur in tropical Africa. Those without a bitter taste are collected as food for humans and animals (Nowiński 1977). The species is not included in the present-day flora of Sahara by Ozenda (1958) and its occurrence in our material might indicate a change of its former range, but contamination by modern seeds of a cultivated form is more likely.

Cynomorium coccineum L., a parasitic plant growing in salt mashes, has an underground stem that can be dried and ground into flour (Nicolaisen 1963). Two possible fragments of the stem of this plant were found in both horizons of Uan

Fig. 5. Uan Muhuggiag. 1: *Balanites aegyptiaca* from sector B, layer 2b: a - e: fruit-stones; f: fruit with epi- and mesocarpium preserved; a, b: filled with *Pennisetum* spikelets, all uncharred. 2: *Cynomorium coccineum* type?, uncharred specimen resembling stem fragment of this plant, sector B, layer 1. 3: *Acacia sp.*, "roasted" seeds, sector A, layer 2a. 4: *Citrullus colocynthis*, uncharred seeds, sector B layer 1. (Photo A. Pachoński).

Muhuggiag shelter (Fig. 5: 3). Various grasses, having grains slightly smaller than the present-day cultivated millet, were available in the wadis and were found in the shelter deposits. They were certainly collected but we have no clear evidence whether the grains were gathered for food or stems (with grains attached) for bedding, or both. It should be stressed here that Ti-n-Torha and Uan Muhuggiag do not differ much in the number of grass remains. This means that plant material does not support the opinion of Barich (1987) that the gathering of grasses was more important in Ti-n-Torha than in Uan Muhuggiag.

The finding of three stones of a palm from the genus *Phoenix* in the uppermost level of Uan Muhuggiag requires comment. The endocarps are relatively short and broad (15×7 mm and 17×8.5 mm), with rounded ends, and resemble the stone described by Hadidi (1980: Fig. A5.3) from Nabta Playa and dated to 7,000 - 6,500 b.p. According to Hadidi this stone is similar in size to endocarps of a wild tropical palm *Phoenix reclinata* Jacq. and to the stones of a dwarf form of date palm *P. dactylifera* L. which grows wild. This dwarf form, in his opinion, may be regarded as one of the prototypes of the date palm and with this form the stone from Nabta Playa is compared. For the time being the stones from Uan Muhuggiag were not identified to the species level because no reference material was available. Their precise age is not known since they were found in the sample No. 1 (layer 1, sector B) which contained uncharred plant remains of various ages (Table 4).

The list of taxa identified from the Acacus by their seeds, fruits and pollen includes some other plants which are gathered for food in various parts of the Sahara today (*e.g. Aizoon* type, *Chenopodium sp.* div., *Maerua*). It should be stressed, however, that the fact that some plants are collected from the wild state today does not prove their utilization at every place and every time in the past. This has to be confirmed by additional observations, such as the frequency or abundance of findings, evidence for special treatment *etc.*, as is the case with *Balanites* stones from Uan Muhuggiag.

Plants known presently only in cultivated forms are represented by *Ceratonia siliqua* L.?, St. John's Bread. A fragment of a legume most probably from this species was found in layer 2a in Uan Muhuggiag. The species has been cultivated in the Mediterranean basin at least since the 1st millennium b.c. (Duran, Baratte 1910; Nowiński 1977) and its presence in the Acacus is difficult to explain. The easiest explanation would be contamination by much younger or modern material but this possibility requires more evidence.

Vegetation of the habitation periods

Plant material found in settlement layers may not have accumulated in the rock shelters in a natural way, except possibly for a few pollen grains blown in. It was partly gathered by people for special purposes outside of the shelters and stored inside and partly brought in unconsciously by people and animals (*e.g.* pollen, seeds and fruits attached to animal hair, or sticking to the other plants which were collected or included in the dung). This mean that the fossil flora reflects surrounding vegetation in a very specific way. It shows which plants were present in the area at the time of habitation but gives no direct information about the quantitative relations between different species. Plants which were of some use to humans and their animals are overrepresented. Taking these reservations into account Schulz (1987) presented an attempt at reconstructing the vegetation in the Acacus Mountains during the time between about nine and five thousand years ago. On the basis of pollen spectra from the shelters Ti-n-Torha North and East and Uan Muhuggiag he concluded that woodlands similar to the present-day communities of *Acacia-Panicum* or *Tamarix-Stipagrostis* type occurred along the wadis. They were probably richer in floral composition and extended farther towards the surrounding plains than today. Probably also the herbaceous vegetation covered these plains with denser populations of perennial and annual species. Places with high ground-water level or more persistent water pools were surrounded by belts of *Phragmites, Cyperaceae* and *Typha*. The vegetation was sufficently rich to provide good pastures. Schulz has stressed the importance of Sahelian elements in the past flora of the Acacus and pointed out the area of Aïr Mountains, about 800 km to the southeast, as a possible modern analogue for the reconstructed fossil vegetation. Pollen spectra indicated also the presence of the Mediterranean/montane pre-Sahara species which could grow in the upper part of the mountains (*Artemisia, Ephedra, Olea*). The presence of these elements, however, was not considered by Schulz as an evidence for the displacement of Sahelian and Mediterranean zones. In his opinion, the rare occurrence of several species representing the Sahelian element in the Tassili-n-Ajjir and the destruction of modern vegetation by overgrazing and by the drought of the last decades demand great caution in the interpretation of the vegetational changes in the Acacus during the Holocene.

Macrofossil analysis has confirmed the presence of several desert savanna elements, such as *Acacia tortilis ssp. raddiana, A. sp., Balanites aegyptiaca, Zilla spinosa ssp. spinosa, Tamarix aphylla, Citrullus colocynthis, Asphodelus* type, *Aizoon* type, *Panicus sp. div., Pennisetum sp. div.* and another grasses (Quezel 1965). We may expect that a more detailed phytogeographical analysis of the macrofossil flora will be possible when more specific determinations are available. Even then, however, it will not be easy to estimate the significance of the savanna element in the fossil flora because many plants can grow in the wadi woodlands within the desert zone as well as in the typical dry savanna zone.

Climatic oscillations described by Pasa (Pasa and Pasa-Durante 1963; Barich 1987) from Uan Muhuggiag on the basis of lithological changes and pollen analysis were not confirmed by much more detailed pollen diagrams presented by Schulz (1987). At the present stage of investigation, macrofossil spectra also do not permit any stratigraphic differentiation of the fossil flora. Instead, they confirm the difference between Ti-n-Torha and Uan Muhuggiag as far as the representation of arboreal flora is concerned. The almost complete absence of trees and shrubs among the identified diaspores from Ti-n-Torha/Two Caves agrees well with the smaller number of arboreal pollen in Ti-n-Torha East and

North compared with Uan Muhuggiag. It was explained by Schulz (1987) as the reflection of a real difference in vegetation between the northern and central parts of the Acacus Mountains because higher climatic dryness of the northern part, caused probably by more peripheral position within the mountain range, resulted in more open vegetation around Ti-n-Torha. A fairly abundant occurrence, in settlement layers, of plant detritus with an admixture of fruits and seeds indicates that local wadi vegetation must have been quite rich during the short seasons when the rock shelters were inhabited.

Acknowledgements

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Evaluation of radiocarbon dates of organic samples from Uan Muhuggiag and Ti-n-Torha, Southwestern Libya

Introduction

Twelve samples were submitted to the Radiocarbon laboratory in Gliwice in order to supplement the series obtained earlier and reported by Barich *et al.* (1984: 413). Samples were submitted as very clean, botanically identified remnants. Site Uan Muhuggiag was represented by eleven samples: 8 samples of fruits of *Balanites aegyptiaca* (layers 1a, 2, 2c in Sector A and layers 1, 1a, 2a and 2b in Sector B), 2 samples of coprolites (layer 2a, Sector A, and layer 1, Sector B) and one small sample of uncharred seeds of *Citrullus colocynthis* from layer 1, Sector B. Site Ti-n-Torha was represented by uncharred plant detritus from layer I, western sector. Results in form of conventional C-14 dates are quoted in Tables 3 and 4 of the source article, together with dates obtained earlier on charcoals in radiocarbon laboratories in Rome and Udine.

Laboratory methods

Age determinations were performed using CO_2-filled proportional counters of different volumes. Since the mass of samples available for dating was relatively low, they were pretreated only with 2% HCl at 80°C for 1 hour. No alkali treatment was applied in order to avoid loss of mass during this step. Relatively large error of date Gd-4290 (2,220 ± 220 B.P.) is connected with very low amount of carbon dioxide obtained from combustion of seeds of *Citrullus colocynthis*. Sample was counted on the smallest proportional counter after dilution with inactive CO_2 (71% of inactive CO_2 was added to fill the counter). Dates Gd-4288 (2,770 ± 80 B.P.) and Gd-4358 (5,780 ± 80 B.P.) were obtained as a mean values from independent measurements performed on two or three counters. Dates obtained on coprolites and fruits of *Balanites aegyptiaca* were corrected for isotopic fractionation by measuring $\delta^{13}C$ values. Obtained $\delta^{13}C$ values are listed in Table 1. Corrections were applied according to recommendations of Stuiver and Polach (1977: 355).

Table 1

Conventional and calibrated ^{14}C dates from site Uan Muhuggiag.

Sector/layer	M	Lab. no.	C	$\delta^{13}C$ %	Age ^{14}C conv. B.P.	Calendric age B.C.	Interquartile range B.C.
A/1a	Ch	Ud-224	–	-25^a	3770 ± 200	2220	2410–2040
A/1a	B	Gd-2962	3	−25.52	3720 ± 90	2140	2250–2050
A/1a	*	Gd-4363	6	−25.52	3800 ± 140	2260	2390–2130
A/2	Ch	Ud-225	–	-25^a	6035 ± 110	4940	?–4840
A/2	B	Gd-4362	4	−23.98	5290 ± 110	4130	4220–4050
A/2a	Co	Gd-2853	3	−21.66	6030 ± 80	4940	?–4840
A/2c	B	Gd-4358	m	−24.05	5780 ± 80	4660	4720–4590
B/1	Ci	Gd-4290	5	-25^a	2220 ± 220	290	490– 110
B/1	Co	Gd-4288	m	−20.98	2770 ± 80	940	1000– 880
B/1	B	Gd-2854	3	−23.38	3810 ± 80	2270	2360–2190
B1/1a	B	Gd-2958	3	−24.39	4980 ± 70	3790	3880–3730
B1/1a	*	Gd-4357	5	−24.39	4980 ± 110	3790	3890–3710
B/2	B	Gd-2959	3	−24.36	5340 ± 120	4180	4270–4080
B/2a	B	Gd-2960	3	−24.99	5420 ± 100	4260	4330–4170
B/2a	*	Gd-4361	6	−24.99	5480 ± 120	4330	4430–4230
B/2b	Ch	Ud-226	–	-25^a	5350 ± 200	4190	4330–4040
B/2b	B	Gd-5337	1	−24.43	5420 ± 50	4280	4320–4250

M – sample material: Ch – charcoal, Ci – seeds of *Citrullus colocynthis*, Co – coprolites, B – fruits of *Balanites aegyptiaca*, * – measurements repeated on the same gas using different counter, C – counter number in Gliwice Radiocarbon Laboratory: m – results obtained as mean from determinations on three or two counters, ^{a} – values of $\delta^{13}C$ assumed equal to −25.00 permille.

Discussion: evaluation of individual C-14 dates

All dates from site Uan Muhuggiag were converted to the calendric time scale using procedure for probabilistic calibration of C-14 dates, described by Pazdur and Michczyńska (this volume). The results are listed in Table 1 and are presented in graphical form in Fig. 1. For clarity of the picture the youngest samples from layer 1, Sector B, are not shown in Fig. 1. Conventional C-14 dates Ud-225 (6,035 ± 110 B.P.) and Gd-2853 (6,030 ± 80 B.P.) cannot be calibrated by the computer procedure and are not shown in Fig. 1. However, it is possible to read approximate values of calendric age of those samples directly from calibration curves of Pearson *et al.* (1986: 928). Obtained values are given in Table 1, though the estimates of uncertainties of the calendric age are not available.

Chronology of Sector A is based on 7 dates obtained from 6 different samples. Dates of charcoal and fruits of *Balanites aegyptiaca* from layer 1a are in excellent agreement, the age of this layer can be therefore estimated as close to 2,200 B.C. Two C-14 dates of charcoal and *Balanites* fruits from layer 2 are not consistent and differ by *ca.* 1000 years. There are two possibilities to explain this

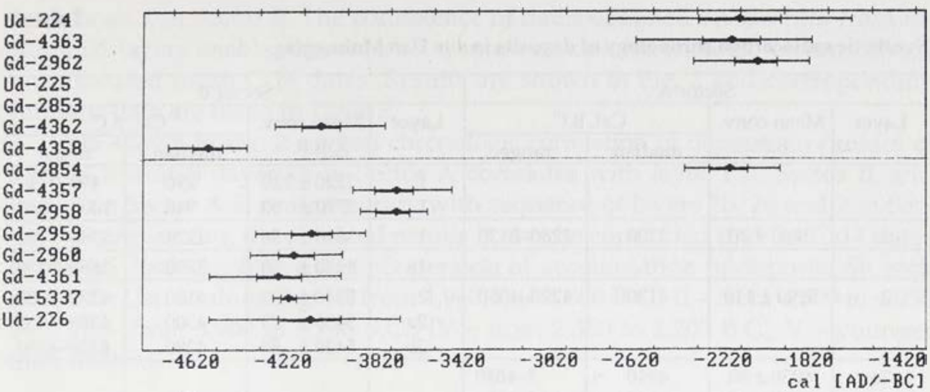

Fig. 1. Calibrated ^{14}C dates from site Uan Muhuggiag (dots); bold lines show interquartile ranges and normal lines show 95% confidence intervals of calendric age. Two youngest dates from layer 1, Sector B, are not included; dates Ud-225 and Gd-2853 are out of range of calibration curve.

difference: either the charcoals were produced by combustion of much older subfossil wood, or the sample of *Balanites* fruits contains admixture from overlying layer. The first possibility seems to be much more probable, and can be additionally supported by significant scatter of C-14 dates of charcoal from the same area (site Ti-n-Torha, *cf.* Barich *et al.* 1984: 413). A second discrepancy in this profile is revealed by C-14 dates obtained from coprolites in layer 2a and *Balanites* fruits in layer 2c. The difference of these dates is equal to 250 years and cannot be regarded as highly significant when compared with dating errors, equal to ± 80 years. Such a small inversion may be caused either by disadvantageous combination of laboratory errors, or by chemical contamination, which was not removed because of insufficient treatment of samples in laboratory (only HCl treatment was applied – *cf.* chapter on laboratory methods), or by mechanical admixtures of some materials from adjacent horizons. Taking into account those probable explanations it may be concluded that C-14 dates from layers 2, 2a and 2c are in relatively good stratigraphic order.

Chronology of deposits in Sector B is based on 10 dates of 8 samples of different type. Layer 1 was dated using three different samples; the results are not consistent. Difference between youngest date on seeds of *Citrullus colocynthis* and the oldest one, obtained on fruits of *Balanites aegyptiaca*, is *ca.* 1600 years. Explanation of this difference by contamination of dated samples with foreign carbon or by laboratory errors seems not probable; it should be therefore assumed that either this layer is not homogeneous, or some fruit of *Balanites* from underlying layer were included during sampling. C-14 dates obtained from repeated measurements of samples from layers 1a, 2a and 2b are consistent, and the sequence of dates in the whole profile of Sector B is in good stratigraphic order. The inversion of dates from layers 2a and 2b (*cf.* Table 1) is insignificant and may be interpreted as the result of counting errors during measurement of C-14 activity.

Table 2

Synthetic radiocarbon chronology of deposits in site Uan Muhuggiag.

Sector A				Sector B			
Layer	Mean conv. B.P.	Cal. B.C.		Layer	Mean conv. B.P.	Cal. B.C.	
		median	range			median	range
				1	2220 ± 220	290	490– 110
				1	2770 ± 80	940	1000– 880
1a	3760 ± 70	2200	2280–2130	1	3810 ± 80	2270	2360–2190
				1a	4980 ± 60	3790	3880–3730
2	5290 ± 110	4130	4220–4050	2	5340 ± 120	4180	4270–4080
				2a	5450 ± 75	4300	4350–4250
				2b	5420 ± 50	4280	4320–4250
2a	6030 ± 80	4940	?–4840				
2c	5780 ± 80	4660	4720–4590				

Significant difference occurs between dates on charcoals from layer I in Ti-n-Torha shelter (8,520 ± 60 and 8,840 ± 60 B.P.) and date on plant detritus (Gd-2855: 5,210 ± 90 B.P.). As indicates by dates listed in Table 2 of source article, charcoals from this site are of different ages and, moreover, the C-14 dates of samples collected from individual layers are not in stratigraphic order. This may suggest that dated charcoals were produced by ancient man by the combustion of subfossil (dead) wood; if this explanation is true the date obtained on plant detritus may be regarded as the most reliable indicator of the time of deposition of layer I. Such conclusion seems to be confirmed additionally by C-14 dates from eastern sector, where layer I was dated as 6,230 ± 50 B.P. (R-1403) and age of layer II is *ca.* 2000 years older, and is close to dates obtained on all charcoal samples from layers I to III in western sector.

Calendric C-14 chronology of site Uan Muhuggiag

The above presented detailed discussion of individual C-14 dates leads to the conclusion that the set of available C-14 dates gives a consistent chronologic picture of formation of deposits in both excavated sectors, with the only exception of outlying results obtained on charcoal from layer 2 (Ud-225) and set of dates

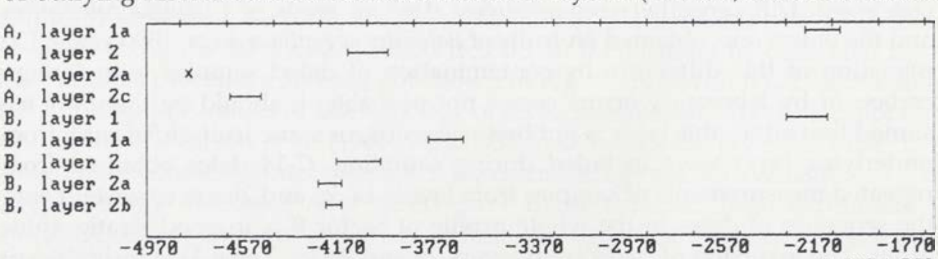

Fig. 2. Synthetic calendric chronology of deposits in Uan Muhuggiag rock shelter. Bars denote interquartile ranges of mean calendric ages of individual layers. Approximate value of calendric age of layer 1a, Sector A, is indicated by cross.

from layer 1 in Sector B. The consistence of dates obtained on samples from individual layers enables to construct a more concise chronologic picture, based on calibrated mean C-14 dates. Results are shown in Fig. 2 and corresponding numeric data are listed in Table 2.

Data shown in Fig. 2 suggest chronologic correlation of deposits in profiles of Sectors A and B: layer 1a in Sector A correlates with layer 1 in Sector B, and layer 2 in Sector A is contemporary with sequence of layers 2b, 2a and 2 in Sector B. Summarizing the obtained results it may be concluded that the C-14 dates enable to distinguish five distinct periods of accumulation of deposits on rock shelter in Uan Muhuggiag: I – from 4,940(?) to 4,600 B.C., II – from 4,300 to 4,050 B.C., III – from 3,900 to 3,700 B.C., IV – from 2,350 to 2,200 B.C., V – younger than 1000 B.C.

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The Aterian of the Central Sahara

Topography and stratigraphy

The Aterian of the Central Sahara is best seen as the isolated massif of Adrar Bous the study of which was carried out in the first nine weeks of 1970 as a team project of the British Expedition to the Aïr Mountains under the leadership of Major (now Colonel) D.N. Hall. Two students – Andrew B. Smith and Allen G. Pastron – from the Department of Anthropology at the University of California, Berkeley, and the writer together with geological colleague, Dr. M.A.J. Williams, then of Macquarie University, New South Wales, Australia, carried out a survey of the massif and the surrounding region. We are greatly endebted to a number of individuals and institutions for making this expedition possible, especially to the Government of Niger and to Major Hall for inviting us to undertake this study.

Adrar Bous is a dissected mass of Younger Granite at the northwest corner of the Ténéré Desert, some 75 km from the northeast tip of the Aïr (Greboun Mountain) which has been made famous by a previous expedition – Berliet-Ténéré-Tchad – and the cultural remains that they brought back (Hugot 1962). Our objectives were essentially survey and some trial excavation to establish a stratigraphic and cultural sequence for the region. In this we were successful and our results have been published in preliminary reports (Hall *et al.* 1971; Clark, Williams and Smith 1973) and in more specialized accounts of the Epi-Palaeolithic (Smith 1976; Cark 1976) and Neolithic (Smith 1974; 1980).

Adrar Bous is very rich in cultural remains dating from the later Acheulian up to the Neolithic and this paper reviews the evidence for Middle Palaeolithic/Aterian occupation there. The geology and sedimentary context of the assemblages were established by Dr. M.A.J. Williams and the sites were systematically collected and tested by excavations by Smith, Pastron, Williams and the writer. The analysis of the assemblages was carried out in the laboratory at Berkeley in 1976 by a group of students under the author's direction. The artifact illustrations are redrawn by Ms. Judith Ogden from the very fine line drawings of Madame Y. Bale of the Musée Royal de l'Afrique Centrale thanks to Dr. Francis

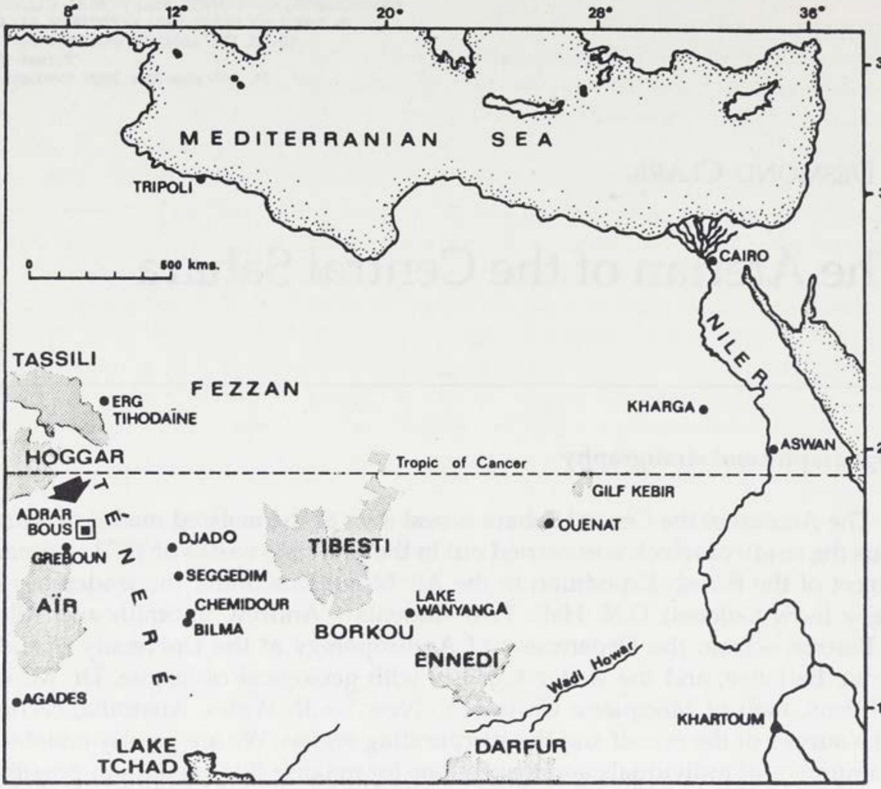

Fig. 1. Map of the Central Sahara to show the location of Adrar Bous and some other Aterian sites referred to in the text.

van Noten. In this paper, the stratigraphic position of the Middle Palaeolithic/ Aterian is identified; the technological and typological nature of the assemblage is described and a general comparison made with that from other regions of the Sahara. A behavioral model for Middle Palaeolithic hunter/gatherer occupation of the Sahara is also presented.

As yet, the Middle Palaeolithic/Aterian occupation at Adrar Bous remains undated radiometrically but new significance comes from the age of ≥ 100,000 for this Techno-Complex in the Eastern Sahara (Wendorf *et al.* 1991) and the molecular biological evidence from DNA that indicates that the first Modern humans evolved in the African continent sometime between 290,000 and 140,000 years B.P. (Cann *et al.* 1987).

Fig. 1 shows the position of Adrar Bous, the Aïr, the Hoggar, Tassili, Tibesti and the Ténéré Desert as well as the Erg Tihodaine and the area of the Lake Tchad Basin in Borku south of the Tibesti where the Aterian has been studied respectively by the late Professor Arambourg and by Professor Balout (1955), by Dr. Thiery Tillet (1983) and earlier, in the region of Lake Wanyanga, by A.J. Arkell (1964). Today there is no water and there are no people living at Adrar

Bous but during much of the Later Pleistocene and Early Holocene, swamps and a lake were present on the south side of the massif. This massif is a dissected upland consisting of granite, metamorphosed rocks, veins of quartzite and dolerite dykes. Mostly local rocks were used by the makers of the Acheulian and Middle Palaeolithic tool kits. These rocks generally comprised metamorphosed sediments and volcanics – rhyolite, basalt, micro-granite, metamorphosed vitric tuff, hornfels and greywacke. With the Aterian, besides hornfels, a fine-grained, silicified vitric tuff (SVT or "greenstone") appears and increasing use is made of this through time. It resembles a green chert and is not local, indeed, outcrops of this rock occur 280 km to the northeast of Adrar Bous so that all that used at Adrar Bous had to have been brought in. This is evidence either for a highly mobile population or for the existence of some pattern of long-distance exchange.

The Quaternary sediments comprise fanglomerates and fine gravel and coarse sand spreads and aeolian sand plains with seif and barchan dunes. Alluvium occurs in former stream courses, swamps and Holocene lake beds, the latter including two periods of diatomite formations. Fig. 2 shows the main localities where Middle Palaeolithic/Aterian assemblages were found: Hidden Valley, in the massif, Agorass Nessoui (Valley of the Lake), Lookout Hill, Yellowstone Hill and the Main Wadi.

Limited geological and archaeological excavations showed evidence for three cycles of erosion and deposition. There is no cultural material associated

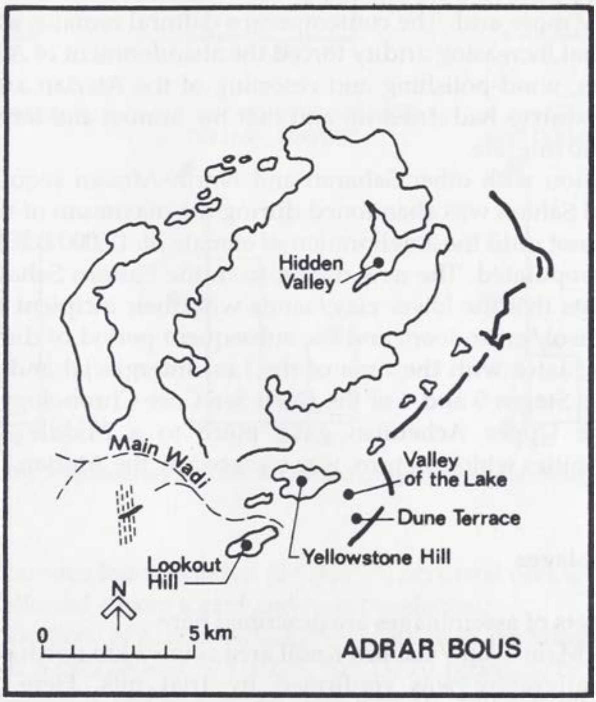

Fig. 2. Mousterian and Aterian localities at Adrar Bous.

with Cycles 1 and 2 but the Acheulian appears in a Lower Sandy Clay Loam in the depositional phase of Cycle 3; this underlies green lacustrine loams and black swamp clays (Lower Vertisol) immediately prior to the appearance of an Early Middle Palaeolithic. Over this is the Upper Sandy Clay Loam – the product of a drier, windy phase with aeolian sands and Aterian assemblages. Above again is the Upper Vertisol and the Early Holocene sequence. Details of the Early Middle Palaeolithic and Aterian will be found in Clark (Clark *et al.* 1973: 250 - 260) and Williams (1976).

This sedimentary sequence is interpreted by Williams as follows: a long period of aggradation of clay/sands ended in a period of pedogenesis during which an incipient soil formed suggesting a fluctuating water table; the Acheulian is contemporary with this phase. A long swampy phase followed when dark clays formed in local swamps (Lower Vertisol) and green clays and loams built up in the lake to the south of the massif up as far west as the Main Wadi. These occupied much of the basin of the "Valley of the Lake" which contained acid water. This main vertisol probably developed in seasonally flooded swamps around the edge of the early lake as in the Tchad Basin in the Sudan. It is to the end of this time that the early Middle Palaeolithic belongs. The drying up of the lake was accompanied by the deposition of carbonates from groundwater. On the lower slopes of the hills, local slopewash and clayey sands accumulated; this and windblown sands interfinger with colluvial sediments. Clearly, this was of reduced but adequate rainfall in a climate that was becoming increasingly more arid. The contemporary cultural remains are Aterian and it is apparent that increasing aridity forced the abandonment of Adrar Bous. The severe deflation, wind-polishing and resorting of the Aterian artifacts suggest that the water sources had dried up and that the human and large mammalian fauna had had to migrate.

The correlation with other Saharan and North African sequences suggests that the Central Sahara was abandoned during the maximum of the Last Glacial and that it was not until the amelioration of climate *ca.* 12,000 B.P. that the desert began to be repopulated. The new dating from the Eastern Sahara (Wendorf *et al.* 1991) suggests that the lower clay/sands with their incipient soil formation, the Lower Vertisol/green loam and the subsequent period of diminishing rainfall probably equates with the time of the Last Interglacial and the early Last Glacial, Oxygen Stages 5 and 4 of the Deep Sea Core Chronology. This was the time when the Upper Acheulian gave place to a Middle Palaeolithic of Mousterian affinities which, in turn, was replaced by the Aterian.

Artifact assemblages

Four main sets of assemblages are described here:

1. From the Main Wadi/Gabbro Knoll area some 2 km north of Lookout Hill where the stratigraphy was confirmed by trial pits. Here, early Middle Palaeolithic (Mousterian) (S/151/70) was found *in situ* in the top 5 cm of an

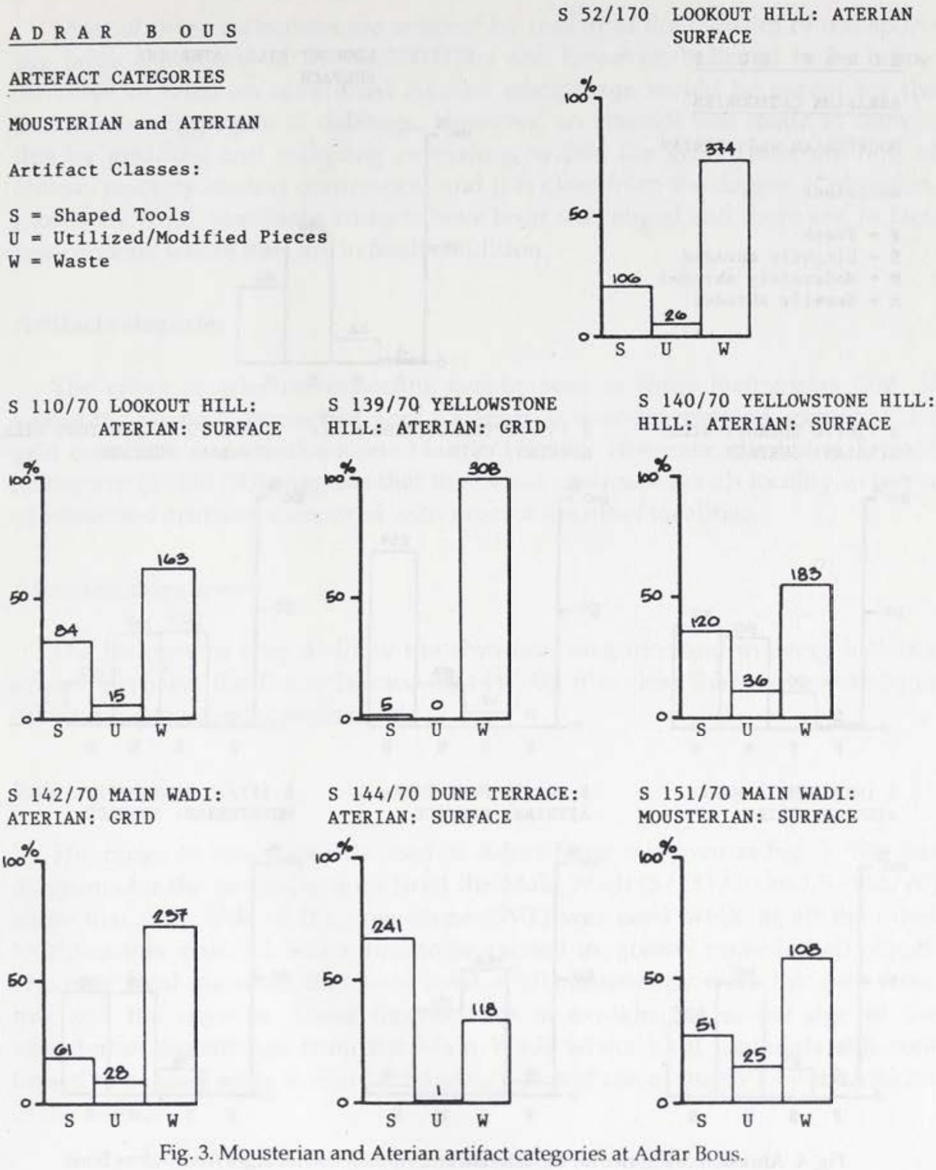

Fig. 3. Mousterian and Aterian artifact categories at Adrar Bous.

olive-green calcareous loam. Aterian (S/142/70) occurred on the eroded surface and was also collected – from a grid and so is unselected;

2. Several collections of Aterian from surface collecting, gridding and excavation at Lookout Hill: S/52/70 and S/110/70, S/123/70 (grid), S/89/70 (geological pit), S/112-116/70 (Pit 14 Excavation). The Aterian comes from yellow-brown sand with gravel lenses and overlying yellow-brown and grey sands;

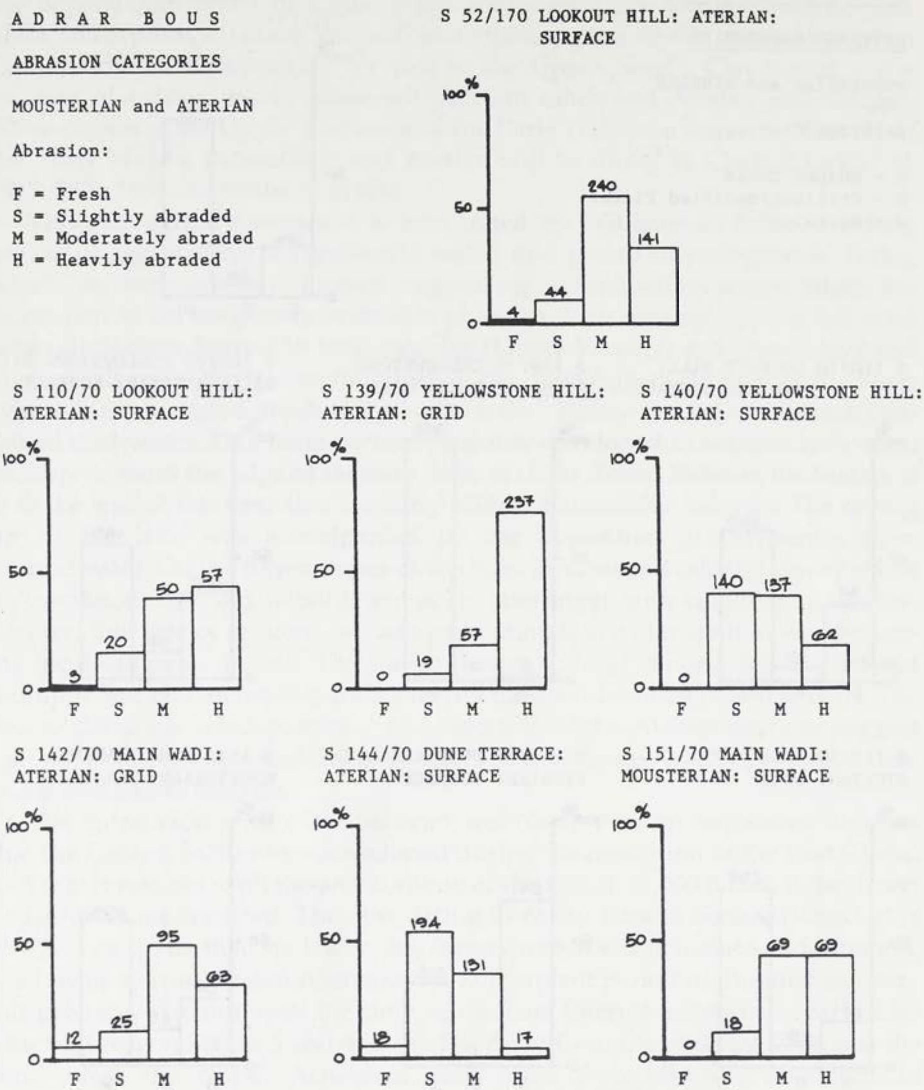

Fig. 4. Abrasion categories for Mousterian and Aterian assemblages from Adrar Bous.

3. A large but selected collection eroding from the foot slopes at the northwest end of the Yellowstone Hill (S/139/70, Grid, and S/140/70, surface);

4. Another large but selected collection from the Terrace at the foot of the High Dunes that line the eastern edge of the "Valley of the Lake" and where the stratigraphic position of the Aterian has been checked by trial pits (S/144/70) in a yellow-brown sand over olive-green loam.

Most of these collections are selected by reason of the logistics of transporting large collections in the desert. They are, however, believed to be representative of what an unselected Aterian assemblage would be except for the quantitative aggregate of debitage. However, an attempt was made to sample this by gridding and collecting everything within the grid. These are not, of course, primary context occurrences and it is clear from the degree of abrasion, mostly by wind, that these artifacts have been rearranged and there are, in fact, few contexts where they are in fresh condition.

Artifact categories

The effect of selective collecting can be seen in these histograms (Fig. 3) where the Shaped/Retouched Tool Category is over-represented, except in the grid collection from Yellowstone Hill (S/139/70). However, the Dune Terrace histogram (S/144/70) suggests that this was a particularly rich locality in terms of retouched artifacts, compared with most of the other localities.

Abrasion categories

The histograms (Fig. 4) show the abrasion categories and in every instance except, perhaps, the Dune Terrace (S/144/70), it is clear that the assemblages have been geologically rearranged.

Raw materials

The range of raw materials used at Adrar Bous is shown at Fig. 5. The bar diagrams for the two collections from the Main Wadi (S/151/70 and S/142/70) show that very little of the greenstone (SVT) was used while at all the other localities. this material, which had to be carried in, greatly exceeded all others. The only local materials that were used at all consistently were the grey vitric tuff and the rhyolite. These figures help to explain the earlier age of the Mousterian assemblage from the Main Wadi where local materials still continued to be used prior to regular introduction and use of the SVT by the makers of the Aterian.

Tool classes

The bar diagram (Fig. 6) that probably best represents an unselected Aterian assemblage is that from the grid at the Main Wadi locality (S/142/70). This assemblage contains points (tanged, bifacial and parti-bifacial, leaf-shaped and unifacially retouched); side-scrapers, end-scrapers, notched and denticulated pieces, burins and miscellaneous artifacts. The other unselected sample shown (S/139/70 from Yellowstone Hill) emphasizes tanged points, side-scrapers and notched pieces.

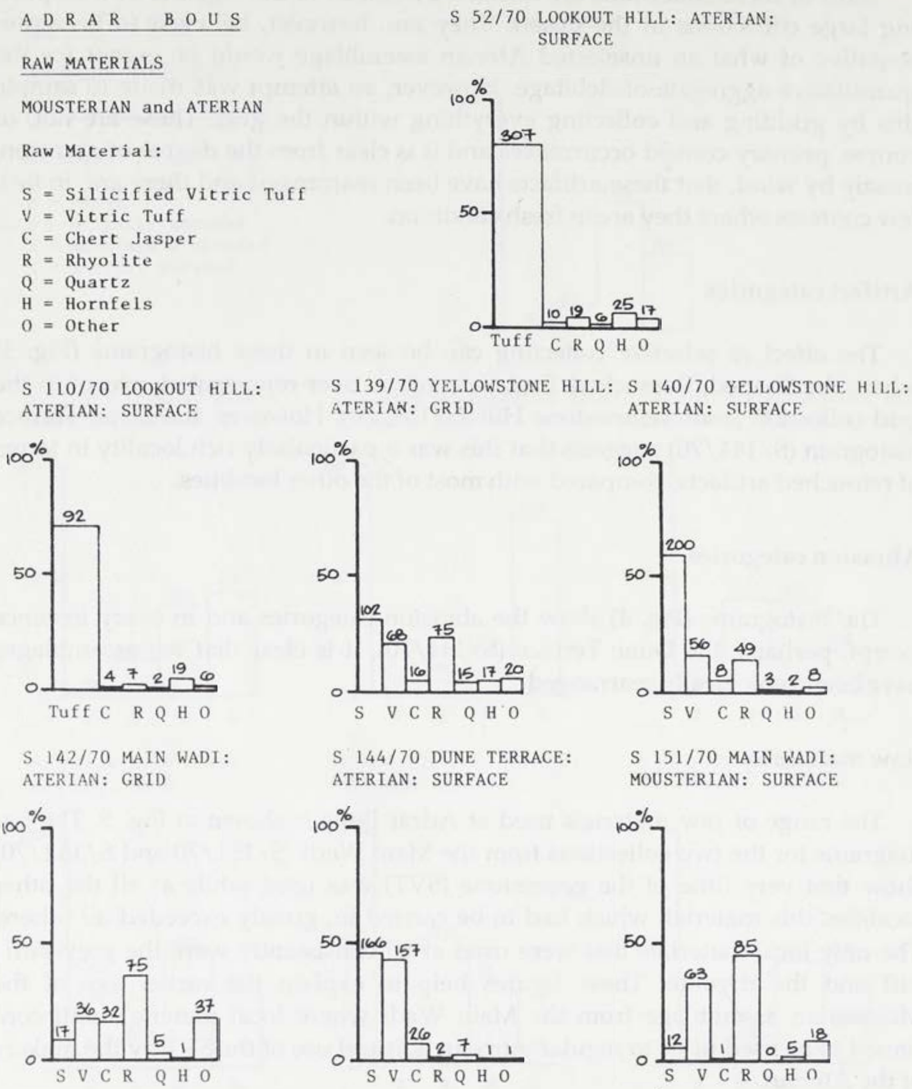

Fig. 5. Raw materials used at Mousterian and Aterian localities at Adrar Bous.

Although the other histograms for Aterian assemblages show the bias of selective collecting, there are no significant differences other than the addition of small numbers of borers. In contrast to the Aterian, the early Middle Palaeolithic (Mousterian) sample (S/151/70) from the Main Wadi has no tanged or bifacial points; the scraper forms are only lightly retouched and the main component consists of unretouched flakes and blades produced by the Levallois method.

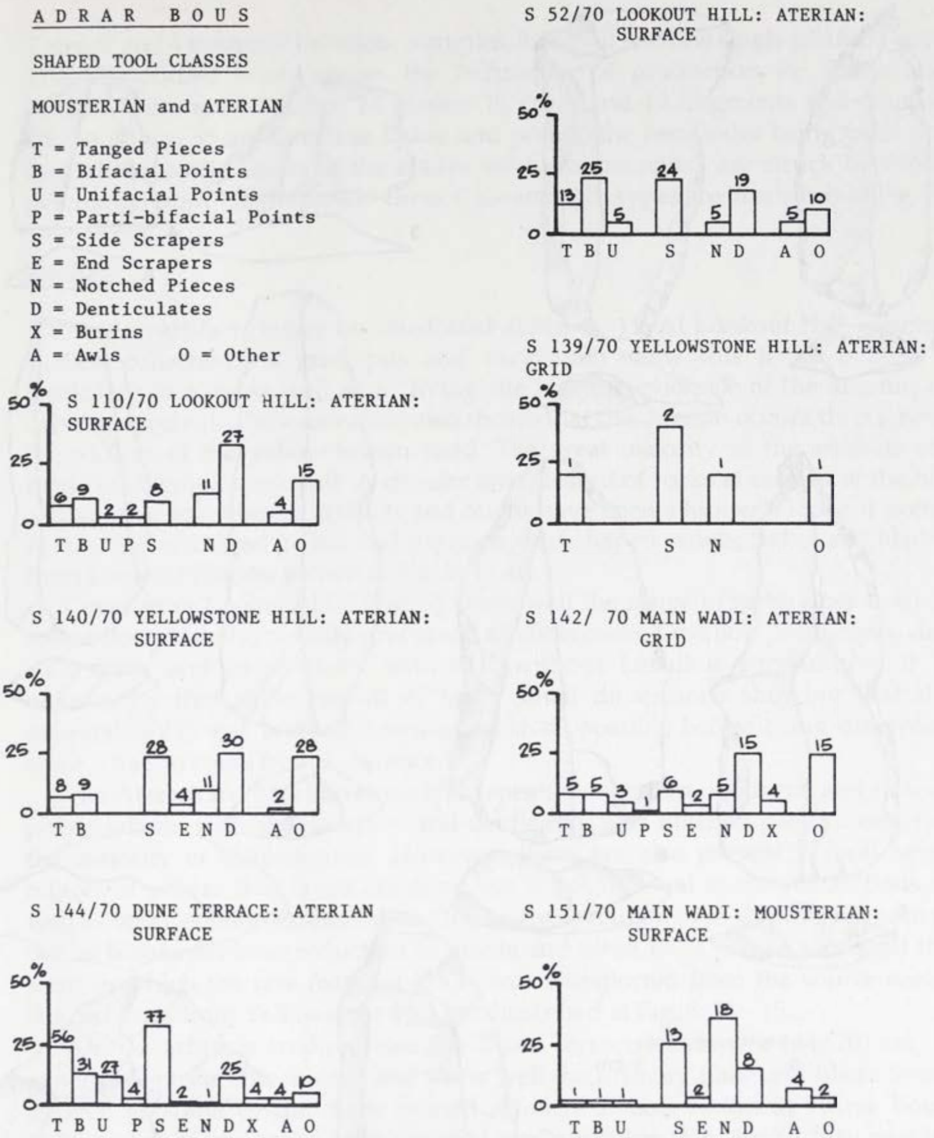

Fig. 6. Shaped tool classes: Mousterian and Aterian assemblages from Adrar Bous.

The earlier Middle Palaeolithic, Mousterian (S/151/70)

This assemblage consists of a total of 184 artifacts of which 27.7% are shaped tools, 13.6% are modified and 58.7% are unmodified waste. The retouch/modification is mostly denticulate. This assemblage is characterized by the Levallois, discoid and single-platform, direct percussion method. The cores comprise

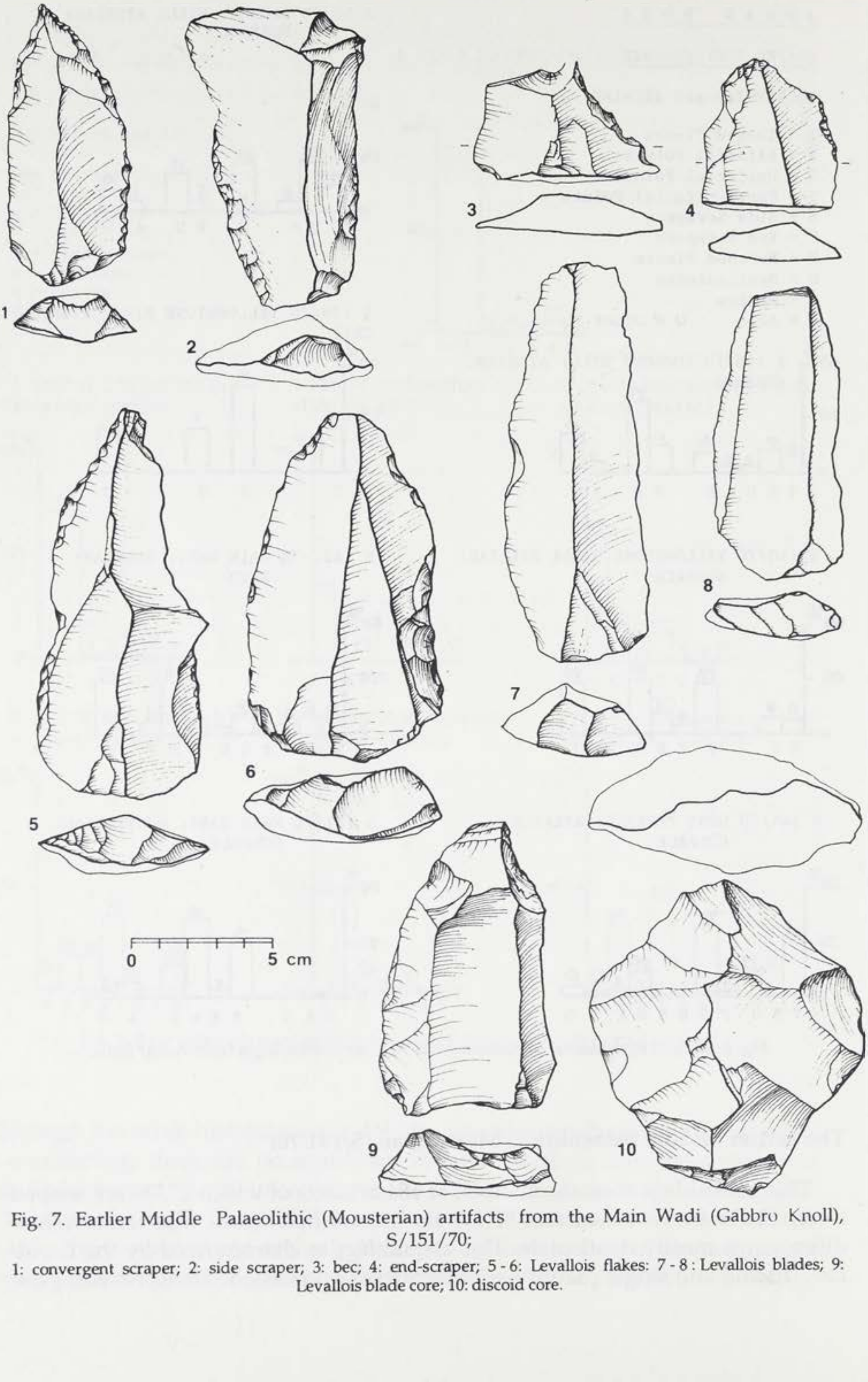

Fig. 7. Earlier Middle Palaeolithic (Mousterian) artifacts from the Main Wadi (Gabbro Knoll), S/151/70;

1: convergent scraper; 2: side scraper; 3: bec; 4: end-scraper; 5 - 6: Levallois flakes: 7 - 8 : Levallois blades; 9: Levallois blade core; 10: discoid core.

2 struck and 4 unstruck Levallois examples, 8 discoid and one single-platform core. The unmodified waste shows the techniques of production for flakes and blades. There are 60 flakes, 14 blades, 15 cores and 19 fragments and chunks. Of the flakes, 35 are Levallois flakes and points, the remainder being from unspecialized cores. Seven of the blades are Levallois and 7 are struck by direct percussion from "unprepared" cores. Characteristic types are illustrated at Fig. 7.

Aterian

Aterian artifact classes are illustrated at Fig. 8 - 11. At Lookout Hill, selected surface collections, a grid, pits and excavation show this to have been a workshop locality as well as a "living site" on the evidence of the amount of debitage present. The excavation also shows that the Aterian occurs throughout the >1.0 m of the yellow-brown sand. The great majority of the artifacts are made of silicified vitric tuff. A circular area cleared of rocks at the top of the hill contained a few Aterian artifacts and might have been a hunter's lookout point. A selection of tanged points and a scraper, leaf-shaped points, flakes and blades from Lookout Hill are shown at Fig. 8: 1 - 10.

Cores from Lookout Hill (Fig. 9) show well the range of techniques used at Adrar Bous namely, radially prepared Levallois cores, Levallois point cores, discoid cores and blade cores with and without Levallois preparation. It is noteworthy that these are all of fairly small dimensions showing that the material (SVT) was worked down as much as possible before being discarded since it had to come from a distance.

The Aterian from Yellowstone Hill repeats the pattern of bifacial and tanged points which, with side-scrapers and denticulate and notched pieces, comprise the majority of shaped tools. However, there are also present several small bifaces of a form that is not common but is not unusual in the Adrar Bous as well as other Aterian assemblages. One might speculate as to whether these may not be blanks for later reduction to points and other tools and so represent the form in which the raw material (SVT) was transported from the source areas. Shaped tools from Yellowstone Hill are illustrated at Fig. 8: 11 - 15.

Aterian artifacts eroding from the Dune Terrace locality (S/144/70) are, in general, of larger dimensions and show well the primary flake and blade forms as well as some of the more refined retouched tools found at Adrar Bous. Pedunculate forms range from tanged Levallois flakes (Fig. 10: 1 - 2) to partibifacial point forms (Fig. 10: 3) and tanged blades (Fig. 10: 4 - 5); these often show scraper-type retouch. Characteristic for Adrar Bous are the large, bifacially flaked and tanged points (Fig. 10: 6 - 7) and another characteristic, though rare, form is the lanceolate, bifacial point that recalls the Lupemban "lanceheads" from Equatoria (Fig. 10: 8 - 9). As at other Adrar Bous localities, however, the commonest bifacial point forms are the leaf-shaped points, either broad or narrow and usually of small dimensions. Fig. 11 illustrates some of the scraper, flake and blade forms. The great majority of these are of silicified vitric tuff. Unifacial, Mousterian-type points (Fig. 11: 1 - 2) are not common. Side-scrapers,

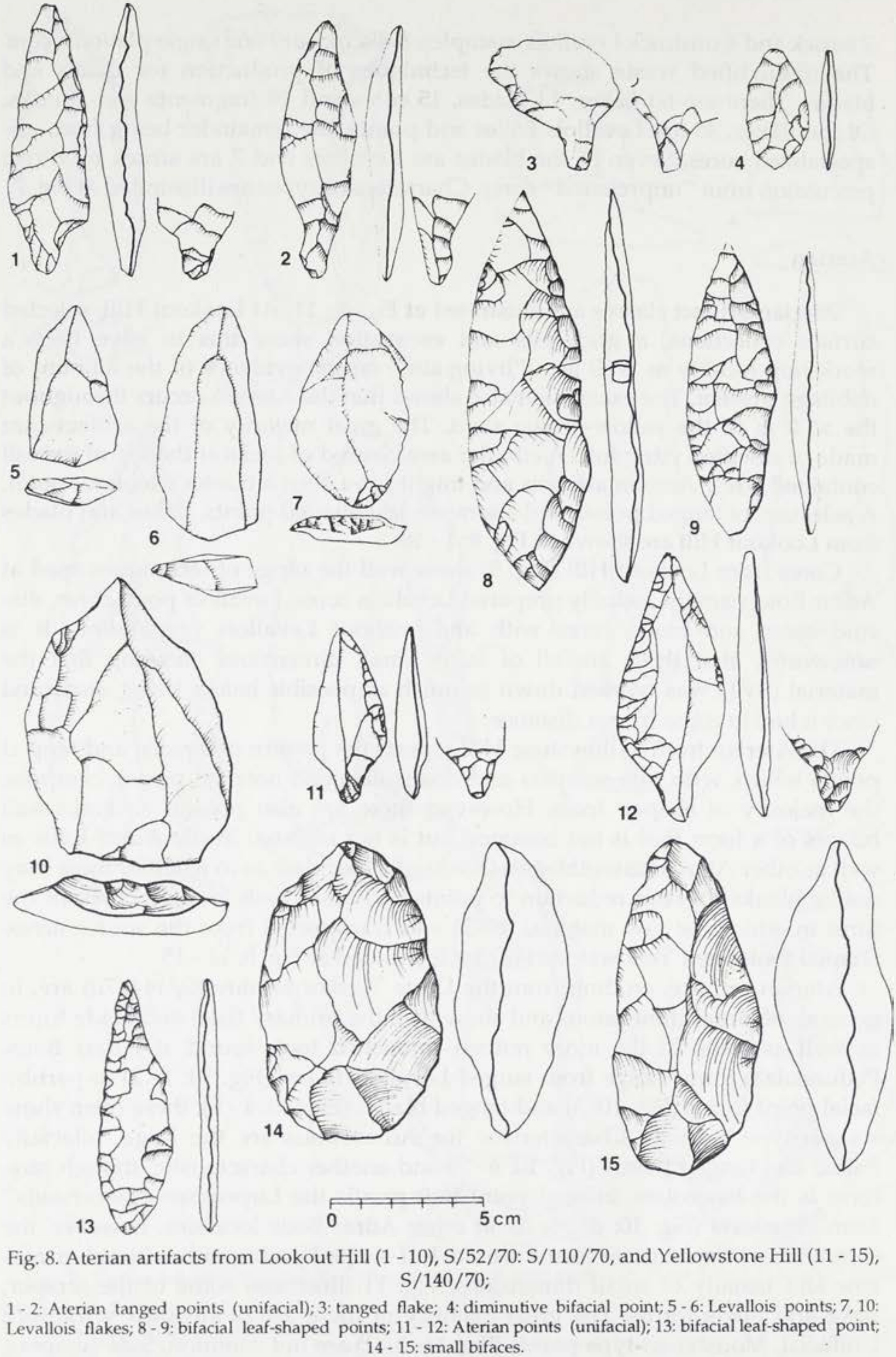

Fig. 8. Aterian artifacts from Lookout Hill (1 - 10), S/52/70: S/110/70, and Yellowstone Hill (11 - 15), S/140/70;

1 - 2: Aterian tanged points (unifacial); 3: tanged flake; 4: diminutive bifacial point; 5 - 6: Levallois points; 7, 10: Levallois flakes; 8 - 9: bifacial leaf-shaped points; 11 - 12: Aterian points (unifacial); 13: bifacial leaf-shaped point; 14 - 15: small bifaces.

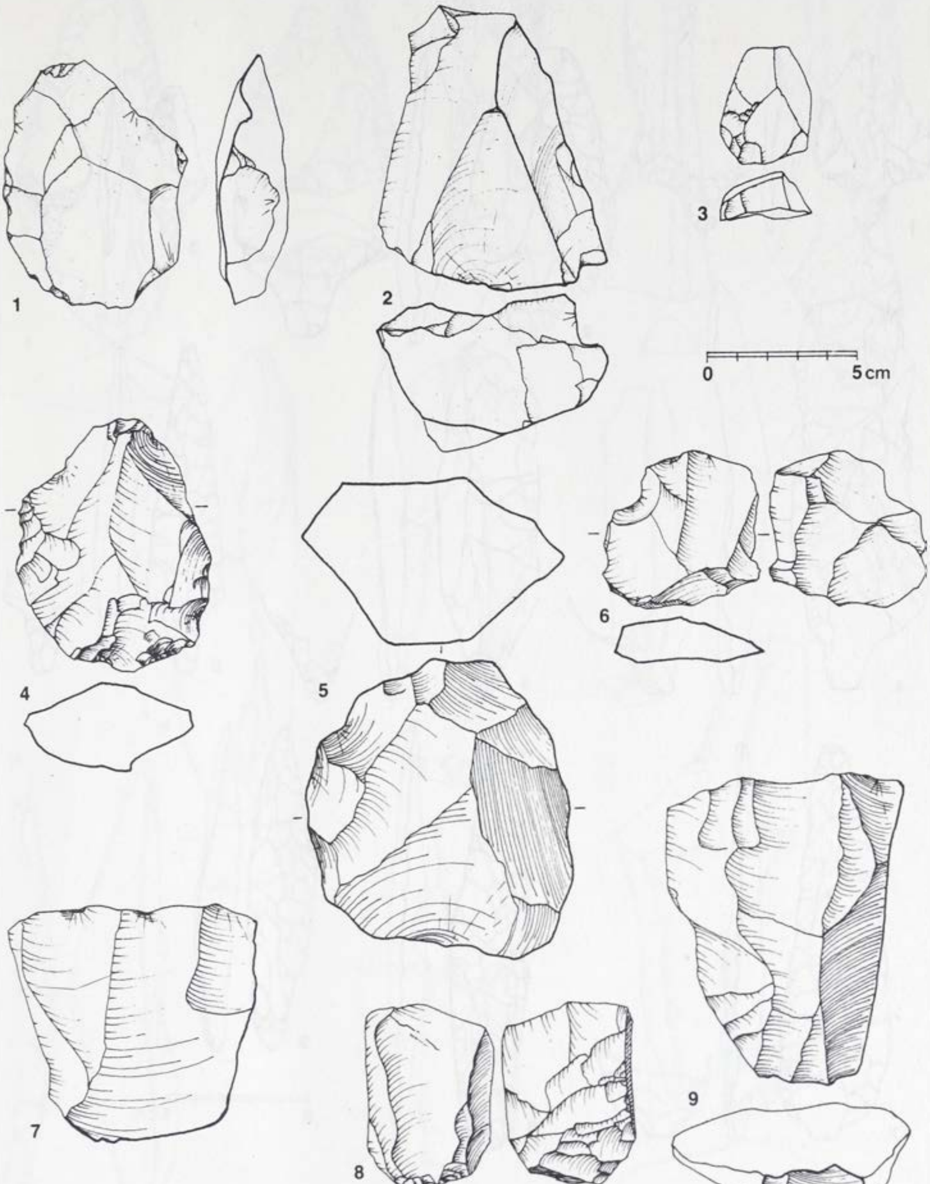

Fig. 9. Aterian cores from Lookout Hill, S/52/70: S/110/70;
1: radially prepared Levallois core; 2 - 3: Levallois point cores; 4 - 6: radially prepared discoid cores; 7 - 9: Levallois blade cores.

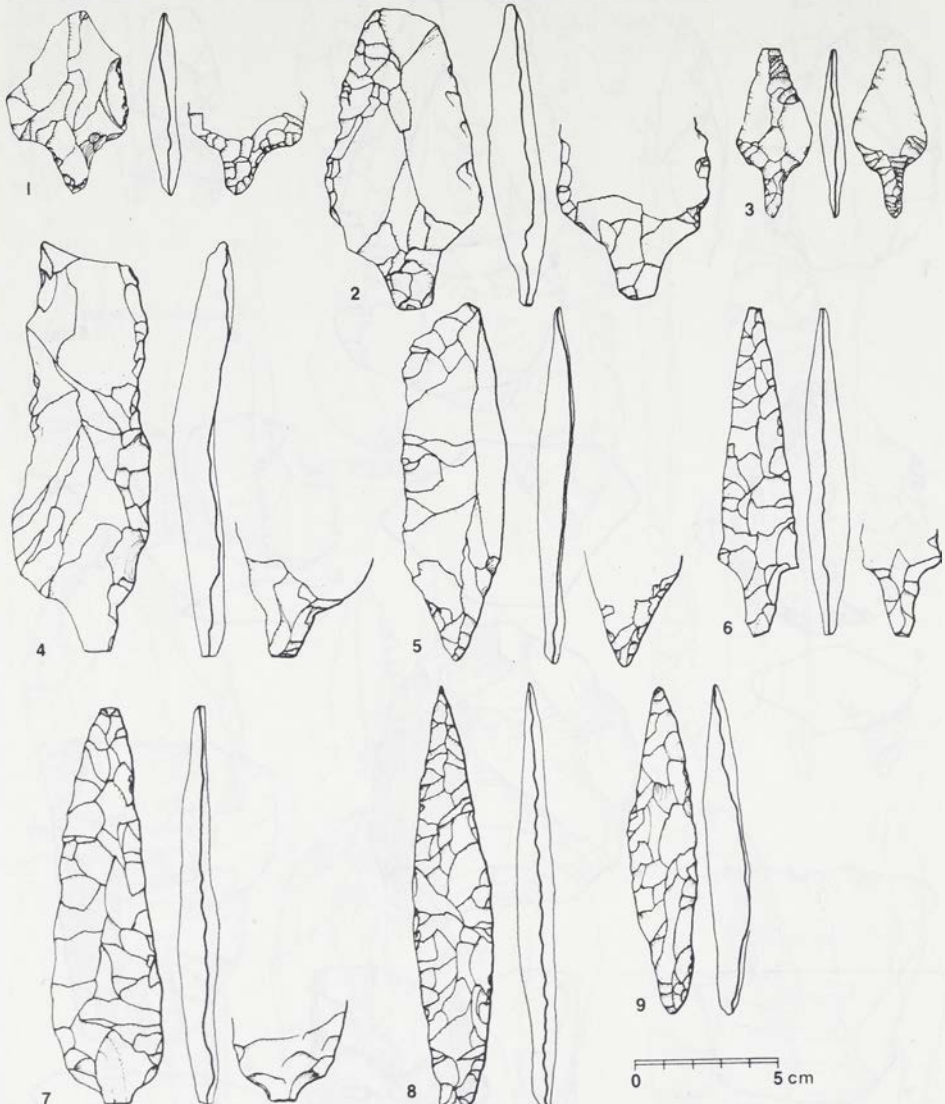

Fig. 10. Aterian artifacts from the Dune Terrace site, S/144/70;

1: unifacial tanged flake; 2: unifacial tanged flake with side-scraper retouch; 3: unifacial tanged point; 4: tanged blade with double side-scraper retouch; 5: shanked or tanged blade with side-scraper retouch; 6 - 7: tanged bifacial points; 8 - 9: bifacial lanceolate points.

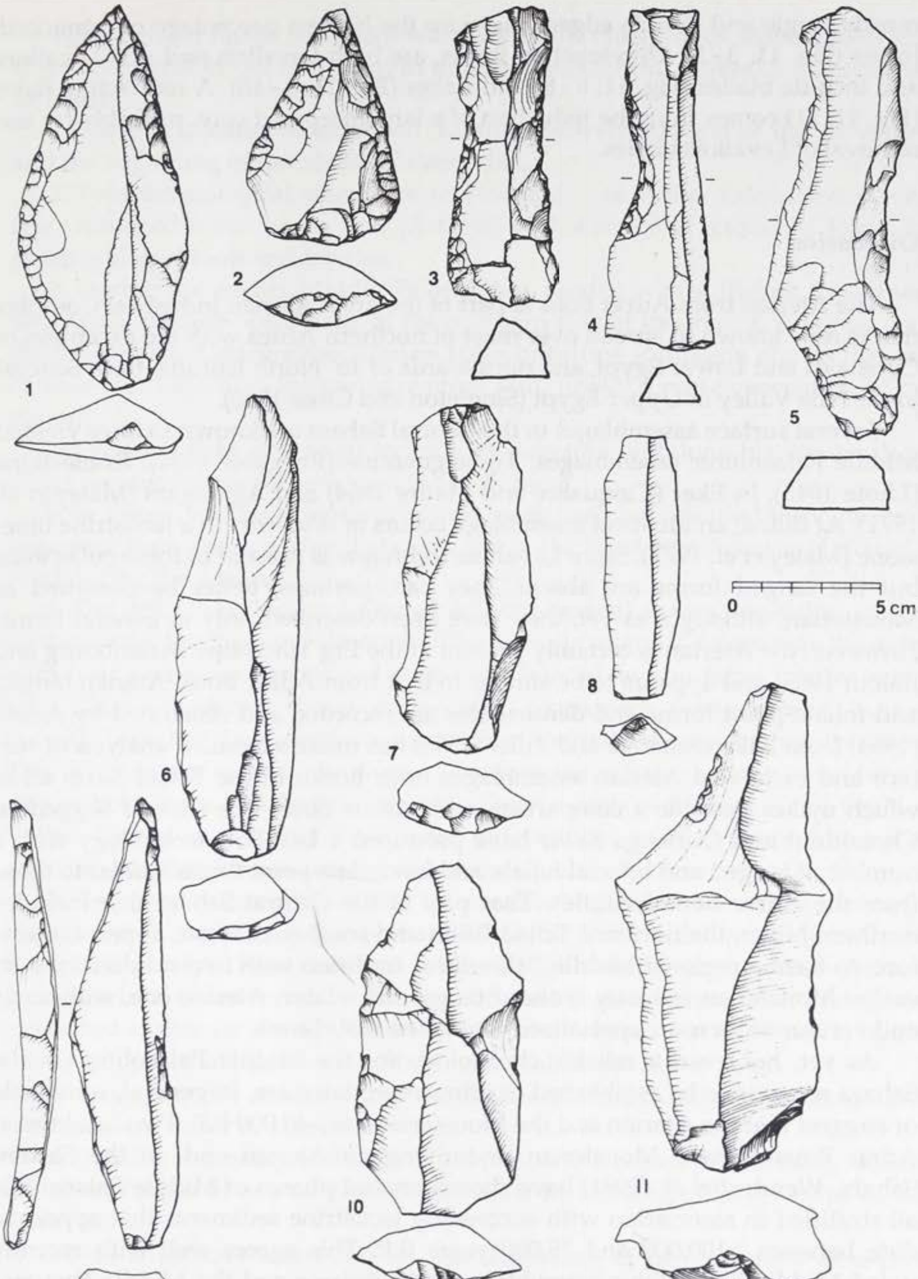

Fig. 11. Aterian artifacts from the Dune Terrace site, S/144/70;
1 - 2: unifacial (Mousterian-type) points; 3 - 5: concave and denticulate scrapers on blades; 6 - 7: Levallois blades; 8: blade from an unprepared core; 9: redirecting flake from a large Levallois blade core; 10 - 11: Levallois flakes.

mostly single and double edged, make up the highest percentage of retouched forms (Fig. 11: 3 - 5). Unretouched forms, are both Levallois and non-Levallois and include blades (Fig. 11: 6 - 8) and flakes (Fig. 11: 9 - 10). A redirecting flake (Fig. 11: 11) comes from the reduction of a large prepared core, probably for the removal of Levallois blades.

Discussion

The Aterian from Adrar Bous is part of the great Aterian Industrial Complex that is now known to spread over most of northern Africa with the exception of Cyrenaica and Lower Egypt, and northwards of 15° North latitude, from Senegal to the Nile Valley in Upper Egypt (Singleton and Close 1980).

Several surface assemblages in the Central Sahara are known to have yielded Middle Palaeolithic assemblages: Tiguelguemine (Reygasse 1934), Esselesikine (Lhote 1943), In-Eker (Cinquabre and Maitre 1964) and Agamgam (Maley *et al.* 1971). At Bilma, an identical assemblage occurs *in situ* beneath a lacustrine limestone (Maley *et al.* 1971). Since Levallois technique is present in these collections but the tanged forms are absent, they can, perhaps, better be classified as Mousterian, although, as yet, they have been described only in general terms. However, the Aterian is certainly present at the Erg Tihodaine (Arambourg and Balout 1955) and appears to be similar to that from Adrar Bous. Aterian tanged and foliate point forms and denticulates are recorded and illustrated by Arkell (1964) from Lake Ounanga and Tillet (1983) has made a detailed analysis of surface and excavated Aterian assemblages from Borku in the Tchad Basin all of which makes possible a comparison with Adrar Bous. The sites of Seggedim, Chemidout and Ounanga Kebir have produced a Levallois technology with a number of tanged and bifacial foliate and lanceolate point forms similar to those from the Adrar Bous localities. That part of the Central Sahara that includes northern Niger, the northern Tchad Basin and southern Tibesti, appears, therefore, to form a regional Middle Palaeolithic tradition with two subdivisions: an earlier Mousterian industry without tangs, and a later, Aterian one, with tangs and various other more specialized retouched tool classes.

As yet, however, a reliable chronology for the Middle Palaeolithic in the Sahara remains to be established. Radiocarbon dates are, in general, unreliable or suggest that the Aterian and the Mousterian are >40,000 B.P. Two localities at Adrar Bous show a Mousterian underlying an Aterian and, in the Eastern Sahara, Wendorf *et al.* (1991) have shown several phases of Middle Palaeolithic all stratified in association with succeeding lacustrine sediments that appear to date between >100,000 and 75,000 years B.P. This agrees well with recently dated Middle Palaeolithic assemblages from Europe and the Middle East and with the Middle Stone Age in southern Africa. It is inferred, therefore, that the Middle Palaeolithic at Adrar Bous covers an equally long period of time during the Last Interglacial and early Last Glacial, in the earlier part of the Later Pleistocene.

Although no fauna is present with any of the Adrar Bous assemblages and there are probably none of them in undisturbed context, several inferences can be made:

1. There is a hiatus of unknown duration between the end of the Acheulian and the beginning of the Middle Palaeolithic;

2. Two technological stages are represented – an earlier (Mousterian) with few retouched forms and a later (Aterian) with a range of retouched forms including tanged tools and foliates;

3. During the earlier Middle Palaeolithic, rainfall was sufficient to support swamps and some open water at the southern side of the massif. Swampy conditions persisted during the Aterian stage but dune formation shows that the climate was becoming increasingly more arid, finally forcing evacuation of the region;

4. Levallois flake and point technology, together with long blades struck by direct percussion are present from the beginning;

5. In the earlier stage, local rocks only were used but silicified vitric tuff was imported from considerable distances and is the most significant raw material used during the Aterian;

6. The Aterian collection (selected and unselected) shows variability in percentages of retouched tool classes but the overall pattern is, in general, the same with heavy emphasis on tanged forms and bifacial and unifacial foliates and a small, but significant Upper Palaeolithic component (end-scrapers, burins, borers). Together these elements constitute a Central Saharan Aterian tradition. This is but one of several traditions or variants in the Sahara at this time, for example those in the Northeastern and the Eastern parts of the desert and the Nile Valley. However, whether these were independent and contemporaneous or were time distinctive remains to be shown;

7. The distance from which the "greenstone" (silicified vitric tuff) had to be brought to Adrar Bous suggests that the Middle Palaeolithic population in the Central Sahara may have consisted of small, highly mobile groups that used different parts of an extensive territory at different seasons of the year. The model suggested earlier for the Epi-Palaeolithic in the Sahara (Clark 1980: 572) might not be inappropriate also for the Middle Palaeolithic of Adrar Bous:

a) during the dry season, camps of dispersed family units are situated close to permanent water in core areas;

b) after the beginning of the rains, the population regrouped forming mobile, transitory camps of two or more family units for hunting of larger game in the desert dunes;

c) near temporary water sources, concentrations of larger groups were possible for communal hunting of migratory game and interaction with other groups;

d) regrouping took place in the early part of the dry season into temporary camps situated by permanent springs and seeps for the hunting of gazelle and Barbary Sheep;

e) during this time, visits to sources of raw materials for stone working, pigment, *etc.*, and further interaction with other groups were possible;

f) as the dry season advanced, the population would again fall back on the permanent water of the core area. Adrar Bous could have been such a core area to which such a model could apply.

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Terminal Palaeolithic industries of Sahara: a discussion of new data

In the recent West African radiocarbon date survey, McIntosh and McIntosh (1986: 420) have stated that the new finds from Temet in Niger: "...directly contradict conclusions drawn by J.D. Clark and A. Smith based on their earlier work in the same area". I would like to discuss these new finds and to place them in context with other work that has been done in North Africa.

Initially the reports by Clark *et al.* (1973) and Smith (1976) were based on work done under the aegis of the British Aïr Mountain Expedition (1970; Hall *et al.* 1971) which had followed the Mission Berliet (Hugot 1962).

Surface collections were made over a large area, mainly around Adrar Bous (20°19'N, 8°57'E), a ring complex outlier of the Aïr Mountains on the edge of the Ténéré, and in Greboun Wadi below Mont Greboun (20°2'N; 8°32'E).

One of the more interesting collections was of a surface scatter on a terrace in Greboun Wadi which yielded an "Upper Palaeolithic" blade and burin assemblage. This comprised blades (notched, backed, truncated) struck from prismatic and double-ended cores, burins, plus a specialized shouldered awl-like tool on a blade commonly referred to as a 'pointe Ounan' (Clark 1971: 456). These Ounanian points amounted to 14.3% of the 84 formal tools in the total collection of 439 pieces of stone, while "geometric microlith forms are not represented" (Clark *et al.* 1973: 270). A similar collection made at the southern end of Adrar Bous at Agorass n'Essoui produced 58 Ounanian points in context which suggested they were discrete from microlithic aggregates of the older diatomites (Clark *et al.* 1973: 270).

Microlithic aggregates on the other hand were found at a number of localities around Adrar Bous (Smith 1976). These microliths, pottery and bone harpoons were in direct association, along with an aquatic fauna of the 710 m lake level at Agorass n'Kiffi which had a *post quem* date of 7,310 ± 120 B.P. (Faure *et al.* 1963) from surface calcium carbonate formation. The highest percentage of formal tools from the three main sites analyzed were from geometric microliths. These ranged from 32% at the Well Area, to 41.3% at Adrar n'Kiffi and 48.3% at Diatomite 1.

From 1978 the Mission ORSTOM, based in Niamey under the direction of J.-P. Roset has visited the north eastern part of the Aïr and done a number of excavations with very exciting results. These included sites previously collected from by myself around Adrar Bous. I had assumed at one of the sites, Diatomite 1, that the collection I made was on a single deflated land surface. Roset (1983) showed I was wrong by cutting a section into the diatomites where he found "les mêmes éléments sous les dépôts lacustres" (Roset 1983: 138) with the addition of charcoal which gave a date of 9,030 ± 190 B.P. (UW-754) and a number of tool types not represented in the collections I made in 1970, namely Ounanian points.

Roset also excavated at another site, Temet (Roset 1983: 129) close to Mont Greboun, therefore not far from our collection locality in Wadi Greboun. This excavation produced similar results to the Diatomite 1 excavations, with an industry *in situ* at the bottom of diatomite beds, and charcoal which gave a date of 9,550 ± 100 B.P. The industry described by Roset includes a macrolithic blade industry and Ounanian points, geometric microliths, truncated blades, backed microliths, projectile points and pottery. In other words in a single site he has the material culture which we had previously suggested was Upper Palaeolithic, ceramic microlithic and Neolithic, all appearing to come from one horizon described as: "la couche aux vestiges préhistoriques". It is unclear from the description how the upper date of 8,565 ± 100 B.P. relates to the cultural material.

The impression given in the description and from the section (Roset 1983: 129) is that the artefacts were found on an old land surface of colluvial sands and gravels. In addition the bifacially flaked projectile points are said to come from test trenches excavated to the north and east of the main cutting, and some in the collection came from the surface. Roset states that there is some risk of mixing of different materials, but seems to reject this on the basis of the raw materials which are similar in all the sites. No pottery was found, but a potter's 'comb' for decorating sherds was retrieved. This is suggested as being used for an "impression pivotante".

I would suggest that the relationship between all the various artefacts is much more complex than has been stated by the author. While the possibility must still remain that the macro-blade industry which produced the Ounanian points also made geometric microliths, we have to consider the evidence from the Greboun Wadi site, not very far away from the Temet site, that no geometric microliths were found.

That a macro-blade industry precedes geometric microlithic forms is documented at several sites in North Africa. At Taforalt (Roche 1963) geometric microliths are very rare. The lowest level X has no geometrics and they remain at very low levels throughout the sequence which lasts until 11,000 B.P. Similarly at the Haua Fteah the Eastern Oranian of McBurney (1967), levels XVI - XI, has no geometrics, although backed blades are common. In contrast in the succeeding Libyco-Capsian (levels X - IX) we see the first appearance of geometric microliths. The dynamic of stylistic changes in stone tool frequencies can be seen in McBurney (1967: Fig. VIII: 2) with a decrease in large artefacts to microlithic ones over the period 10,000 to 7,000 B.P.

The dating sequence at Haua Fteah is only approximate, but the radiocarbon dates indicate the Eastern Oranian begins around 14,000 B.P., and the Libyco-Caspian around 10,000 B.P. (McBurney 1967: 193, 123). Thus the beginnings of microlithization at the Haua Fteah is roughly coeval with the dates for microlithic tools from both Temet and Adrar Bous, Diatomite 1.

Thus from these dated sequences we get a reasonable indication of the evolution of tool types from a macro-blade to a geometric microlithic industry over the period 12,000 to 9,000 B.P. Even in assemblages with geometric microliths throughout the sequence these evolutionary trends continue; at Ain Misteheyia Lubell *et al.* (1983) found that the geometrics from the upper level (7,700 - 7,300 B.P.) were three times more frequent than the lower level (9,800 - 7,700 B.P.). This then brings into question the relationship of the Ounanian macro-blade industry seen in Wadi Greboun and the microlithic industries from our collections at Adrar Bous including the surface deposits at Diatomite 1, where the macro-blade component is absent. Roset's suggestion that the Ounanian points and geometric microliths are from the same industry evokes a question on the technology and use of the various tool types. The Ounanian points are made on macro-blades, which can also be the basis of the geometrics. However, geometric fabrication usually comes from a micro-burin technology, as seen in our collections from Adrar Bous (Smith 1976: 196). No micro-burins were included in the macro-blade collections either from Greboun Wadi or Agorass n'essoui (Clark 1976: 77 - 78). If Tixier (1963) and Raimbault (1983) are correct in assuming that the Ounanian point was most probably a hafted tool, rather than an awl, then we would like to know why these should be chosen rather than the geometrics; I would argue that these and the bifacially flaked 'Tenerian' projectile points, are functional equivalents of each other.

The excavations by Roset at Temet have revealed an old erosion land surface on the edge of a depression that at several times in the past was filled with fresh water to form a lake. After 9,500 B.P. this lake must have reached great depth to permit six meters of diatomite deposit to accumulate. This date is consistent with known expansion of many lakes in the southern Sahara: Lake Chad (Servant and Servant 1970; Servant and Servant-Vildary 1980); Mauretanian Adrar (Trompette and Manguin 1972); Taoudenni (Riser *et al.* 1983), *etc.* What we must recognize is that this locality was attractive for human occupation for some considerable period during the Terminal Pleistocene and Early Holocene. Smaller lakes or temporary standing pools would have filled the depression in the period prior to 9,500 B.P. and it is on the edge of these small lakes that the makers of the Ounanian points and 'ceramic microlithic' material would have camped. The fact that the cultural material lies on a land surface of colluvial sands and gravels indicates this is a catchment area with considerable run-off in the past, with the cultural material deposited during a drier episode, since the tools are on the surface and not intermixed with the colluvium.

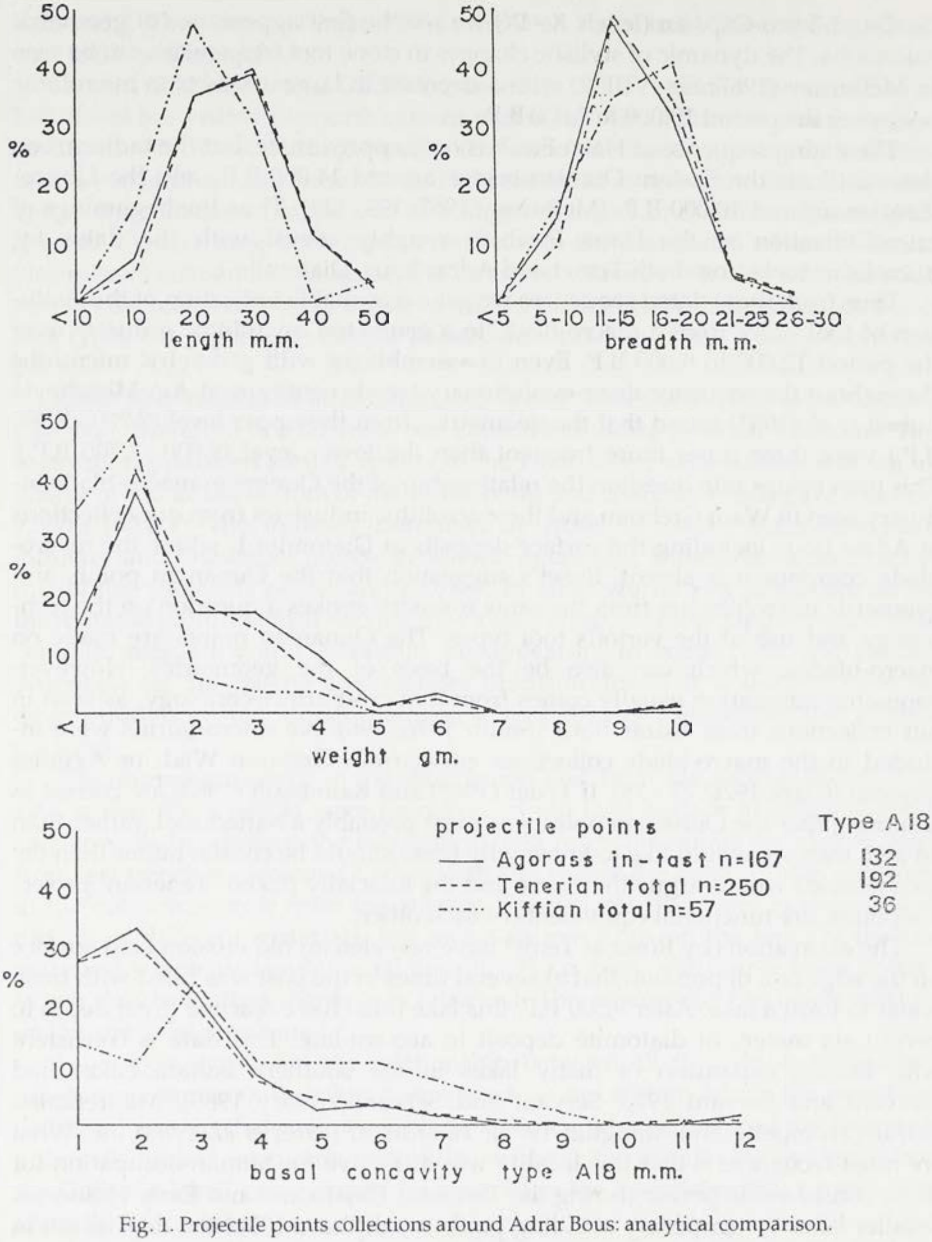

Fig. 1. Projectile points collections around Adrar Bous: analytical comparison.

I would further argue that the period of colluvial deposition would have been a result of what Rognon (1976) calls a transitional period of large seasonal oscillations between 14,000 and 11,000 B.P. Conditions stabilized somewhat after 12,000 B.P. and more surface water was to be found in this region, which would have made it attractive to the macro-blade makers in the Temet basin. A drying episode followed around 10,000 B.P. (Servant and Servant-Vildary 1980) in which erosion and deflation could have occurred over the next 1000 years. This drier episode would be a period of degradation and would permit deflation to take place allowing a mixture of the two industries, as is probably the case around the Taoudenni Lakes at Foum-el-Alba described by Raimbault (1983) where pottery is also found and a date of 7,450 ± 130 B.P. was achieved from shell associated with Ounanian points at MK 36. Following this dry period there was a massive increase in surface water between 9,000 and 7,500 B.P. which probably deposited the thick diatomite beds at Temet and Diatomite 1, Adrar Bous. The locality at Greboun Wadi where we made our macro-blade collections is today a terrace on the edge of the wadi, indicating deposition and deflation prior to a period of massive run-off, which caused erosion and terrace formation.

An additional clue to the complexity of the stratigraphy lies in the associated bifacial projectile points. These forms, well-documented in Hugot (1957) and from my own work at Adrar Bous (Smith 1980), are from industries with domestic stock. All the types illustrated by Roset (1983: 133) were found among the collections in Agorass in-tast, Adrar Bous.

An analytical comparison was made on projectile points from collections around Adrar Bous. Fig. 1 compares samples from the presumed Neolithic sites in Agorass in-tast with those for the Adrar Bous Neolithic ('Tenerian') sample as a whole. These, in turn, are compared with the points associated with the microlithic tools around Adrar Bous. It can be seen that the Agorass in-tast and Tenerian samples are virtually identical. There is some difference between the Tenerian and ceramic microlithic ('Kiffian') sample, but this is marginal, and could be ascribed to the low numbers of points in the 'Kiffian' collection. Only one crescent was found in a stone-tool assemblage of 1432 formal tools from 18 surface sites around Adrar Bous. This indicates that the Tenerian, as the food producing industry of Adrar Bous has been named, does not include geometric microliths, and strongly suggests that the projectile points from Temet are intrusive, as are, most probably, those I described from Diatomite 1 (Smith 1976). Another key to this is the suggestion that the decorative motif "impression pivotante" is to be found with the 'ceramic-microlithic' industry at Temet. Both my work (Smith 1980) and that of Arkell (1953: Plate 32) has shown that this decoration is associated with food production, and is quite different from the earlier wavy-line and dotted-wavy line ware of the 'ceramic-microlithic' (Arkell 1949: Plate 72, *etc.*). The wide range of projectile points and the rocker-stamped pottery are part of the Tenerian industry.

In conclusion, while my arguments for the appearance of Ounanian points in association with geometric microliths suggesting some mixing of two industries may not be conclusive, the appearance of "Neolithic" projectile points and pottery-decoration tools support this contention. The evidence from excavated sequences elsewhere in North Africa would argue against the mixing of macro-blade industries and geometric microlithic industries. Although there may well be transitional industries the large numbers of both Ounanian points and microliths would argue against the Temet assemblage being homogeneous. The evidence from Wadi Greboun shows that at least at this location there was no mixture.

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New approaches to Saharan rock art of the Bovidian Period

The Sahara is one of the world's great parietal art areas, and may be much more complex than the rock art of Southern Africa, Australia and Europe. The ethnographic commentary available for the southern hemisphere paintings has produced some marvellous insights into aboriginal cosmology and symbolism (Lewis-Williams 1981a; 1981b; 1983; Vinnicombe 1976). What is most striking is that the art has such deep meaning for the artists and the communities they served.

The complexity of Saharan rock art is compounded by the probability that it was not a single rock art genre by one society. The range of styles and content suggests very strongly that there were a number of societies who lived at different times and in different parts of the Sahara and who produced their own art forms. Thus trying to interpret what was being said in Saharan rock art is made difficult both by a lack of chronology of the paintings, and identity of the gross cultural groups who were the artists. We are fortunate in having the Cologne Museum catalogue for their Saharan exhibit (Kuper 1978), hereafter referred to as 'K', where many of the fine reproductions of Columbel from the Mission Lhote to the Tassili n'Ajjer are included. Also with this important collection are photographs by Lajoux, many of which had already been published (Lajoux 1963; 1977) and which will hereafter be referred to as 'La' (Mori 1965). Other published sources include Lhote's (1959) and his update (Lhote 1976).

We are faced with a restricted number of published reproductions that can be used, and while we must recognize that these constitute only a minute fraction of the paintings which exist in the Sahara, we can accept nonetheless that these are ones which are the most spectacular. The sample chosen here is that of the naturalistic rock paintings of Lhote's "bovidien" period from the Central Sahara (Tassili n'Ajjer, Acacus). A survey of the published rock art of this 'bovidian period' shows that there are at least two major painting styles, each with different content, although the viewer is left in no doubt that we are seeing pastoral societies, for the common subject is domestic cattle.

Style 1 can be called the "white-face" style. Here the people are drawn with pale skins, long hair, beards on the men and long dresses on the women: K: 234, 418 - 21, 424 - 31 (Fig. 1). Face paint can be seen on some of the individuals, and some of the men are either tatooed or have body paint. These paintings are also the scenes with the circular huts shown from the outside. It is also in this style

Fig. 1. Tassili n'Ajjer. The "white face" style.

that small stock play a prominent role. All the animals are somewhat stylized, and coat markings, while varied, are generalized (K: 420 - 1, 424 - 5). Some of the cattle have a curious wavy-line coat colour. This pattern is repeated in a scene in which some important ceremony or event is recorded (K: 426 - 7 – Fig. 2) the symbolism of which is obscure, but may represent fire-workshippers' (Monès 1988: 229). The ceramics being used appear to be double pots, *i.e.* large ones with saw-tooth and impressed decoration whose rim is enclosed by a smaller, undecorated pot upside down and acting as a lid. Leather bags are shown (K: 418 - 20) with looped decoration.

Even the humans of this "white-face" style can be subdivided, possibly, into three separate but similar social groups on the basis of hair style and clothing. Also the artistic form shows the artists to be aesthetically concerned with a degree of symmetry which can be seen in the repeated motif of cattle horns (K: 417) and animals lined up together (K: 418 - 19, 425 - 5). Even wild animals in one panel show an intermingling of giraffe necks which underline the graceful movement of these animals (K: 418 - 9). Another aspect of this genre is the tendency to allow the animals to focus an human activities (K: 424 - 5, 430 - 1), thus ordering the spatial layout of the scenes.

The recognizable activities in this style are: a lion hunt (K: 430 - 1), movement of camps (K: 418 - 9, 428) and re-erection of huts (K: 418 - 9, 431), possible

Fig. 2. Uan Derbauen, Tassili n'Ajjer. The "white face" style.

tribute to leaders or holy men (K: 424 - 5, 430) and ritual ceremonies (K: 430), as well as a broad range of pastoral activities, *e.g.* tying up the animals (K: 428 - 29) and watering of stock (K: 418).

The second style can be called "black-face" style which is somewhat different in form and content from the previous one. Here the cattle are still the dominant element, but the humans all have dark skin (K: 422 - 3, 427; La: 116 - 132). A range of hair style can be identified (K: 232), and white body paint is occasionally found. The scenes with huts, as noted above, are of plan form and a distinct type is repeated in a number of cases: an oval shape with a door which closes on the inside (La: 120 - 1, 123, 130 - 1; K: 299) and occasionally pots and other domestic accoutrements can be seen (K: 229; La: 123). In this style the cattle are often portrayed very realistically, with great attention paid to coat colours (La: 107, 119 - 21; K: 228). The detail of human faces, always in profile, show strong black African facial characteristics (La: 116, 126, 147 - 8, 170), but even here there are variations, not only in facial structure (*e.g.* La: 119) but in hair design or head covering (K: 232, La: 119, 125 - 7, 140, 142, 144 - 5, 149 - 50, etc.). In this "black-face" style we see even greater variability in the cultural details, suggesting many more social groups than in the "white-face" style.

Social activities which can be recognized are: riding scenes (La: 160 - 1), domestic camp scenes (La: 120 - 1, 130 - 1; K: 427), scenes of general pastoral activity (La: 119; K: 229, 422 - 3; Hampaté Ba and Dieterlen 1966: Plate VIII: D). Other activities are more obscure and are probably of a ritualistic nature, to be discussed below (*e.g.* K: 422-3; Hampaté Ba and Dieterlen 1961: Plates A and B; Lhote 1966: Plates I and IV).

The geographical overlap between these two major styles of 'bovidian' art indicate a broad usage of the Central Sahara by various herding groups during the period between 6,500 and 4,000 B.P. (Smith 1980). The early dating of this art in the Acacus Mountains is confirmed by Mori (1965) who managed to refit a piece of broken panel found in the deposit below the painting at Uan Muhuggiag. He obtained terminus *post quem* date of 4,730 ± 310 B.P.

Who were the pastoralists of the Central Sahara?

The paintings of the 'bovidian' period indicate two quite distinct cultural groups, that might be equated with different physical types. We can make some general comments about the human populations of the Sahara *ca.* 8,500 - 4,000 B.P., the period with two successive lacustrine events in the Central Sahara which ameliorated conditions and permitted human occupation. It would seem that an older, robust African population existed at the earlier part of the period in the lake regions of Hassi-el-Abiod, Tamaya Mellet and Lake Chad. The stone tool industry from the area north of Timbuctou is called "Néolithique ancien" (Raimbault 1983: 339) and dated to 8,450 ± 60 and 6,970 ± 130 B.P. (Dutour and Petit-Maire 1983: 278 - 9). From the typology of the microlithic stone tools I would associate this occupation with the pre-pastoral phases of Adrar Bous (Smith 1976) and Tagalagal (Roset 1982), all sites producing pottery. In the later pastoral period we have two quite distinct populations: (1) 'negroid' typified by the Asselar skeleton and (2) a 'proto-mediterranean' seen in the Ine-Sakane, Tagnout-Chaggeret, Karkarichinkat, *etc.* skeletons. Since the Tilemsi Valley had both 'negroid' and 'proto-mediterranean' populations we might suggest different social groups occupied the Central Sahara with their livestock during the period 6,000 - 4,500 B.P., and that the Tilemsi was the southern waterway from the Sahara, important for all the pastoral people of the Sahara moving southward when desiccation increased *ca.* 4,000 B.P. (Smith 1979).

Saharan rock painting and ethnographic commentary

Hodder has suggested that material culture can be 'read' in the assumption that "there are some very simple rules underlying all languages... underlying the ways in which *Homo sapiens* at all times and in all places gives meaning to things" (Hodder 1986: 123). This has been more explicitly stated for rock art by Davis (1984). Thus if the rules are understood the visual image can be a narrative which can be read by those who recognize the symbols. So compressed is the image that it can be a metaphor for a wide range of layered meanings, and these symbols can, in turn, play a part in the structuring of society. Interpretation of cultural material can only be achieved by identifying the meaning content through abstraction of the symbolic functions (Hodder 1986: 121).

Hampaté Ba and Dieterlen (1966: 143) suggest there are two primary objectives for initiation: (1) as an archive for myths and their conservation for initiation, (2) for ritual ends in themselves, as part of ceremonies or sacrifices. A third objective we can postulate is that the paintings are a metaphor for a religious or mystical experience, and while they also achieve objective (1), and may be involved in (2), are directly related to the painter's experience. At its most basic level of abstraction material culture can be simply the list of objects excavated from an archaeological site. In the case of the prehistoric Saharan pastoralists this included stone tools, ceramics and some items of pastoral adornment, such as beads and bracelets. At a higher level of abstraction we can refer to the seminal work of Lewis-Williams (1981a) where reading of the ethnographic record has offered new insights into the meaning of southern African rock art.

Metaphor and the trance hypothesis

Among the San of the Kalahari there is a belief in the successful intervention by people against disease and social ills. Individuals are capable of "pulling sickness" by being trained to control *Kia*, or trance, which generates *num*, or spiritual energy (Katz 1982). While in trance the healer enters a state of altered consciousness where he or she is capable of "out-of-body travel", sometimes changing into an animal form. Lewis-Williams (1981b) has been able to show that many of the images in Southern African rock art are metaphors for the trance state, and the symbols represent depiction of healers in the state of altered consciousness. The images are not all naturalistic and some become transformed into fantastic creatures.

Work on changes in consciousness has focussed on the universal experience of hallucinations. Some of these may be drug-induced, others attained by ritual dancing and music, meditation or sensory deprivation for periods of time. Regardless of how this is achieved, during the early stage of hallucination there appears to be a common response in the human mind where the individual sees a limited number of forms. These "form constants", or "entoptics" (Siegel and Jarvik 1975), comprise moving geometric shapes, curves, lattices, tunnels, spirals, *etc.* of intense colours. With prolonged hallucination resulting from increase drug dosage or intensified dancing, the person will enter a second stage of imagery of a much more complex nature. This can include naturalistic or recognizable images, such as faces, people, landscapes, animals, *etc.* (Siegel and Jarvik 1975; Tauber and Green 1959; Ludwig 1968).

Turning to the Saharan paintings to see if any of the universal forms that humans experience have been depicted, we find tectiforms, similar to those from Zimbabwe (Summers 1959), have been recorded from the Central Sahara (Lhote 1959: Fig. 46; 1966: Plate IV: 11, 12; Striedter 1984: Fig. 130 - 3). In the trance experience figures become disembodied and without legs, as well as become repeated in long lines. This was described by one informant during a controlled experiment on hallucinogenics who saw "a progression of squirrels with sacks over their shoulders... marching across a snowfield" (Tauber and Green 1959: 101).

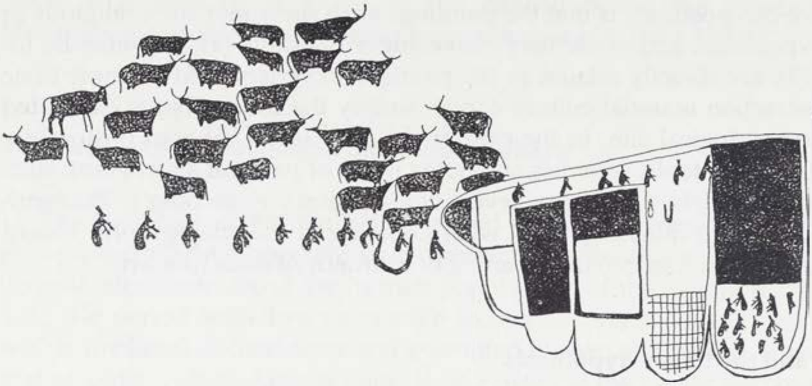

Fig. 3. Ti-n-Tazarift, Tassili n'Ajjer. An example of tectiforms.

Other form constants are the zigzag lines described by Maggs and Sealy (1983) from South Africa. Published examples from the Sahara can be found in Lajoux (1977: 152) from Tahilahi (Fig. 4); although these cannot be directly associated with any particular period, other paintings in the area are of the "white face" style (K: 266, 312). The elongated human figures common in trance imagery in Southern Africa are also to be found in the Sahara (Lhote 1959: Plate 25). Although these are just mentioned here to strengthen the idea of the possibility of trance possession playing a role in the creation of Saharan rock art, we find in the ethnographic record that spirit possession exists among the nomadic Fulani of the Sahel, induced by a string instrument and drums. Among devotees possession becomes hysterical frenzy and the spirit is said to 'escape' by sneeezing (St. Croix 1945: 56 - 57).

Islamicisation of the Fulani varies considerably from area to area and among the pastoral Fulani still exists a core of spirit beliefs which pre-date the spread of Islam. Spirits, for instance, live in baobab and tamarind trees (St. Croix 1945: 54). The baobab has a divinatory character and the tamarind, a symbol of life and resurrection, is used in medical practise (Hampaté Ba and Dieterlen 1961: 34). This close attachment to the world of spirits can be seen in the words of Fulani poet who says: "mes vaches... leur parc est maison de Djinns" (Sow 1966: 311). Traditional initiation of Fulani men into the world of spirit is a long and detailed

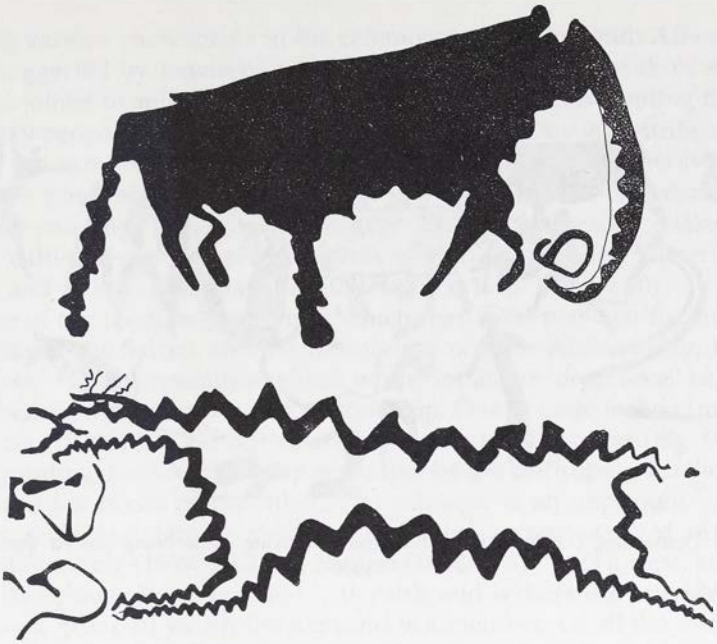

Fig. 4. Tahilahi, Tassili n'Ajjer. Scene with painted zigzag lines.

process of 33 successive levels. The initiate has to prepare himself for this by fulfilling certain obligations between the ages of 14 to 21, so patience and perseverance are qualities which are closely monitored. An important part of this training is learning the therapeutic properties of plants of benefit for humans and the herds. Divination plays a significant role in the lives of the Fulani, and even acceptance of a novice for initiation is dependent upon how a selected herd displaces itself around the *kraal* once it is returned by the postulant. The different levels of initiation raise the consciousness of the initiate and his ability to intervene in the spirit world. "Le postulant doit pénétrer successivement dans douze 'clairières' qui symbolisent, sur un premier plan, l'année et ses douze mois, sur un autre plan, son déplacement sur un terrain ou il rencontre, en passant d'une clairière à l'autre, les personnalités mythiques qui doivent l'enseigner" (Hampaté Ba and Dieterlen 1961: 29). The initiate also comes into contact with wild animals which are symbols of the forces they must deal with, as well as the main vegetation types important to a pastoralist. The initiate thus passes from the disorganized world of men (the camp of his family), to the ordered world of God – the world of the herdsman (Hampaté Ba and Dieterlen 1961: 30).

Ritual behavior similar to that of the modern Fulani has been suggested from paintings recorded in the Tassiii. One specific painting of cattle being passed through a brush 'gate' (Lhote 1966: Plate 1: 2 – Fig. 5) is interpreted by Hampaté Ba and Dieterlen (1961: 1966) as a part of the *lotori* ceremony of the Fulani. Many of the motifs are reminiscent of San imagery, particularly the lines

Fig. 5. Uan Derbaouen, Tassili n'Ajjer. Ritual scene showing cattle being passed through a brush "gate".

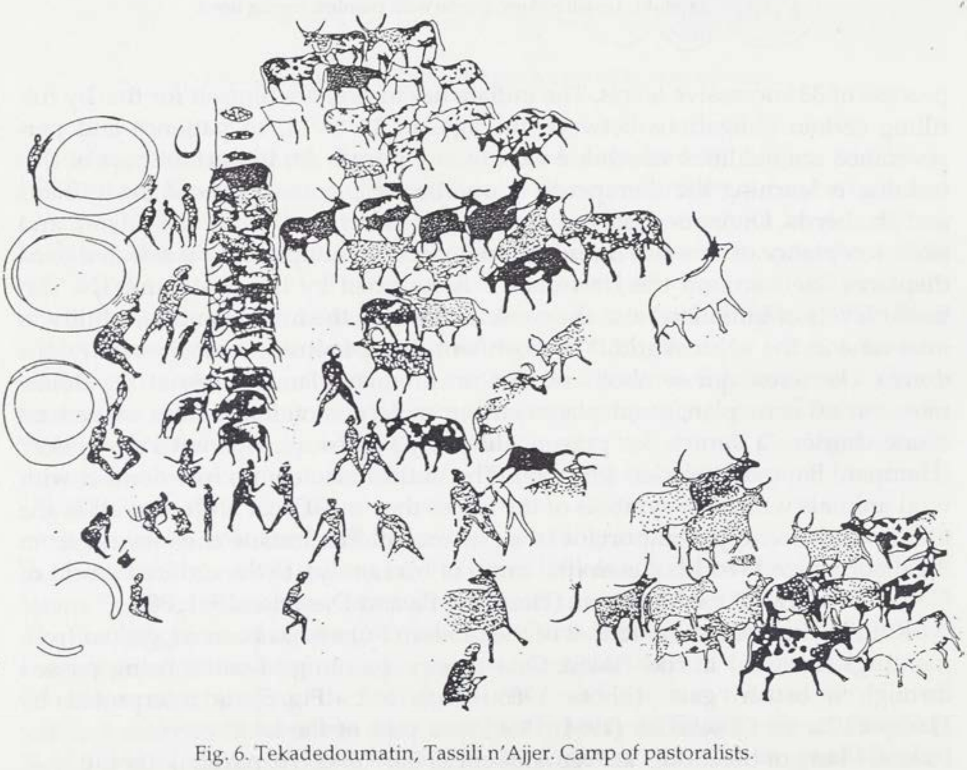

Fig. 6. Tekadedoumatin, Tassili n'Ajjer. Camp of pastoralists.

connecting various participants in the ceremony, which in South African paintings are suggested by Lewis-Williams (1981b: 12) as trance symbols depicting "trancers... joined to animal metaphors by the red lines" transcending the world of "ordinary people" to be able to heal. The *lotori* ceremony is a purification rite, and from the symbolism depicted, and in the past may have involved trance situations or possession states resulting in the imagery seen on Saharan rocks. Many other paintings evoke trance imagery, *e.g.* the two-headed snakes (Lhote 1966: 20), cattle (Lhote 1966: Plate 1: 5; 3: 9; Hampaté Ba and Dieterlen 1961: Plate 9: F) and giraffes (Hampaté Ba and Dieterlen 1961: Plate 4: 10).

In spite of the tenuous connection which may exist between the depictions on the rocks of the Sahara and the pastoralists of West Africa today, there are still a number of other parallels which, while not at the 'deep level' of magico-religious beliefs, indicate a possible relationship. One of these is the camp layout which Lhote (1976: Plate 41) reproduced from Station Tissourar (Fig. 6). In this splendid painting one sees the camp separated by the calf-rope, with the huts on one side and the herds on the other. The calf-rope is an important symbol in separating male and female elements in Fulani society, as laid out in the sketches of Stenning (1959: 106) and Dupire (1962: 158). "It is a rope, and therefore is made by men; it is connected with cattle and is therefore provided by the cattle-owning group of which the husband is a member. Of all the many kinds of rope used by Pastoral Fulani it is the only one made of cowhide" (Stenning 1959: 123).

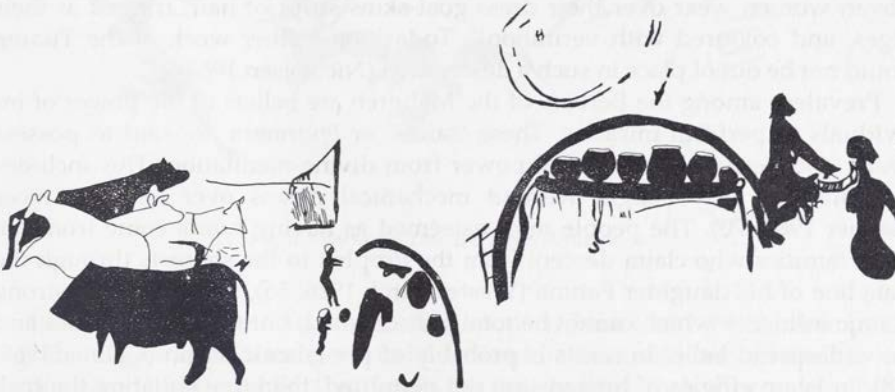

Fig. 7. Tissoukai, Tassili n'Ajjer. Camp scene with females and cattle.

Another symbol, this time of female activities and the marriage, is that of the *kaakul* or the calabashes a woman is given at marriage, which are displayed on a raised bench when setting up camp, or in the back of the shelter once the camp has been set up (Dupire 1962: 158). A similar display is to be seen in the painting from Tissoukai in the Tassili (Kuper 1978: 426 - 7 – Fig. 7), where the cattle once again are on one side and the female figurines on the other.

Pastoralists in North Africa

If the 'black-face' people can be equated with black African herdsmen, like the Fulani, who were the 'white-face' people in the rock paintings? The skeletal data above suggest these may have been 'proto-mediterraneans' and one must look to the history and ethnography of North Africa to find analogues. Some of these paintings indicate that not only was the skin fair, but also, apparently, the hair (*e.g.* Kuper 1978: 440 - 2). In his study of the people of the Rif, Coon (1931: 22) refers to stories of the Mashausha as a tribe of westerners and 'blonds' (see also Bates 1914: 39 - 40). References to "long-haired-people" come from Herodotus (Book IV). These "Libyan" people varied culturally, although all had domestic stock; some groups migrated seasonally from the coastal strip to the hinterland with their animals. They could be distinguished from each other, among other things, by the way they cut or fixed their hair. Libyan men wore a cloak of leather, often highly decorated. Tatooing of the skin was also practised by men (Bates 1914: frontispiece and Plate III), as seen in the Saharan paintings (K: 426, 430). There is a suggestion that this was only to be found among the noble castes or people with power. Not all the humans in the Saharan paintings have body markings and those which do seem to be playing a central role in the activities depicted (*e.g.* K: 426, 430). The dress of the Libyan women would be similar to that seen in the Tassili paintings from Iheren (K: 418 - 9, 424 - 5, 429, 430 - 1), Uan Derbaouen (K: 427) and Uan Amil in the Acacus (K: 234 - 5) described by Herodotus (IV: 189) as being of leather with leather thongs: "The Libyan women wear over their dress goat-skins stript of hair, fringed at their edges, and coloured with vermilion". Today the leather work of the Tuareg would not be out of place in such a description (Nicolaisen 1963).

Prevalent among the Berbers of the Mahgreb are beliefs in the power of individuals to perform miracles. These 'saints' or *Igurramen* are said to possess *baraka*, and derive their mystical power from divine meditation. This includes the ability of direct flight without mechanical means over long distances (Gellner 1969: 70). The people most esteemed as having *baraka* come from the noble families who claim descent from the Prophet to the shereefs through the male line of his daughter Fatima (Westermarck 1926: 36), thus there is a strong Islamic influence which cannot be totally discounted, but the idea of *baraka* and the widespread belief in saints is probably of pre-Islamic origin (Gellner 1969: 378). In Islam effigies of humans are not permitted, therefore equating the rock art of the Sahara with pre-Islamic Berber beliefs can have no modern analogues. The idea of shrines of holy men is almost certainly an Islamic manifestation. Jinn (djinn) or evil spirits can possess a person; this results in disease or convulsions (Gellner 1969: 271, 276). The difference between this spirit possession and that found in black Africa is that the person does not act out the part of the Jinn. In other words, among the Berbers there is assumed to be a casual relationship between sickness and evil spirits, but not the spirit "taking over" the individual. In this case we would not expect to find the universal form constants of hallucinogenatory nature among the Berbers.

The Saharan rock art of the 'white-face' style is certainly much more narrative that that of the 'black-face' style, even when describing important mystical experience (K: 426 - 7). Other panels, while not explicit, suggest preparation for sacrifice, such as at naming ceremonies (K: 430), or tribute to important people (K: 424, 430).

Summary and conclusions

The complexity of even this one genre of paintings of the 'bovidian' period in the Saharan rock art must be obvious by now. This naturalistic art has been divided into two separate styles on the basis of perceived racial distinctions in the humans depicted.

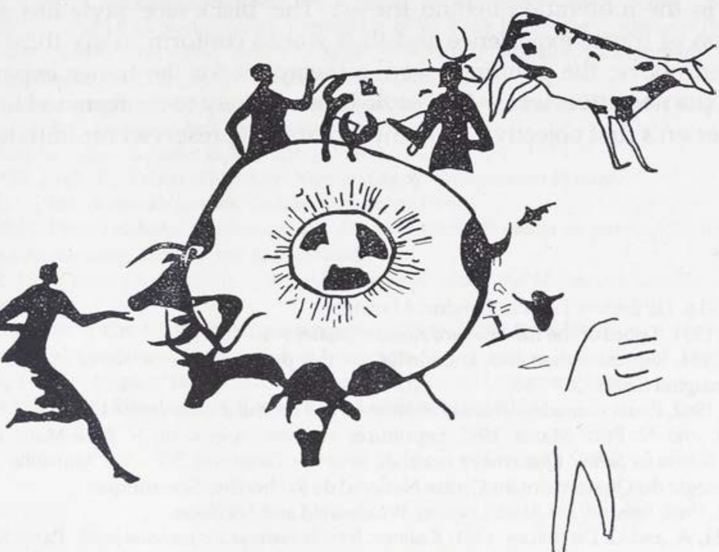

Fig. 8. Tissoukai, Tassili n'Ajjer. Ritual scene.

In spite of the time distance between modern Fulani and the Saharan paintings the degree of fit is too good to be ignored or discarded out of hand, as it is by Vansina (1984). While the details of Fulani ritual behavior can only be glimpsed in outline in the paintings, it is suggested here that spirit possession may have been an important underlying force behind the depictions, and the motive for the paintings, similar to that of the San in Southern Africa, was a metaphor for the trance experience, and a powerful expression of the trancer's contact with 'non-ordinary' reality. Among the Fulani only trained initiates can participate at the deepest level in ritual behavior. These are the people most likely to have been the artists capable of seeing the cattle as metaphorical intermediaries between man and spirit world, which is shown in the rather special painting in Lhote (1966: Plate IV: 10) and Hampaté Ba and Dieterlen (1961: Plate

B: 2 – Fig. 8). This depiction has been interpreted by Hampaté Ba and Dieterlen (1966: 148 - 9) as part of the initiation of Fulani herders who aspire to the grade of *Silatigi*. Their informant Sile Sadio had passed through 12 of the 'clairières' mentioned previously. The last 6 of these were the "demeures de 7 soleils".

The rich details in the 'white-face' style which was equated with the Berber people of North Africa, suggests a slightly different emphasis to the material depicted, but this still represents a metaphorical expression of ritual values and experience. In this case the social structure of Berber society, although economically similar to the Fulani, is quite different, being a highly structured hierarchical society with families of religious specialists who take care of spiritual needs. The role of women in this society is enhanced so that those with *baraka* or special mystical power can be both sexes.

To conclude, I would suggest the major difference underlying the two art styles is in the motivation behind the art. The 'black-face' style has a stronger suggestion of trance experience and thus would conform to my third objective mentioned above; the paintings were a metaphor for the trance experience. In contrast, the narrative 'white-face' style is more likely to conform to Hampaté Ba and Dieterlen's first objective: an archive of myths preserved for initiates.

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ROBERT VERNET

Le Néolithique récent dans le sud-ouest du Sahara

De l'Océan Atlantique au Lac Tchad et aux contreforts du Tibesti, le sud-ouest du Sahara occupe 2 millions de km^2 entre 22 et 15° de latitude nord et 16° W – 16° E en longitude, en Mauritanie, au Mali et au Niger.

De vastes plaines sableuses (Majabat, Tanezrouft, Ténéré), alternent avec des plateaux (Adrar, Tagant, Dhar Tichitt en Mauritanie, Djado au Niger) et des massifs montagneux (Iforas, Aïr, Tibesti). À l'ouest, l'Atlantique et à l'est, le Paléotchad holocène bordent l'ensemble. Une série de réseaux hydrographiques fossiles ont, tout au long de l'Holocène, attiré les populations. Les principaux sont ceux qui descendent des reliefs, noyant les depressions péri-montagneuses (Azrag, Chemchane, Tichitt, Adrar Bous, Fachi, Kawar entre autres). Plusieurs de ces réseaux ont une importance fondamentale dans le Néolithique du Sahara méridional:

– Le système de l'Azawad, né d'un défluent du fleuve Niger, au niveau de Tombouctou;

– Le Tilemsi;

– L'Azawagh, entre Iforas, Hoggar et Aïr, qui est le plus grand réseau hydrographique fossile du Sahara;

– Le piémont du Tibesti avec ses émissaires se jetant dans le paléolac Tchad.

Cette homogénéité géographique se double d'une grande unité climatique, tant actuellement qu'à l'Holocène. C'est la limite entre le Sahara et le Sahel, limite qui se décale en latitude selon les périodes: aujourd'hui un peu au nord de 16°; il y a 5000 ans, 400 à 600 km plus au nord. L'homogénéité est également humaine: le Sahara méridional est depuis 6000 ans la zone de contact entre peuples venus du nord et peuples africains de l'ouest, au gré de l'évolution climatique et parfois technologique, économique, voire politique. Le mode de vie est généralement le même, scindé en bandes latitudinales. Des axes nord-sud liés à la géographie (littoral atlantique, plateaux mauritaniens, Tilemsi, Azawagh, Aïr, Kawar, Tibesti) rompent ce système. Cependant l'unité physique

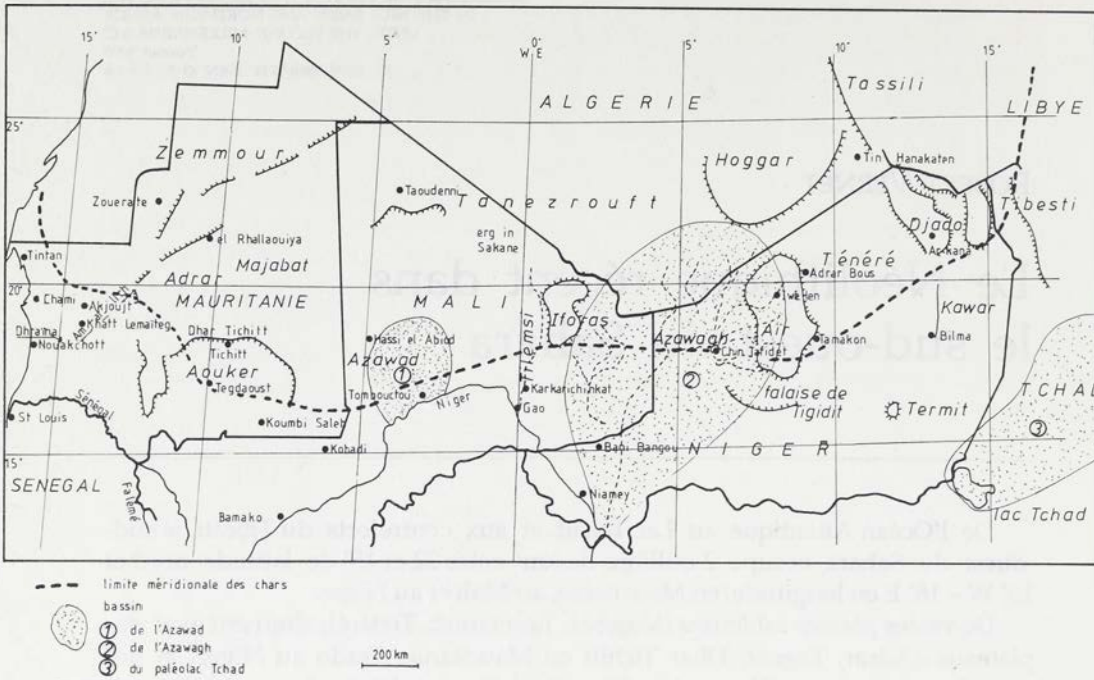


Fig. 1. Le Sahara méridional au Néolithique.

du Sahara méridional s'accompagne au Néolithique d'une réalité humaine très parcellaire. En fait cette région est une mosaïque, tant dans l'espace que dans le temps. C'est d'ailleurs probablement vrai pour l'ensemble du Sahara néolithique. Mais sa partie méridionale commence à être connue région par région, ce qui permet une approche globale (Fig. 1).

Le sud-ouest du Sahara connaît son apogée entre 6000 et 3000 bp, bien qu'il ait été peuplé beaucoup plus tôt. A 9500 bp, l'Aïr possède un Néolithique déjà évolué: céramique diversifiée dans ses formes et ses décors, matériel de broyage, outillage poli, armatures bifaciales (Roset 1987). Le massif de Termit, plus au sud, semble avoir onnu la même évolution. Une date isolée, en Mauritanie, 9120 bp. (Azrag, 22°40′ de latitude nord), indique que l'ouest du Sahara a également été peuplé au début de l'Holocène, sans que l'on connaisse ici le contexte.

Cependant la plus grande partie de la Mauritanie et du Mali n'a été peuplée qu'après 7000 bp, à partir du nord et des massifs centraux. Le boeuf domestique apparaît dans le Ténéré vers 6000 bp et s'étend ensuite vers l'ouest, de l'Azawagh à l'Atlantique, où aucune date concernant l'élevage n'est antérieure à 4000 bp. Sans être plus ancien, un axe de pénétration de l'élevage par le nord (oued Draa et Saoura) n'est pas à exclure dans le nord de la Mauritanie. Il ne fait guère de doute que l'économie pastorale a été le moteur de l'explosion démographique du Néolithique moyen et récent.

L'agriculture, attestée à 3000 bp à Tichitt, est soupçonnée beaucoup plus tôt ailleurs: l'aire d'origine du mil sauvage va en effet de la Mauritanie aux Pays Bas du Tchad, vers 18° de latitude nord. Des travaux en cours sur la génétique du mil (Tostain, Riandey et Marchais 1987) penchent pour une origine de la domestication de cette céréale dans la région, soit après l'aride de 6500 bp, soit après celui de 4000. La métallurgie, qui apparaît dans la deuxième moitié du 4^{e} millénaire bp, est la troisième nouveauté économique dans le Néolithique du Sahara méridional. Son origine est probablement double, les contacts entre populations africaines et protoberbère étant particulièrement importants dans cette période. Le développement économique et démographique du Sahara méridional va être brisé net après 3000 bp, par l'installation de conditions écologiques de plus en plus arides. Les rémissions humides permettront bien le développement de cultures originales et prospères, mais seulement au sud du 18^{e} degré de latitude nord: on est déjà dans le Sahel.

L'évolution paléoclimatique du Sahara méridional à l'Holocène

Elle est rythmée par des humides bien marqués et des arides brefs mais sévères:

– De 9500 à 7500 bp, le premier optimum climatique holocène est général dans le Sahara;

– Peu avant 7000 bp, un aride très brutal est suivi d'un nouveau pic d'humidité assez bref. Il en va de même pour l'aride de 6500 bp. Ces deux accidents climatiques semblent jouer un rôle capital dans le peuplement du Sahara méridional (Ténéréen, peuplement de l'Azawagh, du nord Mali, de la Mauritanie occidentale);

– Le millénaire 6000 - 5000 bp n'est pas très humide, moins en tout cas que le suivant, qui s'achève par l'aride particulièrement sévère de 4000 bp;

– La période 3500 - 3000 bp est le dernier optimum climatique. Sa fin, particulièrement rapide, provoque un premier épisode saharien;

– Ensuite les rémissions seront toujours plus méridionales, vers 2800, 2500 et peut-être 2000 bp (Fig. 2).

Mais elles joueront un rôle essentiel dans le peuplement de la bande 20° - 16° de latitude nord au premier millénaire avant notre ère.

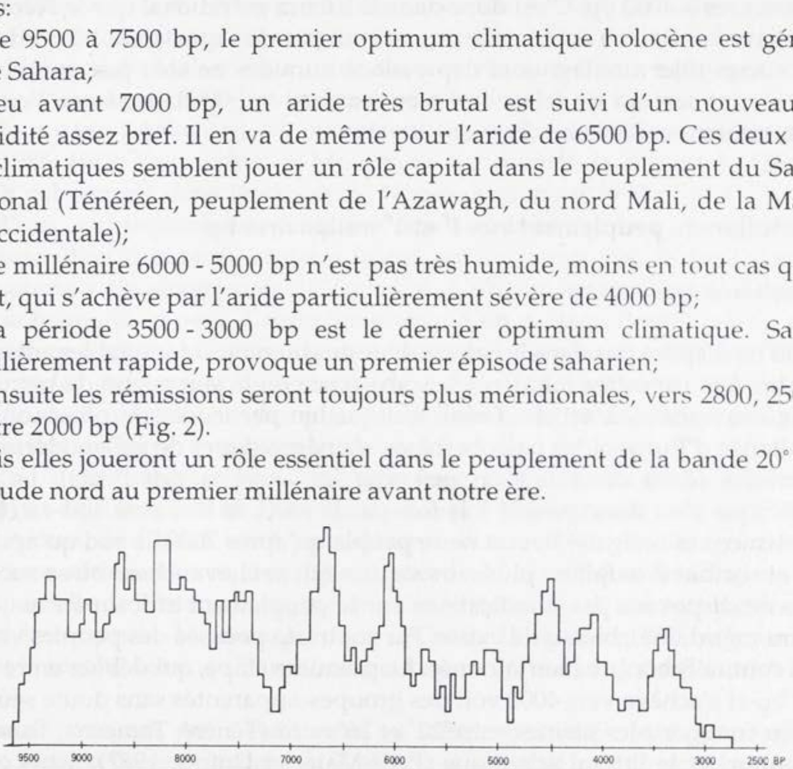


Fig. 2. Datations lacustres et palustres du Sahara méridional au Néolithique (222 dates C-14 B.P.).

Il ne faut cependant pas oublier que ce tableau très général sous-estime les particularismes régionaux: la chronologie est souvent décalée d'une zone à l'autre. Des microclimats, des écoulements d'eau allogènes jouent parfois un rôle primordial. Ainsi le célèbre "Ténéréen" ne fait-il que frôler le désert du Ténéré: la culture matérielle du Ténéréen est surtout visible sur la bordure orientale du massif de l'Aïr. Plus à l'ouest, la civilisation de Tichitt est isolée entre deux immensitée sableuses qui ne semblent guère peuplées après 4000 bp, la Majabat au nord et l'Aouker au sud (Paris et Vernet 1989). 4000 bp est une date charnière dans l'occupation du Sahara, dont la moitié nord se vide presque complètement, car le dessèchement y a commencé plus tôt. Les plaines sableuses du nord du Sahara méridional subissent le même sort, en particulier le Ténéré et le Tanezrouft. Au contraire le sud-ouest du Sahara voit, à partir du 4^{e} millénaire bp, l'apparition de nombreuses cultures, voisines mais bien différenciées. Avant l'aride de 4000 bp, 36% des dates 14c du Sahara méridional sont situées au nord de 20° de latitude nord (32 dates sur 88). Après l'aride, environ 10% (20 sur 199). On remarquera surtout que 70% des datations humaines du sud du Sahara sont postérieures à 4000 bp, ce qui, même en tenant compte des insuffisances de la recherche, est impressionnant. La comparaison avec l'Algérie, la Libye et l'Egypte sahariennes est, de plus, éloquente: moins de 9% des dates 14c y sont postérieures à 4000 bp. C'est donc dans le Sahara méridional que le Néolithique saharien a continué à évoluer, ce qui ne veut pas dire que la moitié nord ne joue plus aucun rôle: montagnes et depressions humides ne sont pas complètement désertées et servent de relais aux mouvements de populations que l'on décèle constamment en direction du sud.

L'évolution du peuplement aux 4^{e} et 3^{e} millénaires bp

Le peuplement avant 4000 bp

On ne dispose pas dans le Sahara de restes humains identifiables antérieurs à 7000 bp. Les rupestres montrent la coexistence ou la succession de populations d'origines variées. L'art du Tassili indique, en particulier, la présence parfois simultanée d'Europoïdes paléoberbères, de négroïdes et de mélanodermes non--négroïdes (dont on a fait un peu vite les ancètres des Peuls). Le Sahara néolithique s'est donc peuplé à la fois par le nord, le sud et le sud-est. Mais ce peuplement est inégal – l'ouest ne se peuple qu'après 7000, le sud qu'après 4000 bp – et surtout il se fait en plusieurs vagues qui se chevauchent ou se succèdent. Nous ne disposons pas d'indications sur le peuplement africain ancien dans le Sahara méridional, bien qu'il existe. Par contre, la poussée des peuples venus du nord commence à être bien jalonnée. La première étape, qui débute entre 7000 et 6000 bp et s'achève vers 4000 voit des groupes-apparentés sans doute seulement de loin conquérir les plaines entre 22° et 16° nord (Ténéré, Tamesna, Tanezrouft, Zemmour) et le littoral atlantique (Petit-Maire et Dutour 1987). Seuls ceux du Ténéré, qui viennent très probablement du Tassili, semblent disposer de bétail.

L'absence de rupestres d'époque pastorale en Mauritanie, au Mali et au Niger, sauf précisément sur un site de la bordure orientale de l'Aïr, Tamakon (Roset 1987) et dans le Djado, est un excellent indicateur de cette limite méridionale, de même que la carte de répartition de certaines tombes construites.

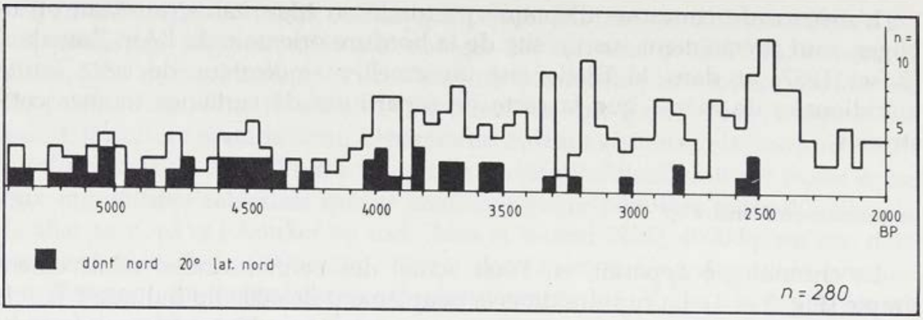
Le quatrième millénaire bp

La chronologie apparaît, en l'état actuel des connaissances, relativement simple (Fig. 3 et 4). La rupture dans le peuplement de 4000 bp indique à la fois une soumission aux conditions climatiques nouvelles et l'introduction de technologies nouvelles. Les cultures du 4^e millénaire bp, de Chami à l'Aïr, ont en commun de pratiquer l'élevage et d'être situées au sud de 20° de latitude nord, ce qui indique bien un glissement vers le sud des isohyètes après l'aride de 4000 bp. Bani Bangou, au Niger, est même situé par 15° nord.

La disparition progressive des pâturages et des points d'eau permanents au nord de 22° (en Mauritanie) ou de 20° (plus à l'est) a poussé les groupes humains, quelle que soit leur origine, à descendre vers le sud, dans des régions déjà occupées (Azawagh, région de Noukchott) ou probablement vides avant 4000 bp (basse vallée du Tilemsi, Tichitt). Un certain nombre de cultures, dans le nord de la zone, disparaissent et ne sont pas remplacées. C'est le cas de celles du Ténéré, du nord du Mali et sans doute aussi de nombre d'autres groupes moins bien identifiés. Après 4000 bp, les Ténéréens traversent ou contournent l'Aïr et s'installent dans l'Azawagh, où prospèrent des groupes d'origine méridionale (Roset 1986; 1987; Paris 1984). En Mauritanie occidentale, la culture du Dhraïna apparaît subitement dans la région de Nouakchott entre 3980 et 3400 bp, porteuse d'une remarquable céramique à fond conique, qui est d'origine septentrionale. Bien que rares, certains jalons ont été retrouvés: le fond conique d'une poterie a été récolté près de Zouerate, à 700 km au nord-est du Dhraïna, avec une bouteille en oeuf d'autruche gravée d'un poisson dont l'âge, en fonction des données paléoclimatiques, est certainement antérieur à 4000 bp (Vernet 1983). Il ne fait donc guère de doute que le groupe du Dhraïna est venu du nord à la suite de l'assèchement des plaines du Sahara septentrional, peut-être en poussant devant lui un troupeau de boeufs.

Le cas du littoral atlantique est exemplaire. Les hommes de Tintan (6390 - 2400 bp) et de Chami (4100 - 2000 bp), un degré plus au sud, sont les mêmes, bien que ceux de Chami aient sans doute subi un certain métissage avec les populations africaines voisines. Une partie de la céramique de Chami est la même que celle de Tintan, ce qui indique l'appartenance – à une époque donée – à une même culture. Mais on pratique à Chami la chasse et l'élevage, non la pêche et la récolte des coquillages, malgré la proximité du littoral (Petit-Maire *et al.* 1979).

D'autres cultures, qui s'établissent au même moment, n'ont pas d'origine connue. Ainsi celle des éleveurs de Tichitt, qui apparaît brusquement vers 3800 bp, sans que l'on sache d'ou elle vient ni qui sont les hommes qui vont bâtir près



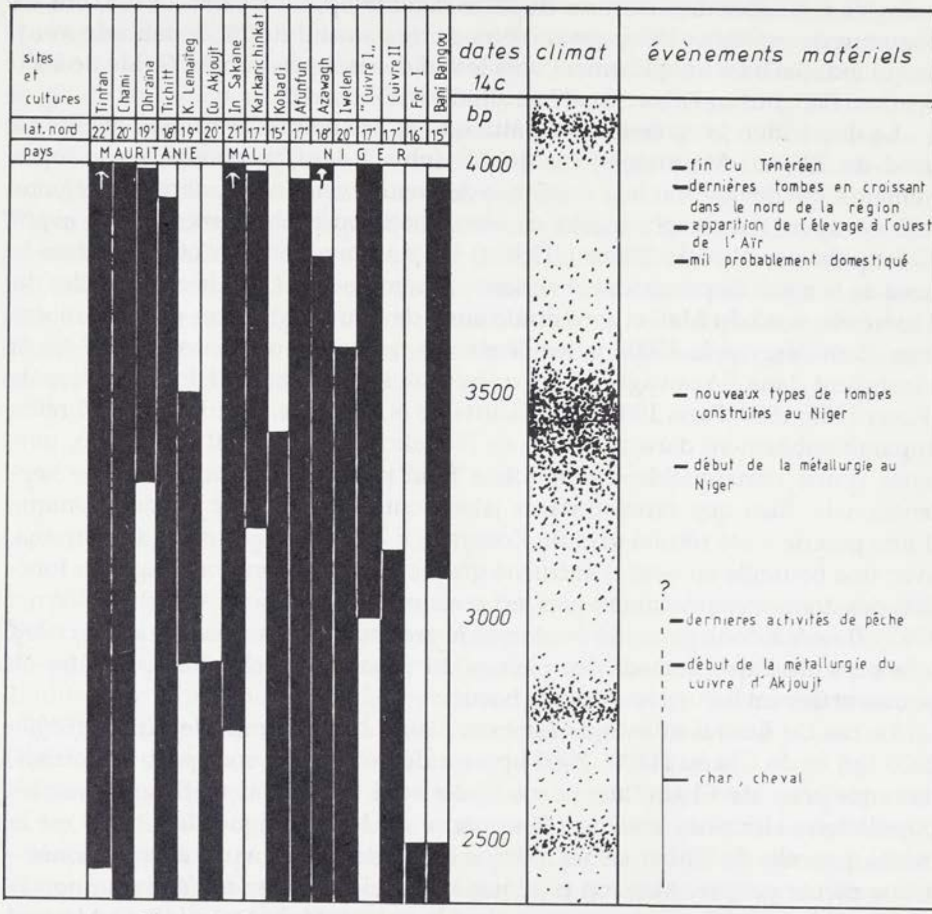
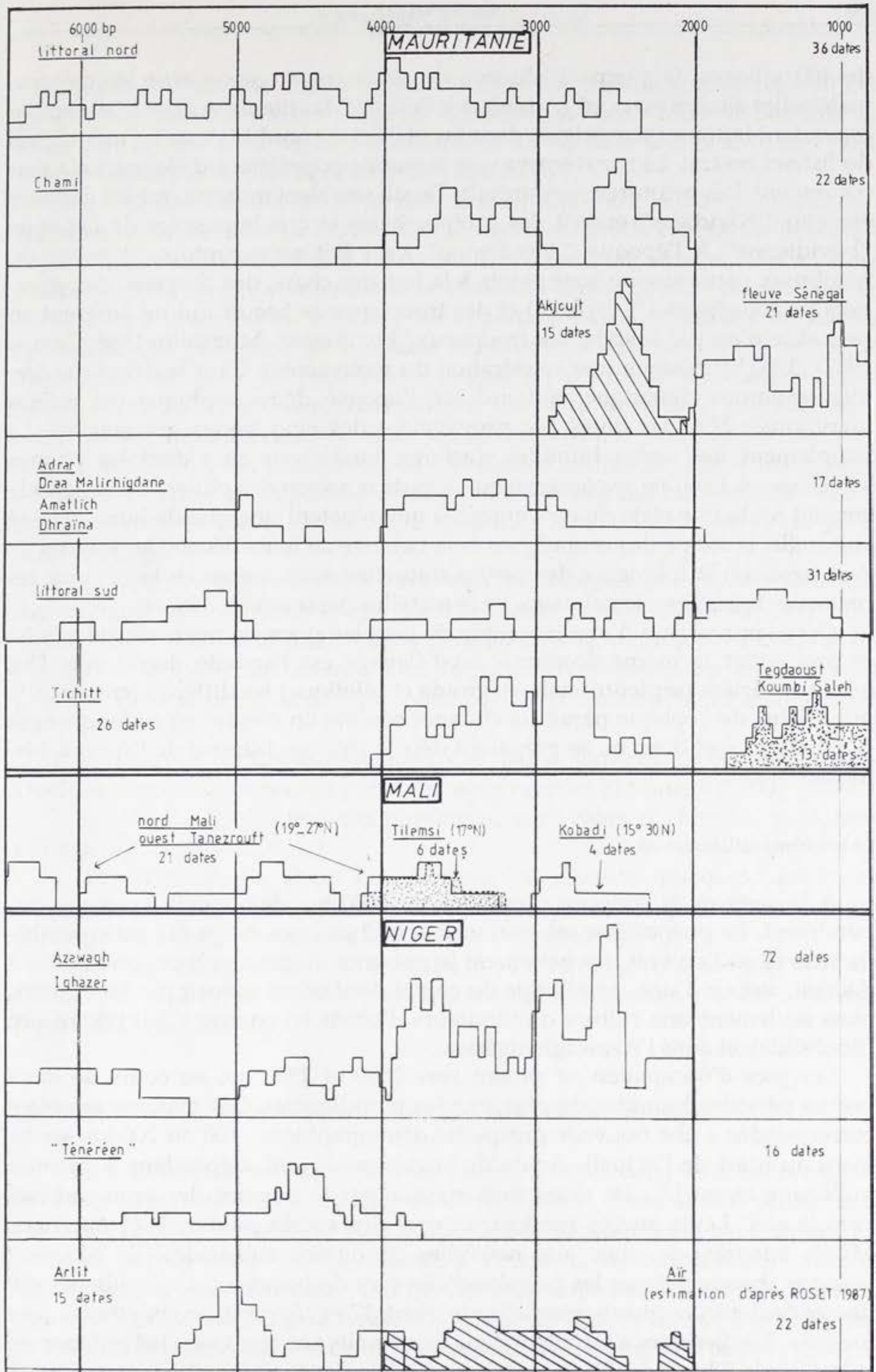


Fig. 3. Néolithique récent du Sahara méridional. Datations C-14 humaines.

Fig. 4. Séquences chronologiques du Sahara méridional.


6000 bp
5000
4000
3000
2000
1000
MAURITANIE
littoral nord
36 dates
Chami
22 dates
fleuve Sénégal
21 dates
Akjoujt
15 dates
Adrar
Draa Malichigdane
Amatlich
Dhraïna
17 dates
littoral sud
31 dates
Tichitt
26 dates
Tegdaoust
Koumbi Saleh
13 dates
MALI
nord Mali
ouest Tanezrouft
21 dates
(19°_27°N)
Tilemsi (17°N)
6 dates
Kobadi (15° 30 N)
4 dates
NIGER
Azawagh
Ighazer
72 dates
"Ténéréen"
16 dates
Arlit
15 dates
Aïr
(estimation d'après ROSET 1987)
22 dates
6000 bp
5000
4000
3000
2000
1000

7

de 400 villages de pierre. L'absence de toute convergence avec les cultures matérielles situées au nord (Adrar) et à l'ouest (Mauritanie occidentale) semble cependant indiquer une origine dans les plaines du nord Mali ou les montagnes du Sahara central. Le mouvement vers le sud de populations d'éleveurs n'a rien d'étonnant. Les peintures rupestres du Tassili semblent montrer que les derniers éleveurs "bovidiens" étaient des protoberbères et que le passage de l'époque "bovidienne" à l'époque "équidienne" s'est fait sans rupture. Il existe de nombreux panneaux où sont peints à la fois des chars, des chevaux, des guerriers protoberbères ("Libyens") et des troupeaux de boeufs qui ne diffèrent en rien, si ce n'est par le style, des troupeaux "bovidiens" (Muzzolini 1986; Camps 1987). 3500 bp marque une accélération du mouvement. C'est le début du dernier optimum climatique, qui indique l'apogée démographique du Sahara méridional: 22% des dates 14c proviennent des cinq siècles qui suivent. Le peuplement des zones humides s'achève, tandis que se vident les plaines sableuses où l'eau ne se conserve que lors de la saison des pluies. Cette période connaît toute une série de convergences qui dénotent une grande homogénéité culturelle: la forme des céramiques et la richesse de leurs décors; les thèmes de l'art rupestre; la fréquence des petites statuettes zoomorphes en terre cuite; les pratiques funéraires; la naissance de la métallurgie; la sédentarité, *etc.*

On a l'impression d'une mosaïque de peuples ayant un mode de vie proche et pratiquant la même économie où l'élevage est l'activité dominante. Des origines variées (septentrionale, négroide et nilotique) les différencient, mais le nord-Sahel de l'époque paraît fonctionner comme un creuset où se fondent ces populations – et donc où se préparent déjà le paysage humain de l'époque historique.

Le troisième millénaire bp

À la suite de la coupure climatique de 3000 bp, de nouvelles cultures apparaissent. Le phénomène est bien visible à Chami qui est en fait un ensemble de sites et où l'on voit très nettement le présence de deux groupes successifs; à Akjoujt, autour d'une métallurgie du cuivre dont on ne connaît pas les auteurs, mais seulement une culture d'utilisateurs d'objets en cuivre, à 200 km au sud (Bouhdida); et dans l'Azawagh nigérien.

Les pics d'occupation se situent vers 2800 et 2500 bp, au cours de deux brèves périodes humides de plus en plus méridionales. Ces maxima semblent correspondre à une nouvelle prospérité démographique, 100 ou 200 km seulement au nord de l'actuelle limite de la culture du mil. Cependant le premier millénaire avant J.C. est avant tout marqué par la poussée des protoberbères vers le sud. Leurs succès territoriaux sont des succès politiques et guerriers. Mieux adaptés, de plus, aux nouvelles conditions sub-arides, ils occupent l'espace abandonné par les peuples d'éleveurs de boeufs et d'agriculteurs qui descendent encore plus bas en latitude, entre 17 et 15° nord, toutes ethnies confondues. Les Berbères s'installent dans l'aire qu'ils occupent aujourd'hui, bornée à l'est par le Tibesti des Toubous (chars et tifinagh ne pénètrent pas ce massif), à l'ouest par l'Atlantique et au sud par l'isohyète limitant la culture du mil. Les géographes arabes du Moyen Age les décriront au nord du fleuve Sénégal, au niveau de la boucle du Niger, entre Iforas et Aïr ou dans le Kawar (Cuoq 1984; Robert-Chaleix 1986; Le Coeur 1985; Devisse 1982).

Dès cette époque, d'ailleurs, on devine le clivage entre Touaregs à l'est, dont les bases de départ sont en Libye, dans le Tassili et dans le Hoggar, et Maures à l'ouest (avant leur arabisation à l'époque musulmane), qui semblent liés à l'Atlas marocain et à ses contreforts sahariens. Plusieurs étapes de cette poussée proto-berbère sont discernables à travers les rupestres. Nous proposons – mais les spécialistes de paléontologie humaine disposeront – de réserver le terme de "paléoberbère" pour les populations originaires d'Afrique du nord que l'on décèle dans le Sahara antérieurement à 4000 bp, le terme "protoberbère" s'appliquant, lui, à leurs successeurs venus du nord à la fin de la période pastorale, dont on peut parfois suivre l'évolution culturelle jusqu'aux grands nomades sahariens de l'époque historique. Ce sont eux qui introduisent dans le Sahara le char, le cheval et, au moins en partie, la métallurgie, au cours du 4^{e} millénaire bp.

Un certain nombre de sites rupestres, fort éloignés les uns des autres, le disent clairement, comme Arkana dans le Djado, Iwelen dans l'Aïr, 500 km à l'ouest (Roset 1986) et El Rhallaouiya, dans l'Adrar de Mauritanie, à 2500 km du Djado (Vernet 1989). Sur ces trois sites de gravures on note, outre la présence de gravures naturalistes d'origine pastorale à Arkana, quattre étages entre 4000 et 2000 bp et au-delà:

1. Un étage à boeufs très nombreux et faune sauvage encore importante. Quelques chevaux pourraient y être liés, mais ni chars ni tifinagh (3500? - 3000?).

2. Un étage à boeufs toujours nombreux, avec chars et chevaux, mais sans tifinagh (après 3000-2500 bp).

3. Un étage où les chars ont disparu, où il reste quelques boeufs au schématisme accentué, où les armes métalliques sont omniprésentes et où apparaisent les tifinagh (peu avant 2000-début de notre ère).

4. Un étage où apparaît le dromadaire et où les tifinagh ont, soit disparu, soit évolué vers des types actuellement encore compréhensibles par les Touaregs (après 2000-vers 1500 bp).

Le mode de vie dans le Sahara méridional au 4^{e} millénaire bp

Avant 4000 bp, le sud du Sahara est surtout peuplé dans les massifs montagneux et autour de ceux-ci; le long de certains cours d'eau et lacs permanents (Azawagh, haut Tilemsi, nord Mali, Adrar de Mauritanie); enfin sur le littoral atlantique. Après 4000 bp, on assiste à l'éclosion de nombreuses cultures régionales: Chami, Dhraïna, Tichitt (Mauritanie), Karkarichinkat, Kobadi, Azawad (Mali), Bani Bangou, Azawagh, falaise de Tigidit, Termit, Djado (Niger) et Tibesti, où les travaux ont été prématurément interrompus. Tous ces groupes pratiquent une économie dont les bases sont identiques:

– La chasse perdure;

– L'élevage est l'activité dominante;

– La pêche se maintient au 4^e millénaire bp en certains endroits privilégiés: on possède plusieurs datations 14c sur ossements d'hippopotames ou de poissons entre 16 et 18° de latitude nord, de l'Atlantique au Tchad;

– L'agriculture, avérée à Tichitt, est vraisemblable ailleurs, même si elle ne fait que débuter;

– La fin du millénaire et le début du suivant voient apparaître le char, le cheval et la métallurgie.

Dans de nombreux cas, le mode de vie devient celui des actuels peuples du Sahel. En particulier, la sédentarité, au moins partielle, est un fait acquis dans le bassin de l'Azawagh, la vallée du Tilemsi, dans les 400 villages en pierre du Dhar Tichitt, le long des cordons dunaires de Mauritanie occidentale et sur le littoral atlantique. Il subsiste bien entendu de nombreux sites minuscules, habitats de quelques jours d'une seule famille de chasseurs ou de bergers. Mais le type dominant semble désormais être le village de cases, fortement implanté et relié à de nombreux voisins. Le village est certainement l'unité sociale, tandis que peut exister une unité politique à l'échelle de la région. Dans le cas de la culture de Tichitt, particulièrement spectaculaire, on a la nette impression de l'existence d'un ensemble humain de plusieurs dizaines de milliers de personnes, sinon plus. Le plus vaste de villages, Dakhlet el Atrouss, compte plus de 600 concessions, ce qui signifie qu'à son apogée, il a dû compter entre 3000 et 10 000 habitants. Il est entouré de villages plus petits et domine une immense plaine propice à la pêche (au moins jusqu'à 3000 bp), à l'élevage et à l'agriculture.

Dakhlet el Atrouss pourrait bien être une véritable ville, ce qui, un millier d'années avant notre ère, prend une dimension toute particulière en Afrique subsaharienne. En fait la culture de Tichitt apparaît comme un ensemble d'aspect très moderne. Culturellement homogène, elle l'est aussi économiquement et spatialement, occupant dans le sud-est de la Mauritanie un arc de cercle de plus de 400 km. Il reste à essayer de comprendre l'organisation politique de cet ensemble: il paraît peu vraisemblable que la hiérarchie des sites ne se double pas d'une hiérarchie politique. Le terme de "nation" est certainement prématuré, d'autant qu'on sait rien de l'origine des hommes de Tichitt. Cependant l'extrême homogénéité de leur culture préfigure les cultures sahéliennes qui se développeront au début des temps historiques autour de solides structures politiques, comme les royaumes de Ghana, de Mali ou du Kanem.

Conclusion

Le sud-ouest du Sahara a été au Néolithique moyen et récent une zone de contact fondamentale pour l'évolution du Néolithique saharien. Ce no man's land, parfois peuplé tardivement, surtout à l'ouest, a mis en relation des populations venues d'horizons divers et parfois lointains, qui ont échangé des techniques et des traits culturels qui font de l'ensemble de la région un centre de civilisation particulièrement brillant. Malheureusement l'aridité devenant progressivement définitive interdit au Sahara méridional d'entrer ainsi dans la période historique. Ce rôle sera dévolu au Sahel où prospèrent dès le VIII[e] siècle de notre ère plusieurs royaumes.

Cependant le Sahara Méridional a été, entre 6000 et 3000 bp, une très riche et très peuplée province du grand désert au moment où décline le Néolithique septentrional, tandis que l'on observe la naissance de l'Egypte "don du Nil".

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Middle Palaeolithic occupations at Bir Tarfawi and Bir Sahara East, Western Desert of Egypt

Recent excavations at several Middle Palaeolithic sites in the two adjacent basins of Bir Tarfawi and Bir Sahara East, in the Western Desert of Egypt, have significantly modified our earlier interpretations of the Late Pleistocene climatic events there, of the nature of the archaeological assemblages associated with those events and of their chronology. The lacustrine and aeolian deposits within the basins record a far more complex sequence of wet and arid episodes than we previously believed (Wendorf and Schild 1980). During the Middle Palaeolithic, there were at least five, and perhaps many more, periods when there was much more rainfall than today. Each wet interval was followed by an episode of hyperaridity. Preliminary efforts to date these episodes suggest that the most recent occurred during the final phases of the Last Interglacial (oxygen-isotope Stage 5), and that the earliest may relate to the Penultimate Glaciation (Stage 7). Earlier lakes, associated with the Late and Final Acheulean artifacts, also occur in both basins but have not been studied in detail.

The two basins, about 11 km apart, are cut into earlier Quaternary sands and gravels that fill an older and much larger deflational depression in the Nubia Sandstone bedrock (Fig. 1). Today they are deflated to just above the modern water-table, which is *ca*. 242 m a.s.l. in Bir Tarfawi and 246 m a.s.l. in Bir Sahara East.

The geological history of the two basins is intimately tied to fluctuations in the water-table. During periods of hyperaridity, the water-table would fall and deflation would remove the softer sediments, creating basins of various sizes. During periods of increased rainfall, both locally and farther south, the water-table would rise, ponds would form in the deflated hollows and lacustrine sedimentation would occur. The recovered fauna indicates a high probability of occasional, even if short-lived, water connections with other areas (Kowalski *et al*. 1989).

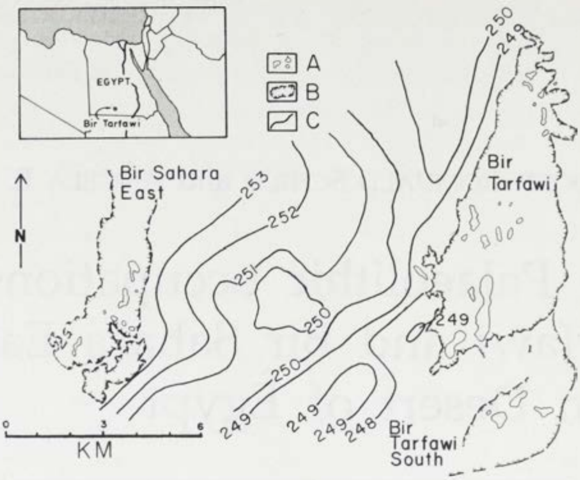

Fig. 1. Contour map of the area of Bir Tarfawi and Bir Sahara East;
A: lake remnant; B: outline of basin defined by plateau escarpment; C: 1-m contour interval.

Archaeological excavations in 1985 - 88 disclosed a sequence of five, or probably six, separate Middle Palaeolithic lake episodes at Bir Tarfawi and five at Bir Sahara East. The chronological relationships between the events in the two basins are not firmly established. Their proximity and the similarities in the number and pattern of intensity of the lacustrine events strongly suggest that the lakes in the basins were synchronous. This conclusion, however, is problematical because the differences between the archaeological remains in the basins are difficult to explain if they are not chronological.

Geology of the basins

Lacustrine sequence at Bir Tarfawi

The earliest Middle Palaeolithic wet episode in the Bir Tarfawi sequence was a seasonal, rain-fed pool in a Silt-Pan in the southern part of the depression. It probably represents a period separate from and earlier than the first Middle Palaeolithic lake in the northern part of the depression, the White Lake, which was an extensive lake fed by high ground-water. After a White Lake, deflation created a large depression in the northern area of Bir Tarfawi, in which a series of four Middle Palaeolithic lake-events are recorded, three "Grey-Lakes" and the "Olive-Green Lake" (Wendorf *et al.* 1987).

Grey Lake 1 formed in a small (*ca.* 40 m in diameter), deep, deflational hollow, initially as a result of both a rising water-table and local rainfall. Later in the sequence, a regimen of seasonal drying, churning, fires and aeolian deposition is indicated. The uppermost deposits of Grey Lake 1 have been removed by deflation, which hollowed out another, much larger basin, during a period of hyperaridity and lower water-table.

Even in the initial stage of Grey Lake 2, there were semipermanent or permanent pools of water, although deposition was interrupted by at least two periods of desiccation. A small pool northwest of the main lake yielded a large collection of microfaunal remains, which is almost exclusively Ethiopian (subsaharan) with a few older desert elements; there are no Mediterranean forms. This accords with our model of a northward advance of the rainfall, and indicates that there may have been as much as 500 mm of rain *per annum* at this time (Kowalski *et al.* 1989; Wendorf *et al.* 1991).

Grey Lake 3 followed the period of aridity in which the upper beds of Grey Lake 2 were markedly deflated. This lake was areally the largest in sequence, so that its later shores lie far from the center and have been completely removed.

A period of hyperaridity, recorded by another major deflation, separated the last Grey Lake from the Olive-Green Lake. In the northern part of the Tarfawi deflation, the shores of the lake have been removed by deflation, but it had a considerable areal extent, perhaps similar to that of Grey Lake 3. Some of the distinctive color of the olive-green silts is due to gley development, which shows that they continued to be waterlogged after the disappearance of open water. Water would thus still have been available for a time to the people and animals that could dig for it. The period of the Olive-Green Lake was the last time the Eastern Sahara was inhabitable until the Holocene.

Lacustrine sequence at Bir Sahara East

Lake 1

The oldest Middle Palaeolithic lake-event in the Bir Sahara East basin is known only from a small remnant near the southern end of the depression. The sediments of this small lake consist of a thick series of lithified limestones resting on (or interfingering with) lacustrine silts. The top of the limestones is at 256 m a.s.l., some 3 m above the highest later Middle Palaeolithic lacustrine deposits. Several Middle Palaeolithic artifacts (a Mousterian point and several denticulates) occurred on the surface of the limestone, while others appeared to be weathering out of beach sediments at the northern end of the remnant. This locality was discovered only in the last few days of the 1988 season and the only detailed studies made here were sedimentary analyses.

This lake is separated from later ones by a long period of hyperaridity and massive deflation. A large deep hollow was excavated to a depth below 245 m a.s.l., about 1 m below the modern water-table and some 11 m below the top of the lithified sediments of the first lake. A dune and then a coarse aeolian sand sheet 8 m thick filled the hollow. The deflation and thick aeolian deposits record a major period of hyperaridity which may have been complex: the subsequent lakes are set in a large north-south trough formed in the sandsheet and deflation of the trough probably represents another arid pulsation.

Lake 2

The earliest of the four later Middle Palaeolithic lake-events was a relatively small body of water. Its base was slightly below the modern water-table at 246 m a.s.l. Deposition began with a dark grey organic soil, followed by a relatively thick bed of lithified carbonates and limestones with numerous snail shells. A large, rich cluster of Middle Palaeolithic artifacts (Site BS-11) occurred within the grey sands on the eastern shore of the lake.

Lake 3

An episode of deflation and the deposition of aeolian sands separate the second lake from the third, which was very large lake, covering an area of several square kilometers. Extensive exposures of the shallow-water and near-shore sediments of this lake are still preserved around the northwestern margin of the depression and massive carbonate remnants can be traced throughout its lower parts. The lake corresponds to the "Lower Lacustrine Series" of 1973 (Schild and Wendorf 1981; Wendorf and Schild 1980). A dark grey, organic soil, presumably indicating rising ground-water, preceded the main carbonate deposition in the deep-water sections of the lake. Near the gently sloping shores, deposition consisted of silts, clays and shallow-water carbonates, with casts of *Phragmites* and other aquatic plants, wasp nests and worm tunnels. The declining phase of the lake is marked by invading phytogenic dunes that interfinger with the shallow-water carbonates.

Most of the known Middle Palaeolithic occupations are associated with Lake 3, especially with the organic soil of the initial phase. One site, BS-12, has several pits, 0.5 - 2 m in diameter, dug down to the water-level of the period. These features, which were presumably wells, intersect each other in a complex sequence, and one has a shelf or platform around a central hole, which is about 1 m deep. Two other excavated Middle Palaeolithic sites, BS-1 and E-88-11, were on the shore of a peninsula that extended between two arms of the lake. The occupations at both sites were within a soil marked by the development of a zone of iron enrichment that graded down into an "upper vegetation horizon" and then into near-shore silts.

Lake 4

Following another period of aridity with extreme deflation and deposition of aeolian sand, deposits of Lake 4 are found only in a very limited area, < 0.5 km in diameter, near the center of the Bir Sahara East basin. The deposits consist of bedded marls and near-shore facies of Olive-Green silts and fine sands. No archaeology was associated with this lake.

Lake 5

Another episode of deflation and deposition of aeolian sands separates the deposits of Lake 4 from those of the last lake-episode recorded at Bir Sahara East. The deposits of Lake 5 occur in many parts of the basin. They are always thin and consist of grey marls that are rich in snail shells. The marls are frequently topped by a dark brown soil, which contains evaporitic salt wherever it is protected by overlying deposits. The encroaching aridity that ended this final lake is recorded by the deposition of phytogenic dunes over the dark, marshy soil. There are no excavated archaeological sites directly associated with Lake 5, but an extensive Middle Palaeolithic site, E-88-2, occurred adjacent to it, within a dune deposited over the truncated lacustrine beds of Lake 3. Occupation was probably contemporary with Lake 5.

Chronology of the basins

The dating of the Middle Palaeolithic lacustrine events at Bir Tarfawi and Bir Sahara East is difficult. We know from the earlier work that both sequences lie beyond the range of radiocarbon dating (Wendorf and Schild 1980), and we are obtaining chronometric dates from a suite of new, and still experimental, techniques: thermoluminescence dating of the sediments; uranium-series dating of ostrich eggshells from the excavated archaeological sites and the calcites which formed in the lakes; electron spin resonance dating of the ostrich eggshell and tooth enamel from the archaeological sites (with the ages estimated by the linear uptake method); and amino acid racemization of ostrich eggshell.

The available preliminary results of these dating efforts have been published elsewhere (Miller *et al.* 1991; Wendorf *et al.* 1991). The uranium-series analyses indicate that the Late Acheulean lakes in Bir Tarfawi are > 350,000 years old, and that the White Lake is about 160,000 years old. The subsequent series of three Grey Lakes, although representing separate lacustrine events, are all about the same age: 135,000 ± 10,000 years ago. The most recent event in Bir Tarfawi, the Olive-Green Lake, is dated between 70,000 and 90,000 years old. Ostrich eggshell racemization indicates an age of 175,000 years for the Silt-Pan in the southern area of Bir Tarfawi, suggesting that it is, indeed, separate from the White Lake. The three Grey Lakes all fall within a span of some ten thousand years, about 130,000 years ago, and the Olive-Green Lake dates to about 104,000 years B.P.

At Bir Sahara, the results are less cohesive. The uranium-series analyses have not been completed, but thermoluminescence dating of the two burned layers in the Lake 3 gave dates slightly more than 100,000 years old. This would suggest that the events in Bir Sahara East are synchronous with those in Bir Tarfawi. On the other hand, ostrich eggshell racemization suggest that Lake 3 (if the occupation of E-88-1 was associated with that event, as we now believe) is about the same age as the Silt-Pan at Bir Tarfawi, about 175,000 years old, while Lake 5 is about the same age as the Olive-Green Lake. This would indicate that most of the Bir

Sahara East sequence precedes that of Bir Tarfawi. We expect that these problems of correlations between the two basins will be resolved when the remaining uranium-series and thermoluminescence samples have been analyzed.

Middle Palaeolithic archaeology of Bir Sahara East and Bir Tarfawi

There are interesting differences between the Middle Palaeolithic assemblages found in the two basins. At Bir Tarfawi, the earliest Middle Palaeolithic, associated with the Silt-Pan and the White Lake, lack bifacial foliates, has rather more converging denticulates than do later assemblages and shows a tendency to use larger blanks for retouched tools. On the other hand, the assemblages associated with the Grey and Olive-Green Lakes consistently include rare bifacial foliates. Pedunculated pieces occur only on the surface of the Olive-Green Lake, and none has been found *in situ*; they were presumably from later occupations associated with the upper part of the Olive-Green Lake and subsequently removed by deflation.

At Bir Sahara East, only the most recent Middle Palaeolithic assemblage, which is believed to be associated with Lake 5, has tools like those with the Grey and Olive-Green Lakes at Bir Tarfawi (Figs. 2 and 3). The Bir Sahara assemblages associated with Lakes 2 and 3 lack foliates, have many converging denticulates, and some of them have larger blanks for the tools (Fig. 4). One site (BS-11 with Lake 2) also contained several stone balls, similar to those oc-

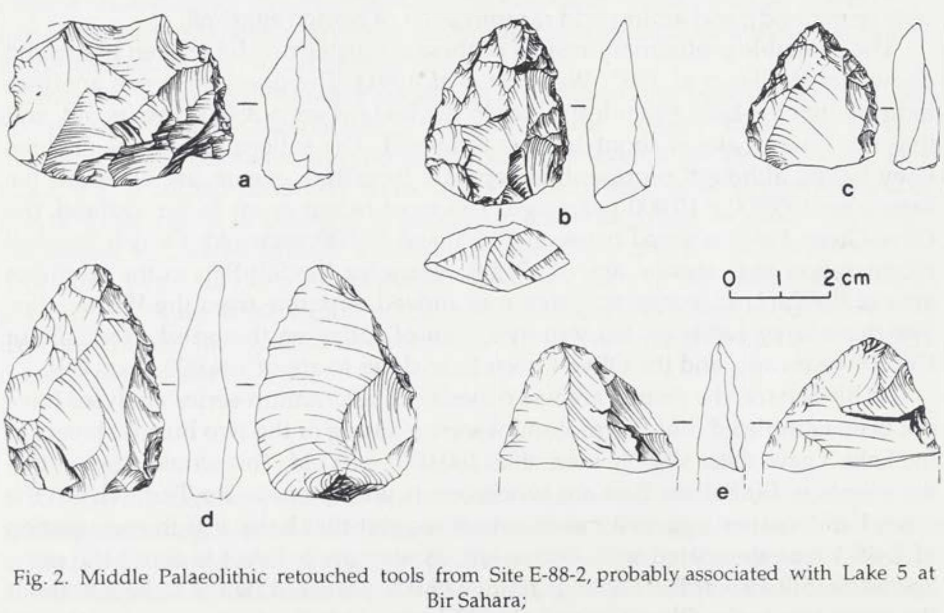

Fig. 2. Middle Palaeolithic retouched tools from Site E-88-2, probably associated with Lake 5 at Bir Sahara;
a: denticulate; b - d: Mousterian points; e: bifacial piece.

Fig. 3. Middle Palaeolithic retouched tools from Site E-88-2, probably associated with Lake 5 at Bir Sahara;

a, b, h: sidescrapers; c,e,g: endscrapers; d, f: denticulates.

casionally found in Late Acheulean sites in this area, but otherwise unknown in the local Middle Palaeolithic.

These differences may well have chronological significance if most of the Bir Sahara lakes and the associated sites preceded all but the Silt-Pan and the White

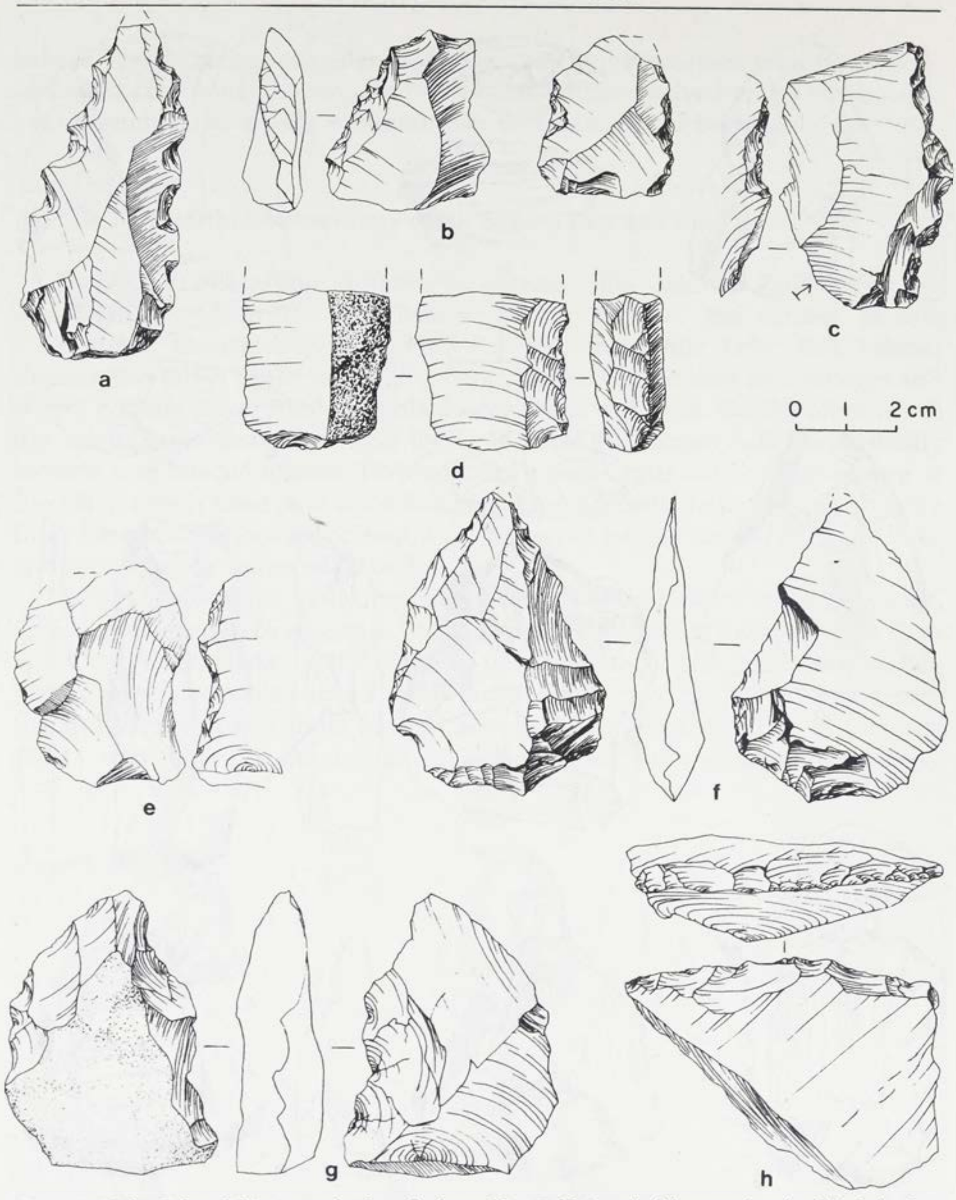

Fig. 4. Middle Palaeolithic retouched tools from Site E-88-1, probably associated with Lake 3 at Bir Sahara;

a, g: converging denticulates (Tayac points); b: sidescraper; c: denticulate; d: inverse sidescraper; e: retouched piece; f: Mousterian point; h: transverse sidescraper.

Lake at Bir Tarfawi. However, the similar patterning of the lacustrine events in the basins strongly argues that they were synchronous; if this was so, the archaeological differences must indicate that the basins were used differently, since their proximity would argue against the existence of two cultural traditions. Some of the differences may reflect the greater distance of Bir Sahara East from the sources of lithic raw material, the ecology of the lakes may have differed, or the lakes may have been used at different seasons for different purposes.

In any case, the absence of foliates from the earliest Middle Palaeolithic assemblages, their presence in the latest sites in both basins and the restriction of tanged pieces to surface occurrences suggest a sequence of three kinds of Middle Palaeolithic in this area. The initial group, a Mousterian, used slightly larger blanks, more coverging denticulates and, occasionally, stone balls. The second group was characterized by rare foliates. The third group had both foliates and tanged tools. We suggest that the term "Aterian" be reserved for the last group and that the second group, with rare foliates and no tanged pieces, be called "Aterian-related".

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BT-14, a stratified Middle Palaeolithic site at Bir Tarfawi, Western Desert of Egypt

Site BT-14 lies in the northern part of Bir Tarfawi, a deflational basin in the Eastern Sahara, at 22°52.4'N, 28°52.9'E. It is a very extensive and deeply stratified Middle Palaeolithic site, associated with a series of lake-sediments. It was first studied in 1974, when most of the effort was devoted to the surface exposures of large, mammal bones associated with Middle Palaeolithic artefacts, and to the separate surface scatters of artefacts without bones (Wendorf and Schild 1980: 53 - 80). Stratigraphic trenching in 1974 also revealed a deep sequence of lake-sediments, which was confirmed when the site was visited in 1985 and one of the earlier trenches reopened and expanded.

Major excavations of the site were carried out in 1986 and 1987. A total of 78 m^2 were excavated through the lake-sediments to the underlying white dune sands, which occurred at a depth of 2 - 2.5 m. These excavations revealed a sequence of four lake-episodes, all associated with Middle Palaeolithic artefacts and separated from each other by periods of aridity, indicated by truncations and, elsewhere in the area, by aeolian deposits. There are the remnants of an earlier Middle Palaeolithic lake nearby in the northern part of Bir Tarfawi and of another, possibly still earlier, pond in the southern area.

The four lakes represented at BT-14 have been named, from earliest to latest, Grey Phases 1, 2 and 3 and the Green Phase of the East Lake (Fig. 1). They were fed by groundwater and reflect increased precipitation locally and, probably, farther to the south as well; the wetter periods in this area during the Holocene resulted from northward shifts of the monsoon belt and this was probably the case during the Middle Palaeolithic. The micromammalian remains from deposits of Grey Phase 2 suggest local rainfall of at least 500 mm *per annum* (Kowalski *et al.* 1989). Uranium-thorium dates (H.P. Schwarcz, pers. comm.) and amino acid racemisation of ostrich eggshell (Miller *et al.* 1991) indicate that Grey

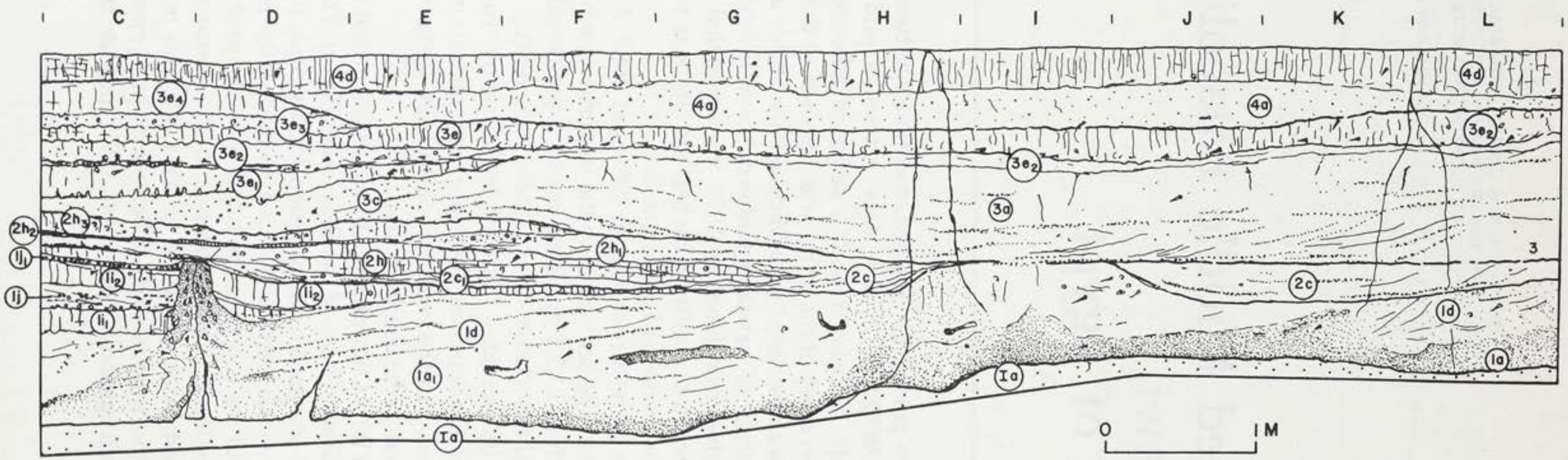

Fig. 1. Northern profile of main excavated area at BT-14;

Ia: zone of bioturbation in basal dune;

Grey Lake 1. 1: dark brown cemented sands; 1a: organic -rich basal section becoming more silty and more cemented toward centre of lake, and bedding becomes broken by desiccation ($1a_1$); 1d: with conspicuous concave bedding; 1e: clay pebbles; 1i: cement ed silty lenses; $1i_1$: clayey silt with blocky structure in places, traces of burning and of sand from above worked in by desiccation processes; 1j: laminated sands with occasional sand-cemented silt pebbles and crushed shells; $1i_2$: silty cemented sand with traces of lamination and animal burrow (*ca* 15 cm diameter); $1j_1$: coarse, gravely sand separating silts; $1i_3$ as $1i_2$;

Grey Lake 2. 2c: coarse beach sands grading laterally into cemented silty sands with lenses of coarser sand (2h); $2c_1$: coarse sand grading into finer sands between silty cemented sands; $2h_1$: consolidated to friable, laminated sands;

Grey Lake 3. 3a: coarser, poorly sorted beach sands, with streaks of finer material, especially in lower part, rare consolidated root-casts in the upper part, and sporadic lenses of more gravelly sand throughout; 3c: upper part of coarse beach sands; $3e_1$: cemented sandy silt with vermicular structure, grading laterally into fine sands ($3e_2$) ($3e_1$: silty sand in western wall); 3e: cemented silt; siltier bed between $3e_1$ and $3e_2$ in the western part; $3e_3$: fine silty sand with gastropods; $3e_4$: mottled, gleyey silt;

Olive-Green Lake. 4a: thick lens of fine, friable sand with slightly cemented root-casts; 4d: cemented, olive-green silts.

(Profile drawn and described by R. Schild.)

Phases 1 - 3 were brief wet intervals, all occurring within a period of less than 10,000 years about 130,000 years ago. There was a longer period of aridity before the Green Phase which is dated to 104,000 BP +10,000/–20,000 years.

Grey Phase 1 was a permanent, quite deep, but areally rather limited body of water. It fluctuated considerably between wet and dry seasons and normally had a maximum diameter of about 40 m. The presence of large fish indicates that the lake did not dry out completely (van Neer, this volume). The excavated area of BT-14 was not far from the deepest part of the lake and was under water during the wet seasons; it must therefore reflect dry-season occupations, probably (and deliberately) close to the dry-season remnant of the lake. This could well have been the only open water available within a considerable distance. The bodies of water were areally larger during the periods of Grey Phases 2 and 3, but the excavated area of BT-14 was, again, seasonally flooded. The repeated occupations and seasonal flooding have combined to destroy any individual living-surfaces, so that horizontal control is very limited. However, the nature of the deposits means that vertical control is quite fine and Grey Phases 1 - 3 together provide a sequence of almost 2 m of Middle Palaeolithic occupations, which will be summarized here.

The artefact recovered from the Grey Phases are generally similar, although much more numerous in the first lake than in the following two (Tables 1 and 2). However, Grey Phases 2 and 3 were much larger than was Grey Phase 1 and it is probable that the main occupations during these periods were outside the area excavated. The artefacts are almost all made of locally available quartzitic sandstone of variable quality; quartz occurs rarely. The quartzitic sandstone used during the Green Phase tends to be lighter in colour than that of the Grey Phases and more consistently fine-grained. The debitage consists mostly of chips and broken flakes; the proportion of whole, identifiable flakes among the debitage increases through the sequence from only 1.7% in Grey Phase 1 to 5.6% in the Green Phase. Identifiable flakes tend to be derived from single platform cores. Primary flakes and early-stage preparation-flakes are very rare, but there

Table 1

Frequencies of core-types and of debitage at site BT-14.

Specimens	Green Lake	Grey Lake 1	Grey Lake 2	Grey Lake 3
Single platform	0	1	2	12
Opposed platform	1	0	2	5
Ninety-degree	1	0	0	7
Patterned multiple platform	0	0	0	4
Globular	0	0	0	12
Levallois	3	1	1	18
Discoidal	1	0	1	12
Initially struck	0	1	1	25
Unidentifiable	0	0	2	16
Total	6	3	9	111
No. of debitage	108	3816	13 016	35 932

are some Levallois preparation flakes. Nevertheless, initial core-preparation does not seem to have been a frequent activity at BT-14.

The frequencies of types of cores (Figs. 2c; 3e, h) within each lake are given in Table 1. Their most notable characteristic overall is their rarity. The site yielded considerable quantities of debitage and retouched tools, so that the number of cores recovered cannot represent more than a small fraction involved in the production of the flakes found and may not, therefore, provide a reliable indicator of the overall core-typology favoured by the inhabitants of BT-14. It should be observed that cores are not relatively rare in the Green Phase, indicating that the nature of the Green Phase occupation(s) was different from those of the underlying layers.

Table 2

Frequencies of tool-classes at site BT-14.

Specimens	Green Lake	Grey Lake 3	Grey Lake 2	Grey Lake 1
Levallois flakes	2	6	4	37
Mousterian points	0	1	0	4
Sidescrapers	1	19	26	182
Upper Pal. group	0	8	12	100
Notches	2	31	55	252
Denticulates	2	31	56	265
Continuously ret'd.	2	23	53	306
Bifacial pieces	0	2	3	13
Other flake-tools	1	31	49	168
Total	10	152	258	1327

The tool-classes are listed in Table 2. Overall, the sequence is typologically consistent. Tools are more frequent in the Green Phase, where there are 10.8 pieces of debitage per tool, than in the Grey Phase, with 30.4 pieces of debitage per tool. They are better made in the early stages of Grey Lake 1 than in later parts of the sequence; the base of the sequence also yielded a series of large tools, which did not occur in higher layers. Only a small minority (18.6%) of the tools are unbroken.

Levallois pieces are present throughout the sequence but are never common; this accords with observations of the debitage and cores. As would be expected, a disproportionately high number of the retouched tools are made on Levallois (that is, better made) blanks; however, the Levallois typological indices are only 9.6, 5.4 and 9.9 in Grey Phases 1, 2 and 3, respectively, but a full 30.0 in the Green Phase.

The Mousterian point group is virtually absent.

Sidescrapers are numerically one of the more important classes and are also usually of a higher standard of manufacture than the notches, denticulates, or pieces with continuous retouch. Most of them are single straight or single convex types, but there is a full range of the complex varieties and combinations, most of them quite typical (Fig. 2a).

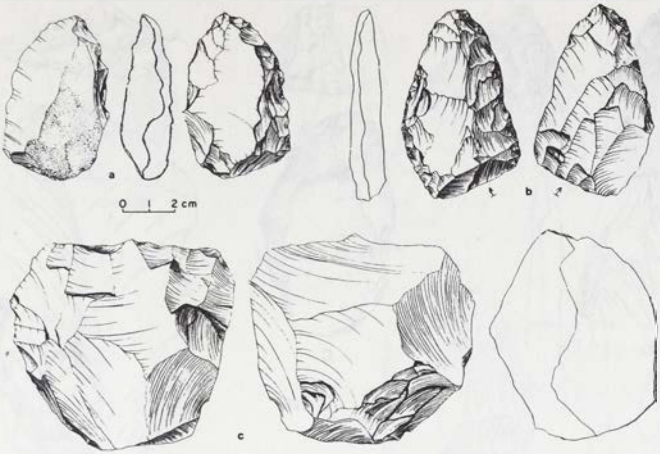

Fig. 2. Site BT-14. Tools and core from Grey Lake 1;
a: alternate sidescraper; b: bifacial foliate; c: core.

The Upper Palaeolithic group is well represented and consists mostly of endscrapers (Fig. 3c, d, g). Most of these are typical and very well made, and many are fine thumbnail scrapers. There is also a consistent group of pieces with alternating scraper-edges. There are a few burins and several small perforators, most of the latter being atypical (Fig. 3i).

Notches are numerically the second most important tool-class, but tend not to be well made. Almost all (84.4% of the class) are fragmentary (Fig. 3f) and a majority of them could well be accidental, particularly in light of the numerous re-occupations of the site.

Denticulates are the third most common tool-class (Fig. 4e), but Tayac points are extremely rare. The denticulates are often irregular. They are not likely to be accidental, but tend to be sinuous (in part because so many are alternating) rather than "toothed". Classic denticulates are not common.

The pieces with continuous retouch (Fig. 3b) are the most common tool-class, but, overall, they are a poorly made and inconsistent group that may well be largely made up of *ad hoc* and accidental "tools". Most (84.4% of the class, as with the notches) are fragmentary and have only limited areas of retouch. The group seems to include a more consistent type, with alternating retouch (Fig. 4c), but even these are not numerous.

Bifacial foliates are rare but occur throughout the sequence of Grey Phases (they occur in occupations associated with the Green Phase in the southern part of Bir Tarfawi) and those that are finished are usually exquisitely made (Figs. 2b, 4d). Two-thirds of them are broken and represented only by extreme tip fragments (Figs. 3, 4b). One complete example is noteworthy for being well below the normal size-range for Middle Palaeolithic foliates (Fig. 4a).

The class of other flake-tools includes occasional, rather poorly made becs, raclettes and truncations and a few very well made choppers (Fig. 5). Some 96.4% of this class are broken and most are simply unidentifiable fragments.

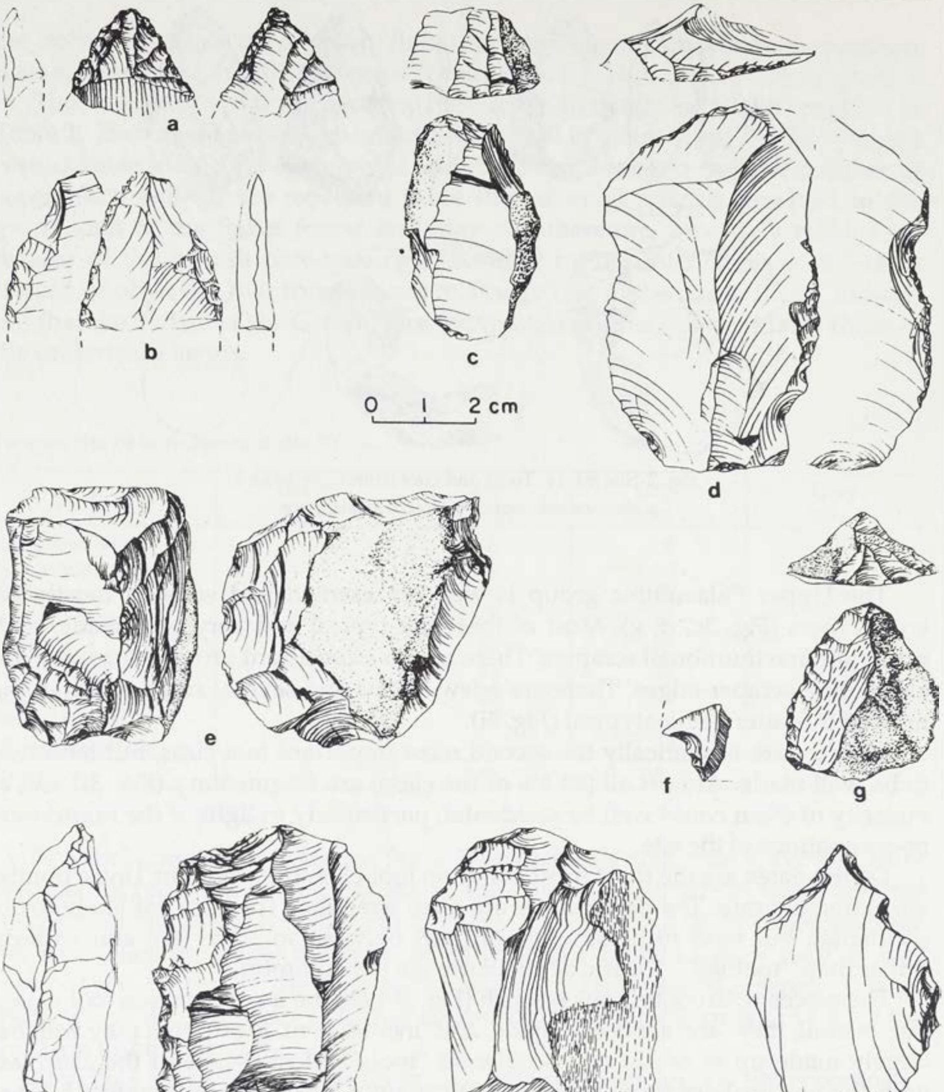

Fig. 3. Site BT-14. Tools and cores from Grey Lake 1;
a: bifacial foliate; b: piece with bifacial retouch; c, d, g: endscrapers; e, h: cores; f: notched triangle; i: atypical perforate.

Apart from the flaked stone tools, a noteworthy feature was the occurrence almost at the base of Grey Phase 1 of six large, ground and pitted artefacts that resemble lower grinding-stones (Fig. 6), or nutting-stones, and a handstone. Two of them have been pecked rather than ground and could be anvils, which would most probably have been for the smashing of bones, since there is no indication of an anvil technique on the artefacts. The others are ground. None of

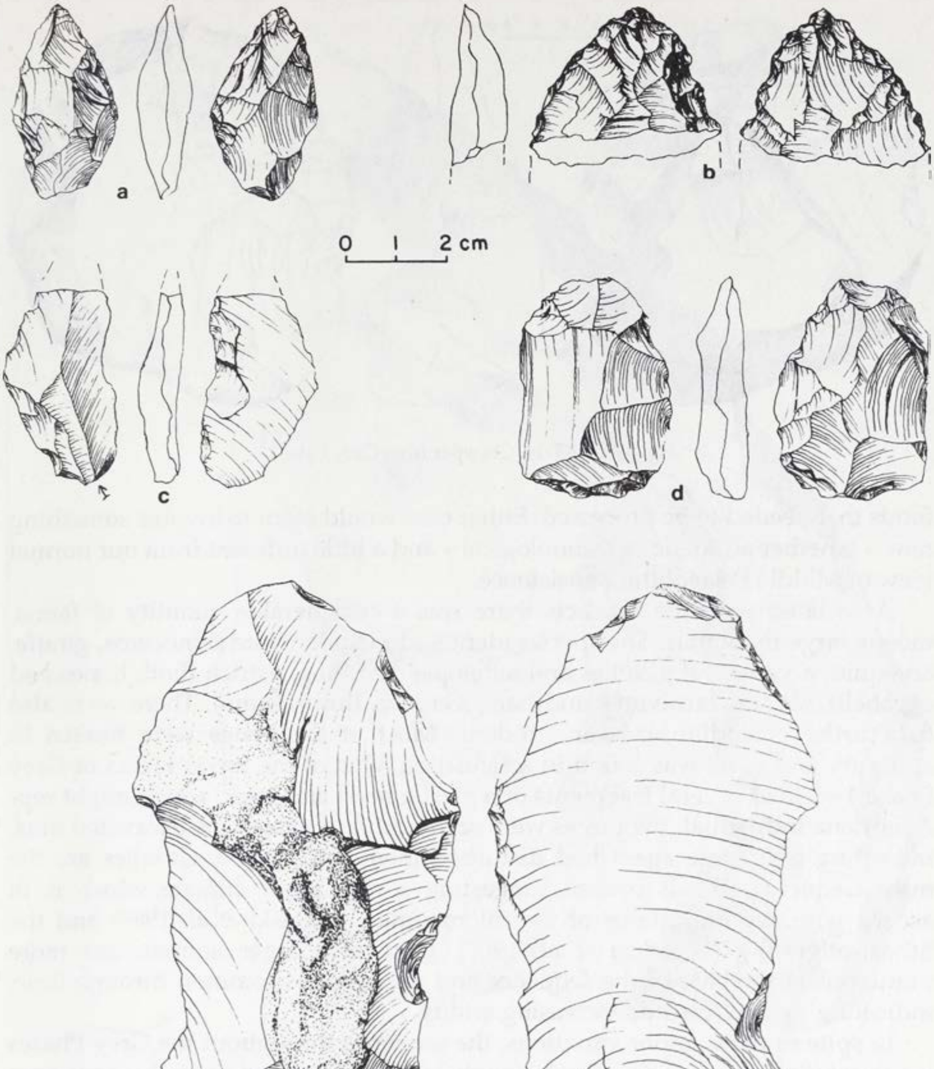

Fig. 4. Site BT-14. Tools from Grey Lake 1;
a, b, d: bifacial foliates; c: piece with alternate retouch; e: denticulate.

them has any traces of ochre, although ochre was found at the site. One supposes that the grinding-stones were used for processing plant-foods, of which, of course, no remains were found. The eating of plants in Last Interglacial times is not surprising, but the existence of tools for processing them is rather different. It would imply either that people had developed a taste for plants processed rather than straight from the bush, or that they were eating plant-

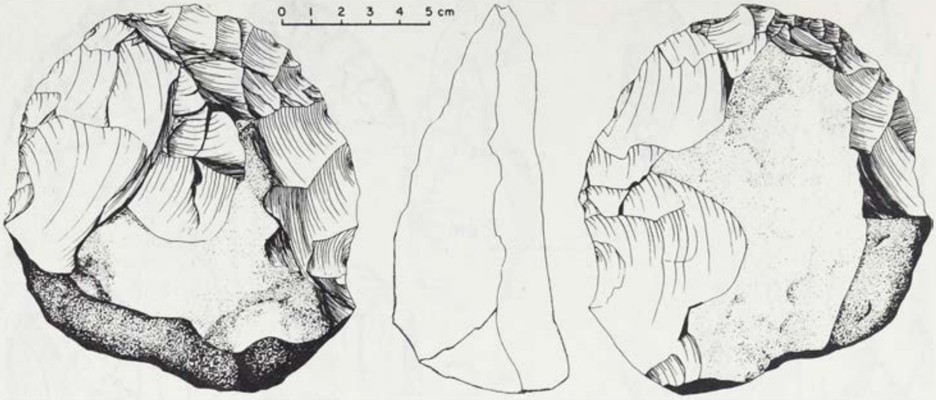

Fig. 5. Site BT-14. Chopper from Grey Lake 1.

foods that needed to be processed. Either case would seem to involve something new – whether aesthetic or technological – and a little different from our normal view of Middle Palaeolithic subsistence.

Associated with the artefacts there was a considerable quantity of fauna, mostly large mammals. The species identified include white rhinoceros, giraffe, an equid, a variety of gazelles and antelopes, warthog, ostrich (both bones and eggshell), several carnivores and hare (Gautier, this volume). There were also fish, turtles, crocodile, birds and rodents. Most of the bones were broken in antiquity and none was found in articulation. One of the lower layers of Grey Phase 1 yielded several fragments of a giraffe head and neck, which might represent one individual; the pieces were scattered throughout the excavated area, indicating that some agent had disturbed them *post mortem*. Gazelles are the most frequent animals overall, suggesting a rather dry climate, which is in accord with the indications of the microfauna (Kowalski *et al.* 1989) and the lithostratigraphy (Wendorf *et al.* 1987). However, larger animals are more numerous at the base of the sequence and become less common through time, indicating a trend towards increasing aridity.

In spite of these minor variations, the sequence throughout the Grey Phases is extremely homogeneous, if not monotonous. The tool typology does not vary through time; the occupants of the site did little core preparation there, nor did they leave their cores behind them when they left. Most of the artefacts are broken, there are many chips and most artefacts are lightly polished, presumably by water. The bones are also fragmentary and are never still in articulation.

The high number of tools and of broken artefacts and the rarity of cores suggest that BT-14 was not simply a living-site. The artefacts and bones are not associated by chance, and suggest the presence of a butchery area. However, until the analyses of the fauna are completed, we cannot tell how the people obtained the animals that they seem to have been butchering. The excavated area was re-occupied so many times – particularly during Grey Phase 1 – that its position next to the dry-season water-hole (that is, the deepest part of the lake) is not

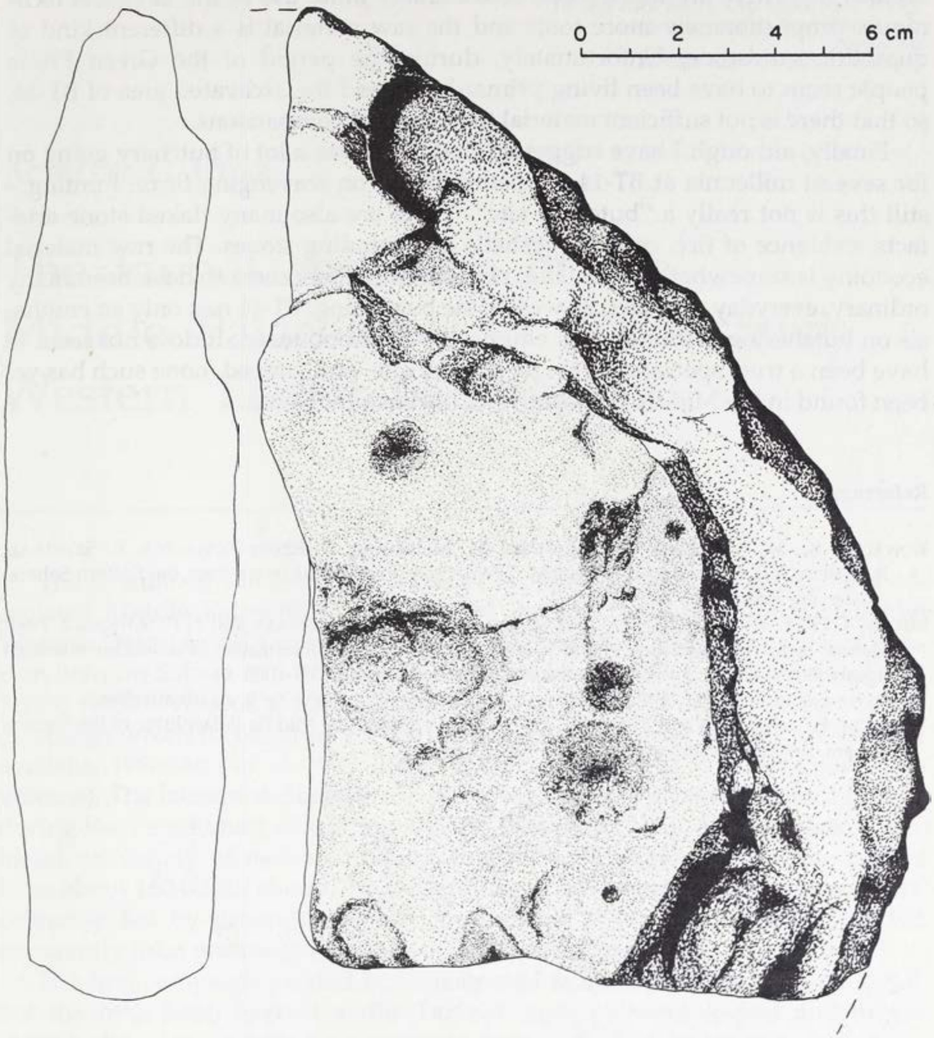

Fig. 6. Site BT-14. Grinding-stone from Grey Lake 1.

likely to be coincidental. It may have been located to take advantage of the animals' coming down to the water to drink: there was probably no other open water for a great distance. However, a dry-season water-hole would be the site of a large number of animal deaths, without need for the intervention of human hunters. In this case, if the occupants of BT-14 simply acted as resident dry-season scavengers, they could have had as much access to carcasses as would resident dry-season hunters, and distinguishing between the two may be difficult.

There seems finally to have been some change in the nature of the occupations of BT-14 during the Green Phase at the top of the sequence, dating to about

100,000 BP. There are more cores, considerably more use of the Levallois technique, proportionately more tools and the raw material is a different kind of quartzitic sandstone. Unfortunately, during the period of the Green Phase people seem to have been living primarily beyond the excavated area of BT-14, so that there is not sufficient material to make firm comparisons.

Finally, although I have suggested that there was a lot of butchery going on for several millennia at BT-14 – whether based on scavenging or on hunting – still this is not really a "butchery site". There are also many flaked stone artefacts, evidence of fire, ostrich eggshells and grinding-stones. The raw material economy is somewhat unusual but, nevertheless, there seem to have been many ordinary, everyday activities, as well as the butchering. BT-14 had only an emphasis on butchering, although that emphasis was pronounced. It does not seem to have been a true, specialized, single-activity site, and, indeed, none such has yet been found in the Middle Palaeolithic of the Eastern Sahara.

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ACHILLES GAUTIER

The faunal spectrum of the Middle Palaeolithic in Bir Tarfawi, Western Desert of Egypt

The Combined Prehistoric Expedition explored lacustrine deposits and associated Middle Palaeolithic sites around Bir Sahara and Bir Tarfawi in the Western Desert in 1973 - 74 and 1985 - 87. The results of the first campaign concern both Bir Sahara and Bir Tarfawi and have been published by Wendorf and Schild (1980). Various investigators are still analyzing the finds of the second campaign which focussed on Bir Tarfawi, but some general reports are already available (Wendorf *et al.* 1990; 1991; Wendorf *et al.*, this volume; Close, this volume). The lacustrine deposits are thought to represent several humid phases during the Penultimate Glaciation and the Last Interglacial. The absolute dates, based on variety of new techniques, suggest a duration of lacustrine phases from about 160,000 to about 70,000 years ago. It would seem that the lakes were primarily fed by groundwater but the increase in available moisture resulted apparently from northward shifts of the monsoonal belt.

The first campaign yielded but a restricted faunal spectrum (Gautier 1980), but the new fossil harvest at Bir Tarfawi, both palaeontological and archaeozoological, has provided a vertebrate fauna which is impressive, especially when compared with the very restricted animal spectrum now found near Bir Tarfawi (some lizards, snakes, a few birds, gerbil and fox; see Kowalski 1988). Seven sites yielded evidence of animal life in the form of bone and tooth remains, but only the excavation of the thick deposits in site BT14 (Close, this volume) yielded a rich and diversified faunal assemblage. The palaeontological date result mainly from the watersieving of some two cubic meters of the peaty littoral deposits of the so called Grey Lake 2, near site BT14. This fauna of small vertebrates includes fish, amphibians, reptiles, birds and micromammals, of which remains occur also sporadically in some of the archaeological sites.

A general preliminary tabulation (Table 1) summarizes the results of the faunal analyses up to beginning of 1988, together with some comments and references. In this table, the animals that have little to do, in a directly way, with Middle Palaeolithic man's presence near the Bir Tarfawi lakes have been listed with a capital I, *i.e.* intrusive. As we have explained elsewhere, animal remains found in connection with archaeological sites can be divided into several taphonomic groups (Gautier 1987). A basic division separates non-intrusives and intrusives. Non-intrusives are animal remains present in a site because of some intentional human activity directly connected with these remains. Intrusives are

Table 1

General spectrum of the vertebrates collected in the Middle Palaeolithic from Bir Tarfawi.

Freshwater fish, mainly catfish (*Clarias* sp.) and tilapia (*Tilapia*)*	I	–
Amphibians (frogs)**	I	–
Reptiles, including snakes, lizards**	I	–
Turtle (*Pelusios adansonii*)**	I	–
Crocodile (*Crocodylus niloticus*)**	I	–
Birds, including cormorant, herons and a small wader**	I	–
*Insectivores***	I	–
Chiropteres (bats)**	I	–
Rodents, various small species**	I	–
Porcupine (*Hystrix cristata*)	–	RR
Cane rat (*Thryonomys swinderianus*)**	I	–
Jackal (*Canis aureus* and *C. adustus*?)	–	RR
Hyaena (*Hyaena hyaena* and *Crocuta crocuta*?)	–	RR
Equid (*Equus africanus*?)	–	RR
Rhinoceros (*Ceratothermium simum*?)	–	RR
Warthog (*Phacochoerus aethiopicus*)	–	RR
Wild camelid (*Camelus thomasi*)	–	RR
Giraffe (*Giraffa camelopardalis*)	–	R
Various medium and large antelopes	–	RR
Large bovid, probably bufallo (*Syncerus/Pelorovis*)***	–	RR
Small gazelle (*Gazella dorcas* and *G. rufifrons*?)	–	FF
Dama gazelle (*Gazella dama*)	–	FF

Based on preliminary identifications.
I: intrusive with respect to the archaeological occurrences. RR, R, FF: (very) rare, very frequent, mostly as non-intrusives in the archaeological occurrences.
* Studied by Dr. W. van Neer.
** Studied by Dr. K. Kowalski and associates; see Kowalski (1987).
*** This buffalo should most likely be referred to *Syncerus caffer* or *Pelorovis antiquus*. In my view however these species may need to be combined.

derived from animals that arrived on (or near) an archaeological site by their own means; through the action of another animal, perhaps a predator; as a not intentional result of human behavior *etc.* In principle, they can be divided into what we have called reworked, penecontemporaneous and late intrusives. Geological intrusives are classical or archaeozoological fossils reworked in site deposits by various geological agents, such as fluviatile erosion and transport, or pit digging hominids. Penecontemporaneous intrusives arrived in the site during the period of its occupation or shortly before or after such an occupation. Late intrusives ended their life in a site long after it was abandoned by people. The identification and separation of the various intrusives is generally based on find context, the state of preservation of the remains, our knowledge of the fossil and archaeozoological record of the region under consideration, the life habits of the creatures involved, their possible cultural or economical value for people *etc.* In the Bir Tarfawi assemblage, we have little difficulty picking out the intrusives: they have generally not been found in direct association with artifact or sites. Moreover evidence for humid periods with diversified fauna other than the Middle Palaeolithic one are missing at Bir Tarfawi; our intrusives are therefore all penecontemporaneous.

The theoretical distinction between non-intrusives and intrusives poses no problem in later sites, but as we move back in the time, the concept of non-intrusives may need clarification. A band of hominids concentrating around a carcass left by predators, can "make" a site around the carcass. They did not bring the animal to their "site", but they moved, as it were, their "site" to the carcass. The presence of the latter is hence intentional from the viewpoint of our scavenging hominids. Also our definition of non-intrusives as animals, the presence of which in a site is determined by some intentional human behaviour dealing explicitly with them, does not specify anything about the relative movements of the non-intrusives with respect to the site or *vice versa*. The concept of non-intrusives can thus be applied even in the case of scavenging hominids, collecting around a carcass; the same applies for intrusives. Nevertheless, it is important that we should distinguish as separate taphonomic groups the non-intrusives resulting from scavenging and hunting.

Recently, it has become fashionable to deride the capabilities of people living during Middle Palaeolithic or MSA-times as big game hunters. The discussion was (re)kindled by the re-analysis by Binford (1984) of the faunal remains found in the Klasies River Mouth site in South Africa. Klein had reached, in our view, the quite acceptable conclusion that MSA-people practiced selective hunting near the site, concentrating on smaller and less dangerous animals, and the young of larger ones (see for example Klein 1975; 1976). Binford (1984) argues that people were hunting smaller animals and scavenging larger ones. In our opinion however, and despite the exercises in high power statistics published on the subject, little or no reliable evidence has yet been produced in favour of scavenging as an important activity of *Homo sapiens* in earlier Palaeolithic times. What is more, at the moment that we are writing this report, we have not yet found intrinsic data *i.e.* data connected with the faunal remains themselves, which may help to solve the problem. As can be seen in Table 1 the non-intrusive fauna is mainly composed of small gazelle and dama gazelle (FF and F!). All the other faunal elements are much less frequent (R and RR!). This situation can be interpreted in two ways. Middle Palaeolithic man at Bir Tarfawi may have been a hunter bagging mainly gazelles and including only now and then larger antelopes, buffalo, giraffe, camel, rhinoceros and equids in his hunters' bag. However, he may also have been a successful hunter but of gazelles and smaller creatures such as porcupine, occasionally scavenging on the carcasses of the bigger game already mentioned. In the latter case, the few finds of jackal and hyena may be remnants of scavenging carnivores man had to kill when he stole the prey of these or other carnivores. However, we should also consider the possibility that the faunal assemblages contains some so-called background fauna *i.e.* remains of "natural" thanatocoenoses which were constituted at Bir Tarfawi in the course of time. What we know about Middle Palaeolithic and MSA-people makes the present writer believe that these archaic *Homo sapiens* were able to cope with large animals. Already *Homo erectus* may have killed primitive elephants with the use of the weapons available to him, stones and wooden spears (Adam 1951). Cooperative hunting of larger herbivores was practised by Middle Palaeolithic man, as for example in the site of Zwoleń located in Polish Central European plain, where apparently seasonal drives of horses were conducted for countless generations (Schild and Sulgostowska 1988; Gautier 1988). Several other archaeological observations suggest that these people and their African cousins had already acquired quite complex habits: the exploitation of various natural resources; burial and other rituals; use of pigment; long distance exchange of raw materials; mining (see Vermeersch, Paulissen this volume) *etc.* We have no doubt that they could go for large game but perhaps they did so only under special conditions, *i.e.* when specific hunting tactics could be applied. The foregoing does not exclude that they scavenged when the opportunity presented itself; on the contrary, it could be a proof of their flexibility.

As both as our non-intrusives and intrusives date from the same general period, they can be used to characterize the landscape in which Middle Palaeolithic man dwelt near Bir Tarfawi (and of course Bir Sahara). As explained elsewhere (Kowalski 1987), the small rodent fauna is Ethiopian. Moreover, it suggests that precipitation may have been reached about 500 mm during Middle Palaeolithic times. The non-intrusive and larger game animals are also basically African animals, which could perhaps do with less rain, since they are more mobile. There is no doubt however that the Middle Palaeolithic wet phases were more pronounced than the Holocene Neolithic ones at Nabta (Wendorf and Schild 1980) or at Bir Kiseiba (Wendorf, Schild and Close 1984), which were estimated to have received some 200 mm of rain. Indeed, during these latter phases very few herbivores larger than dama gazelle roamed the Western Desert (Gautier 1980; 1984). While the Neolithic landscape may have been something like a Sahelian steppe, that of the Middle Palaeolithic would have been a kind of dry savanna with more grazing, shrubs and trees. The changes in precipitation and landscape can generally be seen as northward shifts of climatic belts, with concomitant movements of African faunal elements; they corroborate the view that the climatic changes are essentially due to monsoonal shifts.

We hope that the detailed, quantitative analysis of the faunal changes throughout the sequence found in site BT14 may shed some light on the subsequent faunal communities at the disposal of Middle Palaeolithic people at Bir Tarfawi, and how exactly the latter made use of these.

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PHILIP VAN PEER

Levallois variability and the Middle Palaeolithic of the Lower Nile Valley and the Eastern Sahara

Introduction

Since the end of sixties, Near Eastern Middle Palaeolithic research has paid much attention to the analysis of unretouched debitage and to technological aspects of lithic assemblages (Watanabe 1968; Munday 1976; Jelinek 1977; Marks and Volkman 1983). Harvey Crew (1972; 1975) dealt specially with Levallois technology. He introduced a quantitative approach for assessing the variability in Levallois flake samples. Since then, his method has been adopted by others (Boutié 1981; Meignen and Bar-Yosef 1988). The general idea behind these approaches was that such variability, if demonstrated, would reflect a very basic level of variation in terms of human behavior. Indeed, it was believed that variation in the execution of reduction sequences, or at least in some of its aspects, was independent of certain economic conditions, which might for instance be responsible for quantitative typological differences (Crew 1975: 5 - 6; Meignen and Bar-Yosef 1988: 82).

Following the research developments in the Near East, it was my aim to study the Levallois artefacts of the Middle Palaeolithic in Northern Africa, using a methodological approach similar to that of Crew. In this contribution, I will investigate the relationship between variability in Levallois flake attributes and typological taxonomy in that region. Depending on the nature of that relationship, some problematic issues concerning the northeast African Middle Palaeolithic might eventually be clarified.

The state of research

Although dating is certainly one of the most acute problems in Lower Nile Valley Middle Palaeolithic research, the evidence allows us to distinguish at least three gross chronological stages in the probably very long period during which the Middle Palaeolithic is represented (van Peer and Vermeersch 1990: 145).

Early Middle Palaeolithic

The Early Middle Palaeolithic comprises the Nubian and Non-Nubian Middle Palaeolithic, described for Nubia by Guichard and Guichard (1965; 1968). Most of the sites are located in the desert east of Wadi Halfa. They are always surface sites, located on top or at the foot of inselbergs. Artefacts from these sites are more aeolized than those from Nubian and Denticulate Mousterian sites, which occur in similar topographical positions (*cf.* below). This observation may indicate the greater age of the former. Moreover, many assemblages contain important numbers of handaxes.

Mid-Middle Palaeolithic

Mid-Middle Palaeolithic assemblages from Middle Egypt (Vermeersch *et al.* 1978; 1979; 1980; 1990) are usually found in derived position within local wadi deposits (Paulissen and Vermeersch 1987: 38). Such situations point to humid environmental conditions. TL-dates from Wadi Kubbanyia suggest that the last Pleistocene humid period ended before 60,000 B.P. (Schild 1987: 21). Based on a differential use of Levallois methods, two groups can be distinguished within these assemblages: the N-group with the Nubian 1 method and with classical method for flakes; the K-group with only the classical method. Denticulate and Nubian Mousterian sites from Nubia (Marks 1968a), mostly located on the surface of inselbergs at distance from the Nile floodplain, belong to this second stage as well. Scarce typological evidence suggests that the Nubian Mousterian might be equated with the N-group, the Denticulate Mousterian with the K-group. Marks (1968a) distinguished two groups within the Nubian Mousterian (A and B), based on the presence or absence of handaxes. The term Nubian Mousterian as it is used here refers to the Nubian Mousterian A.

Late Middle Palaeolithic

The third stage or Late Middle Palaeolithic comprises the Khormusan in Nubia. The sites are always associated with Nilotic sediments and dune sands. The environment was apparently too dry to support occupation of areas outside the floodplain (Marks 1968b: 321). Radiocarbon dates strongly suggest an age beyond the present range of radiocarbon dating (Wendorf and Schild 1976a: 239; Wendorf *et al.* 1979).

Late Middle Palaeolithic sites are rare in more northern regions. At Wadi Kubbanyia, a small scatter of "Khormusan-like" artefacts was found on the eroded surface of floodplain silts and dune sands (Wendorf and Schild 1986: 36). At the site of Makhadma 6 near Qena, a small *in situ* scatter of Middle Palaeolithic artefacts was situated on top of a gravel layer with rolled Middle Palaeolithic artefacts (Paulissen and Vermeersch 1987: 38). This indicates that the *in situ* assemblage post-dates the last Pleistocene humid period. Its technological characteristics are similar to that of N-group assemblages. The chert extraction Middle Palaeolithic sites at Nazlet Safaha (Vermeersch *et al.* 1986; Vermeersch, this volume) also belong to the Late Middle Palaeolithic.

The Halfan and Levallois-Idfuan, considered as Upper or Late Palaeolithic industries (Marks 1975: 441; Wendorf and Schild 1975: 163; Close 1987: 320), are characterized by the use of a special Levallois variety, called the Halfa method (Marks 1968c: 394). We have argued that the Halfa method evolved out of the K-group classical Levallois method (van Peer and Vermeersch 1990). A number of other arguments have led us to believe that Halfan and Levallois-Idfuan are technologically transitional between Middle and Upper Palaeolithic (van Peer and Vermeersch 1990). This issue will not be further dealt with here.

As far as the Eastern Sahara is concerned, Middle Palaeolithic sites from Bir Tarfawi and Bir Sahara are associated with successive Pleistocene lakes. Correlations between both areas are not established yet. Absolute dating of the sites is in progress. Assemblages from Bir Sahara have been called Denticulate Mousterian and those from Bir Tarfawi Aterian (Wendorf and Schild 1976b). The former are now referred to as Mousterian (Wendorf, this volume); the latter as Denticulate Aterian (Wendorf *et al.* 1987: 62) or "Middle Palaeolithic with foliates" (Wendorf, this volume).

Aspects of Levallois variability

Twenty-eight assemblages were selected for analysis (Table 1). Some Halfan and Levallois-Idfuan assemblages have been included only to show the relationship between Halfa technology and earlier K-group Levallois technology.

Levallois methods

It has been known for many years that within the global Levallois concept (Boëda 1988: 14) different methods can be distinguished, according to the specific organization of the preparation on the upper core surface. Several Levallois methods occur in our research area. As a matter of fact, three of them have been defined on the basis of Nile Valley material: the Nubian 1 and 2 methods (Guichard and Guichard 1965: 68-69) and the above mentioned Halfa method. The various methods and the industries in which their presence is frequently noticed, are presented in Table 2.

The classical method for flakes has been used throughout the Middle Palaeolithic. The Nubian 2 method occurs frequently only in the Early Middle Palaeolithic. Afterwards, it disappears almost completely. During the second stage, the Nubian 1 method is present in Nubian Mousterian and N-group assemblages. The Halfa or classical-related method finally is attested in the Halfan and Levallois-Idfuan.

Table 1

Assemblages and their taxonomic attribution.

Assemblage		Taxonomic group	Region	Reference
113A	(29)	Non-Nubian Middle Palaeolithic	Nubia	Guichard and Guichard 1965
Brinikol	(18)	Nubian Middle Palaeolithic	Nubia	Guichard and Guichard 1965
400-0	(21)	Nubian Middle Palaeolithic	Nubia	Guichard and Guichard 1965
1033 lower layer	(23)	Nubian Mousterian	Nubia	Marks 1968a
1033 upper layer	(88)	Nubian Mousterian	Nubia	Marks 1968a
1035	(15)	Nubian Mousterian	Nubia	Marks 1968a
1038	(26)	Nubian Mousterian	Nubia	Marks 1968a
1000	(16)	Denticulate Mousterian	Nubia	Marks 1968a
77/17	(40)	N-group	Middle Egypt	Hassan 1979
Nazlet Khater 1			Middle Egypt	Paulissen and Vermeersch 1987
– lower layer	(22)	N-group		
– middle layer	(87)	N-group		
– upper layer	(238)	N-group		
Nazlet Khater 3	(108)	N-group	Middle Egypt	Paulissen and Vermeersch 1987
Nazlet Khater 2	(145)	K-group	Middle Egypt	Paulissen and Vermeersch 1987
Beit Allam	(75)	K-group	Middle Egypt	Paulissen and Vermeersch 1987
Bir Sahara 1	(16)	Mousterian	Eastern Sahara	Wendorf and Schild 1976b
Bir Tarfawi 14 C	(53)	Middle Palaeolithic with foliates	Eastern Sahara	Wendorf, this volume
34A	(49)	Khormusan	Nubia	Marks 1968b
1017	(88)	Khormusan	Nubia	Marks 1968b
34D	(66)	Khormusan	Nubia	Marks 1968b
ANW-3	(136)	Khormusan	Nubia	Marks 1968b
2004	(310)	Khormusan	Nubia	Marks 1968b
101B	(105)	Halfan	Nubia	Marks 1968c
1020	(97)	Halfan	Nubia	Marks 1968c
624	(22)	Halfan	Nubia	Marks 1968c
E71P1A	(28)	Levallois Idfuan	Upper Egypt	Wendorf and Schild 1976a
E71P1C	(101)	Levallois Idfuan	Upper Egypt	Wendorf and Schild 1976a
Nazlet Khater 5	(65)		Middle Egypt	

Numbers of classical flakes analyzed are between brackets.

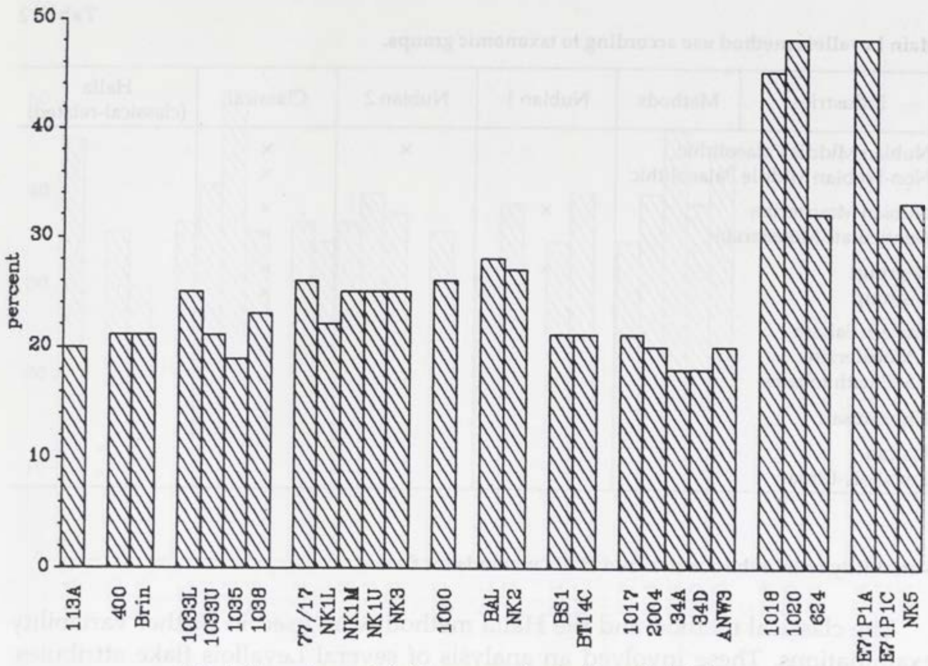

Fig. 1. Percentages of distal scars on classical Levallois flakes.

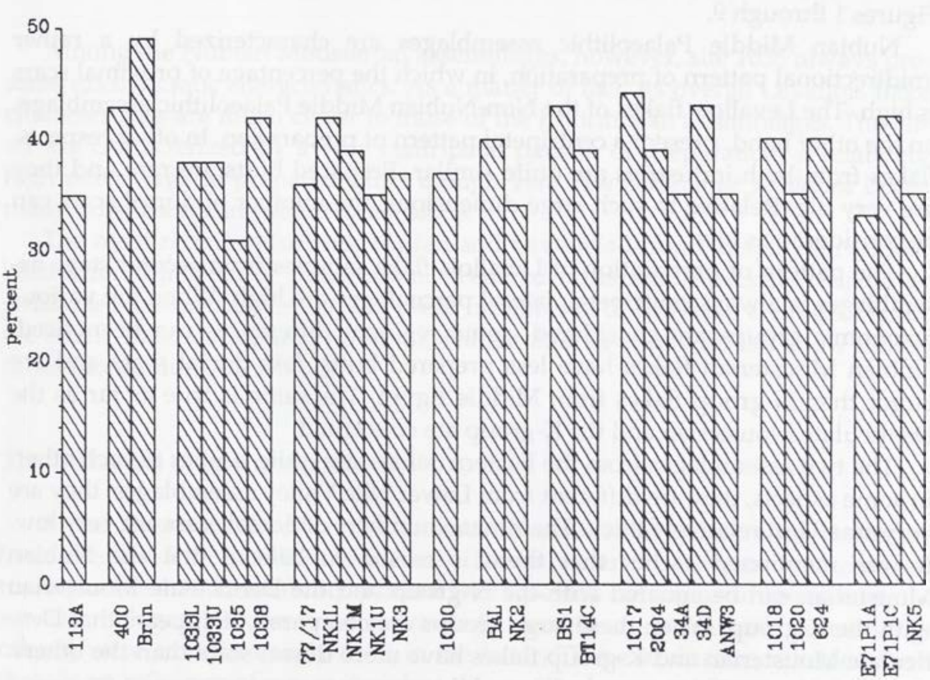

Fig. 2. Percentages of proximal scars on classical Levallois flakes.

Table 2

Main Levallois method use according to taxonomic groups.

Industries	Methods	Nubian 1	Nubian 2	Classical	Halfa (classical-related)
Nubian Middle Palaeolithic			×	×	
Non-Nubian Middle Palaeolithic				×	
Nubian Mousterian		×		×	
Denticulate Mousterian				×	
N-group		×		×	
K-group				×	
Eastern Sahara					
Mousterian				×	
MP with foliates				×	
Khormusan				×	
Halfan					×
Levallois-Idfuan					×

Variability within the classical and Halfa methods for flakes

The classical method and the Halfa method were used in further variability examinations. These involved an analysis of several Levallois flake attributes. Numbers of flakes analyzed are given in Table 1. Results are presented in Figures 1 through 9.

Nubian Middle Palaeolithic assemblages are characterized by a rather unidirectional pattern of preparation, in which the percentage of proximal scars is high. The Levallois flakes of the Non-Nubian Middle Palaeolithic assemblage, on the other hand, present a centripetal pattern of preparation. In other respects, flakes from both industries are quite similar. Prepared butts are rare and they are very big. Relative to such large dimensions, the number of dorsal scars can be considered as low.

The pattern of preparation of Levallois flake samples from second stage assemblages is always centripetal: lateral percentages are high. When the various taxonomic groups are considered, some regional differences can be noticed. Nubian Mousterian flakes have less prepared butts, less dorsal scars and are larger than N-group flakes from Middle Egypt. The same is true as far as the Denticulate Mousterian and the K-group are concerned.

The two assemblages from the Eastern Sahara are quite similar to each other. In some aspects, they are different from Lower Nile Valley assemblages: they are very small but relatively thick. Their mean numbers of dorsal scars are very low. It was mentioned earlier that there is reason to believe that the Nubian Mousterian can be equated with the N-group and the Denticulate Mousterian with the K-group. When these large groups are compared, it appears that Denticulate Mousterian and K-group flakes have more dorsal scars than the others. On the other hand, they are smaller and thinner.

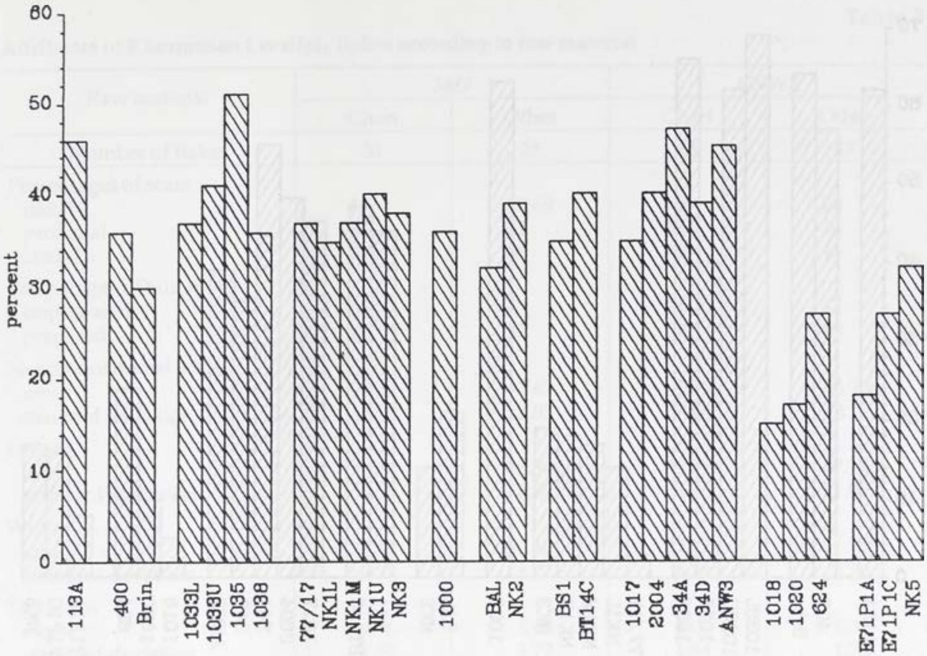

Fig. 3. Percentages of lateral scars on classical Levallois flakes.

Among the Nubian Mousterian assemblages, however, site 1035 always presents idiosyncratic characteristics. As a matter of fact, its overall Levallois flake characteristics are much closer to those of the Khormusan assemblages. The latter are characterized by a very centripetal pattern of preparation, a relatively high percentage of prepared butts though very few *chapeau de gendarme* butts, many dorsal scars and small dimensions.

The most recent industries, Halfan and Levallois-Idfuan, display an almost bidirectional pattern or preparation. Prepared butts and especially *chapeau de gendarme* butts are numerous. The mean numbers of dorsal scars are high. Flakes are small. In some aspects, however, Halfan and Levallois-Idfuan show minor differences among each other.

The influence of raw material

At the sites considered in this examination, different types of raw material have been used for Levallois reductions. The importance of the raw material factor in the observed variability pattern was assessed by means of two Khormusan assemblages. Different raw materials (ferrocrete sandstone and chert among others) were simultaneously used in the latter. This examination revealed that there is an influence of raw material on dimensional aspects, the number of dor-

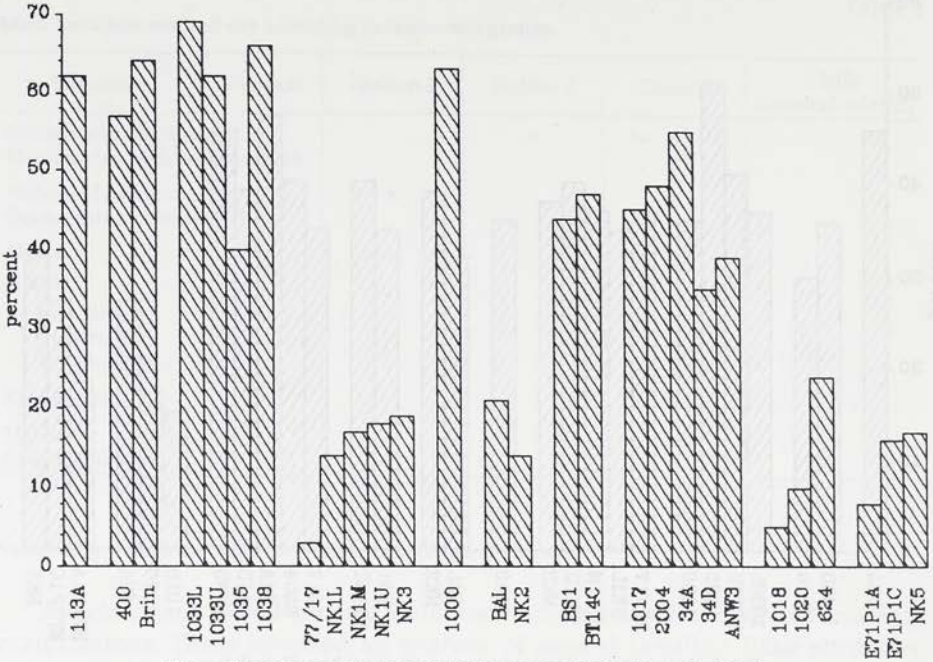

Fig. 4. Percentages of unprepared butts on classical Levallois flakes.

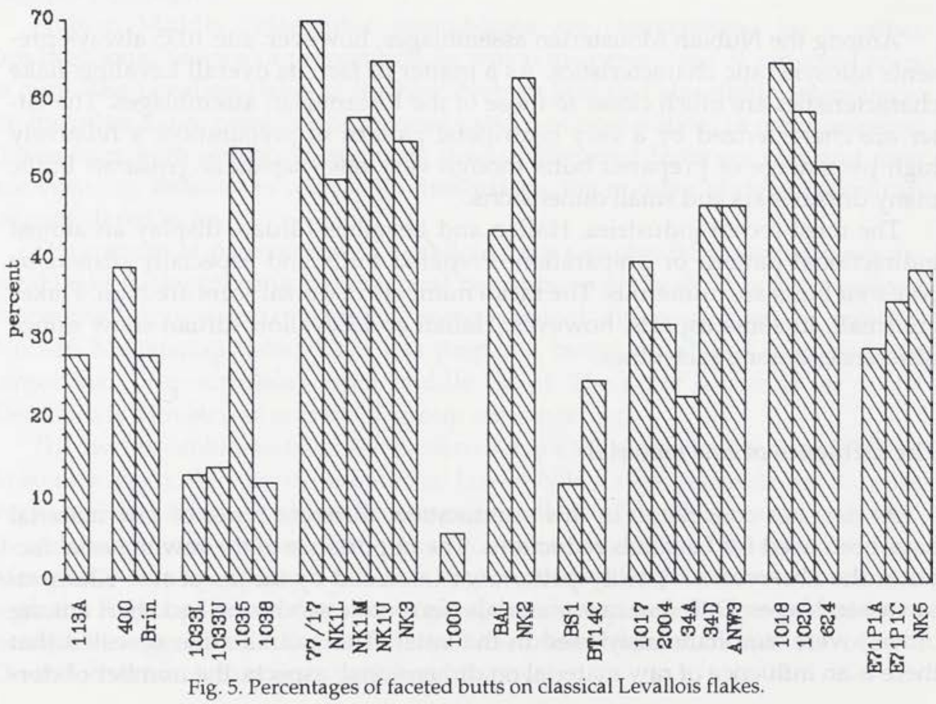

Fig. 5. Percentages of faceted butts on classical Levallois flakes.

Table 3

Attributes of Khormusan Levallois flakes according to raw material.

Raw material	34D		ANW3	
	Chert	Other	Chert	Other
Number of flakes	31	28	55	43
Percentages of scars				
distal	17	20.69	19	20
proximal	45	42	35	36
lateral	38	38	45	45
Percentages of butt types				
unprepared	33	42	34	42
prepared	49	37	58	49
Number of dorsal scars				
mean	8.19	7.67	7.76	6.90
standard deviation	2.71	2.03	2.40	2.17
Length				
mean	32.97	38.54	39.71	47.19
standard deviation	9.58	8.59	9.93	11.99
Width				
mean	24.87	32.40	27.77	31.72
standard deviation	7.31	8.91	8.31	6.79
Thickness				
mean	4.46	5.65	5.03	6.32
standard deviation	1.79	1.72	1.64	1.78

Other is ferrocrete sandstone (site 34D) or Precambrian quartzite (site ANW3). Percentages of scars per sector were calculated according to the system developed by Crew (1975: 13). By unprepared butts, I understand flat and dihedral butts. Prepared butts are faceted and *chapeau de gendarme* butts. Percentages of butt types may not always add up to 100, since some rare types are not included in these counts.

sal scars and butt preparation (Table 3). The pattern of preparation, on the other hand, is not affected. This evidence allows us to explain the overall regional differences for the second stage. Indeed, ferrocrete sandstone was used in Nubia, whereas chert was the preferred raw material in Egypt. In the Eastern Sahara, a coarse quartzitic sandstone was mainly used.

Not only the type of raw material, but also the size and form in which it occurs is of importance. The size difference between Halfa and Levallois-Idfuan flakes, in both cases almost exclusively out of chert, are likely to be due to this factor. In the region where the Halfan occurs, chert pebbles available for use are rather small (Marks 1968c: 459).

The raw material factor must certainly be held responsible for a certain amount of variability. Nevertheless, it is also clear that another part of the variation cannot be explained in terms of differences in raw material use. The pattern of preparation has been shown not to be affected by that parameter. Nevertheless, important variation in the disposition of dorsal scars is attested. Even changes in dimensional aspects, which are the most sensitive to the raw material factor, are not always related to the latter. This is clearly shown by the Middle Egypt second stage assemblages. At Nazlet Khater, similar chert nodules were used for the manufacture of Levallois flakes at three sites. The Nazlet Khater 2 flakes, however, are smaller than those of Nazlet Khater 1 and Nazlet Khater 3.

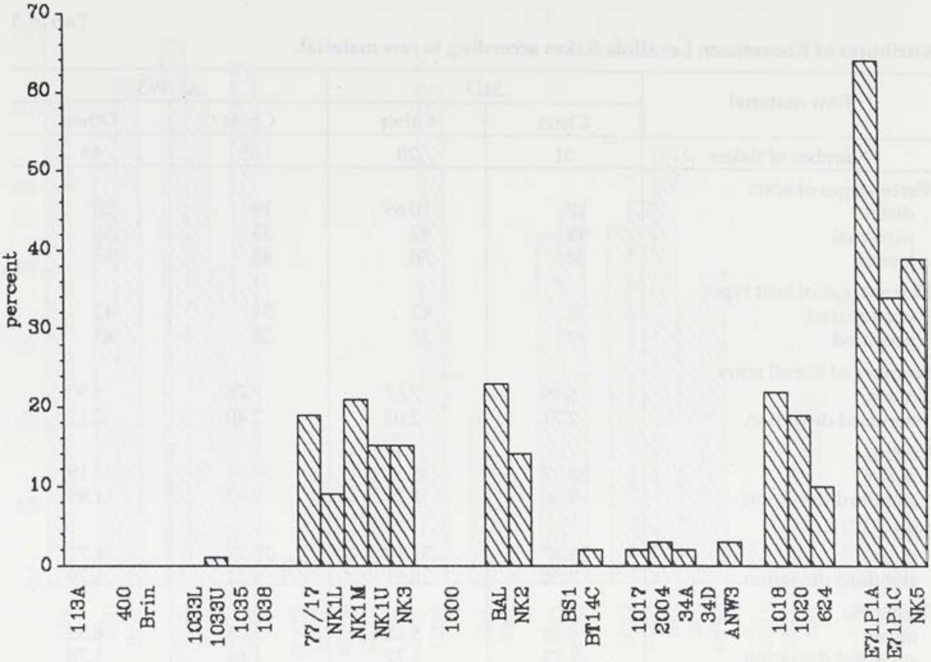

Fig. 6. Percentages of *chapeau de gendarme* butts on classical Levallois flakes.

Diachronous and synchronous Levallois variability

A change through time, largely independent of raw material constraints, is clearly attested both in the use of Levallois methods and in classical Levallois flake attributes. As far as the latter are concerned, there is a change in the pattern of preparation, prepared butt frequencies and dimensions. In later periods, more "delicate" Levallois flakes are produced.

During the Early Middle Palaeolithic, inter-industrial variation can not be detected, except for a slight difference in the pattern of preparation. However, both industries differ in terms of the Levallois methods used. Inter-industrial variation, both in method-use and classical flake attributes, is beginning to show up during the second stage, between the Nubian Mousterian/N-group and the Denticulate Mousterian/K-group. Regional differences between Nubia and Egypt are likely to be due to a differential use of raw material. The Eastern Sahara assemblages are in several respects different from those of the Lower Nile Valley.

In the Late Middle Palaeolithic, the Nubian 1 Levallois method disappears from the Nile Valley. The transitional industries, Halfan and Levallois-Idfuan, both rely on the same Levallois method. Their overall Levallois flake characteristics are reminiscent of those of second stage Denticulate Mousterian/

Fig. 7. Mean numbers of dorsal scars of classical Levallois flakes. Lines represent one standard deviation.

K-group assemblages. It seems indeed that the Halfa method is rooted in this particular classical Levallois method and can therefore be called a classical-related method.

Conclusion

The reduction strategies of Middle Palaeolithic industries from the Lower Nile Valley and the Eastern Sahara are for a large part based on the Levallois concept. Within that general concept, variations are attested at different levels. On the one hand, different Levallois methods have been used. On the other hand, a complex variability has been observed within the endproducts – Levallois flakes – manufactured according to one particular method.

There is evidence that, from the second stage of the Middle Palaeolithic on, the pattern of variability in classical Levallois flake samples does largely reflect the various taxonomic groups present in this region. This observation is of importance since it provides us with a more extended basis for taxonomic classification. It also invites us to critically consider earlier classifications. These statements can be illustrated with several examples.

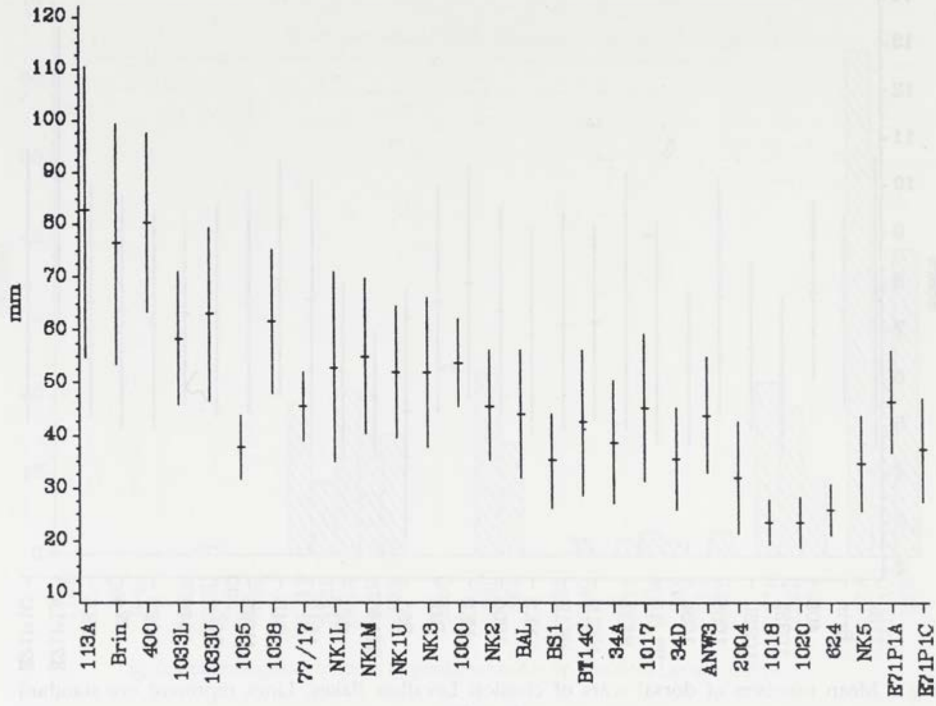

Fig. 8. Mean length of classical Levallois flakes. Lines represent one standard deviation.

The Nazlet Khater 5 assemblage, which remained undetermined in Table 1, may on the basis of its Levallois flake characteristics be integrated within the Levallois-Idfuan.

The peculiar position of the 1035 assemblage within the Nubian Mousterian was already referred to. Since its Levallois flake characteristics are very close to those of Khormusan assemblages, it could be integrated within the Khormusan. In other respects such as Levallois method use, typology, raw material use and site location, however, it is indeed close to Nubian Mousterian assemblages. Assemblage 1035 seems to suggest that the Khormusan has evolved out of the Nubian Mousterian. During this evolution, the Nubian 1 method disappears and occurs only very sporadically in the Khormusan. This phenomenon can be explained in economic terms. Since this method was very raw material intensive and since raw material was much more difficult to procure (in view of the sites being located in the floodplain), the Nubian 1 method had to be abandoned.

As far as the nature of Eastern Sahara Middle Palaeolithic assemblages is concerned, it appears that both assemblages studied are very similar. This suggests that they are to be inscribed in the same industrial tradition. The latter is different from Lower Nile Valley industries of the second stage. The moderate presence of the Nubian 1 method in the Eastern Sahara assemblages, however, suggest some Nile Valley affiliation.

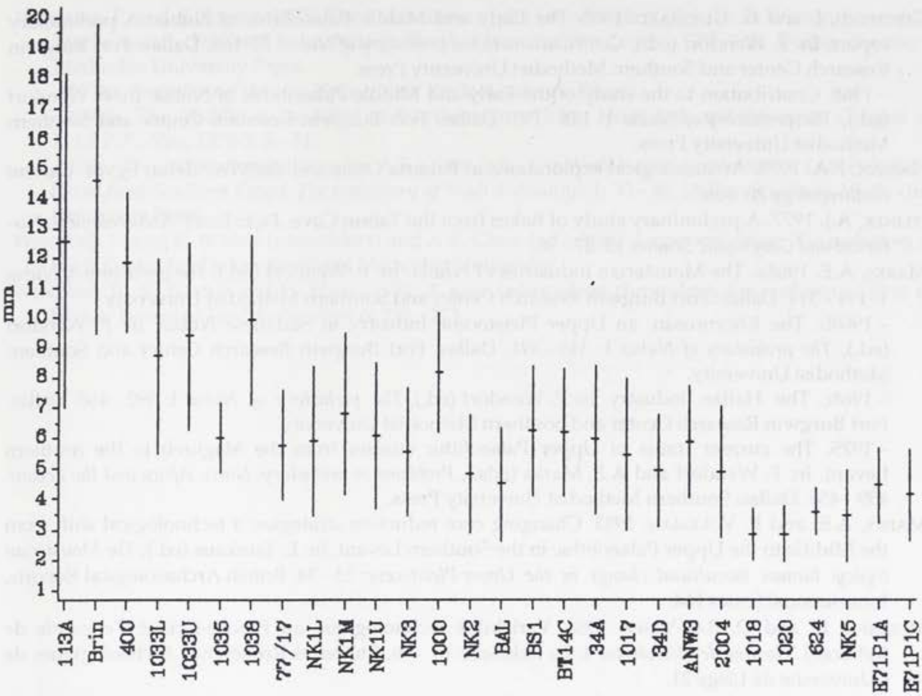

Fig. 9. Mean thickness of classical Levallois flakes. Lines represent one standard deviation.

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Environmental and climatic change in the northern part of the Eastern Desert during Middle Palaeolithic and Neolithic times

The mountainous regions of the northern part of the Egyptian Eastern Desert are characterized by a multitude of widespread, partly interlocked systems of pediments and wadi-sediments. In search of possibilities for relative dating methods of the origin and the development of these geomorphologic forms, the cooperation of prehistoric and geomorphologic studies is of particular importance. Especially the palaeo-geographic reconstruction of a repeated alternation of erosion and accumulation can provide clues to former climatic and environmental conditions. The general value of a cooperation between geomorphologic and prehistoric studies in Northern Africa had been emphasized by Gabriel (1977; 1979; 1986).

To exemplify the geomorpho-dynamic processes of the Eastern Desert, brief account of results obtained on the southeastern slope of the Gebel Galala el-Qibliya (Andres 1987), the region of Wadi Deir Bolos and its drainage system, is pointed out here. Wadi Deir Bolos can easily be detected even in satellite maps, since in contrast to most of the adjacent wadis, it does not follow a W-E direction to the Gulf of Suez, but extends from the SW to the SE, probably along a tectonic fault-line. The investigations also include an affluent, which flows from the NE into the Wadi Deir. For better map orientation this wadi has been titled "Northern Wadi" (Fig. 1).

Within the eastern slope of the Gebel Galala el-Qibliya two steps of terraces had been formed in eocene and cretaceous chalks; they limit the study area to the NW. To the E and SE they are immediately followed by Nubian Sandstone. Miocene and pliocene sediments mark the transition to the coastal fringe. The drainage area of Wadi Deir Bolos is characterized by extended pediments of old

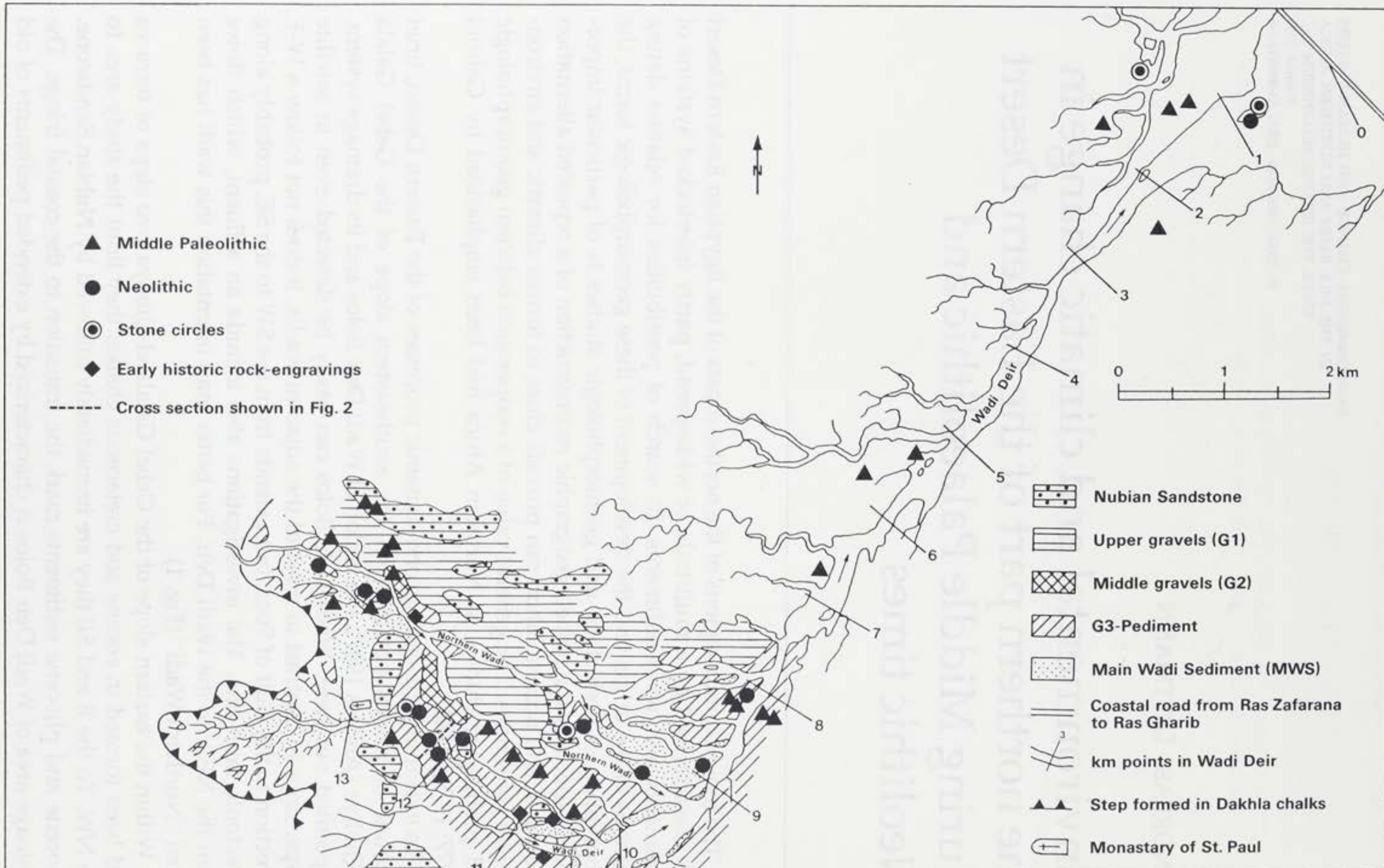

Fig. 1. Prehistoric traces of occupation with regard to distribution of pediments and wadi sediments in Wadi Deir, Eastern Desert.

gravels, which – especially in the middle and upper sections – are deeply dissected by wadi channels. Altogether three different levels of pediments can be recognized: The two upper levels, the G1- and G2-gravels, do not appear in all areas. The lower G3-gravels, however, form the pediments which are dissected by the recent wadi-channels (Figs. 1 and 2). The gravel material of the pediments is on the whole unsorted and more or less rounded.

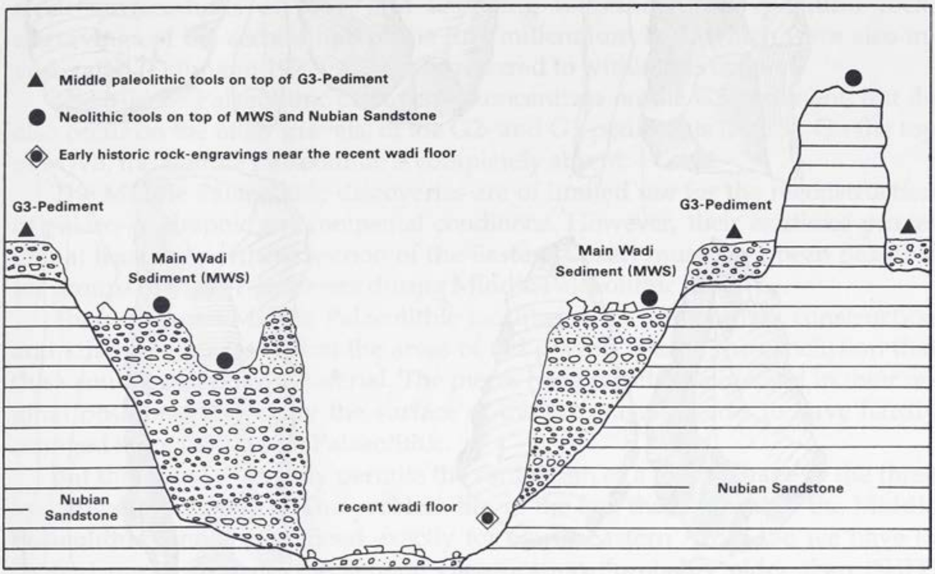

Fig. 2. Superelevated cross section through Upper Wadi Deir.

The recent channels of the wadis are deeply cut into the G3-pediment. They partly are following the course of older drainage systems within the Nubian Sandstone. Especially in the upper section of the wadis, these cuts are characterized by sediments of a recent wadi filling, which in the following will be titled "Main Wadi Sediment" (MWS) (Andres 1987). The MWS have also been cut; within the Northern Wadi it is still widely distributed, but within the upper Wadi Deir it is only partly preserved.

The structure of the MWS differs completely from that of the older gravels. Mostly horizontal levels and interlocked "fining-up" layers indicate that the MWS was formed by regular fluvial processes. These were characterized by an extreme overloading as well as by water flow, which started heavily and slowed down rapidly.

Between the MWS and the actual wadi-floor a terrace exists which is 1 m to 1.5 m high. This terrace originated when the MWS had already been cut. It represents the very recent product of geomorpho-dynamic processes within the drainage area of Wadi Deir.

Under present climatic conditions the drainage of the study area is characterized by single, episodic events of heavy wadi discharge and by dislocation of

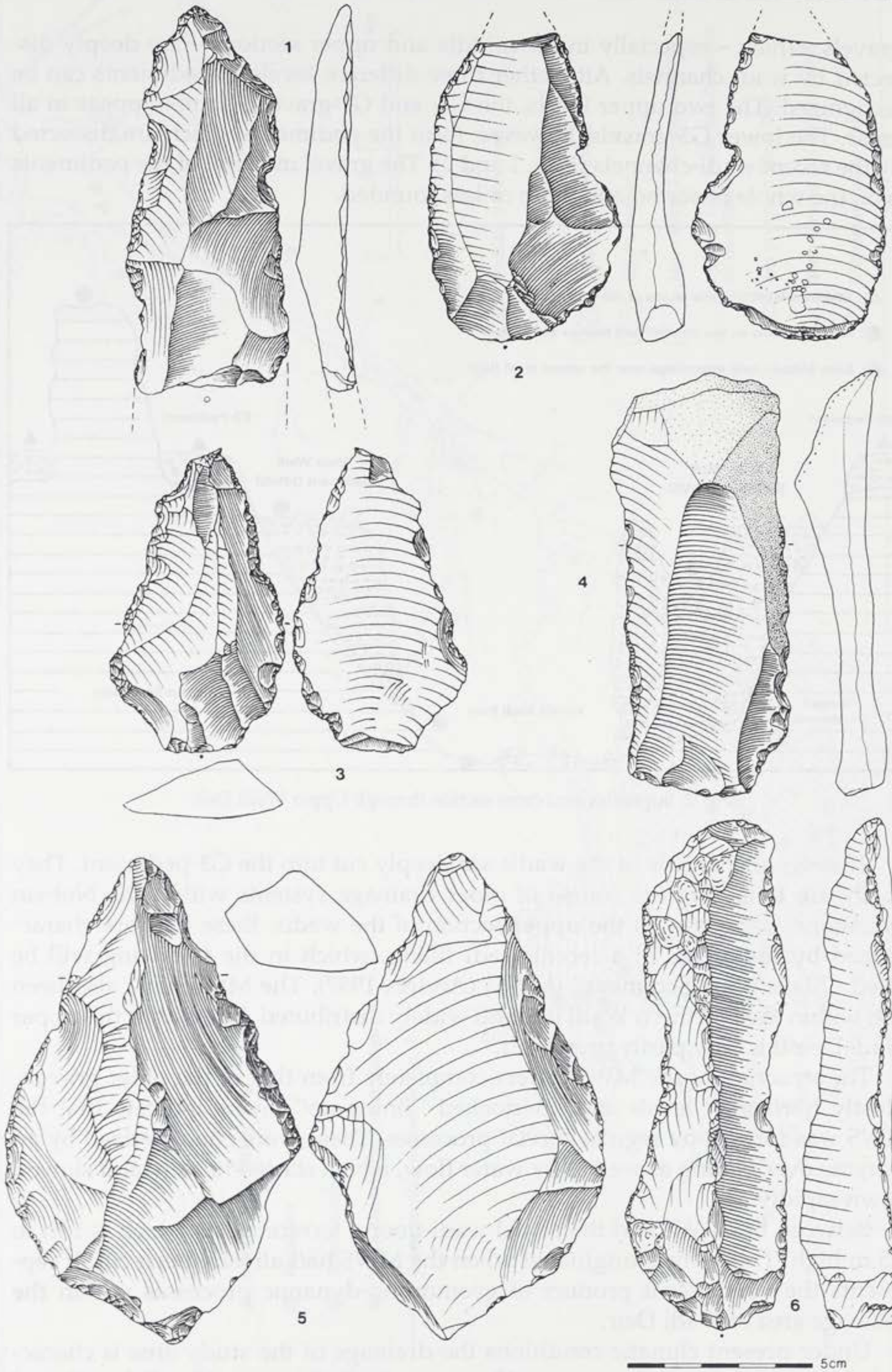

Fig. 3. Middle Palaeolithic tools from Upper Wadi Deir.

material being restricted to the actual wadi floor. Vegetation hardly exists but within the upper Wadi Deir a small spring is enclosed by the buildings of St. Paul's Monastery. The significance of this spring, should not be neglected during a palaeo-geographic reconstruction of former environmental conditions.

Within the area of Wadi Deir, traces of former settlement have been documented for both, the Middle Palaeolithic and Neolithic (Fig. 1). They mostly include surface-finds of tools and knapping workshops. The plentiful rock-engravings of the second half of the first millennium B.C., which were also investigated (Dittmann 1990), cannot be referred to within this context.

The Middle Palaeolithic discoveries concentrate on the G3-pediment, but do also occur on the older gravels, of the G2- and G1-pediments (Fig. 3). On the top of MWS, the Middle Palaeolithic is completely absent.

The Middle Palaeolithic discoveries are of limited use for the reconstruction of palaeo-geographic environmental conditions. However, their existence proves that at least the northern section of the Eastern Desert must have been passable for groups of hunter-gatherers during Middle Palaeolithic times.

The numerous Middle Palaeolithic localities with undisturbed construction and knapping places within the areas of old gravels lead to the conclusion that this cannot be relocated material. The pieces have mostly maintained in their orginal positions. Especially the surface of the G3-gravels seems to have hardly changed since the Middle Palaeolithic.

But this conclusion only permits the estimation of a minimal age of the three known pediment levels. The problem lies in the fact that the end of the Middle Palaeolithic cannot be defined exactly for North-Eastern Africa. So we have to content ourselves with the general classification "probably older than 30,000 B.C." A differentiation of the pediment-levels G1, G2, and G3 according to their age on the basis of prehistoric discoveries is not possible.

However, it is worth mentioning that the Middle Palaeolithic tools and knapping-places on top of the G3-gravels are concentrated where this pediment sinks down to the MWS-level or directly to the recent wadi floor. Such a concentration at the immediate margins of the wadi channels could be a proof for the fact that the basic structure of the actual drainage-system had already been developed during the Middle Palaeolithic.

However, the geomorphologic importance of the Middle Palaeolithic discoveries mainly lies in the determination of the relations between the MWS and the G3-pediment. The fact that Middle Palaeolithic discoveries do not occur on the top of the MWS suggests that these sediments did not exist during Middle Palaeolithic times.

Especially the sedimentological results seem to prove that the MWS-sedimentation took place after the end of a humid period: 95% of the MWS materials consist of chalk from the upper drainage area of the wadis, while Nubian Sandstone hardly occurs. During a humid period this material was fixed to be a protective vegetation cover on the slopes in the upper wadis.

Later the drying-up of the region truly took the character of an ecological catastrophe: the protective vegetation cover disappeared, the loose deposits fell victim to erosion and their deposition took place within the upper and middle sections of the drainage systems of the G3-gravels. However, these fillings of the valleys never reached up to the levels of the older G3-gravels.

Indications of a humid phase, which existed before the deposition of the MWS, are not only furnished by relicts of fossil soils on the G3-gravels, but also by the dating of samples of sinter. These were taken from the upper Wadi Deir. The sinter was developed at a time when a spring within this area became so active that open water surfaces and sinter terraces were built up. The C-14 dates of the sinter are 26,350 and 26,900 B.C. (Andres 1987).

Heavily sintered older gravels were also found in the Northern Wadi and dated to 26,000 B.C. They were formed when the G3-pediment had already been deeply cut, that is to say not long before the deposition of the MWS. At this time large amounts of chalk-carrying water flooded along the bottom of the G3-gravels. Biogene CO_2 was largely responsible for the deposition of the chalk, so that the existence of a relatively rich vegetation may be assumed.

The sinter datings hint at the existence of a climatically favorable humid period at about 26,000 B.P. However, we cannot say when this humid period began, when it finished and how long it already had existed before 26,000 B.P. (Table 1). Therefore, we cannot definitely decide, whether the Middle Palaeolithic discoveries belong to the same or another, earlier, humid period.

It must be emphasized that shortly after the deposition of the MWS its erosion began without any climatic change. The cutting of the MWS occurred during arid conditions. After the slopes had been freed from fine material down to the rock, the lack of further erosive-materials immediately led to the cutting of the MWS in the wadis during episodic or periodic floods.

Neolithic finds provide information about the period after the deposition of the MWS: Their existence on the surface of these deposits proves that the MWS must already have existed during the Neolithic. Moreover, finds within cuts and bulges of the sediment document that its cutting was already more or less finished during this time. The Neolithic finds concentrate mainly on the surface of the MWS, but also frequently occur on G3-gravels and on the higher levels within the Nubian Sandstone (Figs. 1 and 2).

Important for the MWS, and providing a relative dating for deposits and recuttings, is a Neolithic occupation site within the upper Wadi Deir at km 12.2 (Fig. 1). It consists of relicts in an abri which roof has fallen, and conservated parts of stratified layers. This abri was formed, within MWS-deposits, which here extend to 13 m above the wadi bottom. The site is marked by a formation of a sediment pillar (Fig. 2) connected to the deposits on the margin of the wadi by two dumps of loose and dislocated material which are relics of the collapsed shelter. One of these two dumps faces north-east, the other south-west. During the investigations the site attracted attention because of eroded and dislocated pieces of bones and charcoal within the actual wadi bottom. Unfortunately, it soon turned out that the organic material had not, as was hoped, been incorporated during the deposition of the MWS. Thus it became evident that a dating of the site could not furnish information about the time of deposition of the MWS, but only about the minimum age of its recutting.

The shelter's appearance at the time of its occupation must already have been similar to that of today. Stratigraphic indications hint that there once was a continuous bottom surface between the stratified charcoal layers of the eastern and western side. The stratified layers on the western side are covered by great, compact sediment-blocks which do not show the typical horizontal stratification, but have slid down from their original position. The structure of their stratification is similar to the upper layers of the MWS-deposits encountered towards the edge of the wadi. The sediment-blocks here lie directly on the stratified layers with Neolithic finds and it seems that an overhang which was formed within the MWS served as a resting-place. Close to the sediment pillar the sediment layers are, however, not covered by MWS-sediment-blocks but by loose material from the nus. Either the sediment-pillar was already istolated, or there was an arc-like connection to the deposits at the edge of the valley. Today it is impossible to know which of these two possibilities is the most probable. In order to reconstruct the appearance of the site at the time of occupation the possibility of the existence of an arc-like connection was assumed.

C-14-datings exist for five stratified layers of the site. After a dendrochronologic calibration four clearly distinguishable occupation periods emerged:

Layer WR-4 on the western side belongs to the first occupation period between about 3,630 and 3,360 B.C. The second period between 3,050 and 2,690 B.C. is characterized in particular by numerous fragments of animal bones (nubian wild donkey, ibex, sheep/goat). Layers belonging to this period are WL-1, WL-2, WM-1 and WM-2 on the western side as well as OL-3 on the eastern side of the abri. Shortly afterwards, between 2,660 and 2,390 B.C., the third settlement period follows with layers OL-2 and OL-1 on the eastern side, which show stratigraphic connections with WR-3 and WR-2,5 on the western side. The stratified layers WR-2 and WR-1 between about 2,150 and 1,920 B.C., represents the fourth period, the last documentable phase of occupation.

The positions of the stratified layers WR-4 and OL-3, which are situated only 4.5 - 4.0 m above the actual wadi floor, proves that the MWS must have been cut down already to this level at about 3,700 B.C. Probably it had been cut much more deeply. Considering the fact that Late Neolithic camp sites most probably were not founded on the same level as the former gully, it can be concluded that during the first occupation period the MWS was cut at least to a level of about 1.5 - 3.0 m above the recent wadi floor.

The superelevated profile of a gross section through the upper Wadi Deir illustrates a synopsis of the present results (Fig. 2 and Table 1). The restriction of the Middle Palaeolithic discoveries to the G3-pediment and the concentration of the Neolithic discoveries to the MWS and higher landmarks is clearly shown. Also marked are post-Neolithic rock-engravings, which positions show that there have been no important changes of the level of the wadi bottoms since the second half of the first millennium B.C.

The investigations carried out within the region of Wadi Deir prove that numerous palaeo-geographic and palaeo-climatic questions can only be answered by a combination of geomorphologic and prehistoric research. But there are

Table 1

Climatic conditions and human culture in the later prehistory of the northern part of the Eastern Desert, Egypt.

Time	Climatic conditions	Geomorpho-dynamic processes	Human culture
Recent to proto-historic	Arid	Episodical wadi floods (one event during 5 - 6 years). Erosion at the margin of older sediments.	Rock-engravings
4,000 to 2,000 B.C.	Semi arid	Periodical wadi floods. No important transformation processes.	Neolithic occupation (hunting, stock breeding sheep and goat)
After 20,000 B.P.?	Arid	Episodical wadi floods. Dissection and erosion of the MWS.	
After 26,000 B.P.	Arid	Episodical wadi floods. Erosion on the slopes and accumulation of the MWS in the upper and middle sections of the wadis.	?
About 26,000 B.P.	Semi arid to semi humid	Longer, periodical wadi floods. Open water surfaces and development of sinter. No important geomorphic transformation processes.	?
Before 26,000 B.P.	? (Semi arid)	Dissection of the G3-pediment.	Middle Palaeolithic occupation

limits of such a cooperation: A relative dating especially of the higher, that is to say, older geomorphologic forms (pediments) is impossible at such places where exact differentiations of the prehistoric materials into different phases can not be effected. This holds true especially where older surface profiles are concerned. On the other hand not all pre- and protohistoric results can be converted to a geomorphological context.

In the overlapping fields of both sciences it is the task of palaeo-geography to lay out a rough and temporary frame for early climatic and environmental conditions; it is for prehistory to allocate the necessary cultural significance to this frame.

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Holocene vegetation of the Eastern Sahara: charcoal from prehistoric sites

Introduction

The Eastern Sahara, *i.e.* Egypt and Northern Sudan West of the Nile, is one of the most arid regions of the world. The larger part of the area is an absolute desert with almost no vegetation (Fig. 1) and one can easily travel for hundreds of kilometers without coming across a single plant. In contrast to this harshness, a great number of prehistoric settlement remains act as evidence to indicate rich environmental resources in the past. Many studies on quaternary sediments, on prehistory and on faunal remains have stated a more humid period for the Eastern Sahara during the Early and Middle Holocene coinciding with a savanna-like environment. Yet, direct evidence of such savanna was missing and the reconstruction of the vegetational changes were based almost entirely on data provided by other disciplines (Wickens 1975; 1982). The interdisciplinary project "Settlement history of the Eastern Sahara" (B.O.S.) of the University of Cologne, searches into the relations of Neolithic culture development and the changes of natural environment during the Early and Middle Holocene (Kuper 1981; 1988; see also the contributions of Cziesla, Hahn, Keding, Kröpelin, Kuper and Schuck, this volume), relying especially on botanical evidence. Funded by the German Research Foundation, 514 prehistoric sites along a north-south transect of 1300 km were registered and partly excavated in the years 1980 - 1985. During the field campaigns more than 1500 botanical samples were recovered, most of them consisting of charred wood.

In the past, most of the research concerning Holocene Saharan Vegetation history has been conducted in the Central Sahara. The first palynological studies interpreted the presence of mediterranean and temperate elements in the Late Pleistocene and Holocene pollen spectra as resulting from northern influence

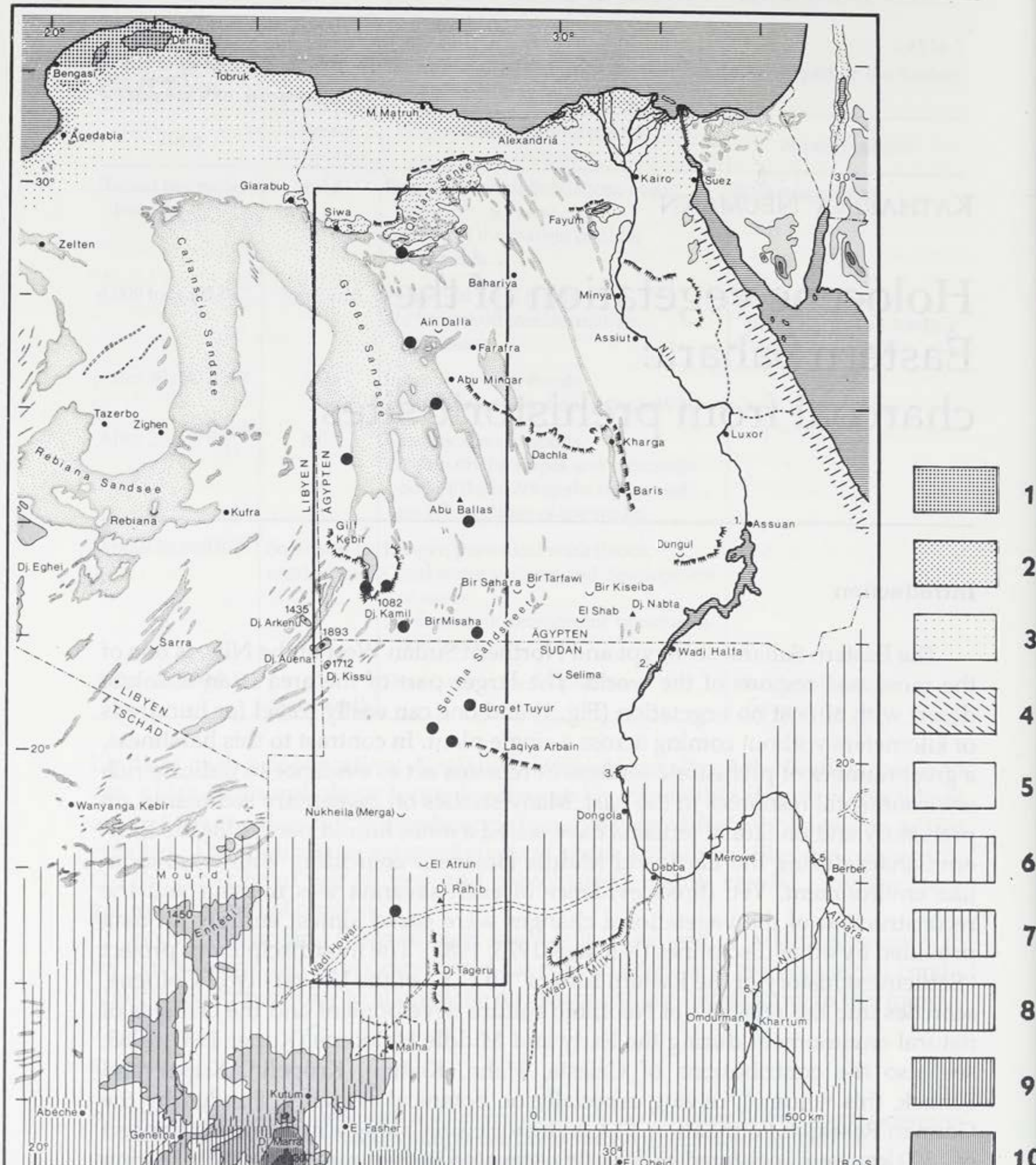

Fig. 1. The Eastern Sahara. Vegetation zones and areas where identifiable charcoal was found (after Kassas 1971; UNESCO/AETFAT/UNSO 1983; and Wickens 1982, modified).
Explanations for Figures 1 - 3;

1: mediterranean sclerophyllous forest; 2: sub-mediterranean anthropic vegetation; 3: contracted desert vegetation, northern type with dwarf shrubs, rainfall in winter; 4: coastal desert along the Red Sea; 5: absolute desert; 6: contracted desert vegetation, southern type with grasses and tropical trees and shrubs, rainfall in summer; 7: *Acacia* desert scrub; 8: thorn savanna; 9 : deciduous savanna; 10: montane vegetation of Jebel Marra.

(Quézel and Martinez 1958/59; van Campo *et al.* 1964). Later, when the recent pollen rain was investigated, it became clear that most of these "northern" pollen were due to long-distance transport. It was evident that additional methods were needed to ascertain a more distinct picture of the plant cover in the past. The identification of charcoal from prehistoric sites provides a good tool to reconstruct the woody vegetation at a particular place. In general, pieces of charred wood can be regarded as direct evidence that this species was growing on the site or close by. This method is complementary to palynology and can give precise information on the local woody flora, or at least on that part of it that was selected by man for firewood. Charcoal samples can be radiocarbon-dated after microscopic examination which furnishes the possibility of an exact temporal association of each sample.

In contrast to Europe with its elaborate archaeobotanical research, there are only a few scattered studies on botanical macro-remains from African sites. The first attempts on the identification of charcoal failed to result in any broader application because of difficulties with preparation. In the 1960's, Couvert (1970) embedded the charcoal pieces into synthetic resin to produce thin-cuts and also tried to reconstruct past climate and vegetation with the help of archaeobotanical data (Couvert 1976). The use of scanning electron microscopy (SEM) has opened new perspectives for the identification and documentation of botanical macro-remains. It allows to take well-focused photographs of the irregular charcoal surfaces without complicated preparations and also observation of even the finest anatomical details.

This paper refers only the general results of the archaeobotanical investigations. A detailed version will be published elsewhere (Neumann 1989). It includes C-14 dates, the complete results, figures of recent and reconstructed vegetation types and an atlas of the wood anatomy of 27 taxa.

Recent climate and vegetation

There are only a few meteorological stations in the Eastern Sahara – four in Egypt, none in the Sudan – and most of the data have to be extrapolated from adjacent stations. The area is affected by two climatic regimes: 1) In the north the mediterranean one with winter rains; 2) Approximately from 22°N southwards the tropical regime with higher temperatures and summer rains. Precipitations decrease from 50 - 100 mm at the northern and southern margins to almost zero in the centre (Walter and Lieth 1967). Mean annual temperatures rise from 10°C in the north (Siwa) to 28°C (Khartoum) in the south. In Egypt winter frosts are common (Alaily *et al.* 1987), which set distribution limits for thermophil tropical plant species.

The greater part of the research area is a rainless desert without periodical precipitations where perennial plant life is only found in cases depending completely on fossil groundwater (Fig. 1). Outside the oases an "accidental" vegetation may occur, consisting of potential perennials which can survive as long as there is some soil moisture derived from the incidental rains (Kassas 1971). However, the greatest part of the Eastern Sahara is completely bare of vegetation.

In the southwestern corner of Egypt there are two mountain areas which receive slightly higher rainfall supplying a comparatively richer vegetation than the surrounding plains. In some of the wadis which dissect the northwestern and the southeastern cliffs of the Gilf Kebir plateau, trees (*Acacia tortilis* subsp. *raddiana, Acacia ehrenbergiana, Maerua crassifolia* and *Balanites aegyptiaca*) and accidental shrubs can be found (Alaily *et al.* 1987). For Jebel Uweinat, Léonard (1969) even states that he collected more than 100 plant species during a three month field survey. Above 1250 m he found mediterranean elements whereas in the lower lying parts Saharo-Sindian and Sudano-Sahelian species prevail. Another mountain, Jebel Kissu, with a height of more than 1700 m, is situated 50 km southeast of Jebel Uweinat. It carries a very poor vegetation which is completely unknown up to now.

North of Laqiya Arba'in, three connected wadis stretch along the sandstone escarpments: Laqiya Valley, Wadi Shaw and Wadi Sahal. At the lower lying parts of the valleys there are groundwater-dependent shrubs of *Acacia ehrenbergiana, Capparis decidua* and hummocks of *Tamarix articulata,* which can reach a maximum height of 12 m. In smaller runnels coming down the escarpment, some acacias are growing which seem to be supported merely by precipitations, despite the fact that the mean annual rainfall probably does not exceed 5 - 10 mm. Further south, areas with accidental vegetation increase and solitary specimens of *Maerua crassifolia* and *Capparis decidua* are found on the plains where they can draw some water from the cleft sandstone.

Wadi Howar is a band of vegetation 2 - 5 km wide that stretches 640 km from the mountainous regions between Ennedi and Jebel Marra into the southern Libyan Desert. Its southwestern part is situated in the Sahelian *Acacia* desert scrub while in the greater part of the wadi desert conditions prevail. The vegetation between 25°E and 27°25'E (Jebel Rahib) is monotonous and comprises only four woody species: *Acacia ehrenbergiana, Acacia tortilis* subsp. *raddiana, Capparis decidua* and *Salvadora persica.* East of Jebel Rahib, the wadi is bare of plant growth. In the sandy areas south of Wadi Howar and west of Jebel Tageru, the perennial grass *Panicum turgidum* gains a diffuse distribution and in the depressions scattered trees are found. This "Saharan savanna", already described by Schulz (1988) for W-Africa, indicates that the southern border of the Sahara is reached.

Charcoal identification: material and methods

Flotation of the desiccated charcoal is not possible because the pieces disintegrate to dust during the procedure. On the site the charcoal was therefore separated from the sediment by dry sieving with 2 mm and 1 mm mesh width and packed carefully in sterile sand or it was taken home with parts of the coarser sediment and picked out by hand. 320 representative samples from different sites, covering the time span from 9,000 to 3,300 b.p., were chosen to examination, containing altogether more than 10,000 pieces. The smaller samples (< 200 - 300 pieces) were identified completely whereas 10 - 30% were taken as random samples from the larger ones after the method described by van der Veen and Fieller (1982).

The charcoal pieces with the size from 1 mm to 15 mm were fractured manually into the diagnostic relevant transverse, tangential and radial planes. For the SEM examination, the pieces were fixed on aluminium stubs with conductive carbon cement and coated with gold. Yet, for "everyday" determination most of the charcoal pieces had not to be treated in this way. Instead, after fracturing they were transferred into a small plastic box filled with fine sand which was mounted on a slide. The sand allows fixing the pieces in a proper position for the examination under an incident light microscope. Furthermore, these charcoal samples can be C-14 dated afterwards. As the diagnostic relevant features do not change significantly during the charring process, a slide collection of recent woody species can be used for checking the identity of the charcoal.

The interpretation is based on comparison of the species composition in the archaeological samples with that of recent plant communities. The ecological conditions under which the trees and shrubs grow today and information on environmental factors of the sites themselves furnish the main frame for the reconstruction of the former vegetation. No associations in terms of plant sociology can be reconstructed because of three reasons: 1) The herbal flora is not represented in the samples; 2) Plant sociological studies on the present vegetation of the Sahara and the Sahel are very limited; 3) Savanna and even desert vegetation have been altered by man to a very large extent which limits the use of present types as models for the past. Rather, I prefer using the "formations": these are plant communities defined by the presence of dominant plant species. There is a good chance that these dominants will appear also in the charcoal samples, especially when they make good firewood.

Results

Northern Egypt down to 25°N

From this region 48 samples were examined, coming from Sitra in the south of the Qattara depression and from the southwestern and eastern edges of the Great Sand Sea. They cover a time span from 9,000 b.p. to 6,150 b.p. with one exception from the western Sandsea which was dated around 5,400 b.p. The species combination is poor (*Tamarix sp., Acacia sp.* and *Chenopodiaceae*) and there are no differences between the Early Holocene and the Middle Holocene samples. It seems that the vegetation consisted of the same elements as today, but with a wider distribution. A contracted desert vegetation of trees and shrubs was growing along the escarpments, in wadis and depressions. The slightly higher precipitations, indicated by the occurrence of woody plants, supported also dwarf shrubs, grasses and herbs the remains of which unfortunately have not been preserved. Yet, pollen diagrams from Saudi-Arabia show Gramineae, Cyperaceae and a number of dwarf shrubs as evidence for a semi-desert similar to the north-eastern Sahara or the An Nafud/Saudi-Arabia (Schulz and Whitney 1986). Like the An Nafud today, the sandy areas of the Egyptian Sahara, especially the Great Sand Sea, were temporarily visited by nomads who found there a rich wildlife and pastures for their stock. Today this whole region is completely bare of plant life.

Abu Ballas / Mudpans

South of the Abu Ballas escarpment there is an area of deflation hollows filled with fine-clastic playa sediments dated between 10,000 and 6,400 b.p. which are interpreted as resulting from interacting eolian processes and flooding (Pachur and Braun 1980: 352).

The three sites, 83/39, 85/56 and 85/50, yielded very rich botanical material from which 99 samples were selected for examination. The results indicate a marked chance of vegetation and climate over a period of 1700 years. The species spectrum of 83/39 (dated by 8,200 b.p. with three C-14 dates) and of 85/56 (dated by 7,500 b.p. with eight C-14 dates) is quite poor. Like in the samples from the other parts of the Egyptian Sahara, acacias and tamarisks prevail, with additional presence of solitary pieces from *Maerua crassifolia, Leptadenia pyrotechnica* and Chenopodiaceae. This combination points to a contracted desert vegetation along runnels and in depressions as it has been described for the present Central Sahara by Schulz (1980: 40 - 43).

Around 7,000 b.p. climatic conditions changed, resulting in a richer species combination of the samples from site 85/50 (five C-14 dates between 7,000 and 6,500 b.p.). Besides *Acacia sp.* and *Tamarix sp.* still dominant in the samples, *Maerua crassifolia, Grewia tenax, Calotropis procera, Leptadenia pyrotechnica, Ziziphus sp.* and cf. *Cassia senna* appear. These are the northernmost outposts of the tropical savannas which were moving northwards and reached their maximum expansion during this period. Nevertheless, the vegetation at Mudpand was not a diffuse savanna as it is characteristic for the Sahel. Due to the cleft sandstone and the marked relief with high runoff, mudpans offered favorable conditions for Sahelian elements arranged in "contracted" patterns: this type of vegetation is characteristic for desert habitats which receive additional runoff water by means of which plant growth concentrates at the deeper-lying parts of the relief.

Some of the species found in the samples have edible fruits and propagation of these plant outside of their original distributions areas might have been supported by man. The occurrence of *Calotropis procera* points to a human disturbance of the natural vegetation; this species is regarded as an indicator for desertification (Batanouny 1983). A situation comparable to site 85/50 is found today in the Bayuda at the southern margins of the Libyan desert. Annual precipitations from 25 to 50 mm support an extrazonal Sahelian woody vegetation which is used by the nomads as pasture and for firewood and charcoal production (Pflaumbaum 1987: 24 - 25).

Gilf Kebir

The Gilf Kebir is a plateau of "Nubian" sandstone reaching 1000 m above sea level. Its southeastern cliffs are dissected by numerous wadis, in two of which, the Wadi el Akhdar (Arab. = *wadi* with the green floor) and the Wadi Bakht (Arab. = happy *wadi*) the main archaeological work was conducted. The lower parts of both wadis are filled with thick layers of playa sediments. The playas developed during the Early and Middle Holocene behind fossil dunes which blocked the wadi entrances (Kröpelin 1987; 1989). From the excavated charcoal samples, 46 were examined covering a time span from 7,700 b.p. to 4,300 b.p.

The most abundant taxon in the samples is *Tamarix sp*. This points to a more or less arid environment for the entire Early and Middle Holocene. The drier phases of this period witnessed a sparse tree cover whereas, during the moister phases, the vegetation may have consisted of dense stands of tamarisks *(Tamarix articulata?)* in the lower parts of the wadis. These "gallery forests" are known today from some wadis in the Hoggar and Tibesti (Quézel 1965: 179) and northern Egypt (Kassas 1952; Kassas and Iman 1954) under an average rainfall of 50 - 100 mm.

Although there is no evidence of a permanent groundwater table in Wadi el Akhdar and Wadi Bakht (Kröpelin 1989), the sandy layers of the playa sediments were capable of water storage and supplying the trees with sufficient moisture. Temporary pools, indicated by thick pelitic playa layers (Kröpelin 1987: 195 - 197) probably carried at their margins dense stands of sedges and other hygrophylous herbs mixed with *Tamarix*. Today we can find this plant community around shallow *guelti* in the wadis of the Central Saharan mountains (Quézel 1965: 203).

The second dominant taxon in the samples, though much less abundant, is *Ziziphus sp.* A clear identification of that wood up to the species level as it was formerly stated (Neumann 1987: 184) is not possible because of the quantitative changes which occur during the charring process. Probably the wood does not belong to the Irano-Turanian *Z. lotus* but rather to one of the Sahelian species *Z. mauritiana* or *Z. spina-christi*. Because of their edible fruits, both might have been introduced from the south by man. Today, *Z. mauritiana* is a common plant in the Ennedi where it sometimes forms impenetrable thickets (Carvalho and Gillet 1960: 73). *Z. spina-christi* occurs as a rare element of the desert woodland in some wadis of northern Egypt (Kassas and Iman 1954).

In contrast to other contemporary samples from the Eastern Sahara, the Gilf Kebir samples rarely contain *Acacia* wood. This might be due to the fine-grained nature of the playa sediments not suitable for the acacias which prefer coarser ground. In most of the samples where *Acacia* is present, it occurs in combination with one or more of the tropical species *Maerua crassifolia, Ziziphus sp.* and *Balanites aegyptiaca.* This assemblage is present around 6,600 b.p., 5,700 b.p. and 4,800 b.p. During these phases, climatic conditions were slightly more favorable and tropical plants were able to invade the Gilf Kebir whereas the drought-resistant tamarisks survived even under extreme conditions. The isolate presence of *Acacia albida* around 6,150 b.p. also points to a slightly moister period with precipitations between 50 and 100 mm which is the minimum under which the recent *Acacia albida* survives in the Central Sahara.

Generally speaking, the archaeological data fit with the results of the sedimentological (Kröpelin 1987; 1989) and the archaeozoological investigations (Peters 1988; van Neer and Uerpmann 1989). Both state arid to, at best, semiarid conditions for the Gilf Kebir throughout the Holocene. Kröpelin postulates a "semiarid" phase from 6,000 to 5,000 b.p., but according to the botanical results the more humid climate lasted only for a short period around 5,700 b.p. From 5,600 b.p. onwards, the environment must have been very dry because the samples from this period contain only *tamarix* wood. The assumption of Kröpelin (1987: 203) that there was either a climatic optimum or an unique millennial rainfall event not long after 5,000 b.p. is confirmed by the occurrence of *Ziziphus sp., Maerua crassifolia, Acacia sp.* and *Balanites aegyptiaca* between 5,100 and 4,800 b.p.

In spite of the arid climate the Gilf Kebir offered a favorable environment for prehistoric nomads because of the seasonal availability of surface water. A slight increase in precipitation created extensive stands of ephemeral grasses and herbs and thus furnished a basis for nomadic cattle keeping and gathering activities. The episodic visits of nomads to the Gilf Kebir continued up to the hyperarid 20th century (Almasy 1939: 131, 163) even though the surrounding lowlands then were a hostile and almost barren landscape.

Selima Sand Sheet

The Selima Sand Sheet covers an area of *ca.* 60,000 km^2 north and south of the recent frontier between Egypt and Sudan. Eolian sands form a featureless landscape of vast flat plains and gently undulated dunes without any vegetation. Plant remains were found in the excavations of Bir Misaha (one sample identified) and Burg et Tuyur (22 samples identified).

The Bir Misaha sample from around 6,300 b.p. consists only of *Acacia* wood while the samples from the Burg et Tuyur, dated between 6,000 and 5,700 b.p., yielded an assemblage of the following nine taxa: *Acacia sp., Acacia albida, Maerua crassifolia, Leptadenia pyrotechnica, Ziziphus sp., Bosica senegalensis, Balanites aegyptiaca,* cf. *Cassia senna* and *Chenopodiaceae.*

Comparison between the Burg et Tuyur samples and those from Mudpans 85/50 shows that the sites have five species in common. But taking into consideration that the ecological conditions of both sites are not the same, a different type of vegetation has to be reconstructed for Burg et Tuyur. As Walter (1979: 116) and Rognon (1980: 47) have shown, sandy soils in arid regions are capable of storing large amounts of water compared to clay soils and rock surfaces where runoff is high. On sands, precipitations infiltrate the soil quickly and evaporation is reduced. Under slightly higher rainfall, these areas are immediately colonized by grasses which take advantage of the moisture in the upper layers. In the beginning tree growth is very sparse and confined to depressions where some runoff water accumulates. With an increased moisture content of the deeper layers, flat-rooted woody plants will be found also on the upper parts of the dunes. This is what we call a savanna in the sense of Walter (1979: 92): a homogeneous tropical grassland with scattered trees and shrubs. The most important feature of a savanna is its diffuse distribution of plant growth whereas all desert formations are characterized by a contracted pattern.

The Sahelian savannas comprising the same species as those found in the Burg et Tuyur samples are called "Acacia desert scrub" (Smith 1949) in the Sudan. The situation at Burg et Tuyur around 5,700 b.p. is comparable with the recent *goz* in northern Darfur and northern Kordofan. However, the density of tree growth on the *goz* cannot serve as a model for the Middle Holocene Selima Sand Sheet because it has been severely altered by man during the last decades.

Gabriel and Kröpelin (1983) have proposed a low density of settlement remains on the Selima Sand Sheet which they think to be due to the penetrable sands and a deep groundwater table that was not easily accessible to Neolithic man. Yet, hundreds of prehistoric sites were discovered during the recent surveys of the B.O.S. project. The presence of *Acacia albida* in the charcoal samples points to a comparatively high groundwater table at Burg et Tuyur. In general, this species is regarded as a reliable indicator for the presence of groundwater (Carvalho and Gillet 1960: 56; Maydell 1983: 89), and the Zaghawa say: "When we find *(teli)* in a place, we dig wells and we are sure to find water" (Tubiana 1977: 35).

To sum up, the Sahelian savanna of Burg et Tuyur around 5,700 b.p. was suitable for cattle-keeping because of its groundwater reserves, its grass cover and the trees and shrubs most of which can be used for fodder (Maydell 1983: 50 - 52; Tubiana 1977: 95 - 98). A periodic settlement of the site seems likely and the famous rock picture of a cow might be for such find an explanation.

Wadi Shaw / Wadi Sahal

The tectonically induced wadi-like depressions, Wadi Shaw and Wadi Sahal cut about 30 - 60 m into the slightly undulating rocky plains of the southern Libyan Desert. In the depression, there are a number of playa-like deposits which always show a similar stratigraphic record of two limnic accumulation separated and accompanied by sandy layers (Gabriel and Kröpelin 1983; 1984). Most of the settlement remains and the charcoal samples were found in the deposits younger than 6,000 b.p., above the limnic accumulations. During the main phase of settlement, no permanent lakes existed any more and drinking water had to be obtained from wells. 71 charcoal samples were examined; from the results three phases can be distinguished.

Phase one starts around 5,700 b.p. and ends around 5,400 b.p. The samples contain *Acacia sp.* and *Tamarix sp.*, furthermore the Sahelian taxa *Maerua crassifolia, Balanites aegyptiaca, Ziziphus sp.*, cf. *Grewia tenax, Boscia* cf. *senegalensis, Acacia nilotica, Grewia* type *villosa/bicolor* and cf. *Rubiaceae.* The spectrum is similar to that from Burg et Tuyur and it seems that both areas were included in the same vegetation zone, the northern Sahelian Acacia desert scrub. No Sudanian influence is noticeable, except maybe the badly preserved wood of cf. Rubiaceae; no woody Rubiaceae are growing today in the Sahel and only a few relics survived in the Ennedi (Gillet 1968: 159).

Due to the pronounced relief and high runoff, the valleys probably carried a dense woody herbal vegetation as described by Murat (1937: 28) and Gillet (1968: 130) for the Ennedi. At the edge of temporary pools, larger specimens of *Acacia nilotica, Ziziphus sp.* and *Balanites aegyptiaca* were growing. On the slopes tree growth was sparser, including *Maerua crassifolia, Boscia senegalensis* and the two *Grewia* species. The grass cover was not as dense as in Burg et Tuyur because water supply on the cleft sandstone is more favorable for deep-rooted woody plants.

The wood of *Tamarix sp.* does not seem to fit well into the Sahelian assemblage. The recent distribution of tamarisks in the Eastern Sahara is limited to the area north of the transition zone Sahara/Sahel. In the Sahel tamarisks occur only around brackish pools (Aubréville 1950: 76; Carvalho and Gillet 1960: 33), and they are replaced by other species, especially *Acacia nilotica,* when freshwater conditions prevail. The presence of *Tamarix sp. Acacia nilotica* in the same samples might be explained by an arid period around 6,000 b.p. when tamarisks were only plants to survive. The humid phase that followed around 5,700 b.p. was of short duration, so that the Sahelian woody plants were not able to replace the tamarisks completely.

During phase two, from around 5,200 b.p. to 4,400 b.p., the environment was very dry and in the samples from this period only *Tamarix sp.* and *Acacia sp.* are present. In the samples from phase three (4,000 to 3,300 b.p.) *Tamarix sp., Acacia sp.* and *Capparis decidua* are the main constituents, with occasional admixture of *Salvadora persica,* cf. *Grewia tenax, Maerua crassifolia* and *Boscia* cf. *senegalensis.* The presence of the Sahelian taxa may be due to the great number of the identified samples and their excellent preservation which increases the probability of discovering rarer species. A desert-like environment, comparable with the recent Wadi Howar, did not offer very rich resources for man and his animals. However, the high groundwater table in the valleys created favorable conditions for tree growth and temporary settlements, even with cattle (Cziesla 1986), while on the surrounding plains the sparse vegetation gave way to an absolute desert.

Wadi Howar

Wadi Howar is an ancient river system that was connected with the Nile during the Early and Middle Holocene (Pachur and Kröpelin 1987). Excavations were conducted in the area east of Jebel Rabib, between 26°30′ and 27°30′. From the sedimentological, archaeological and zoological data it can be stated that local rainfall was markedly higher from 9,500 to 4,000 b.p. (Pachur *et al.* 1987: 359). This on the other hand led to a deterioration of the conditions for the preservation of plant material. 17 botanical samples from the sites dated between 4,600 and 4,000 b.p. were examined. The reconstruction of the vegetation for the earlier periods has to rely on archaeobotanical results from other sites.

There is evidence that Wadi Howar was included in the Sudanian or southern Sahelian savanna zone in Middle Holocene times. Comparison between palynological data from the Eastern (Ritchie *et al.* 1985) and the Central Sahara (Schulz 1987) suggests that a northward shift of the vegetation zones occurred simultaneously in both areas around 7,000 b.p. Therefore, it seems possible to transfer the archaeobotanical interpretation from Fachi-Dogonboulo/Niger (18°18'N) (Neumann 1988; Neumann and Schulz 1987) to the Wadi Howar (17°30'N).

At Fachi-Dogonboulo, in the heart of the hyperarid Erg de Ténéré, a charcoal layer resulting from a bush fire was found between limnic sediments. A sample from this layer contained the following 12 woody taxa: *Terminalia* cf. *macroptera, Anona senegalensis,* cf. *Rhus sp., Crateva adansonii, Celtis intergrifolia, Ximenia americana, Ficus sp., Boscia* cf. *salicifolia, Balanites aegyptiaca, Cadaba farinosa, Ziziphus sp.* and *Acacia albida*. All these species have their recent main distribution area in the Sudan Zone, 550 - 600 km further south (Aubréville 1950). They can be associated with 1) The alluvial habitats near the lake and along the drainage lines, and 2) The more xerophytic vegetation on the slopes of the escarpment. Typical Sahelian taxa, especially the acacias, are missing in the sample. It is probable that Fachi-Dogonboulo was not an extrazonal outpost of the Sudanian savannas but rather situated in the Sudan zone itself. The formation was either savanna or even woodland, with a rather dense cover of trees and shrubs. A similar vegetation can be assumed for the dunes of Wadi Howar around 7,000 b.p. The deeper-lying parts of the wadi were periodically inundated and apparently some of these lakes existed for decades (Pachur *et al.* 1987: 359). They were surrounded by a swampy environment with a dense grass cover and only scattered trees as it has been described for the Central Chad by Pias (1970: 29).

With increasing aridity from 5,300 b.p. onwards, the Sudanian vegetation in Wadi Howar was replaced by Sahelian types. In the charcoal samples *Acacia sp.* is dominant; minor constituents are *Acacia nilotica, Ziziphus sp.,* cf. *Grewia tenax* and Capparidaceae. This poor assemblage cannot be attributed to a particular formation. Most likely the environmental changes between 5,300 and 3,300 b.p. were more quantitative than qualitative in nature: the density of the savanna formations outside Wadi Howar decreased and woody plants became confined to the wadi-bed. The dry conditions resulted in a concentration of settlement in the wadi, in an intensified use of its plant resources and finally to a desertification, *i.e.* a man-made degradation of the plant cover (Neumann, in press).

In 11 of the archaeobotanical samples from Wadi Howar uncharred kernels of *Celtis integrifolia* were found. *Celtis integrifolia* is a species with mainly a

Sudanian distribution; in the southern Sahel it is confined to the edge of lakes and river courses. In the case of Wadi Howar, we cannot use this plant as an indicator for a Sudanian savanna in the fifth millennium b.p. because it occurs together with charred wood of northern Sahelian species in the samples. The tree bares edible fruits which are collected today by the people in the Sahel. Around 4,000 b.p., either the fruits were imported from the savanna regions of the upper Wadi Howar or the tree was planted and was able to survive because of human care and the extraordinary water supply in the wadi.

Palaeoclimatic interpretation

The poor species assemblage in all the Early Holocene samples from Egypt seems to be in contradiction with the sedimentological evidence which is supposed to correlate with increased precipitation during this period (Pachur and Braun 1980; Pachur *et al.* 1987; Wendorf and Hassan 1980; Wendorf and Schild 1980). This might be explained by another climatic factor that has not been taken into consideration so far: if the temperatures had been lower than today, a slight increase of the precipitation would have led to temporary lakes due to reduced evaporation and at the same time tropical elements were prevented from expanding further to the north. Under cooler conditions, a mean annual rainfall of 30 - 50 mm should be sufficient to support a quite dense desert vegetation. The lack of mediterranean plants in the samples points to a plant cover that consisted of the same elements as today but with a wider distribution.

Unfortunately there are no Early Holocene charcoal samples from sites in the Sudan. From the investigations of Ritchie and Haynes (1987) and Ritchie *et al.* (1985) we know that from 10,000 b.p. onwards, the lake levels of Selima and Oyo were rising and the tropical savannas started to expand northwards. Around 7,000 b.p. a climatic change, especially a rise of temperatures, took place and tropical elements immigrated into the Gilf Kebir and the area of Mudpans. Even if we admit that the richer flora of Mudpans was an outpost of the Sahelian savannas and was not included in the Sahel itself, we can assume a northward shift of the tropical vegetation zones of about 500 - 600 km. The vegetation was *Acacia* desert scrub on the Selima Sand Sheet, thorn savanna at Laqiya Arba'in and deciduous savanna in Wadi Howar (Fig. 2). Most likely the southern and the northern "wetting front" (Haynes 1987) touched each other somewhere in Central Egypt during this climatic optimum between 7,000 and 6,500 b.p., so did the vegetation zones and the absolute desert disappeared. Around 6,000 b.p., a dry phase followed the climatic optimum. Tamarisks replaced the tropical plants in Wadi Shaw and the lake of Oyo became shallower (Ritchie *et al.* 1985). Around 5,700 b.p., a second, minor shift occurred and the vegetation zones were situated 300 - 400 km north of their present range (Fig. 3). Nomadic cattle keeping was possible as far north as Burg et Tuyur. In Egypt, a very dry environment prevailed from 6,000 b.p. onwards and there are no charcoal samples from later sites, except from the Gilf Kebir where settlement activities

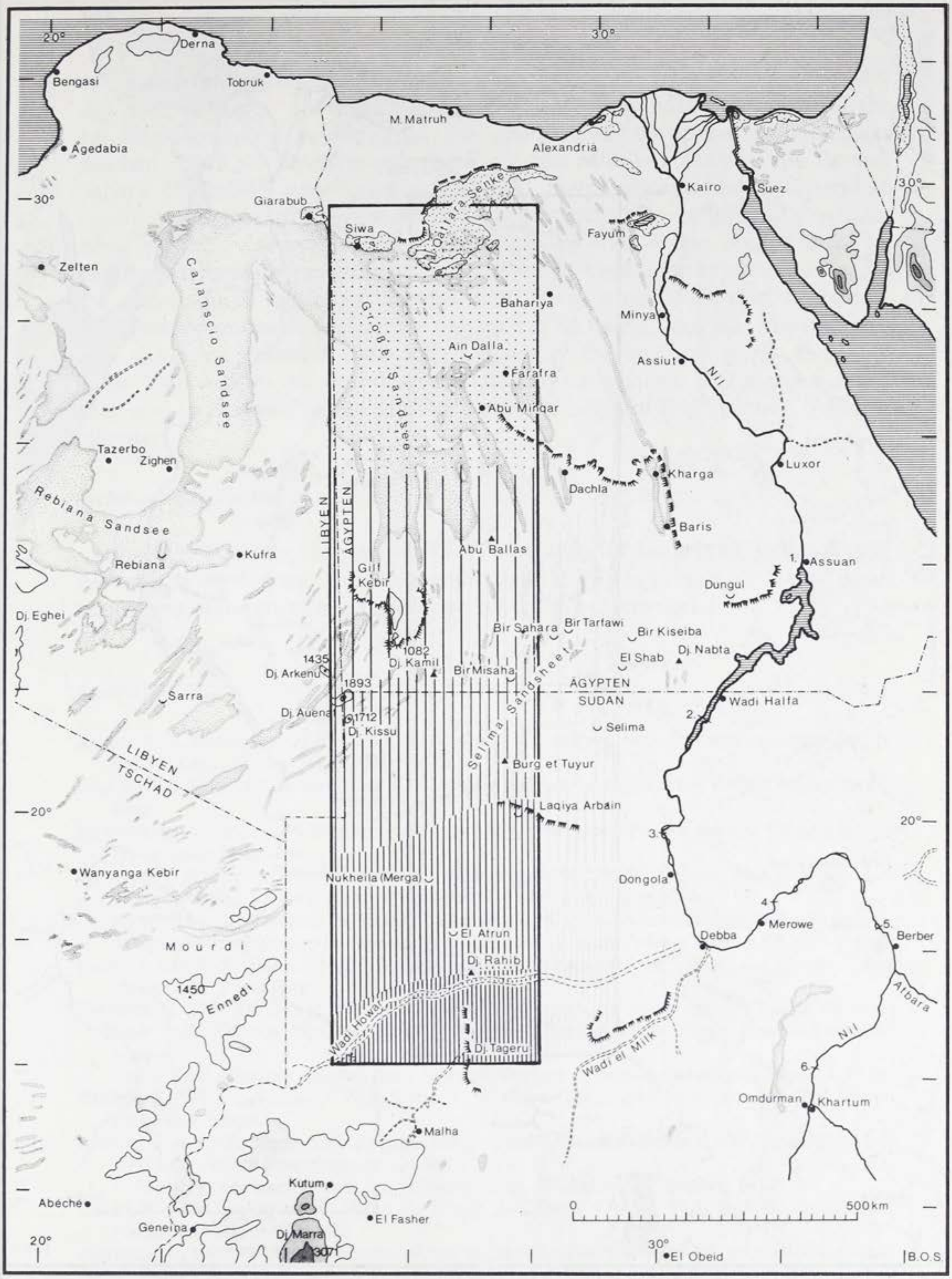

Fig. 2. Vegetation zones in the B.O.S. working area for the period 7,000 - 6,500 b.p.

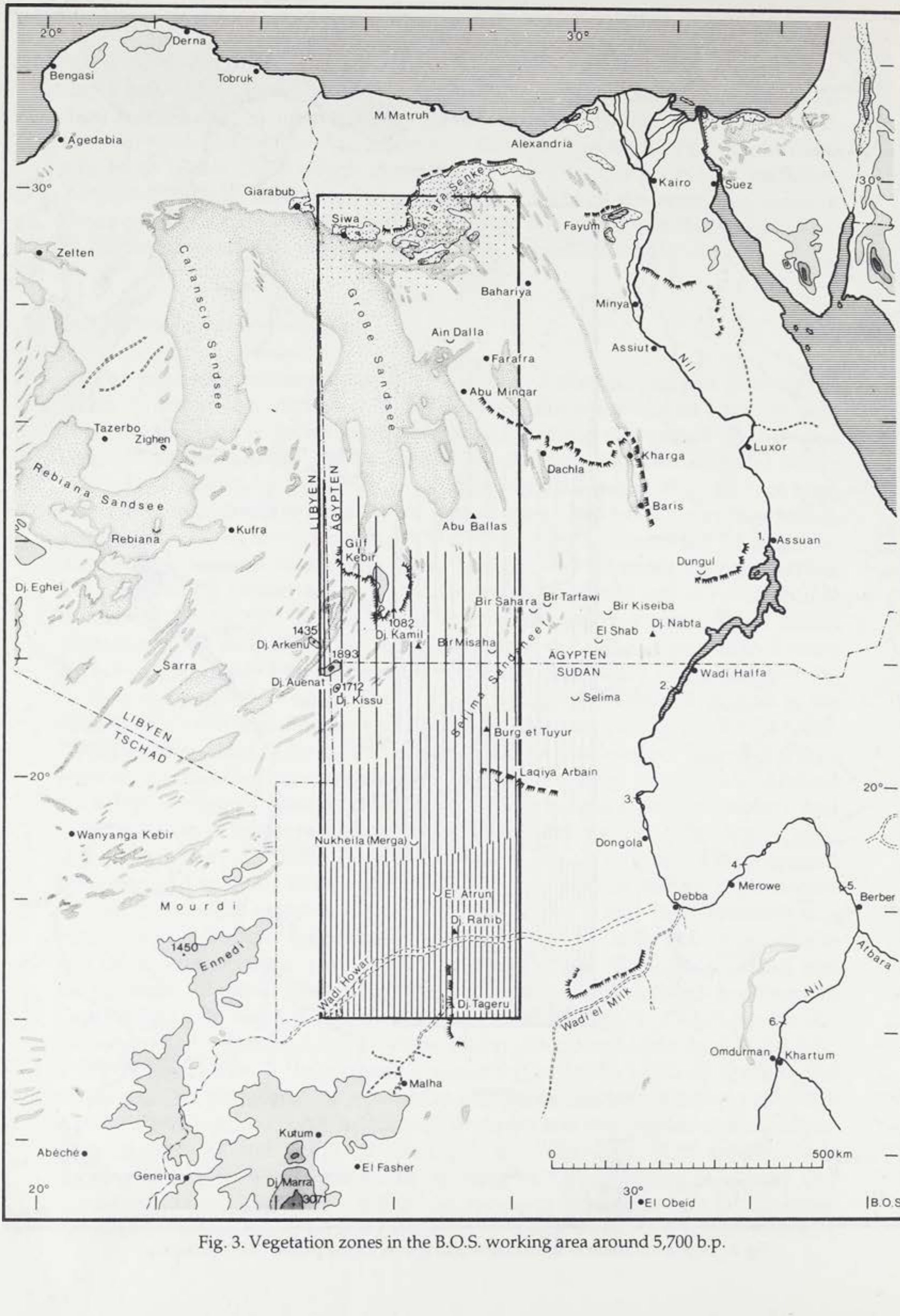

Fig. 3. Vegetation zones in the B.O.S. working area around 5,700 b.p.

continued until 4,300 b.p. But even in the Sudan, the second "wetter" phase did not last for a very long time. At least from 5,200 b.p. onwards the savanna formations retreated to the south until the present status was reached by 3,300 b.p. Through the Early and Middle Holocene, the Eastern Sahara comprised two ecological regions: Egypt always had a desert-like environment, though with a much denser plant cover than today, and precipitations probably never exceeded 50 - 100 mm. In the Sudan, south of 22°N, tropical savannas prevailed. Comparable recent vegetation types occur under the mean annual rainfall of 100 - 500 mm. There is no doubt that the Middle Holocene savannas of the Eastern Sahara can be traced back to a climate that was distinctly different from today. However, the last few years and especially 1988 with its extreme downpours again have shown that a green desert may also be the result of an extraordinary oscillation of the "normal" Sahelian climate.

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Culture and environment between the Sahara and the Nile in the Early and Mid-Holocene

Introduction

In approaching the subject of culture and environment, the archaeologists of today cannot leave out of consideration the significance that any of these themes have assumed in our discipline. These require reference to the principles of cultural ecology and of geoarchaeology. Culture – and by this I mean the group which expresses such culture – lives in interaction with the natural environment: not only aspects of material culture but also economic choices and the characteristics of settlement and demography are determined by the environment.

The emphasis placed by functionalist archaeology upon the processual concept of culture, that is culture as a product of systemic functioning, has pushed to the fore certain research strategies. Firstly, assessments have been made of the spatial dimensions of phenomena. This have involved the abandonment of the traditional unit of the site, and the projection of research onto a wider, regional scale. Secondly, attention has been paid to processes of sedimentation, of archaeological site formation and destruction (closely dependent upon palaeoclimatic oscillations) and to the stratigraphic contexts and post-depositional dynamics. To these considerations should be added the need for studies of the distribution of resources (water, plants, animals, raw materials), for this also is closely related to the character of the environment.

These last points, especially, have been developed within geoarchaeology, the discipline which has shown archaeology the ways in which to apply quantitative principles and techniques, particular to environmental studies, to archaeological research. As has been noted, the works of K.W. Butzer (1971; 1982) represent a major development of the principles of functionalist archaeology, and provide a quite firm basis for archaeological research, aiming to supply not only the theoretical tools but also the technical ones required by the archaeologist. An example of this is given by the concept of culture which in Butzer's view does not assume the "metaphysical" value of system, an idealized model of the behavior of a society, which was developed within the field of cultural ecology. However, in both cases a change may be seen, interest moving from the artifacts and their typological classification, to transformations in behavior: that is, to the "dynamics by which people order their existence through their interaction with others and their cultural, physical and metaphysical environment" (Hassan 1983: 15). The most obvious transformation in the behavior of the Saharan groups of the Early to Mid-Holocene may be seen in the first experiences of food production: that is, in the passage from a position of dependence upon the environment to one of actually organizing and producing resources. The production of food may be viewed as an effect of adaptative dynamics, produced by man's selective and informed exploitation of the environment.

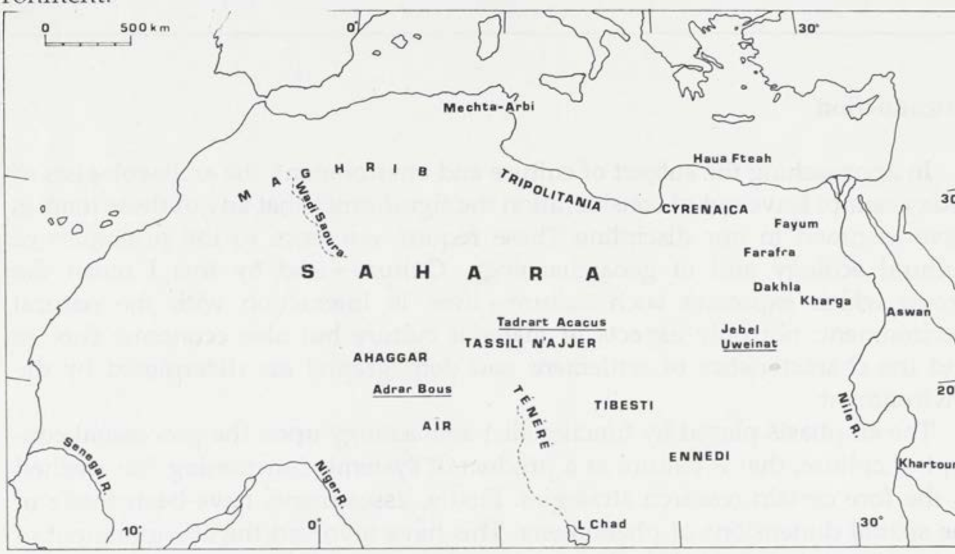

Fig. 1. Map of the Central Sahara.

Although it could be observed that the systemic functioning and the correlated adaptation concepts bring about a mechanistic explanation of cultural phenomena which excludes individual participation (Hodder 1985), we cannot deny that the systemic concept has allowed us to reach a degree of control and of data quantification that could not be obtained in the traditional paradigm. In dealing with human society, we are agreed that change may be caused not only by the environment but also by other factors such as demography and symbolism-ideology. However, in desert situations the impact of the environment must have been decisive in determining a group's decisions. In the Early Holocene the opportunities for choice on the part of groups were still quite numerous: the flourishing of civilization specifically along the water courses

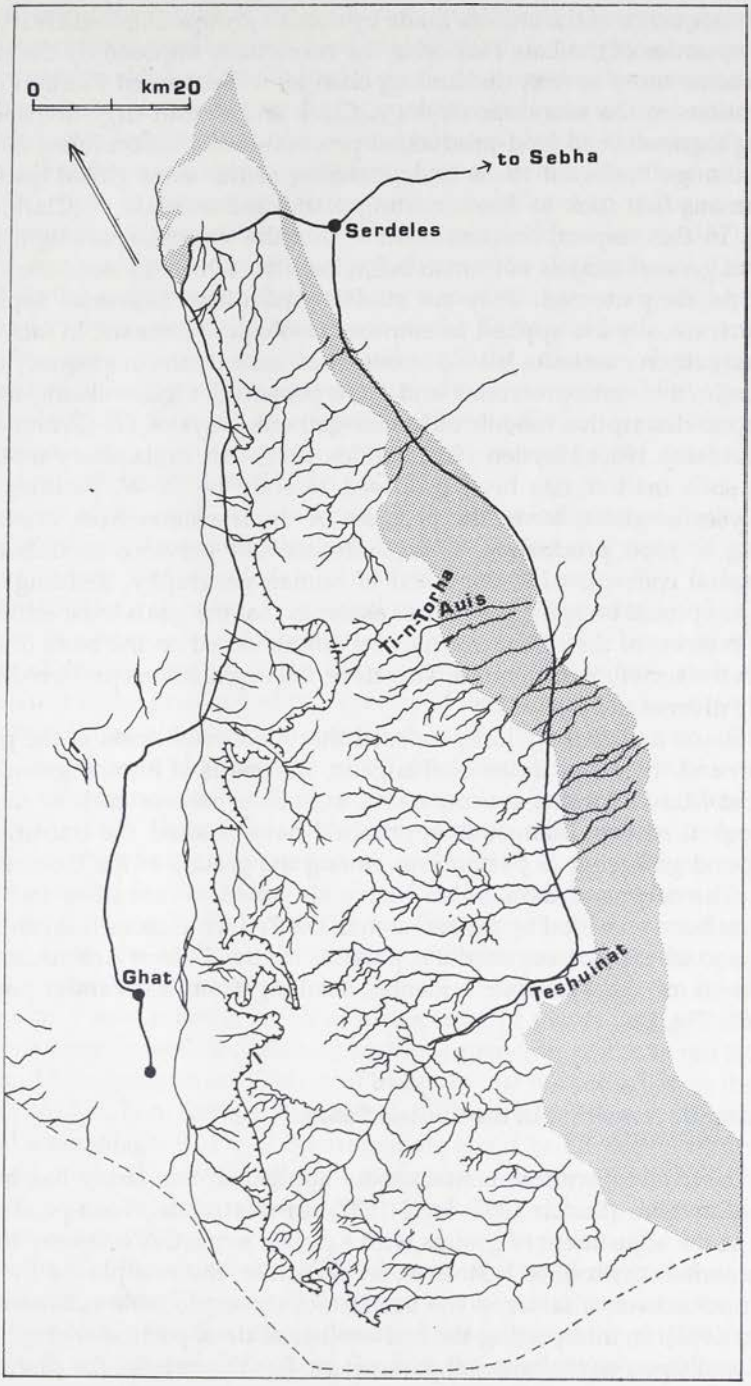

Fig. 2. Tadrart Acacus, Libyan Sahara. Regions mentioned in the text.

was a consequence of the choices made by human groups. Subsequently, during the dry episodes of the Late Holocene, the restrictions imposed by the environment became more severe, demanding changes in settlement location and the modifications in the economic strategy. Clark and Brandt urge archaeologists devoting themselves to food-production process studies to formulate models of culture change "relevant to an understanding of the more global question of why humans first took to domesticating plants and animals..." (Clark, Brandt 1984: 2). In this respect, one can observe that the systemic paradigm justifies the use of general models of human behavior, after which the concrete observational data are patterned. They are models which have universal application, and which usually are applied in ethnoarchaeological contexts. In fact, studies of hunter-gatherer societies have demonstrated recently the inadequacy of traditional, inductive, interpretations and have proposed a generalizing approach based upon descriptive models of hunter-gatherer ways of life (Bronitsky [ed.] 1983; Hardesty 1980; Hayden 1981; Rindos 1984). An explanatory model concerning such matters has been proposed recently by R. W. Redding (1988). He analyses in global terms the problem of the transition from hunting and gathering to food production, taking into account previous models and the fundamental concepts of ecology and of human geography. Redding's model returns to optimal foraging theory but assumes that the goals to be attributed to groups in terms of their behavior may be differentiated on the basis of the way in which the society is structured. Therefore, the explanations preferred must be similarly diverse and flexible.

Processual archaeology has proposed that food production is the principal factor, in and the major index of change in, the status of human groups in the Early and Mid-Holocene, encompassing in such a process each advance of a technological nature. Using this approach I have studied the transition from hunting and gathering to pastoralism among the groups of the Central Sahara (Fig. 1). The corpus of data which I have also used to formulate and test the model has been provided by my research in the Tadrart Acacus (Libyan Sahara). Recourse to an explanatory model is possible for the Tadrart Acacus because of the richness of the available evidence, resulting from substantial periods of fieldwork (Fig. 2).

The economic transition in the Central Sahara

The descriptive, environmental model applied to this study has been discussed elsewhere (Barich 1987; [ed.] 1987). In this model, food-production is viewed as the adjustment of groups with a purely extractive economy to special environmental constraints. It stresses, in particular, the role played by fluctuation in resources as a factor in the increase of the exploitable subsistence base (Hayden 1981). In interpreting the archaeological data, particular emphasis has been placed upon environmental parameters. For this reason, the discussion of the artifactual evidence and of change in the economic strategy has been shaped, bearing in mind the results of the studies of the different aspects of the environment. Geomorphological research has pointed clearly to the existence, especially along the eastern slope, of the Tadrart Acacus, of groundwater resources. These would have been accumulating during moisture-rich phases and would have been stored over long periods of time and released slowly, favoring vegetation and fauna. Furthermore, the preservation of groundwater resources only in the outer belts – both to the east and to the west – could have encouraged a certain degree of mobility in the settlement of human groups (Marcolongo 1987).

Pollen analysis has indicated a much more open vegetation at Ti-n-Torha (situated on the eastern side), thus favoring a more extensive use of the land by man. Conversely, in sheltered areas such as the Teshuinat basin, the influence exerted by the hydrogeological location of the eastern slope provided microclimates with greater atmospheric humidity and increased local precipitation (Schultz 1987). This led to a greater concentration of water resources, a phenomenon which persisted even when the resources of the marginal belts began to diminish (starting *ca.* 7,000 b.p.).

The recent study by K. Wasylikowa of the botanical macrosamples (seeds and fruit) confirms the results obtained from the pollen analyses and provides further important and detailed information (Wasylikowa 1993). It has been shown that there is a richness of botanical material in occupation levels which is due at least in part to man's deliberate use of such resources. The importance of the family of grasses, and especially of the sub-family *Panicoidae* is clear. Of particular interest is the presence of two species of *Pennisetum*, the use of which by human groups has already been recorded in the Western Sahara. The new evidence arising from the research of K. Wasylikowa confirms the economic model that I have proposed for the groups of the Ti-n-Torha facies (Barich 1984; [ed.] 1987: 97 - 112). These hunters-gatherers-fishers, who preferentially settled on the eastern slope of the mountain, may have played a role in the pre-selection of species intended for domestication. Stratigraphic evidence at three sites, Two Caves, Torha East and Torha North (V - VI), indicates that this form of exploitation lasted from the tenth to the seventh millennium b.p. A change in the original subsistence pattern at the end of the Ti-n-Torha phase can be inferred for there was a new interest in the domestication of plants and animals. This new phenomenon is well documented by the sequence at and material from the site of Uan Muhuggiag in the Teshuinat basin. Whilst the collection of the same plants as noted at Ti-n-Torha continued, A. Gautier (1987) noted differences in the faunal assemblage: 92.4% of the fragments could be attributed to domestic animals and only 4.2% to wild animals. In the two lower levels (2d - 2c) the ratio of cattle to caprid is 1 : 1, whilst in the upper levels (2, 1a, 1) caprids were dominant (Gautier 1987).

On the basis of these data and of the absence of actual breaks in the regional stratigraphic sequence, I suggested a change in the economic model that would accommodate local stimuli, such as climatic factors, but at the same time minimize the role of external influences. In fact the availability within a rather limited region of a series of complementary micro-environments would allow the counterbalancing of the effects of unfavorable climatic developments and the consequent stress upon resources, through the exploitation of new zones.

This type of economic transition, recognized in the Tadrart Acacus, may be taken as an example of an ideal sequence, and may be extended to other areas of the Saharan region for which unfortunately such rich sources of data are not available.

The Farafra Oasis, Western Desert, Egypt

The research in the Farafra Oasis begun by the University of Rome in 1987, has as its aim the reconstruction of the social and economic context. In addition the environmental considerations which inspired the research in the Libyan Sahara are relevant. Although ultimately as research progresses we may be able to attain a level of explanation just as detailed as that which proved possible for the Tadrart Acacus, at present our work has the following more immediate objectives: firstly, a comparison of the nature of the contexts of an oasis with the general Saharan model; secondly, the verification of the existence of exchange between the oases and the Central Saharan region; and thirdly, an assessment of the role which the oases assumed as mediator between the Sahara and the Nile Valley (Fig. 3). Professor F.A. Hassan is responsible for the geological and palaeoenvironmental work whilst the present author is in charge of the archaeological research. The possibility of integrating geological and archaeological studies seems particularly promising in a playa region in which human occupation during the Holocene was strongly influenced by the lake basins. During the 1987 field-season we carried out an extensive survey of the Farafra territory, extending to the small Ain Dalla Oasis. Work during the 1988 field season concentrated on the investigation of Bahr Playa, on top of the El-Quss Abu-Said Plateau, for this appears to be an extremely interesting area in terms of occupation. As this investigation is still in progress, the results presented here are preliminary: they will be summarized here with reference to the general lines of research.

Archaeological survey has shown that the territory was densely occupied, there being numerous concentrations of finds and *in situ* deposits related to playa formations. Within the depression, over an area of approximately 60 sq. km, we identified a total of fourteen areas of artifact concentration. Some of these, such as Aine-Raml and Bahr Playa are true sites, the latter having also evidence of long-term occupation; others are represented by small surface clusters of material, generally still in their original positions, and are the remains of short-term camps (Fig. 4). The assemblages recovered around Qasr Farafra (FA II, FA IV and Aine-Raml, for example) may represent the first phase of occupation. Two radiocarbon dates of $6{,}950 \pm 60$ (R-1894) and $6{,}670 \pm 95$ (R-1895) place these sites at the beginning of the moist phase which Hassan (1986; Barich and Hassan 1987) suggests occurred at the Early and Mid-Holocene. The manufacturing techniques as revealed by the debitage, involving single and opposed platform cores, and the tool types have affinities with those at Baharya

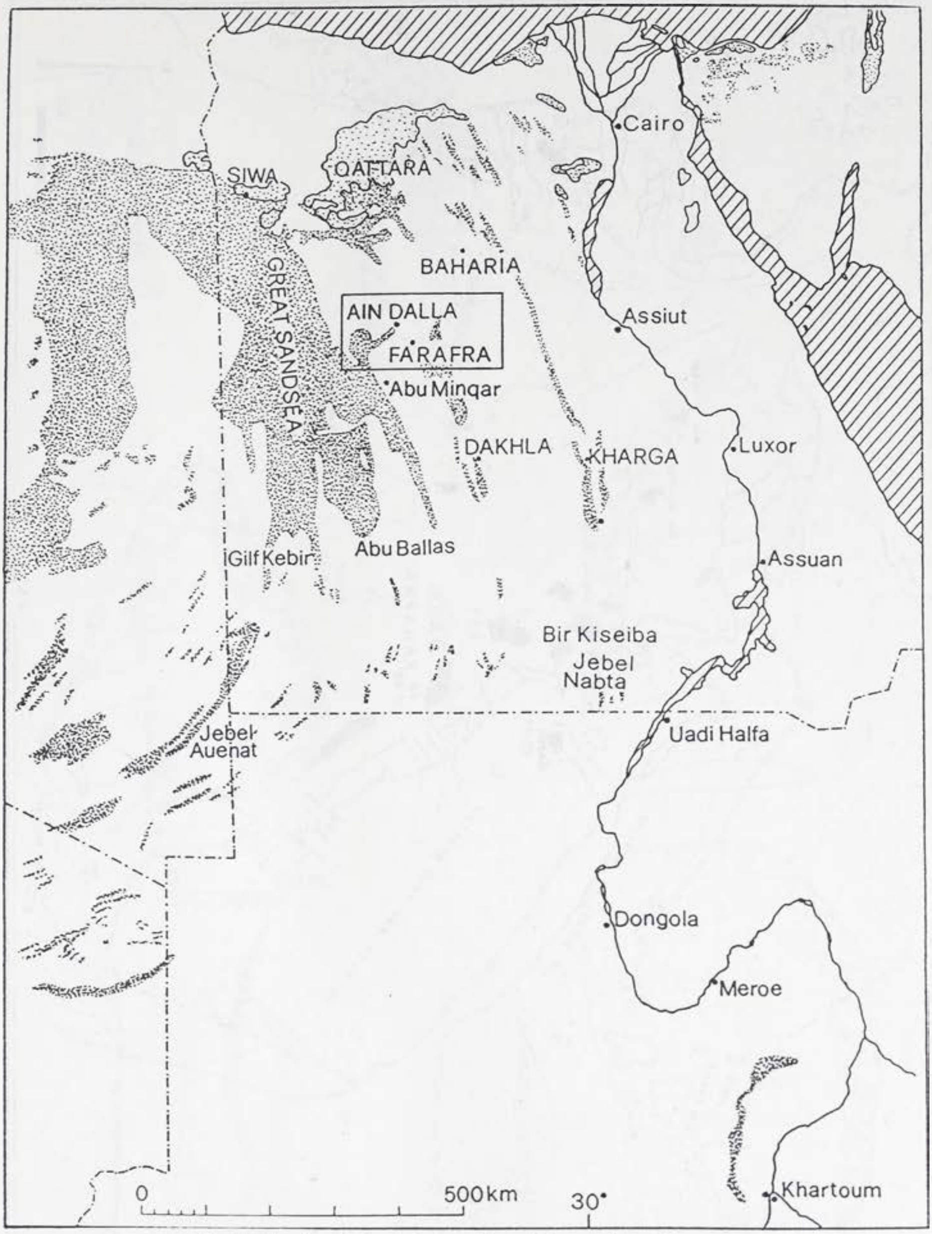

Fig. 3. Farafra Oasis, Western Desert, Egypt. Location map.

(Ain Khoman: 6,940 ± 140 B.P.; Fig. 5). This first phase probably coincides with the final phase of this occupation for this period as described for Baharyia (Hassan 1978) and also, in greater detail, for Siwa (Hassan and Gross 1987). It is

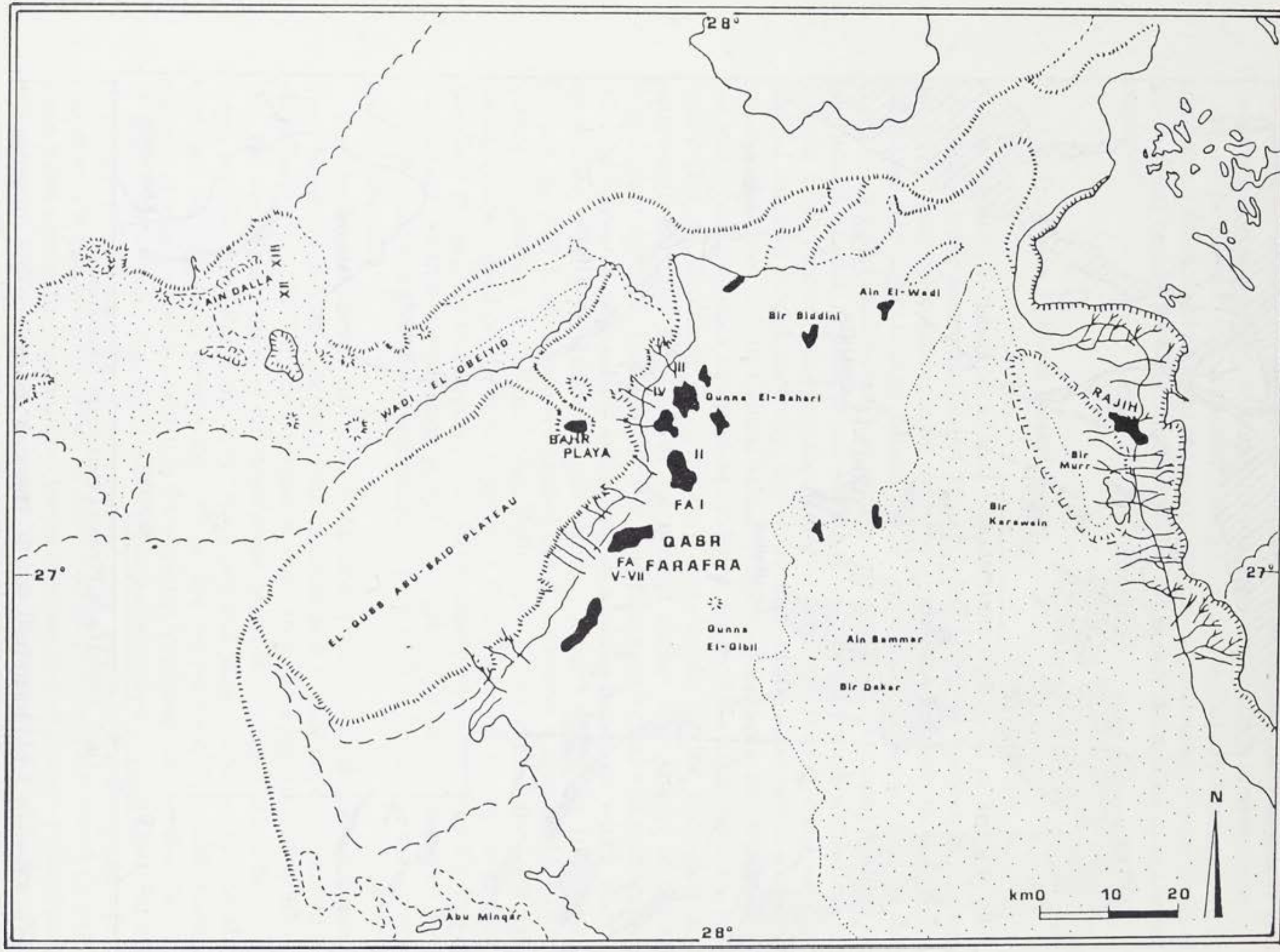

Fig. 4. Farafra Oasis, Western Desert, Egypt. Map showing regions mentioned in the text.

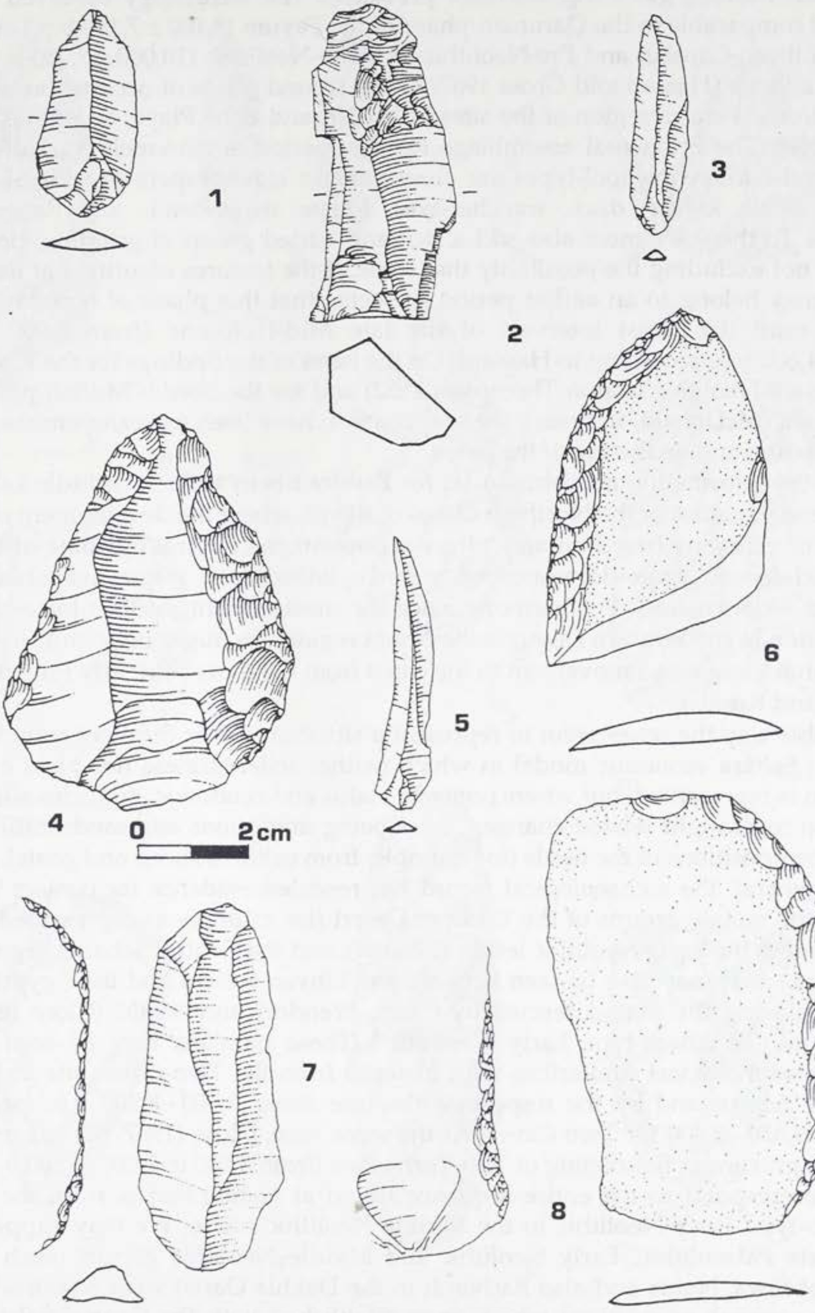

Fig. 5. Farafra Oasis, Western Desert, Egypt. Stone artifacts from Qasr Farafra.

datable to the Final Palaeolithic and corresponds to the Early Holocene moist phase, in which hunting-gathering activities prevailed. The technology observed at Siwa is comparable to the Qarunian phase of the Fayum (8,100 ± 7,140 b.p.) and to the Libyco-Capsian and Pre-Neolithic or Proto-Neolithic (10,000 ± 7,000 b.p.) at Haua Fteah (Hassan and Gross 1987: 87). A second phase of occupation was noted in the Farafra region at the sites of FA VII and Bahr Playa, as well as at Ain Dalla. The artifactual assemblage for this period is extremely varied although the following tool-types are characteristic: side-scrapers on side-blow flakes, sickle knives, discs, tranchet-axes, foliate arrow-heads and daggers (Fig. 6). To these we must also add a rich and varied group of grinding tools. Whilst not excluding the possibility that some of the features identified at Bahr Playa may belong to an earlier period, it seems that this phase of occupation lasted until the moist intervals of the late Mid-Holocene (from 5,900 to 4,800/4,600 b.p. according to Hassan). On the basis of the findings for the Kharga Peasant Neolithic (Caton-Thompson 1952) and for the Sheikh Muftah phase of Dakhla (McDonald, in press), there appears to have been a greater emphasis on gathering and on the use of the oases.

All the information available so far for Farafra fits in with the Middle Late-Holocene sequence of the Northern Oases of Egypt, where the development of a Neolithic economy based on agriculture represents the natural outcome of the Early Holocene proto-domestication, which, linked into water availability, favored sedentariness. Furthermore, since the most ancient nucleus for cereal cultivation in the Western Desert is the Nabta region, we might infer quite justifiably that there was a movement to the oases from the more southerly region of Nabta and Kiseiba.

In this way the oases seem to represent a situation rather different from the Central Sahara economic model in which neither sedentariness nor plant cultivation is represented, but where nomadic status and economic strategies allow reaction to drought-related changes, there being migrations and modifications in the compositions of the herds (for example, from cattle to sheep and goats).

In general, the archaeological record has revealed evidence for contact between the mobile groups of the Western Desert (for example as represented at Siwa and in the Early Neolithic levels at Nabta), and the Central Saharan region. Close parallels may also be seen between the Libyan Sahara and the Egyptian Sahara during the period termed by Close, Wendorf and Schild (Close [ed.] 1984) the "El Adam-type Early Neolithic". These parallels may be seen in precise technological similarities with material from the Two Caves site in the Tadrart Acacus and by the respective absolute dates: 9,800 - 8,900 b.p. for El Adam, 9,350 - 8,400 for Two Caves. At the same time, Close (1987: 81) suggests that the maximum flourishing of Ti-n-Torha East (from 8,500 to 7,000/6,500 b.p.) could correspond to the entire sequence found at Nabta, that is from the El Ghorab-type Early Neolithic to the Middle Neolithic phase. We may suppose that Late Palaeolithic, Early Neolithic and Middle Neolithic groups (such as those of Siwa, Nabta and also Bashendi in the Dakhla Oasis) were responsible for the network of relations which were established with the Central Sahara. This is indicated by the diffusion of elements of the lithic industry and by

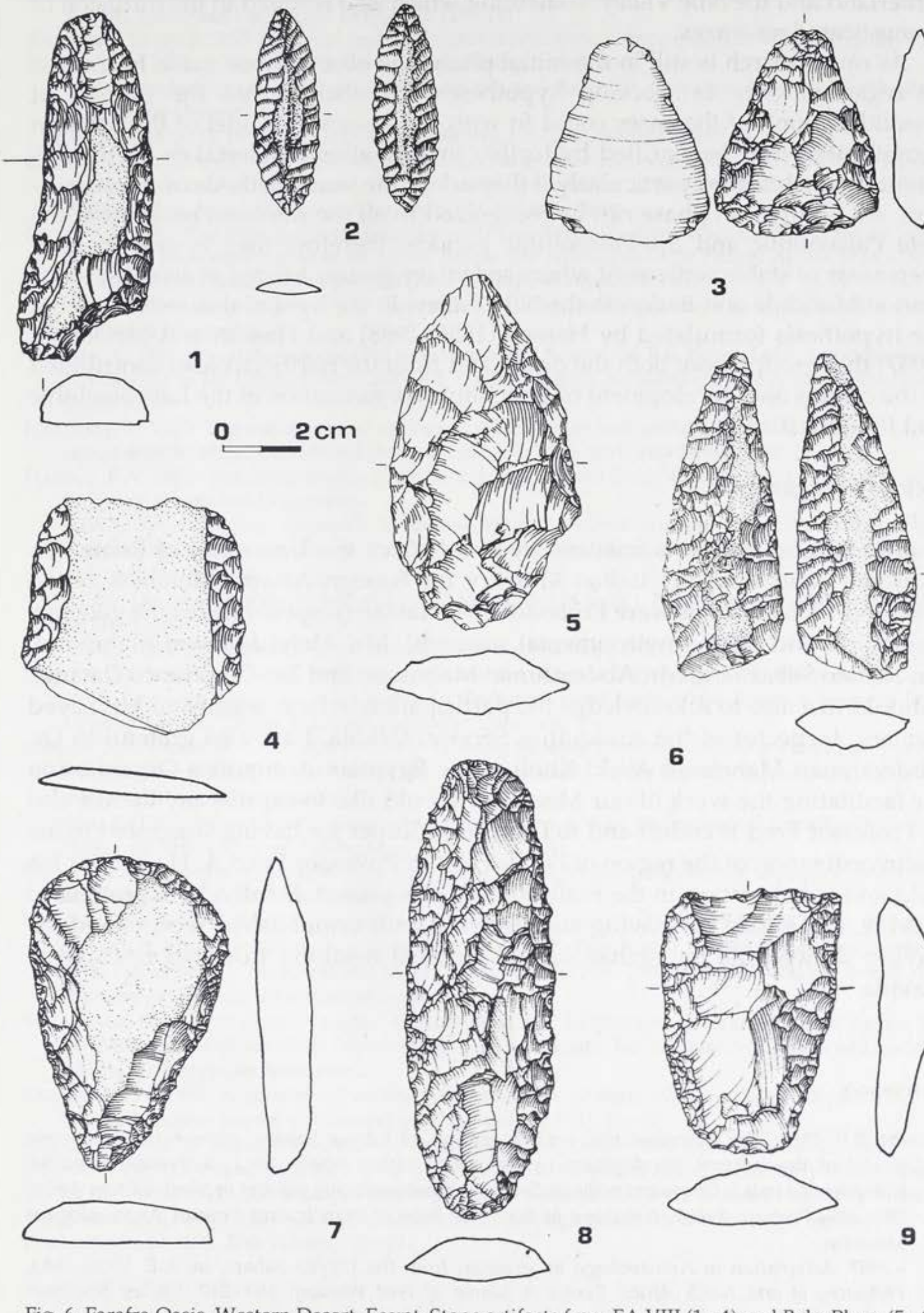

Fig. 6. Farafra Oasis, Western Desert, Egypt. Stone artifacts from FA VIII (1 - 4) and Bahr Playa (5 - 8).

decorative motifs on ceramics. We can atribute to these mobile groups of hunter-gatherers and early pastoralists the role of mediator between the Saharan hinterland and the Nile Valley, something which also resulted in the diffusion of domesticated resources.

As our research is still in the initial phase, the observations made here must be regarded only as working hypotheses. Whether or not the process of "neolithisation" of the oases could fit with the economic model of the Saharan communities may be clarified by further investigations undertaken by the different research teams, particularly if they adopt the same methods of reconstruction. An occupation phase can be recognized in all the northern oases from the Late Palaeolithic and Epi-Palaeolithic periods: therefore they appear to have been areas of stable settlement where sedentary groups existed at an earlier date than at Merimde and Badari in the Nile Valley. In the light of this we can accept the hypothesis formulated by Hassan (1986; 1988) and Hassan and McDonald (1987) that groups from both the desert and from the northern oases contributed to the origins and development of agricultural organization in the Late Neolithic and Predynastic Egypt.

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Investigations into the archaeology of the Sitra-Hatiyet, Northwestern Egypt

Introduction

In order to complete the north-south transect through the Eastern Sahara (Kuper 1981; 1988) the University of Cologne project B.O.S. also investigated the Qattara-Siwa area in 1983 and 1985.

In 1975 and 1976 investigations had already been carried out by Fekri Hassan's Siwa Oasis Project (Hassan 1976) in the immediate surroundings of the Siwa Oasis, as well as in the neighboring oases of Gara, Ain Tibaghbagh and El Araq, southeast of Siwa (Fig. 1). The surface sites produced various stone artefacts, generally consisting of local chert and silicified limestone. Bone or plant remains were not preserved, but in three sites evident structures were present: two fire-places and a stone circle (Gross 1980; Hassan 1976). A series of radiocarbon dates from ostrich egg-shell fragments (Hassan and Gross 1987) made it possible to arrange the find inventories into two periods: the first one between 9,000 - 8,000 B.P., and second one around 6,800 - 5,000 B.P.

In 1983 B.O.S. archaeological survey set out from Siwa past El Araq along the lakes of Bahrein and Nuweimisa to Sitra (Fig. 1). Only a few eroded surface sites and no datable material were found (sites 83/1 - 8). The situation was only different in the immediate surroundings of the Sitra oasis and north of the Sitra-Lake, where intact and spatially differentiated sites were found. During a previous expedition in 1983 only two days were available to investigate two sites in this area (site 83/11 and site 83/12; Cziesla 1989). In spring 1985 this work was continued and in ten days, several new sites were surveyed intensively including geomorphological measurement and many large quantities of datable materials were found.

Preliminary investigations of the stone artefacts, and also a consideration of the 11 radiocarbon-dates so far available allow a first analysis of the successive occupations in the Sitra-Hatiyet area.

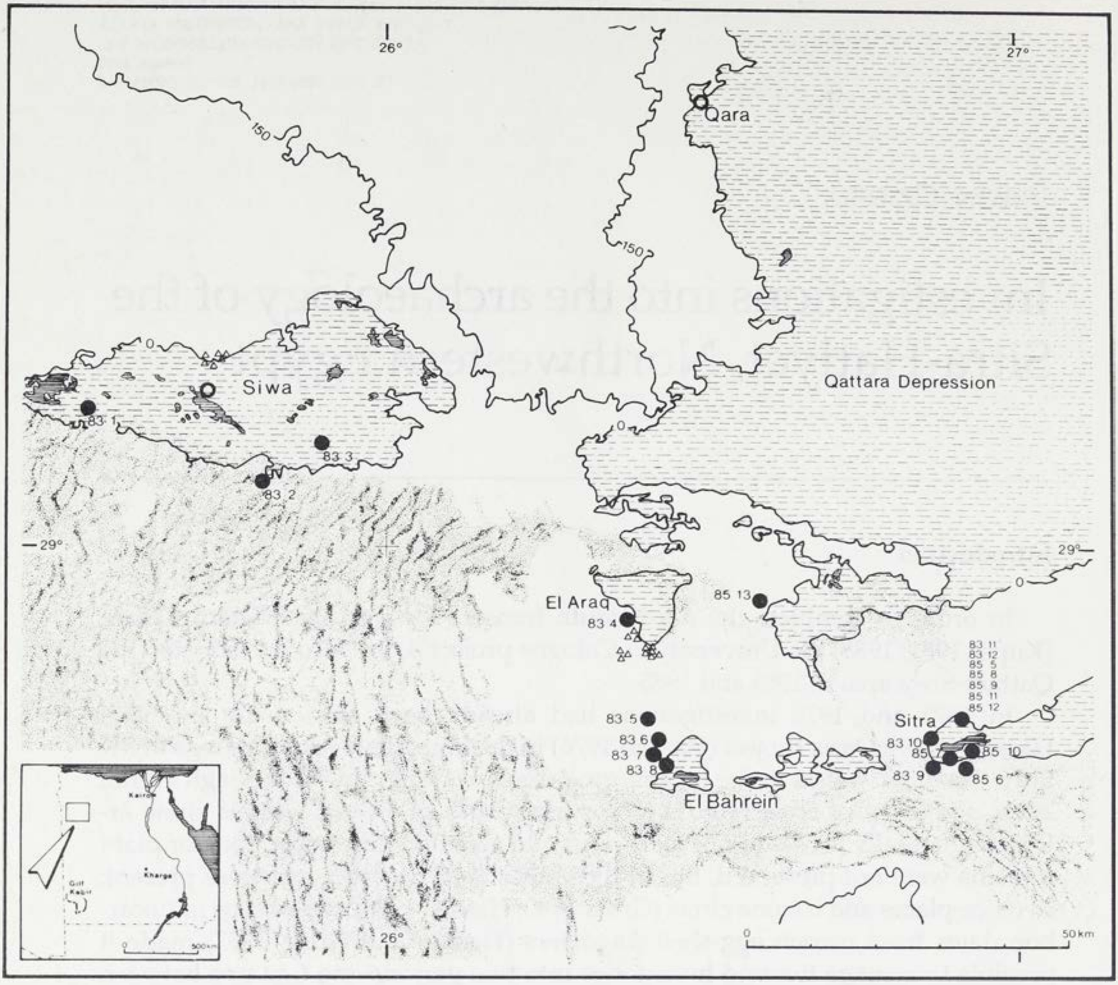

Fig. 1. Map of the Qattara/Siwa area with the geographical position of the sites of F.A. Hassan's Siwa Oasis Project (triangles) and those of the B.O.S.-sites (points with site-number).

Archaeological sites north of Sitra-Lake

The oldest archaeological evidence comes from Site 85/08 in the Sitra-Hatiyet itself where several Middle Palaeolithic artefacts were washed into an area of a few square meters. Their tool characteristics are hardly recognizable. According to their form they are probably bifacially surface retouched thin artefacts, which were produced from a relatively soft raw material. One flint artefact was found, a Levallois flake with facetted butt, which was half-way between the depression and the present lake.

Not in the immediate surroundings of the depression, but on a small plateau west of it, some 50 microliths were found, which were washed into a shallow

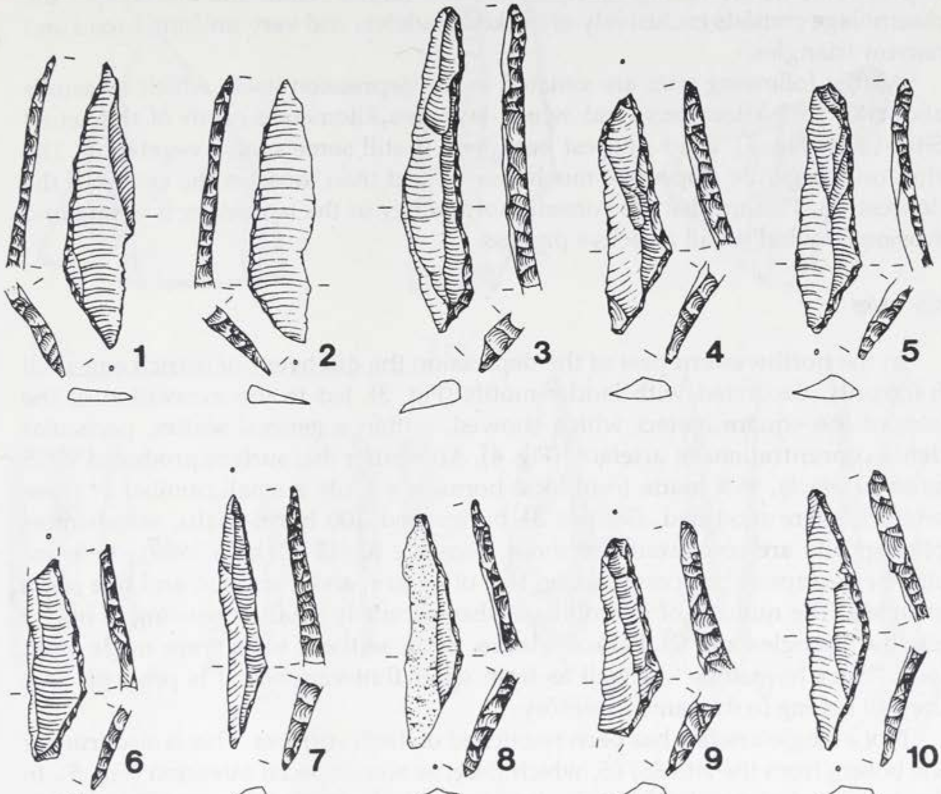

Fig. 2. Artefacts from site 85/11, west of Sitra-Hatiyet.

depression (site 85/11; Fig. 2). Apart of a few flakes, blades and one scraper the assemblage consists exclusively of backed bladelets and very uniform broad and narrow triangles.

All the following sites are situated in the depression itself, which measures about 1.5 to 2 kilometers, and which lays five kilometers north of the actual Sitra-Lake (Fig. 1). In its deepest part there is still some sparse vegetation. The sites on the gentle slopes are much more intact than those in the center of the depression. This means: the current morphology of the landscape is young and erosion by wind is still an active process.

Site 85/05

In the northwestern part of the depression the discovery of ostrich egg-shell fragments, decorated with ladder-motifs (Fig. 3), led to the excavation of the area of 356 square meters which showed, within a general scatter, particular dense concentrations of artefacts (Fig. 4). Altogether this surface produced 9,875 stone artefacts, 96% made from local hornstone. Only a small number of these artefacts were modified. Besides 31 burins and 100 burin-spalls, which morphologically are comparable to those from site 83/12 (Cziesla 1989), there are also two scrapers, one combination-tool of a burin and a scraper, and five *pièces esquillées*. The number of microliths is also extremely small, consisting of only 9 narrow triangles and 21 backed blades. Because these tools were made from local "Sitra-hornstone" as well as from other flint-varieties, it is probable that they all belong to the same inventory.

Not a single artefact has been retouched on both surfaces. This is also true for the borers from the site 85/05, which deserve some special attention (Fig. 5). In the excavated area only 11 borers were found, but outside this area several additional borers were located which were situated in separated find-concentrations. Some of these long tools, made from relatively thick triangular or trapezoid formed bladelets, show on part of the backed bilaterally retouched edges, an undoubtedly intentionally made "gibbosity" (Movius *et al.* 1968; Brézillon 1971: 298). As is shown in the other finds from the Sitra-Hatiyet area, as well as in a site outside this region above the oasis El Araq (site 83/04), this gibbosity is characteristic not only to the site 85/05, where it may show the personal technique of one individual knapper, but for the whole area (Fig. 5). When compared with similar bilaterally retouched thick long borers with a "gibbosity" – several authors call them *mèche de fôret, taraud* or *tarière* – there seems to exist quite a wide distribution of these artefacts. In the study area of the B.O.S. – Project, they are known from the Abu Minguar area (Klees 1989), from the area of Siwa-Oases (McBurney and Hey 1955: Fig. 35), while F.A. Hassan showed them from El Araq (Hassan 1978: Fig. 2). Further comparable pieces are known from the Haua Fteah (McBurney 1967: Fig. IX, 2) in Cyrenaica as well as from the Haurudj in Central Libya, collected there by Hans Rhotert during the last days of World War II (Richter 1956). More to the west they are also known from sites in Tunesia (Redeyef; Vaufrey 1955: Fig. 72) and Algeria, especially from the

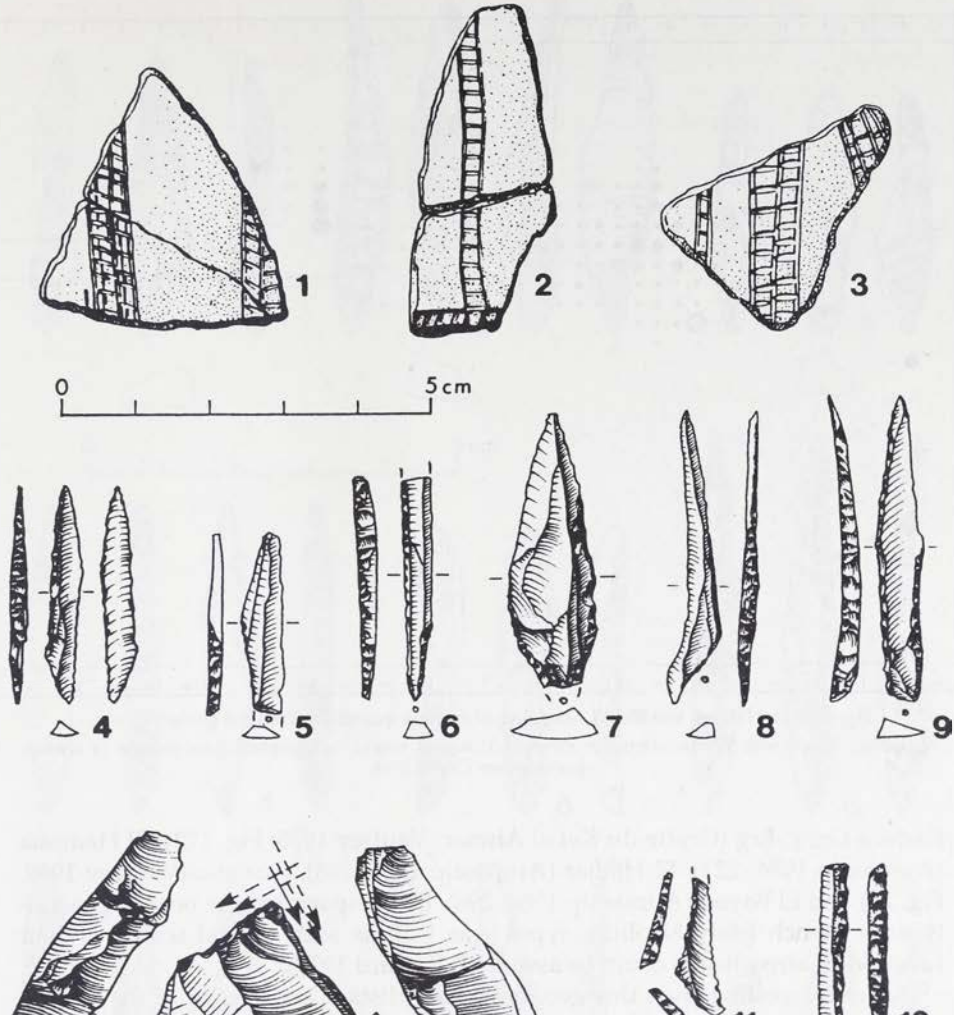

Fig. 3. Sitra-Hatiyet, site 85/05. Decorated ostrich-shells and stone-artefacts.

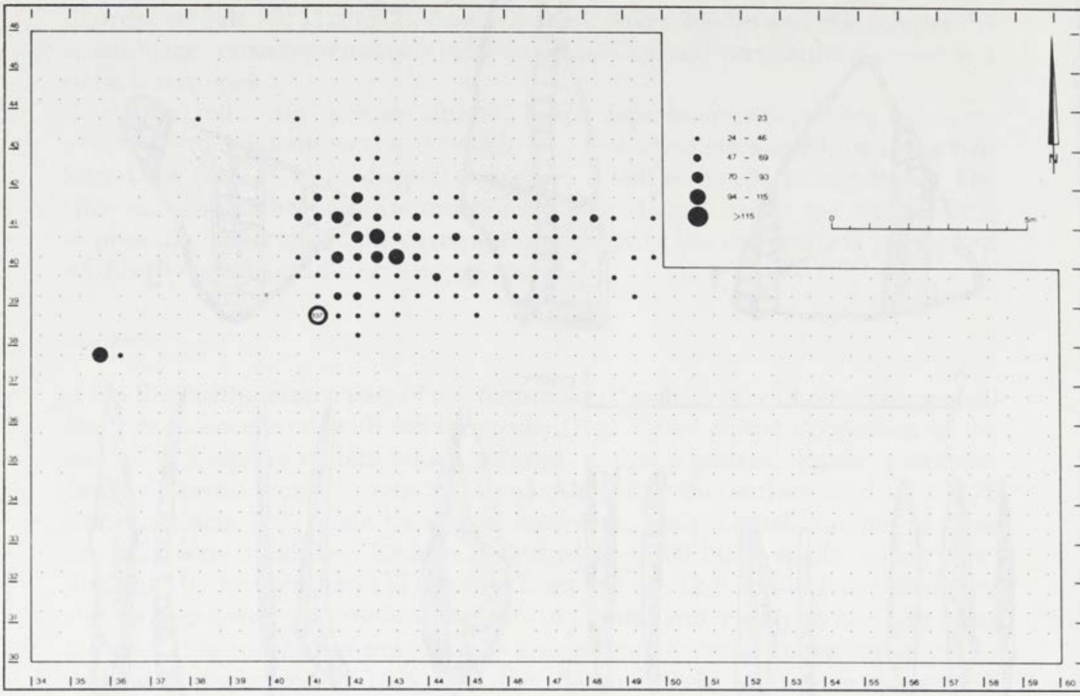

Fig. 4. Sitra-Hatiyet, site 85/05. Mapping of artefact quantities from the surface of site.
Altogether 356 m^2 with 9,309 artefacts. For the methodological way of cartographic demonstration of artefact quantities, see Cziesla 1988.

Eastern Great-Erg (Grotte du Kef el Ahmar; Vaufrey 1955: Fig. 172), El Hamraïa (Aumassip 1986: 221), El Hadjar (Aumassip 1986: 198), Ouargla (Vaufrey 1969: Fig. 22) and El Bayed (Aumassip 1986: 296). By comparing these borers, generally with French Early Neolithic types – as well as with ventral scaling – their function as arrowheads could be assumed (Paccard 1979).

More interesting than this geographically distant occurrence to the west is the fact that they seem to be chronologically linked to this period between 8,000 and 7,000 B.P. This age seems also acceptable for the borers from the Sitra-Hatiyet, as is indicated by two radiocarbon dated ostrich egg-shell samples, one originating from the dense artefact concentration, and the other from the location with the ornamented ostrich egg-shell fragments: 7,860 ± 65 B.P. (KN 3756) and 7,760 ± 75 B.P. (KN 3754) respectively.

After having sieved all artefacts from the surface, in four locations further artefacts were found in the sediment; obviously these were lower parts of former hollows (Cziesla 1990a: 154), whose limits could not be recognized. These hollows were also excavated in a quarter of square meter grid and produced maximally 2,368 artefacts per quarter square, vertically distributed in the sediment up to 15 cm below the present surface. Due to post-depositional processes the artefacts in the hollows have lowered their original position so

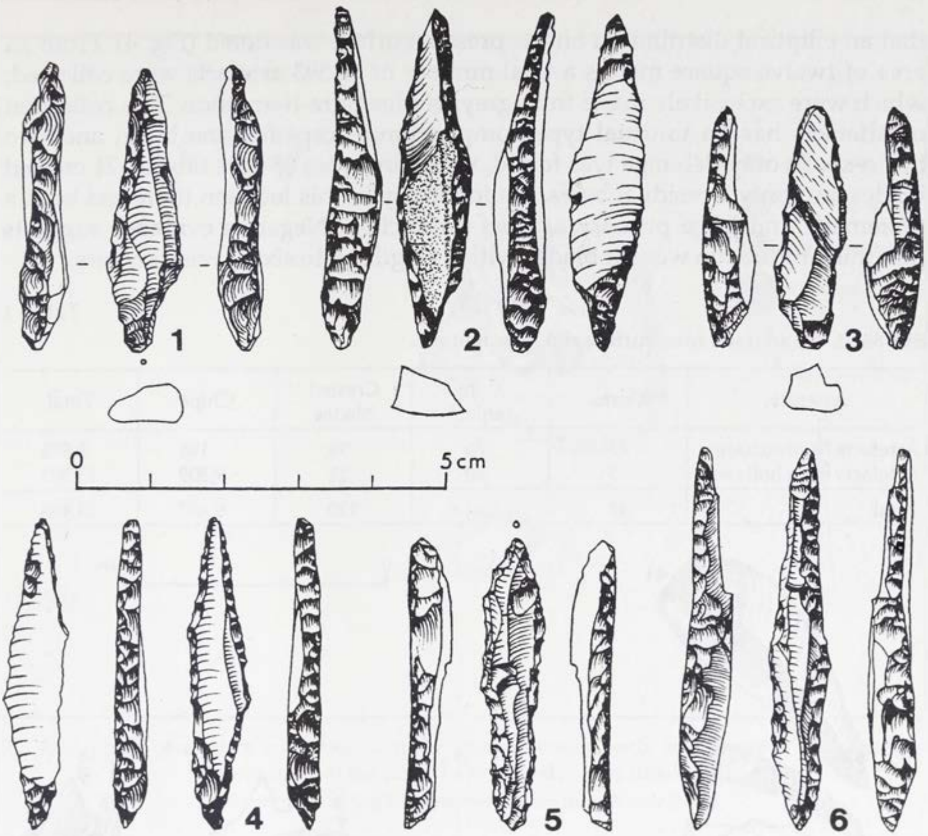

Fig. 5. Sitra-Hatiyet. 1 - 3, 7: borers from site 85/05; 6: borer from site 83/11.
Comparable tools. 4: El Araq, site 83/04; 5: Abu Minquar-area, site 81/55 - 5; 8 - 9: Haurudj in Libya.

that an elliptical distribution on the present surface was noted (Fig. 4). From an area of twelve square meters a total number of 13,593 artefacts were collected, which were exclusively made from greyish-blue Sitra-hornstone. This collection of artefacts has an unusual type composition: except for one burin and two burin-spalls only débitage was found, which includes 88 core tablets, 21 crested blades and only 5 residual cores. Undoubtedly in this location there has been a systematic and large primary artefact-production. Negative evidence suggests that this production was for blades with a length up to sixteen centimeters.

Table 1

Site 85/05. All artefacts from surface and from hollows.

Artefacts	Cores	Core tablets	Crested blades	Chips	Total
Artefacts from surface	43	176	99	148	9,875
Artefacts from hollows	5	88	21	9,309	13,593
Total	48	264	120	9,457	23,468

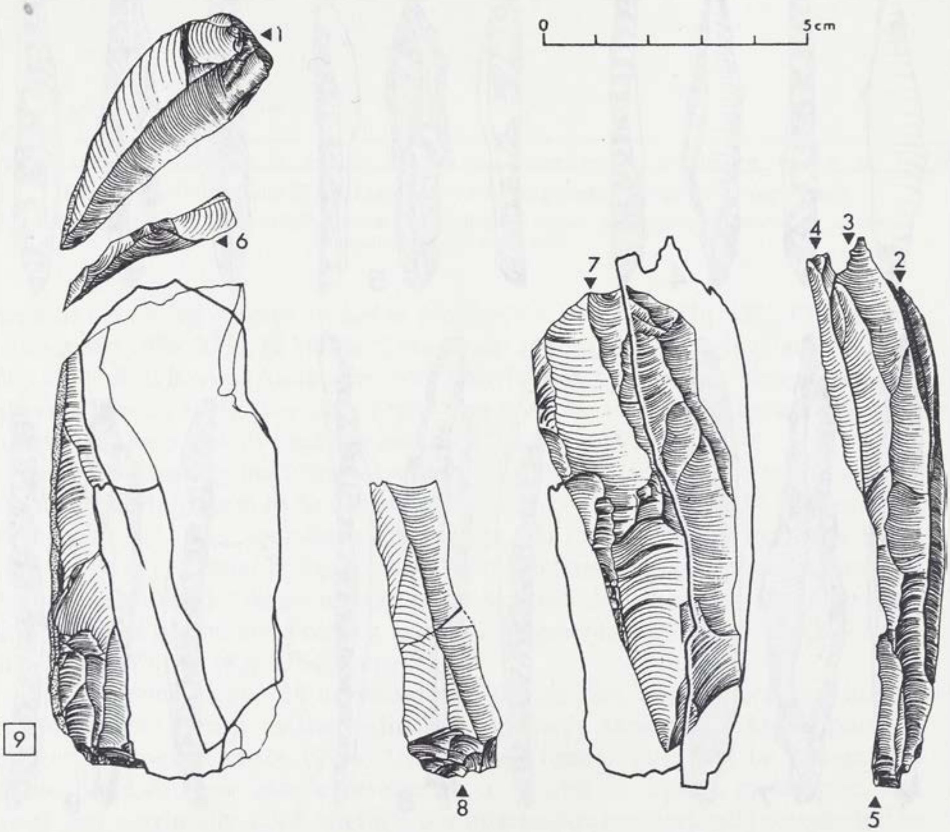

Fig. 6. Sitra-Hatiyet, site 85/05. Refitted core showing the high skilled technique of blade-production with platform preparation by using core-tablets.

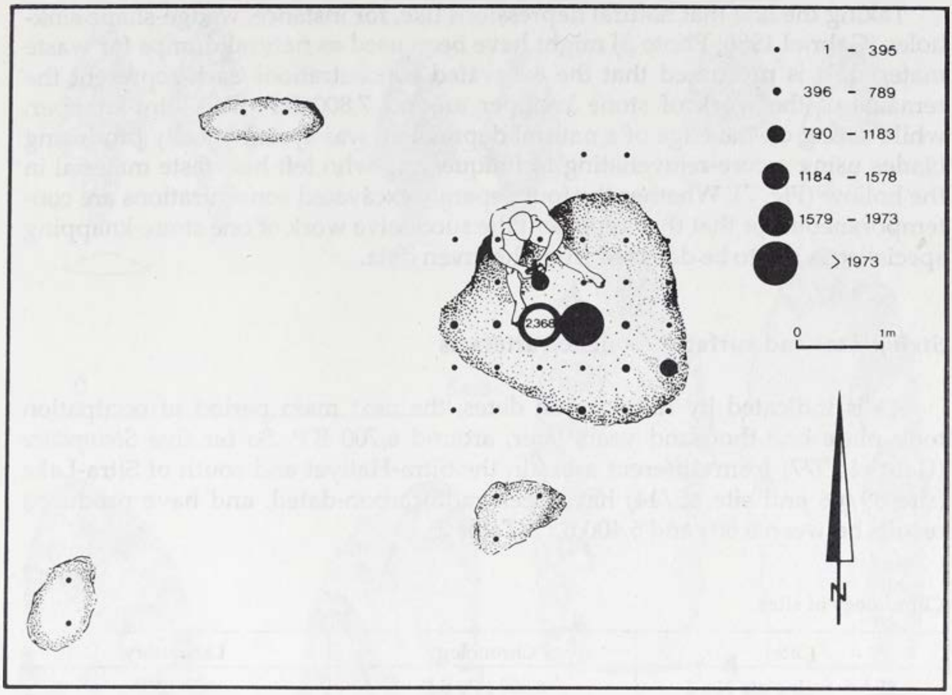

Fig. 7. Mapping of artefact quantities from the pits, combined with interpretation of a sitting flint-knapper at the edge of a proposed former sink-hole.
The figure of the sitting flint-knapper is taken from Weiner (1990).

A small sample of the artefacts allowed core reconstruction, which has made possible to analyse stone working technology as well as to test the state of various interpretations (Cziesla 1990c: 279 - 333).

The number of core rejuvenating flakes is considered high as compared to the number of crested-blades (Table 1). This suggests a highly skilled preparation-technique, which is supported by the occurrence of series of fitting core tablets. The sequence which was obtained by refitting demonstrates that after the production of each half a dozen blades the core platform was rejuvenated by removing a flake (Fig. 6). *Fractures en nacelle* indicate that the punch-technique was performed to remove blades from a core (Eloy 1975; Weiner 1990), this is also shown by the platform preparation by removing flakes. As such a preparation is extremely wasteful of the raw material, and as each preparation will cause the next series to be approximately half a centimeter shorter blades (Ophoven 1943), the raw material must have been readily available, and the length of blades not an important criterion, as can be seen by the dimensions of the smaller residual-cores.

It was also established by refitting artefacts from the hollows that each series of artefacts originated from the same concentration, and thus that the four excavated concentrations in hollows each represent a separate activity area.

Taking the line that natural depressions like, for instance, wedge-shape sinkholes (Gabriel 1986: Photo 3) might have been used as natural dumps for waste material, it is presumed that the excavated concentrations each represent the remains of the work of stone knapper around 7,800 B.P. This flint-knapper, while sitting on the edge of a natural depression, was systematically producing blades using a core-rejuvenating technique, and who left his waste material in the hollow (Fig. 7). Whether the four separate excavated concentrations are contemporaneous, or that they represent the successive work of one stone-knapping specialist, is not to be detected from the given data.

Steinplätze and surface-retouched artefacts

As is indicated by radiocarbon dates, the next main period of occupation took place one thousand years later, around 6,700 B.P. So far five *Steinplätze* (Gabriel 1977) from different areas in the Sitra-Hatiyet and south of Sitra-Lake (site 85/06 and site 85/14) have been radiocarbon-dated, and have produced results between 6,800 and 6,400 B.P. (Table 2).

Table 2

Chronology of sites.

Site	Chronology	Laboratory
85/05 Steinplatz No. 2	6,850 ± 70 B.P.	KN 3555
83/12 Steinplatz No. 2	6,840 ± 65 B.P.	KN 3223
85/05 Steinplatz No. 3	6,760 ± 70 B.P.	KN 3727
85/06 Steinplatz No. 1	6,760 ± 65 B.P.	KN 3857
85/14 Steinplatz No. 1	6,670 ± 65 B.P.	KN 3785

Table 3

Chronology of the youngest sites.

Site	Chronology	Laboratory
85/12 Steinplatz No. 1	6,420 ± 65 B.P.	KN 3799
83/11 Steinplatz No. 2	6,290 ± 65 B.P.	KN 3222
83/11 Steinplatz No. 3	5,940 ± 60 B.P.	KN 3589

With these *Steinplätze* a few generally rarely occurring surface-retouched artefacts were found (Fig. 7). A definite association is not sure, as all *Steinplätze* were completely lacking in archaeological finds. It is probable that those who created these sites, were not primarily concerned with the production of stone tools, like their predecessors: the surface-retouched tools are not made from the previously frequently used Sitra-hornstone, and there are no known sites with a débitage which suggests a local production of surface-retouched tools from tabular flint.

There is still a question whether the arrow-heads (Fig. 8) are to be seen as part of these assemblages or not. Additional dates from two more Steinplätze, around 6,000 B.P. (Table 3), perhaps may also date the arrow-heads.

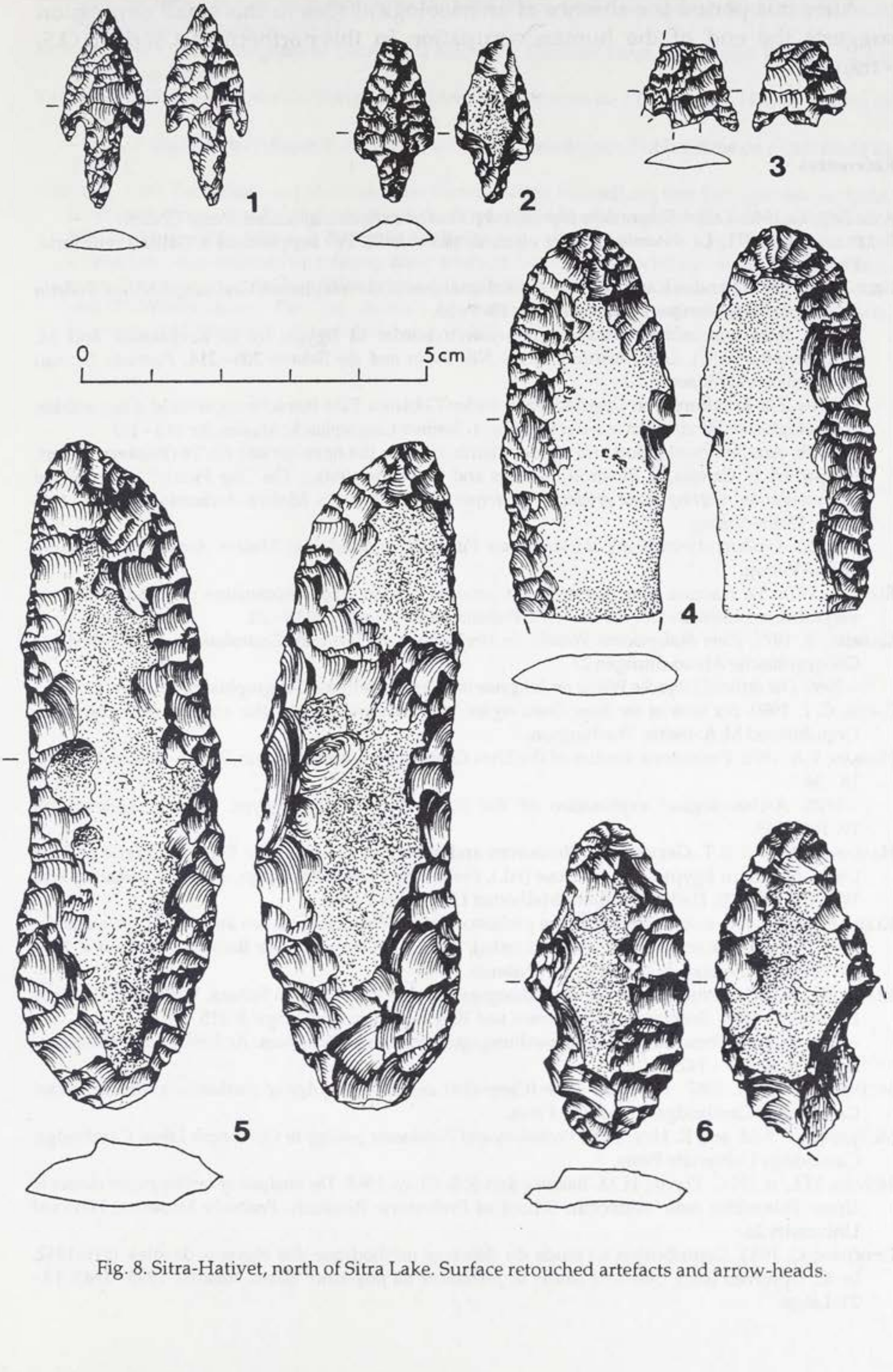

Fig. 8. Sitra-Hatiyet, north of Sitra Lake. Surface retouched artefacts and arrow-heads.

After this period the absence of archaeological sites in this small depression suggests the end of the human occupation in this northern part of the B.O.S. – transect.

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Cultural adaptations in Dakhleh Oasis, Egypt, in the Early to Mid-Holocene

This paper is a review of the cultural sequence for Early to Mid-Holocene Dakhleh Oasis in light of new palaeoenvironmental evidence, and a dozen new radiocarbon dates for the period, making a total of twenty. Three late prehistoric cultural units, distinguishable by their artifact inventories and site locations, have been identified to date in Dakhleh Oasis. The earliest, dating to the ninth millennium, is called the Masara unit, while two later Neolithic units have been labelled the Sheikh Muftah and the Bashendi respectively. This paper reviews these late prehistoric units, outlining their distinguishing artifact inventories and site locations, and discussing palaeoenvironmental data and dating evidence for each unit.

The earliest, Masara unit, consists of two variants, A and B, differing on the basis of chipped stone raw material and tool assemblages, as well as site location. Masara Variant A is predominantly a blade and bladelet industry, made mostly on good quality fresh chert nodules. In the debitage, blades outnumber flakes, while the most common core type has a single platform, usually unfacetted. The toolkit (Table 1) includes notches, denticulates, and piercers, all on blades or bladelets, stemmed arrowheads, and only rare burins. In one collection, 70% of tools are microlithic, either backed bladelets or scalene triangles.

The second Masara variant, Variant B, shares with A such features as backed elements, the occasional notched or denticulated blade, and use of the microburin technique (Table 1), but it is in fact a very different industry, based largely on old worn chipped stone produced by an earlier culture, rather than on fresh chert nodules. It is not primarily a blade industry. Toolkits are dominated by classes fashioned from the worn material – rough notches, denticulates and piercers, but especially burins (60 - 80% of tools in most collections), a class which in this industry grades into core scrapers and single-platform cores. The burins are produced, usually on the proximal ends of thick-sectioned Levallois flakes, in a sequence that also yields distinctive double-patinated spalls with retouch, and various resharpening spalls (McDonald, in press).

Table 1

Collections from Masara B (sites 30/420-D1-1 and 30/420-C5-1) and Masara A (site 31/420-H10-1). Distribution of retouched tool types.

Sites	30/420-D1-1				30/420-C5-1				31/420-H10-1			
	Coll. 2		Coll. 1		Coll. 2		Coll. 4		Coll. 1		Coll. 2	
Specimens	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%
4. Core-like end-scraper	7	10.8	9	19.1	1	5.0						
12. Single piercer	2	3.1										
17. Dihedral burin	29	44.6	23	48.9	13	65.0						
19. Burin on break or single-faced	6	9.2	4	8.5	1	5.0	1	9.1				
20 Multiple dihedral burin	10	15.4	3	6.4	2	10.0						
45. Pointed straight backed bladelet							2	18.1	7	18.9		
51. Pointed straight backed, rtch. base									1	2.7		
56. Curved backed bladelet									2	5.4		
64. Shouldered bladelet					1	5.0	2	18.1				
66. Fragment backed bladelet					1	5.0			8	21.6	10	83.3
67. Obtuse ended backed bladelet									1	2.7		
74. Notched flake	2	3.1	2	4.3	1	5.0						
75. Denticulated flake	2	3.1	1	2.1			1	9.1				
76. Notched blade	3	4.6	1	2.1					3	8.1		
77. Denticulated blade									1	2.7		
79. Notched or denticulated, cont. rtch.	1	1.5	1	2.1								
80. Truncated piece											1	8.3
82. Segment of semi-circle							3	27.3				
90. Scalene triangle									1	2.7		
95. Elongated scalene triangle with very short side									5	13.5		
101. Bladelet with microburin scar			1	2.1								
102. Microburin			1	2.1			1	9.1	1	2.7		
105. Retouched piece	3	4.6	1	2.1			1	9.1	6	16.2	1	8.3
112. Varia (arrowhead)									1	2.7		
Total	65	100.0	47	99.9	20	100.0	11	99.9	37	99.9	12	99.9

All categories numbered according to type list of J. Tixier (1963).

Masara sites of both variants, all surface sites, are relatively impoverished in artifact classes other than chipped stone, and in economic information. There are ground stone items including a few grinding slab fragments and hand-stones, as well as hammerstones, pounders, and a mortar made in tough quartzite. A few potsherds, both shale- and sand-tempered, occur on sites of both variants. Ostrich eggshell scatters are relatively rare, but buried eggshell water containers were found on one site, and a single eggshell bead on another. Apart from ostrich eggshell, virtually no faunal remains have been recovered from Masara sites.

The two Masara variants differ strikingly in site distribution (Fig. 1). Masara B sites, four of them so far, are confined to one small locality within Dakhleh, a portion of the sandstone ridge SW of the modern village of Ezbet Sheikh Muftah in east central Dakhleh. These sites occupy shallow basins within the sandstone cuesta, some of which they share with Masara A sites. Sites of the lat-ter unit are distributed more widely, however, occurring also on the periphery

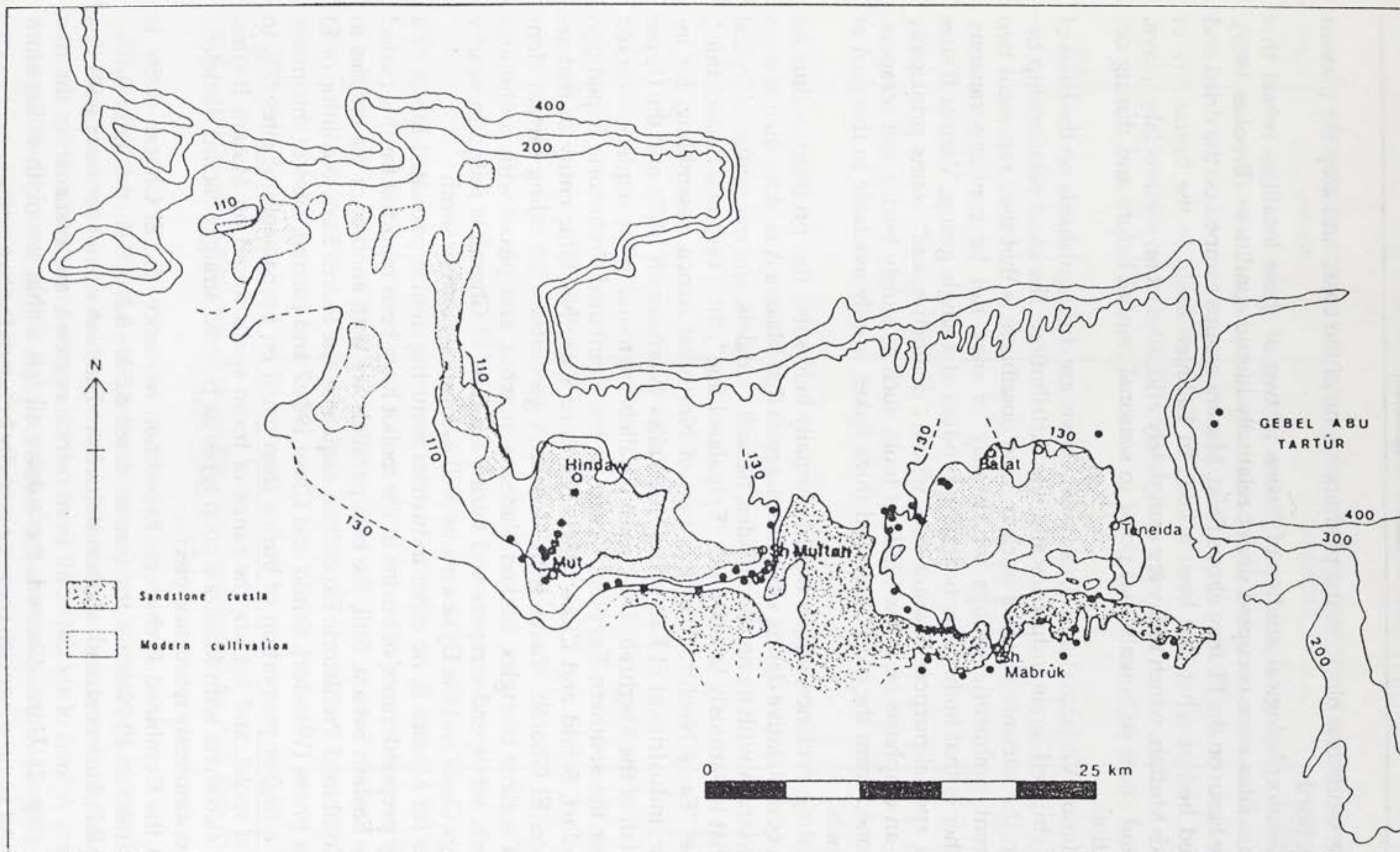

Fig. 1. Dakhleh Oasis. Distribution of Masara sites.

of the sandstone block, in the piedmont zone of the oasis, and atop the plateau to the north.

Geomorphological studies of basins in two of these localities reveal that Masara sites were occupied under relatively humid conditions (Brookes 1989). In the basin on the Plateau above Balat, Masara groups camped on the dried and eroded bed of what had been a lake. In Dakhleh itself, in the basins SW of Sheikh Muftah, which today are completely arid, sites sit on shallow lake, playa, or sand sheet sediments that point to seasonal rainfall before and during occupation.

Masara Variants A and B, as stated above, are distinguishable on the basis of their chipped stone industries and site distribution. The exact relationship between the variants remains unclear. One possibility is that they represent two different prehistoric groups which may or may not be contemporaneous. Another is that both variants are the product of a single group, Variant B sites being special-purpose Masara sites whose "distinctiveness" stems principally from an emphasis on a few kinds of tools, such as sturdy burins and scrapers, fashioned from the old bifaces and thick flakes readily available in this part of the oasis.

Dating evidence, which would normally help solve this problem, is thus far equivocal. Relative dating evidence suggests that Masara A is older than Masara B. Masara A with its notched blades, backed bladelets, and microliths, is typical of what is variously labelled the "Epipalaeolithic", the "Terminal Palaeolithic", or the "Early Neolithic" of this part of Northeast Africa, resembling, for instance, industries at El Kab in the Nile Valley (Vermeersch 1978), and the Upper Capsian of the Maghreb. The closest parallels are found in the sequence worked out for the southern Egyptian Desert by the Combined Prehistoric Expedition (Wendorf, Schild and Close 1984). The third Early Neolithic entity in that sequence, El Ghorab, shares with Masara A geometrics, including certain elongated scalene triangles, backed bladelets, notches, and pieces with continuous retouch, while end-scrapers and burins are rare. El Ghorab is found in nearby Kharga Oasis and the Dyke area, as well as locations further south.

As for Masara B, no other industries featuring double patinated lithics or a heavy preponderance of burins in the toolkit have been reported for this period in the Eastern Sahara. Still, the best parallels are with another of the entities in the Combined Prehistoric Expedition sequence, the fourth Early Neolithic or El Nabta phase (Wendorf, Schild and Close 1984:7 and *passim*). Sites of this phase yield a higher proportion of burins than usual on Epipalaeolithic sites (7% to 30% of tools), and feature the range of burin spalls found on Masara B sites. They also share with Masara B such types as pointed straight-backed bladelets, and continuously retouched pieces.

In the Combined Prehistoric Expedition sequence, the El Ghorab entity is older than in El Nabta – the former dated 8,500 - 8,200 B.P., the latter 8,100 - 7,900 B.P. However, radiocarbon dates from Dakhleh do not conform with this pattern. A total of six dates, all from ostrich eggshell, are available for the two units (Fig. 2). Unrecalibrated, these dates all fall within the ninth millennium B.P., and suggest a rough contemporaneity between the two units.

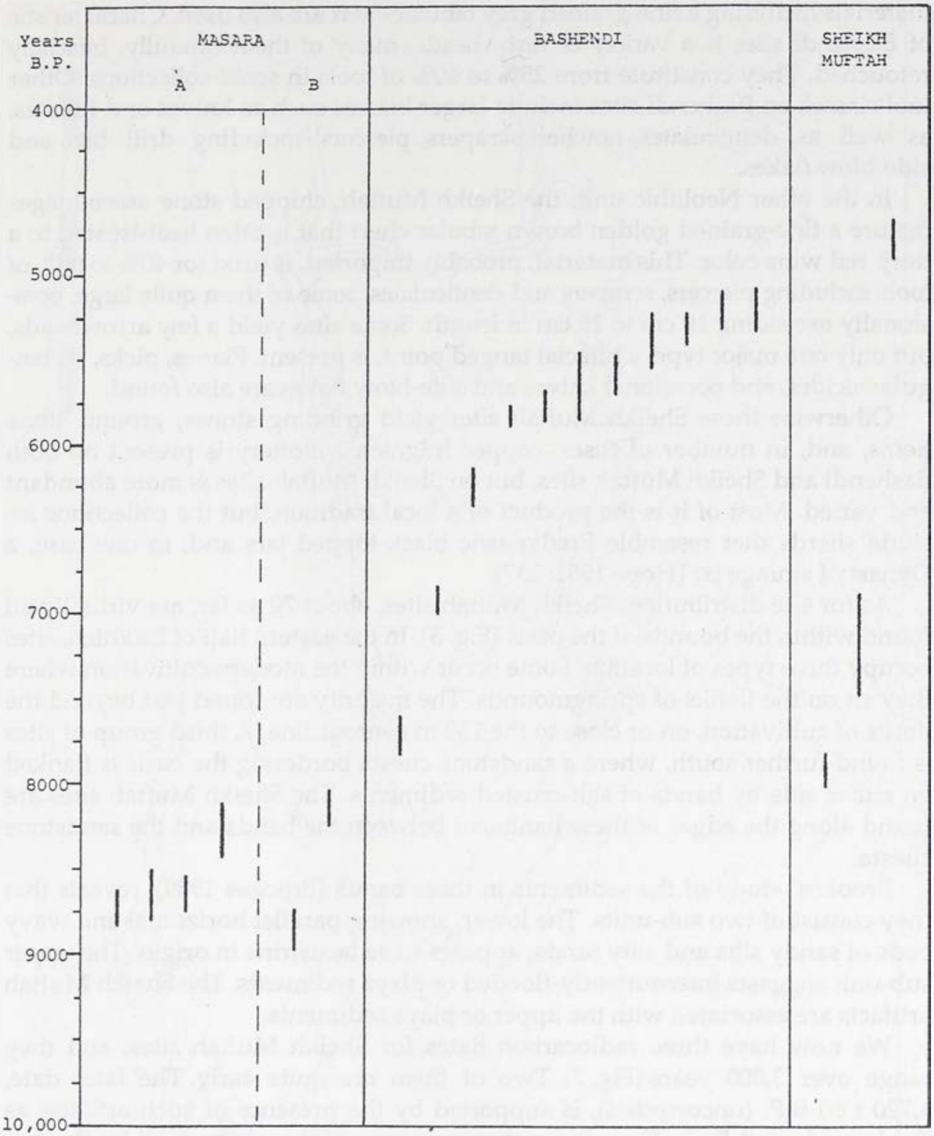

Fig. 2. Dakhleh Oasis. Distribution of radiocarbon dates (uncalibrated) for three Early to Mid-Holocene cultural units.

The other two Holocene prehistoric cultural units in Dakhleh, the Bashendi and Sheikh Muftah, differ strikingly from the Masara in artifact classes and site location, and from each other as well.

In the Bashendi unit, the chipped stone industry is predominantly a flake industry made on small nodules of chert and quartzite. A number of other materials including a fine-grained grey tabular chert are also used. Characteristic of Bashendi sites is a variety of arrowheads, many of them carefully, bifacially retouched. They constitute from 25% to 40% of tools in some collections. Other tool classes on Bashendi sites include larger bifaces such as knives and foliates, as well as denticulates, notches, scrapers, piercers including drill bits, and side-blow flakes.

In the other Neolithic unit, the Sheikh Muftah, chipped stone assemblages feature a fine-grained golden brown tabular chert that is often heat-treated to a deep red wine color. This material, probably imported, is used for 40% to 60% of tools including piercers, scrapers and denticulates, some of them quite large, occasionally exceeding 10 cm to 15 cm in length. Some sites yield a few arrowheads, but only one major type, a bifacial tanged point, is present. Planes, picks, rectangular sickles, and occasional knives and side-blow flakes are also found.

Otherwise these Sheikh Muftah sites yield grinding stones, ground stone items, and, in number of cases, copper fragments. Pottery is present on both Bashendi and Sheikh Muftah sites, but on Sheikh Muftah sites is more abundant and varied. Most of it is the product of a local tradition, but the collections include sherds that resemble Predynastic black-topped jars and, in one case, a Dynasty I storage jar (Hope 1981: 237).

As for site distribution, Sheikh Muftah sites, about 70 so far, are virtually all found within the bounds of the oasis (Fig. 3). In the eastern half of Dakhleh, sites occupy three types of location. Some occur within the modern cultivation where they sit on the flanks of springmounds. The majority are found just beyond the limits of cultivation, on or close to the 130 m contour line. A third group of sites is found further south, where a sandstone cuesta bordering the oasis is flanked on either side by bands of salt-crusted sediments. The Sheikh Muftah sites are found along the edges of these bands, or between the bands and the sandstone cuesta.

Brookes' study of the sediments in these bands (Brookes 1989), reveals that they consist of two sub-units. The lower, showing parallel horizontal and wavy beds of sandy silts and silty sands, appears to be lacustrine in origin. The upper sub-unit suggests intermittently-flooded or playa sediments. The Sheikh Muftah artifacts are associated with the upper or playa sediments.

We now have three radiocarbon dates for Sheikh Muftah sites, and they range over 3,000 years (Fig. 2). Two of them are quite early. The later date, 4,720 ± 80 B.P. (uncorrected), is supported by the presence of such artifacts as Predynastic and Early Dynastic pottery on some of these sites, and by the fact that Sheikh Muftah material occurs together with Old Kingdom artifacts of the Fifth or Sixth Dynasty, in some cases in stratified contexts.

To return to the Bashendi unit, site distribution is quite different from that of Sheikh Muftah (Fig. 4). Sites occur within the oasis, both in the vicinity of the modern cultivation, or well beyond it. Unlike the Sheikh Muftah pattern, though, many sites occur beyond the borders of the oasis strictly speaking – at various locations on the Northern Plateau, and in the desert well to the south of Dakhleh.

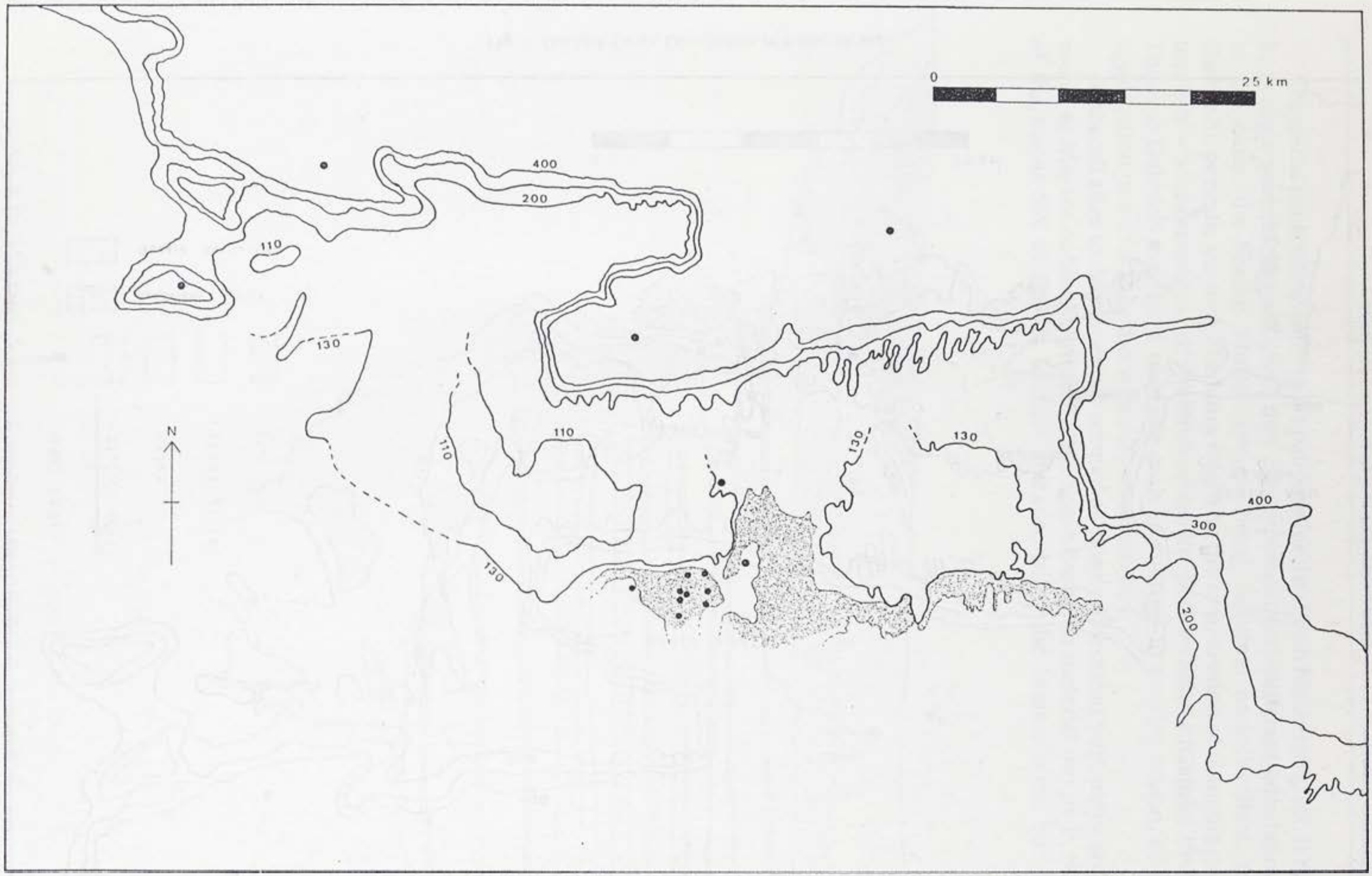

Fig. 3. Dakhleh Oasis. Distribution of Sheikh Muftah sites.

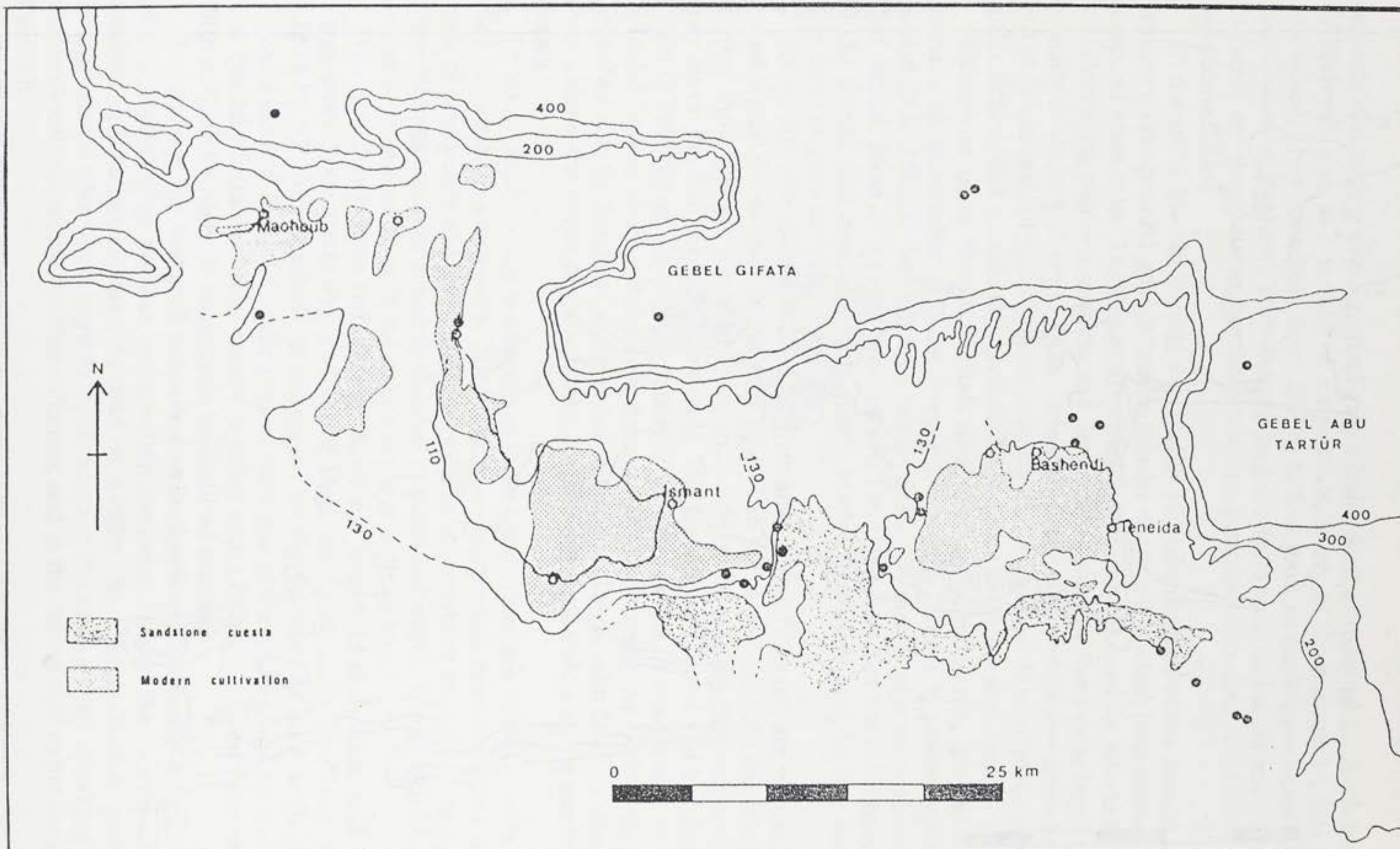

Fig. 4. Dakhleh Oasis. Distribution of Bashendi sites.

Given the contrasting settlement patterns for these two Neolithic units, it has been suggested (McDonald 1986) that they represent very different adaptations to the oasis, the Sheikh Muftah groups being full-time oasis-dwellers, the Bashendi, periodic visitors. The latter might be the local version of nomadic pastoralists whose campsites are scattered across the Eastern Sahara (Gabriel 1984). Those at Dakhleh may have used the oasis as a refuge in the dry season, or an aggregation point for the otherwise dispersed bands.

Bashendi sites to date have not seemed as closely associated with playa sediments as Masara or Sheikh Muftah sites. Some Bashendi material occurs in two of the basins SW of Sheikh Muftah that also boast the Masara sites, but no

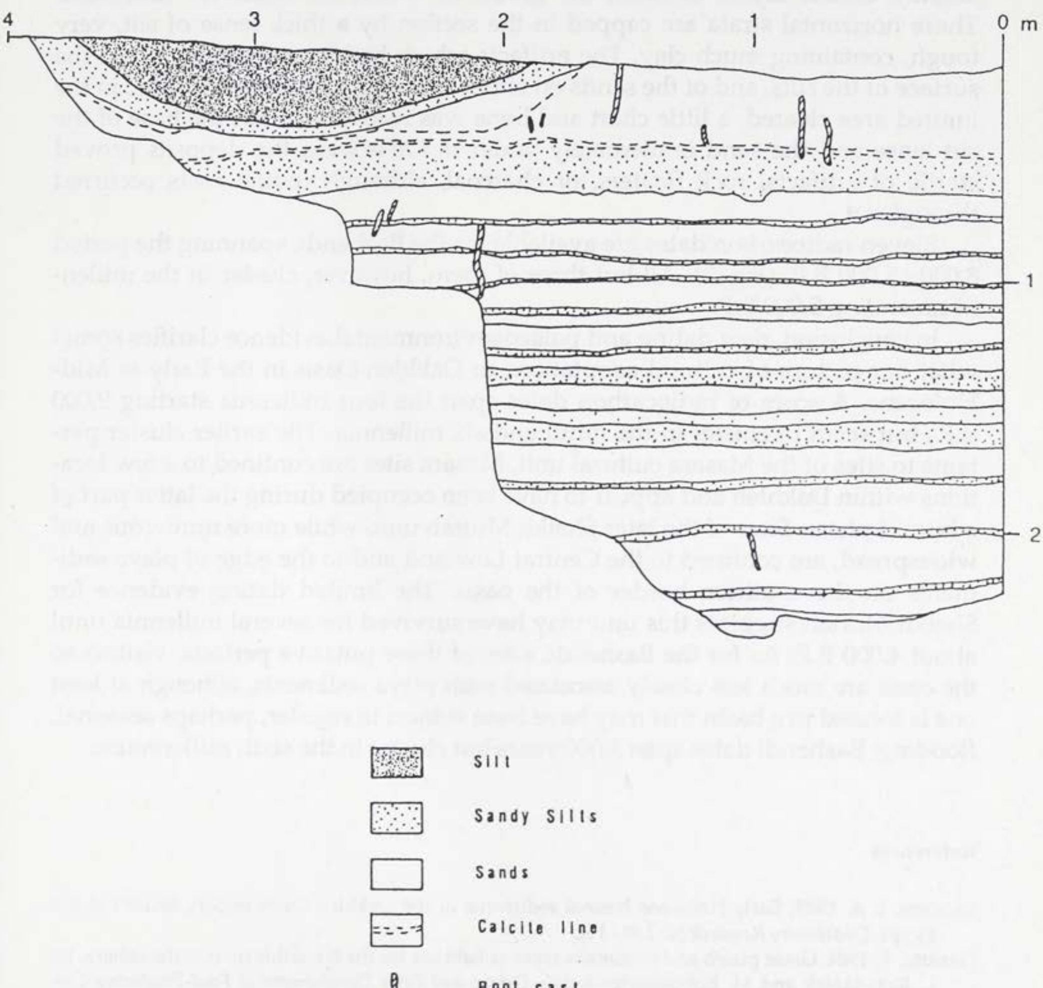

Fig. 5. Dakhleh Oasis. Stratification in the test trench 228 Cl. 1, west profile.

Bashendi sites have been found on the borders of the crusted playa sediments with the Sheikh Muftah material. For most Bashendi sites, associated Holocene sediments are gone, and the artifacts are scattered on bedrock, or on Pleistocene Laminated Sediments.

One site examined in 1988 did, however, yield some information on the Mid-Holocene environment. Site 30/450-A9-1, south of the oasis, is a large entity, *ca.* 2×4 km, consisting of scatters and heavier concentrations of Bashendi material sitting on the surface sands and silts.

A test trench excavated under one of these scatters after it was mapped, and dug to a depth of over 2 m without hitting bedrock, revealed a total of 30 strata (Fig. 5). From the bottom these consist of thin layers of sandy silts, separated by slightly thicker layers of sand, the grains of which are relatively unfrosted. These horizontal strata are capped in the section by a thick lense of silt, very tough, containing much clay. The artifacts which had been mapped sit on the surface of the silts, and of the sands on either side of the lense. In addition, in the limited area cleared, a little chert and bone was recovered from the base of the silt lense and the sand immediately under it. Otherwise, the deposits proved sterile of artifacts, rock floaters, or charcoal, although rootlet casts occurred throughout.

Eleven radiocarbon dates are available for the Bashendi, spanning the period 8,000 - 5,000 B.P. (Fig. 2). All but three of them, however, cluster in the millennium ending 5,000 B.P.

In conclusion, new dating and palaeoenvironmental evidence clarifies somewhat our picture of cultural adaptations in Dakhleh Oasis in the Early to Mid-Holocene. A score of radiocarbon dates span the four millennia starting 9,000 B.P., but seem to cluster in the ninth and six millennia. The earlier cluster pertains to sites of the Masara cultural unit. Masara sites are confined to a few locations within Dakhleh and appear to have been occupied during the latter part of a humid phase. Sites of the later Sheikh Muftah unit, while more numerous and widespread, are confined to the Central Lowland and to the edge of playa sediments on the southern border of the oasis. The limited dating evidence for Sheikh Muftah suggests this unit may have survived for several millennia until about 4,000 B.P. As for the Bashendi, sites of these putative periodic visitors to the oasis are much less closely associated with playa sediments, although at least one is located in a basin that may have been subject to regular, perhaps seasonal, flooding. Bashendi dates span 3,000 years but cluster in the sixth millennium.

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IAN A. BROOKES

Early Holocene basinal sediments of the Dakhleh Oasis region, Egypt (theses)

Sediments from basins in four contrasting geologic-topographic settings in Dakhleh Oasis region (approx. 25.5°N, 29°E) record perennial, intermittent and ephemeral lacustrine conditions, with variable eolian sediment influx, inversely proportional to lacustrine dominance. Twenty radiocarbon dates on artifactual ostrich eggshell and hearth charcoal firmly to loosely associated with these sediments range from *ca.* 8,800 years to *ca.* 4,700 years B.P. This information provides a general picture of an Early Holocene pluvial beginning a few centuries before *ca.* 9,000 years B.P., followed by gradual desiccation to *ca.* 4,500 years B.P. Data currently available do not permit subdivision of this interval. Differences of hydrogeology and morphometry amongst and within basin types complicate the interpretation of hydrological response to pluviation in the Dakhleh region.

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ENVIRONMENTAL CHANGE AND HUMAN CULTURE
IN THE NILE BASIN AND NORTHERN AFRICA
UNTIL THE SECOND MILLENNIUM B.C.
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RUDOLPH KUPER

Sahel in Egypt: environmental change and cultural development in the Abu Ballas area, Libyan Desert

In order to complete the planned transect between the Mediterranean and the Sahel zone (Kuper 1988; 1989a), B.O.S. fieldwork in 1985 and 1987 was concentrated upon the area of Abu Ballas, in southwestern Egypt, about 500 kilometres west of the Nile. The region is named after a small, conical hill which, curiously enough, can be found even on large scale maps. Among thousands of similar hills this one has the advantage of being named by John Ball, who passed through this practically unknown part of the Libyan Desert during a geological survey in 1918 (Ball 1927: 122). At the foot of that inconspicuous sandstone cone – approximately 200 kilometres southwest of Dakhla Oasis – he discovered over one hundred big jars, which led to the Arab name of the site: "Father of Jars" or "Pottery Hill". The ceramic material has been dated by different authors partly to the Late Predynastic or Early Dynastic period, partly to the Ramesside Dynasty of the 12th century B.C. Recently French excavations at Balat near Dakhla uncovered jars of a quite similar shape in mastabas of the VI Dynasty. At the time of discovery the pots were still lying well arranged in a closed band at the northern foot of the hill. The Frobenius Expedition of 1935 (Rhotert 1952: 70) found the original arrangement already destroyed, and in 1985 nearly all of the complete jars had disappeared (Kuper 1989b: 19).

Pharaonic Egyptian influence can also be detected in two rock engravings below the top of the hill, which were discovered by Prince Kemal el Din in 1924 and later recorded by Hans Rhotert (Rhotert 1952: Table XXXVI; Kuper 1989b: 20). The first, showing a hunter aiming at a gazelle, strongly resembles Egyptian wall paintings – an impression which is particularly stressed by the costume of the man. The same can be stated in the case of the nearby engraving of a cow suckling its calf, a motif quite popular in Early Dynastic Egypt. If this most barren part of the Desert was still included in the Egyptian world at a time when desertification was already far in progress, then the more remains from the Neolithic could be expected there.

On his way from Dakhla to the Gilf Kebir in 1932, Ralph Bagnold passed through that area following a southwest oriented escarpment which has not yet

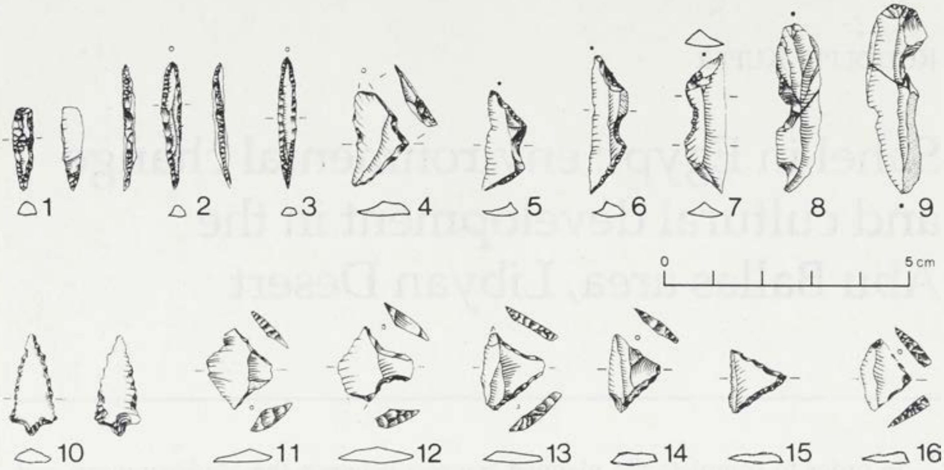

Fig. 1. Site Westpans 85/52. 1 - 3: perforators; 4: isosceles triangle; 5 - 7: notched trapezes; 8 - 9: refitted microburins.
Site Mudpans 85/50 - 1. 10: pendoculated arrow head; 11 - 13: trapezes; 14 - 16: isosceles triangles.

been reported on topographic maps but is clearly visible on satellite images. In his report he mentions a "chain of ancient lakes" that he describes as "one nearly continuous Neolithic site" (Bagnold *et al.* 1939:283). While the western part of the escarpment is formed by high cliffs with picturesque yardangs at their foot, this range is much lower further eastwards and altered by erosion into thousands of inselbergs.

It was here that members of the B.O.S. expedition of 1983 – on their way back from the Gilf to Kharga – rediscovered by chance one of Bagnold's sites in a position where, from his observation, the term "mud pans" is printed on the old British 1 : 1,000,000 map. Since finding a name for a prehistoric site in the desert is always a problem, this term was chosen for the main excavation field there. Another smaller pan, lying in a similar topographical position 50 km further west, was named "Westpans".

Although only limited work has been done there, this short overview has to start with Westpans site 85/52 which technologically had an Epipalaeolithic appearance and, by its radiocarbon date of 8,700 ± 190 b.p. (KN 3671; corrected, not calibrated), represents the oldest archaeological complex in the Abu Ballas area so far. The site consisted of four relatively well defined accumulations of artefacts and bone splinters. The 952 stone artefacts, mainly made of chert, were analyzed by Andrea Hahn and comprised 75 microliths and 117 microburins (Hahn 1990). This observation, and the fact that more than 30 percent of different raw materials could be refitted, support the interpretation of this place being a hafting and retooling site. Special mention has to be made of a specific type of trapeze, characterized by a broad notch (Fig. 1: 5 - 7). Comparable types appear sporadically in the Capsian culture but do not allow any further conclusions (Vaufrey 1955: 199, 317; Cadenat 1963: 98 - 99; Mateu 1970: 162).

At "Mudpans" the main excavation was situated at the northern edge of the playa where most of the sites are between or on top of the inselbergs on the slope of the escarpment. Within the mapped area of 800 to 350 m (Fig. 2) four separate settlement areas have been studied, all covering a timespan of more than 2,000 years.

Site 83/39 on the edge of the playa is the oldest one within the whole excavation area. There is a quite limited test excavation followed the surface layer of artefacts up to 20 cm into the playa sediment. Apart of a single bone of a giraffe, hare and gazelle could be identified among the faunal remains. The stone artefacts are not very diagnostic and consist mainly of small flakes. Only a few retouched blades and bladelets could be found, and among these only two triangles. Three radiocarbon measurements date this site to about 8,200 b.p.

Just slightly larger was the test area at site 85/56, some 500 metres further north, but it provided a much greater amount of different material and even some unexpected settlement features. At 20 cm below the surface the excavation uncovered quite clearly defined circular structures, which could be traced down to 1 metre depth. It was clearly visible that the relatively soft sandstone had been broken by following its natural cracks and structures. In one case carvings and scratch-marks in the sandstone might well be interpreted as traces of these activities. With a diameter ranging from 2.5 to 3 metres the dimension of these holes correspond close to other settlement structures like the systematically arranged features at Nabta Playa site E 75 - 6 (Wendorf and Schild 1980: 131). Both might have served as the lower parts of dwellings whose superstructures left no traces.

The sediment consisted mainly of loose, grayish sand mixed with sandstone fragments, rubble and cultural remains. No clear stratigraphy could be identified, but near the bottom a burnt layer has been found. Artefacts appeared throughout the whole sequence, but in remarkably higher frequency in the uppermost levels. Bones and charcoal are relatively well preserved. Among all 1600 bones analyzed by Wim van Neer, *Gazella dorcas* and *dama* are dominant, followed by *Oryx* and, to a much smaller extent, ostrich, turtle, hare and fox; domestic animals are missing. Besides a series of radiocarbon dates grouped around 7,500 b.p. (not calibrated) the charcoal identified by Katharina Neumann provided some instructive information about the vegetation of this phase.

The other organic material comprises ostrich eggshell beads and fragments, which are partly decorated, some of them obviously the orifice fragments of

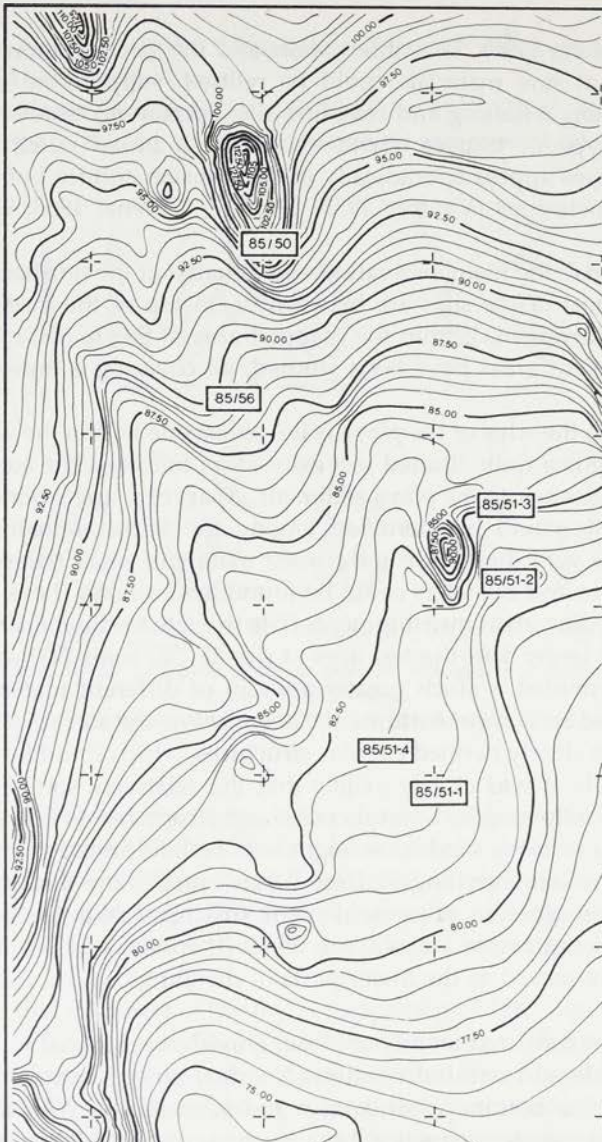

Fig. 2. Topographic map showing excavated sites in the Mudpans area.

eggshell bottles (Fig. 3: 7 - 12). Some *Aspatharia* shells from the Nile and some modified Cowrie shells from the Red Sea indicate connections over more than 700 kilometres to the East.

The pottery shows mainly complete decoration of the surface applied in a rocker stamp technique by using a square toothed comb instrument (Fig. 3 and 4). So far it seems to be the northernmost outpost of this Khartoum-related type of decoration, otherwise found in the Nile Valley, for instance at the Dongola Reach (Shiner 1968: 773, 784; 1971: Fig. 17), and also on some sherds from Nabta

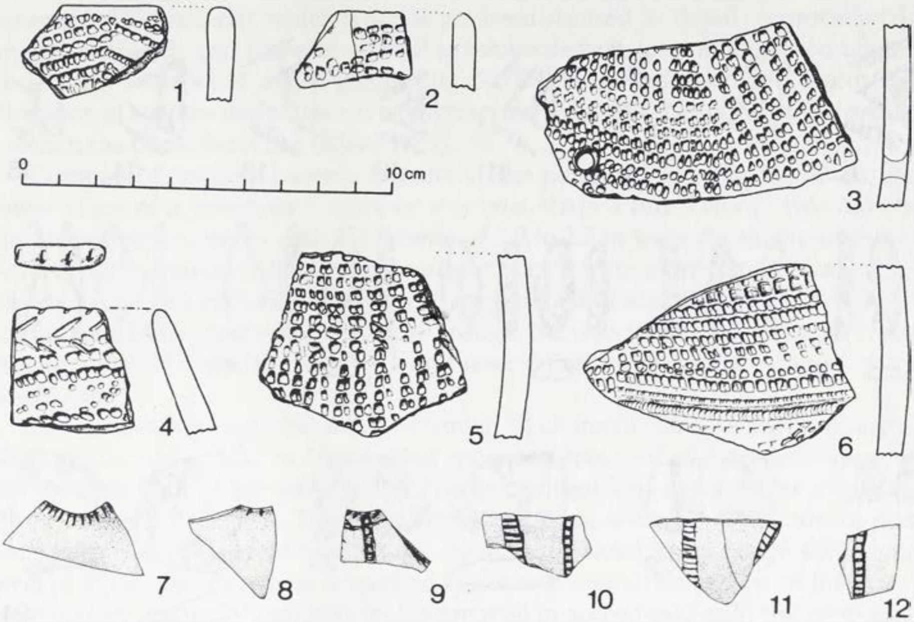

Fig. 3. Site Mudpans 85/56. 1 - 6: decorated potsherds; 7 - 12: decorated ostrich eggshell.

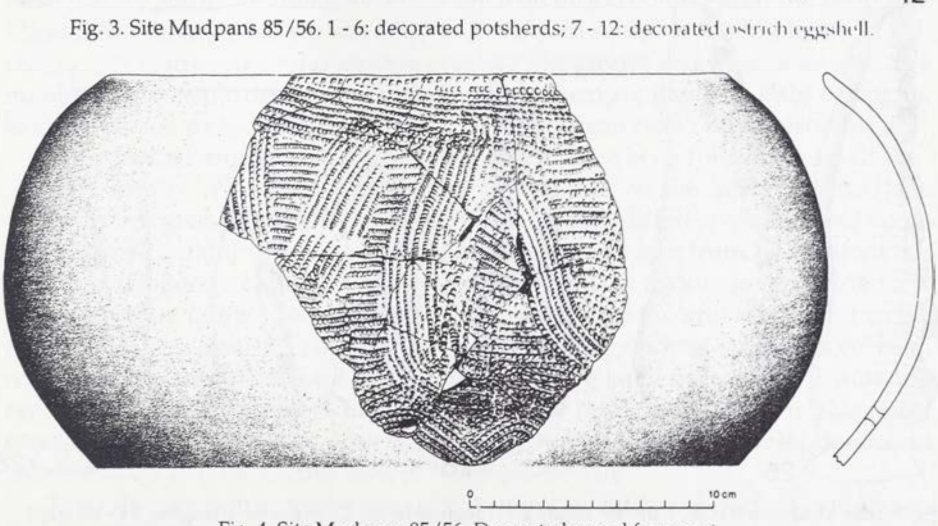

Fig. 4. Site Mudpans 85/56. Decorated vessel fragment.

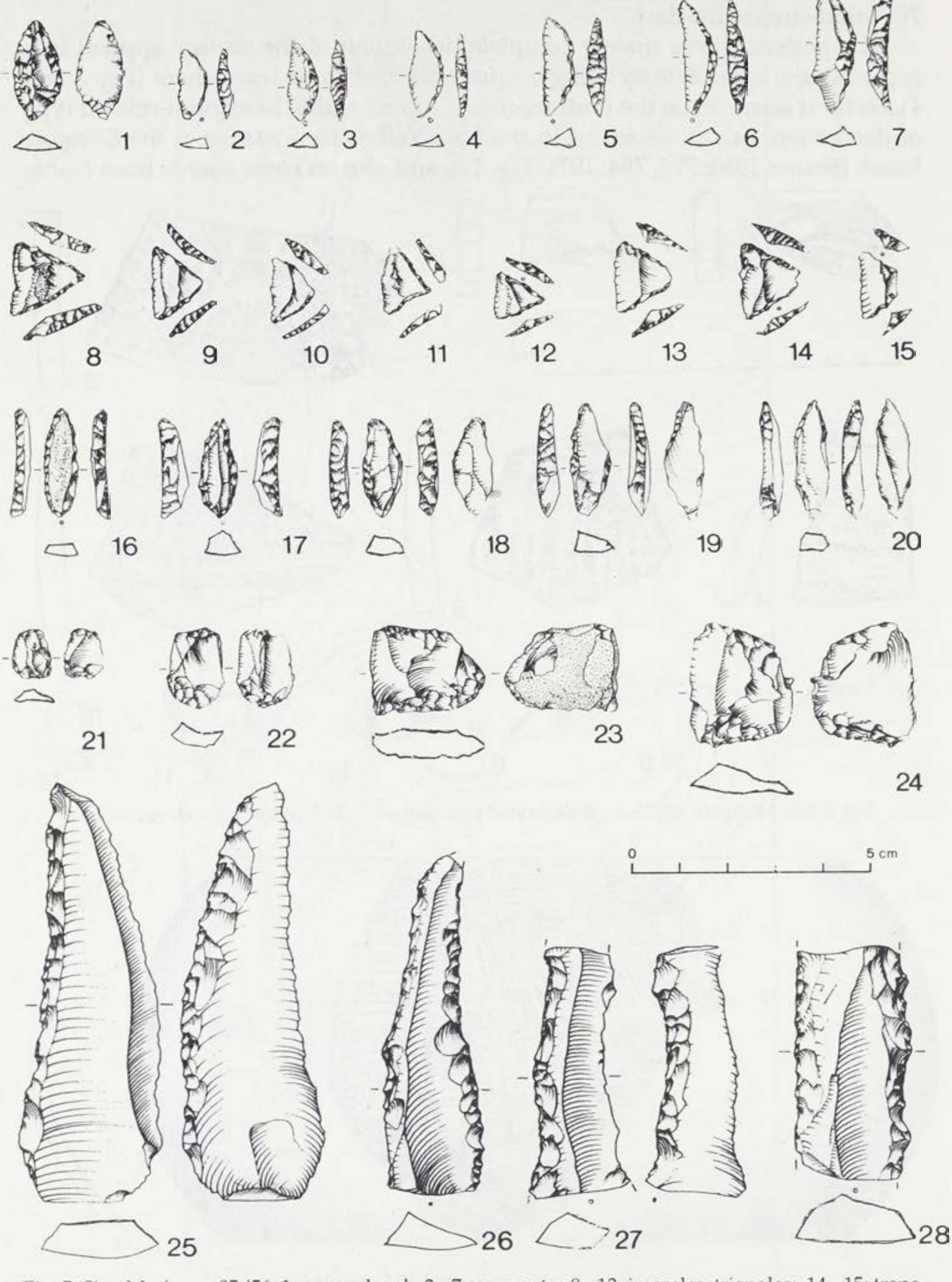

Fig. 5. Site Mudpans 85/56. 1: arrow head; 2 - 7: segments; 8 - 13: isosceles triangles; 14 - 15: trapezes; 16 - 20: perforators; 21 - 24: scales pieces; 25 - 28: bilaterally retouched blades.

Playa sites E-75-7 and E-75-8 (Wendorf and Schild 1980: 149, 156). These are obviously of a much coarser fabric and dated somewhat later, to the Middle Neolithic around 6,800 b.p. While the decorated sherds appear throughout the whole sediment, the undecorated ware is limited to the upper strata. Its fabric and the notched rim may allow us to ascribe them to a later phase, which also seems likely for a small part of the stone artefacts.

About 65 percent of these were found on surface and subsurface while the rest of it came from lower levels, associated with the bulk of the decorated ceramics. The material which has not yet been studied in detail, comprises triangles, segments and trapezes as well as *mèches de foret*, lateral retouched blades and a large number of scaled pieces (Fig. 5). The latter and also some scanty indications of surface retouch seem to correspond to Middle Neolithic sites further north in the Great Sand Sea (Klees 1989).

Comparable material seems to exist at the neighbouring site 85/50 on the lower slope of a prominent, more or less boat-shaped hill. Twenty two mostly circular stone structures with a diametre of 2.0 to 2.5 m were documented there, built of slabs, partly still standing upright. One of the stone circles was completely excavated and showed up to 60 centimetres of standing walls. After the stones had been removed, a shallow trough became visible in the centre obviously worked out of the base rock and resembling the dwellings of the nearby site 85/56.

The excavation provided a large number of charcoal samples that Katharina Neumann could ascribe to 10 different species of trees, all of them belonging to the modern flora of the Sahel zone. The six radiocarbon dates so far available cluster around 6,800 b.p. This is in correspondence with the few undecorated potsherds from the excavation, whose fabric is the same as that from the upper level of 85/56. Besides some retouched flakes and a small tanged point the stone tools mainly consist of triangles which are well in accordance with the proposed Middle Neolithic age of the site (Fig. 1: 10 - 16). In addition the hill bears 28 different rock engravings representing animals like giraffe and gazelle as well as a number of geometric designs. Although some of them are found on slabs belonging to stone circles, a chronological relation between them could not be established.

Some further engravings, especially giraffes, have been found at a small conical hill nearby. Four test excavations carried out in the surroundings (site 85/51) uncovered a knapping site representing two different phases and some eroded pits containing a larger number of bones. The spectrum of the stone artefacts corresponds closely to that of site 85/56. This excavation provided the youngest dates of the Mudpans area. They come from the area southwest of the hill where also nearly 300, mostly fragmentary, grinding stones have been mapped. Together with these several large milling stones were found showing regular notches at the rim, which could possibly have served for lying them for transportation. Those slabs with notches are also known from a later context in the Gilf Kebir and the Laqiya area in Northern Sudan.

Their distribution corresponds to that of our so far latest artefact complex in the Abu Ballas area which leads us again to Westpans. Here on the extended

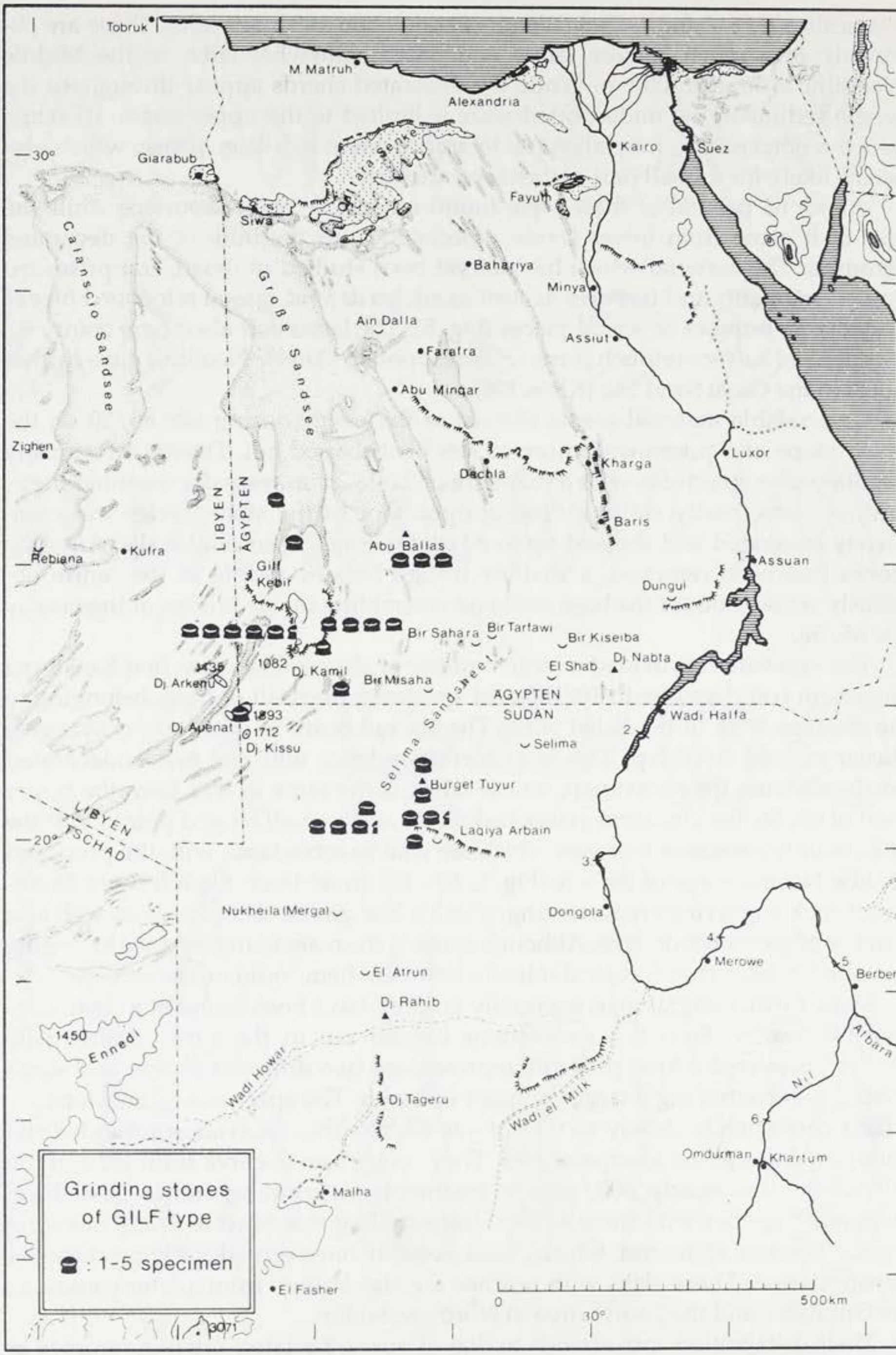

Fig. 6. Distribution of grinding stones type "Gilf" in the Eastern Sahara.

surface site 85/54 we were able to map more than 15 specimen of that special type of grinding stone, that is characterized by a carefully shaped handle and has been named the "Gilf" type (Kuper 1981: Fig. 29; Schuck 1988: Fig. 4), because it was found there first and in considerable number (Fig. 6). In the Gilf Kebir it covers the time range of the Late Neolithic burnished pottery of the sixth millennium b.p., whose decoration mainly consists of a horizontal herring bone pattern, applied by a fine comb instrument (Kuper 1988: Fig. 3). Like the grinders this can also be found in the Laqiya area in the Northern Sudan (Schuck 1988: Fig. 2: 1), where it persists for more than 1000 years longer and can be followed into the A-Group of the Nile Valley, providing good new evidence for the discussion of its origin.

Turning back from the later development in the South to the early settlement of the Abu Ballas region, in the area of Mudpans its evidences can be followed through more than two millennia from about 8,500 to 6,500 b.p. (Fig. 7). Our summary of the Holocene sequence starts at site 83/39 at the playa border. Dated to the time of El Ghorab (Wendorf, Schild and Close 1984: 7) its artefacts are too scarce to allow any detailed comparison, while the limited information that comes from the botanical remains seems to indicate a moister, but cooler climate than in the following period.

This subsequent period is somewhat better known from the rock-dwelling at site 85/56. It seems to reflect a growing influence from the South, as far as the botanical remains are concerned, but also with respect to the ceramics which connect this site to the Khartoum complex. The Sahelian environment is even more present in the following phase, represented by site 85/50, where the charcoal

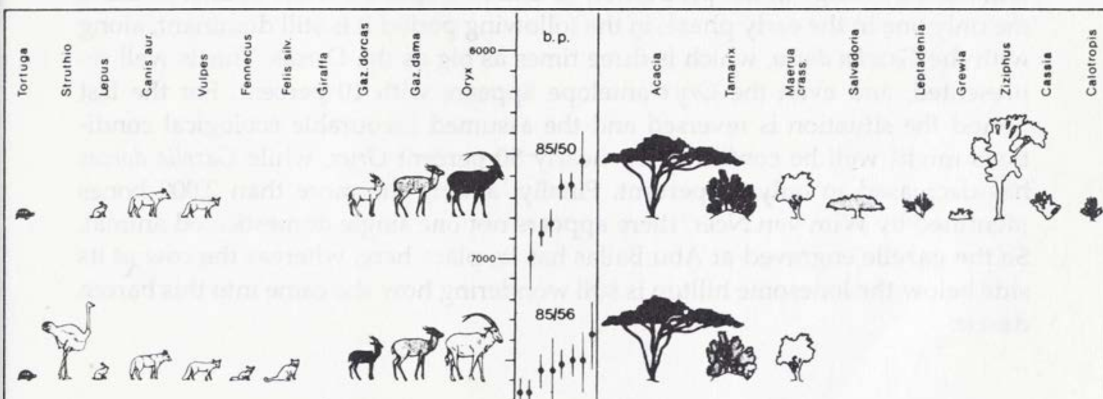

Fig. 7. The archaeozoological and botanical results from the excavations at Mudpans arranged according to their radiocarbon dates demonstrate the environmental change in the Abu Ballas area between 8,500 and 6,500 b.p. (dates not calibrated).

remains comprise several southern species, obviously as a consequence of a warmer climate with sufficient rainfall. This might have been preceded by a period of lower precipitation shortly before 7,000 b.p., which is indicated by climatic data from elsewhere, and by a general lack of dates in our radiocarbon list.

For this final part of the Mudpans sequence, the reconstruction of the environment at around 6,800 b.p. as it has been proposed by Katharina Neumann (Neumann 1989a: Fig. 37; 1989b: Fig. 7), shows that the acacia desert scrub, which represents today the typical vegetation for the latitude of Khartoum, reached into southern Egypt. At the same time Abu Ballas was enjoying a contracted vegetation similar to that of today's Wadi Howar, some 800 kilometres further south. But these favourable climatic conditions do not seem to have lasted very long. There are strong indications that they end in a new arid period starting around 6,000 b.p. The dearth of radiocarbon dates suggests that from this time on a break of settlement must have happened from the Siwa area southwards through the whole of western Egypt. According to the vegetation map for the time around 5,700 b.p. (Neumann 1989a: Fig. 39; 1989b: Fig. 8), wetter conditions did not return to this part of the Libyan Desert where the prehistoric settlement came to a definite end. Only in the Gilf Kebir was the deadline somewhat postponed, while in the Fayum and in the Nile Valley Neolithic life started to flourish.

What do the Mudpans results tell us about the environmental impact on the economic development in the Libyan Desert? As Figure 7 shows, the animal bones comprise mainly the typical prey of desert hunters like hare, antelope and gazelle. With respect to gazelle, however, the total of faunal remains shows a remarkable change in the proportion of different species: while *Gazella dorcas* is the only one in the early phase, in the following period it is still dominant, along with the *Gazella dama*, which is three times as big as the *Dorcas*. This is well represented, and even the *Oryx* antelope appears with 10 percent. For the last period the situation is reversed and the assumed favourable ecological conditions might well be confirmed by nearly 50 percent *Oryx*, while *Gazella dorcas* has decreased to only 15 percent. Finally: among the more than 2,000 bones identified by Wim van Neer, there appears not one single domesticated animal. So the gazelle engraved at Abu Ballas has its place here, whereas the cow at its side below the lonesome hilltop is still wondering how she came into this barren desert.

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Neolithic settlement patterns in the Gebel Kamil area, Southwestern Egypt

From 1980 to 1985 the B.O.S. research group of the University of Cologne, financed by the German Science Foundation, conducted several expeditions into the Eastern Sahara of Western Egypt and Northern Sudan (Kuper 1981; 1988). In 1983 the surveys were carried out in southwestern Egypt near the Sudanese border. In this area, a high conical hill, Gebel Kamil, is a widely visible landmark. This quartzitic inselberg (Sabaya formation) rises abruptly from a flat dune covered sand sheet to more than 300 feet (Fig. 1). To the south there is an elongated east-west orientated basin structured by several small depressions

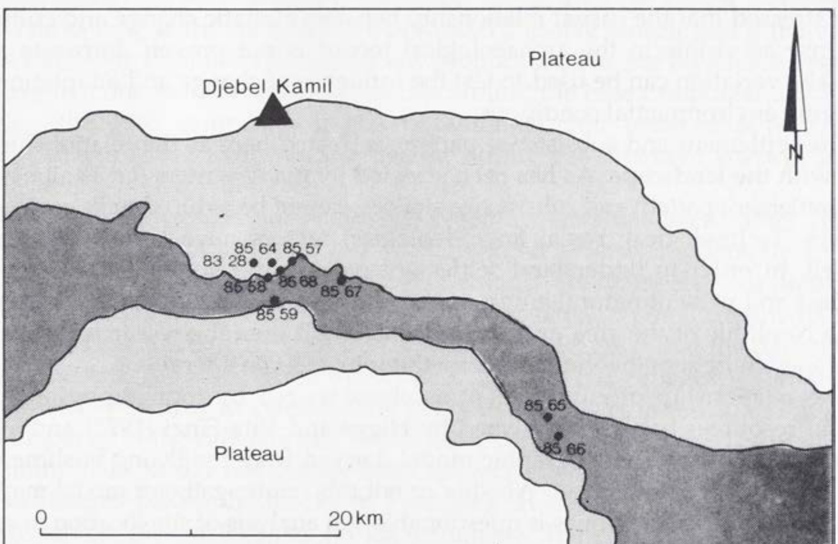

Fig. 1. Major excavated or tested Gebel Kamil sites;
1: 83/28-1; 2: 83/28; 3: 85/64; 4: 85/54; 5: 85/58; 6: 85/68; 7: 85/59; 8: 85/67; 9: 85/65; 10: 85/66.

and a quartzitic hamada. In its deeper slopes a granitic formation (red granite) has been exposed with its characteristic rounded and dome-shape block fields. The basin may be a deflation depression but its orientation indicates that it has been a part of the tertiary "Radar" fluviatile system of the Sahara (Wendorf *et al.* 1987). Minimally it dates to before the Acheulean because four sites with handaxes have been found to the north of the major deflation basin. No Old or Middle Palaeolithic has been discovered on the basin floor. A recent fill of the basin can be assumed which does not exclude erosional processes having removed the Palaeolithic sediments.

During the 1983 survey a number of Neolithic surface sites were found in various parts of this basin. But a small test excavation in a granite rock shelter seemed most promising: starting from surface finds, artifacts and pot sherds occurred up to 40 cm in depth. Therefore the stratigraphy was expected at this point, made more interesting by the fact that, in front of the granite blocks, surface finds extended well into the north-south running wadi. In the 1985 campaign, the excavation of this rockshelter and the adjoining area was one of the major research goals. Extensive surveys conducted by car and on foot added a number of other Stone Age sites in the Kamil area.

General approach

A short summary of the theoretical background treated here is presented. According to cultural ecological theory it is assumed (Steward 1977) that climatic change influences human settlement patterns and economies. But it has to be stressed that the casual relationship between climatic change and cultural response as visible in the archaeological record is not proven. Intra-site and inter-site variation can be used to test the influence of change and adaptation to changing environmental conditions.

The settlement and subsistence pattern is treated here as the relationship of man with the landscape. As has been stressed by many writers (*i.e.* White 1985; 4), a settlement pattern and subsistence strategy cannot be reduced to its ecological aspects. Technological, social and ideological factors have to be considered as well. In order to understand settlement pattern and subsistence strategies, the past and present natural environments have to be discussed, a background to the Neolithic of the area must be presented and then the research results be developed in light of theoretical and methodological considerations.

The relationship of environment as characterized by topography and the natural resources has been analyzed by Higgs and Vita-Finzi (1972) and Vita-Finzi (1978) using an ethnographic model derived from the !Kung bushmen as to the catchment area utilized. Whether or not this hunter-gatherer model may be used for Neolithic economies is questionable. An analysis of site location in relation to relief and site function as deduced from the artifacts and the features can provide indications of landuse. Unexcavated surface sites rich in material cannot be used to infer residential sites used by a large group of people in contrast to small sites with few artifacts which have been used for a special purpose for a short period by few people. This simple equation, often used in archaeology, surely is not valid except under the most controlled conditions. Rich sites may correspond to a repeated short-term occupations by few people. Sites poor in remains may have been settled by people who did not leave much trash depending on activities, technology or refuse disposal. However, from an ecological point of view, a site rich in material, no matter how often and how long occupied, should signal a special location in the landscape. Though social and ideological reasons may sign for this intensive reoccupation, certain natural resources can be responsible and have to be sought first. The occurrence of artifacts in sites does not necessarily mean that related activities were executed here. Lithics and expedient tools and the locale of their abandonment does not always correspond to the place of their use (Binford 1976: 242). There is probably a difference as to heavy, barely movable artifacts, Binford's "site furniture" like grinding stones. These may be produced at special raw material sites, but once moved, they are left in the site and used during the subsequent occupation until the area is abandoned or the grinding stone is unusable.

Past and present environments

The research conducted in the Kamil area is preliminary, most of the material has not yet been analyzed. Therefore the goal of this paper can only be to state the problems and present hypotheses will have to be tested in future field work.

The numerous surface sites in the Gebel Kamil area can be the focus of our analysis as long as the surveys have produced a usable sample and if the visible sites represent a statistically significant proportion. The surveys have been intensive in a one to three kilometer radius around the base camp near site 83/27 during the 1985 campaign. It can be assumed that between 50% to 80% of all surface sites have been discovered during the intensive surveys in the small area.

The deflation which uncovered the Neolithic sites has been rather recent. Generally the lithics are relatively fresh without or only moderately dulled, rounded or abraded edges and surfaces. Ceramics are relatively well preserved with the exception of site 85/67 where they occurred in small fragments with heavily wind abraded edges. This supports the assumption that the deflation in the Kamil area is rather recent. The humic top soil has probably been eroded rather lately resulting in a destruction of bones and some ceramics, and in a certain dispersal of the sites situated in the valleys and on the slopes. The erosion of the granite blocks did not change them appreciably during the last 4,000 years: the sediments below the blocks as excavated in the site 83/28-1 consist of a sandy matrix rich in feldspar on the pediment. The rock face buried by this pediment does not exhibit a marked change in extension nor form. The waste from the granitic rocks has been swept over the small wadis and into the main basin. Even if today, the Kamil area is extremely arid, some water erosion may have been active in addition to deflation. The artifact accumulation of 83/27, in a valley fill without any evident structuring, may be a redeposited site originally situated farther upslope, which surely did not move any great distance. If this is so, the site must have been slightly displaced, but probably not with much water, because the artifacts are rather fresh.

The present day environment of the Kamil area is that of an arid desert practically devoid of vegetation. No surface water is available. Animal life is restricted to snakes, scorpions, desert rats and some insects. Several dead mummified barbary sheep partially buried, seem to have died in the recent decades indicating worsening climatic conditions. The limited excavations give to date some indications of prehistoric environments, mainly derived from fauna. These must be supplemented with data from the Gilf Kebir (Kuper 1981; Kröpelin 1987; Haynes 1982; Neumann 1987) to the North and the Bir Kiseiba (Wendorf *et al.* 1984) to reconstruct the climate of the Early Holocene.

The Bir Kiseiba Early Holocene climatic sequence (Wendorf *et al.* 1984: 405) consists of 3 humid Playa phases:

I: 10,000 to 8,200 B.P.,
II: 8,100 to 7,900 B.P.,
III: 7,700 to 5,400 B.P.

Each of these is separated by an arid interval. There is no direct agreement with the neighboring Nabta sequence nor with the local changes between dry and more humid phases from the Gilf Kebir (Kuper 1981: 231 - 236) nor the more distant Paleo-Chad basin. In the Wadi el Akhdar of the Gilf Kebir, Playa sediments have been dated to 9,400 B.P. Playa sediments with evident root structures are dated to 7,750 B.P. and a site on the surface to a later period *ca.* 5,700 B.P. The 4 m section indicates 7 humid and arid phases ending by 5,000 B.P. Kröpelin (1987) gives a less dramatically fluctuating climatic reconstruction: between 9,500 and 6,000 B.P. the climate was arid but showed rare heavy rainfalls, the period between 6,000 to 5,000 B.P. less arid with rains up to 100 mm/year. To the south of the Kamil area rain was more intense, as assumed by the presence of a snail-limicularia (Haynes and Mead 1987). It is therefore possible that the Kamil area was not as dry as the Gilf Kebir with somewhat intermediate climatic conditions. Charcoal remains analyzed by Neumann (1987) give similar results of rather arid conditions with a reduced vegetation and a slightly more humid period around 6,000 B.P.

A few radiocarbon dates for the Kamil area have been processed, whose results correspond to the sequences established for the neighboring northern and eastern areas:

83/28-1 (Abri) ostrich egg shells 4,310 ± 65 B.P. (KN-3975),
85/58-2 surface site, ostrich eggs 6,520 ± 70 B.P. (KN-4031).

The first date compares well to the late occupational period of the Wadi Shaw in the Sudan, whose dates are grouped between 4,000 and 3,600 B.P. It also corresponds to the last settlement in the Wadi el Akhdar, site 80/14 (Kuper 1981: 248). In the general radiocarbon histogram for the Western Desert (Kuper 1988: Fig. 9) it falls into the Phase D. As it comes from near the surface, it may also as well be the last occupation of the Gebel Kamil area.

Table 1

Faunal remains from Neolithic sites of Gebel Kamil area.

Faunal remains	Sites					
	83/28-1	85/57	85/59-1	85/59-2	85/68	Total
Gazella dorcas	1	3		1	1	6
Large bovid (cf. *Oryx*)	1	3	1	3		8
Unident. mammals	?	478	245	186	16	945
Total	2?	484	246	190	17	959

The earlier date fits the presumed favourable climatic conditions much better. At the same time, it indicates that the late prehistoric occupation may have spanned – with long interruptions – the time between 7,000 and 4,000 B.P. Environmental data are restricted to one floral determination of acacia by K. Neumann and the faunal determinations by W. van Neer which are the only means to reconstruct the environment during the human occupation of the Gebel Kamil area. Five sites yielded the remains of *Gazella dorcas* and a large bovid, cf. *Oryx* (Table 1).

The Dorcas gazelle has a wide distribution in the Sahara where it prefers dry savanna to desert environments. Its habitat is characterized by a scarcity or even absence of water, low humidity and extreme temperatures. If the large bovid is indeed the *Oryx*, its environmental characteristics are similar. It forages often in company of the Dorcas and Dama gazelles, the latter surprisingly missing from the faunal list. This may be due to the small numbers. These wild animal forms identified point to an environment of desert or dry savanna where ephemeral grasses that spring up after rain on dry sand and gravel may have provided the pastures for the Dorcas gazelle and possibly the *Oryx*. Both species can do without water for a limited period at least, but a prolonged human occupation of the Gebel Kamil area could not. Vegetation had to have been present at low level: some acacia, seasonal grasses and sufficient ground water in the basins accessible for a human occupation.

Cultural chronology

The Neolithic in the Gebel Kamil area is characterized by rather hard-burned, fine-grained pottery, red to strong brown (7.5 YR 5/6 to 10 R 4/6), with an impressed comb decoration. The motif is a herring bone design of vertical or oblique lines, delimited by horizontal lines (see Fig. 4: 10). The fine tempered potsherds are dated in the Gilf Kebir area to the 4th to 3rd millennium B.C. and named "Gilf pottery" by Kuper (1981).

The stone technology is based on flakes and large, long blades, made from quartzitic sandstone, and on a fine-grained creamy opalic flint. The latter has been used to produce triangular microliths, segments or small, narrow perforators made by abrupt retouch. The blades served as blanks for end-scrapers and denticulated blades. Some of the attributes correspond to those described by Wendorf *et al.* (1984: 416) for their Middle Neolithic. Generally, only indicators for a Middle or mainly Late Neolithic exist. Comparisons with other regions are not possible at this stage of the analysis. The special handstones with a longitudinal groove as described from the Gilf Kebir as the Gilf type (Kuper 1981: 251 - 252) also occur in the Kamil site of 85/67. Thus links may be more pronounced with the Gilf Middle to Late Neolithic than with the northern Sudanese Neolithic of the Wadi Shaw and Wadi Sahal (Schuck 1988).

The sites

Generally, the size of the surface scatter and the amount of artifacts give indications on the use of the landscape. At this stage of the study, only medium and small sites are distinguished. Large sites which contain several tens of thousands of artifacts and many hundred tools are apparently not represented. Both large and medium sites are difficult to ascertain, however. Without spatial analyses and refitting the record will not be sufficiently fine-grained to allow us to distinguish several superimposed short-term occupations from single, extended and extensive occupations.

A total of 27 sites has been discovered of which 10 were partially excavated (Fig. 1). These will be described briefly.

Site 83/28

This surface site is situated in a small north-south running valley which transverses the granitic belt. As to its surface area and wide artifact spread it is one of the largest sites in the Gebel Kamil area. Its tools consist of large blades and flakes which served as blanks for end-scrapers, laterally retouched pieces, burins, denticulates. Smaller blades were transformed into perforators. Microliths are rare and comprise trapezes and segments. The pottery is the incised red-brown Late Neolithic one. Two upper grinding stones of the Gilf type are also present.

Site 83/28-1

This is a rockshelter in the granitic belt, discovered and tested in 1983. A small surface was excavated in 1985. The assumed stratigraphy consists only of surface finds and some artifacts in the sandy sediment rich in feldspars dispersed over more than 40 cm. No accumulation in levels could be discerned, except for irregular clusters and a gradual decrease of finds (Fig. 1). Careful inspection of the sediments during the excavation revealed that some of the deep occurrences were associated with animal burrows, barely visible in the uniformly colored sand. It is therefore probable that the stratigraphy is indeed due to the vertical dispersal in sandy soils (Cahen and Moeyersons 1977), where strong disturbances occur due to the nature of the soil and the presence of roots and burrowing animals. This had to be tested by the final analysis of the artifacts, *e.g.* through refitting.

The finds themselves consist of debitage, some microliths and decorated potsherds. The microliths are composed of segments, some irregular, trapezes and triangles, some very small.

Site 85/58

This large surface scatter of artifacts and potsherds, grinding stones is situated on the southern slope of the main depression. It is as rich as the site 83/28. The rather dispersed finds indicate an intensively reoccupied site. Upper grinding stones *in situ* near lower ones suggest that the site is at least partly intact. Besides some denticulates, segments are the main distinguishing element in its artifact assemblage.

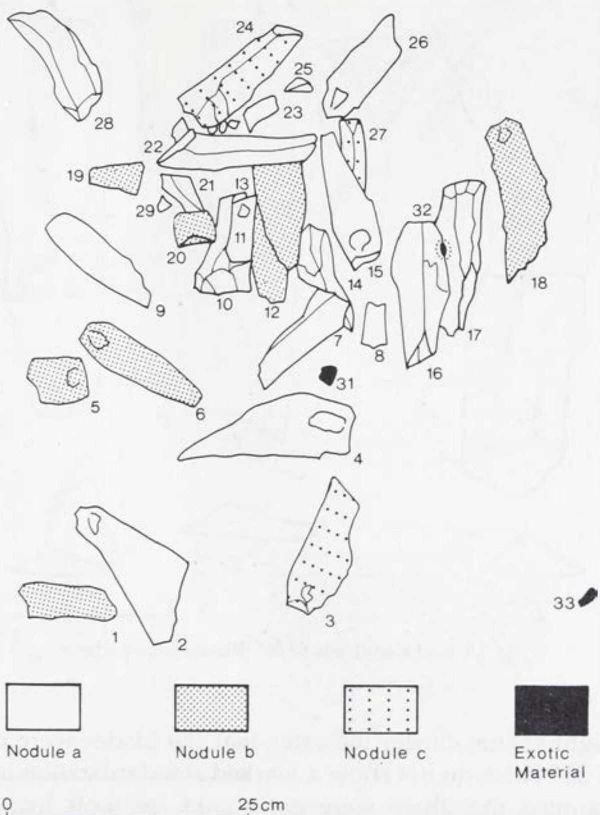

Fig. 2. Cache of blades at the 85/65 site near Gebel Kamil; a - d: nodules 1 to 4.

Site 85/57

This surface site, tested, is situated on the northern slope of the depression (Fig. 1). Large end-scrapers and denticulates on blades are the typical stone tools for this site as well as a grinding stone of the Gilf type.

Site 85/65

This site was discovered during a car survey in 1985 in a flat deflation depression southeast of Gebel Kamil (Fig. 1). On the surface measuring 55 by 40 cm (Fig. 2) 25 blades are concentrated which consist of 32 parts. Eleven of these can also be refitted on the dorsal surfaces originating from 4 nodules or cores

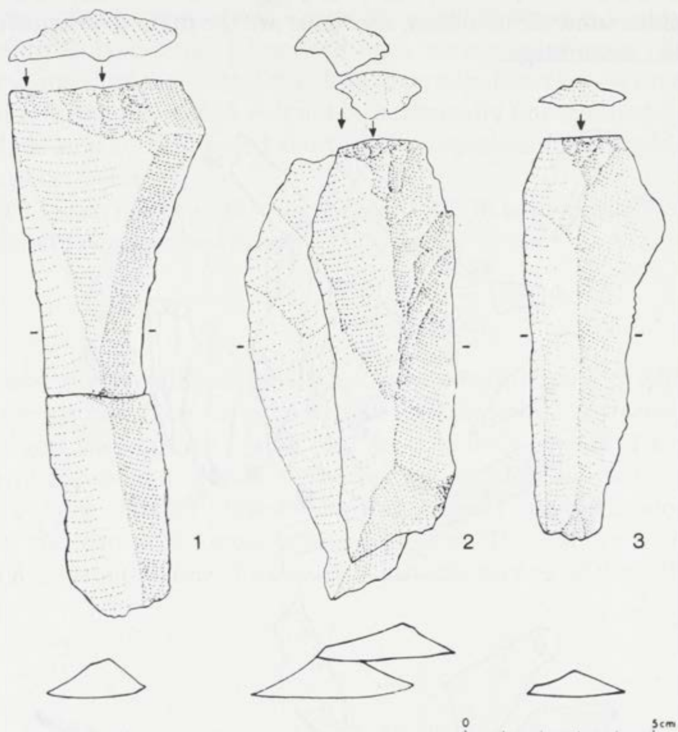

Fig. 3. Gebel Kamil, site 85/65. Blades from cache.

(Fig. 3). The tight spatial cluster indicates that the blades were originally in a container. The 25 blades do not show a marked standardization in their dimensions. It is assumed that these were not blanks for tools like end scrapers, denticulates or points but their use was to be that of cutting instruments.

Site 85/67

This medium sized site is situated at the mouth of a small tributary valley to the main east-west depression. From west to east four major artifact concentrations contain Neolithic with pottery, an upper grinding stone of the Gilf type, end-scrapers (Fig. 4: 8), perforators (Fig. 4: 9) and transverse arrowheads (Fig. 4: 1 - 7), handaxes and crude flakes, bifacial points and Levallois cores. Though some overlap exists, there are distinct accumulations of spots where bifacial points have been produced. Four accumulations of differently colored quartzitic sandstone flakes indicate flaking spots for bifacial points.

Detailed information is not yet available for all of these sites, but there seems to be no preference for special topographic features (Table 2).

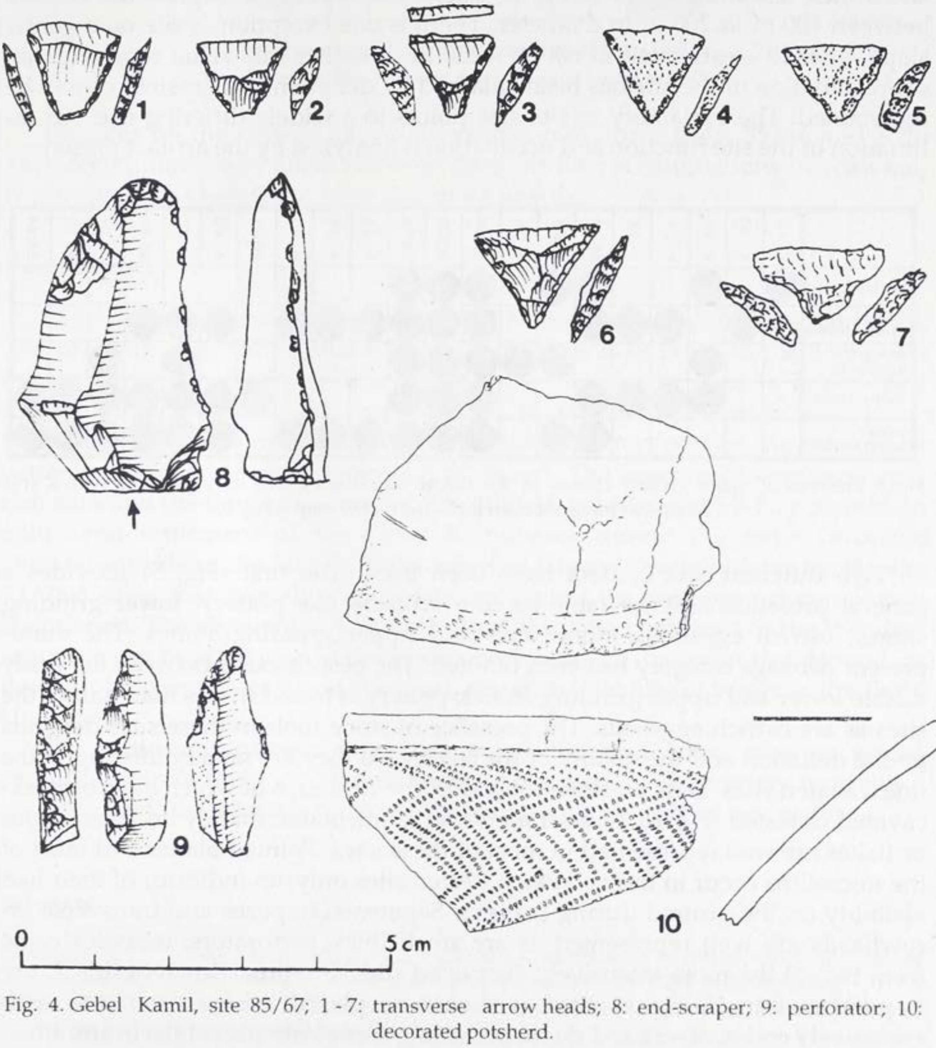

Fig. 4. Gebel Kamil, site 85/67; 1 - 7: transverse arrow heads; 8: end-scraper; 9: perforator; 10: decorated potsherd.

Table 2

Topographic setting of the Gebel Kamil sites.

Top feature sediment	Sand	Debris	Total
Slope	6	4	10
Plateau	2	2	4
Depression	7	2	9
Total	15	8	23

The surface sediment is mainly sand, even on the slopes where debris, including Serir and Hammada, are slightly, though not significantly, more numerous. As to size, there is a clear separation: on the slopes there are usually small sites, less than 80 m × 50 m, the size of the sites in the depressions centers between 100 m to 200 m in diameter. There is one exception, a site on a gentle slope – 83/28 – estimated at 600 m × 200 m. Whether this value represents an overestimation or the site has been enlarged by deflation and erosion, cannot be ascertained. The variability in site size points to a widely differing use. An estimation of the site function and occupation is analyzed by the artifact presence.

	K 45	K 26	K 29	K 27	K 28	85/67	85/57	K 36	85/66	83/28	85/58	K 24	K 25	K 43	85/68	K 20	K 40	85/59	K 37	K 32	85/64
pottery	●		●			●	●		●	●	●										
lower grind. stones		●		●	●	●			●	●	●	●	●	●		●	●	●			
ostrich eggshells			●				●	●	●	●	●						●		●		
stone tools			●	●	●	●			●	●	●				●	●	●	●	●	●	●
upper grind. stones						●	●		●	●	●	●	●	●		●	●	●	●	●	●

Fig. 5. Presence of major artifact classes in the Gebel Kamil sites. The surveyed sites with K and a number have not been included on the map – Fig. 1.

Two different sets of data have been used. The first (Fig. 5) provides a general presence/absence table of core artifacts like pottery, lower grinding stones, ostrich eggshells, stone tools and upper grinding stones. The omnipresent debitage category has been omitted. The best fit exists between the easily visible lower and upper grinding stones; pottery is found in less than half of the sites as are ostrich eggshells. The presence of stone tools in these sites depends on the deflation and the quality of the survey, so they are mainly missing in the unexcavated sites. Data on stone tools exist for 10 sites, 6 of which have been excavated or tested (Fig. 6). End-scrapers and denticulates, mainly on large blades or flakes are well represented in most of these sites. Pointed blades and most of the microliths occur in the excavated/tested sites only, an indicator of their bad visibility on the ground during surveys. Segments, trapezes and transverse arrowheads are well represented as are small thick perforators; triangles come from two of the more intensively excavated sites. If a breakdown of this figure is possible into classes of sites, it should be placed between the sites with exclusively end-scrapers and denticulates and those with microliths in addition.

	85/64	K 20	K 40	85/66	K 25	K 43	85/57	85/67	83/28	85/58
end - scraper	●	●	●	●			●	●	●	●
blade	●				●			●	●	
denticulate		●	●	●		●	●	●	●	●
point						●	●	●	●	
transversal arrowhead					●			●		●
segment							●		●	●
perforator								●	●	●
trapeze								●	●	●
triangle									●	●

Fig. 6. Presence of tool types in the Gebel Kamil sites.
The shaded columns represent sites where excavations took place.

Features on the surface are rarely visible, only three (K45, 85/66 and K25) gave accumulations of burnt stones, 8 dense artifact accumulations provisionally interpreted as knapping spots and one a hearth.

Conclusions

Only a hunting economy is visible archaeologically from the animal bones. The presence of grinding stones in the large sites may point to plant use, but ethnographic information indicates that these can also be used to grind dried meat. If cattle, sheep or goats were present, it can only have been in small numbers. If they were the main food, blood, milk and meat producer, they should be better represented in the archaeological record. The absence of very large and rich sites and the time span covered, the 4th to 6th millennium B.P., points to an ephemeral settlement of the Gebel Kamil area during the more favorable climatic episode of the Middle Holocene. The late radiocarbon dates for the site 83/28-1 show that even during the late dry phases the area was not completely abandoned. The apparent lack of Early Neolithic sites compared to the Wendorf sequence can be attributed to the preliminary research, but may also depend on geomorphological events and the local, casual availability of water in the Early Holocene.

The settlement pattern comprises many different types of sites whose vicinity does not favor a contemporaneous occupation. The variety indicates a complex land use, possibly too complex for a purely short term occupation.

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An archaeological survey of the Selima Sandsheet, Sudan

As part of the Western Desert so named by Haynes (1982: 631) the Selima Sandsheet with an expanse of 60,000 square km covers a large area and was, until recently, believed to be free or, in relation to other regions nearly free of prehistoric remains. Now, that the exploration of the Western Desert has turned from geographical to geological and archaeological studies, this view must be revised. The archaeological work of the Combined Prehistoric Expedition around Bir Kiseiba and Bir Sahara/Bir Tarfawi (Wendorf, Schild and Close [eds.] 1984), the expeditions carried out by Haynes (1983; 1985) and the discovery of number of buried features in Southern Egypt and Northern Sudan by the Space Shuttle Columbia (McCauley *et al.* 1986) gave reason to carry out the survey in the vicinity of Burg et Tuyur (Fig. 1). In its first years, the mainly archaeological B.O.S. project concentrated field work in the regions of the Qattara Depression, the Great Sandsea and Gilf Kebir in Egypt and the Wadis Shaw and Sahal near Laqiya Arbain and the Wadi Howar in Northern Sudan (Kuper 1981; 1986. For the work in Egypt and Wadi Howar see reports of E. Cziesla, B. Keding, S. Kröpelin, R. Kuper, K. Neumann and W. van Neer, this volume). The Selima Sandsheet was then only crossed to save time for the work in the Northern Sudan but by comparing material from Gilf Kebir and Wadi Shaw/Wadi Sahal sites it became obvious that there were very strong similarities in artefacts, especially in ceramic decoration and grinding-stones; for example comb-impressed decoration below rims and grinding stones of the Gilf-Type (Schuck 1988; 1989).

In 1983 we discovered nearly 40 sites while crossing the Selima Sandsheet on our way to Wadi Shaw and this gave reason for intensive survey in 1985 to fill the gap in the North-South-Transect of the B.O.S. Project. The area is generally a featureless flat sandsheet with some variation in the south near the rock of Burg et Tuyur. There it is undulation because of long sand-ridges running northeast-southwest with, between the ridges, elongated depressions. Sometimes small and low outcrops of quartzite and brown chalcedon occur in such depressions

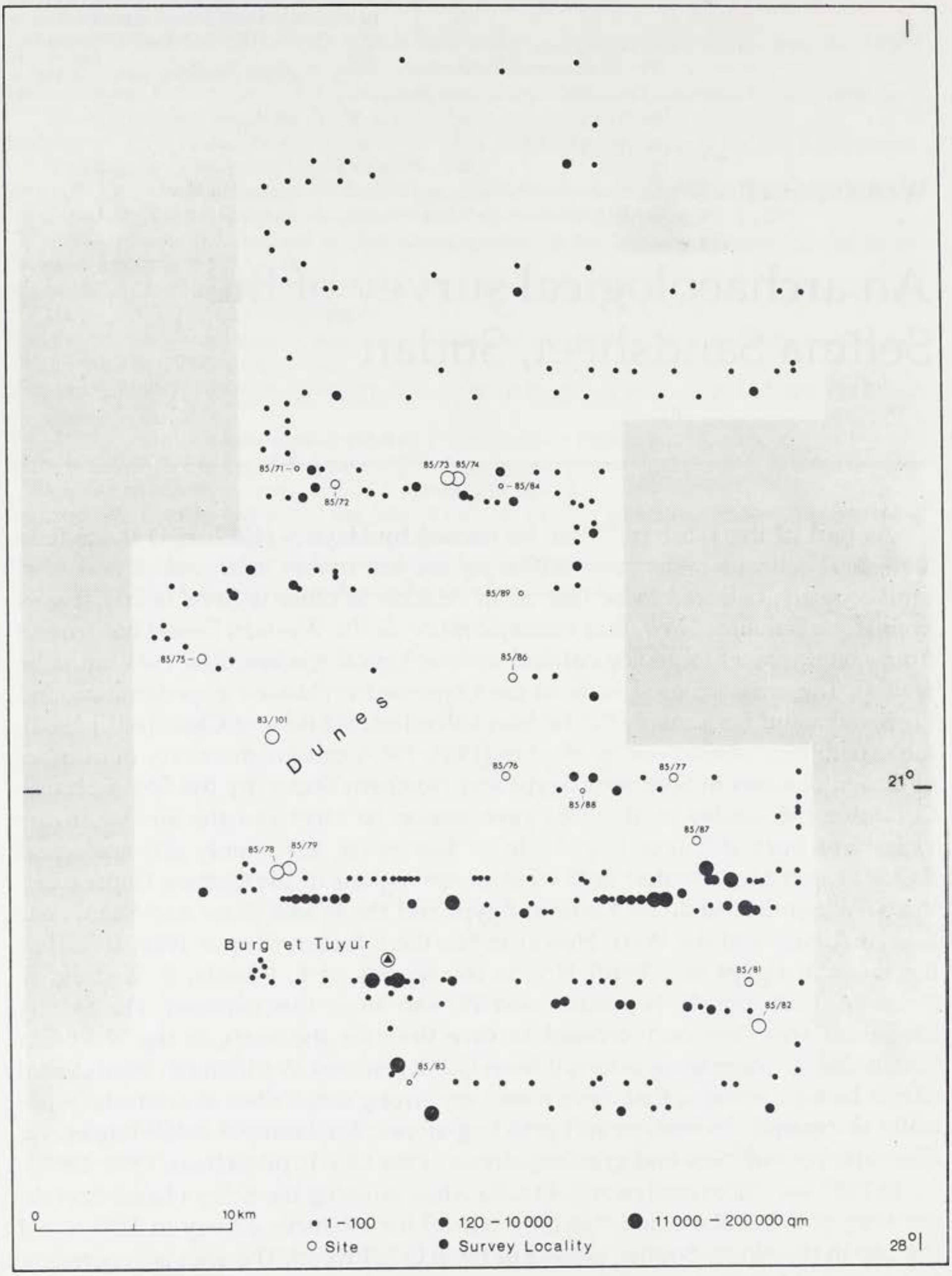

Fig. 1. Survey Area in the Selima Sandsheet with sites and survey localities.

and were much used as raw material sources as indicated by thousands of artefacts. East and west of Burg et Tuyur Barchan dunes running from Northeast to the Southwest rise to a height of more than 10 m.

The northernmost corner of the survey grid was 45 km N of Burg et Tuyur (Fig. 1). This point is north of the subsurface Wadi Moktafia (McCauley *et al.* 1986: 627 - 628) and the survey covered most of the width of this wadi and the southern part of the space shuttle sweep across southern Egypt and Northern Sudan. The base line of the Survey was 10 km south of Burg et Tuyur. From the northern point on the survey was conducted in eleven parallel W-E or E-W runs, spaced at 5 km intervals. An area of 1200 sq. km was covered and a linear distance of 260 km by two cars. 285 archaeological sites were located within this area, and each was examined by two or four archaeologists. Because of the surprising number of sites and limited time (only 10 days for survey and test excavations) this description of sites and registration of artefact-types is only a preliminary one.

Sites of two main types are associated with the sand-ridges and the depressions: Palaeolithic and Neolithic. The palaeolithic artefacts – mainly handaxes – occur in the bottoms of some depressions; they are extremely aeolized, indicating a long period of exposure on the surface and will not be further considered here. In most cases the Neolithic sites occur in the same positions, on top and along the northern slopes of the sand-ridges, also in the bottoms of the depressions. A few sites occur on very low dune ridges as long artefact scatters with concentrations at intervals only two or three metres above the surrounding surface. Most of the sites assigned to the Neolithic are very small, some included only a few artefacts or 50 to 100 pieces in an area of 10 sq. metres, and represent the working of one or two cores. The artefact types are limited and undiagnostic. Probably they represent short-time camps – overnight or possibly longer stops by small groups – as was suspected for such small sites discovered during the survey near Bir SafSaf (Wendorf and Close 1984; Wendorf *et al.* 1987).

On the other hand some large sites cover an area ranging from 10,000 to more than 100,000 sq. metres with thousands of artefacts. Within the larger sites dense artefact scatters represent the working of cores of different raw materials (mostly quartzite but also chalcedon). Between these working areas general and regular artefact scatters occurred. There were also variations in the pattern of artefact types, normally retouched tools were limited to flakes, but some sites had blades and bladelets. Grinding-stones occurred more frequently at these larger sites than at the smaller ones. Ostrich eggshells were also found here frequently. One single find of a complete ostrich egg with a hole on one side could be seen as a water bottle and some other fragments may have been also remains of broken water bottles.

Faunal remains were very rare except in one case where a pit in the vicinity of a large site yielded many bones, including ostrich, wild cat, giraffe, dorcas and dama gazelle, oryx and sheep/goat (determinations by Wim van Neer, Tervuren).

Ceramics were very rare, only a few sherds being found in a poor stage of preservation. The absence of ceramics is ascribed to erosion because sherds were

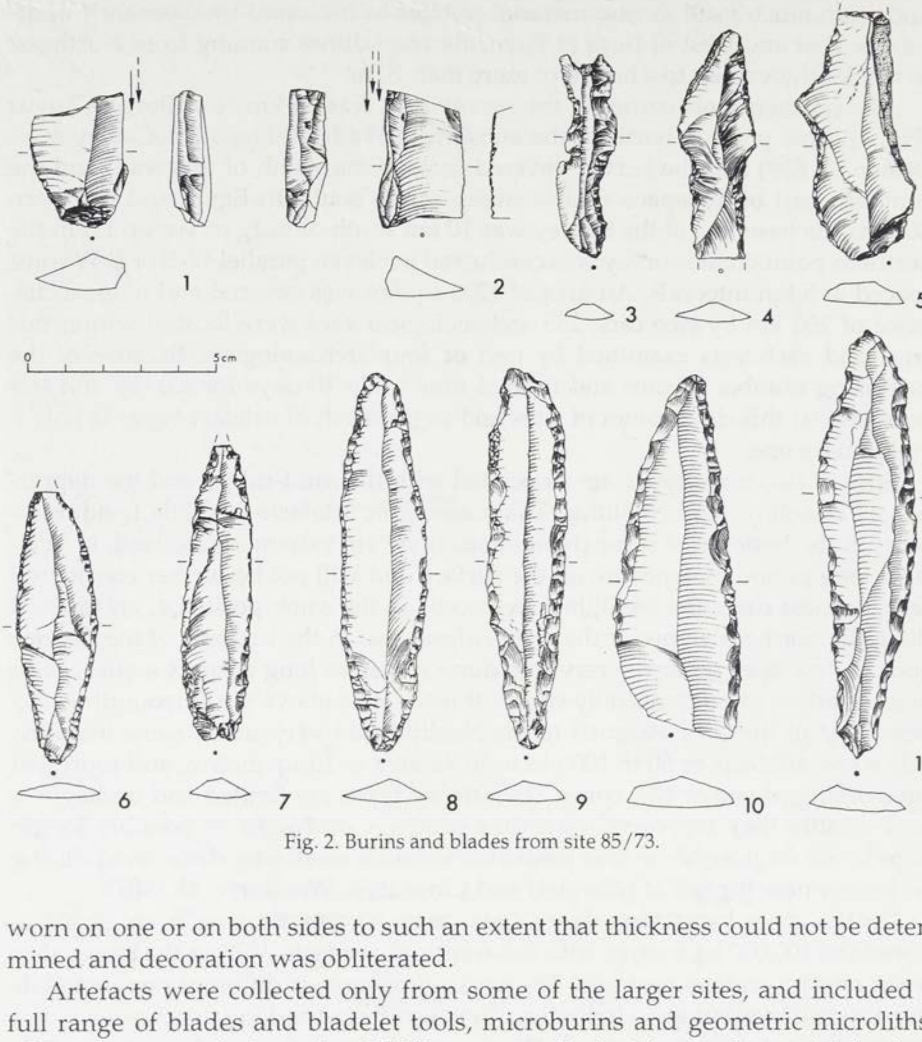

Fig. 2. Burins and blades from site 85/73.

worn on one or on both sides to such an extent that thickness could not be determined and decoration was obliterated.

Artefacts were collected only from some of the larger sites, and included a full range of blades and bladelet tools, microburins and geometric microliths. Although a sample from site 85/73 was very limited in numbers with backed bladelets, burins and large bilateral backed blades (Fig. 2), it was comparable to site E-79-5, an example of Early Neolithic El Nabta Type (Connor 1984: 183) dated around 8,000 B.P.

At site 85/74, some hundred metres to the East, a small excavation within a dense scatter of artefacts produced a few large bilateral retouched blades and many microliths (Fig. 3); after retouched bladelets, elongated scalene triangles were the most frequent tool, while shouldered bladelets were common, and segments, borers, truncations and triangular points with basal retouch rare. Similar artefact assemblages have been found on site 85/78 and site 85/79 separated by a 400 m wide depression floored by a reddish soil similar to playa deposits, 6 km west of Burg et Tuyur (Idris 1988: Fig. 4 and 7). Probably water collected in

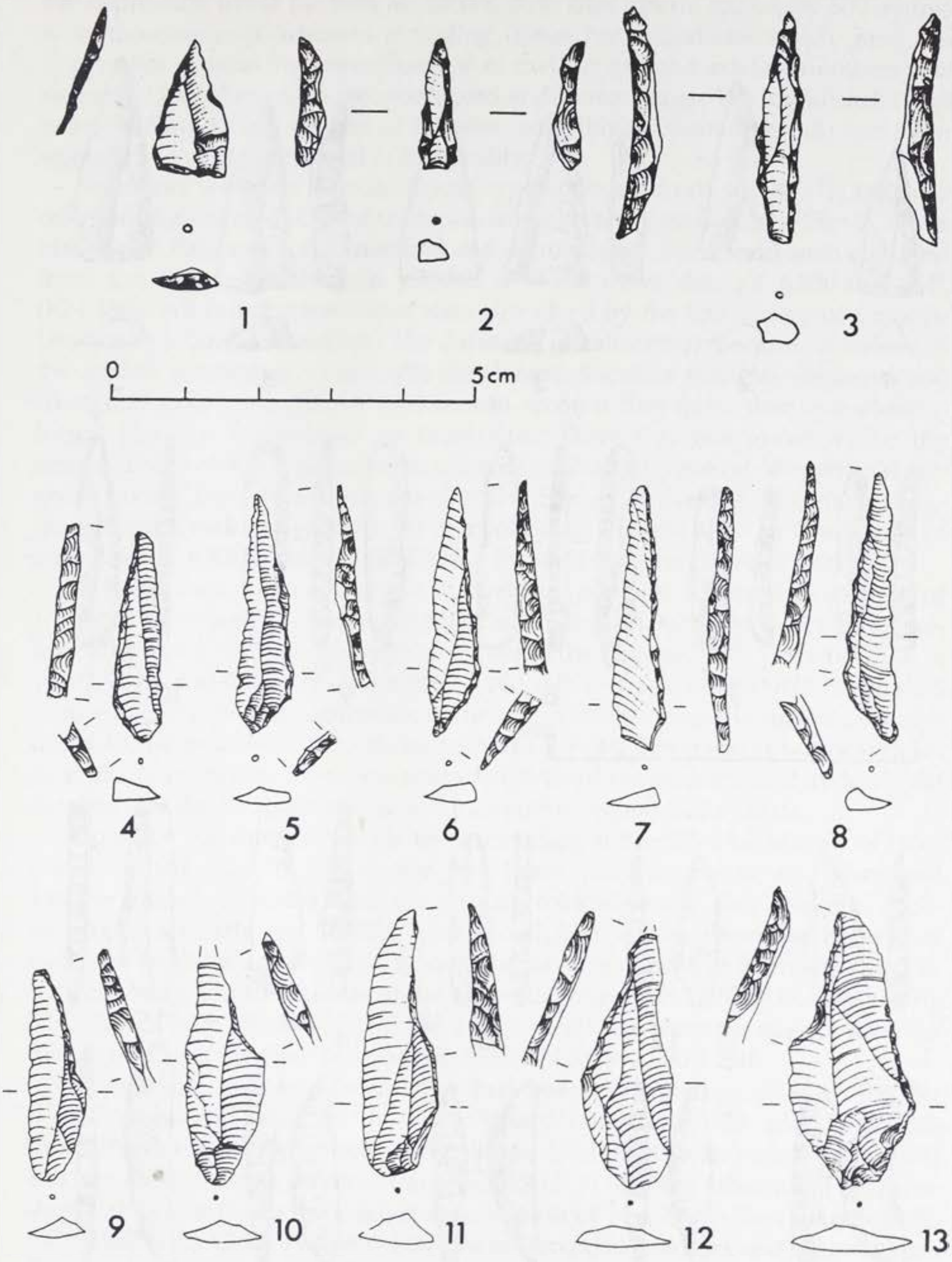

Fig. 3. Triangular point, perforators, elongated scalene triangles and shouldered bladelets from site 85/74.

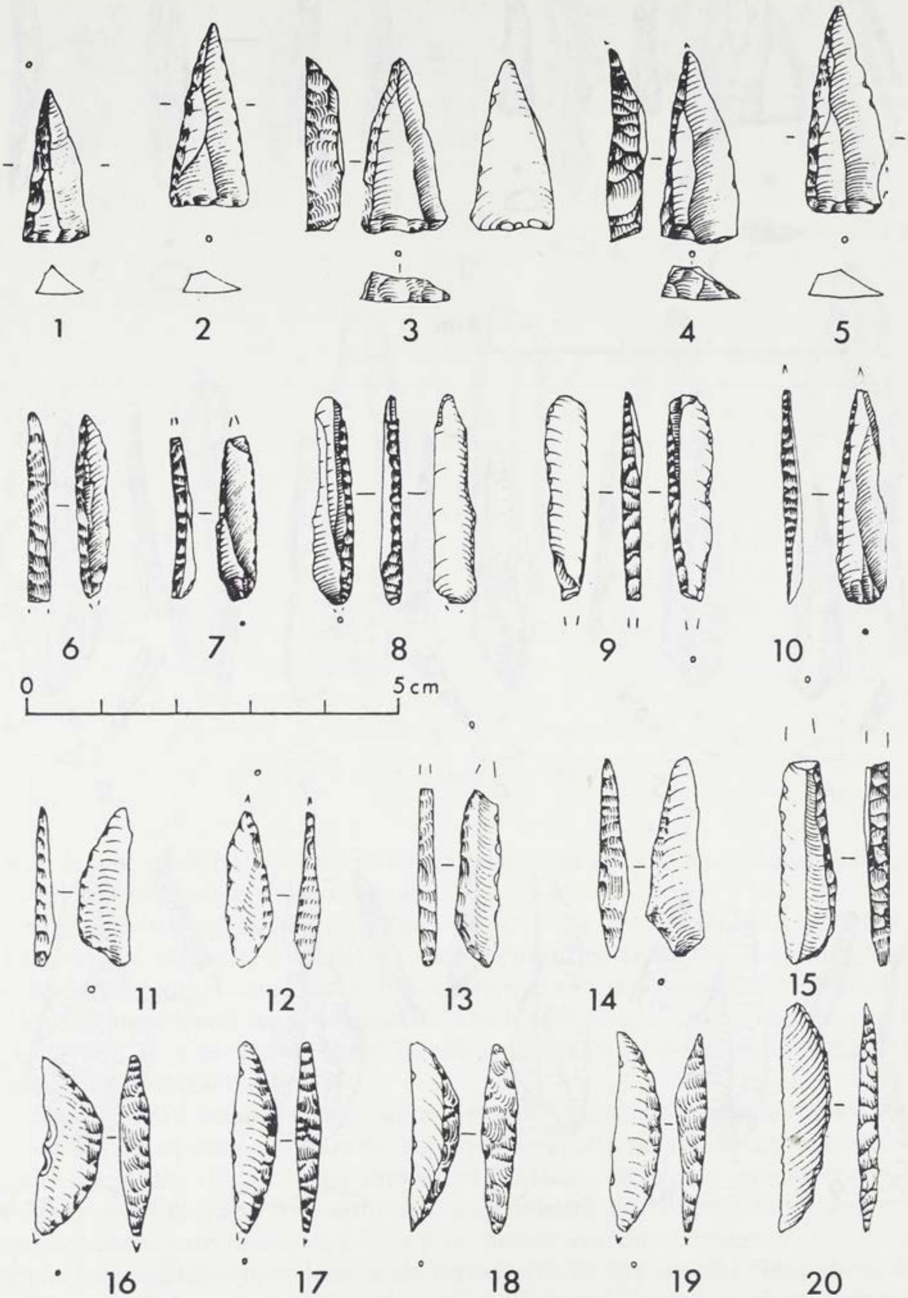

Fig. 4. Triangular points, backed bladelets, elongated scalene triangles and segments from site 85/79.

the depression made the area attractive. Both sites extend for nearly 500 metres with thousands of artefacts including dense concentrations which gave the impression of working areas. Because of their length and artefact numbers it is suspected that these sites are reoccupied at different times. We found such large heavy milling-stones on one of the sites posssibly deposited here to use them again, when people returned to the locality.

Segments were the dominant tool type collected from site 85/79, but also microlithic elongated scalene triangles, triangles and points occur (Fig. 4), while blades and flakes are often notched and denticulated. Bone fragments collected from the surface of the site yielded a radiocarbon date of 6,550 ± 65 B.P. (KN 3880. All radiocarbon dates were processed by the Laboratory of Cologne University – Dr. J. Freundlich. The dates are uncalibrated). Because of nature of the artefact assemblage – especially the elongated scalene triangles, segments and triangular points – we have to take into account that more than one chronological phase is represented on these sites. There was one grave within the scatter. The skeleton was buried in extreme contracted position, but without any grave goods. First determinations (by Chr. Simon, Université de Genève) suggests it was a male between 40 - 50 years old with a height of 1.7 m. The dating of this skeleton, 6,630 ± 160 B.P. (KN 3646), fits well with the date just mentioned.

In a test excavation at Burg et Tuyur itself artefacts occurred to a depth of 1.2 m. At the lower level some Middle Palaeolithic artefacts were excavated, followed by strata containing sherds assigned to the Laqiya-Type, very common in Wadi Shaw and dated around 6,000 - 5,000 B.P. (Schuck 1988; 1989). Small well fired and burnished but otherwise undecorated sherds from the surface could be dated to the middle of the 4th millennium B.P. by comparison with ceramics from the Wadi Shaw. The stone artefacts have not yet been studied in detail but notched and denticulated pieces and microlithic segments dominate.

From 50 - 100 m north of this test excavation at Site 80/64-2 sample of tools was collected (Fig. 5). The major tool types were segments and elongated scalene triangles, backed bladelets and microburins were also frequent. Probably again an Early and Middle Neolithic phase could be identified here. Four radiocarbon dates are available from the excavation: three of them are dated to the beginning and the middle of the 6th millennium B.P. (KN 3705: 5,990 ± 170; KN 3706: 5,730 ± 130; KN 3708: 5,690 ± 140), while one from the surface dated to the beginning of the third millennium B.P. (KN 3398: 2,990 ± 250).

Comparable artefact assemblages had been excavated at sites in the Bir Kiseiba area and also in the Nile Valley (sites DIW 53 and 5: Schild, Chmielewska and Więckowska 1968; Shiner 1968; El Kab II: Vermeersch 1978) and the Dakhla Oasis (Wendorf and Schild 1977). On the other hand relationships can be seen with the artefact assemblages of Ti-n-Torha East (Barich 1974; 1976; 1987 [ed.]; Close 1987: 63 - 85), where elongated triangles and segments are frequent. Segments and triangular points have been seen as the diagnostic elements of the Middle Neolithic of the Eastern Sahara (Wendorf, Schild and Close [eds.] 1984) so that most of the artefact collections from the Selima Sandsheet could be ascribed to the Early or Middle Neolithic.

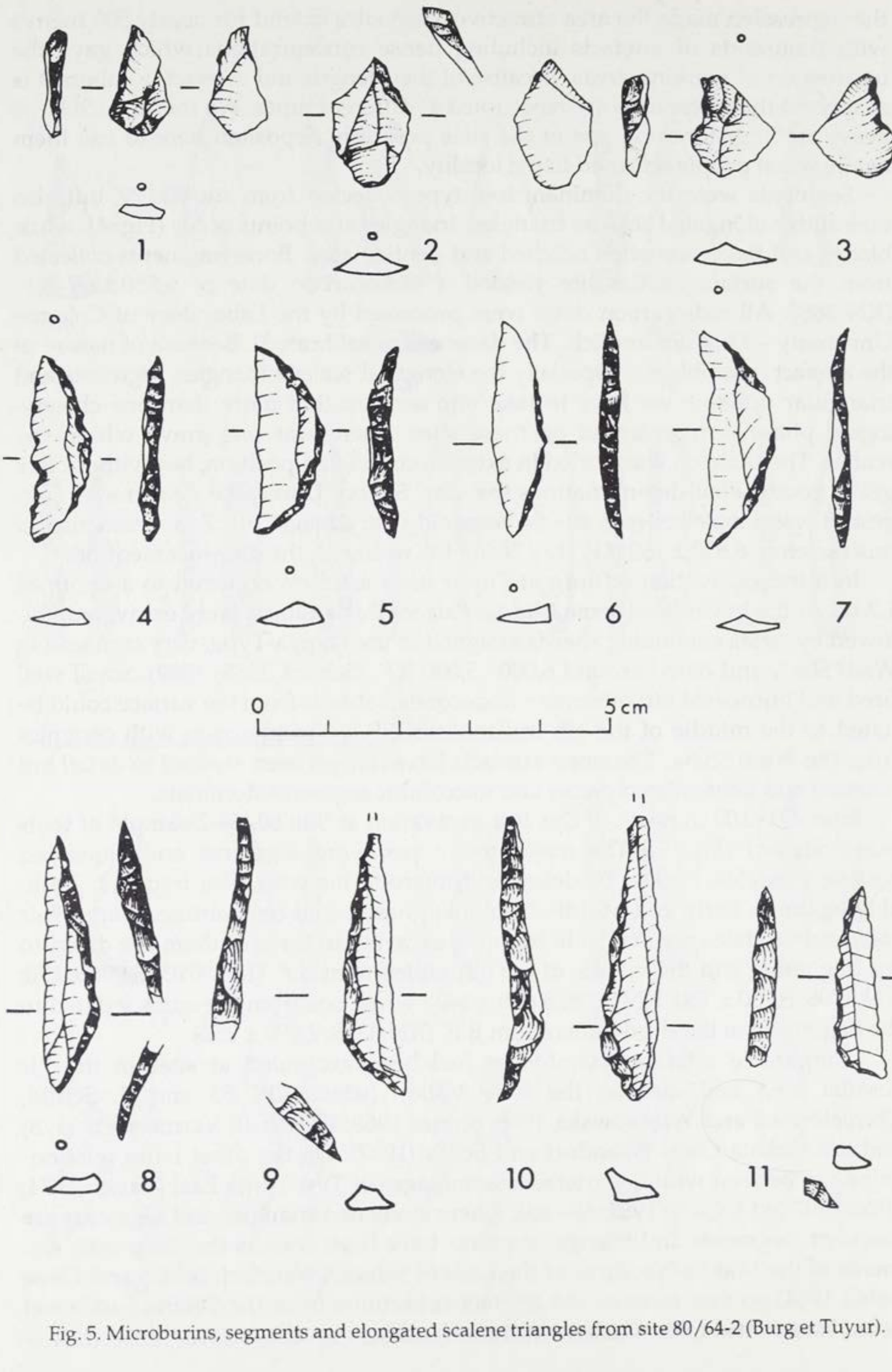

Fig. 5. Microburins, segments and elongated scalene triangles from site 80/64-2 (Burg et Tuyur).

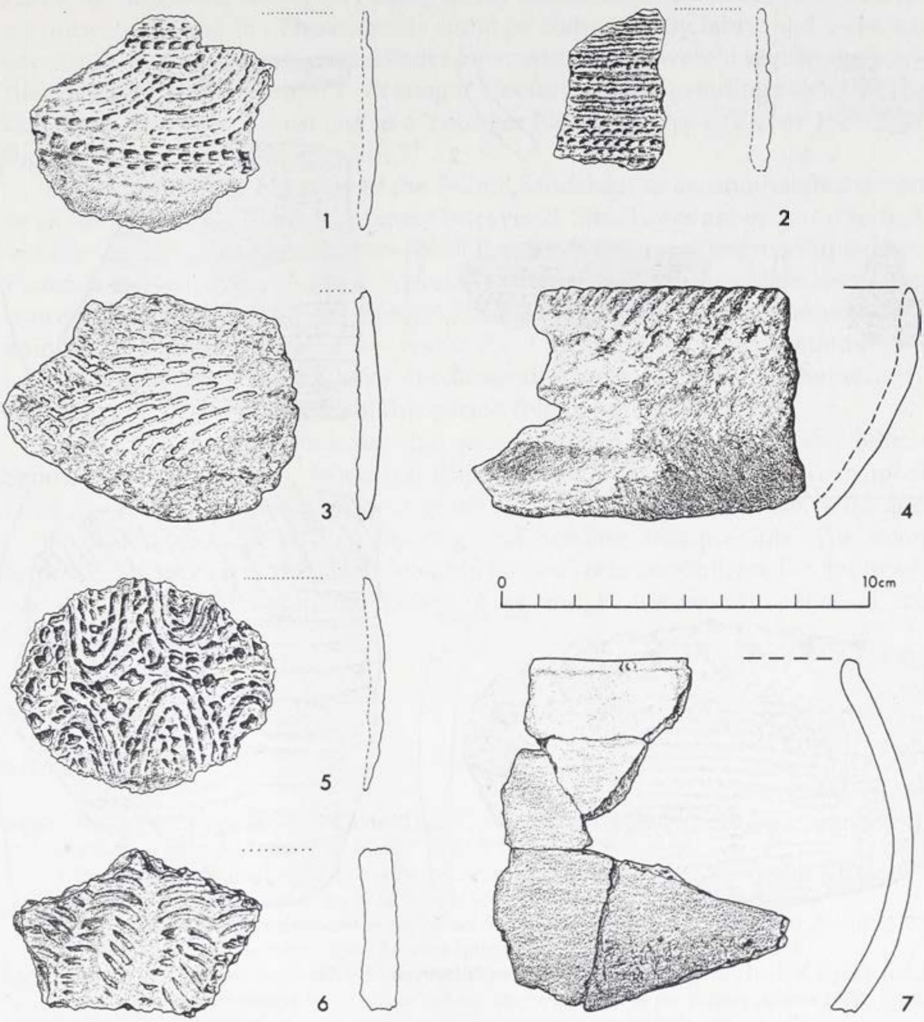

Fig. 6. Sherds from different sites in the Selima Sandsheet.

In general sherds from different sites are very homogeneous in fabric and decoration. The pottery is quartz-tempered and either reddish brown or greyish red. Because most of the sherds are extremely aeolized and very small, only globular bowls could be reconstructed (Fig. 6: 4, 7; 7: 2, 5). Two decoration techniques were employed: impression and punctation, the latter as a series of round dots. Impression otherwise was varied: parallel bands or rows of impressions occur as well as rockerstamp motifs. On some sherds impressions are rectangular (Fig. 7: 1, 7), while on other sherds they are more circular to long-oval (Fig. 6: 3; 7: 6). The motif of one sherd (Fig. 6: 6) is comparable with the chevron

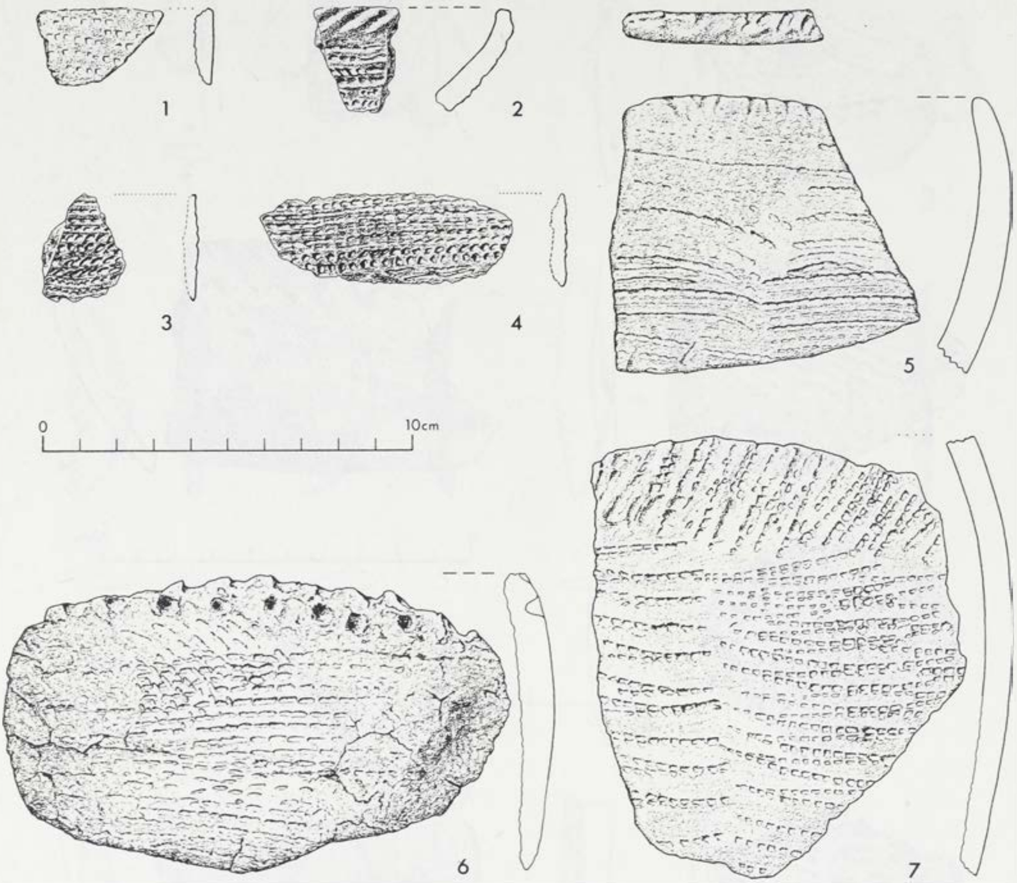

Fig. 7. Sherds from site 85/79.

design of sherds from sites E-79-5 and E-80-5 (Connor 1984). One sherd is decorated with dotted-wavy-lines (Fig. 6: 5) while another one shows a composite decoration of parallel and curved lines of comb impression (Fig. 6: 1) and is very similar to sherds from Adrar Bous (Smith 1980: Photo 18: 4). Rim decorations are very uniform: short strokes perpendicular or angled to the outer edge (Fig. 6: 4; 7: 2). All these sherds are comparable to sherds from sites of the Nabta and Bir Kiseiba area where they would be placed within the Early or Middle Neolithic assemblages in the general Saharo-Sudanese-Tradition. This is also proposed for the lithic material.

Two brown sherds – one completely undecorated (Fig. 6: 7), the other one with three punctations on the rim – are different for the interior and exterior is carefully smoothed, the temper being a very fine sand. One vessel is a bowl with an outward-flaring lip. These sherds could be compared by fabric and technical aspects with some sherds from Wadi Shaw, where they were dated to the middle of the 5th millennium B.P. (Younger Neolithic). Two grinding-stones of the Gilf-Type also give indications to a Younger Neolithic phase (Kuper 1981: 253, Fig. 29; Schuck 1988: 148, Fig. 4: 1, 2).

In conclusion, the old view of the Selima Sandsheet as an uninhabited desert or an area with only a few finds must be revised. Small sites are very numerous, but the very large artefact clusters show that long-lived or often reoccupied settlements existed. The elongated depressions between the dune ridges may have concentrated water (and vegetation), hence their attraction to humans and animals. Combining these facts – water, local concentrations of vegetation and animal resources – would have encouraged people to settle in the vicinity during the Early or Middle Neolithic period (Neumann, this volume).

Only a few artefacts indicate that people settled in or crossed the Selima Sandsheet in later times, when conditions became dryer, although occasional rains probably supported seasonal grass, useful for grazing of both, wild and domesticated animals, so that hunting and herding was possible. The main settlement activities in the Late Neolithic period were concentrated in the wadi systems of the Gilf Kebir, the Laqiya Area and at the eastern edges of the Selima Sandsheet.

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The Gilf Kebir and Lower Wadi Howar: contrasting Early and Mid-Holocene environments in the Eastern Sahara

In this paper I will focus on two localities: the Gilf Kebir which is situated in the center of the Eastern Sahara, and the Lower Wadi Howar and its southeastern periphery (Fig. 1). The following results evolved from several field seasons carried out within two projects: the multidisciplinary B.O.S. Project of Cologne University and the Quaternary Geology Section of the Berlin-based Joint Research Project "Arid Areas". Though most of the evidence presented here is geological, the palaeoclimatic impact upon human activity and some geoarchaeological aspects will also be mentioned.

The sandstone plateau of the Gilf Kebir is situated at 23°N in the southwestern corner of Egypt and thus in the hyperarid core of the Eastern Sahara with an estimated annual rainfall of below 5 mm. During the Terminal Pleistocene one of the box canyons on the eastern side – Wadi el Bakht – had been dammed up some 12 km below the valley head by a huge blocking dune which caused the accumulation of thick playa deposits during the first half of the Holocene. The importance of this locality was stressed by McHugh (1980: 65) when he wrote: "This locale has outstanding potential for contributing to the study of the late prehistoric palaeoenvironments and cultural adaptation in the area".

An outcrop in the gorge breaching the former dune barrier gives an excellent insight into the sequence of sedimentary processes. It shows the eolianite components of the fossil dune consisting of consolidated cross-bedded sand striking about north-south corresponding to the trade winds, and the impounded playa deposits which are over 8 m thick at this site near the former playa lake shore. Mapping of the surface deposits revealed that these pelitic still-water sediments extend over some 65,000 km^2 (Kröpelin 1987). They consist of thin alternating layers of alluvial sand and silty-clayey deposits which were charcoal-dated at 8,700 B.P. at the base and around 5,000 B.P. at the top (Fig. 2). Only the top layer,

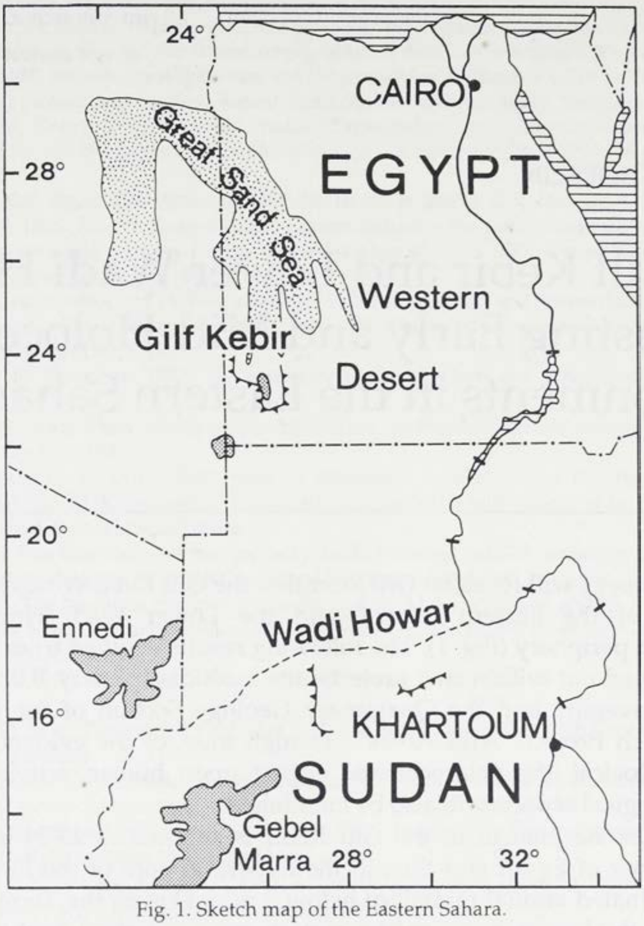

Fig. 1. Sketch map of the Eastern Sahara.

dated firmly from 6,000 to 5,000 B.P. by several dates, has a thickness of more than 1 m, while 77% of the strata are less than 2 cm thick, with an average thickness of only 14 mm (Kröpelin 1989). Grain size analyses show the high clay fraction of the playa layers which are built up by clastic silicate mud deposits including detritic kaolinite (Pachur and Röper 1984). A characteristic structural feature are load casts which occur at the basal sides of the sand layers. These pressure marks are important for the argument that the sand layers, which probably have been flooded from the slopes, have been deposited on the still water-saturated playa mud. These sandy red beds have been consolidated by iron oxides and mechanically infiltrated clay minerals during succeeding playa lake phases (Kröpelin 1989).

The 89 pelitic strata occur in a period between approximately 9,000 to 5,000 B.P. indicating short-lived rainpools containing water for weeks or months at most fed by about four heavy rainfalls per 100 years (Fig. 2; Kröpelin 1987). Such rainfall distribution is characteristic of arid climates.

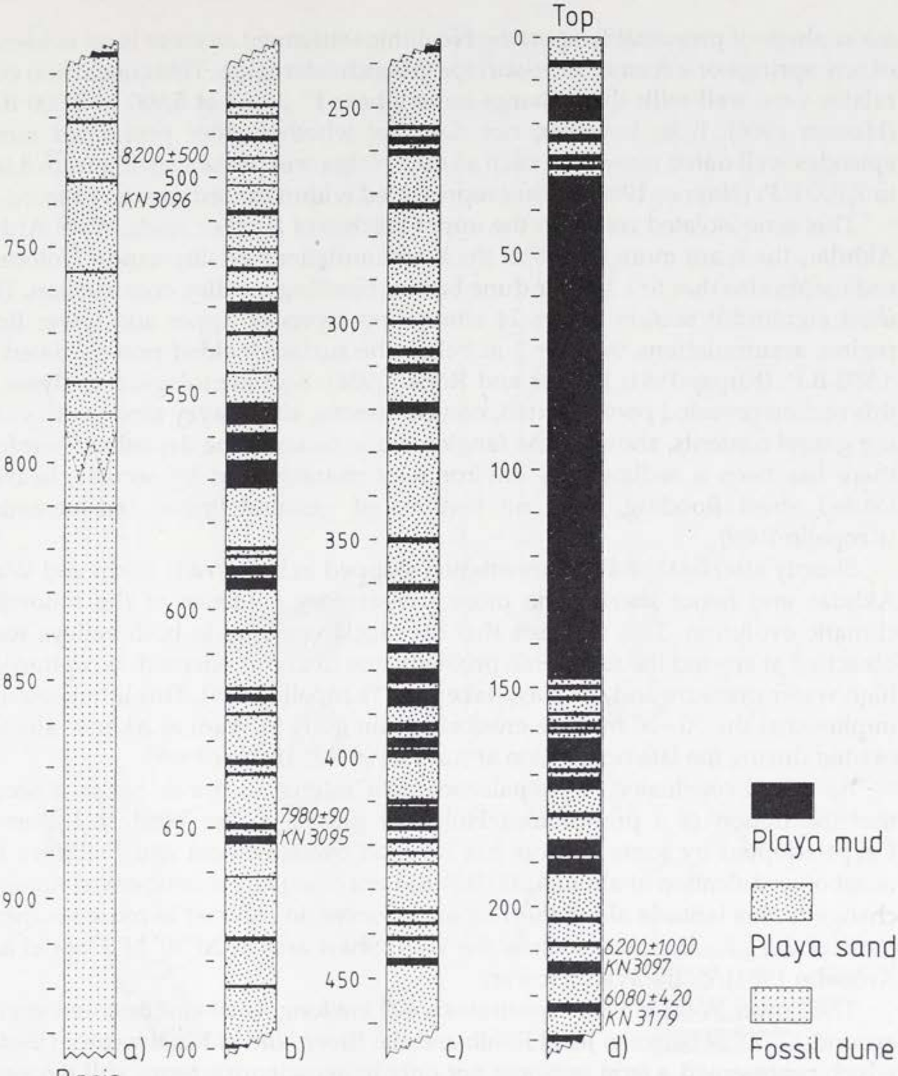

Fig. 2. Wadi Bakht, Gilf Kebir. Stratigraphy of section 82/13 with radiocarbon ages of charcoal in uncalibrated years B.P.

Only between 6,000 and 5,000 years B.P. did conditions tend toward moderate aridity with an estimated maximum rainfall of 100 mm (Kröpelin 1987). These inferences have been corroborated by charcoal identifications yielding only species still forming part of the modern Saharan flora (Neumann 1987) and lie significantly below the earlier estimates of 200 - 800 mm/yr by McHugh (1974: 13) which he based on the normal ecological requirements of the giraffe, ostrich, oryx and domestic cattle depicted by rock art. According to numerous radiocarbon dates (Kuper 1989), this millennium also seems to represent the main phase of presumably sporadic Neolithic settlement as there is no evidence of any springs or a former near-surface groundwater table. This conclusion correlates very well with the "Kharga moist phase I" dated at 5,900 to 5,000 B.P. (Hassan 1986). It is, however, not clear yet whether other postulated moist episodes well dated elsewhere such as the "Nabta wet phase" lasting from 8,600 to 7,100 B.P. (Haynes 1980) are not represented within the sedimentary record.

This is no isolated result. In the upper reaches of another wadi, Wadi Ard el Akhdar, there are more than 8 m thick accumulations of silty-sandy Holocene sediments also due to a former dune barrier blocking a valley construction. The most significant section shows 14 alternating layers of upper and lower flow regime accumulations. A layer 2 m below the surface yielded pottery dated at 8,500 B.P. (Kuper 1981; Pachur and Röper 1984). Sedimentological analyses of this section revealed poorly sorted, non-calcareous, silty-clayey sands with varying gravel contents, showing the fanglomeratic facies of the deposits. Therefore there has been a sedimentary environment characterized by secular, heavily loaded sheet flooding, with no features of genuine limnic sedimentation (Kröpelin 1989).

Shortly after 5,000 B.P. sedimentation stopped in both Wadi Bakht and Wadi Akhdar and hence there is no more sedimentary evidence of the following climatic evolution. This suggests that the blocking dunes in both valleys were breached at around the same time probably due to unprecedented, exceptionally high water pressure and/or playa lake level (Kröpelin 1989). This interpretation implies that the 50 - 80 m wide erosional main gully in Wadi el Akhdar already existed during the late occupation around 4,000 B.P. (Kuper 1989).

As a final conclusion of the palaeoclimatic inferences drawn so far, it seems that the notion of a pronounced Holocene pluvial in the Western Desert of Egypt adopted by some authors has been an overstatement and therefore the onset of aridification at about 4,500 B.P. did not bring any drastic environmental change to this latitude along the Tropic of Cancer, in contrast to more southerly parts of the Libyan desert such as the Wadi Shaw area at 20°30′ N (Gabriel and Kröpelin 1984), or the Wadi Howar.

The Lower Wadi Howar constitutes a 400 km long, west-east oriented stretch around 17°30′ N between Jebel Rahib and the River Nile in Northwestern Sudan which represented a *terra incognita* not only in geoscientific terms still ten years ago. All former maps of the area show the end of the wadi bed south of Jebel Rahib (Fig. 3). During several field seasons in the last few years, however, we could verify earlier speculations on an eastward connection to the Nile during the Tertiary (Newbold 1924), and interpretations of Landsat imagery (Meissner and Schmitz 1983). Ample evidence was found that the Lower Wadi Howar drained parts of this 400 km wide, now extremely arid region with an estimated average rainfall below 40 mm/year, as late as mid-Holocene (Kröpelin 1990a; Pachur and Kröpelin 1987). The Wadi Howar joined the Nile between the third and fourth cataract some 30 km northwest of Ed Debba, opposite to the site of the early Christian, Makourian capital Old Dongola on the east bank of the Nile (Jakobielski 1970; Krzyżaniak 1968; Michałowski 1966; 1970).

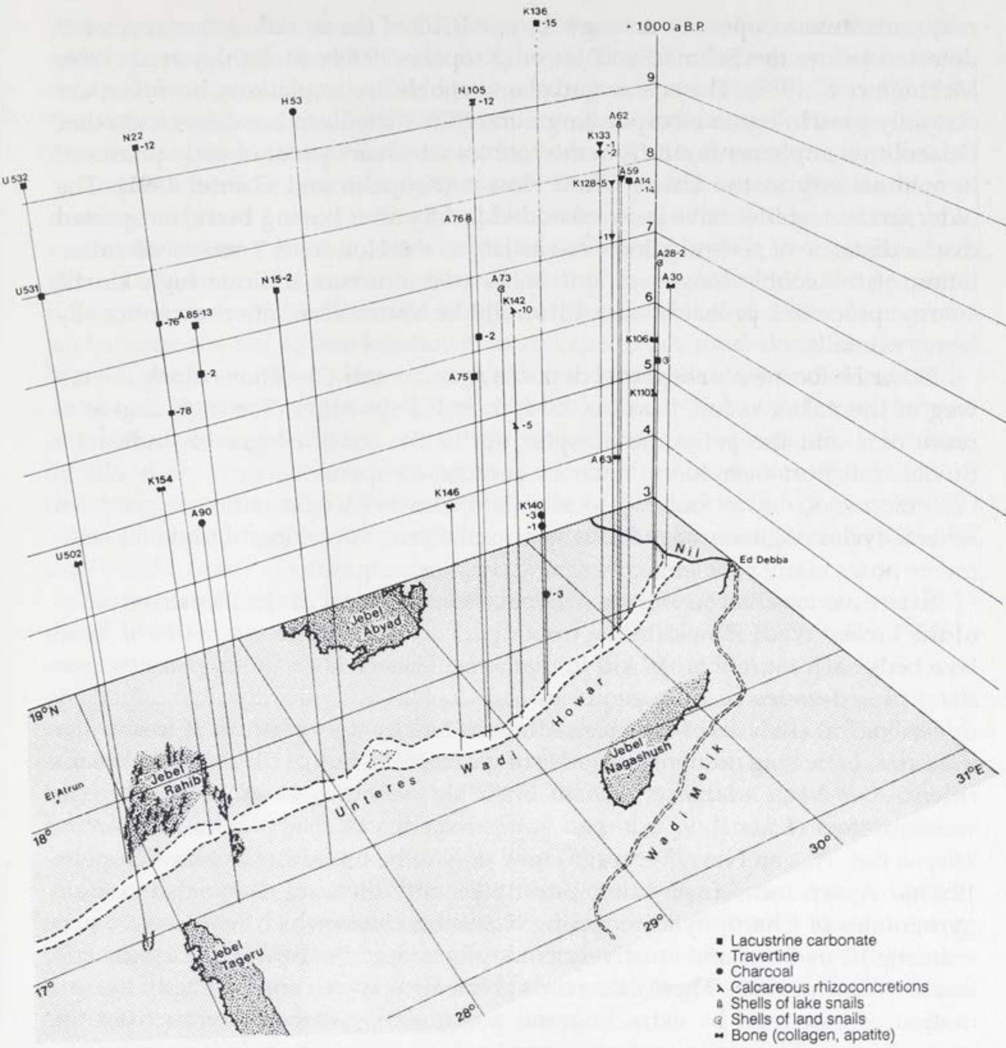

Fig. 3. Sites and ages in uncalibrated years B.P. of radiocarbon-dated materials from Lower Wadi Howar. Vertical time-scale is isometric.

While interpretation of Landsat imagery suggests a uniform fluvial origin of the valley, ground work showed narrowly interlocked sedimentary environments of various fluvial and lacustrine stages dating back at least until the late Tertiary. So far some 300 sites, sections and backhoe trenches have been recorded which allow a spatially and chronologically differentiated reconstruction of the palaeoriverine environment during the late Quaternary (Kröpelin 1993).

Fluvial high velocity deposits occur as 9 m thick and several hundred meters wide cobble terraces within braided inset channels in the bedrock valley which may constitute an open-air analogy to type RR-2 of the so-called "radar rivers" detected below the Selima Sand Sheet (Kröpelin 1990b; McCauley *et al.* 1986; McHugh *et al.* 1988). The coarse gravel and cobble accumulations, however, are certainly pre-Holocene incorporating numerous Acheulean handaxes and other Palaeolithic implements cut from the cobbles which are proof of early phases of human activity in the Lower Wadi Howar (Kröpelin and Gabriel 1991). The older terrace cobbles have been rebedded locally after having been transported over a distance of several kilometres as late as the Holocene. Transversal orientation of the cobble long axes and imbricated structure indicate high kinetic energy processes probably due to swell-like water flow after exceptionally heavy rainfalls.

Other Holocene coarse gravel deposits occur at many locations along the talweg of the palaeovalley down to the former Nile-junction. The high degree of roundness and the petrographic spectrum of the stratified gravels indicate a fluvial transport over long distances because components, such as rhyolithic volcanic rocks, do not outcrop locally (Kröpelin 1990a). Since there have been several cycles of Quaternary fluvial accumulations, reworking of previous sediments poses many problems concerning chronostratigraphy.

Extensive fossiliferous lake marl deposits are typical of the lacustrine facies of the Lower Wadi Howar in the upper part of which there is a series of fossil lake beds each more than 10 km in diameter. These lakes were apparently persistent for decades or even centuries and contained freshwater, as judged by mineralogical analyses of the lake sediments and by the spectrum of freshwater molluscs, including numerous species of gastropods, fluvial bivalves *(Aspatharia rubens, A. arcuta, Caelatura aegyptiaca, Corbicula fluminalis, Mutela nilotica)*, freshwater oysters *(Etheria elliptica)* and several species of fish *(Alestes, Synodontis, Tilapia;* det. W. van Neer, Tervuren) now only to be found in the Nile (Kröpelin 1990a). Apart from freshwater ostracodes and diatoms, they also contain gyrogonites of Charophytes including *Nitellopsis obtusa* which witnesses to permanent, 10 m deep and relatively cold, oligotropic freshwater (Kröpelin and Soulié-Märsche 1991). These calcareous green algae were contributing to the formation of lake marl by extracting and accumulating carbonate ions from the groundwater. The sediments also contain bones of large savanna and amphibious mammals such as elephant, rhinoceros and hippopotamus which have been dated to between 6,325 and 3,825 B.P. (Kröpelin 1993). The diversity and widespread distribution of the specimens are proof of a water-course surrounded by a highly developed savanna ecosystem providing animals with optimal living conditions (Pachur and Kröpelin 1987). Worth mentioning is the skeleton of an apparently drowned human in lake marls dated to 5,640 ± 70 B.P. (Hv-14434).

Sandy alluvium, silicate muds and subhydric soils give evidence of tens of kilometers wide marsh environments. Their thickness is considerable, not even 4.5 m deep backhoe trenches reaching their base. To find out about seasonal changes in the weather, the oxygen isotope ratios within the shells of individual

Melanoides tuberculata snails from the mud deposits have been studied on the mass spectrometer. Sample A 62 revealed quite stable living conditions with relatively minor changes in biological productivity at around 8,585 ± 135 B.P. (Hv-14432) with the low $\delta\ ^{18}O/PDP$ ratio of –8.5% indicating "extremely cool" and wet conditions at that Early Holocene period (P. Abell, pers. comm.).

Important evidences of a very favorable human habitat are widespread fossil dunes which had been stabilized by a thick cover of lithic artefacts, lithic raw materials, pottery, burials, often with furnishings, grinding stones, polished stone axes, microliths, and a variety of other cultural debris including animal bones and charcoal (Gabriel and Kröpelin 1986; Gabriel *et al.* 1985). Numerous such dunes, several square kilometers in size, are to be found along the northern bank of the Lower Wadi Howar suggesting a quasi-sedentary and presumably persistent human occupation during Neolithic times. In several cases former parabolic dunes which stand for a high groundwater table, periodical flooding by wadis, and/or relatively dense grass or herbaceous vegetation at the time of first occupation have been preserved because of the thick anthropogenic debris cover. Concentrations of grinding sites in the surroundings of the dune habitats may point to early agriculture.

Numerous finds of bones of domesticated cattle (det. J. Boessneck, Munich), some of which dated to 5,350 ± 275 and 3,915 ± 210 B.P. (Hv-15589, Hv-15588), suggest widespread cattle herding during the Middle and Late Neolithic wet phase. Several former watering places are supporting evidence. Additional evidence is provided by so-called "pierres à gorge" (Morel 1982) or "tethering stones" (Pachur and Röper 1984) which are thought to have been used either as trap stones for large savanna game (Morel 1982), or to hinder grazing domestic cattle from straying (Pachur 1982); in either case they indicate sufficient grassland and water supply.

Recently published rock engravings from South Libya show, in fact, domesticated cattle with a rope around the hind leg connected to a shaped stone (Castiglioni *et al.* 1986). Hundreds of grave mounds which line the edges of the braided inset channels of Lower Wadi Howar point to presumably later phases of human settlement perhaps of C-group peoples.

The concept of the Wadi Howar being an indicator of a significant shift in the rainfall regime of the Eastern Sahara is based on the field evidence that its lower course was not an exotic river sustained by rainfall in the mountainous source area of the Jebel Marra or Meidob Hills but that it was fed by substantial local rainfall. Supplementary proxy data support this statement. Along the wadi banks – as for example in the environs of an only recently discovered, presumably Meroitic or Christian fortress, some 110 km away from the Nile (Kröpelin 1993; Kuper 1988), there are erosional relics of more than 100 m wide travertines testifying to extensive spring horizons. Some of these apparently annually laminated calcareous sinter deposits were dated at 8,355 ± 180 B.P. (Hv-15580, Hv-15578; Kröpelin 1993). Due to their geomorphological position they must have been fed by infiltrated local rainfall. Other evidences are up to 80 cm thick iron-crusts that formed at the groundwater interface in the near vicinity of the wadi high above the talweg, pointing to a significantly higher groundwater table during the Early and Mid-Holocene wet phase (Pachur and Kröpelin 1987).

Figure 3 gives an overview of the radiocarbon dates currently available from the Lower Wadi Howar with their distribution between 9,300 and 2,075 B.P. Synchronous occurrence of individual sedimentary events of fluvial or lacustrine nature cannot be inferred from these dates. In an order of magnitude of centuries, however, there is increasing evidence of a fully developed and uninterrupted amphibian and savanna ecotope between 17° and 18° N during the entire Early and Mid-Holocene, during which parts of the large, now extremely arid region of "Western Nubia" drained into the Nile *via* the Lower Wadi Howar. Since the indicators of increased palaeorainfall culminate in the Lower Wadi Howar region, there is conclusive evidence of a distinct gradient of decreasing palaeohumidity from here northwards to the Gilf Kebir, a distance of some 600 km. Therefore, the tropically induced Holocene shifting of the northern fringe of the palaeo-Sahel, which was subject to important oscillations, has apparently never passed beyond 22° N which coincides with the present political border between Egypt and Sudan.

These conclusions are in agreement with other workers using different approaches (Gabriel 1986; Haynes 1987; Haynes and Mead 1987; Neumann 1989; Pachur *et al.* 1987; 1990; Pachur and Kröpelin 1989). However, in spite of the increasing evidence on the palaeoclimate of the Eastern Sahara during the last 10,000 years there still is a dearth of data concerning a reliable, detailed and regionally differentiated chronology of palaeoclimatic events, and thus wide scope for interpretation.

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The natural conditions for Pre- and Early Dynastic settlement in the Western Nile Delta around Tell el-Fara'in, Buto

Palaeogeographical investigations of the late Quaternary development of the Nile Delta have been intensified during the last few years. This research, however, which was occasionally connected with archaeological surveys and excavations, focused on the eastern Delta (Sneh *et al.* 1986; Coutellier and Stanley 1987; Stanley 1988; van Wesemael and Dirksz 1986; Sewuster and van Wesemael 1987; de Wit and van Stralen 1988; de Wit, this volume), whereas the western part was rather neglected. Especially the knowledge of the younger geological history of the region south of Lake Burullus is incomplete. Only few data are available from the widely scattered borings described by Fourteau (1915) and Attia (1954); they merely allow for a general outline of the late Quaternary stratigraphic sequence.

In order to add to the fragmentary information on the late Pleistocene and Holocene evolution of this part of the Delta, palaeogeographical research has been carried out in the area of Tell el-Fara'in (Andres and Wunderlich 1986; Wunderlich 1988; 1989). The research project was made possible by a grant from the Stiftung Volkswagenwerk, FRG. It chiefly aimed at the detection of the environmental conditions at different times, changes in the deltaic fluvial system and fluctuations of the sea level and the coastline.

The results of those studies were also to contribute to the recent investigations of the German Archaeological Institute, Cairo at Tell el-Fara'in (von der Way 1984; 1985; 1986; 1987; 1988; 1989) which showed that at the site of ancient Buto settlement started during the Predynastic period and there are different cultural layers up to the Early Dynastic and Dynastic periods (von der Way 1989; Schmidt, this volume). The archaeological findings raised questions about

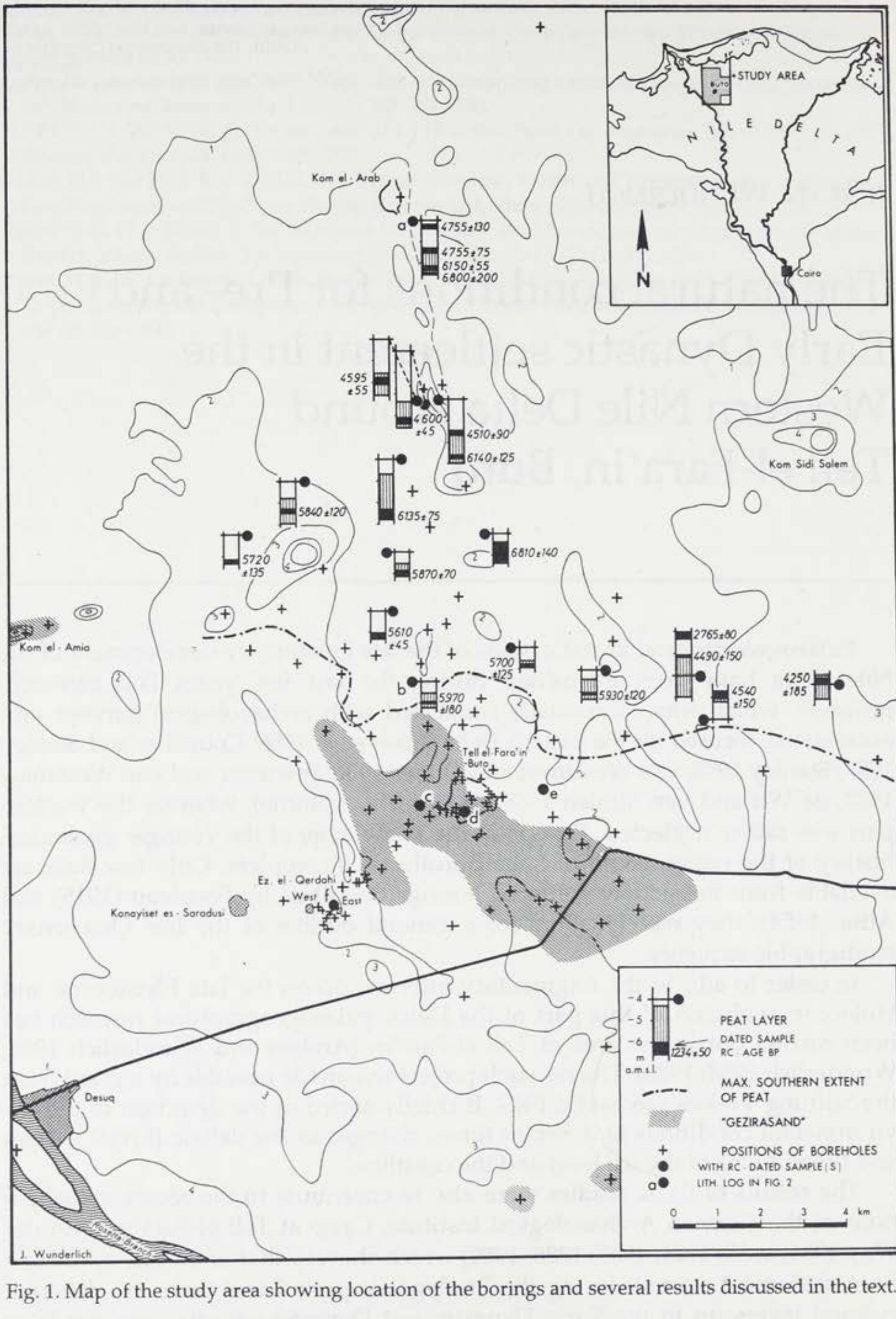

Fig. 1. Map of the study area showing location of the borings and several results discussed in the text.

the natural conditions facing early man in this region as well as about the function of the settlement and its relation to ancient Nile branches or to the coast. Furthermore, it was of great interest whether other settlements of an equivalent age, which are now buried below Nile sediments, existed close to Buto. All these archaeologically relevant problems are not to be solved without any detailed information on the subsurface structure.

The study area (Fig. 1) around Tell el-Fara'in extends from the southern border of Lake Burullus for nearly 30 km to the south, its southwestern corner just touching the Rosetta branch; from west to east it is about 20 km wide. It includes different geomorphological units: the northern part is covered by the brackish Lake Burullus and the adjacent vast plains of bare soil and salt marsh with low ridges and seasonally flooded saltpans; adjoining to the south there is the highly cultivated and irrigated floodplain with a dense network of canals and drains; it also contains different morphological features, *i.e.* ridges or small mounds.

As the most valuable information could be expected from studying the subsurface, boring and subsequent analyses of taken sediment samples, including radiocarbon dating, were concentrated upon. Two different drilling equipments were used: an auger of the Edelman type and a motor-driven gouge auger with a gouge of 1 m in length and 3 cm in diameter. More than 150 drillings to depths of 15 m maximum and an average depth of about 9 m have been carried out in the working area (Fig. 1). They were concentrated around Tell el-Fara'in. The stratigraphic records provided from borings were partly completed by geoelectric soundings. Beside of own measurements a lot of soundings were carried out by Prof. Gamili, Dept. of Geology, Mansoura University, Egypt. As far as possible, the fieldwork was supported and completed by digital processing and interpretation of Landsat MSS and TM data as well as by studying topographic maps of different years. The latter research methods allowed for the detection of possible courses of abandoned Nile distributaries and other features like subdeltas, former lakes and small mounds, which are mostly Tells or Koms (Wunderlich 1988: Fig. 2).

This paper focuses on the results of the borings and the laboratory analyses. They indicate that the subsurface conditions inside the study area – especially close to Tell el-Fara'in – are highly complex. Nevertheless, a general outline of the upper sedimentary sequence can be drawn. In Fig. 2 it is illustrated by lithologic logs being typical for different parts of the working area.

Normally the upper few meters of the sediment column are made of floodplain deposits. This well known Nile mud mainly consists of dark brown or in the lower sections (below actual mean sea level) of dark grey clay, silt and silty clay. The sediments are locally interrupted by loamy or sandy intercalations, reflecting the shifting of Nile distributaries or changes in their discharge and sedimentation pattern. Nodules of FeMn and $CaCO_3$ as well as molluscs are recorded. The content of the organic matter varies around 8% of weight.

To the north of the working area peat or highly organic muds underlie the rather homogeneous clay and silt mostly below –4 m actual mean sea level (Fig.

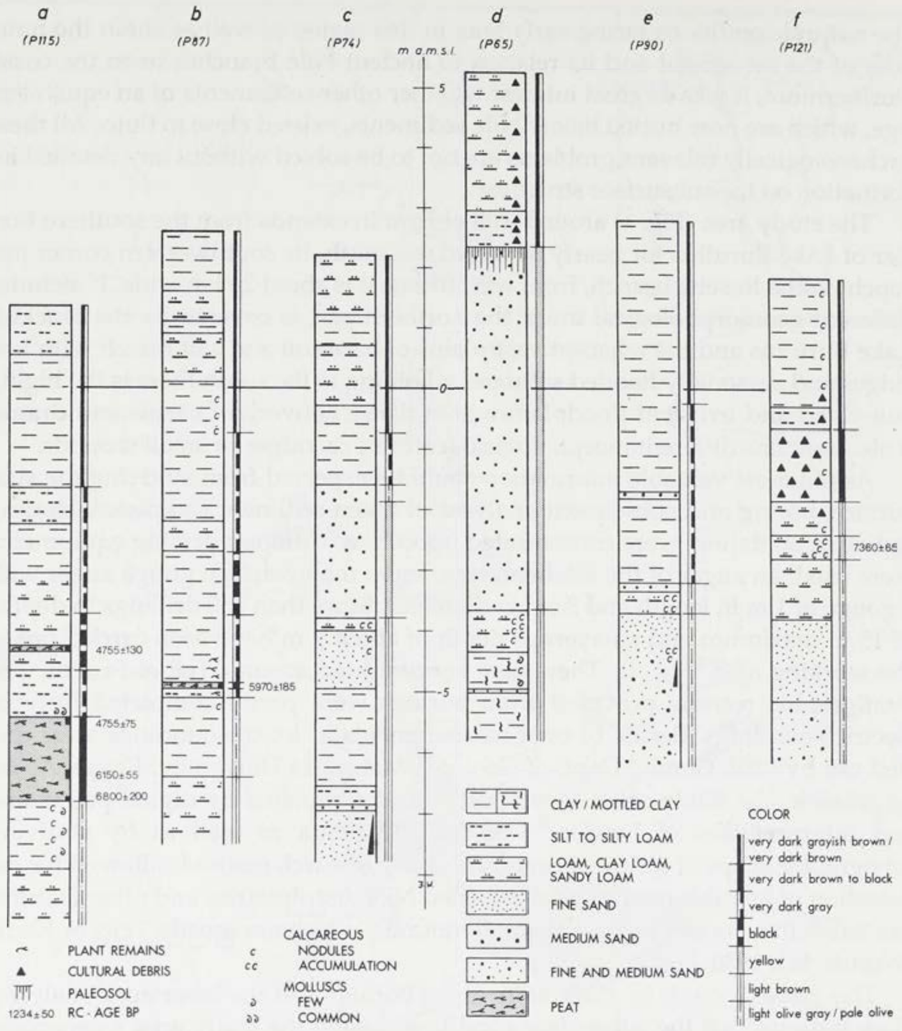

Fig. 2. Lithologic logs (a - f) of selected borings showing characteristic sedimentological sequences from different parts of the study area. For the locations of the borings see Fig. 1.

2: a, b). Their thickness decreases in a southward direction from more than 1 m to about 10 cm and they completely disappear south of the line shown in Fig. 1. The content of organic material varies from approximately 75% of weight (peat) to about 15% of weight (organic mud) finding an expression in the very dark brown or black color. This remarkable sediment layer obviously represents a former southward advance of the marsh- and lagoon-belt near the coast. It was proved by abundant molluscs on top of the peat indicating a brackish environment.

Several samples of the organic material were radiocarbon dated. The C-14-datings were carried out by the Institut für Umweltphysik, Universität Heidelberg, FRG. The C-14-ages as well as the spatial distribution and the level of the dated samples are depicted in Fig. 1. They show that in the northern part of the working area the top of the peat layer is about 4,500 radiocarbon-years old, whereas the bottom is older than 6,500 B.P. According to Pearson *et al.* (1986) this fits with a range from nearly 3,000 to 6,000 cal. B.C. The thin organic layers further south yielded C-14-ages of about 5,800 B.P. This corresponds to a calibrated age of about 4,500 cal. B.C. (after Pearson *et al.* 1986; for the complete dates including lab-numbers *cf.* Wunderlich 1989). The C-14-ages indicate that to the north of Buto the maximum southern extent of the lagoon- and marsh-environment was reached shortly after 6,000 B.P. Subsequently, sedimentation of Nile mud prevailed and the southern border of peat development was pushed to the north.

To the south of the peat deposits a characteristic sand layer was detected below the upper clay- and silt-sequence (Fig. 2c). The numerous sediment borings in the vicinity of Tell-el-Fara'in allowed us to delineate the extent of this sand deposit with some reliability. As shown in Fig. 1 it is restricted to a sharply defined area. Similar sands were also recorded at some other places, but due to long distances between the boreholes they could not be associated with the sandsheet around Tell el-Fara'in.

The layer of yellow and greenish grey sand is normally 1 or 2 m in thickness. It increases to more than 6 m below the ruins of Tell el-Fara'in, where it appears at the base of the cultural horizons (Fig. 2d). Presumably Predynastic people found this sand hill overtopping the surrounding floodplain like an island. In the eastern Delta those sandy elevations are called *gezira*. Thus the sand forming this characteristic layer will be termed *gezirasand*. This does neither mean anything about its age and origin nor its belonging to any stratigraphic formation.

Various investigations were carried out in order to derive information about the environmental conditions leading to the deposition of the *gezirasand*. Grain-size analyses of several samples proved that more than 50%, occasionally more than 60% of weight are made of medium sand which consists mainly of quartz. Fair sorting and a skewness of about 0.9 as well as majority of subangular to subrounded, well polished sandgrains indicate that the sand has been deposited in a fluvial system. Additional information provided studies of the grain-morphology using a Scanning Electron Microscope (it was carried out by Dr. Igel, Mayence). They also gave evidence that the *gezirasand* is mainly a fluvial deposit, but there are some clues that it was redeposited by wind.

In the course of the excavation carried out by the German Archaeological Institute Cairo at Buto several cuts were dug down to the surface of the *gezira*. They gave an insight into the upper stratum of the sand body. It became evident that the top of the *gezira* is highly disturbed by bioturbation and therefore no sedimentary structures are visible. However, it was found that below the sand surface the soil profile of a cambisol type had developed before the place was occupied by man. Formation of this paleosol presumes adequate climatic conditions with sufficient rainfall and it indicates that the mound was covered by more or less dense vegetation.

A lot of drillings gave evidence that the *gezirasand* at and around Tell el-Fara'in as well as adjacent fine grained deposits (Fig. 2e) and the peat overlie a sediment sequence, which obviously differs in composition and color from the sediments above (Fig. 2a - f). The surface of this sequence was recorded at about –4 m a.m.s.l. The sediments mainly consist of stiff mottled clay, silt, fine grained micaceous sand or even medium to coarse sand. They are chiefly of light greenish-grey or light brown colour. These non-marine facies are complex not only in their vertical but also in their horizontal succession.

The characteristic stratigraphic unit is usually capped by a thin loamy and often highly calcareous layer. The nodular or poorly consolidated accumulations of $CaCO_3$ are typical for a calcic soil horizon which frequently develops near to the surface under semi-arid conditions due to precipitation of calcium carbonate by descending water. Two samples taken from this horizon at Buto and about 2 km southwest of Tell el-Fara'in yielded radiocarbon-ages of 13,000 ± 600 B.P. (HD 12511 - 11987) and 14,315 ± 285 B.P. (HD 12510 - 11973) (these dates were provided by the Institut für Umweltphysik, Universität Heidelberg, FRG. They are corrected to 85% of the recent C-14-activity). As C-14-dates of soil carbonates are rather uncertain because of possible contamination, these ages can only be regarded as an approximation for the development of the paleosol. Nevertheless the calcareous layer indicates that during the period of soil formation an extensive area must have been free from inundation caused by the annual Nile flood, before the overlying sediments were accumulated.

Drillings carried out about 4 km southwest of Buto led to the detection of a distinctive cultural layer (Fig. 2f) close to the villages of el-Qerdahi East and West (Wunderlich *et al.* 1989). It provided further valuable information not only on the sedimentological but also on the cultural history of the study area. Analysis of the cultural debris revealed that the typology of pottery and lithic material corresponds exclusively to that of the prehistoric Buto-Maadi culture (Wunderlich *et al.* 1989; Schmidt, this volume). The base of the characteristic layer was localized in depths of –0.8 to –1.9 m a.m.s.l. but occasionally sediments interspersed with cultural debris were recorded down to –2.4 m a.m.s.l. The maximum thickness of the horizon runs up to 1.5 m. The sharply confined layer is covered by very dark grey or brownish grey clay and silt and also at its base fine grained but light colored sediments were found. In some borings the latter are interrupted by a highly calcareous horizon at about –2.5 m a.m.s.l. The carbonates were radiocarbon dated to 7,360 ± 65 B.P. (HD 11561 - 11204). These dates were provided by the Institut für Umweltphysik, Universität Heidelberg, FRG. They are corrected to 85% of the recent C-14-activity. Below a depth of –3 to –3.5 m a.m.s.l. fine micaceous sand follows.

The level of the prehistoric horizon corresponds well with the findings at and close to Buto (von der Way 1985: 271; 1988). However, it is remarkable that at el-Qerdahi no Early Dynastic or later material was found. Furthermore it is an important fact that during the 4th millennium B.C. settlement was obviously not restricted to elevated *geziras*.

A great number of results from the fieldwork as well as the interpretation of maps, aerial photographs and satellite images allow us to model the Late Pleistocene and Holocene evolution of the area around Tell el-Fara'in. This model has also to consider the geology, palaeohydrology, palaeoclimatology and cultural history of the entire drainage basin of the Nile including the Delta itself, and the submarine Nile cone. The main features of the model are as follows.

Assuming that the two radiocarbon-ages of the calcic horizon at and close to Buto are correct, the sediments below this layer must have been deposited during the (Late?) Pleistocene. They are possibly identical with the "fine Nilotic sands" described by Butzer (1975: 1044) who correlates them with the Masmas and Gebel es-Silsila formation of Upper Egypt. During the major Wurm regression at about 18,000 B.P. these sediments were partly eroded. The vigorous incision concentrated on channels outside the working area. When sea level rose again, sediments were first accumulated in those deeply incised channels. Simultaneously, on the higher elevated areas a soil with a calcic horizon developed.

Later on, the landsurface was covered by the *gezirasand* but also by the peat to the north and the dark Nile mud further south. These different facies, however, are not contemporary. It can be supposed that the *gezirasand* was deposited first. The sand originated from an abandoned channel of a highly competent distributary, which had run to the west of Buto in a north-westward direction. During a mid-Holocene arid phase (Nicholson and Flohn 1980: 324) or even earlier the channel deposits were redeposited by wind, forming large dunes. Thus the *gezira* below the ruins of ancient Buto is not comparable with the *geziras* and "turtlebacks" of the eastern Delta. There, according to Butzer (1975) and others, the sand ridges are remnants of Pleistocene sand deposits, which were eroded during the last glacial maximum.

Reduced sedimentation as well as continuous rising of the sea level after the last Pleistocene regression and to some extent the downward trend of the Delta plain allowed for the southward advance of the lagoon- and marsh-belt close to the coast. Its southernmost position (Fig. 1) was reached shortly after 6,000 B.P. A decrease in sea-level rise, as supposed by many authors (Kidson 1986), enhanced by increasing accumulation of the fine grained Nile mud north of Tell el-Fara'in, caused a northward shift of the area of peat formation during the Neolithic wet phase. This was the period when a soil developed on top of the *gezira* and the sand was stabilized by more or less dense vegetation.

During the 4th millennium B.C. the increasing floodplain as well as the level of the annual Nile floods had not reached a level of –2.5 m a.m.s.l. Thus not only at Buto but also at el-Qerdahi and probably at different other places within the research area, Predynastic people found appropriate places for settlement. However, rising of the floodplain coupled with an increasing level of the Nile flood caused that the occupation of the site at el-Qerdahi ended prior to the Early Dynastic period. In contrast to this at Buto the high elevation of the *gezira* allowed for continuous settlement.

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Comments to the lithic industry of the Buto-Maadi culture in Lower Egypt

New investigation of the Predynastic cultures of Lower Egypt – for a long time only known from short preliminary reports of old excavations – now allow a better understanding of the period in this region. The excavations at Merimde-Benisalame (Eiwanger 1984; 1988) and Tell el-Fara'in (von der Way 1986; 1987; 1988; 1989), the historical Buto, as well as re-examination of old excavation finds from el-Omari (Debono and Mortensen 1990), Heliopolis (Debono and Mortensen 1988) and Maadi (Rizkana and Seeher 1984; 1985; 1987; 1988) have changed the situation. Today the prehistory of Lower Egypt is better known than that of Upper Egypt. In addition to pottery, normally used in "classical" comparative studies, now in Lower Egypt exists the possibility for comparisons in lithics. The investigations of Upper Egyptian lithic samples, especially the reassessment of old material are restricted by the absence of good stratigraphic sequences (McHugh 1982: 85; Holmes 1988)).

The continuing excavation at Tell el-Fara'in (Buto) present, after Merimde, a chronologically extended stratigraphic sequence of different cultural layers: starting with the period of Maadi (layer I) the stratigraphy at Buto continues into the Early Dynastic Period (layer V) without any visible hiatus (von der Way 1989). Now we are able to recognize that the Maadi culture is not a local phenomenon, but distributed over the whole Delta with some additional smaller sites south of Cairo (Habachi and Kaiser 1985; Kaiser 1985; Mortensen 1985; Junker 1912: 2). The stratigraphic sequence of Buto offers a better view into that culture. The new term Buto-Maadi culture considers the different geographic locations of both sites as well as the existence of layer II at Buto. This layer seems not to be represented at Maadi, an absence which can be explained by its more vulnerable geographic situation in the Cairo region, presumably in view of the expanding Nagada culture (Kaiser 1985).

As with pottery, the lithic material can be used to characterize the Buto-Maadi culture. The basic feature of the blade industry as a direct opposite to the

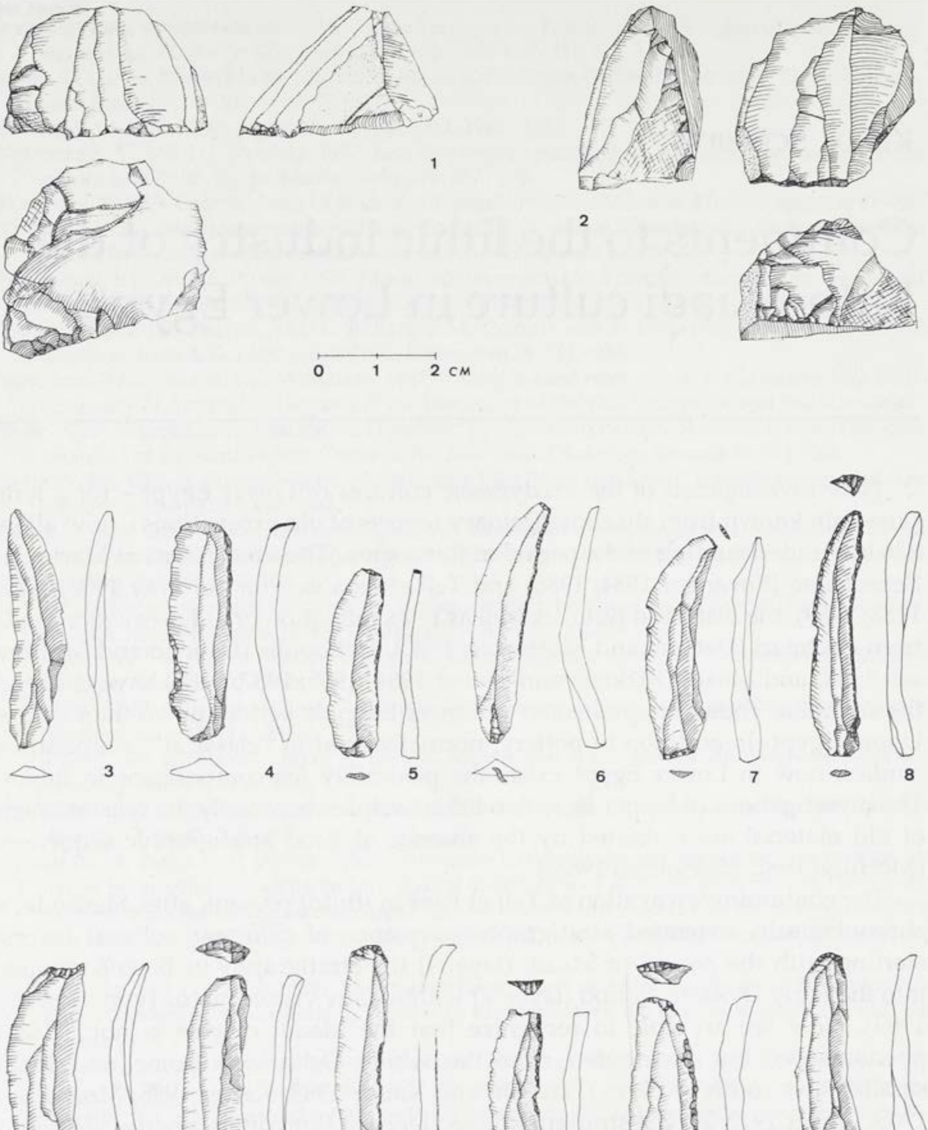

Fig. 1. Buto. Layer I/II. Lithic industry.

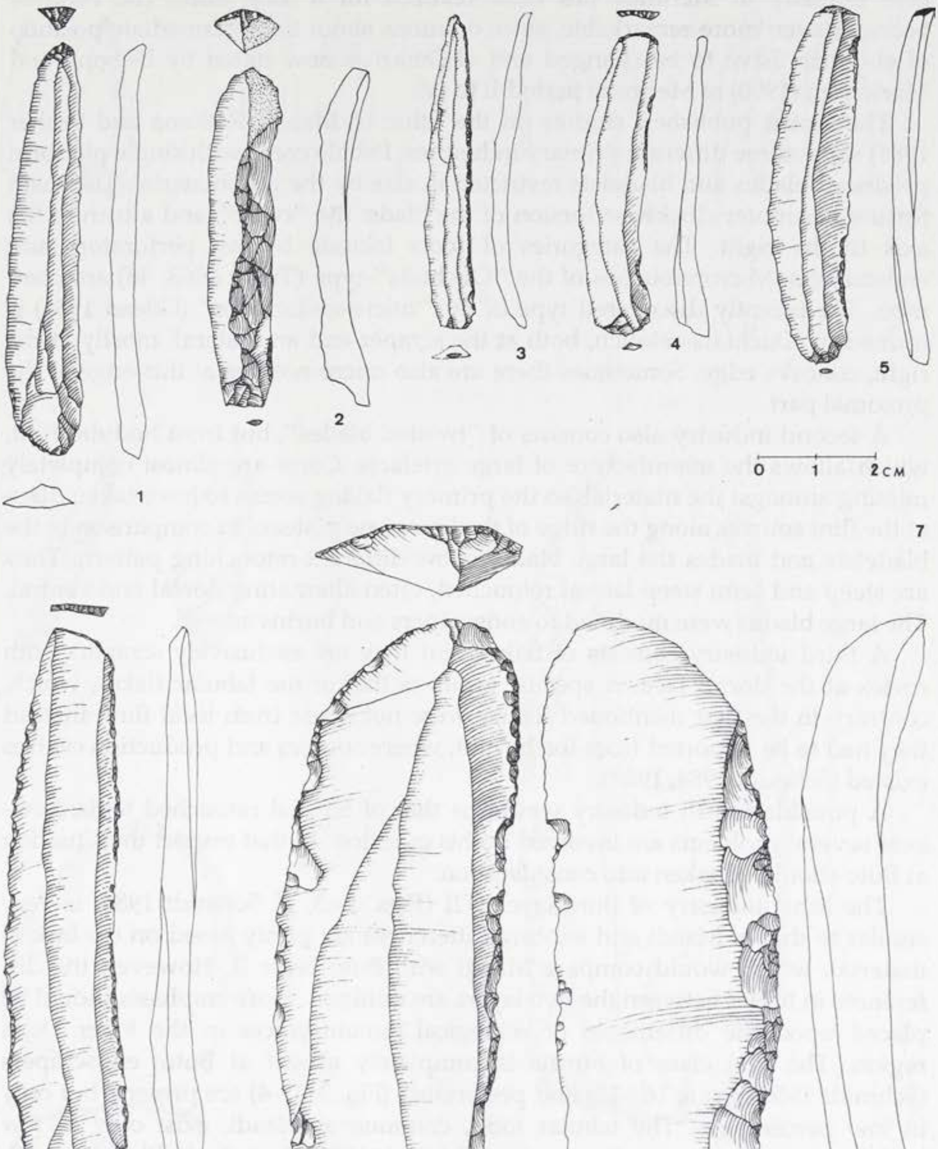

Fig. 2. Buto. Layer I/II. Lithic industry.

core industry at Merimde has been realized for a long time. The contrast becomes even more remarkable, since opinions about the intermediate position of el-Omari have to be changed and el-Omari is now dated by Debono and Mortensen (1990) to Merimde period II to IV.

The recent published studies on the lithic of Maadi (Rizkana and Seeher 1988) show three different primary industries. Pebble cores with single platform produced blades and bladelets restricted in size by the raw material. The main feature is counter clockwise torsion of the blade: the "twist", and a turn of the axis to the right. The categories of tools include burins, perforators and endscrapers. Microretouches of the "Ouchtata"-type (Tixier 1963: 48) are common. The recently discovered type of the "micro-endscraper" (Gilead 1984) is formed by Ouchtata-retouch, both at the scraper end and lateral, mostly at the right, concave edge. Sometimes there are also micro-notches at this edge at the proximal part.

A second industry also consists of "twisted blades", but from nodular flint, which allows the manufacture of large artefacts. Cores are almost completely missing amongst the material, so the primary flaking seems to have taken place at the flint sources along the ridge of the limestone plateau. In comparison to the bladelets and blades the large blades show different retouching pattern. They are steep and semi steep lateral retouched, often alternating dorsal and ventral. The large blades were modified to endscrapers and burins as well.

A third industry consists of flakes, but they are exclusively scrapers with cortex at the dorsal face. A specific group is that of the tabular flakes, which, contrary to the first mentioned flakes, were not made from local flint. Instead they had to be imported from the Levant, where sources and production centres existed (Schmidt 1984; 1988).

A possible fourth industry would be that of bifacial retouched tools, however several problems are involved in this question. In that respect the situation at Buto should be taken into consideration.

The lithic industry of Buto layer I/II (Figs. 1 - 3; *cf.* Schmidt 1986) is very similar to that of Maadi and existing differences are partly based on the lack of material, which would compare Maadi with Buto layer II. However, the differences in lithics between the two layers are minimal. More emphasis should be placed upon the differences of ecological circumstances in the inner Delta region. The tool class of burins is completely absent at Buto; endscrapers (Schmidt 1986: Fig. 6: 16 - 18) and perforators (Fig. 3: 1 - 4) are present, but only in low percentages. The tabular tools, common at Maadi, exist only as few broken pieces from secondary context (Schmidt 1988: Fig 9: 1 - 4). Bladelets with microretouch dominate (Fig. 1: 4 - 14) often in the form of microendscraper (esp. Fig. 1: 11). The bladelet tools must have been involved in some way with the exploitation of the aquatic resources, which one would expect as an important role in the economic life at Buto (Boessneck and von den Driesch 1988).

Further the complete lack of tools with sickle sheen at Buto has to be mentioned. This tool category is also rare at Maadi. Only four pieces of twisted blades show gloss. There are a few "Canaanean blades", imported from the

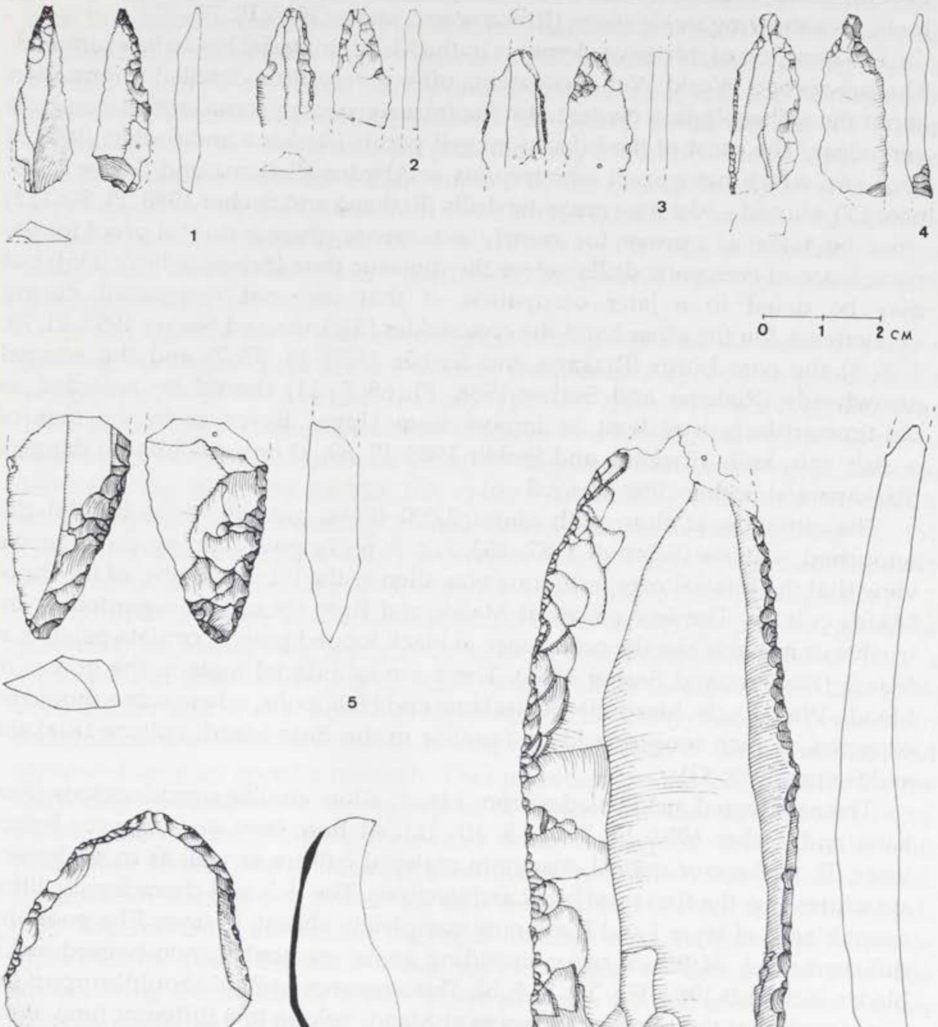

Fig. 3. Buto. Layer I/II. Lithic industry.

Levant, some segmented, non-twisted blades and finally some bifacial core tools, also showing sickle sheen (Rizkana and Seeher 1988: Pl. 73 - 75).

The question of intrusive elements in the Maadi material has to be examined. The pre-second World War excavations offer a very little detailed information about the archaeological context. But the intrusiveness of some artifact groups is very clear. The most of the bifacial tanged points (Rizkana and Seeher 1988: Pl 68: 1 - 6), which have exact counterparts at Abydos (Rizkana and Seeher 1988: note 67), should – like the crescentic drills (Rizkana and Seeher 1988: Pl. 80: 1, 2) – not be taken as a prove for mearly occurrence (there is no real proof for the occurrence of crescentic drills before the dynastic time [Schmidt 1985: 285]) but may be dated to a later occupation of that site, not recognized during excavations. On the other hand the core sickles (Rizkana and Seeher 1988: Pl. 73: 1 - 6, 8), the core burin (Rizkana and Seeher 1988: Pl. 73: 7) and the winged arrowheads (Rizkana and Seeher 1988: Pl. 68: 7 - 11) should be regarded as old-time artifacts or at least, as import from Upper Egypt, as in the case of a fish tail knife (Rizkana and Seeher 1988: Pl. 69: 1) or some bifacial daggers (Rizkana and Seeher 1988: Pl. 69: 2 - 6).

The situation at Buto with about 2,000 flints, but only four bifacial flat retouched artifacts (Schmidt 1987: 253, Fig. 5: 6 - 7), give a strong prove to the view that the bifacial core technique was alien to the lithic industry of the Buto-Maadi culture. The few pieces at Maadi and Buto should be regarded as intrusive or imports like the occurrence of black topped pottery or slate palettes at Maadi (Rizkana and Seeher 1984). There are no bifacial tools in the graves of Maadi, Wadi Digla, Merimde-Benisalame and Heliopolis, where some should be expected, if such tools would be familiar in the Buto-Maadi culture (Rizkana and Seeher 1988: 32).

The segmented sickle blades from Maadi allow similar considerations (Rizkana and Seeher 1988: Pl. 74: 1 - 8, 10 - 11). At Buto they do not occur before layer III, a phase of radical change in material culture as well as in settlement structures (*e.g.* the first mud brick architecture). The rich and characteristic lithic assemblages of layer I and II are now completely absent. In layer III a poor and different stock of lithics occur including some segmented, non-twisted sickle blades (Schmidt 1989: Fig. 14: 1 - 5, 8). This sequence at Buto should support the suggestion that the segmented pieces at Maadi belong to a different time of occupation, or, at least, are of foreign production. Similar sickle blades occur both at el-Omari (Debono and Mortensen 1990: Pl. 18: 7 - 10) as in Upper Egypt (*e.g.* Hemmamiya [Brunton and Caton-Thompson 1928: Pl. 78: 22 - 27]); the chronological and cultural evidence of that tool class is until now unsatisfactorily proved. Only four twisted blades with gloss can be regarded as indigenous sickle elements at Maadi. Accepting that suggestions, we have the same situation at Maadi with the absence of sickle elements in the lithic industry. This can be explained by special harvesting techniques. But the cutting of reed, which also produced strong gloss (Anderson-Gerfaud 1982), should be expected in sites like Maadi and Buto, which are placed nearby the river; we know nothing of the gloss, which would be produced by cutting papyrus.

As curious as the lack of sickle elements is a lack of stone axes. The explanation that metallic tools had replaced them (Rizkana and Seeher 1988: 74), is acceptable, but the opinion that in the case of Buto heavy wood working had not existed, is also possible. The use of bundles of reed or papyrus for the major constructing elements of the huts, without any wood, could explain the typical postholes with clay reinforcement (von der Way 1986:198). The collapse of bent and tied bundles could have been stopped by the clay circles; their construction is not explained by the intersection of wooden beams. On the other hand many wooden posts had been observed at Maadi. One of it "was so regularly and so sharply cut that the implement used could only have been a good metal axe" (Menghin and Amer 1932: 48).

A last class of tools, that of projectile points, remains. At Buto it is again missing. At Maadi there are the already mentioned Abydos-like points, some winged points of the Merimde-Fayum type and three trapezes (von der Way 1986: Pl. 68: 13 - 15). One arrowhead (Rizkana and Seeher 1988: Pl. 68: 9) seems to be a part of a small, developed group of Nagada I/II in Upper Egypt (Needler 1984: 115, Fig. 20: 20; Pl. 38: 153; 262, Pl 38: 154; Garstang 1902: 36, Pl. 3: middle left and right). Trapezes exist *e.g.* in Uruk-Warka (Eichmann 1986: 111, Fig. 16 - 18). They all should be regarded as intrusive or foreign. The Buto-Maadi industry was without any projectile points, which can be explained morphologically.

The lithic industry of the Buto-Maadi culture, as well as pottery, gives the possibility of identifying predynastic sites. A few kilometers west of Buto a second site of that culture was detected first by lithics (Schmidt 1985: 285; 1986: 204); a third site is now added (Wunderlich *et al.* 1989). A dense network of predynastic sites becomes visible, buried by thick alluvial sedimentation and recovered only by specific research. That investigation has been started by the University of Amsterdam in the region of Faqus (van den Brink 1987; 1988). Beside many younger sites there had been discovered several tells with predynastic layers. Two of them are investigated by test trenches (el Tell el-Iswid, Tell Ibrahim Awad). The pottery as well as the lithics are of clear Buto-Maadi type. Together with the sites in the region of Cairo and the graves at Merimde (Afifi Badawi 1980) the Buto-Maadi culture could be distributed over the whole Delta; the southern border is, at present, the entrance of the Fayum depression (Fig. 4).

In the Fayum region itself there is a recently described second Neolithic culture, the "Moerien" (Ginter and Kozłowski 1983; 1986). In comparison to the older Fayum A or "Fayumien" there are great differences in the material culture as well as in the way of life with a preference for aquatic resources (von den Driesch 1986). The pottery and the lithics are closely related to the Buto-Maadi types and, together with the existence of the sites nearby the entrance of the Fayum and long known "predynastic" site south of Qasr Qarun (Caton-Thompson and Gardner 1934: 69) and the preference of aquatic resources, we should add the "Moerien" to the Buto-Maadi culture.

The origin of that culture, in our context seen from the view of the lithic industry, is not yet clear. The elimination of el Omari as a connection with

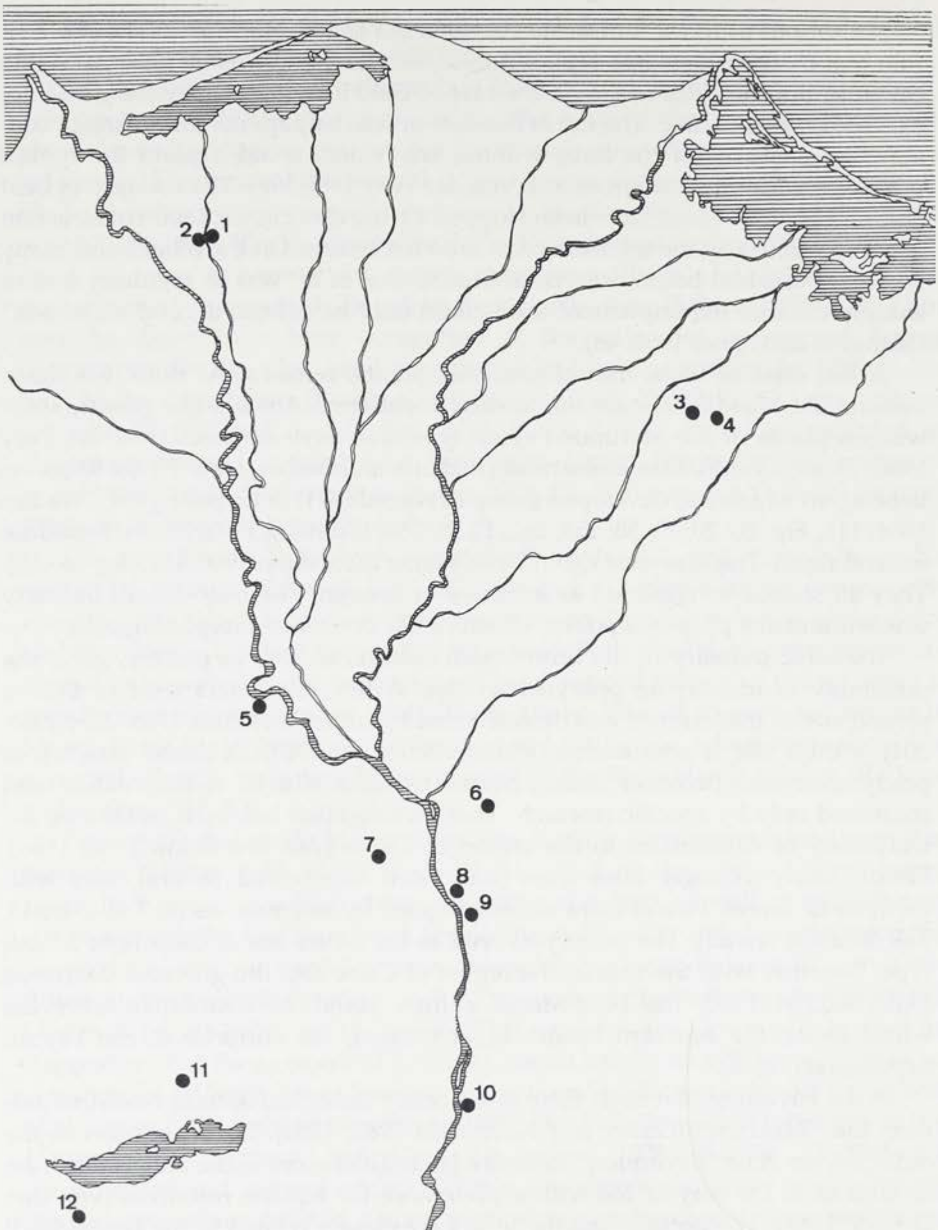

Fig. 4. Sites of the Buto-Maadi culture;
1: Buto; 2: El Qerdawi/Saradusi; 3: Tell el-Iswid; 4: Tell Ibrahim Awad; 5: Merimde-Benisalame; 6: Heliopolis; 7: Giza; 8: Maadi, Wadi Digla; 9: Tura, railway station; 10: Es-Saff; 11: Qasr es-Sagha ("Moerien"); 12: "Predynastic site" south of Qasr Qarun.

Merimde has emphasized this discontinuity and until today the inner Delta has shown no neolithic sites which could be predecessors. On the other hand the state of research of the Upper Egyptian lithic industries doesn't allow an exact determination. The twisted blade tools of Nagada II (Baumgartel 1960: 40) and especially the "Mostagedda"-industry, recently described by Holmes (1988), seems to have strong relations, but the interaction between Lower and Upper Egypt is one of the main questions in Early Egyptian history and any attempt to build up relations should have been done with completely proved data. The "bifacial" industries of Merimde-Fayum and Badari, the denticulated sickle blades and the blade knifes of el-Omari and southern Egypt, the twisted blades in Lower and Upper Egypt are elements, which contrast in some aspects the stressed differencies of northern and southern Egyptian cultures.

Connection to the Palestinian Ghassul-Beersheba culture (Perrot 1955: 183), which produced the main part of the imported pottery at Maadi, are better to determine: the micro-endscraper is, as well as in Buto-Maadi culture, a recently discovered "Leitfossil" in the Levantine Chalcolithic (Gilead 1984; Dollfus *et al.* 1988: 593). In that region we could possibly find the "roots" of this lithic industry in the Neolithic period, especially in the Yarmukian (Stekelis 1972). Here both bifacial core tools and bladelets occur; but again there is an absence of well stratified samples.

Conspicuous similarities with the Buto-Maadi lithic exist also in some Levantine and North African Upper Palaeolithic industries (especially the "Ahmarian" [Baruch and Bar Yosef 1986]), and the "Iberomaurusian" (Tixier 1963: 115; Phillips 1975), but we have yet no proof for any continuity of those lithic traditions into the neolithic. We are only able to determine the lithic tradition of the Buto-Maadi culture as a Lower Egyptian phenomenon with strong Levantine relations, a culture which disappears with the later predynastic phase

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Settlement patterns in the Northeastern Nile Delta during the fourth–second millennia B.C.

Introduction

Over the past four years (1984 - 1987) an archaeological and palaeogeographical survey has been conducted in the Sharqiya governate, northeastern Nile Delta, in an area of 30 × 30 km around the towns of Abu Kebir, Faqus, Tell Rak and el-Huseiniya (Fig. 1).

In this project members of the Department of Egyptology and of the Department of Physical Geography and Soil Science, both of the Amsterdam University, cooperated in what has become known as the Amsterdam University Survey Expedition.

The Sharqiya governate is the third most densely populated in Egypt. As a response to the demands of a rapidly increasing rural population, land use has been intensified and there has been a sharp increase in land reclamation programs. The resultant negative effect on archaeological remains has necessitated the current survey.

The survey, divided over 4 seasons, two to three month each, was part of the research program titled "Regional diachronic investigations into settlement patterns in the northeastern Nile Delta" the scope and aims of which have been described *in extenso* in van den Brink (1987a).

A recent historical-geographical study of the eastern Delta written from an archaeological perspective (Bietak 1975), including a theoretical reconstruction of former rivers by interpretation of modern contour maps, provided an initial framework for the data collected during the survey.

The main aim of this project included the determination of potential settlement patterns in a single region and an explanation of their development through time. Special attention was paid to the environment of individual sites, the relation between the original landscape and the spatial distribution of ar-

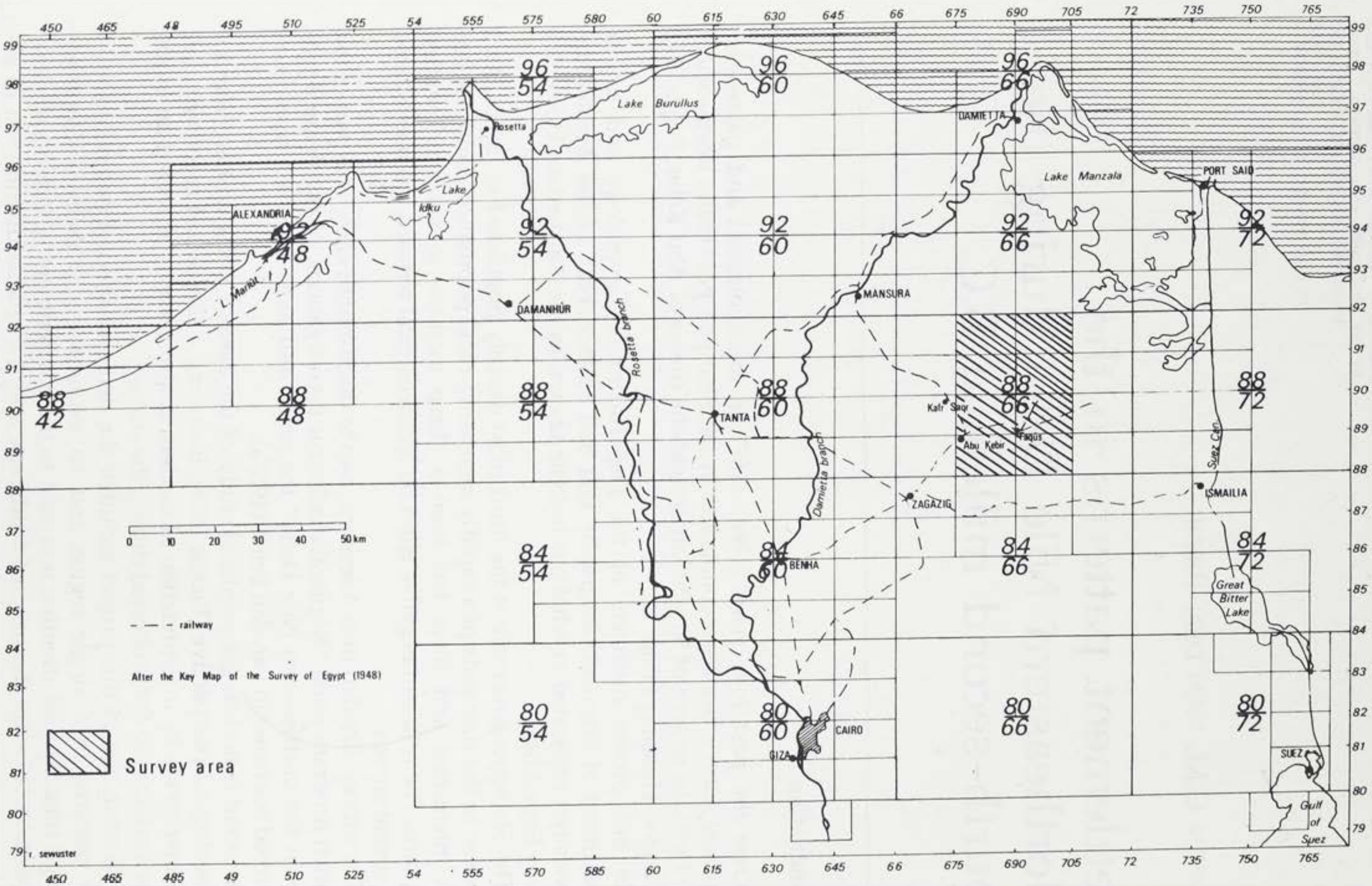


Fig. 1. Map of the Nile Delta, showing the survey area (after the Key Map of the Survey of Egypt, 1948).

chaeological remains. An attempt was made to explain the distribution patterns of these remains at least partially by their position in the original landscape. A brief exposition of the palaeo-environment of this part of the Delta is inevitable, before we can focus on the results of the archaeological survey proper.

Geological history of the Eastern Nile Delta

"In general the natural environment of a delta, as of the Nile Delta before the construction of the Aswan dams, is subjected to continuous and relatively quick modifications. Successive cycles of deposition, erosion and redeposition produce highly complex patterns of sediments. The cyclicity of processes is governed essentially by regional factors such as variable river discharge, sealevel fluctuations and climatic oscillations. This complexity inevitable effects the palaeogeographical studies" (de Wit and van Stralen 1988a: 135).

Although the Delta has a long and respectable geological record, we confine ourselves here to that part of it which has immediate relevance to the spatial distribution of human relics, *viz.* habitation sites. For the successive rivers and types of sediments deposited in the Delta since Late Miocene times (5,400,000 B.P., *cf.* Table 1).

Table 1

Successive rivers and types of sediment deposited in the Nile Delta.

Period Age in thousand years B.P.	River	Lithology	Occurrence of sediments in the Nile Delta
0 Holocene 10	δ Neonile		
	γ/δ recession γ Neonile Neonile β/γ recession β Neonile α/β recession	clay, silt and fine sand; similar to modern Nile sediments	max. 40 m thickness
	α Neonile	silt and fine sand	
130 Pleistocene			
	Prenile/Neonile	gravel	absent in Delta
200	Prenile	cross-bedded sands and gravels	max. 1000 m thickness
650	Protonile		300 m thickness
		gravel, coarse sand, loam	
	Paleonile/Protonile		absent in Delta
1850		conglomerates	
	Paleonile	marine silt and clay	1000 m thickness
Pliocene 5400	Eonile/Paleonile	sand and shale	?
Miocene	Eonile	coarse sand and pebbles	bottom of Eonile can at 2500 m below the surface

After Said 1981.

Fig. 2. Western part of Geziret Sineita (partly quarried away). To the right in the background the cemetery of the contemporary village of Sineita.

As a convenient point of departure we consider the top of various layers of coarse, rounded quartz sands of Mid-Pleistocene age (700,000 - 200,000 B.P.), deposited in the Delta by the Prenile. From the heavy mineral composition, Kholief *et al.* (1969) concluded that these sand layers (reaching a maximum thickness of 1000 m) originated in the Abbysinian highlands.

Especially in the eastern Delta relics of these sediments still rise above the alluvium today, appearing as seemingly isolated sandy hills (arabic: *gezira)* in the midst of the green, arable land (Fig. 2).

Both in the past and present these large expanses of sand islands have invited extensive settlement of a permanent nature beyond the reach of the annual Nile floods. As was demonstrated during the survey, the majority of archaeological sites recorded (see further below) was located at the edges of the *geziras* in order to be as close as possible to the arable land on the alluvium and to the river, and just high enough on the *gezira* to stay out of reach of the annual inundations (*viz.* 1.5 m - 2 m above the surrounding floodplain). The parts higher up the *gezira,* and therefore at a greater distance of the alluvium, were most ideal for the location of cemeteries (van den Brink 1987b: 22, Figs. 7 - 8). The embankments of the various water courses flowing in-between these sand islands accommodated permanent settlement on a smaller scale.

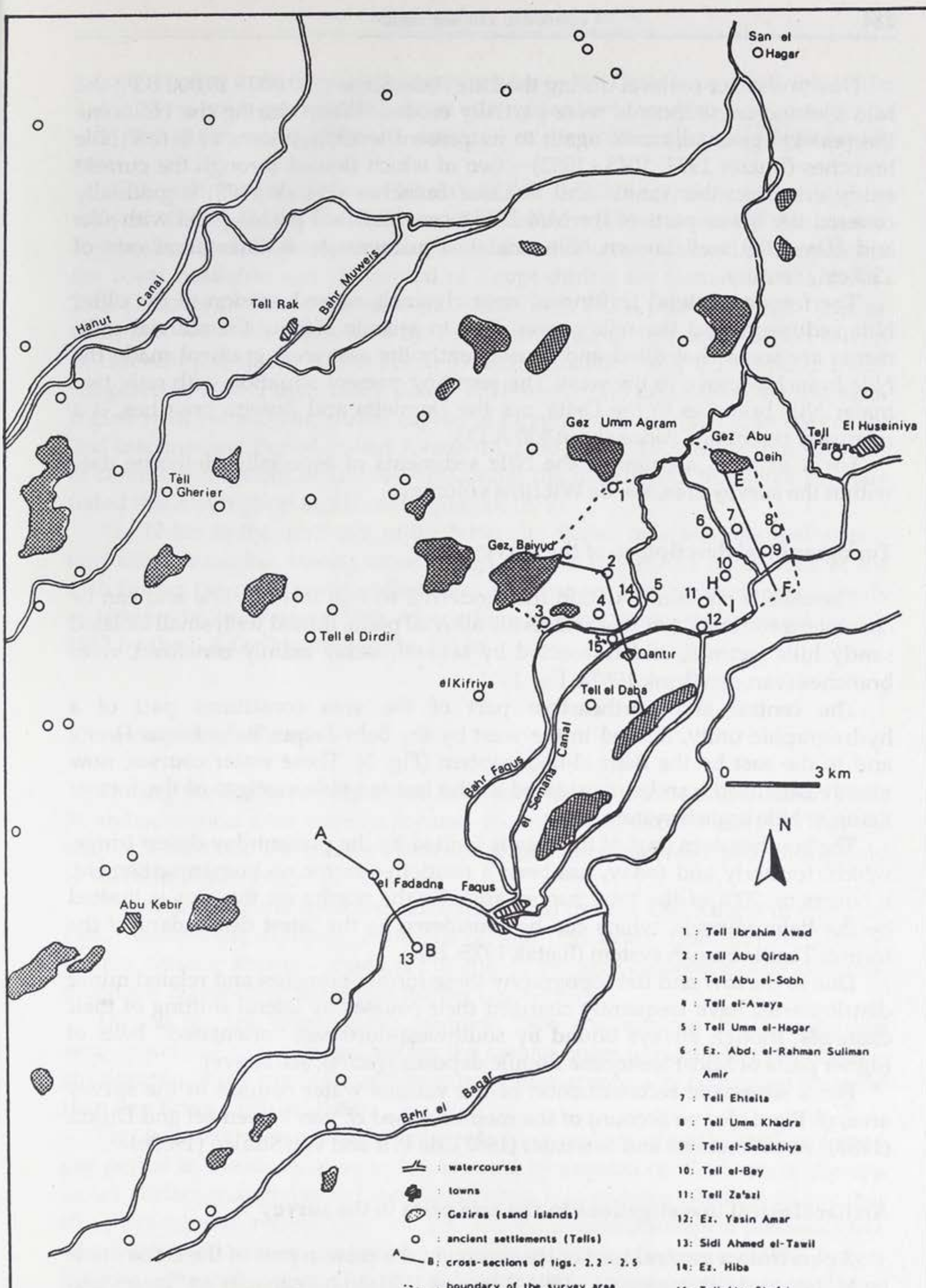


Fig. 3. Schematic map of the survey area, showing *i.a.* the position of *geziras* and a number of the recorded archaeological sites (after van Wesemael and Dirksz 1986: Fig. 2, 1).

Due to a lower sealevel during the Late Pleistocene (100,000 - 10,000 B.P.) the Mid-Pleistocene sediments were partially eroded. When during the Holocene the sealevel gradually rose again to its present level, a system of 5 to 7 Nile branches (Butzer 1974: 1043 - 1052) – two of which flowed through the current study area, *viz.* the Tanitic and Pelusiac branches (Bietak 1975) – gradually covered the lower parts of the Mid-Pleistocene deflated palaeo-relief with silts and clays (the well known Nile muds) at an average sedimentation rate of 12.5 cm/century.

The frequent lateral shifting of river channels caused erosion of the older Nile sediments and the relic *geziras*. Due to seismic activity the alluvial sediments are somewhat tilted and consequently the east-west gradient made the Nile branches move to the west. The resulting present situation with only two major Nile branches in the Delta, *viz.* the Damietta and Rosetta branches, is a relatively recent one (since about 950 A.D.).

For a detailed account of the Nile sediments of especially Holocene date within the survey area, see de Wit (this volume).

Topographical description of the survey area

The area is contained within the modern 2 to 7 m contour line and can be characterized today as a low and fertile alluvial plain, dotted with small isolated sandy hills *(geziras)*, and transected by several, today mainly canalized, river branches (van den Brink 1987a: Fig. 1).

The central and northeastern part of the area constitutes part of a hydrographic unity, limited in the west by the Bahr Faqus/Bahr Faqus Drain, and in the east by the Bahr el-Baqr system (Fig. 3). These water courses, now mainly canalized, can be considered as the last tangible vestiges of the former Pelusiac Nile branch system.

The southeastern part of the area is limited by the present day desert fringe, which, formerly and today, has been a restrictive factor on human settlement. It covers *ca.* 20% of the total survey area. To the northwest the area is limited by the Bahr Muweis, which can be considered as the latest descendant of the former Tanitic branch system (Bietak 1975: 28).

Due to the low and flat topography these former branches and related minor distributaries have frequently changed their courses by lateral shifting of their channels, though always bound by southwest-northeast "orientated" belts of higher parts of Mid-Pleistocene Prenile deposits *(geziras*, see above).

For a schematic reconstruction of the various water courses in the survey area, *cf.* Fig. 6; for an account of the methods used *cf.* van Wesemael and Dirksz (1986), van Wesemael and Sewuster (1987), de Wit and van Stralen (1988b).

Archaeological investigations in the area prior to the survey

Apart from a general tour of inspection in the eastern part of the Delta made by M. Foucard between 1893 - 1894 (Foucard 1901) in his capacity as "inspecteur du service des antiquités" and beside a number of mainly limited soundings at an odd 15 sites made by E.A.O. inspectors since the 1960s (van den Brink 1987a: Table 1), research prior to the current survey has been concentrated on two sites – or perhaps more correctly site clusters – in the northeastern part of the study area.

Although the area between Khata'na/Tell el-Dab'a-Qantir was examined as early as 1885 by E. Naville (1887) and W.F.L. Petrie (1888), it was M. Hamza who first realized, while excavating in Qantir, that this area contained the remains of the royal residence and the capital of Egypt during the Ramesside era (19th - 20th Dynasty), called Piramesse (*ca.* 1300 - 1080 B.C.), (Hamza 1930). This assumption was later confirmed by the excavations in this area carried out by L. Habachi (1954), Sh. Adam (1955; 1958), M. Bietak (1975; 1979) and E. Pusch (Eggebrecht 1981; Pusch 1987). It was L. Habachi who first connected this same region with yet another, earlier capital of Egypt, *viz.* during the later part of the 2nd Intermediate Period, called Avaris *(ca.* 1650 - 1540 B.C.). More than 20 years of careful excavations at Tell el-Dab'a under the direction of M. Bietak substantiated this assumption significantly (Bietak 1979).

Ca. 12 km to the northeast of the latter site cluster is located another important site, containing among other things the remains of the metropolis of the 19th Lower Egyptian nome, called Imet. Excavations here were started as early as 1886 by W.F.L. Petrie (1888). After a long interval work was resumed here in 1962 by the E.A.O. (Mustafa 1988a; 1988b).

The archaeological survey

During the first two seasons of fieldwork (autumn 1984 and autumn 1985) 92 archaeological sites were (re)located, recorded and surface sampled. For the methods used and the range of practical problems confronted with in the field *cf.* van den Brink (1987a: 10 - 11).

The analysis of the collected surface material (for the Old Kingdom and Late Predynastic–Early Dynastic materials *cf.* van den Brink 1988: 66 - 76; 1989) – mainly ceramic sherds – made it possible to prepare chronologically differentiated site distribution maps (see further below).

During the last two seasons (autumn 1986 and autumn 1987) soundings were made at 7 sites selected within the area in order to establish their chronostratigraphy more precisely and to extract stratigraphically controlled material (van den Brink 1988: 76; 1989).

Fig. 4 illustrates in a simple histogram the numbers of settlements involved per period in the study area, as far as could be attested on the basis of the collected surface material of the individual sites. It is perhaps needless to say that this picture only reflects part of the reality; geomorphological processes like alluviation and erosion as well as a number of other, uncontrollable, factors like the present-day intensification of land use, the illegal activities of *sebakheen, etc.*, all affect site-discovery in a negative way.

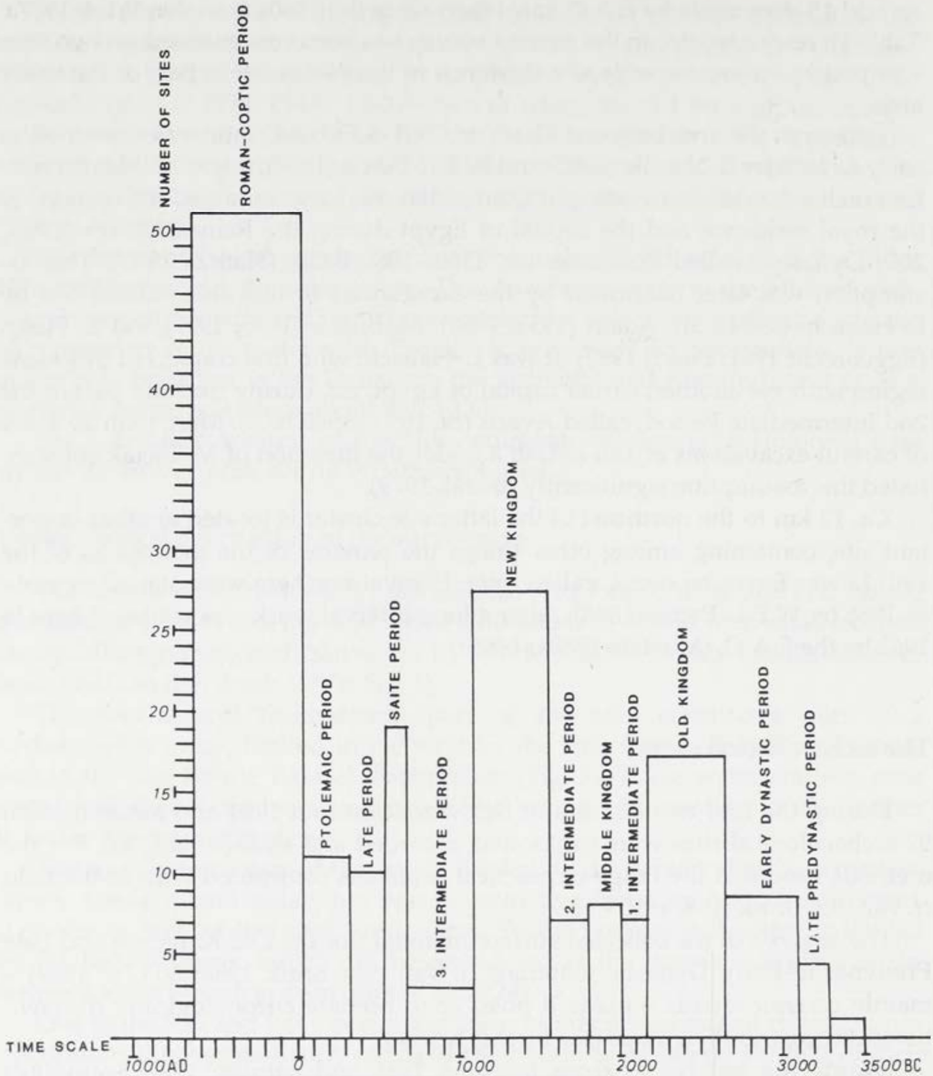


Fig. 4. Histogram showing the numbers of sites per period within the survey area.

Whatever the degree of distortion may be – which is difficult to estimate and/or to correct for – some significant information nonetheless emerges, for instance, an observed sharp decrease in the number of settlements after the collapse of the New Kingdom (*ca.* 1,080 B.C.).

There are 27 New Kingdom sites with attestable material while the succeeding period (the Third Intermediate Period) only has a mere three. Although future research may redress the balance by making material of the latter as recognizable as that of the former, the downward trend seems real enough.

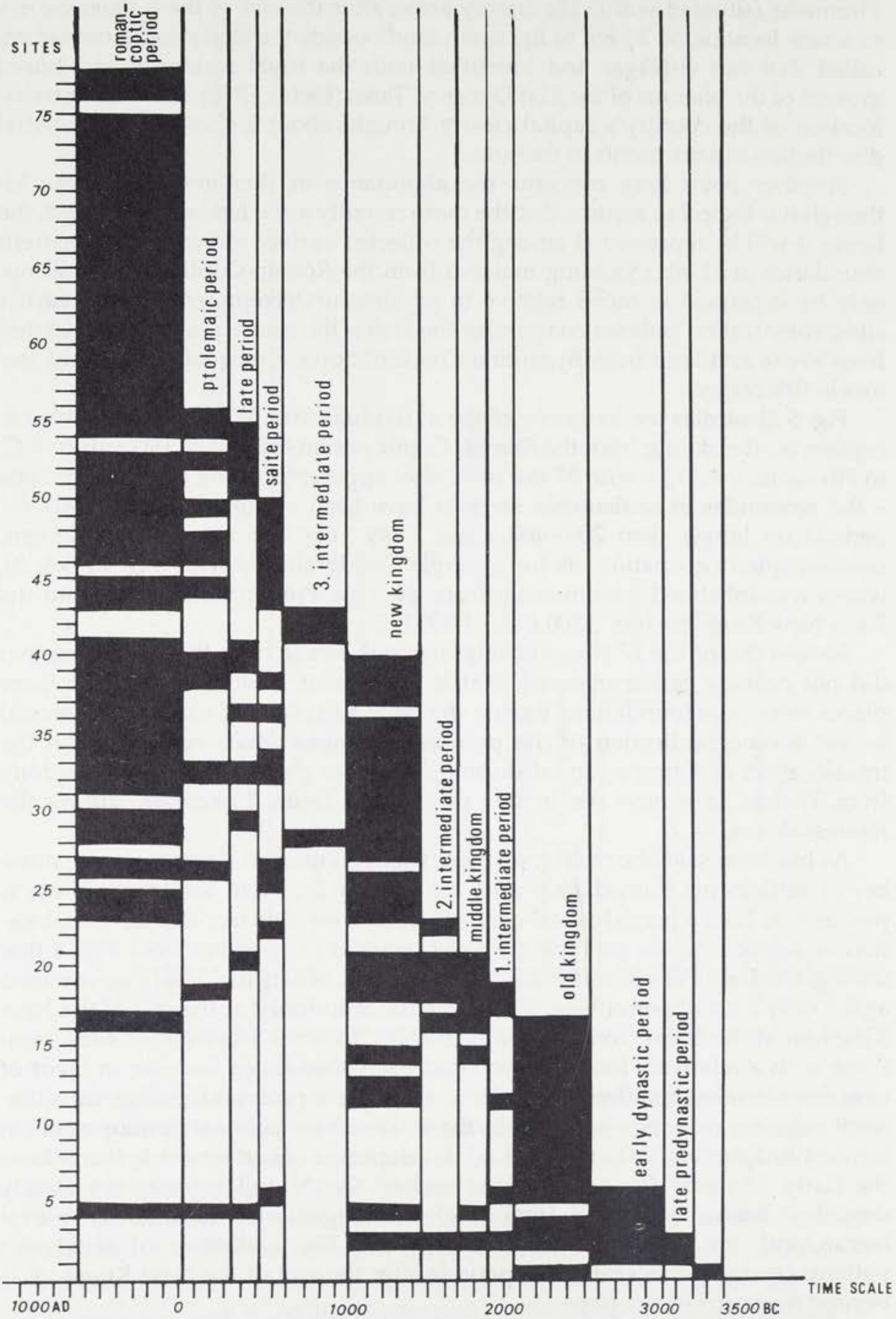
A possible explanation could be the contemporary shift of Egypt's capital, Piramesse (situated within the survey area), after the end of the Ramesside era to a new location *ca.* 20 km to the north (and outside the study area), nowadays called Tell San el-Hagar and identified with the royal residence and burial ground of the pharaos of the 21st Dynasty, Tanis (Bietak 1975); the shift or translocation of the country's capital clearly brought about a change in the spatial distribution of settlements in this area.

Another point here concerns the abundance of Roman-Coptic sites. Although it is logical to assume that the more recently a site has been occupied, the better it will be represented among the collected surface material, the apparent abundance of 51 sites yielding material from the Roman-Coptic period can not only be explained in terms relative to possible underrepresentation of earlier sites; colonization policies concerning the Delta, the granary of Egypt, dictated from Rome and later from Byzantine Constantinople are equally dominant factors in this respect.

Fig. 5 illustrates the longevity of the individual sites. With the noticeable exception of sites dating from the Roman-Coptic period *(ca.* end of 1st century B.C. to 7th century A.D.) – with 37 out of 52 sites apparently being new foundations – the remainder of settlements seem to have been occupied continuously for periods no longer than 200 - 400 years. Only very few sites show a longer, uninterrupted occupation, as for example Tell Ibrahim Awad (Fig. 5, No. 3), which was inhabited continuously from the Late Predynastic Period until the Early New Kingdom (*viz.* 3,300 B.C. - 1,300 B.C.).

Sixteen out of the 27 sites yielding material dating from the New Kingdom did not provide earlier material, that is to say that it would seem that these places were new foundations during the New Kingdom. If correct, this would be yet another indication of the profound changes which resulted from the translocation of Egypt's capital during the earlier part of the New Kingdom, from Thebes, to a new site in this part of the Delta, Piramesse, during the Ramesside era.

As has been said above (Fig. 4), there was a significant decrease in the number of settlements immediately after the end of the New Kingdom. There is probably at least a partial causal connection between this fact and the translocation of Egypt's capital to Tanis (San el-Hagar); it is apparent from Fig. 4 that during the Late Period and subsequent periods, when the area was resettled again, only a small percentage of settlements, abandoned at the end of the New Kingdom at the latest, were reoccupied again. In other words most sites, even those with a relatively long life span had been abandoned for ever in favor of new foundations at different locations, showing a profound change in settlement behavior on a regional scale. In the wake of new political developments in the first millennium B.C., the gradual development of settlement systems from the Early Dynastic Period until the end of the New Kingdom, tentatively described below as starting from a relatively egalitarian to a finally 6-level hierarchical one, had come to an abrupt end. The evaluation of settlement patterns/systems concerning the periods after the end of the New Kingdom is beyond the scope of this paper.


SITES
roman-coptic period
ptolemaic period
late period
saite period
3. intermediate period
new kingdom
2. intermediate period
middle kingdom
1. intermediate period
old kingdom
early dynastic period
late predynastic period
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
1000 AD
0
1000
2000
3000
3500 BC
TIME SCALE

Settlement patterns and settlement systems

Having prepared chronologically differentiated settlement maps, and subscribing to the fact that "human behavior has spatial corollaries", and that "some of the corollaries can be expressed as point maps" (Pinder *et al.* 1979: 430), *i.e.* that point maps (here representing settlement locations) can be considered to a certain extent as spatial expressions of human behavior, we can start to look for meaningful patterns – if any – in the data obtained through the survey. We will try to identify the "empirical patterns" (expression by Flannery 1976: 162) drawn from our data, adequately characterizing the regularities perceived, in order to reveal glimpses of any underlying system which may have generated these patterns.

The developments of formal methods of spatial analysis in archaeology, especially during the last two decades, have provided us with a variety of statis-

Fig. 5. Histogram showing the longevity of the individual sites within the survey area. Legenda of the numbers 1 - 78.

1. Tell Gez. el-Masha'la
2. el-Tell el-Iswid (south)
3. Tell Ibrahim Awad
4. Tell Abu Dawud
5. Tell Fara'un
6. Tell Gherier
7. Tell el-Khasna
8. Tilul Moh. Abu Hasan
9. Tell el-Dirdir
10. Tell Ginidba
11. Tell el-Marra
12. Tell el-Akhdar
13. Tell el-Abbasiya
14. Tell Umm 'Agram
15. el-Tell el-Iswid (north)
16. Tell Umm el-Zaiyat
17. Tell Gez. el-Faras
18. Tell el-Hagge
19. Tell el-Dab'a
20. 'Arab el-Sheikh Mubarak
21. Tell Fauziya
22. Ezbet Hilmi (Tell Qirqafa)
23. Tell Farasha (Tell Maghud)
24. Tell Samuni
25. Ezbet el-Shuhada (Ma'askar)
26. Sidi Ahmed el-Tawil
27. Ezbet Razaiqa
28. el-Salatna (Tell Abu Samandi)
29. Gez. Sultan Hasan
30. Ezbet Gayel
31. Qantir
32. el-Tell el-Abyad
33. el-Tell el-Ahmar
34. Tell Za'azi
35. Ezbet Abd el-Rahman Suliman Amir
36. Tell Abu Suliman
37. Tell Gimeima
38. el-Kifriya
39. Tell el-'Awaya
40. Aulad Musa
41. Kom Sultan Khadr
42. el-Alaqma
43. el-Fadadna (Tell Mindar)
44. Tell Tukh el-Qaramus
45. Tell el-Riyad
46. Ezbet Tell Abu el-Rus
47. Tell el-Bey
48. Gez. Abu Mitawi
49. Tell Abu Husa
50. Tell Umm el-Hagar
51. Tell el-Shaqf
52. Ezbet Salih Rif 'at
53. Tell Abu Kharufa
54. Urban Gez. Abu Imran
55. Gez. el-Nisf
56. Faqus
57. Tell Muftah
58. Tell Mirdas
59. Gez. el-Tawila
60. el-Dimeiyin
61. Tell Gindiya
62. Tell el-Hilayla
63. Tell el-Barriya
64. Ezbet Rushdi Kebira (Tell Abu el-Filus)
65. Tell Abu el-Sobh (Tell Safra)
66. Tell Abu el-Shaf'ei
67. Ezbet Yasin 'Amar
68. Ezbet Heiba
69. Gez. Sineita
70. Tell Abu Qirdan
71. Tell Habrash
72. Tell el-Batal
73. Tell Atrash
74. Tell Ehteita
75. Tell Abu Qeih
76. Tell el-Shuwan
77. Tell el-Sebakhiya
78. Sintiris

For the exact location of these sites *cf.* van den Brink 1987a: Fig. 1 and Table 1.

tical and analytical methods to approach questions in this field. They include techniques such as nearest-neighbor analysis, various forms of quadrat analysis and – concerning more in particular the interpretation of *e.g.* stratified society settlement patterns – the construction of central-place models and the application of rank-size (normally population size) analysis.

Appropriate application of any of these procedures to the data collected, with the exception perhaps of nearest-neighbor analysis, is hampered by the fact that archaeological survey data generally "rarely include more variables per period than site location and the site size" (Paynter 1983: 238). In our case, moreover, for reasons explained already elsewhere (van den Brink 1987a: 10, 13) even the data concerning site size have real significance only in a very few cases. It is therefore not possible to establish relationships between site size and actual settlement size, or between settlement size and population size, information essential for application of the rank-size rule for instance, an analytic procedure analyzing the entire distribution of settlement sizes without requiring the isolation of individual hierarchical levels.

Our approach, therefore, towards identification and understanding of patterns in the spatial distribution of the recorded sites, has been to give in the first place an objective description of the point maps by using nearest-neighbor analysis together with a general characterization of regularities observed, and in the second place to try to offer some tentative explanations of these patterns by using contextual or circumstantial information.

Discussion of the spatial distribution of settlement sites from the Early Dynastic Period through the Old Kingdom (*ca.* 3,150 - 2,185 B.C.). An attempt to describe and to comment on the "empirical" patterns

Introduction

As a first step to describe the individual point maps or site distribution maps, the nearest-neighbor statistic (R_n) was calculated for each of the distinguished periods. This analysis (developed by plant ecologists) concerns itself only with location points (here human settlements) in space and it does not use any further contextual information. The R_n values thus obtained are a description of spatial patterns by distance to the first nearest-neighbor, expressable in general terms by four basic point patterns employed by archaeologists as goal models, *viz.* linear, random, clustered, dispersed.

Being aware of the fact that "underestimation is an inherent flaw of the technique", particularly "...when point populations are small" (Pinder *et al.* 1979: 430 - 431), due to what has been labelled by Johnson (1981: 167) as the "boundary effect", *i.e.* the problem that boundaries of a study area are not likely to coincide with the boundaries of a complete settlement system, and *ergo* it is unlikely to recover the entire pattern of a past system, thus causing distortions, the present writer does not see any other appropriate method, given the limitations of the data variables obtained during the survey. Finally, moreover, "if we are interested in comparing (emphasis added) two or more point patterns, such as settlements in a series of phases, built-in clustering (due to "boundary effects", the author) may not matter greatly. This is because holding the area constant when making the comparisons places all analyses on the same base. Thus the interesting aspect of the R_n values will be their magnitude in relation to each other rather than the 1.0, the null hypothesis value" (Pinder *et al.* 1979: 435 - 436).

The Early Dynastic Period (Dynasty 0 – Dynasty 2; *ca.* 3150 - 2685 B.C.)

The R_n value calculated for the 8 sites yielding Early Dynastic materials is 1.23 (Table 2); this value greater than 1.0 means that the average distance between first nearest-neighbors is greater than it would be in a random distribution and therefore represents a more dispersed or regular pattern (Figs. 6 and 7). For the observed distances between first nearest-neighbors see Table 3.

Table 2

Nearest-neighbor statistic for the Early Dynastic Period and later periods.

Period	No. of sites	$\sqrt{a}/n$	Dran	Dobs	R_n
Early Dynastic Period	8	10.61	5.30	6.54	1.23
Old Kingdom	16	7.50	3.75	2.84	0.76
1st Intermediate Period	7	11.34	5.67	5.61	0.99
Middle Kingdom	8				1.11
2nd Intermediate Period	7	11.34	5.67	9.44	1.76
New Kingdom	27	6.00	3.00	3.30	1.10

a = 900 km^2; reduction coefficient = 0.5.

A simplified map of the survey area and surroundings immediate to the west (Fig. 6) shows, beside the locations of the sites, a schematic reconstruction of former rivers and minor distributaries (based on the study of *ca.* 1500 soil samples; *cf.* van Wesemael and Dirksz 1986; van Wesemael and Sewuster 1987; de Wit and van Stralen 1988a; 1988b) together with the outlines of the sandy hills *(geziras)* as they rise today above the present plain. Given the fact that the flood plain was considerably lower during the time under consideration here, *viz.* the beginning of the 3rd millennium B.C., it will be understood that these sand bodies stood out even more above the alluvium then, than they do now.

All settlements, located at an average 6.5 km from each other, are situated in the near vicinity of a water course, reflecting the dependence on the river (for *e.g.* traffic, irrigation, drink water supply *etc.*) This accounts partially for the linear distribution pattern, the components of which seem to form a network along two axes (Fig. 7).

The first one is a NE-SW axis alongside a major former river, identified as the former Tanitic Nile branch. Its course is also indicated and confirmed by the

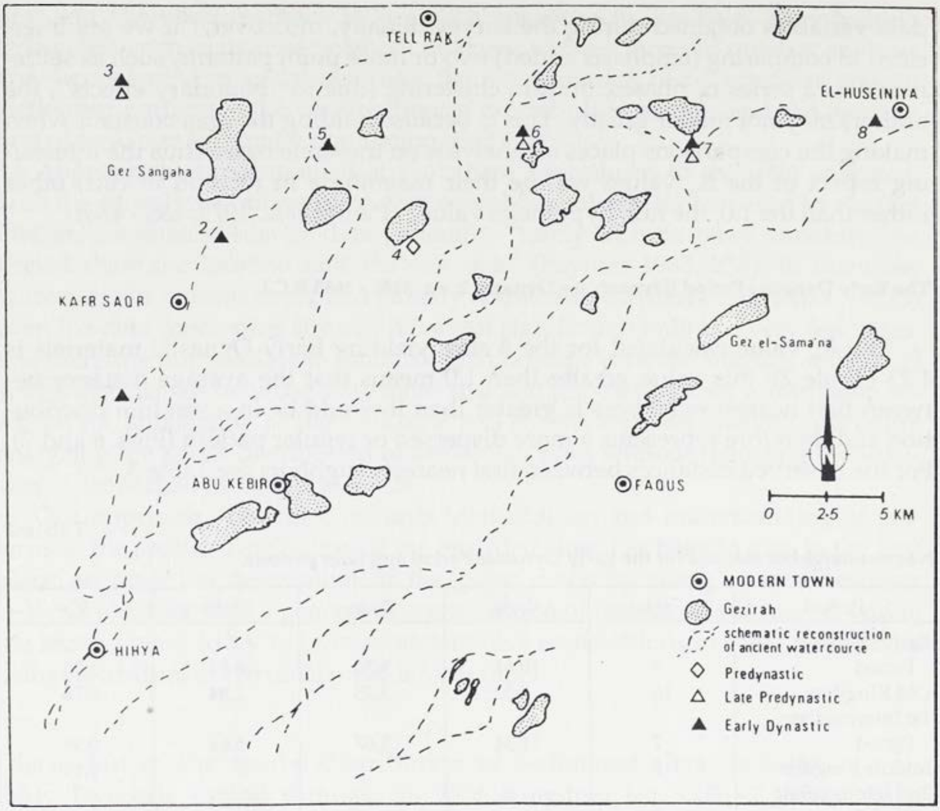


Fig. 6. Simplified map of the survey area and its surroundings immediately to the west, showing the reconstructed courses of former water courses and the distribution of Late Predynastic–Early Dynastic sites.

position of a number of contemporary Early Dynastic sites both within the survey area (Fig. 6, Nos. 1, 2, 5) as well as outside the study area (Table 3: c, d). The latter two are located at respectively 19.06 km and 24.53 km south of Ezbet el-Tell (the southernmost identifiable Early Dynastic site in the survey area), and at 5.47 km from each other, which would fit very well within the range of dobs between first nearest-neighbors in the survey area (Table 3). In view of the regularities observed (see further below) we could hypothesize the presence of another three Early Dynastic sites along the Tanitic branch in-between Ezbet el-Tell and Beni Amir.

With the exception of Gezira el-Masha'la, the second axis forms an almost straight east-west line, indicated by the position of a number of contemporary sites, perhaps significantly all contained within the modern 3.5 m and 3 m contour line. These are from west to east (Figs. 5 and 6): Tell el-Farkha, once more Tell Gherier, conveniently located at the spot where the Tanitic branch and one of its distributaries converge, el-Tell el-Iswid (south), located on a *gezira* east of

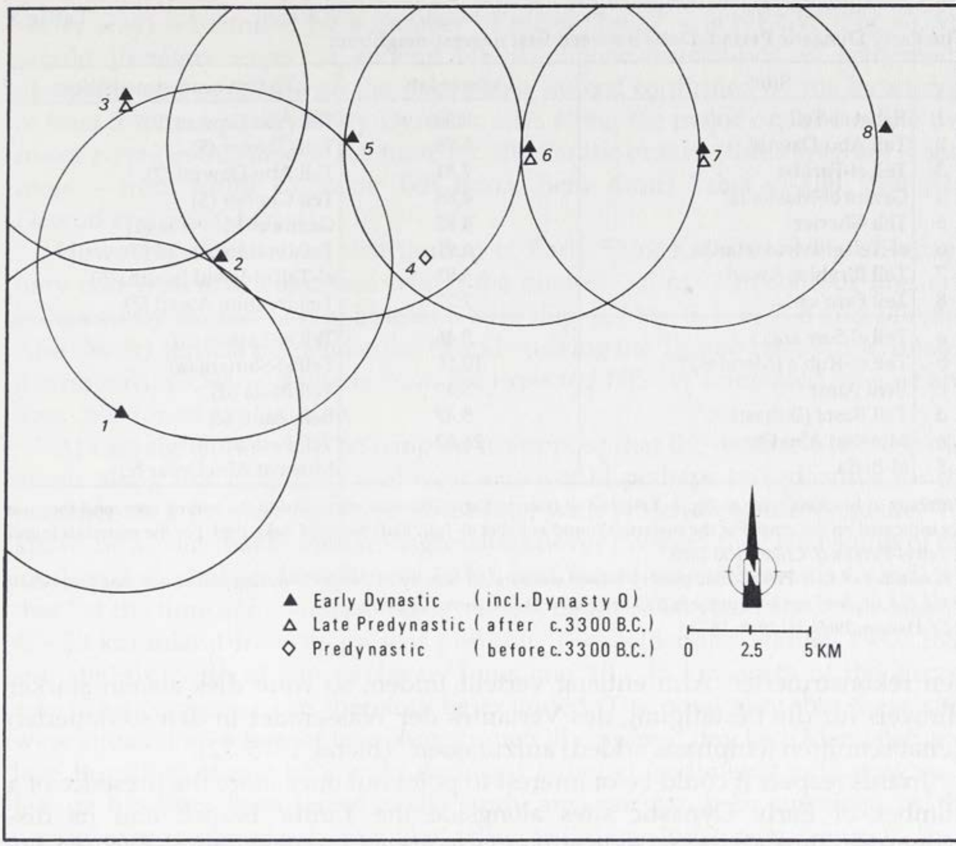


Fig. 7. Abstraction of Fig. 6, showing the distribution of Late Predynastic–Early Dynastic sites within the area; radius of circles is 6.54 km (= dobs) *cf.* Table 2.

yet another distributary channel (*cf.* also van den Brink 1990), Tell Ibrahim Awad, also situated on a *gezira* in the near vicinity of the spot where a former distributary channel seems to have bifurcated (van den Brink 1988: 76), and Tell Fara'un, located west of a former channel (Mustafa 1988b) which in this period either has to be considered as the easternmost distributary channel connected with the Tanitic branch or perhaps can be identified as belonging to the former Pelusiac branch (see further below). Alongside the same water way, outside the survey area at a distance of *ca.* 26.5 km northeast of Tell Fara'un we find yet another partially contemporary site, *viz.* Minshat Abu Omar (Kroeper and Wildung 1985).

Because sufficient numbers of C-14 datings of sediments of succeeding rivers and related distributaries during the Holocene in this area are still lacking, it is necessary to resort to an admittedly indirect method in order to at least arrive at some conclusions about when a river has been active. This method starts with the assumption "Wenn sich mehrere Fundstätten mit gleichen Belegungsschichten

Table 3

The Early Dynastic Period. Dobs between first nearest-neighbors.

	Site	Dobs in km	To first nearest-neighbors
1	Ezbet el-Tell	8.36	Tell Abu Dawud (2)
2	Tell Abu Dawud	5.76	Tell Gherier (5)
3	Tell el-Farkha	7.81	Tell Abu Dawud (2)
4	Gezira el-Masha'la*	4.85	Tell Gherier (5)
5	Tell Gherier	4.85	Gezira el-Masha'la (4)
6	el-Tell el-Iswid (south)	6.91	Tell Ibrahim Awad (7)
7	Tell Ibrahim Awad	6.91	el-Tell el-Iswid (south) (6)
8	Tell Fara'un	7.27	Tell Ibrahim Awad (7)
a	Tell el-Samara	5.46	Tell el-Farkha (3)
b	Tell el-Rub'a (Mendes)**	10.16	Tell el-Samara (a)
c	Beni Amir	5.47	Tell Basta (d)
d	Tell Basta (Bubastis)	5.47	Beni Amir (c)
e	Minshat Abu Omar	26.62	Tell Fara'un (8)
f	el-Beda		Minshat Abu Omar (c)

Numbers in brackets refer to Fig. 6. Letters a - f refer to Early Dynastic sites outside the survey area, and they are not indicated on the map. For the materials found at Ezbet el-Tell/Kufr Nigm *cf.* Bakr 1988. For the materials found at Tell el-Farkha *cf.* Chłodnicki 1988.

* A number of Late Predynastic pottery vessels were found here by M. Nesha'at during soundings made on behalf of the E.A.O.; they are kept in the E.A.O. magazine at Tell Basta/Zagazig.

** *Cf.* Hansen 1965: 36; 1968: 16.

den rekonstruierten Arm entlang verteilt finden, so wäre dies als ein starker Hinweis für die Bestätigung des Verlaufes der Wasserader in den so datierten Zeitabschnitten (emphasis added) aufzufassen" (Bietak 1975: 72).

In this respect it could be of interest to point out once more the presence of a number of Early Dynastic sites alongside the Tanitic branch and its distributaries (thus giving an indication of the period in which this river had been active, *viz.* at least at the beginning of the 3rd millennium B.C.) and the absence of contemporary sites alongside the former Pelusiac branch, where the earliest *in situ* finds are dated to the end of the First Intermediate Period/beginning of the Middle Kingdom (Bietak 1979: 290), *i.e. ca.* one millennium later than the first *in situ* finds alongside the Tanitic branch.

Having observed that human occupation started a thousand years earlier along the Tanitic branch than along the banks of the Pelusiac branch, one could wonder – though not conclusively answer yet – whether the Pelusiac branch had perhaps not yet been active at the beginning of the third millennium B.C.

If, on the other hand, one would assume that the Pelusiac branch had been active already in the Early Dynastic Period then the only alternative explanation for an apparent settlement vacuum along this river during most of the 3rd millennium B.C. would be that the Tanitic branch indicated the easternmost, natural border for human settling during this time in this part of the Delta, and that apparently there had been no urge to settle down far beyond the Tanitic branch eastwards.

We have observed before the very general tendency of settlements to be located near the water way, reflecting human dependency on the presence of rivers. We also have pointed out before that the general orientation of these water ways – bounded by a number of *gezira* "belts" – is NE-SW (Fig. 6). We would therefore expect a general NE-SW linear distribution of settlements alongside and parallel with the rivers, as is indeed confirmed by the location of at least 5 contemporary Early Dynastic sites along the major c.q. one of the two major rivers in this area at the time, *viz.* the Tanitic branch (these sites are – once more – from south to north: Tell Basta, Beni Amir, Ezbet el-Tell, Tell Abu Dawud and Tell Gherier).

However, an observed distribution of Early Dynastic sites along an imaginary east-west axis, contained within the modern 3.5 m - 3 m contour line, and indicated by the location of at least 6 sites (Fig. 6, Nos. 3, 5, 6, 7, 8 and Minshat Abu Omar), almost perpendicular to and crossing the Tanitic branch and related distributaries, clearly deviates from the expected NE-SW orientated scheme and thus calls for an explanation.

At first sight one could be tempted to suppose that the locations of the settlements along this imaginary east-west axis would perhaps be indicative for the presence of a former, Holocene coast-line, with which it would coincide. We know, however, that marine transgressions never invaded the Delta south of the modern 2 m contour line (Butzer 1976), and recent research seems to indicate that "at the time of maximum transgression, about 5,000 years ago, the coast lay 40 - 50 km inland from its present position" (Coutellier and Stanley 1987: 268), still slightly north of San el-Hagar/Tanis and 10 - 15 km north of the survey area. This conjecture can therefore be excluded. The possibility that these sites were situated on a former lake shore (much like present day lake Manzalah and lake Burullus) cannot be *a priori* excluded although sediments indicating such feature have not been found in the study area nor can it be sustained by the preliminary results of current pollen analyses (W. van Zeist, pers. comm.).

We should take into account here that the regions adjoining the current survey area immediately to the north and west have not been systematically covered by any archaeological survey. Theoretically therefore, it is possible that what we observe in the area as an east-west orientated "belt" of settlements, in reality represents only a partial and therefore distorted picture of the total former pattern, and thus would illustrate, as a case in point, the dangers of "boundary effect", mentioned above.

We are confident, however, that the "empirical pattern" does have a validity of its own, basing ourselves on circumstantial information presented below.

In this respect, we would like to mention some of the results of another archaeological survey, carried out during the years 1972 - 1982 by E.D. Oren in northern Sinai, between the Suez Canal and the Gaza Strip. The survey revealed the presence of *ca.* 250 sites yielding in varying quantities materials from both the Canaanite Early Bronze Age I - II cultures and the partially contemporary Late Predynastic–Early Dynastic cultures in Egypt. According to the surveyor the data indicate that "The complex of sites in northern Sinai represents, in our view, the eastward extension of the Egyptian sphere of interest and civilization, which served as a springboard for commercial (and military?) ventures in Southern Canaan at the very beginning of the Dynastic period" (Oren 1989).

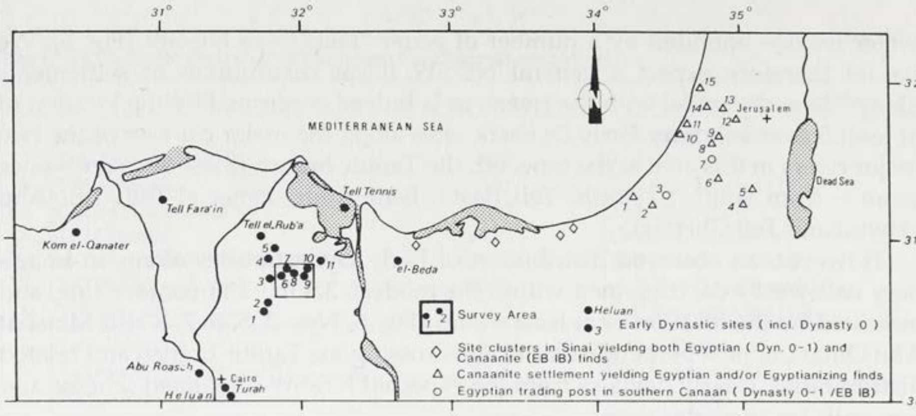


Fig. 8. Map showing distribution of sites dating from around the beginning of the 3rd millennium B.C. in the Nile Delta, northern Sinai and southern Canaan;

Nile Delta

1: Tell Basta; 2: Beni Amir; 3: Ezbet el-Tell; 4: Tell el-Farkha; 5: Tell el-Samara; 6: Tell Abu Dawud; 7: Tell Gherier; 8: el-Tell el-Iswid (south); 9: Tell Ibrahim Awad; 10: Tell Fara'on; 11: Minshat Abu Omar.

Southern Canaan

1: Taur Ikbeineh; 2: Site H; 3: 'En Besor (str. III); 4: Tell el-Malhata; 5: Tell Arad (str. IV - III); 6: Tell Halif; 7: Tell Ma'ahaz; 8: Tell 'Erani (Tell Gat); 9: Lachisch; 10: Afridar; 11: Nizzanim; 12: Hartuv; 13: Gezer; 14: Mdar; 15: Azor.

At present, some 25 sites in Southern Canaan are known to have yielded in varying quantities Egyptian and/or Egyptianizing finds dating from Dynasties 0 - 1, certainly testifying to the intensive contacts between Egypt and Canaan at this time. As for the true nature of this contact, more specific data need to be presented, in order to test the validity of such statements made *e.g.* by R. Gophna (1976: 9) already more than 10 years ago that "the Egyptians dominated not only the southern border areas of Canaan, which were not settled at that time (*viz.* the beginning of the Early Dynastic Period in Egypt, the author), but also exercised some control over the settled part of southern Canaan, chiefly for the purpose of economic exploitation".

When we take a look now at the map which reflects this situation around the beginning of the 3rd millennium B.C. (Fig. 8), and taking into consideration the following three points:

1. The northeast-southwest distribution of a number of Early Dynastic settlements spaced at regular intervals from each other along the banks of the former Tanitic branch both inside and outside the study area (*viz.* Tell Basta, Beni Amir, Ezbet el-Tell, Tell Abu Dawud and Tell Gherier);

2. The presence of a number of Early Dynastic sites equally regularly spaced along an imaginary east-west axis, off the northernmost site in the area (*viz.* Tell Gherier) and almost perpendicular to the Tanitic branch and distributaries, both inside and outside the survey area (*viz.* Tell el-Farkha, Tell Gherier, el-Tell el-Iswid [south], Tell Ibrahim Awad, Tell Fara'on, Minshat Abu Omar, el-Beda);

3. The flow of contemporary contacts *via* northern Sinai between Early Dynastic Egypt (and more specifically the Delta) and Early Bronze Age I southern Canaan;

we are inclined to explain the observed phenomena, particularly the imaginary east-west axis, in terms of a natural, corridor-like passage overland, possibly linking up with what is known to us from later texts as the Way(s)-of-Horus, thus connecting the southern and perhaps more central parts of the Delta with northern Sinai and eventually southern Canaan.

The clustering of *geziras* in this part of the survey area between the former Tanitic branch and distributaries, possibly provided the right conditions for donkey caravans for instance (Amiran 1985) to cross this watery area, even during the period of annual inundations, on the route to Sinai (copper trade) and southern Canaan.

At least three sites along this corridor yielded positive evidence for contemporary contacts with Sinai and Canaan, *viz.* Minshat Abu Omar *(e.g.* copper tools, EBA I ceramic imports, *cf.* Kroeper and Wildung 1985), Tell Ibrahim Awad (copper vessels, EBA I ceramic imports, *cf.* van den Brink 1988: 80, VI and 82 - 83) and el-Tell el-Iswid (south) (ceramic imports, *cf.* van den Brink 1989).

The Late Predynastic Period:
Excursus

The transition from terminal prehistory to (proto)history *viz.* the transition from the Late Predynastic Period to the Early Dynastic Period, is marked in the Delta by cultural discontinuity (van den Brink 1989). It would seem that the last exponents of a truly Lower Egyptian culture (standing in the tradition of, in chronological order, the Neolithic Fayum A, Merimde Beni-Salame/el-Omari, Maadi, Buto (Schicht II; von der Way 1989) and el-Tell el-Iswid (south) (phase A; van den Brink 1989), finally dissolved, during the process of "unification", into the Early Dynastic culture.

This cultural discontinuity can be inferred from observed radical changes in the ceramic and lithic assemblages and *e.g.* the proliferation of mudbrick architecture at the beginning of the Early Dynastic Period at a number of contemporary Delta sites.

These events do not seem to have caused a discontinuity in site occupation: at least 4 out of the 8 Early Dynastic sites mentioned above (Table 3) had already been inhabited during the Late Predynastic Period *(ca.* 3,300 B.C.), *viz.* Tell el-Farkha (R. Fattovich, pers. comm.), Tell Ibrahim Awad (van den Brink 1988: 77), Gez el-Masha'la (Rundbrief MDAIK 1988) and el-Tell el-Iswid (south) (van den Brink 1989). Tell el-Fara'in/Buto and Minshat Abu Omar, where the same phenomena have been observed, complete this picture, contrasting with the abandonment of Maadi at the beginning of the Early Dynastic Period.

Based on the presence of ceramic imports we also know that contacts between the Delta and Sinai-Canaan existed already during the Late Predynastic Period, for instance Minshat Abu Omar, grave groups 1 - 2 (Kroeper and Wildung 1985; Amiran 1985); Tell el-Fara'in/Buto, Schicht II (von der Way 1989); el-Tell el-Iswid (south), phase A (van den Brink 1989; N. Porat, pers. comm.).

Whether and to what degree these Late Predynastic settlements located within the "corridor" were later on functionally integrated in the network of Early Dynastic settlements, is a question which cannot be answered yet.

Inferences about Early Dynastic intersite differentiation

One would of course want to know whether the rise of central government and the crystallizing hierarchical structuring at the beginning of the Early Dynastic Period (including Dynasty 0) are reflected in the eventual system underlying the Early Dynastic settlement pattern.

A key characteristic of stratified society landscapes, found in studies of settlement patterns and systems, is that settlements are arranged in hierarchies with a large number of small places and a small number of large places.

Due to the deplorable state of preservation of many tells, rank-size relations, which could help us to explain the "empirical pattern" in this respect, cannot be inferred directly from the survey data alone. The linear distribution of these sites, however, spaced at rather regular intervals from one another, and the apparent absence of site clustering, seem to suggest a relatively egalitarian system.

On the level of social structuring intrasite and intersite differentiations do occur though; if one accepts that a relationship exists between certain variables in mortuary data (like size and structure of graves, the nature and number of funerary gifts included in a grave) and the social status or social persona of the deceased (*e.g.* Saxe 1970), then the Early Dynastic data-set at for instance Minshat Abu Omar mirrors a much wider range of internal social differentiation among the (cemetery) population than that reflected in the contemporary cemetery data at Ezbet el-Tell (Bakr 1988). In Minshat Abu Omar the extremes on the scale poor/rich burial (for a *caveat* concerning the interpretation of seemingly rich burials *cf.* Eiwanger 1987: 91 - 93), or low/high status are much further apart from each other than at Ezbet el-Tell.

For instance, at the former site grave structures vary from plain shallow pits with only few goods, to big rectangular mudbrick tombs, subdivided in 2 to 3 separate rooms, covered with a roof supported by wooden beams and containing more than 50 objects (Kroeper 1988: 12 - 13, 17).

At the latter site such extremes on this scale are virtually absent, the only deviation from the standard practice (burial in pottery coffin in shallow grave pit) being the addition sometimes of a small annex to the grave for extra storage (Bakr 1988: 51).

The only grave excavated so far at Tell Ibrahim Awad is comparable in structure and nature and number of funerary gifts included with those few graves, excavated in Minshat Abu Omar, which tend to the extreme "rich" side of the scale (van den Brink 1988: 77). That the owner of this particular grave, datable to the first half of the First Dynasty, had access to the royal workshops is indicated *e.g.* by the presence of a schist chalice (van den Brink 1988: Fig. 21, No. 28), a totally equal example of which has been found in Saqqara, tomb 3507, belonging to the earliest period of Udimu (Dwn), probably to Queen Her-Nit (consort of

Zer/Dr). The three burials uncovered so far at el-Tell el-Iswid (south) are perhaps indicative of a certain diachronic, internal development. The two earliest burials (A/87/2, stratum VIIIc and A/87/1, stratum IX) slightly predating those found at *e.g.* Ezbet el-Tell, where placed in shallow pits and – apart from a single bowl in grave A/87/2 – were not equipped with funerary gifts. The latest burial (A/87/3, stratum X) – contemporary with *e.g.* Minshat Abu Omar grave group 4, was placed in a *ca.* 1.3 m deep grave pit, equipped with numerous stone and pottery vessels as well as two grinding stones (van den Brink 1989: Figs. 6 and 7).

Uniformity in at least one major aspect concerning the disposition of the dead did exist among all sites mentioned above, *viz.* the burials were always single, the burial position contracted, left lateral, head in the north/northeast, facing east/southeast, feet in the south/southwest.

The Old Kingdom (Dynasties 3 - 6; *ca.* 2,685 - 2,185 B.C.)

With an average distance of 2.84 km in-between first nearest-neighbors (Table 4) and an R_n value of 0.76 (Table 2) it would seem that the spatial distribution of settlements during the Old Kingdom represents a less dispersed and relatively more clustered pattern (Figs. 9 - 10) compared to that of the preceding Early Dynastic Period.

At least five out of the 17 sites yielding materials dating from the Old Kingdom (van den Brink 1988: 66 - 69, Figs. 3 - 7) had already been inhabited

Table 4

The Old Kingdom. Dobs between first nearest-neighbors.

Site		Dobs in km	To first nearest-neighbors
1	Tell Abu Dawud*	1.81	Tell Hasanin (2)
2	Tell Hasanin	1.81	Tell Abu Dawud (1)
3	Tilul Moh. Abu Hassan	1.81	Tell Hasanin (2)
4	Tell Umm el-Zaiyat	3.03	Tell Ginidba (5)
5	Tell Ginidba	1.81	Tell Gherier (6)
6	Tell Gherier*	1.70	Tell el-Marra (8)
7	Gezira Tell Faras	6.06	Tell Umm el-Zaiyat (4)
8	Tell el-Marra	1.70	Tell Gherier (6)
9	Tell el-Akhdar	2.79	Tell el-Abbasiya (12)
10	Tell el-Masha'la*	1.33	Tell el-Dirdir (11)
11	Tell el-Dirdir	1.33	Tell el-Masha'la (10)
12	Tell el-Abbasiya	2.79	Tell el-Akhdar (9)
13	el-Tell el-Iswid (south)**	0.61	Tell el-Abbasiya (12)
14	el-Tell el-Iswid (north)	2.91	Tell el-Abbasiya (12)
15	Tell Umm 'Agram	2.91	Tell Ibrahim Awad (16)
16	Tell Ibrahim Awad**	2.91	Tell Umm 'Agram (15)
17	Tell el-Khasna	8.72	Tell Abu Dawud (1)
a	Tell el-Rub'a (Mendes)	15.63	Tell Umm el-Zaiyat (4)
b	Tell Basta (Bubastis)	23.44	Tell el-Khasna (17)

Numbers in brackets refer to Figs. 9 - 10. Letters a - b refer to sites outside the survey area, and they are not indicated on the map.

* Inhabited since the Early Dynastic Period.

** Inhabited since the Late Predynastic Period.

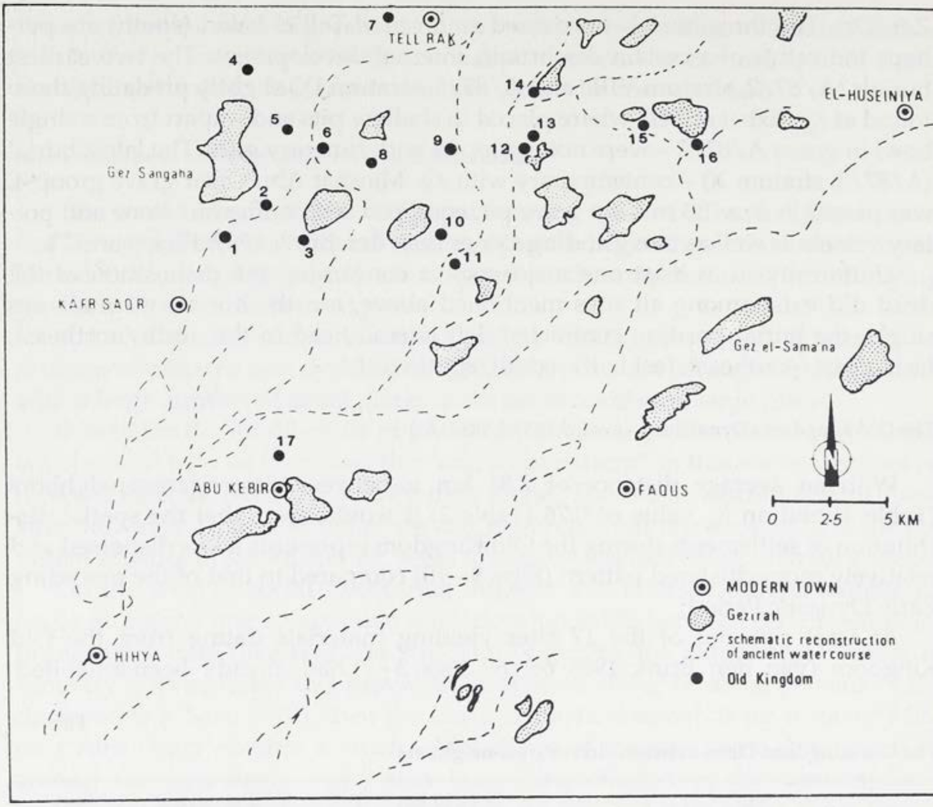


Fig. 9. Simplified map of the survey area and its surroundings immediately to the west, showing the reconstructed courses of former rivers and the distribution of Old Kingdom sites.

during the preceding Early Dynastic Period; of those five, three had already been occupied since the Late Predynastic Period (Table 4). This can be seen perhaps as an example of the "cumulative impact of prehistorical (and protohistorical, the author) social aggregation" (Butzer 1984: 929).

The 12 remaining sites that do not yield any material prior to the Old Kingdom are therefore considered to be new foundations. They illustrate the dynamics during this "pyramid age". Although future research of these sites may still reveal the presence of some earlier vestiges of human occupation, the sharp increase in the number of settlements is realistic enough. It is this fact that testifies to the interest of the central government in this region during the Old Kingdom, and perhaps also, more specifically, to the presence of a "local historical trajectory" (Butzer 1984), *viz.* the "corridor" described above, linking up with the Way(s)-of-Horus, giving access to the overland route *via* Sinai to southern Canaan.

Taking a look at the map (Fig. 9) and its abstraction (Fig. 10) one is given the impression that satellite foundations started to develop during the Old Kingdom around and in-between the surviving elements of the Early Dynastic

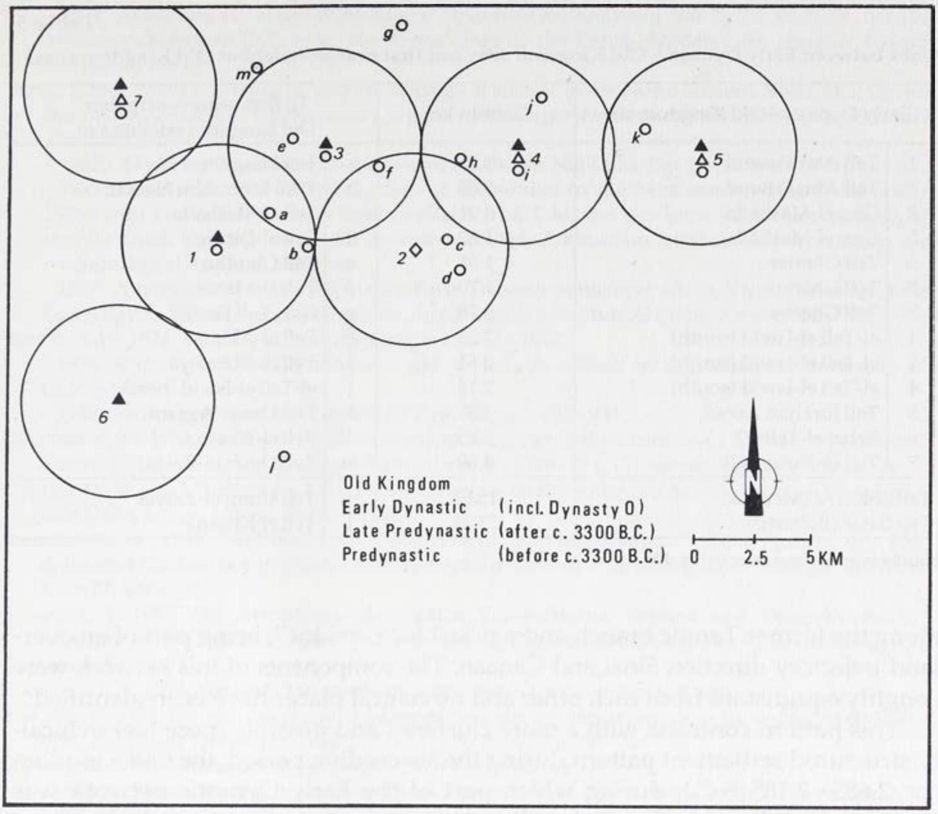


Fig. 10. Abstraction of Fig. 9, showing the distribution of Old Kingdom sites within the area; radius of circles is 2.84 km (= dobs) *cf.* Table 2. For explanation of the numbers and letters *cf.* Table 5.

settlement network (Table 5). During this process a shift in balance emerged favoring Old Kingdom foundations. This is indicated by the position of Tell el-Marra (Fig. 9, No. 8), located at equal distance from el-Tell el-Iswid (south) (6.06 km), Tell Abu Dawud (6.3 km) and Tell Umm el-Zaiyat (6.3 km) and by the position of Tell el-Abbasiya, situated at an equal distance from Tell Gherier (7.27 km) and Tell Ibrahim Awad (7.15 km; *cf.* Fig. 10).

In as far as this picture of the changes in settlement patterns is accurate, it indicates that centers of importance were developing for the first time in the region, the spatial distribution possibly reflecting an underlying hierarchical structure.

To summarize: So far we have tried to point out a development observed in the spatial distribution of sites within the survey area from the Late Predynastic Period through the Old Kingdom. Initially the sites formed a rather linear and egalitarian pattern during the Early Dynastic Period (*ca.* 3,150 - 2,685 B.C.), characterized by sites located at an average distance of *ca.* 6.5 km from each other

Table 5

Dobs between Early Dynastic–Old Kingdom sites and first nearest-neighbor Old Kingdom sites.

Early Dynastic–Old Kingdom site		Dobs in km	To first nearest-neighbor Old Kingdom satellite site	
1	Tell Abu Dawud	1.81	a	Tell Hasanin
1	Tell Abu Dawud	3.03	b	Tilul Moh. Abu Hassan
2	Gez. el-Masha'la	0.91	c	Tell el-Masha'la
2	Gez. el-Masha'la	1.82	d	Tell el-Dirdir
3	Tell Gherier	1.81	e	Tell Ginidba
3	Tell Gherier	1.70	f	Tell el-Marra
3	Tell Gherier	5.78	g	Gez. Tell Faras
4	el-Tell el-Iswid (south)	3.03	h	Tell el-Akhdar
4	el-Tell el-Iswid (south)	0.61	i	Tell el-Abbasiya
4	el-Tell el-Iswid (south)	2.18	j	el-Tell el-Iswid (north)
5	Tell Ibrahim Awad	2.91	k	Tell Umm 'Agram
6	Ezbet el-Tell (?)	6.25	l	Tell el-Khasna
7	Tell el-Farkha (?)	4.69	m	Tell Umm el-Zaiyat
Tell el-Rub'a (Mendes)		15.63	m	Tell Umm el-Zaiyat
Tell Basta (Bubastis)		23.44	l	Tell el-Khasna

Numbers and letters refer to Fig. 10.

along the former Tanitic branch and a possible "corridor", being part of an overland trajectory direction Sinai and Canaan. The components of this network were roughly equidistant from each other and no central places have been identified.

This pattern contrasts with a more clustered and possibly more hierarchically structured settlement pattern during the succeeding period, the Old Kingdom (*ca.* 2,685 - 2,185 B.C.), during which part of the Early Dynastic network was interwoven with newly founded settlements (at an average distance of only 2.8 km from each other), probably precipitating the development of centers, a process which continued, as will be shown later on in Part II, after the Old Kingdom, culminating in the foundation of the country's capital during the Ramesside era, Piramesse, in exactly this region, during the later part of the New Kingdom.

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ENVIRONMENTAL CHANGE AND HUMAN CULTURE
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The evolution of the Eastern Nile Delta as a factor in the development of human culture

Introduction

The work of the Netherlands Foundation for Archaeological Research in Egypt (NFARE), the successor of the Amsterdam University, Survey Expedition (AUSE) focuses on the earliest settlement patterns in the Eastern Nile Delta, the area close to the Sharqiya desert border (Fig. 1). The archaeological research is dealt with by van den Brink (1988 and this volume). Palaeo-geographical research forms an integrated part of this work and is intended to back-up archaeologists' insights in the cultural development in the area. Topics specifically addressed by the archaeo-environmental research are the drainage pattern of ancient Nile distributors, suitability of terrains for the various exploitations by ancient man, natural causes for changes in settlement patterns and so on. The results of the first years of the survey are described in van Wesemael and Dirksz (1986), Sewuster and van Wesemael (1987) and de Wit and van Stralen (1988a; 1988b).

The survey area of *ca.* 1,000 square kilometres is confined to the Delta plain, defined as that part of the Nile Delta which lies permanently out of reach of coastal processes, between the Delta front (the Mediterranean shore) and the Delta apex (Cairo). Yet, this typical environment forms an integrated part of the Delta as a whole. Numerous professional studies were devoted to the geology and morphodynamics of delta systems in general. These have resulted in models and empirical quantifications of relevant factors (Reading 1986) which, while valid for the entire Nile Delta, also are applicable to the NFARE survey area on a much smaller scale. Reversely, the survey area may have predictive value for the Nile Delta as a whole. Palaeo-environmental studies of the survey

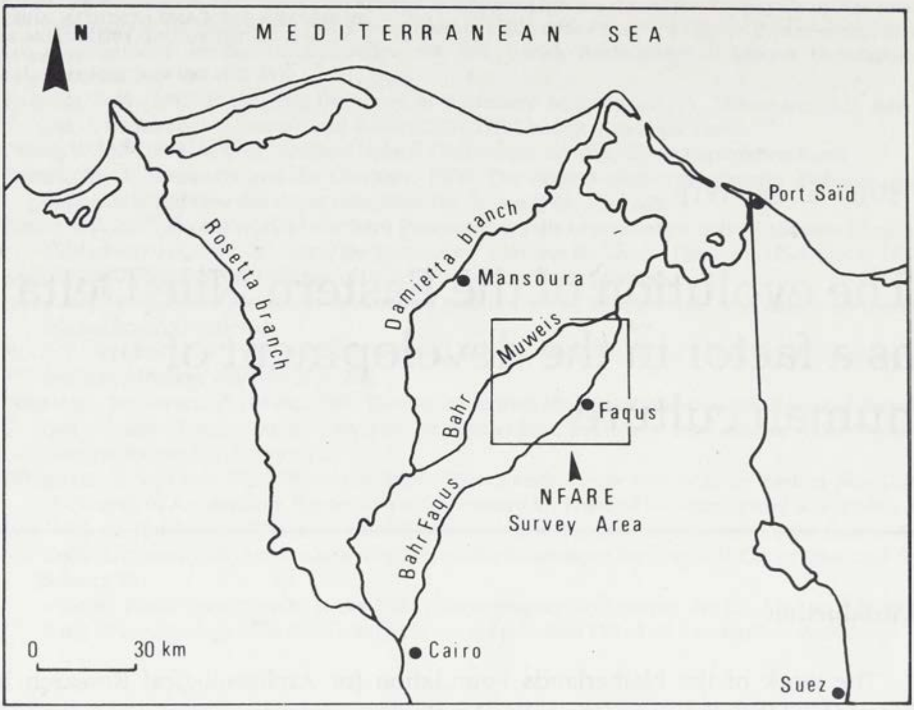

Fig. 1. The NFARE survey area in the Nile Delta.

area therefore should incorporate regional factors such as fluctuations of Nile discharge, Mediterranean sea level and climate. Also cultural factors should be regarded, as they will have invoked changes of the natural conditions. For instance, patterns of sedimentation and erosion may have adapted to socio-economic developments such as increased cultivation and irrigation or to neglect and abandonment.

In archaeology the Nile Delta is a relatively new area of interest, but research is rapidly expanding (van den Brink 1988). Equally, investigations in the natural evolution of the Nile Delta have intensified (Hamroush, Krzyżaniak and Wunderlich, this volume). In literature concerning the Nile Delta, the Delta front is described in most detail (*e.g.* Rizzini *et al.* 1978; Stanley 1983; 1988; Sneh *et al.* 1986; Coutellier and Stanley 1987). Several studies were published concerning the composition of Nile sediments in relation to provenance, age, type and location of deposition (Shukri 1950; Kholief *et al.* 1969; Hassan 1976; Stanley and Liyanage 1986; for an overview see Frihy and Stanley 1988). The Delta plain, however, often simply is referred to as the area where the Nile diverged into seven branches from which the "well-known Nile muds" were deposited during annual floodings. When mentioned, most attention is paid to the overall thickness of the alluvial deposits, the magnitude of the annual floodings and the reasons for the silting up of five of the former branches (*e.g.* Butzer 1975; 1976). Recent field campaigns indicated that the subsoil of the Delta plain is highly complex (el-Fawal 1975; Andres and Wunderlich 1986; van Wesemael and Dirksz 1986; Hamroush 1987; de Wit and van Stralen 1988a; 1988b; Dorner 1985; Wunderlich, pers. comm.). This brought up the need for an overall palaeo-geographic model as a framework for more specific archaeo-environmental questions. In this paper such a model for the Eastern Nile Delta plain is presented, based on the compiled field stratigraphy of the AUSE/NFARE survey area. A thusfar unknown formation of this stratigraphy is introduced, called the Nile 2 formation. Its deposits were preserved possibly as a result of the area's location at the Delta-desert interface. The Nile 2 deposits and the special position of the survey area are explored with a view to the environmental conditions just before the present Nile regime settled and gave the area (as a final expansion of the entire Nile Delta) its present shape. In a separate paragraph the model for the natural evolution is interpreted in terms of its potentials for the development of human culture.

Methods

The palaeo-environmental research for the AUSE/NFARE project is split up in two parts: one aiming at the development of a model for the natural evolution with implications for living conditions in the past, and a second concerning more specific archaeo-environmental questions. In many respects the two approaches are complementary. Inasmuch as the difference between the two merely is a matter of scale, both may profit from common practical techniques.

Survey techniques comprise hand- and mechanical drillings, whereby primary sedimentological and pedological features are evaluated, besides geo-electrical methods and interpretation of remote sensing data (aerial pictures and satellite images). As a policy, laboratory analyses (radiocarbon datings, grain-size distributions and mineral assemblage determinations) only are carried out when indispensable for specific purposes. Methods and progress of the research were described in the reports by van Wesemael and Dirksz (1986), Sewuster and van Wesemael (1987) and de Wit and van Stralen (1988a). Augerings initially were made to a medium depth of 3 metres, along transects perpendicular to the inferred (Bietak 1975) ancient Nile streamchannels. During the 1987 and 1988 seasons the augerings had to serve the general palaeo-environmental research, for which reason the auger depths were increased to 5 - 8 metres with a maximum of 12 metres. Moreover, the initial regular layout of transects was abandoned in favor of *ad hoc* grids which served particular stratigraphical objectives and detailed mappings. Radiocarbon datings were calibrated according to Stuiver and Kra (1986). The results of satellite imagery interpretations are not yet included explicitly in this paper.

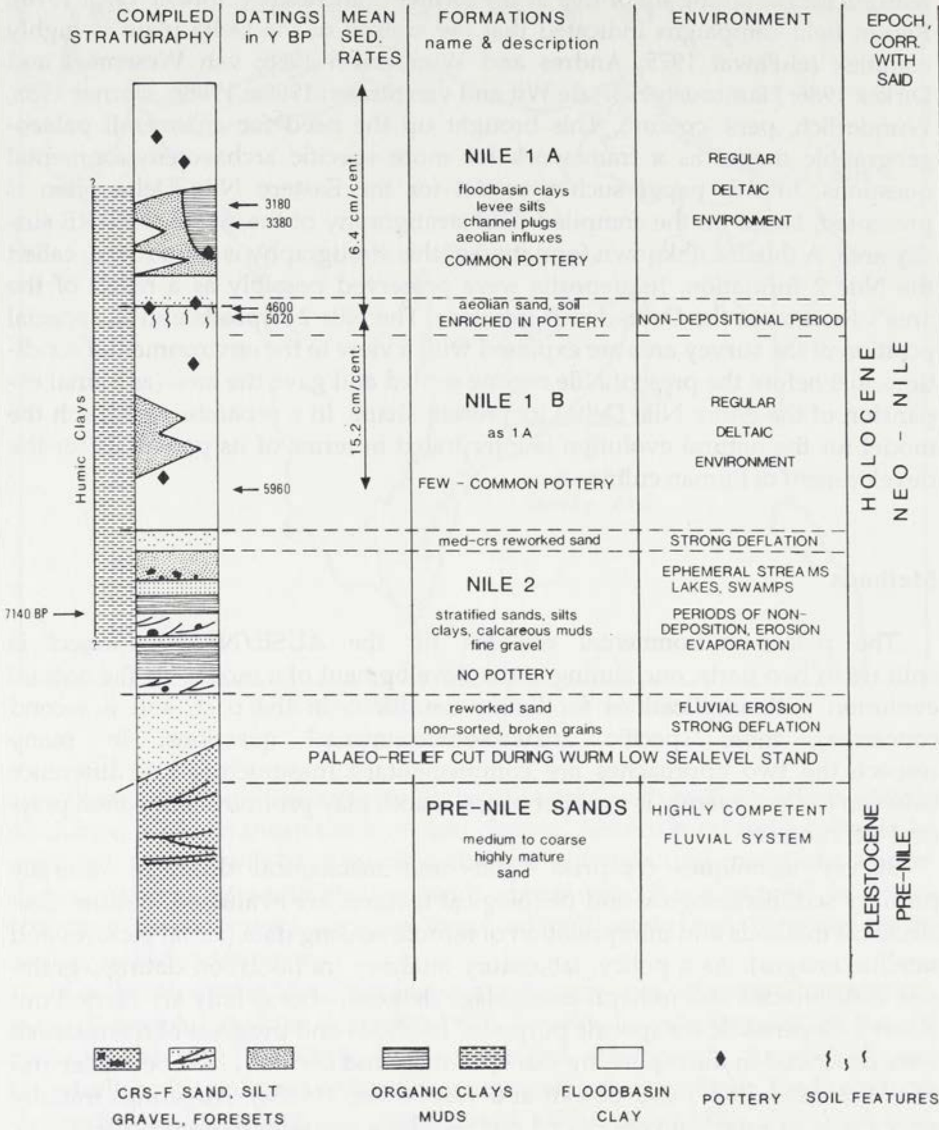

Fig. 2. Compiled Upper Quaternary Nile Delta stratigraphy;

The stratigraphical column to the left gives a pictural summary of lithologies, sedimentary characteristics and stratigraphic correlations of the different formations. Being a compilation, the column is not to scale; in reality the thicknesses of the formations vary widely over the area. For the same reason, arrows at the radiocarbon ages indicate relative positions of dated samples in different formations. The ages are calibrated according to Stuiver and Kra (1986). The period of low sealevel stand, separating Pre- and Neo-Nile deposition is named after the last glacial period in Europe, the Würm. As a stratigraphical formalism, the Nile 1a and Nile 1b are members of the Nile 1 formation rather than formations of their own. Descriptions and environmental interpretations are given in the text.

Stratigraphy

The Upper Quaternary stratigraphy of the survey area is given in Figure 2. Referring to the earlier mentioned continuity of natural environments on a regional scale (the survey area being part of the entire Nile Delta) it may be expected that much of this stratigraphy is valid also outside the survey area.

The stratigraphy comprises three formations separated by non-depositional or erosion horizons. Each formation is made up of several types of deposits reflecting the variability of the environment at the various epochs. For environmental reconstructions the stratigraphic boundaries (or boundary-layers) between formations are equally important; they represent stratigraphic gaps or, in a chronological sense, periods of non-deposition or erosion, and consequently, they too represent environments which may have been stable for considerable periods of time.

Nile 1 formation

The Nile 1 formation consists of what traditionally is called the Nile muds or Nile alluvial sediments, formed in a standard deltaic environment under regular flow regime of the Nile (the Neo-Nile phase: Said 1981; for historical descriptions of the flow regime of the Nile see Hassan and Stucki 1987). The formation comprises uniform floodbasin clays, levee silts, channelplugs (organic muds, often with shells, formed when a channel is abandoned and silted up) and intermittent eolian sandy influxes.

The Nile 1a and 1b is separated by a repeatedly observed stratigraphic boundary. The horizon on which the distinction of the Nile 1a and 1b members is based is characterized by increased soil formation and often by enrichment of anthropic material and fine laminated sands. Such features point to prolonged exposure without deposition, for which reason the horizon is interpreted as a stratigraphic boundary. The horizon is not always apparent, but can be inferred; for instance in one continuous core of pure floodbasin clays the mean sedimentation rate in the lower half of the augering was calculated at 15.2 cm per century until at least 5,020 years B.P. (cal.; based on radiocarbon dated samples at 3.17 and 4.60 m respectively below the surface), more than twice as high as in the upper half of the augering (6.4 cm per century; datings incorporated in Figure 2 are not at true depths). This either could mean that sedimentation before the fifth millennium B.P. indeed took place at a much higher rate than in more recent times, or that the auger core contains an (invisible) stratigraphic gap. Each interpretation sympathizes with an inferred boundary separating the Nile 1a and 1b members, as each points to a marked break in environmental conditions. By extrapolation of the mean sedimentation rate of 15.2 cm per century up to the top of the core, the time gap would amount to nearly three millennia, which seems unrealistic. Rejecting the idea of a stratigraphic gap, on the other hand, one should accept a drop of the mean sedimentation rate to 6.4 cm/century, which is lower than anywhere else estimated for the Neo-Nile deltaic sediments. The average of four (other) calculated mean sedimentation rates for the entire Nile 1 formation in the survey area amounts to 13.6 cm/century, while for upper deltaic sediments closer to Lake Manzala mean sedimentation rates lie between 10 and 20 cm/century (calculated from data from cores S6 - S8 of the Smithsonian Institution, published by Coutellier and Stanley 1987 and Stanley *et al.* 1988). Butzer (1975) estimates the average sedimentation rate at 20 cm per century.

It is realized that a sudden decrease of the calculated mean sedimentation rate from a certain point upward, as registered in one single augering, could point to de-activation of the nearest distributary channel. However, a well defined boundary indeed was observed in many other augerings, at the depth of about three metres below the surface (de Wit and van Stralen 1988a; 1988b). Probably the drop of the calculated mean sedimentation rate in this one core represents a combination of the two factors: non-deposition followed by reassumed deposition at a lower rate. From one core where the boundary was clearly visible, a sample directly above it was radiometrically dated at 4,560 B.P. (cal.). For comparison, Horowitz (1979) draws the lower boundary of the period with present climatic conditions in Israel at 4,500 B.P. According to this author, the preceding period would have been characterized by milder climatic conditions. Evidence for milder conditions were not found in the Nile 1b deposits, but in the underlying Nile 2 deposits. Bietak (1975) postulates a period of zero Nile sedimentation between the 34th and 29th century B.P.

As stated above, the lithologies of the Nile 1b member are similar to those of the Nile 1a member and point to identical, standard Nile-deltaic conditions. The two deepest samples of the Nile 1b member which were radiometrically dated both yielded an age of 5,960 years B.P. (cal.). Butzer (1975) dates the abrupt lower boundary of the "alluvial muds" at 6,500 B.P.

Nile 1 – Nile 2 boundary

The boundary between Nile 1 and underlying formations (Nile 2 or Pre-Nile formations, respectively) is marked by a sharp unconformity. The underlying lithologies form a strong contrast to the Nile 1 deposits, pointing to entirely different environmental conditions from those known from the modern Nile. Since environmental conditions do not change overnight, the observed differences suggest that the unconformity represents a time gap. Indeed often the unconformity is erosional and may be accentuated by a thin (several cm) layer of coarse sand with milky blue minerals, which is interpreted as a deflation horizon (formed by wind or rainstorms). Based on the age of the lowermost Nile 1b deposits, the gap would date before the sixth millennium B.P. It is not known what length of time the gap represents.

Nile 2 formation

The Nile 2 deposits are clearly different from the Nile 1 deposits as they are not uniform but distinctly bedded instead. The merely stratigraphical name "Nile 2 formation" is unfortunate, it might suggest that the deposits were derived from the Nile itself. The contrary is the case: the Nile 2 deposits are distinguished from the Nile 1 deposits because by no means can they be interpreted as normal deltaic sediments. Different beds consist of different lithologies, and display a variety of sedimentary structures. The lithologies comprise (gravelly) sands, silts, clays and organic or pure calcareous muds. Sand and silt beds are graded, crosslaminated or lenticular (ephemeral stream sediments, characteristic of a turbulent flow regime). The muds are mostly homogeneous: organic (deposited in swamps) or calcareous (formed in well- or wadi-fed stagnant pools). The silts to fine sands mostly form thin intercalations which are parallel laminated with a high content of heavy minerals (eolian and sheetflow deposits, the latter being formed by catastrophic runoff from topographic heights). The different kinds of deposits alternate rapidly in a lateral and vertical sense. In general, the Nile 2 deposits have a high content of syn-depositional carbonates, which point to substantial water influxes from allochtonous sources, and strong evaporation. The carbonates are not of pedogenous origin, as they are lacking in similar Pre-Nile and Nile 1 deposits at comparable depths. Considering the foregoing, the formation cannot be attributed to a regular, major fluvial system comparable to the present Nile: a spatially and chronologically much more varied environment (as will be described furtheron) should be inferred.

In case of the Nile 2 deposits consisted of organic or humic clays (stained black by fine dispersed organic material), no boundary can be observed between presumed Nile 2 and Nile 1 formations. The humic deposits have their base at equivalent depths, but their top at much shallower depths than the Nile 2 formation (see Fig. 2); hence their correlation with both Nile 1 and Nile 2 formations. Laterally the deposits measure several hundreds meters across. The base of the humic clays at one location was dated by radiocarbon method at 7,140 years B.P. (cal.), which is older than any deep sample taken from the Nile 1 deposits thusfar. For lithologically more strictly defined Nile 2 deposits no datings are available yet; based on stratigraphic correlations, for the Nile 2 formation a similar age is expected.

Nile 2 – Pre-Nile boundary

The base of the Holocene Nile Delta is an erosional unconformity, formed during the low sealevel stand of the last glaciation, which had its maximum between 18,000 and 11,000 B.P. (Horowitz 1979; Brinkmann 1986; Coutellier and Stanley 1987 give an age of 18,000 B.P.). It is not clear when exactly the eastern delta became part of the modern so called Neo-Nile distributary system. Based on datings from the survey area, this happened early in the sixth millennium B.P. (lowermost samples from Nile 1b). Consequently the Pre-Nile erosion surface and the Nile 2 deposits represent the period of 18,000 to *ca* 6,000 B.P. In fact, it is likely that the relief dates close to the 6th millennium B.P. because the buried Pre-Nile sand surface still shows a topographical gradient, pointing at active erosion until the palaeorelief eventually was covered. During the glacial maximum, sealevel was over 100 m lower than at present (Butzer 1975;

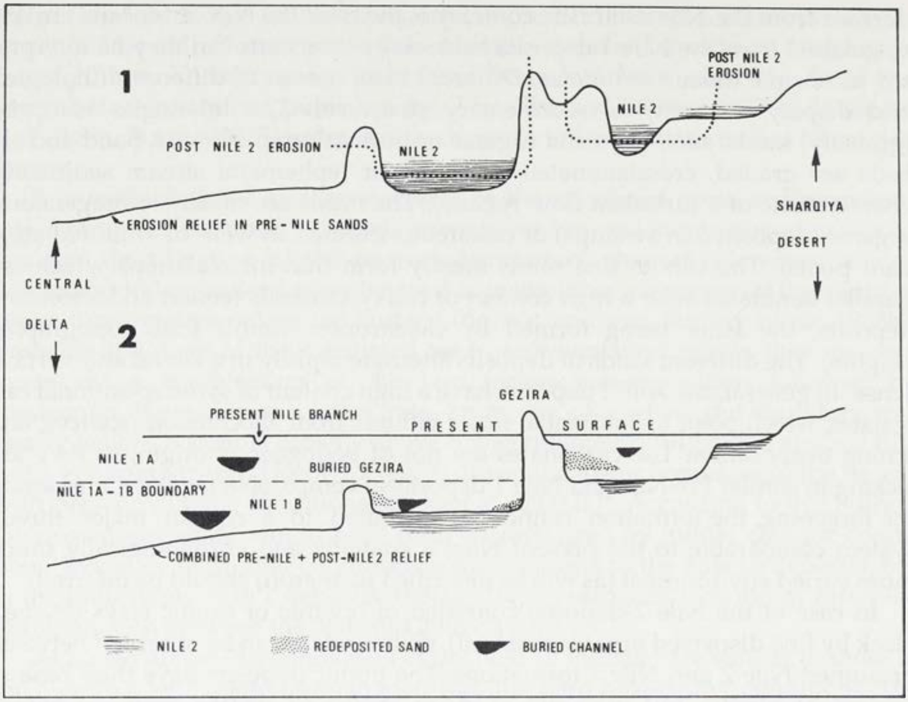

Fig. 3. Development of the Eastern Nile Delta since the Late Pleistocene;

1: Early Holocene, deposition of the Nile 2 formation upon a palaeo-relief cut in Pre-Nile sands. After the Nile 2 depositional phase the entire area again was submitted to erosion, reducing Nile 2 outcrops and further cutting back erosion relics of the Pre-Nile sands.

2: Present situation. The combined Pre-Nile and post-Nile 2 erosion relief (*cf.* top figure) is buried by Nile 1 deltaic sediments. The erosion relics of the Pre-Nile sands are reduced in size, but still stand out above the present-day surface as so called *geziras*. The Nile 1a - 1b boundary (indicated) represents the stable land surface during a period (5th millennium B.P.?) of low to zero deposition as mentioned in the text

Horowitz 1979). Central parts of the Nile Delta basin may have been carved out as deeply; the unconformity is burried to an observed depth of 40 to 80 m below the present surface in the central and northern Delta (Attia 1954; Butzer 1975; Madkour 1988; IWACO 1988; Stanley 1988), gradually decreasing to zero at the Delta edges. The *geziras*, isolated sand mounds standing out above the Delta plain close to the Delta fringes, are the last exposed relics of this erosion surface (Fig. 3:2).

Pre-Nile formation

The older deposits in which the palaeo-relief was cut, consist of mature (texturally and compositionally pure) sands. As can be established in *gezira*-outcrops, the sands are devoid of sedimentary structures but may form large mega-crossbeddings. The formation pertains to the Pre-Nile phase (Middle Pleistocene; Said 1981), and accordingly will be called Pre-Nile formation. The frequently used name "*Gezira* sands" is misleading as it only refers to a physiographic unit of plurigenetic origin. Geo-electrical soundings leave room for an interpretation that a deeper levels in the formation silts and clays are intercalated (de Wit and van Stralen 1988a; IWACO 1988).

Interpretation: Chronologic evolution of the Quaternary Nile Delta

On the general geological setting of the Nile Delta the following inferences are based. The geographical limits of what was to become the Neo-Nile Delta were set when the palaeo-relief was cut in Pre-Nile sands during the low sealevel stand of the last glaciation (Said 1981). With sealevel rising again after the glacial maximum, sediment began to accumulate in the eroded basin, gradually burying the palaeo-relief. It may be safely assumed that true Delta-type deposition was initially confined to the Delta front and the central, deepest parts of the basin. Direct clues regarding environmental conditions in the Delta during the Early Holocene are hard to obtain. Coutellier and Stanley (1987) describe basal Delta sediments, notably older (Pre-Nile?) riverine sands which have been reworked in an erosive fluvial or coastal setting during the Late Pleistocene to Early Holocene. The oldest Neo-Nile clays of the central Delta would date to *ca.* 10,000 B.P. However, being suspension sediments of the Nile, these clays are of allochtonous origin (Said 1981; Butzer 1974) and do not tell much about local conditions. The range of Early Holocene Delta-front deposits tell much about environmental conditions inland, as these are genetically related to coastal processes. Hence the central Delta and the Delta front provide restricted stratigraphic evidence regarding local conditions during the period between 18,000 and 6,000 B.P. The local stratigraphy from the AUSE/NFARE survey area indicates that at that time Delta edges were still beyond the reach of the regular Nile branches. The Nile 2 deposits, found in the area, are of local origin. The Early Holocene conditions in the eastern Nile Delta are reconstructed from that stratigraphic evidence.

Lithologies and facies characteristics of the Nile 2 deposits point to a variety of (coeval) small scale environments. Many of the small depositional systems seems to have been fed by intermittent (ephemeral), high-energy water influxes of local provenance and by heavy rainstorms (wadis from the adjacent desert). At the same time the area suffered strong evaporation (calcareous muds). Eolian activity was not dominant. Secondly, more permanent water-bearing systems existed, such as larger rivers, swamps and lakes. Though these rivers were not capable of producing overbank clays, the swamps (at least several of them) were stable enough to outline the Nile 2 phase. Most lake deposits show no obvious traces of temporal desiccation.

The coeval existence of these kinds of depositional environments can only be accounted for by assuming an arid climate with a total water-influx or amount of precipitation which was considerably higher than at present (*cf.* the "pluvial" period with rich vegetation and paludine environments which Horowitz [1979] postulates for the Middle East from 7,000 to 4,500 B.P.). The depositional environments depending on intermittent water-influxes would fit to arid climatic conditions as known today in the Eastern Desert, but this is contradicted by the lack of major eolian deposits. Moreover, the scale of the ephemeral and other deposits points to a higher intensity and frequency of tempestuous precipitation than at present. The presence of larger, perennial waterbearing systems, which clearly were no ordinary Nile distributors, may be explained in several ways. Perhaps singular Nile branches already had reached the area, simply traversing it and cutting such deep channels that they precluded spillover and flooding during the annual high stage. Instead, sediment taken up by scouring of the subsoil was transported downstream to be deposited at the Delta front. (*Cf.* new

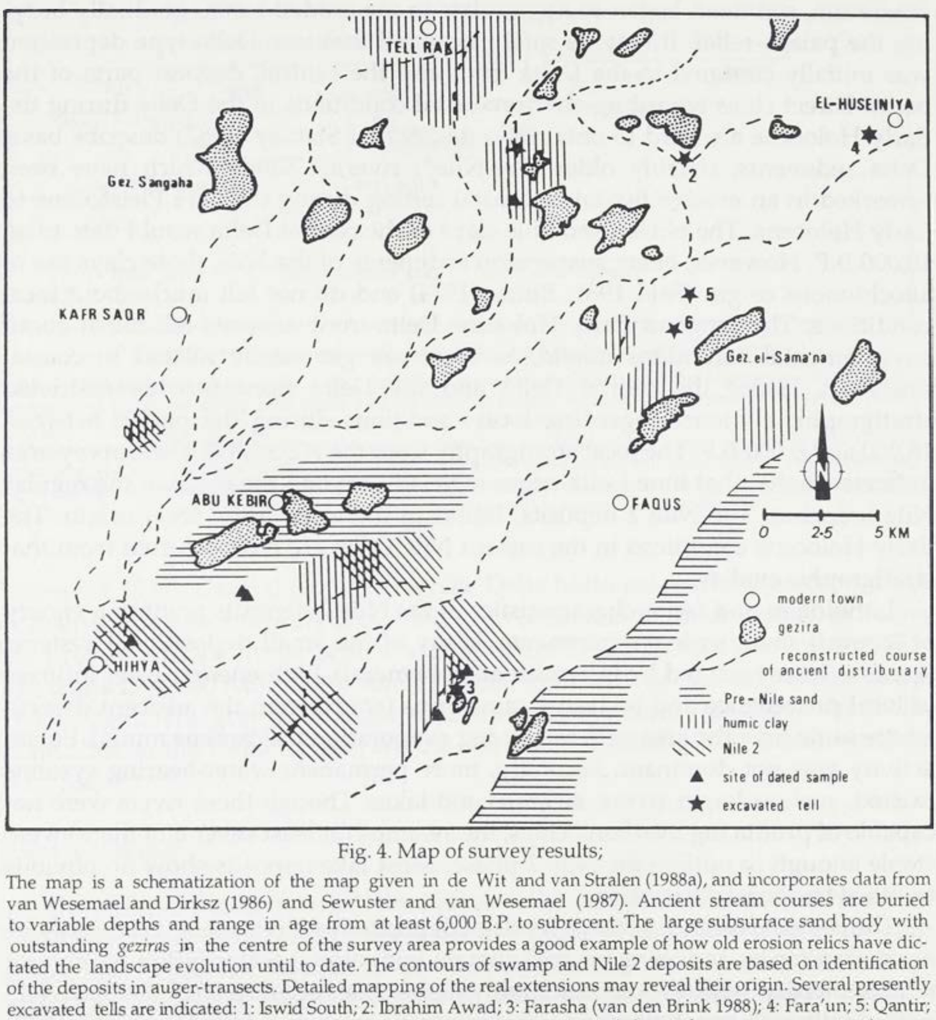

Fig. 4. Map of survey results;

The map is a schematization of the map given in de Wit and van Stralen (1988a), and incorporates data from van Wesemael and Dirksz (1986) and Sewuster and van Wesemael (1987). Ancient stream courses are buried to variable depths and range in age from at least 6,000 B.P. to subrecent. The large subsurface sand body with outstanding *geziras* in the centre of the survey area provides a good example of how old erosion relics have dictated the landscape evolution until to date. The contours of swamp and Nile 2 deposits are based on identification of the deposits in auger-transects. Detailed mapping of the real extensions may reveal their origin. Several presently excavated tells are indicated: 1: Iswid South; 2: Ibrahim Awad; 3: Farasha (van den Brink 1988); 4: Fara'un; 5: Qantir; 6: el Dab'a (1 and 2 date back to Pre-Dynastic times and were situated close to large swamps; see text).

channel divergences on alluvial fans [*e.g.* Miall 1985; Reading 1986], to which an incipient Delta bears some resemblance). Predominant scouring would account for the high rate of progradation of the Delta front in the Early Holocene, as reported by Coutellier and Stanley (1987), Shea (1977) and Sneh *et al.* (1986). The large swamps, stable and not suffering from droughts, may represent the Nile distributary blocked by the topography of the palaeo-relief. Similar deposits, but of subrecent age, were found close to the desert border during the 1988 field survey and need further study. The stagnant pools with calcareous mud precipitation, however, again point to higher local water-influx, as it is hard to imagine that pure calcareous muds have been deposited directly from the Nile waters.

A period of general erosion succeeded the Nile 2 phase. When plotted on a map (Fig. 4), the occurrences of former Pre-Nile erosion relics and Nile 2 deposits appear greatly reduced. The post Nile 2 erosion relief is so irregular that it is inconceivable that it was formed otherwise than by larger streams; yet, the normal Nile regime as we witness today, is not capable of such severe scouring. Probably the early Nile branches kept on scouring the area and had not yet evolved to the kind of tranquil meanders that cause sediment accumulation by annual floodings. At the same time local water-influxes and precipitation diminished and thus precluded further Nile 2 deposition. Prevailing erosion also is evidenced by the thin deflation horizon topping the Nile 2 deposits (irrespective of their type of origin) in many auger cores. Increased deflation indicates a relatively dryer period marking the end of the Nile 2 phase.

When in the Early Nile 1 phase standard depositional Neo-Nile conditions eventually reached the area, this last palaeo-relief became buried by regular deltaic deposits (Fig. 3: 2). The base of the Nile 1 formation is identical to higher parts of the formation, for which reason it is assumed that once the local distributary (Nile branch) system matured into its constructive phase, it did so for good. Standard Nile sedimentation is a well known story: during annual floodings sediments from higher upstream were left behind on the Delta plain as overbank deposits. Only the distributary pattern was determined in the Delta plain itself, other sedimentation was entirely governed by regional factors. Windblown sand influxes as well as runoff sediment-sheets closer to the *geziras* occur on a limited scale, emphasizing climatic conditions similar to the present one, since at least 5,960 B.P. (cal.). Holocene redeposition of Pleistocene sands can be deduced from incorporation of anthropic material in the sands, but also from the fact that wedges and sheets of pure, typical Pre-Neo-Nile sands regularly occur extending from the *geziras* and "floating" in the flood-basin clays. Archaeologists should be aware that even such pure sands need not necessarily constitute the virgin soil. As pilot studies have revealed that pollen preservation in the Nile 1 deposits is rather poor (Prof. van Zeist, pers. comm.) hopefully microfaunal analyses (diatoms) may help determining local environmental conditions.

The non-depositional boundary between the Nile 1a and 1b members again may be explained by regional factors. When for some period the magnitude of the Nile floodings was considerably less than usual, the natural irrigation and gradual build-up of the floodbasins was interrupted. The effects were a break in the sedimentary record (effectively a drop of calculated mean sedimentation rate), and increased soil formation and concentration of non-Nile and anthropic material on the permanently exposed land surface. Reduced Nile floodings would have occurred in the first half of the 5th millennium B.P. (see datings in Fig. 2).

Archaeological implications: The evolution of the Eastern Nile Delta as a factor for cultural development

The palaeo-environmental model can fully explain all field observations and provides an adequate framework for the cultural development in the NFARE survey area. Figure 4 is an interpretation of the observations, showing principal palaeo-environmental elements of widely different ages. The figure is not a palaeo-geographical map, but merely serves to illustrate the mechanisms of the natural evolution of the area. It shows that the Pre-Nile erosion-relief has dictated patterns of deposition and renewed erosion throughout the Holocene. Nile 2 deposits are found along the desert border and wherever they are shielded from erosion by the Pleistocene relics. Equally the erosion relics have controlled the course of the Nile 1 distributary channels until today. The Pre-Nile sands themselves, or the erosive surface of Early Holocene age at their top, have yielded no indications regarding human settlement in the area. Because of their age they are excluded from the NFARE program.

During the Nile 2 phase nomadic subsistence may have been possible in the area (*cf.* sites described from the Egyptian Sahara: *e.g.* Brookes, Kröpelin and Neumann, this volume; and the Negev: Horowitz 1979), provided that precipitation was not only more intense, but also more frequent than at present. The swamp and lake deposits (vertical- and cross-hatched in Fig. 4) indicate sites with a relatively stable watersupply, even in the period of drought and deflation before regular Nile conditions come about in the area. Such sites will have offered good opportunities for (semi)permanent settlement during Upper Palaeolithic (depending on the maximum age of the deposits), Neolithic and Early Dynastic times. For instance, the sample dated at 7,140 B.P. (cal.) was recovered from vast swamp deposits close to the AUSE archaeological site of el-Tell el-Iswid (South). Recorded settlement at this site dates back to Pre-Dynastic times, 5,350 years B.P. (van den Brink 1989). Based on stratigraphic correlations, the swamp still existed during much younger occupation periods of the tell. During the 1988 survey a similar configuration was discovered at another Pre-Dynastic site, notably Tell Ibrahim Awad. This suggests that the early settlement sites were directly related to nearby swamps or waterpools. Due to northward decreasing topographic (palaeo)elevations, more swamp deposits may be expected towards the present Delta front. These too were potential sites of human occupation (Krzyżaniak, this volume).

The westernmost major distributary depicted in Fig. 4 (the so called Tanitic branch system) may already have been active during the Nile 2 phase. The assumption is based on a direct correlation of the Tanitic bedload and the underlying fluvial Nile 2 sediments. In this respect it is remarkable that most of the oldest sites are concentrated along this (pro)Tanitic branch (van den Brink, this volume, and 1989). Also due northwest of the Sharqiya desert border an incipient distributary may have existed during the Nile 2 phase; its remains, however, are too scattered to fit a consistent pattern. Depending on what major Nile 2 fluvial systems actually looked like, they may have provided favorable opportunities for human settlement. However, thusfar no archaeological remains have been recovered from any of the Nile 2 deposits.

The Nile 2 phase was concluded by a period of erosion and deflation. Prevailing dry climatic conditions will have prevented other than marginal possibilities for cultural development, except at sites with a more stable water-supply such as described above.

The Nile 1 phase was characterized by a climate and Nile flowregime such as we know today in northern Egypt. Though regional conditions were fairly constant, by no means the Nile 1 Delta itself was a static landscape. The continuous shifting of the various distributors caused a dynamic evolution of the area. This is illustrated by the variable ages (birth and extinction) of virtually each of the stream channels which are depicted in Fig. 4. Once more it should be realized that the apparent homogeneity of the Delta surface is misleading. The entire survey area, except for the desert and the *geziras,* is covered by alluvial sediments, mainly floodbasin clays. Traces of alleged backswamps, based on ancient Egyptian and historical sources (Bietak 1975; *Déscription de l'Egypte* 1809 - 1822), are obliterated. The original deposits now are identical to floodbasin clays, probably as a result of biological burrowing and oxidation during dry seasons. The unfortunate effects hereof are that the distinction of ancient agricultural fields *versus* backswamps and wasteland areas is impracticable, and that hardly any pollen have been preserved. During the 1988 season singular, highly organic swamp deposits were found which still contain pollen, that will be analyzed in the future (Bottema, pers. comm.). The clays bear numerous traces of human utilization, such as anthropic material, (cultivated) soils and even man-made canals. Settlement patterns were dictated by the *geziras* and ancient river courses: *tells, i.e.* centers of human settlement, are found preferentially on *geziras* close to stream channels. Increasingly in the course of the Egyptian history, settlement patterns became related to other than natural causes (van den Brink, this volume).

In the period represented by the Nile 1a - 1b boundary, regular deltaic deposition fell short, due to regional but possibly also human causes. Regional causes could be temporary waning of the Nile discharge or temporal climatic changes. Man-induced causes could be damming or decapitation of the eastern Nile branches somewhere upstream. Accumulation of anthropic material on the boundary surface indicates that the area remained occupied during this period.

One final point merits consideration. The continuous build-up of the Nile 1 Delta resulted in gradual burying of older deposits to increasingly greater depth, as *e.g.* can be traced at *gezira* edges. Similarly, the Nile 2 calcareous muds nowadays are buried to such depth that they had not been rediscovered thusfar. Corrected for gradual burying, the calcareous muds did rest at lesser depths and locally may have been exposed in Pre- and Early Dynastic times. The muds provide an excellent raw material (pure or admixed with clay) for ceramics. White ceramics regularly were found at excavations in the Delta, but up to now have automatically been considered imported ware: the natural occurrences of raw material for such ware (*e.g.* marl clays) were thought restricted to the area south of Cairo (Butzer 1974; Arnold 1981). The Nile 2 calcareous muds prove that white ceramics might as well have been manufactured locally in the Delta itself.

Conclusions

The Neo-Nile Delta was founded on a palaeo-relief of Late Pleistocene age. The natural evolution of the Eastern Nile Delta since then, as reflected in the stratigraphic record, comprises two constructive phases, separated by a period of erosion. The lower, Nile 2 constructive phase is characterized by abundant ephemeral deposition-environments of restricted dimensions, and possibly by the introduction of the first Nile branches which only were capable of scouring the subsoil. Climatic conditions appear to have been arid with a relative high intensity or frequency of torrential precipitation. These conditions will have permitted (semi)permanent settlement at the banks of larger waterbearing systems, and nomadic subsistence over the entire area. The age of the Nile 2 phase is not established, but stratigraphic correlations indicate that it dates to the Early Holocene, *ca.* 7,000 B.P. and older.

Between 7,000 (?) and 6,000 B.P. a phase of dry climatic conditions and deflation concluded the Nile 2 phase, inhibiting human occupation of the area.

Provisionally dated at *ca.* 6,000 B.P. the regular Nile regime settled in the Eastern Delta. The area became traversed by numerous distributors from which the floodbasin clays were deposited, gradually building up the Delta plain. At some time during the first half of the fifth millennium B.P. Nile floods fell short as a response to changes in the upstream Nile regime or possibly induced by human activities. The non-depositional surface which then developed testifies of man's uninterrupted utilization of the soil. At a later stage this horizon was buried again as Nile floodings resumed and human culture further developed.

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LECH KRZYŻANIAK

New data on the late prehistoric settlement at Minshat Abu Omar, Eastern Nile Delta

A preliminary report on the augering programme carried out at Minshat Abu Omar, in the eastern part of the Nile Delta has just been published by this author elsewhere (Krzyżaniak 1992) but it is felt that its updated version still may be of interest to the reader of this volume.

The location of the habitation area of the social group which buried its dead in the Late Predynastic–Early Dynastic cemetery at Minshat Abu Omar (Kroeper and Wildung 1985) has been one of the major aims of the Munich East Delta Expedition. As a result, a research programme has been formulated at an early stage of this project which comprises an extensive surface examination of the land in a radius of several kilometers from the Minshat Abu Omar *gezira* mound and on the mound itself, as well as the sondages and augerings in the vicinity of the cemetery.

Unfortunately, no sites of pre-Ptolemaic–Roman times were found as a result of this surface examination (Krzyżaniak 1989). Bearing this evidence in mind and the widely believed ideas suggesting the location of older settlements in the Delta below the present level of the ground (*e.g.*, Trigger 1985: 21) it was decided to embark on a programme of a systematic field-work by sondages and augerings in the area of the *gezira* mound of Minshat Abu Omar. It was hoped that the older habitation would be located below the level of the cultivated fields, not far from the local burial ground.

A further step was a testing of the pre-Ptolemaic–Roman settlement situated in the northern part of the local *gezira* and known as Tell es-Saba'a Banat. It was made by a 5 m deep sondage and it was hoped that the predynastic midden rested under the remains. However, it turned out that the floor settlement layers, resting on the archaeologically sterile *gezira* sand could be dated to the Saitic period (*ca.* 7th century B.C.) while the upper portions of the midden contain layers dated to the Ptolemaic and Roman periods. The settlement history at this part of the *gezira* was thus dated to *ca*. 700 B.C. – 400 A.D.

After several attempts at augering made in order to gain the technical experience, to train the local workforce and to work out the method of recording, the first systematic investigation of the *gezira* by drilling took place in the spring of 1987. A narrow strip of cultivated land adjoining the present limit of the Minshat Abu Omar *gezira*, at the southern end of the mound, was investigated by augering a net of points. As a result, habitation remains of New Kingdom times were found in this area, containing potsherds, lithic implements, isolated personal adornments and animal remains (food offal). It seems that these remains constitute a midden of *ca*. 2 m in depth; the top part of this midden equals the cultivated level.

The next step was to investigate by auger the cultivated fields in the immediate vicinity of the local cemetery. In choosing the place of the testing the local surface relief, the horizontal stratigraphy of the Late Predynastic–Early Dynastic cemetery and what is known about the ancient Egyptian settlement habits in the riverine environment were taken into account.

Consequently, the testing was made on the cultivated fields to the east of the present *gezira*. The augering was executed along two lines. The borings were made for a distance of 1000 m along one line and 300 m along the other at 50 - 150 m intervals, depending on the accessibility.

A hand-operated auger was used in this testing. A team of four local workmen was employed in the field-work (Fig. 1). Depending on the depth of augering and a kind of the sediment penetrated, three different heads of the auger have been used (Fig. 2); the maximum depth of the testing was 7 m.

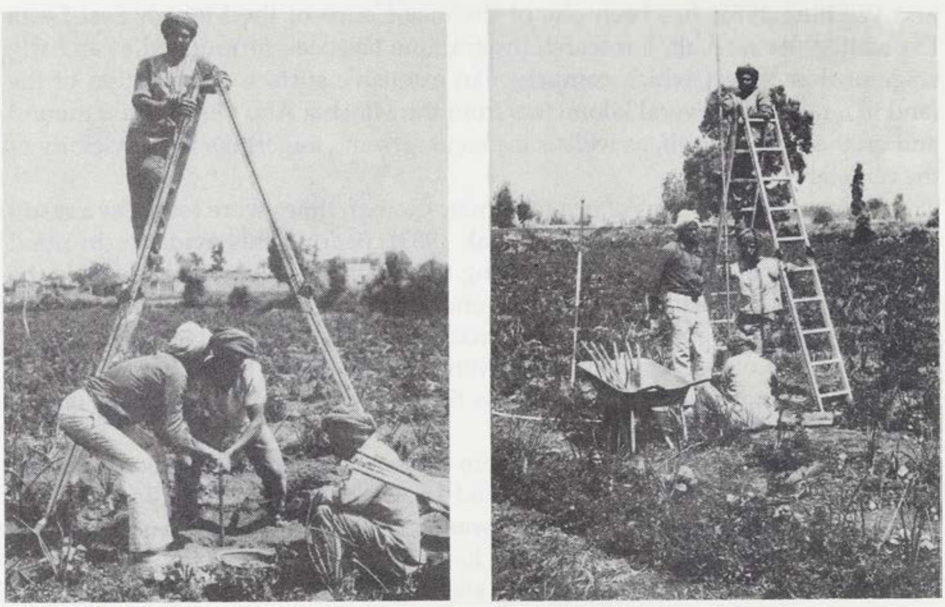

Fig. 1. Minshat Abu Omar. Different stages of the augering.

Fig. 2. Minshat Abu Omar. Head of auger.

The results obtained in the course of the testing can be summarized as follows:

1. The present sandy *gezira* mound constitutes only the top portion of a much larger sandy hill which is now submerged in alluvial sediments of riverine origin which are younger than the hill; its size and surface area have therefore been much larger in the past.

2. A settlement layer of Late Predynastic–Early Dynastic date was found on the slope of the submerged part of the hill, some 500 - 700 m away from the contemporary burial ground. As indicated by the contents of the several borings, it has the features typical of a midden, being rich in potsherds, flaked and ground lithic implements, food offal in the form of charred botanical and mineralized

animal remains and the remains of fireplaces and probably constructions made of mud clay. The midden, with a maximum thickness of 2 m, rests on archaeologically sterile yellow sand and is overlayed by a layer of similar sand *ca.* 0.5 - 1.0 m in thickness which, in turn, is overlayed by a thick, 2.0 - 3.0 m, layer of dark-brown river silt. It seems that this silt was deposited in post-Roman, perhaps Medieval times, when very high Nile floods took place (Hassan 1981: 1142, 1144). Few Saitic–Roman period potsherds found in this silt may originate from the nearby settlement or tombs of this date. It is worth adding that the present ground water level is *ca.* 1.5 m below the surface of the land and, therefore, the Late Predynastic–Early Dynastic midden is well water-logged.

3. In the course of augering made further up along this line, some 600 - 1000 m away from the Late Predynastic–Early Dynastic cemetery and outside its settlement midden, a different geomorphic situation and archaeology have been met. Here the now submerged and rather flat surface of the hill is overlayed first by thick deposit of compact dark-grey-violet mud, rich in organic material. It, in turn, is overlayed by a layer of dark-brown river silt (the surface of this silt is now cultivated). On the flat, sandy surface of the hill, some 6 m down, finds of potsherds were made in several borings. The potsherds are not diagnostic in shape, and are of a rough ware clearly different from anything previously found at Minshat Abu Omar. It seems that their technology may be similar to the Neolithic wares of Northern Egypt. The layer of mud overlaying the ceramic-bearing surface of the hill, later therefore than the potsherds, was radiocarbon dated by four measurements made on samples of mud. The dates form a sequence starting at 4,030 b.p. ± 70 in the upper portion of the mud layer and ending at 5,720 b.p. ± 80 at its floor and above the ceramic-bearing surface. It seems, therefore, that this pottery is older than 5,700 b.p.

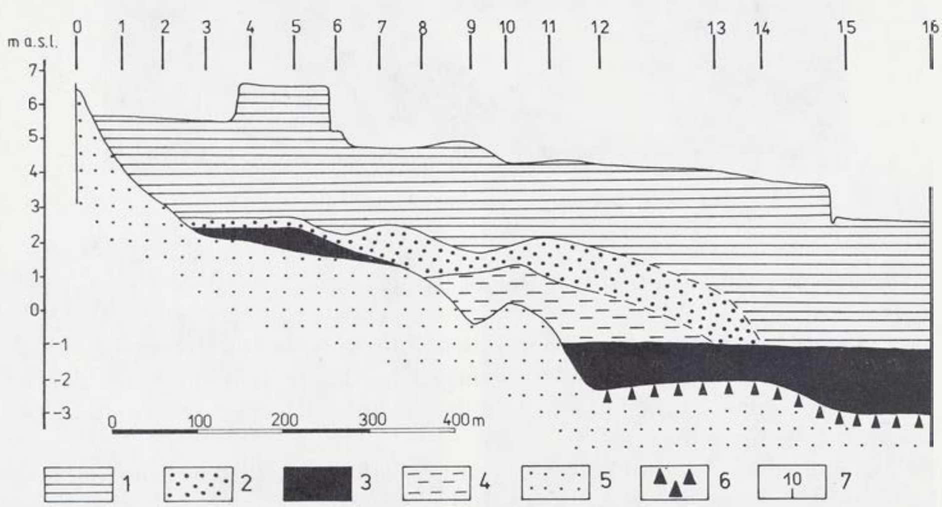

Fig. 3. Minshat Abu Omar. Preliminary stratigraphy;

1: dark-brown silt of post-Roman (?) date; 2: fine, light-coloured sand; 3: heavy, compact dark-violet mud rich in organic matter; 4: Late Predynastic settlement remains; 5: coarse sand; 6: occurrence of the Neolithic (?) potsherds; 7: augering point.

The above results can be illustrated by a section showing the geomorphic and archaeological stratigraphy at Minshat Abu Omar (Fig. 3). It is to be mentioned that the results presented in this paper are of preliminary character and should be substantiated by future field-work, particularly by more augering.

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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.

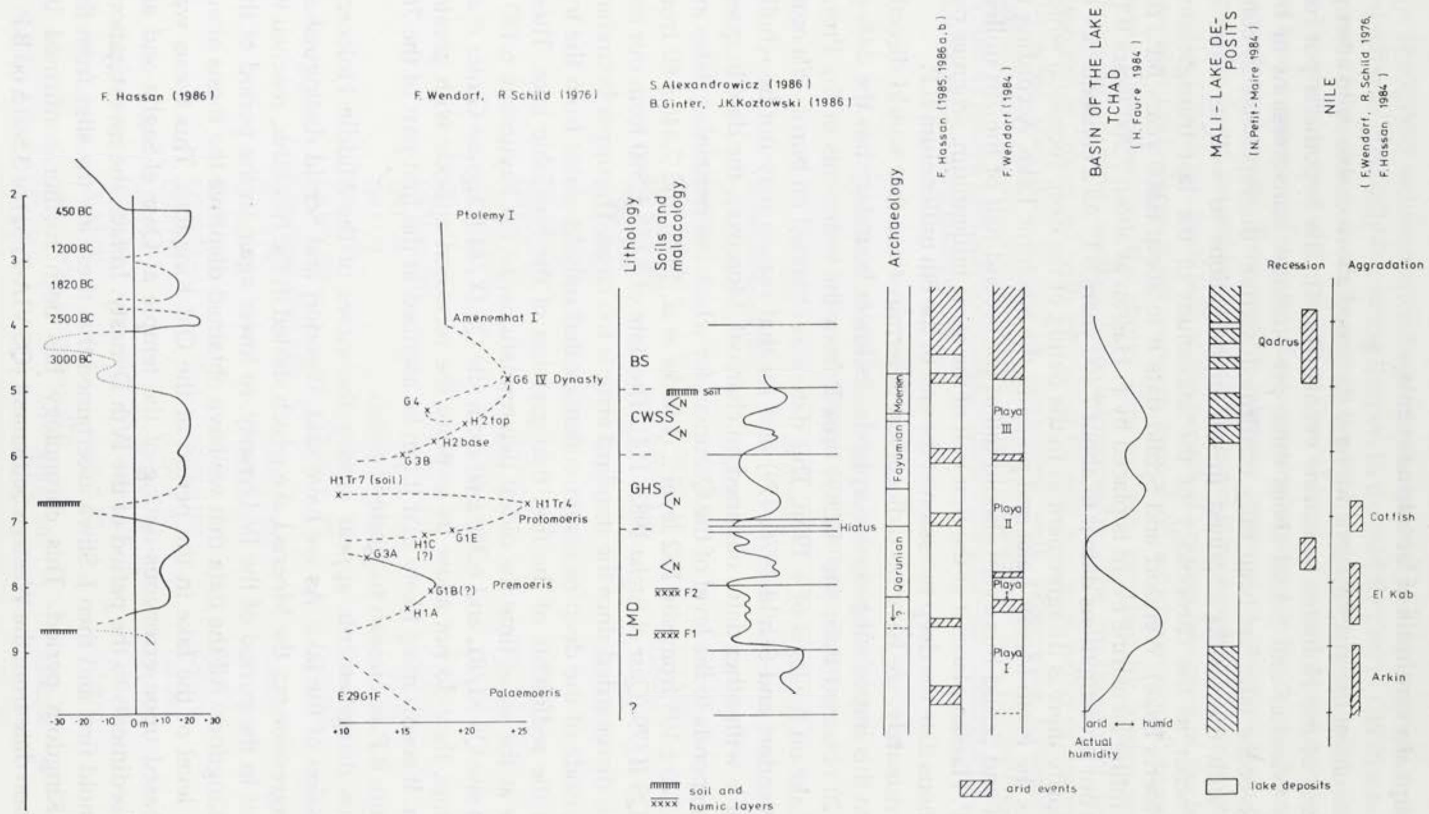

Fig. 1. Lacustrine events in Fayum Depression in comparison with Western Desert arid and dry intervals, other Saharian lakes fluctuations and with Nile aggradations and recessions during the Holocene.

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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Palaeolithic chert quarrying and mining in Egypt

Chert mines are among the first structures of prehistoric man's activities to have been observed. The economical changes and the population expansion accompanying the spread of early agriculture in the Near East and Europe constitute a real technical revolution. According to G. Smolla (1987), flint mining could have been an especially important part of this process, and indeed, until

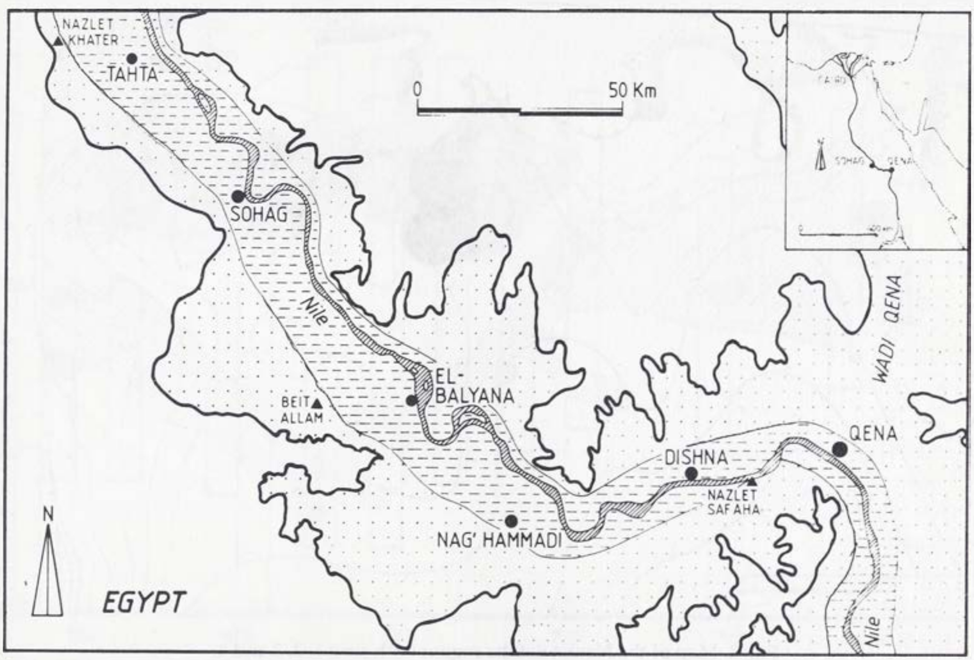

Fig. 1. Situation map of the sites, floodplain (shaded area) and lower desert (dotted area).

some years ago, all chert mining sites reported in the literature, were younger than 12,000 years, most of them being confined to the period of 6,000 to 4,000 years ago (Weisgerber, Slotta and Weiner 1980).

Research by the Belgian Middle Egypt Prehistoric Project of Leuven University since 1980 led to the discovery of two important Palaeolithic chert exploitation areas, one at Nazlet Safaha, near Qena, and another at Nazlet Khater, near Tahta, both in southern Egypt (Fig. 1).

Middle Palaeolithic quarrying

The area of Nazlet Safaha is situated on the west bank of the Nile, downstream of Dandara Temple (Vermeersch *et al.* 1986. In this publication the site has been erroneously named Nazlet Sabaha). It is located near the river Nile, on a Nile cobble terrace remnant, which is still quarried for gravel in many small pits. The bars of the former channel deposits, with their top at about 7 m above the Nile floodplain, are 2 to 3 m thick and rest disconformably on very coarse Nile sands. The terrace deposits contain mainly metamorphous and eruptive, but also quartz and chert cobbles with a diameter of up to 0.2 m. The matrix is composed of pebbles and coarse sands. The chert cobbles are round or ellipsoidal. The cobble deposit is overlain by medium sands of variable thickness (about 0.5 m).

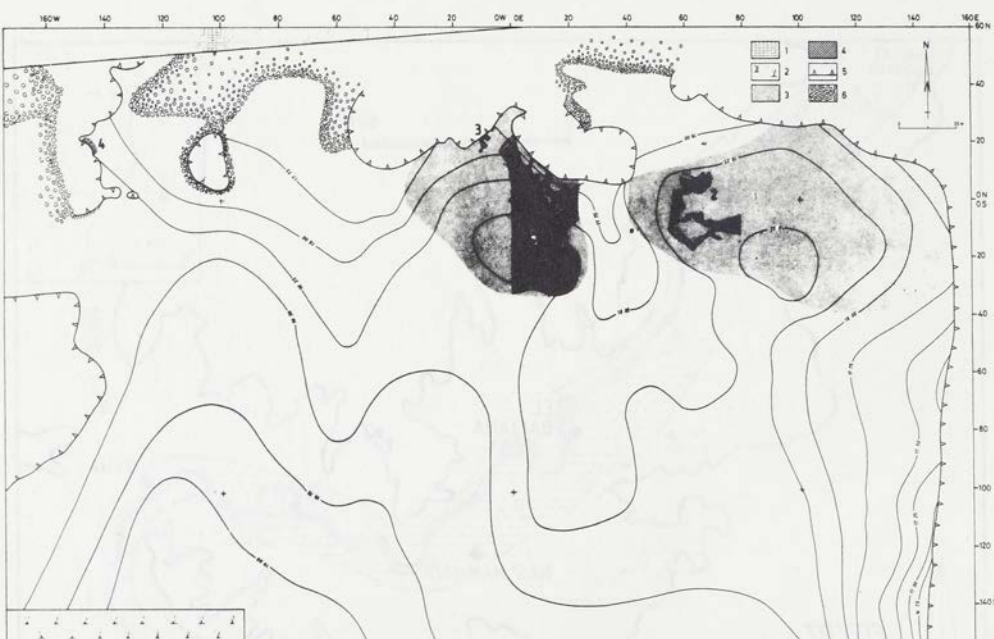

Fig. 2. Map of the Nazlet Safaha region with sites 1, 2, 3 and 4;
1: abandoned Maghar canal; 2: cultivated area; 3: man-made desert pavement; 4: area exploited by Middle Palaeolithic man as reconstructed in our excavations; 5: recent quarry front; 6: recent quarry dump.

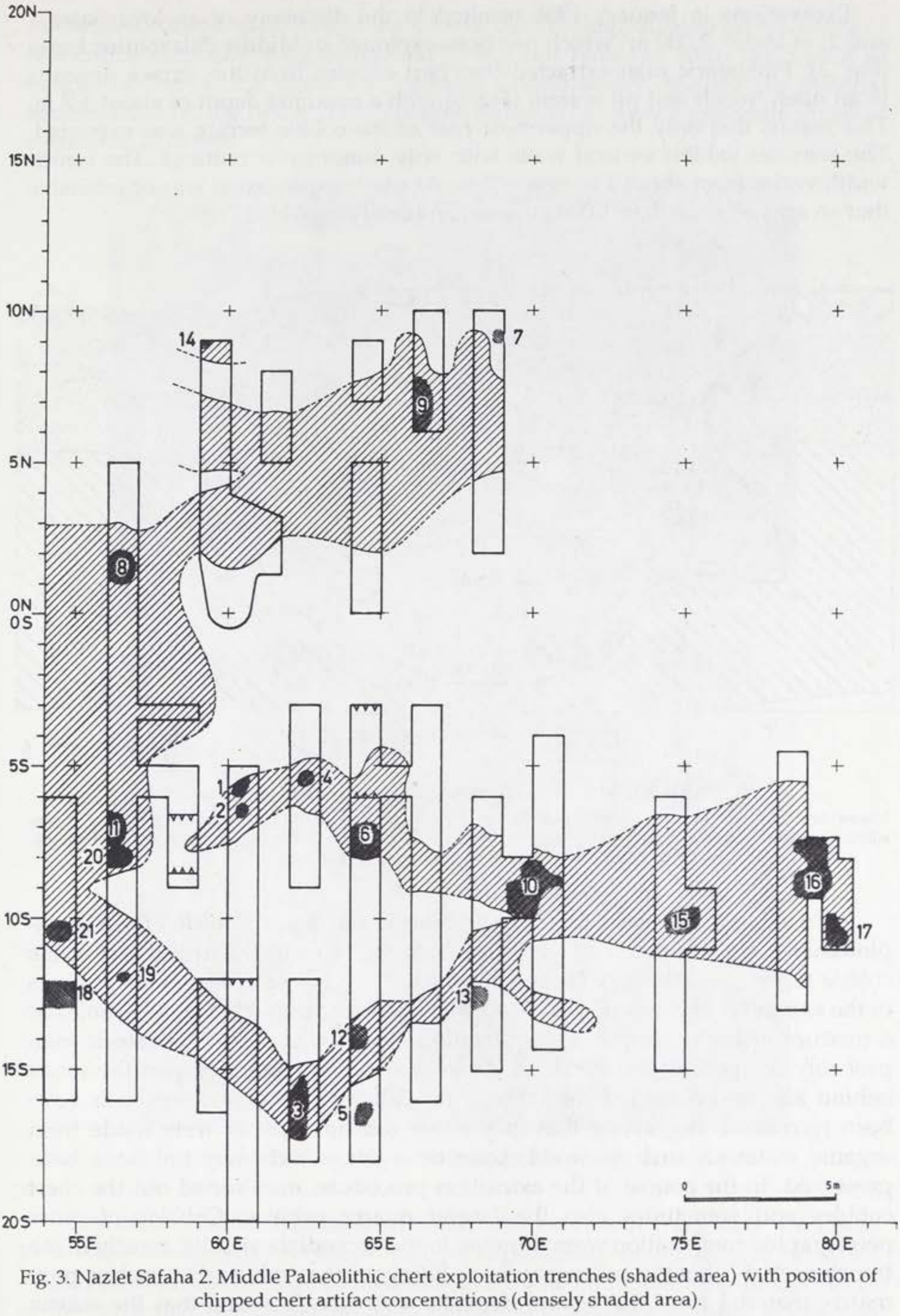

Fig. 3. Nazlet Safaha 2. Middle Palaeolithic chert exploitation trenches (shaded area) with position of chipped chert artifact concentrations (densely shaded area).

Excavations in January 1988 resulted in the discovery of an area (sites 1 and 2) of about 3,000 m^2 which had been exploited in Middle Palaeolithic times (Fig. 2). Prehistoric man extracted the chert cobbles from the terrace deposits in an open trench and pit system (Fig. 3) with a maximal depth of about 1.7 m. This means that only the uppermost part of the cobble terrace was extracted. The trenches exhibit vertical walls with only minor undercuttings. The trench width varies from about 1 to nearly 2 m. At site 1, exploitation was so intensive that an area of more than 1,000 m^2 was completely exploited.

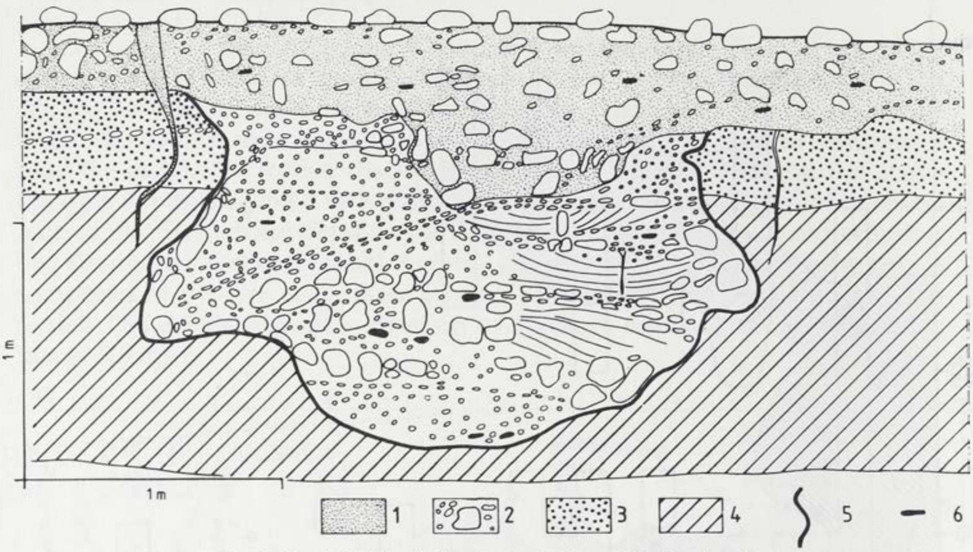

Fig. 4. Nazlet Safaha 2. Section through exploitation trench;

1: loose fine and medium sands with desert pavement on top; 2: man-made heterogeneous infillings; 3: consolidated medium granuliferous sands (substrate); 4: Nile cobble terrace (substrate); 5: delimitation of Middle Palaeolithic trench; 6: Middle Palaeolithic artifacts.

Field evidence suggests that Middle Palaeolithic man proceeded from an exploitation front composed of sterile sands at the top and the upper part of the cobble terrace, mostly only six cobbles thick. The very heterogeneous infillings of the exploited trenches (Fig. 4 - 5), clusters of pure sands, clusters of cobbles or a mixture of both, suggest an exploitation in different steps. Prehistoric man probably scraped off the sterile sands from small surfaces, dumped the sands behind him and extracted the cobbles individually. No excavation tools have been recovered, suggesting that they either did not exist or were made from organic materials such as wood, bone or antler, which may not have been preserved. In the course of the extraction procedure, man sorted out the chert cobbles and sometimes also the largest quartz pebbles. Cobbles of other petrographic composition were dumped in the immediate vicinity, mostly in the trench itself. Within the anthropogenic infillings of the prehistoric trenches, pure matrix material from the terrace deposits was rare. It seems that the matrix material occurs concentrated at the base of the infilling, situated on top of the *in situ* cobble deposits, suggesting that it was not removed from the trench in course of the trench extraction process. Consequently, the matrix material accumulated on top of the *in situ* cobbles, hampering or even preventing further extraction in depth.

Fig. 5. Nazlet Safaha 2. Similar profile as in Fig. 4.

Very often Middle Palaeolithic artifacts and charcoal fragments are incorporated in the fillings. During prehistoric exploitation the whole area probably displayed an irregular topography with many pits and low dump-heaps. Some of the excavated pits contained an accumulation of large quantities of chipped chert artifacts. Refitting together many of these artifacts indicates that prehistoric man has transformed the chert cobbles into prehistoric artifacts in or in the vicinity of the quarrying trenches. In the course of the extraction procedure aeolian sand was blown into certain exploitation pits, causing some of the artifact concentrations to be stratified in aeolian deposits. Absence of running water deposits or erosional features in the trench fillings and the aeolian sands suggests that climate during the exploitation periods was hyperarid.

After the abandonment of the area, the exploited surface was littered with cobbles lying in an unnatural position above the sterile sands. Since then the whole surface has been levelled off by denudation and an aeolian cover has filled the pits. Finally, a desert pavement, bearing a dark desert varnish, has developed over the whole surface, covering filled pits, aeolian deposits and dump materials (Fig. 2). This desert pavement is man-made as it is mainly composed of cobbles extracted by prehistoric man and of artifacts. Our excavations at the outer edge of the desert pavement zone indicate that its extension is a very precise indicator of the delimitation of the prehistoric exploitation area.

Living structures or hearths have not been recognized. In some places, however, charcoal could be observed in relation to some of the chert artifact accumulations. As a whole, the quarrying site gives the impression of being rather unstructured, probably as a result of intermittent, non-continuous exploitation.

Original discovery by prehistoric man and access to the cobble deposit is probably due to the fact that the river Nile was already, in those former times, in present nearby position, eroding the terrace deposits. Moreover, the sand cover is thinning out towards the Nile so that it is likely that the cobbles were outcropping near the river and thus directly available at the surface.

The lithic artifacts recovered in and outside the prehistoric dump deposits at site 1 and 2 mainly represent a Levallois technology. Retouched tools are nearly absent. As far as we know at present, the Levallois technology belongs to the classic Levallois (K) group as defined by van Peer and Vermeersch (1990). The occurrence of Nubian technique, absent at sites 1 and 2, was observed at site 4. At the latter site, however, excavations have not yet been undertaken. The presence at site 1, 2 and 4, of Levallois or Nubian technology exclusively, points to a Middle Palaeolithic age of the exploitation.

Similar artifacts, belonging to the classical Levallois group, have been recorded at other sites in the Egyptian Nile Valley, such as Nazlet Khater-2 and Beit Allam (Vermeersch, Paulissen and van Peer 1990). These sites are considered older than 60,000 years (Paulissen, Vermeersch 1987; 1989). Taking into account that the site of Nazlet Safaha is coeval with an hyperarid climate, it is probably of somewhat younger age and we estimate that it can be placed around 50,000 years ago. Accelerator datings of the dispersed charcoal in the aeolian sands and in the infillings are in progress.

Chert exploitation, where no chert was visible at the surface, testifies that Middle Palaeolithic man already had the intellectual capacity of geological reasoning. Indeed, he was able to extrapolate what he observed during the initial extraction: the fact that exploitable cobbles were still present under a thin cover of sterile sands. Middle Palaeolithic exploitation techniques were simple but well adapted to the chert occurrence in fluviatile deposits.

A detailed survey of the terrace remnants and along all recent quarry fronts in the Nazlet Safaha area revealed the presence of other exploitation sites. Quarrying activity lasted probably over a long period of time, starting at least in the Middle Palaeolithic but probably continuing over some ten thousands of years into the Upper and Late Palaeolithic periods. Indeed, although we did not perform excavations, surface collection and inspection of prehistoric extraction pits, visible in recent quarries, suggest the presence of younger cobble exploitation sites, utilizing the same quarrying methods as Middle Palaeolithic man. At site 3 (Fig. 5), the extracted chert cobbles have been worked for flake production without the utilization of Levallois technique. Site 5, some 200 m east of site 2, is characterized by numerous double platform cores which, by using a crest preparation technique, have been flaked for blades. Here also, Levallois technique is lacking. Debitage techniques at the latter site are characteristic for the Upper and Late Palaeolithic period.

All these quarrying activities produced a landscape where most of the area with a thin sand cover had been exploited by prehistoric man.

Upper Palaeolithic mining

Some 150 km to the north of Nazlet Safaha, at Nazlet Khater near Tahta (Fig. 1), we excavated a chert mining site with an exploitation system of trenches, vertical shafts and horizontal subterranean galleries, C-14 dated at 33,000 years ago

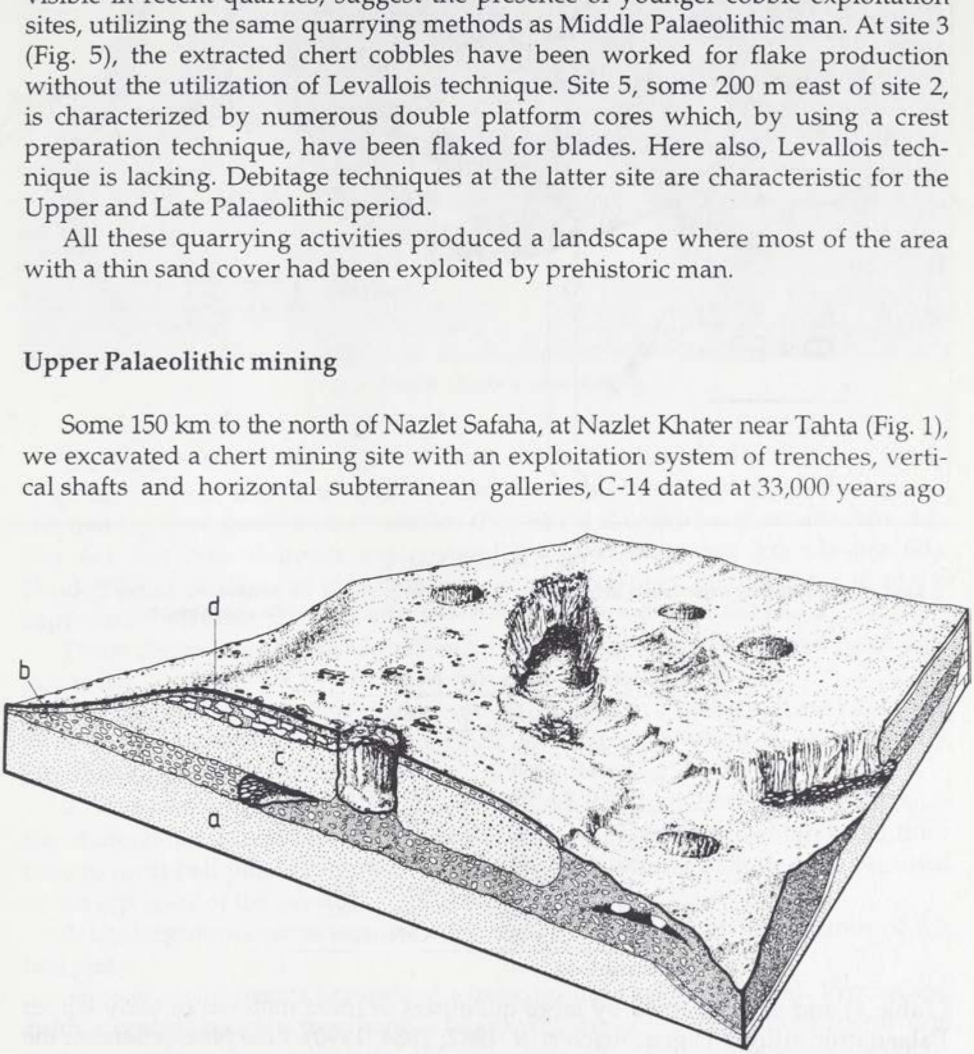

Fig. 6. Nazlet Khater 4. Stratigraphy and extraction systems of the Upper Palaeolithic exploitation; a: greenish silts; b: Nile gravels; c: brown granuliferous silts and fine sands; d: local limestone gravels.

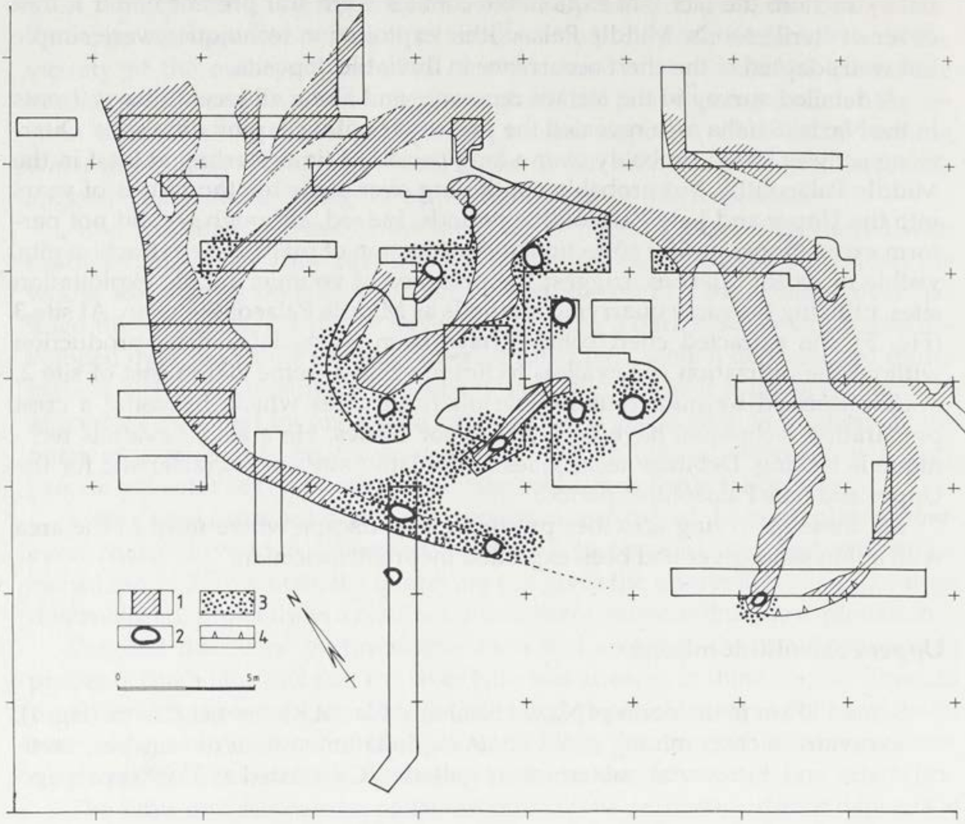

Fig. 7. Nazlet Khater 4;
1: location of prehistoric exploitation trenches; 2: vertical shafts; 3: during the excavations explored galleries; 4: outer limit of the Nile terrace gravels coinciding with an Upper Palaeolithic trench.

Table 1
Radiocarbon dates for Nazlet Khater 4.

C-14 years ago	Laboratory
30,360 ± 2,310	Lv-1139 D
30,980 ± 2,850	Lv-1141 D
31,320 ± 1,990	Lv-1142 D
32,100 ± 700	GrN-11297
33,100 ± 650	GrN-11299
33,280 ± 1,280	Lv-1140
33,650 ± 450	GrN-11301
34,950 ± 600	GrN-11300
35,100 ± 1,100	GrN-11296

All on charcoal.

(Table 1) and accompanied by large quantities of lithic material of early Upper Palaeolithic affinity (Vermeersch *et al.* 1982; 1984; 1990). Like Nazlet Safaha, the site is situated on a low Nile terrace remnant, at the edge of the cultivated plain near the limestone cliffs, bordering the valley.

Fig. 8. Nazlet Khater 4. Shaft orifice.

The base of the Nazlet Khater 4 site consists of greenish silts and fine sands (Fig. 6a) covered by about 1 m of Nile deposits, composed of well rounded channel lag gravels with chert cobbles (Fig. 6b) and of brown granuliferous silts (Fig. 6c). The Nile deposits are covered by local limestone gravels (Fig. 6d). The 1987 excavations provided us with a ground plan of the site and of the exploitation features (Fig. 7).

Three different types of Upper Palaeolithic digging activities can be distinguished:

1. Trenches with a width of 1 m and depth of 2 m in which gravel deposits have been exploited for their entire thickness and from which all chert cobbles have been removed (Fig. 7: 1);

2. Vertical shafts (Fig. 7: 2; 8), dug down to a depth of 2 m, reaching through the channel lag gravel into the greenish silts, were sometimes enlarged at their base to form bell pits. Exploitation of this type sometimes included the removal of the top layer of the greenish silts over some 0.5 m;

3. Underground extraction from the trench walls or from the bottom of the bell pits.

Most gravel deposits between the trenches have been extracted. Proceeding from a central bell pit, the channel lag gravels have been exploited for several meters, creating short horizontal galleries, very often with subterranean connections. The largest galleries (Fig. 7: 3) which could be explored, extend for more

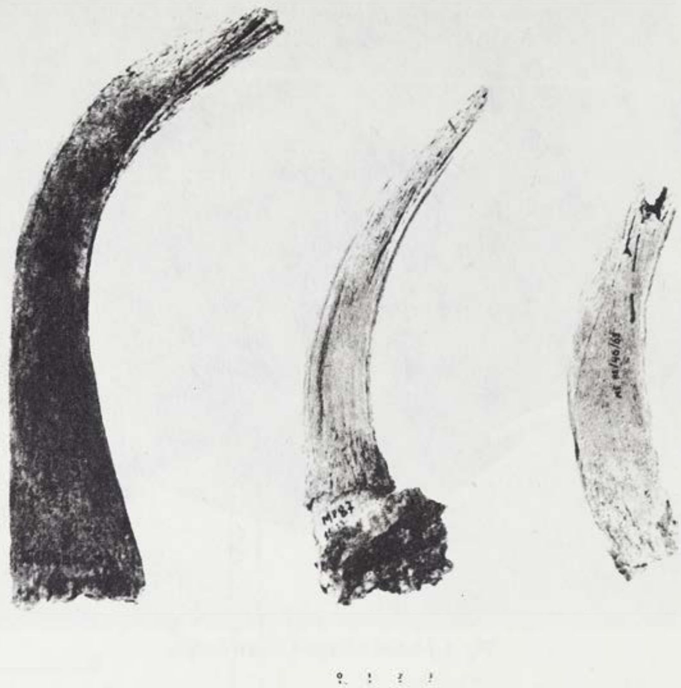

Fig. 9. Nazlet Khater 4. Horn picks of gazelle and hartebeest.

than 10 m^2 under the ground. The horizontal distribution of trenches and bell pits suggests that very large areas of the site are really undermined. Gallery roofs have collapsed here and there.

On the walls of shafts and galleries cutting marks of picks used in gravel extraction can often be observed. Sometimes these cutting marks have been covered with a calcite crust, proving their antiquity. Some picks have been recovered from the horizontal gallery fillings. They consist of gazelle and hartebeest horns of which the extremity is very worn (Fig. 9). Rough extraction activities have been performed by using heavy hammerstones (Fig. 10), of which numerous examples have been found.

The post-exploitation deposits in the trenches, in the bell pits and in the horizontal galleries consist of anthropogenic gravel dumps at the base, covered with yellow fine aeolian sands. The gravel unit, containing Upper Palaeolithic artifacts, is generally heavily encrusted by a thick calcrete. The overlying infillings of loose aeolian sands completely obscure all Upper Palaeolithic diggings. The presence of *in situ* hearths in the aeolian sand unit indicates that the site was occupied during a period of active sand blasting. The post-occupation evolution

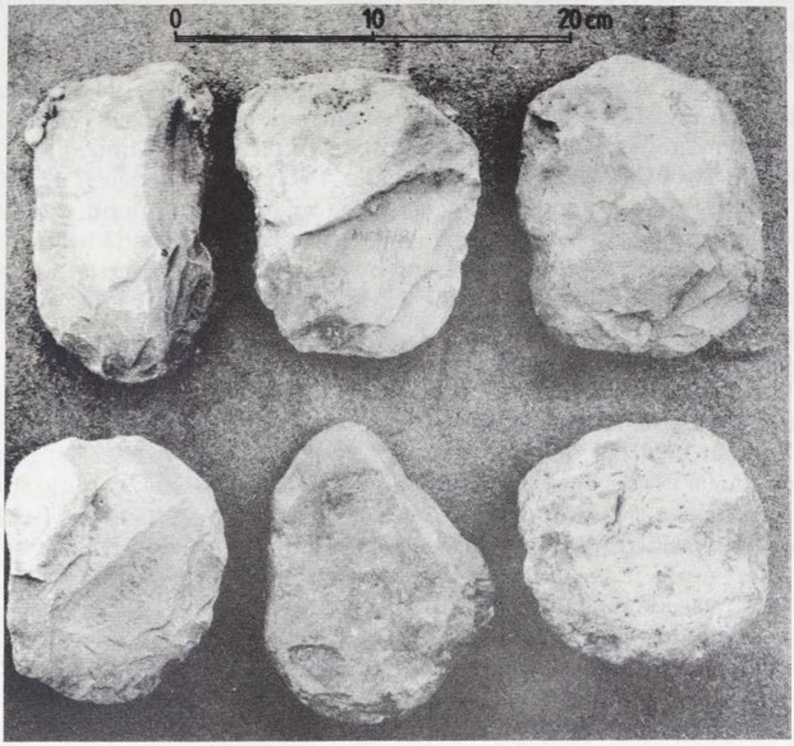

Fig. 10. Nazlet Khater 4. Hammerstones.

of the site consisted of the formation of a salt crust with desiccation of the overall perfect gently eastward dipping slope.

The Upper Palaeolithic diggings were clearly intended for the extraction of chert cobbles from the Nile channel lag deposits. The flat elongated chert cobbles have been utilized as raw material for an intensive debitage activity by early Upper Palaeolithic man. This resulted in the production of large quantities of artifacts, which have been recovered during the excavations. Clearly, the production of blades was the ultimate purpose of the Upper Palaeolithic miners.

Conclusions

Comparison of the Middle Palaeolithic and the Upper Palaeolithic exploitations shows that both systems used trenches. However, the Upper Palaeolithic extraction system differs from the Middle Palaeolithic one in the sense that the exploitation is more regularly planned, involving parallel trenches at fairly constant intervals, enabling a complete exploitation of the cobble deposits. Most evidently, the Nazlet Khater exploitation system is more systematically conceived.

As far as presently known, the quarrying sites of Nazlet Safaha and the mining sites of Nazlet Khater represent the oldest exploitation sites of raw material intended for artifact manufacturing. Some other Middle Palaeolithic sites have been reported from the Suisse Jura (Schmid 1968) and from the north-east Hungary (Siman 1986). At these sites, however, it was impossible to determine the exact age of the exploitation system, because later Neolithic exploitations had thoroughly perturbated the evidence (Schmid 1980). Much better documented is a Final Palaeolithic open air pit for the extraction of chocolate flint at Orońsko II-2 in Poland (Schild 1987), dated between 12,000 B.P. and 11,000 B.P. From none of these sites, however, underground exploitation techniques have been recorded. The well-dated sites of Nazlet Khater 4 and 7 (GrN-14910: 34,900 ± 500 B.P.) represent, by far, the oldest subterranean mining sites in the world. In other parts of the world, in Europe in particular, systematic underground exploitation of chert and flint is known only from the Late Holocene, posterior to 6,000 B.P. (Weisgerber, Slotta and Weiner 1980).

In this context we should mention, however, that very old underground extraction of hematite is reported from the Lion Cavern in Swaziland (Beaumont 1973; Volman 1984). Here, Middle Stone Age people were extracting hematite perhaps 120,000 years ago, utilizing a large horizontal gallery, cut into the side of the specularite rich portion of the hematite cliff face. A sample of charcoal from this site yielded a date of 43,200 + 1,350 – 1,200 B.P. (GrN-5313). Paint quarrying in open pits of early Upper Palaeolithic age has also been reported from sites near Lovas in Hungary (Meszaros and Vertes 1955).

With the evidence of Nazlet Safaha and Nazlet Khater it is clear that organized chert extraction is much older than generally thought. It demonstrates that Middle Palaeolithic man was already well aware of the geological and petrographical potentialities of covered cobble beds and was able to organize their systematic exploitation. Complex subterranean mining, however, involving the construction of shafts or bell-pits, is probably a practice introduced by Upper Palaeolithic man. The development of this type of extraction technology may therefore not be considered strictly related to the economic changes accompanying the introduction of a Neolithic way of live, as was stated by G. Smolla (1987). In Egypt, at least, it is much older.

Acknowledgements

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Plant remains from the Neolithic site at Armant: preliminary report

The plant material comes from the sites MA21/83 and MA21a/83 at Armant in the Upper Egypt. The sites are situated at the margin of the Western Desert near the cultivation zone. Archaeological excavations were carried out in 1985, 1986 and 1988 by B. Ginter, J.K. Kozłowski and B. Drobniewicz of the Jagiellonian University and A. Dagnan-Ginter of the Archaeological Museum in Cracow in cooperation with the German Institute of Archaeology in Cairo (Ginter *et al.* 1989). The geology of the area was studied by M. Pawlikowski from the Academy of Mining and Metallurgy of Cracow (Pawlikowski, this volume).

On the basis of the archaeological material the chronology of the site was defined as a local variant of the Nagada culture. Three settlement phases were distinguished. Their radiocarbon dating was performed by M. Pazdur in the C-14 Laboratory in Gliwice. The settlement lasted from 5,100 to 4,820 b.p. in uncalibrated years or 6,000 to 5,540 B.P. after calibration (Ginter *et al.* 1989).

Rich plant material was represented by fruits, seeds, fragments of ears, grass stems, vegetative parts of other plants, and by charcoal and scarce impressions on daub (Fig. 1). Two hundred samples with plant remains were collected by the author during field seasons 1986 and 1988. In addition, all charcoal pieces found in each layer were collected (except surface layer at 0 - 5 cm depth) and a portion of them was kept for future taxonomic identification. Plant remnants were encountered within individual layers and inside separate features, most commonly in the hearths. Samples were taken only in places of undisturbed stratigraphic sequences and clearly defined archaeological context. Two preservation types were observed, charred and uncharred ones. Charred fragments occurred in the hearths, uncharred in postholes while other features contained charred and uncharred remains. The color of remnants varied from yellow to brown. They were air-dried and very fragile, their state of preservation made wet sieving impossible because any contact with water caused their disintegration.

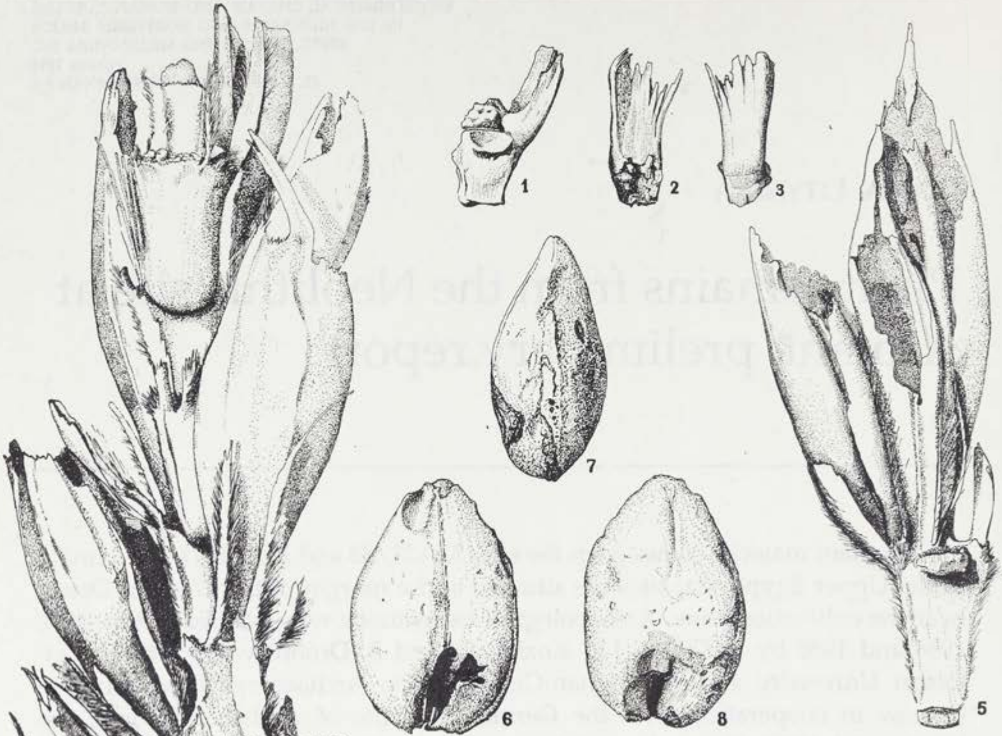

Fig. 1. Armant, Upper Egypt. Sites Ma 21-21a/83;

1 - 3: *Triticum dicoccum* Schübler. 1: spikelet base, 2 - 3: one glume; 4 - 8: *Hordeum vulgare* (L.) Lam., naked. 4: spike fragment, 5: triplet fragment, 6 - 8: one grain; 9: *Citrullus colocynthis* (L.) Schrad., seed; 10: *Compositae* indet., fragment of flat receptade.

Table 1

Plant macrofossil from the Neolithic site near Armant.

Species	Occupation area	
	Ma 21/83	Ma 21a/83
	Number of determined remains	
Triticum dicoccum Schübler	606	86
Hordeum vulgare L. em. Lam.	28	298
Hordeum distichum L. em. Lam	5	
Cerealia indet.	3	3
Lens culinaris Medicus	3	
Citrullus colocynthis (L.) Schrad.	158	
Papilionaceae		1
Papilionaceae Vicia type		1
Echinochloa crus-galli (L.) P.B.	1	
Carex sp.	5	
Graminae indet.	4	1

The determination of plant macrofossils is not yet completed but already many cereal remains have been identified (Table 1).

Wheat is represented by numerous charred glumes and 2-grained spikelet forks and by scare caryopses and rachis internodes. Spikelet bases show the disarticulation of rachis of a from of *Triticum dicoccum.* Detached glumes on the other hand, show certain characters which resemble spelt *Triticum spelta* and not emmer *Triticum dicoccum.* Emmer glumes have two distinct lateral nerves on the ventral and dorsal sides and slightly concave surface between them in the basal portion of the glume. With spelt, glume basis is broader and only the ventral nerve is clearly marked. The lateral glume side is convex and has 4 - 5 distinct nerves. Glumes from Armant are as broad as typical spelt glumes, have one distinct nerve of the keel on the ventral side, and parallel venation on the lateral side. They differ from *Triticum spelta* in that the venation does not reach the lowermost end of glume. All fossil glumes have damaged apexes and the shape of the shoulder is not visible. In spite of this unusual combination of characters the ancient specimens belong to *Triticum dicoccum* Schübler. The determination of this material was discussed with Professor Willem van Zeist.

The remains of barley *Hordeum vulgare* L. em. Lam. include caryopses, spikelets and ear fragments. Most of them are preserved in uncharred condition. The grains have spindle-like outline and broad and shallow ventral furrow. Delicate and wrinkled fragments of lemma and palea are attached to several caryopses. Rachilla is visible at the base of palea. Abundant rachis fragment were composed of up to 6 internodes and often had spikelets attached. Five ear fragments were identified as *Hordeum distichum* L. em. Lam.

Other cultivated plants were represented by seeds of *Lens culinaris* Medicus. They all were uncharred and had traces of insect activity.

Fairly abundant were seeds of *Citrullus colocynthis* (L.) Schard., a wild plant of the family *Cucurbitaceae.* Uncharred grey seeds, narrow ovate in outline, were preserved detached or in small lumps. Nicolaisen (1963) writes that seeds of the colocynth can be eaten after boiling and drying. Other wild plants are represented by few specimens from the *Compositae*, *Papilionaceae*, *Cyperaceae* and *Gramineae* families.

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Mineralogy of Nile Valley sediments as an indicator of changes of climate: the Armant–Luxor area, Upper Egypt

Investigations were carried out at the left bank of the Nile, between Qurna and Armant during four years of intensive field work; more than 20 Neolithic and Palaeolithic sites were discovered.

One of these sites, Ma 21/83 was investigated in detail. The site is located just behind small village called Hagar Dabija between low hills elevated about 7 - 8 metres above the cultivated zone. All regions between Qurna and Armant were tested geologically by more than 30 trenches and pits. Each separated sediment was sampled and tested mineralogically using X-ray, infrared, microscopic and chemical methods. Field and mineralogical investigations showed that the sediments of the Nile Valley were deposited here in five morphological zones as following: zone I, II, high mountains; zone III, hills; zone IV, small hills, level of Neolithic period sites; zone V, flood plain.

The Neolithic sites were localised between two very different zones of sedimentation; at the rapid sedimentation of hill streams and the slow sedimentation of the Nile. In this situation the main problem of interpretation was the identification of the Nile and the hill stream sediments as well as determination of eolian sediments; this was possible with the use of grain and mineral analysis.

Nile sediments

They are represented by different types of fine grained sediments *i.e.* silts, composed of quartz, feldspars, clay minerals, organic substance and heavy minerals. All of the investigated silts of the Nile contain them, but the proportions between them vary.

The material transported from the gebels

This is represented mainly by river gravels composed of well rounded rocks present in the gebels. At Armant–Qurna they are represented by Theban Limestones, which sometimes contains varying admixtures of sand.

Eolian sediments

These are fine grained and are represented by eolian quartz or calcareous sands containing admixtures of small grains of limestones or other rocks.

Residual rocks

These are from red soils developed in the past on the surface of limestone. Relics of these soils are preserved in some regions of the Theban Gebel.

Slope sediments

These are poorly rounded or sharp patinated fragments of Theban Limestones.

Taking into consideration all the sediments, one can determine the general profile of the V zone, in which the archaeological sites are located. At the base of the analysed geological profiles are Sahaba silts which represent one or more layers of Nile mud; the number of layers depends on the locality of the outcrop. Near the gebel, where gebel streams were active, Sahaba silts are interlocated with stream gravels; similar situations can be observed in the old wadis which were transporting material from the gebels during the laying down of Sahaba silts.

The colour of Sahaba silts depends on the admixture of red soils eroded from the gebel during their formation; if the admixture was high, silts were brown or reddish, if low, grey. The Sahaba Formation documents a high level Nile as well as a wetter climate in the region investigated.

The next stage of the sedimentation is represented by sandy silts containing calcified roots of reeds and sometimes mud cracks, contemporary with these sediments, but at other localities there are lake sediments represented by sands, laminated sands and other sediments containing fish bones, mollusca, wood, *etc.* All these document the lowering of the Nile level and the presence of local small relic lakes.

Sahaba silts as well as lake sediments are covered by a pediment deposit of gravels transported from the gebels. This old pediment shows high activity in streams flowing from the gebel and indicates high rainfall. The thickness of this old pediment is much greater in the stream beds than at other places.

The next sediment is represented by river sands which fill the old wadis and show less activity in the streams flowing from the gebels; thin intercalated sediments were also observed. On the sediments described above, mostly Neolithic sites were found.

The morphological phase is documented by the formation of new wadis, which cut earlier strata and destroyed parts of archaeological sites. The banks of the wadis show three phases of terraces, in which the grain size of the gravels showed changes in the transporting abilities of the streams flowing from the gebels. These changes can be linked to local changes in rainfall. During the formation of the wadis another generation of river gravels (*i.e.* young pediment) was laid down; between the activity phases of the wadis eolian sediments were continuously deposited.

At the end of the Neolithic and in the Early Dynastic periods, climate was very dry and the level of the Nile was very low; this is confirmed by the El Tarif mastabas, which are practically on the Nile flood plain. This very dry climate and low level of the Nile continued in Middle Kingdom times, when probably heavy torrential rains destroyed Amenophis III's temple as well as other mud brick structures situated near the flood plain. It is impossible to determine precisely the date but it must have been after 3,350 B.P.

The geological and morphological pattern is complicated by wind activity eroding the sediments and leading to the formation of surfaces covered by coarse pebbles. The data show that the Neolithic site Ma 21/83 was located on sediments older than the top of the younger pediment.

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Problems of assessing environmental impact on the Predynastic settlements of Hierakonpolis

Introduction

This paper presents taphonomic and environmental observations derived from our work in the Predynastic and Early Dynastic settlements of Hierakonpolis. Hierakonpolis possesses the largest and best preserved Predynastic settlement complex known in Egypt as well as extensive cemeteries and rock art localities. The area played a pivotal role in the evolution of the Egyptian state during the fourth millennium B.C. In discussing the Predynastic settlements of Hierakonpolis it is always necessary to consider that they are found in two radically different environments – desert and floodplain – each with its own, often contrasting, erosional and depositional regime.

Recent exploration of both desert and floodplain sites has thrown light on the nature of Predynastic settlement remains, helped document the impact of natural and cultural processes on those settlements and pinpointed a wide variety of sources for detecting and evaluating environmental change. A number of interesting issues have been raised, including the interpretation of radiocarbon dates from Predynastic settlement sites.

The nature of Predynastic settlement remains

A wide variety of materials, construction techniques and building froms were employed in Predynastic times. Material typically used included: reed, light timbers, mud plaster, mud clods, mudbricks, stone cobbles and even potsherds.

Superstructures were generally of mudplastered reed supported by light (*Tamarix*) wooden poles. The walls were anchored in shallow, linear trenches and the posts were grounded in circular holes of varying sizes and depths. Mudbrick was known throughout the Predynastic, but used sparingly in the earliest periods. In the floodplain, massive mudbrick structures date from Nagada II/III (Gerzean-Protodynastic) times (*ca.* 3,200 B.C.). These were generally built on an existing surface. By the First Dynasty (*ca.* 3,100 - 2,900 B.C.) builders' trenches and sand builders' levels were employed. In the desert Predynastic mudbrick buildings utilized foundations of cobblestones, brick bats and potsherds all cemented together with mud and often mixed with midden.

Predynastic house plans ranged from rectangular to circular, with the former being more characteristic of "permanent" dwellings. A number of *ad hoc,* irregular structures served as outbuildings much as they do in contemporary Egyptian villages. Houses might be semi-subterranean or built on the surface.

Dwellings were sometimes spaced far apart and surrounded by large, fenced-in areas or squeezed one against the other, sharing common walls. An intermediate spacing strategy included arranging rectangular houses and their appended courtyards next to one another. At least by the Gerzean (Nagada II) period (*ca.* 3,500 - 3,200 B.C.) there were large temple and place-like complexes within settlements, reflecting increasing social, economic and political differentiation.

The impact of natural and cultural processes on Predynastic settlement remains

Cultural processes

Included under cultural processes are the day-to-day activities which occurred at a site after its initial Predynastic occupation as well as blatantly destructive activities of *sebakhin,* looters and previous archaeologists. The tendency of Predynastic peoples to treat their yards and abandoned homes as barrow pits and trash heaps (both modern customs as well) increases difficulties of interpretation. On top of such human activities are imposed a wide range of natural erosional and depositional processes.

Usually, in archaeology we discount or minimize the effect of ancient peoples in alternating their landscape in major ways. Nevertheless, in a country like Egypt, which has had a central government and a tradition on monumental public works for over 5,000 years, it is necessary to consider the effect of such activities.

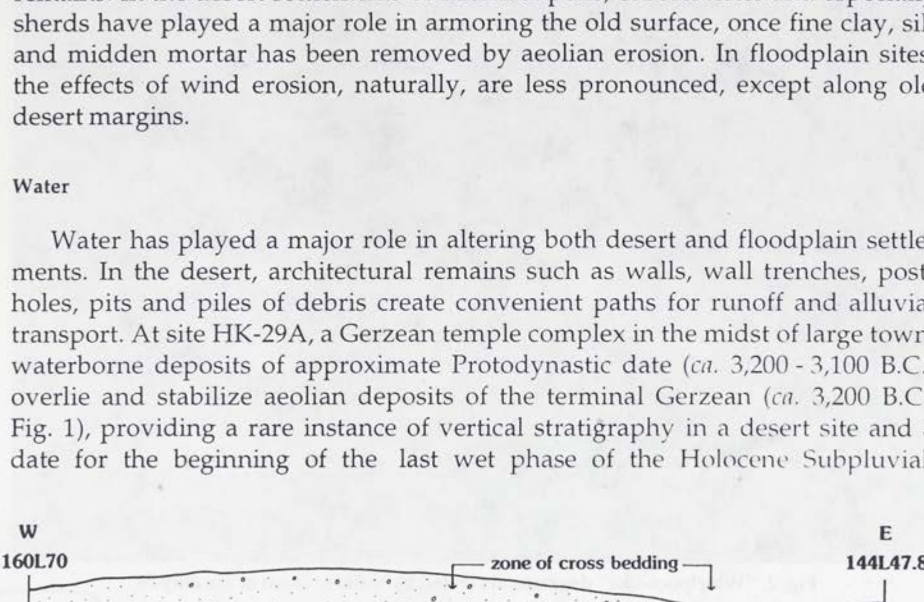
Our geoarchaeological investigations in the floodplain, have recovered evidence through reverse stratigraphy that apparently "natural" strata of mid-Holocene silts were mixed with midden and redeposited on an old desert surface to extend the cultivable land in early Roman times (Hoffman *et al.* 1986: 186; 1987: 10). Interestingly, a wide range of archaeological material ranging in age from Predynastic to Ptolemaic was transported 200 - 300 meters. Unlike riverine redeposition, no sherd erosion was evident.

Wind

In most cases, un-fired mudbrick has eroded away on desert sites and all that remains are "ghost walls" marked by lines of stones and sherds. Where cobblestone foundations were large and terraced (as in two famous Gerzean and Protodynastic "stone mounds" at Hierakonpolis) their collapse has added to the general disarray and made detection of room patterns difficult. In other instances, the nature of underlying architectural features, such as wall stubs and wall trenches, can encourage dune formation which hides and protects structural remains. In the desert settlements of Hierakonpolis, cobblestones and especially sherds have played a major role in armoring the old surface, once fine clay, silt and midden mortar has been removed by aeolian erosion. In floodplain sites, the effects of wind erosion, naturally, are less pronounced, except along old desert margins.

Water

Water has played a major role in altering both desert and floodplain settlements. In the desert, architectural remains such as walls, wall trenches, postholes, pits and piles of debris create convenient paths for runoff and alluvial transport. At site HK-29A, a Gerzean temple complex in the midst of large town, waterborne deposits of approximate Protodynastic date (*ca.* 3,200 - 3,100 B.C.) overlie and stabilize aeolian deposits of the terminal Gerzean (*ca.* 3,200 B.C.; Fig. 1), providing a rare instance of vertical stratigraphy in a desert site and a date for the beginning of the last wet phase of the Holocene Subpluvial.



Water lain sediments with large numbers of small, rolled carbonate encrusted sherds

Clean wind blown sand

× Late Gerzean (Naqada II) "squatters' deposit pottery"

Brick bats

Dissolved clay

Packed mud floors (Structure II)

PH Post hole

Fig. 1. Interpretative summary of microstratigraphy over HK-29A. Structure II, mud plastered floor (not to scale).

Because water erosion and deposition are much more important factors in desert site taphonomy than generally realized by archaeologists, it is necessary to pay close attention to artifact provenience to avoid inaccurate dating and contamination.

Another major problem of water erosion on desert sites is "whirlpool-like" depressions (Fig. 2). These have previously (Butzer 1959) been misinterpreted as

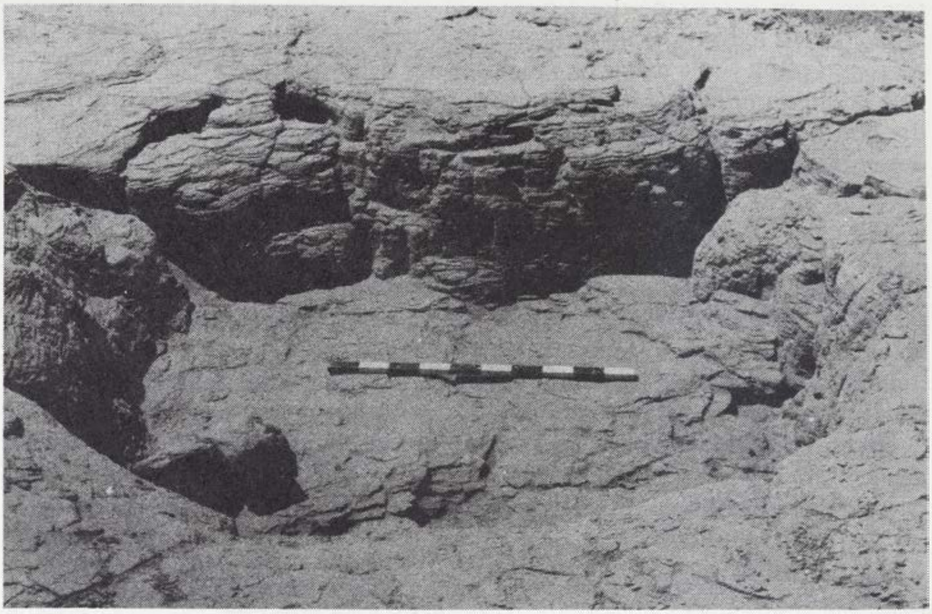


Fig. 2. "Whirlpool-like" depression created by water erosion at Locality 54.

cultural features (houses) and subsequently used to generate Predynastic population estimates. Excavation and analysis of these features at Hierakonpolis (Hoffman [ed.] 1982: 25) has shown that they are caused by water erosion.

In alluvial sites, occasional flooding by high Nile inundations creates an array of problems. Stratigraphic investigations below Nekhen in 1984 suggest that the earliest phases of occupation there (Badarian?, Amratian and Early and Middle Gerzean) are characterized by periodic flooding and reoccupation. From Late Gerzean (Nagada II/III) times on, direct flooding ceased, possibly because the Nile floods were declining and possibly because the large walls (*e.g.* 2.7 m thick) were now protecting the site. In cases where alluvial flooding of settlements with substantial architecture does occur, we can expect unusually rapid buildup of sediments due to the flood shadow effect. Given sufficient time, eroded and reworked clay and mudbrick structures can be reduced to a seemingly "natural" appearance.

Soil cracks

When Brunton visited Hierakonpolis in 1928, he noted that, "The ground is seamed with little trenches running in all directions. These vary in size, but probably none is wider or deeper than 2 feet. They do not seem to be made in any definite order or plan" (Brunton 1932: 272 - 273).

In recent seasons we have encountered similar features which we have identified as soil crack resulting from desiccation. Furthermore, we have established criteria by which man-made trenches and their natural equivalents, soil cracks (Fig. 3), can be differentiated: Man-made trenches are typically characterized by: 1. Being relatively wide (up to *ca.* 70 cm) and shallow (5 - 65 cm); 2. Showing occasional digging tool scars; 3. The inclusions of postholes and, less frequently, actual post remains; 4. "U"-shaped cross-sections; 5. Being orientated in relatively straight lines and at right angles.

Natural soil cracks are, by contrast: 1. Relatively narrow (10 cm or less) and deep (often over 50 cm); 2. Very long (of six continuous 10 × 10 meter squares excavated we never found both ends of a natural trench); 3. "V"-shaped in cross-section; 4. Meandering in plan, and generally do not turn or intersect at right angles; but typically diverge at oblique angles, forming a "Y" intersection.

The patterning and extent of natural soil cracks is best explained by the structural characteristics of the local Pleistocene Sahaba-like silts and their

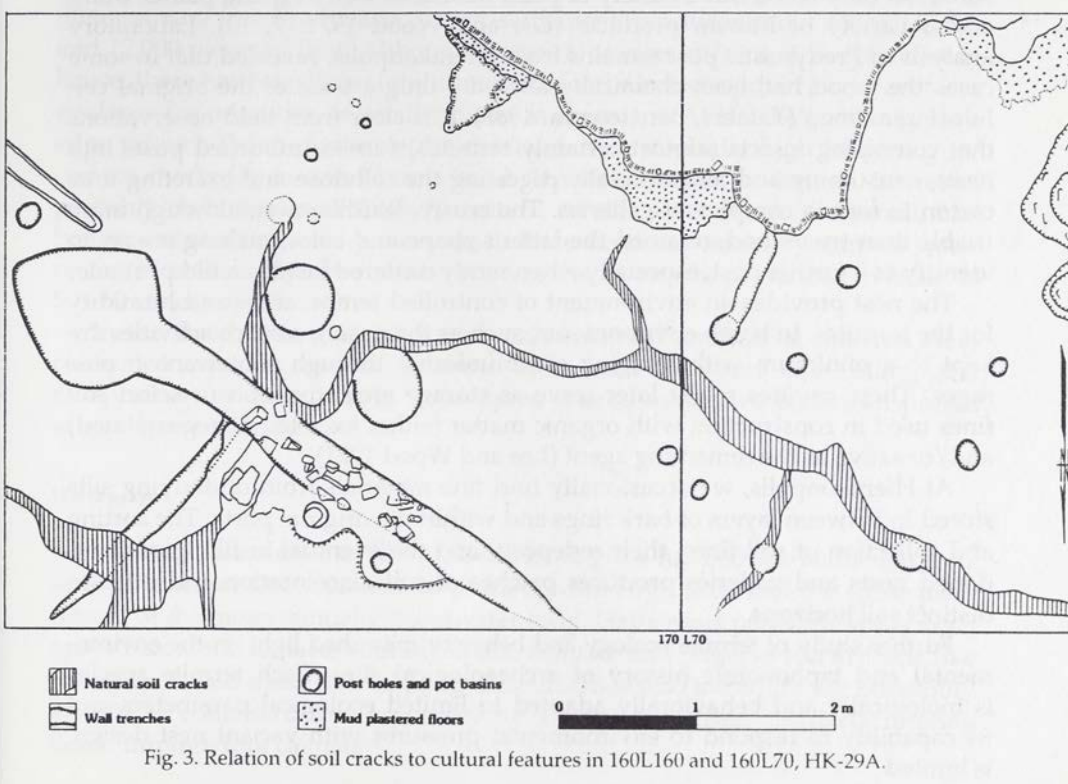


Fig. 3. Relation of soil cracks to cultural features in 160L160 and 160L70, HK-29A.

mechanical response to desiccation in an arid environment. Specifically, these silts are vertisols, which in drying contract and crack vertically. The patterning of soil cracks at Locality 29A was further influenced by pre-existing cultural features, such as postholes, wall trenches, and pits, which as voids lack the tensile strength of a relatively homogeneous silt bed. During desiccation, cracking sought a path of least resistance and was drawn towards and often through cultural features (Fig. 3). Additionally, contraction and splitting of the soil was found to shift architectural alignments.

Insect activity

Insects, specifically termites, may be responsible for considerable site disturbance. In arid regions of the world, termites are generally scarce, but some are apparently confined to such regions (Lee and Wood 1971: 21). In the Sahara, *Anacanthotermes ochraceus* inhabits areas with clayey soil, and in sandy regions is replaced by *Psammotermes hybostoma* (Lee and Wood 1971: 89, after Harris 1970). Both construct entirely subterranean nests (Lee and Wood 1971: 91, after Bernard 1954), often within their food source, such as a stump or dung heap, or beneath artifacts which reinforce nest architecture.

Both *Psammotermes hybostoma* and various species of *Anacanthotermes* consume not only wood but a variety of plant debris, as well as living plants, dung and a variety of human products (Lee and Wood 1971: 7, 10). Laboratory analysis of Predynastic post remains from Hierakonpolis, revealed that in some cases the wood had been chemically altered – only a trace of the original cellulose remained (Tamers, pers. comm. 1988). It is clear from field observations that colonizing insects (almost certainly termites) turned unburned posts into nests, consuming and almost totally digesting the cellulose and excreting it as carton to form a complex of galleries. The crusty, leaf-like nest, although more friable than true wood, retained the latter's shape and color, making it easy to identify as a former post, especially when nicely centered inside an old posthole.

The nest provides an environment of controlled temperature and humidity for the termites. In harsh environments, such as the desert, surface activities are kept to a minimum with foraging communicated through subterranean passages. These cavities might later serve as storage areas for food or select soil fines used in construction with organic matter (either excreted or regurgitated) and/or saliva as the cementing agent (Lee and Wood 1971).

At Hierakonpolis, we occasionally find fine materials from underlying silts stored in between layers of bark rings and within the original posts. The sorting and collection of soil fines, their redeposit, and the eventual in-filling of abandoned nests and galleries produces patches of soil discoloration and diffuses distinct soil horizons.

Further study of termite ecology and behavior may shed light on the environmental and taphonomic history of archaeological sites. Each termite species is biologically and behaviorally adapted to limited ecological parameters and its capability to respond to environmental pressures with variant nest design, is limited.

In terms of termite influence in Predynastic times, it should be noted that they may have totally denuded large areas of grassland only to enrich the soil with the nitrogen rich remains of their nests, thus enhancing later plant growth (Lee and Wood 1971). Termite nests may also have served as an alternate source of slow-burning fuel for hearths or kiln fires.

Weathering of culturally altered silt surfaces

In desert settlements it is often difficult to distinguish between natural surfaces within the late Pleistocene silts and those which have undergone cultural alteration. Slick or gently smoothed surfaces are found throughout Predynastic desert settlements and often indicate intentional or unintentional molding of living floors by water. In cases of clear cultural alteration, patterns may be detected by cleaning surfaces and viewing them in oblique light or by repeated brushing and natural drying. We have detected the application of mud "plaster" applied directly onto natural silts in which the raw material for both the natural and cultural units was Sahaba-like silt.

Artifact migration

Our most prevalent artifacts are sherds and chipped flint. An average 10 meter square in a Predynastic desert settlement, produces about 40,000 sherds and 12,000 pieces of flint. Although statistical studies show that, despite disturbance, there has been little significant horizontal displacement of larger artifacts, evidence for migration of smaller pieces is abundant. At HK-29A, although fine edge retouch flakes dominate the debitage, their normally high frequency increases markedly in wind borne sand deposits. Lateral movement, however, probably does not exceed 10 - 20 meters. At the same desert site, small, carbonate encrusted sherds were seen to have been deposited by surface water on top of aeolian deposits. In this instance, sherds may have come from as far as 50 - 60 meters uphill.

In the floodplain, geological and archaeological analysis of material from controlled trenches and cores show both wadi transport and rolling and redeposition by the river. In these cases, sherds may have been transported several hundred meters.

Halfa grass

In the alluvium on sites like Nekhen, halfa grass has become an increasingly serious problem since completion of the Aswan High Dam and the subsequent raising of the mean annual groundwater level. Halfa roots penetrate well over a meter below the surface, splitting walls, features and large, *in situ* artifacts like storage pots and make neat digging difficult. They also introduce the possibility of greater contamination, especially by small "diagnostic" artifacts filtering down through root cavities.

Salt

The negative results of ground salts may be seen most clearly in the modern alluvium where, since completion of the Aswan High Dam, the mean annual water table has risen slowly but steadily under the pressures of constant cultivation. To give an idea of the degree of change, the same salt crust which took six weeks to form on an open profile twenty years ago, now takes about six hours. This situation not only adversely affects preservation of materials, but often obscures subtle soil differences useful in "reading the dirt".

In the desert the problem of salinization is mainly the result of ancient historical pluvials and provides useful environmental and chronological information. This is balanced by the negative effect salt has on pottery.

Sources of environmental information in Predynastic settlement sites

Carbonate horizons

Carbonate horizons are widespread throughout the desert at Hierakonpolis. One horizon in particular is consistently found on top of Amratian (Nagada I) and Gerzean (Nagada II) occupations. It is about 1 - 2 cm thick and seems to represent the onset of the latest rainy episode of the Holocene Subpluvial. By combining this information with other stratigraphic and ceramic data, it is possible to date the beginning of the last wet phase of the Holocene Subpluvial to Protodynastic (Nagada III) times (*ca.* 3,200 - 3,100 B.C.). The moist interval lasts until *ca.* 2,500 B.C.

Potsherd taphonomy

As a part of our detailed, multivariate pottery analysis program, we have, to date, studied approximately three quarters of a million sherds, mostly from Predynastic settlements. Based on the ceramicists' observations, we have set up two coding categories (which complement longer notebook entries about particular pottery deposits) – encrustations and abrasion. These allow us to note, in the first instance, whether a sherd is encrusted with a foreign material, such as carbonates, sand, *etc.*, after breakage and, in the second case, whether or not it has been abraded by wind, water or both agencies. The taphonomy of sherds can be quite useful. For example, in geological trenches in the alluvium it was noted that Hard Orange Ware sherds of Protodynastic date were water worn, reflecting the local pluvial conditions previously alluded to. In a desert site, small carbonate encrusted sherds indicated a water deposited stratum (also of Protodynastic date). The size and condition of sherds and the type of wear on their edges may also give an indication of post-depositional processes. In contrast to natural processes, a number of cultural activities can effect pottery distribution, including their reuse in buildings and features, like ovens, both common Predynastic practices.

Root casts

Carbonate root casts are often found in Late Pleistocene silts. Usually they are believed to date to the time of deposition when the Nile ran high and the climate was hyper-arid. Given the correlation of Predynastic settlements, low desert Sahaba-like silts and root casts Fairservis (pers. comm. 1988), has recently suggested the possibility that the root casts represent plants which thrived during the Predynastic. According to this view, the herding-oriented Amratian peoples (see McArdle 1982 and current research) would have sought out areas favorable to their flocks. Given the rainy conditions reconstructed for the Amratian and the needs of the economy, it is possible that our root casts are the product of Holocene and not Pleistocene conditions. Dating of carbonates is the only way to test this hypothesis.

Changing settlement distribution

Settlement patterns at Hierakonpolis show a marked shift from Amratian through Early Dynastic times (Hoffman, Hamroush and Allen 1986: 175 - 187; 1987: 1 - 13; Hoffman 1970). The shifting of population away from the low desert toward and into the alluvium in early Gerzean times (*ca.* 3,500-3,400 B.C.) reflects a drying trend. Earlier Amratian sites were widely distributed throughout a variety of low desert microenvironments and display maximum functional variability and abundant wild and domesticated macrofaunal remains (see below).

Floral remains

Twenty different species, ranging from domesticated wheat and barley to weeds such as Halfa grass and xerophytic trees like tamarisk and acacia have been documented in low desert Amratian settlements (Hadidi 1982). They reflect environmental diversity and relatively high desert biomass. These provide strong evidence of moist desert conditions between approximately 3,900 and 3,500/3,400 B.C. The possibility that this wet interval extended earlier is good but, so far, we lack direct evidence.

Faunal remains

One of the most surprising facts about Predynastic faunal assemblages (approximately 5,000 identifiable bones have now been analyzed by McArdle from Amratian and Gerzean settlements) is the almost total lack of wild forms. Contrary to earlier speculations (*i.e.* Butzer 1959) and the impression gained from the rock art, wild animals were apparently quite rare (less than 1%). Judging by the high percentages of grazing animals (cattle, sheep and goats), whatever plant cover did exist in the low desert must have been under severe pressure during the earlier part of the Predynastic.

In light of the recent statement that a domesticated donkey from Maadi is the earliest published specimen (Caneva *et al.* 1987: 107), the senior author notes that in our 1982 monograph, *The Predynastic of Hierakonpolis*, McArdle published a domesticated donkey (*Equus asinus*) from an Amratian settlement at Hierakonpolis. Since this time, additional specimens have been identified.

Radiocarbon estimates

The interpretation of C-14 estimates is usually regarded as a strictly chronological problem. Our work in the Predynastic settlements of Hierakonpolis suggests some alternate interpretations. Initially, our dating of local Amratian settlements (Hoffman [ed.] 1982: 139) produced a fairly tight and consistent clustering of radiocarbon estimates which was more or less in line with what we expected. The corrected dates ranged from *ca.* 3,800 to 3,500 ± 100 years B.C. Our one date for Late Protodynastic (on a tomb) likewise was close to traditional estimates at 3,025 ± 80 B.C. More recently, however, problems have arisen. A suite of dates on a clearly Gerzean settlement complex (see Table 1, and note that one new date is also too old), produced another fairly tight and internally consistent clustering of estimates. Unfortunately, the Gerzean dates fall squarely within the range of Amratian dates from nearby sites. Moreover, a single date on an apparent C-Group campsite (not shown in Table 1) came out to *ca.* 3,200 B.C., *i.e.* to the Early Protodynastic. Obviously, most of our dates cannot be contaminated, since they are all consistent. We suggest that these dates may or may not date the associated cultural materials, but that they certainly date local moist intervals of the Holocene Subpluvial. This interpretation is also supported by settlement pattern distribution, geology, pedology, and the ancient flora and fauna. We suggest that, in the Hierakonpolis region of southern Upper Egypt at least,

Table 1

Radiocarbon estimates from HK29A.

Date No.	Provenience (site/square/find)	Archaeological context/remarks	Uncalibrated date B.P.	Calibrated date B.C.*
Beta 16150	HK-29A/140L40/8 - 2	Loose sand filling WT#1, Level 3. 0.1 g. carbon, extended counting time.	4820 ± 330	4350 (3636) 2071
Beta 16151	HK-29A/140L60/20 - 3 Feature 7	Large posthole (Fea. 7) of Struct. III, from burned ash and wood within silty level below sand (unit 8).	4580 ± 70	3510 (3351) 3044
Beta 16152	HK-29A/140L60/23	Level 4, fine sandy silt fill within Wall Trench 3A, Structure III.	4890 ± 90	3944 (3695) 3385
Beta 16154	HK-29A/150L50/26 - 6	Wall Trench #1, charcoal Level 3, organically stained silt.	4770 ± 70	3771 (3619, 3576, 3531) 3370

* Intercepts and maximum range at two sigma. Value with highest probability in parenthesis and underlined. Calibrations provided by courtesy of Beta Analytic, Inc.

xerophytic trees like tamarisk and acacia stopped taking in C-14 during periods of extreme stress (*i.e.* drought) but either survived in dormancy for a long time or eventually died but remained standing in the desert. They were subsequently harvested by local peoples and used as construction elements in light wattle and daub type superstructures or as fuel. This presupposes a fairly high production of biomass before drought conditions developed about 3,500/3,400 B.C. in the early Gerzean times. Nevertheless, it helps explain the failure, to date, of radiocarbon dating to differentiate Amratian and Gerzean periods at settlements which are clearly (stratigraphically and seriationally) distinct as well as the anomalous date on the C-Group site at HK-64. In light of recent comments from the International Radiocarbon Congress in Yugoslavia (Tamers, pers. comm. 1988) which suggest that trees like tamarisk cease accumulating C-14 in periods of drought, and in light of the importance often given by pre- and protohistorians to radiocarbon dating over more conservative stratigraphic and seriational techniques, we feel that we need to determine to what degree many of our apparently consistent suites of C-14 estimates are dating cultural processes and to what degree they may be dating natural events. At present, we suggest that two wet intervals are in evidence at Hierakonpolis, one dating *ca.* 3,900 - 3,500/3,400 B.C. and one dating *ca.* 3,200 - 2,500 B.C.

Summary and conclusion

In this paper we have suggested that a rich diversity of architectural forms and materials may be recovered from Predynastic settlements, given favorable conditions of preservation and sufficiently sensitive survey and excavation techniques. We have discussed a number of natural and cultural processes which effect the taphonomy of Predynastic settlement sites and suggested identified sources of environmental information available from those sites. Finally, we have noted problems of interpretation raised by some of the environmental information, especially radiocarbon dates.

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BIRGIT KEDING

Leiterband sites in the Wadi Howar, North Sudan

The Wadi Howar is one of the longest dry river systems in the Eastern Sahara, stretching over 1000 km from eastern Tchad to the Nile. Today the central Wadi Howar appears as a shallow depression between 4 and 8 km wide, where bushes and small trees can be seen from far away as a greenish line in the desert. In the Rahib Mountains the wadi is blocked by sand dunes and this was looked upon as its terminus until it was proved to be a tributary of the Nile by an interpretation of satellite photographs (Meissner and Schmitz 1983) and field survey.

Freshwater molluscs from the wadi sediments confirmed the Wadi Howar to have still been an important river in the Early Holocene (Pachur and Kröpelin 1987). Later the river became a chain of freshwater lakes fed by local rainfall separated by dunes. Today the groundwater is tapped by small wells at Rahib and allows seasonal stays by small nomad groups.

Little was known from the area before 1920 (Rhotert 1934) but travellers then began to mention the archaeological richness of the region (Maydon 1923: 34 - 41; Newbold 1924: 43 - 92; Newbold and Shaw 1928: 164 - 171; Shaw 1936: 43 - 92; Bagnold 1933: 103 - 109).

In 1933 the Frobenius team collected pottery ascribed to the Nubian C-Group by Hölscher (1955: 53 - 58), and accepted as such by Bietak (1979: 126), but finds by the BOS group of the University of Cologne (Kuper 1981: 86) showed that C-Group-like patterns were greatly outnumbered by a ceramic complex now known as "Leiterband" (Kuper 1981; Richter 1989).

One of the most important sites with Leiterband ceramics, Djabarona 84/13, is located on the southern bank of the central Wadi Howar (Gabriel *et al.* 1985) south west of Jebel Rahib on a very flat dune. The area of this site is remarkable for it covers nearly 1 km^2; more than 1000 dense concentrations of bones and sherds with artefact scatters between characterize it. Comparisons of topographic features and artefact distribution show that the concentrations are lying mainly on the dune top with a few concentrations near the edges (Fig. 1).

Some surface concentrations were shown to be pits of up to 2 m depth filled with strata of bones and ceramics imbedded in very fine dusty grey sediment; this suggests the majority of surface concentrations are pits in different state of erosion. Excavated pits contained between 200 and 14,000 g of archaeological material, the contents comprising mainly pottery and bones.

In contrast to pottery and bones, the stone artefacts, made of quartz, fine grained quartzite and chalcedony, have mostly been found outside the pits, in the artefact scatters between them. The industry is dominated by microlithic elements, mainly micro-tranchets and tanged micro-tranchets are dominating (Fig. 2). They show a wide spectrum of shapes in all stages of transition. Denticulated and notched pieces and borers are fairly rare. There are numerous fragments of broken heavily used grinding stones. A special feature are ground axes of Darfur-type made of greenish stone (Newbold 1924: Pl. IV). A remarkable number of fragments and flakes from cutting edges were found.

The stone inventory does not match those from further east (Arkell 1953; Caneva 1984: 357; Nowakowski 1984: 345) or west (Courtin 1966: 270 - 278) and the characteristic feature of the Leiterband-sites, the numerous types of micro-tranchets, are missing in neighboring areas. Nevertheless the inventory has some features, such as segments and axes, in common with the Khartoum Neolithic (Arkell 1953). The differences in the typology may be explained by chronological differences and as a result of a different type of exploitation of the natural environment.

The ceramic material was found in two main classes: small sherds with worn edges and large sherds from nearly complete vessels. The pottery is reddish-brown, thinwalled, burnished and chiefly sandtempered. Within the limited range of forms, globular (Fig. 3: 4) and bag-shaped (Fig. 3: 5) vessels with round bottoms dominate. Some vessels have rims showing four ears, two of which are perforated for suspension. The outside of the pots are decorated with bands, encircling the vessel parallel to the rim. About one hundred different variants were identified, most of them versions of the Leiterband which has decorated and undecorated bands alternating each other (Fig. 3: 2 - 5; 4: 4).

Two techniques of decoration were mainly employed: incision as rim ornament and (comb)impression, particularly the rockerstamp technique, as wall-ornament. For this technique two implements were used; the first group are implements with plain or continuous serrated edges, the second group are implements with a gap (Fig. 5). Implements producing this kind of decoration were already known from the Khartoum Mesolithic and Khartoum Neolithic in the Nile Valley (Khartoum: Arkell 1949: Pl. 88: 2; 1953: Pl. 31: 32).

Implements with plain (Fig. 4: 1) or continuously serrated edges (Fig. 4: 2) were used to make zig-zag patterns on 20% of the material from site 84/13 (Fig. 2) and had been over a long time and a very wide area. Both plain and serrated zig-zag patterns have been found in the Nile basin in the Khartoum Mesolithic at Khartoum (Arkell 1949: Pl. 65, 90: 2) and in the Butana area at Shaqadud (Otto 1964: 11: Fig. 27d,g,h), in the A-Group (Nordström 1972: Pl. 132) and at Kerma (Gratien 1978). These zig-zag patterns were also present west of

Fig. 1. Djabarona, site 84/13. Map of site, showing bone and ceramic concentrations.

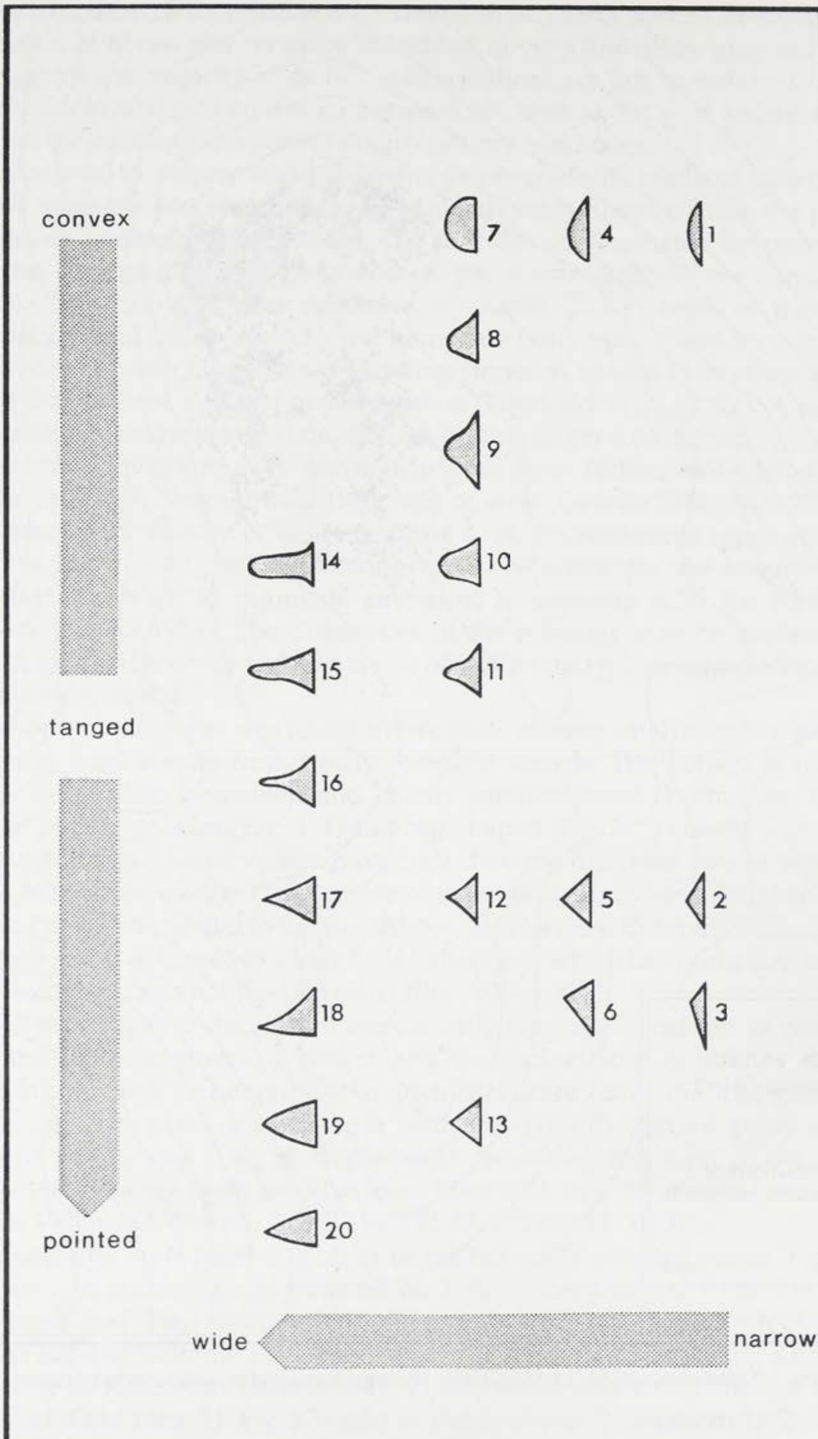

Fig. 2. Djabarona, site 84/13. The spectrum of microlithic elements.

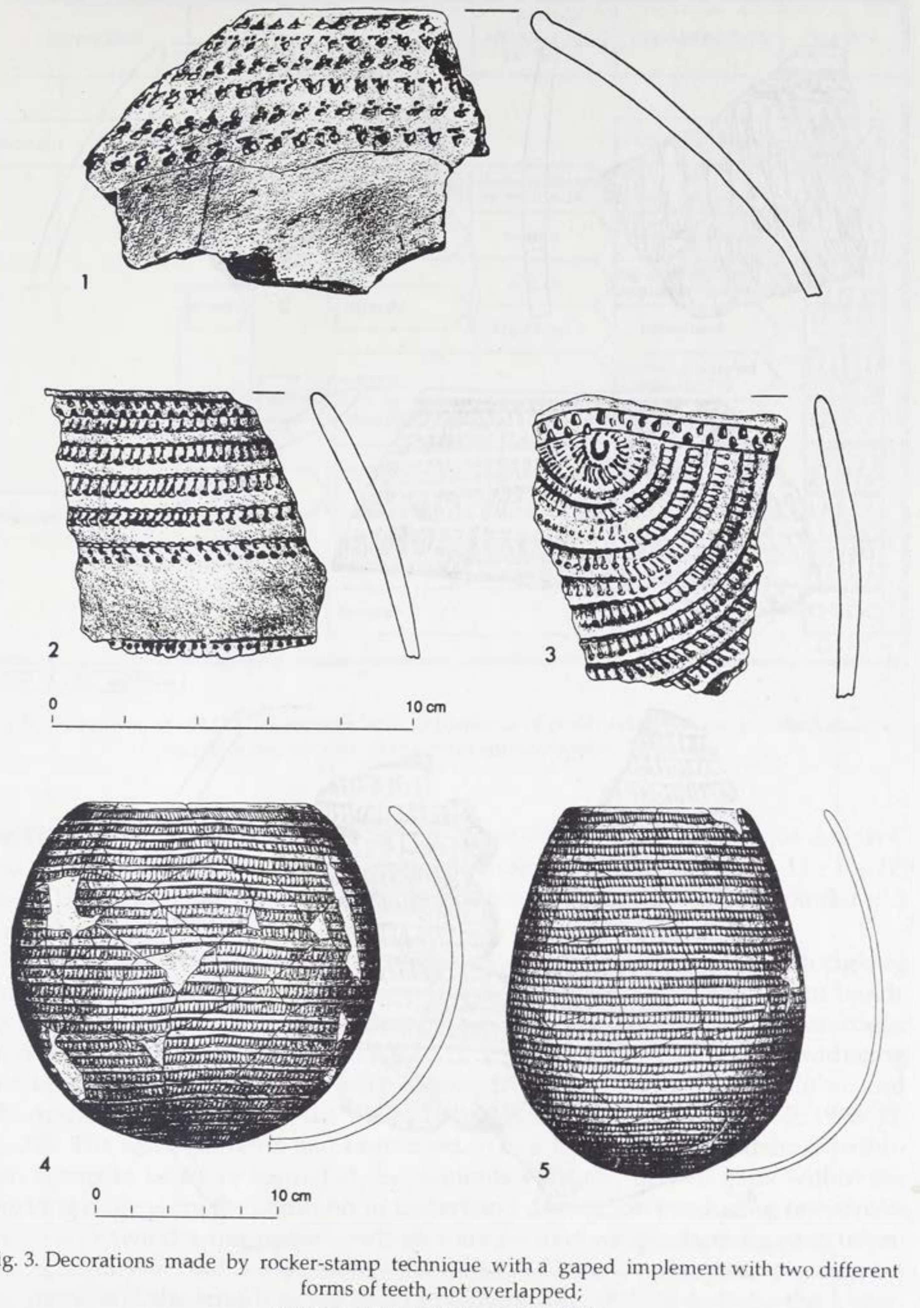

Fig. 3. Decorations made by rocker-stamp technique with a gaped implement with two different forms of teeth, not overlapped;
2 - 5: Leiterband decorations at site 80/86.

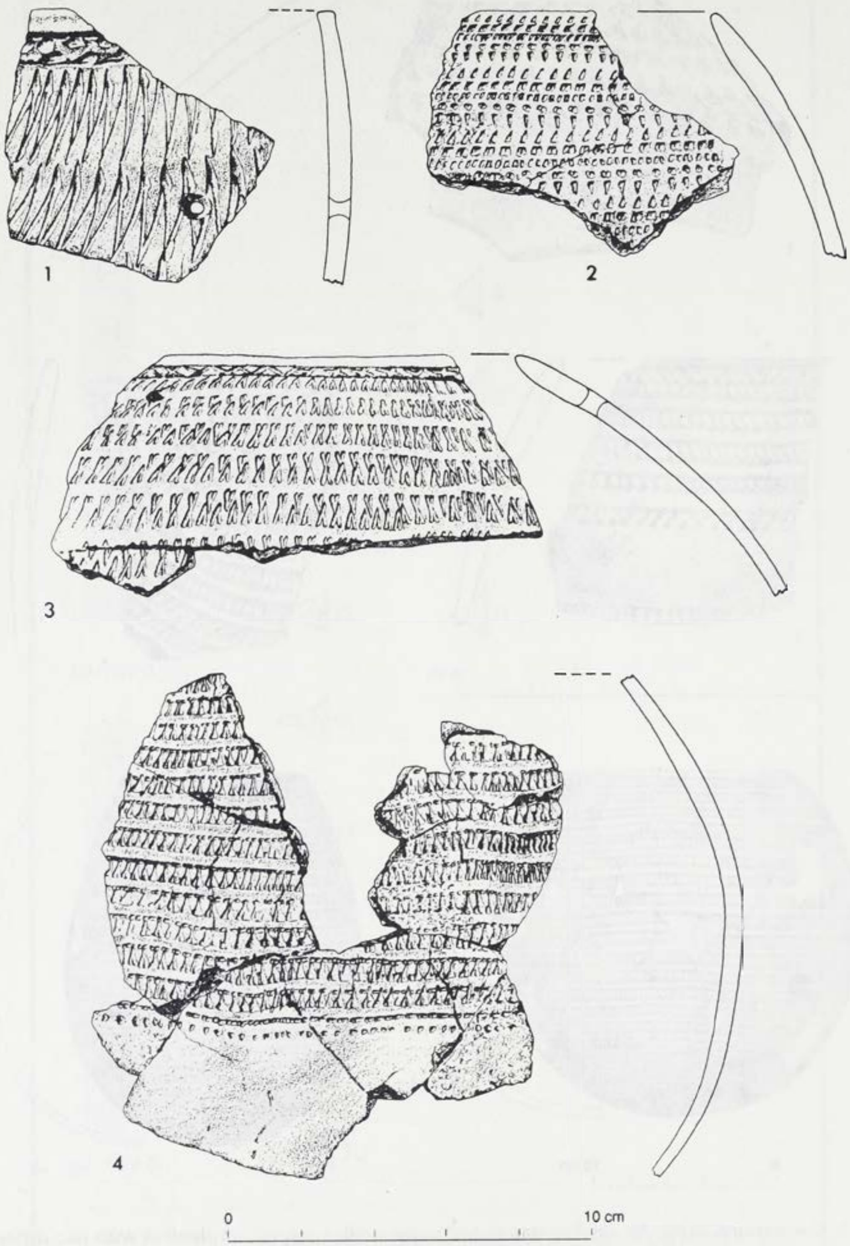

Fig. 4. Djabarona, site 84/13. Decorations by rocker-stamp technique using different implements;
1: implement with plain egde; 2: implement with continuous edge; 3: implement with gap in the centre producing sequence stroke-gap-stroke; 4: implement with one or two gaps producing sequence stroke-one or two gaps-one or two dots, partially overlapped.

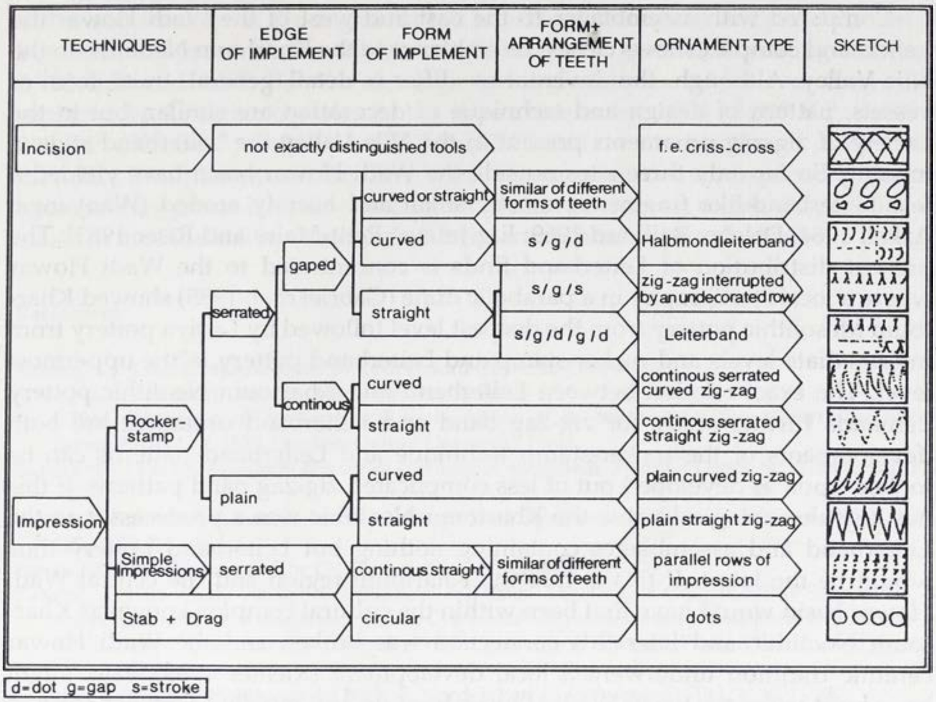

Fig. 5. Djabarona, site 84/13. Techniques and implements of pottery-decorations. Incisions and stab and drag decorations were almost entirely applied to the rim.

the Wadi Howar, in northern Tchad and Nigre during the "Néolithique Ancien" and in the "Néolithique Final" (Treinen-Claustre 1982: Pl. 2: 4 - 6, 6: 11 - 13, 42; Roset 1983: 127; Courtin 1966: Fig. 23), but here they occur not on globular but on necked pots.

The second group of implements with a gap in their edges produce a zig-zag pattern interrupted by an undecorated row (Fig. 4: 3). These rows form bands set one beneath the other on the sides of the pot, so that every impression could be recognized in its form and size (Fig. 3: 1; 4: 3). Such implements producing this kind of decoration are already known from the Khartoum Mesolithic and Khartoum Neolithic in the Nile Valley (Khartoum: Arkell 1949: Pl. 88: 2; 1953: Pl. 31, 32). The same patterns had been used over a long period but their distribution seems to be more restricted. Implements with one or two gaps within the working edge were the common in Leiterband decoration producing one stroke and one or two dot-impressions which were set in rows overlapping each other; it is necessary to find the last row, which has not been overlapped, to recognize the shape and the length of the gap-implement (Fig. 3: 2 - 5; 4: 4). So the Leiterband decorations have been produced by a modified implement which had been already known in the Khartoum Mesolithic and Khartoum Neolithic, but is now used in a more complicated form of the traditional technique.

Compared with assemblages to the east and west of the Wadi Howar the Leiterband complex shows closest resemblance to the Khartoum Neolithic in the Nile Valley. Although the inventories differ in detail, general traits, form of vessels, pattern of design and technique of decoration are similar, but in the variety of zig-zag ornaments present in the Nile Valley the Leiterband style is missing. So far only three sites outside the Wadi Howar basin have yielded a few Leiterband-like fragments, mostly small and heavily eroded (Wanyanga: Arkell 1964; Delebo: Bailloud 1969; Erg Jmeya: Petit-Maire and Riser 1983). The present distribution of Leiterband finds is concentrated to the Wadi Howar where a local stratigraphy in a parabolic dune (Gabriel *et al.* 1985) showed Khartoum Mesolithic pottery from the deepest level followed by Laqiya pottery from intermediate levels and rocker-stamp and Leiterband pottery in the uppermost level. The exact relation between Leiterband and Khartoum Neolithic pottery demands further study for zig-zag band and Leiterband ornament are both developments of the rocker-stamp technique and Leiterband patterns can be looked upon as developed out of less complicated zig-zag band patterns. If this has any chronological value the Khartoum Neolithic was a predecessor to the Leiterband and assemblages containing nothing but Leiterband pottery thus would be the latest. If this is true the Khartoum region and the central Wadi Howar basin would have first been within the cultural complex known as Khartoum Neolithic and later this connection was broken and the Wadi Howar ceramic tradition underwent a local development (Richter 1989). This might have been when the lower Wadi Howar dried up and mobility between the two regions decreased. An important source of information about the ecology and economy of the Leiterband people is the bones which have mainly been found in pits and which never show any cutting-traces. Cattle dominate at site 84/13 and there is no doubt that cattle were still kept in the Early Holocene. There is still lack of explanation for the surprisingly good condition of the bones for there are complete skeletons in many pits. Only a few bones come from wild animals but some very shallow pits were full of fish-bones of which fourteen species could be distinguished. Fishing must have been possible as well as cattleherding.

Site 84/13 shows evidence for repeated occupations which caused the artefact scatter, the large area of the site and the pits filled with pottery and bones of cattle which show no traces of butchering. In spite of intrasite details still under discussion, Leiterband people can be shown to have lived within a very well defined and limited area which was climatically still favorable enough for an economy based on cattle and fish, although acacia and zizyphus plants grew in the area (Neumann 1989). According to ethnological models, transhumant cattle pastoralists might well have had their dry season camps here, the cattle being concentrated around the campsites close to the water.

Another kind of camp might have been on parabolic dunes in the plains around the lower Wadi Howar east of Djebel Rahib. Here high quality palaeosoils have been found and dense grass cover must have existed until the 2nd millennium B.C. allowing the dunes to retained their shape. The beginning of the sequence from zig-zag band to Leiterband patterns is not properly dated but comparisons with the Khartoum Neolithic suggest a beginning between 5,700 B.P. and 4,500 B.P. for the zig-zag band complex which was then fully replaced by Leiterband styles in the Wadi Howar by 4,000 - 3,300 B.P.: 4,000 ± 200 B.P. (KN 3405) to 3,360 ± 120 B.P. (KN 3416) on site 84/13 and 3,530 ± 120 B.P. (KN 2940) on site 80/86. The Wadi Howar sites demand special attention because they prove intensive settlement at a time when an archaeological hiatus exists in the Nile Valley (Fattovich, Marks and Mohammed-Ali 1984).

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Holocene evolution of climate and environment, and stone "city" ruins in Northern Darfur, Sudan: is there a relationship?

Introduction

One paradigm of modern archaeological thinking is that cultural and environmental evolution are linked variables. Thus nomadism, with its low level of exploitation of natural resources prevails in marginal habitats, while sedentarism with its corollaries of demographic expansion, agriculture, animal husbandry *etc.*, requires a predictable environment with one outstanding limiting factor: a sufficient amount of precipitation.

Today the number of permanently inhabited villages in Darfur drops sharply north of 14°30′ *i.e.* north of a line drawn between the cities of Mellit and Kutum, where mean precipitation drops below 250 $mm \cdot y^{-1}$. At the small township of Malha (situated north of 15°N), the long-ranging average is as low as 114 $mm \cdot y^{-1}$ (Ibrahim 1984) and agriculture is limited to a few depressions in humid valleys. North of Malha, only desert remains. Present-day as well as ancient stone-built villages of the Fur and related tribes are plentiful on the well-watered, terraced flanks of Jebel Marra where peak precipitations of 1,000 $mm \cdot y^{-1}$ occur (Wickens 1976). Run-off water from this massif, collection at its foot, permits the existence of modern cities such as El Fasher and Nyala.

We postulate that, for sizable human settlements of a permanent nature (*i.e.* in the present case, "cities" composed of circular stone huts) to have once extended north of Jebel Marra (including its southern extension, the Furung Hills) a sustained increase in precipitation must have occurred. By sustained we mean an increase lasting longer than the fluctuations of, say, decadal length which are typical of monsoonal climates. The remainder of this article is concerned with the probable origin of a number of ruined "cities" first discussed by Arkell (1951 -1952).

Materials and methods

A study was undertaken of the climatic history of the area of Meidob in Northern Darfur, Sudan (Nys 1986), by lifting a 9.25 m sediment core from the bed of the crater lake of Malha (Fig. 1). Biological, mineralogical, and radiological dating techniques were applied to successive layers of sediment at intervals of one to several centimeters (Mees *et al.* 1991; Mees and Stoops 1990). The field work took place in November 1985, in the framework of a Belgian-Sudanese

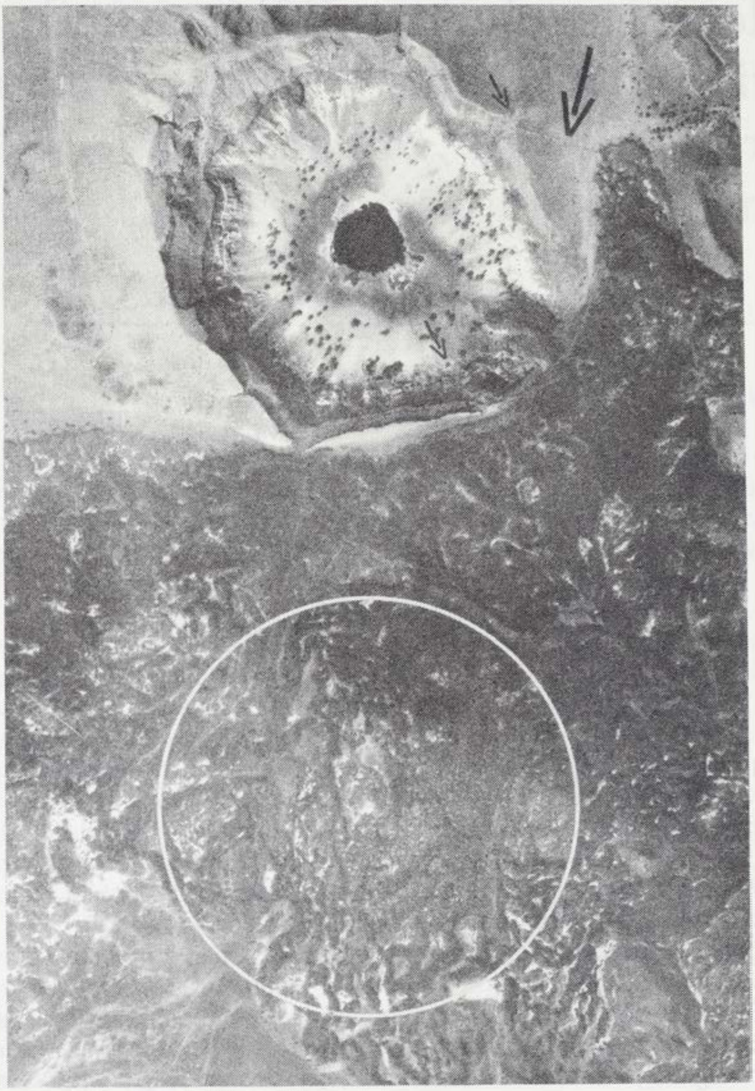


Fig. 1. Malha crater. The ruins of Malha city are encircled. Arrows indicate a solitary hut inside the crater, a long stone wall, and a concentration of tumuli.

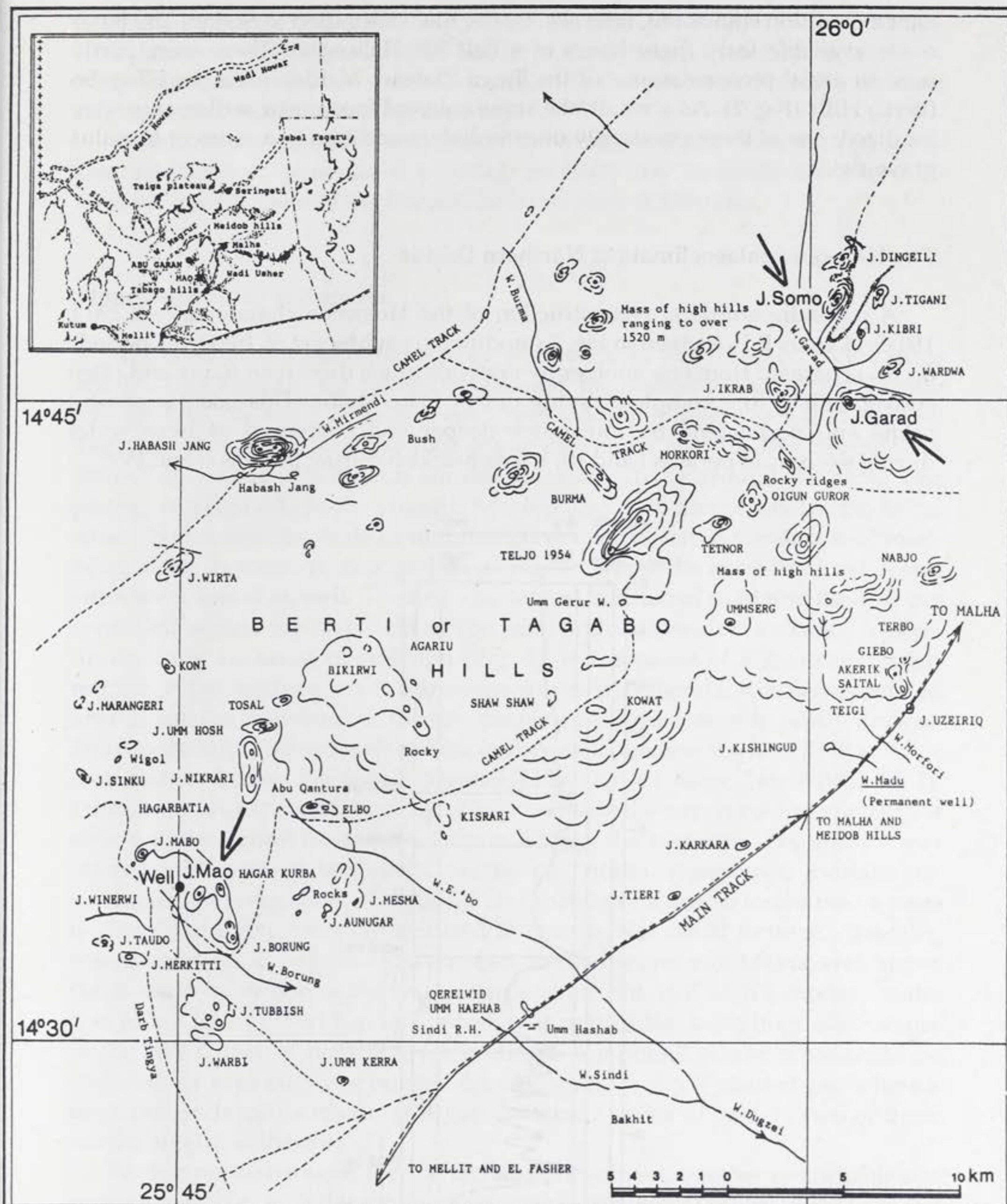


Fig. 2. Map of study area, indicating the situation of four stone-built cities.

joint expedition sponsored, *inter alia*, by the EEC delegation to Sudan. The latter made available forty flight hours of a Bell 205 Helicopter. These were partly used in aerial reconnaissance of the Teiga Plateau, Meidob Hills, and Tagabo (Berti) Hills (Fig. 2). As a result, the stone ruins of four major settlements were localized, one of them previously unrecorded, in addition to a series of tumulus grave-fields.

The Holocene palaeoclimate of Northern Darfur

A palaeolimnological reconstruction of the Holocene climate since 8,290 ± 150 C-14 years B.P. is given in Fig. 3 (modified from Mees *et al.* 1991). Six periods occur, separated from one another by intervals much drier than today and often corresponding to a complete drying out of Lake Malha. This lake, at present saline and permanent, became much deeper and composed of fresh water during the humid periods I and III. It was brackish during periods II and IV.

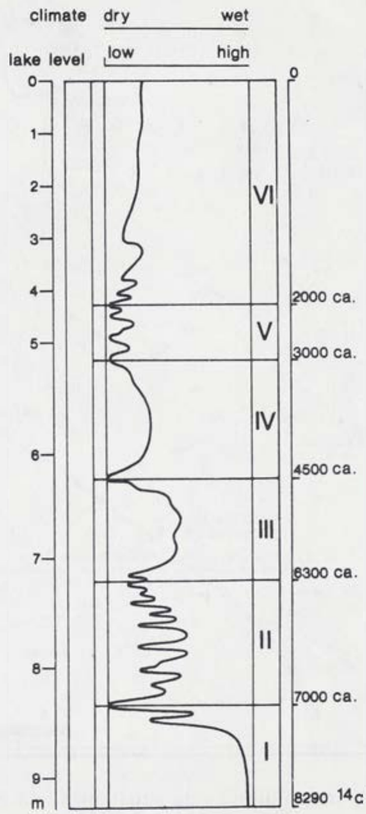


Fig. 3. Evolution of lake level since 8,290 C-14 years B.P. at Malha crater lake, reflecting climatic change throughout the Holocene. Major periods in Roman numerals, dates are approximate.

It is important to note that the region of the lake:

1. Has recovered since *ca.* 2,000 B.P. from a spell much drier than today;

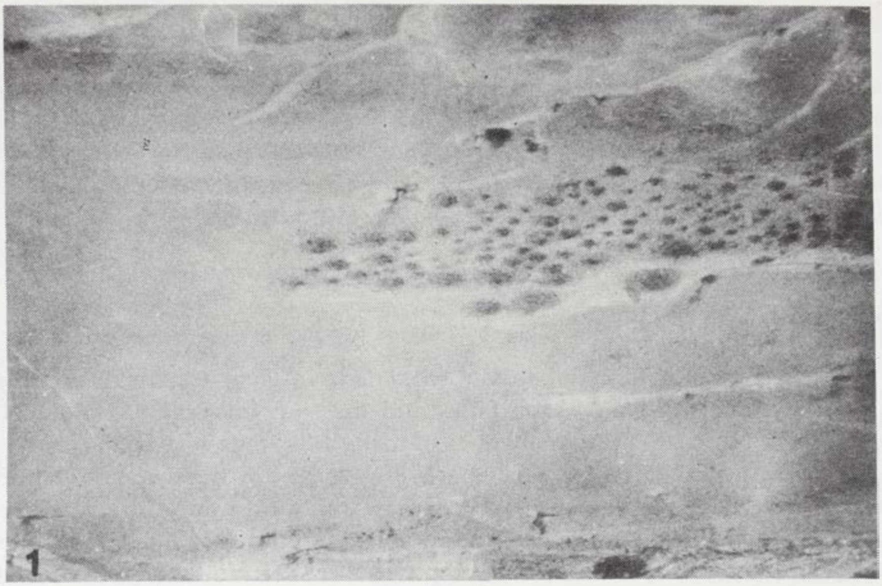
2. Shows no trend towards more aridity in the course of Period 6 (the last two thousand years), but rather contrary;

3. Has, on average, been much drier since 3,000 B.P. than before. A progressive aridification, punctuated by brief, intensely dry intervals, has therefore been the overall trend of the Holocene climate since 8,300 years.

Stone-built cities and graves

As stated earlier, an aerial survey was made of Jebel Tageru (West ridge only), Teiga Plateau, the Meidob Hills, and the southern half of the Tagabo (Berti) Hills. No trace of permanent man-made buildings was found in Jebel Tageru (where a rich group of rock engravings and a few frescoes representing cattle was visited in a canyon named Musawareid), or around the sandstone plateau of Teiga. Inside the volcanic Meidob land no traces of cities were found either, but numerous fields of tumulus graves were seen in the region of inselbergs along its western, dissected edge (Fig. 4). Where the remains of two major cities were found as well. The first and largest is situated at Malha itself. It lies concealed within the lava field of the Jebel Sodur (Sowidor) volcano. A plan, drawn from an aerial photograph (Fig. 5), is indicative of a structured community. When visited there is a downtown area, peripheral fortifications, and an area of smaller huts outside the city proper (this area was only partly drawn). Stray stone huts also occur elsewhere in the small oueds of the lava field and, for that matter, across the whole Meidob Hills (*e.g.* at Khor Tat: Arkell 1947). Tumuli graves are predominantly situated outside the city. A row of graves (not shown in the figure) fringes the western edge of the lava flow. The surface was littered with pottery fragments, ostrich egg beads, stone axes, mortars, arrowheads, and fragments of obsidian. One metal axe was also found near a partly destroyed grave, strongly oxidized fragments of a metal (bronze?) bracelet, cowries and ostrich egg beads were seen. Inside the crater of Malha, well above the present water line of the lake, a single stone hut, still with a mortar inside, was found (*cf.* arrow in Fig. 1). Malha city is not walled, but a huge wall occurs in the NW corner of the crater (delimiting a compound where cattle could be gathered, or kept out). Just outside the compound was a V-shaped gap where a track descends into a crater. This gap contains a series of tumuli, two of these are the biggest in the area.

Further north, between the 100 and 50 mm isohyets, another remarkable site was spotted (Fig. 6). It lies where the north-westernmost volcanic tongue of the Meidob Hills forms a triangular plateau, and is fringed by the bed of a meandering oued some 10 - 15 m below. The "open" site of this city is defended by three walls. There are few stone huts inside, but numerous large compounds occur. However, in the plain around the plateau stone remains of former villages



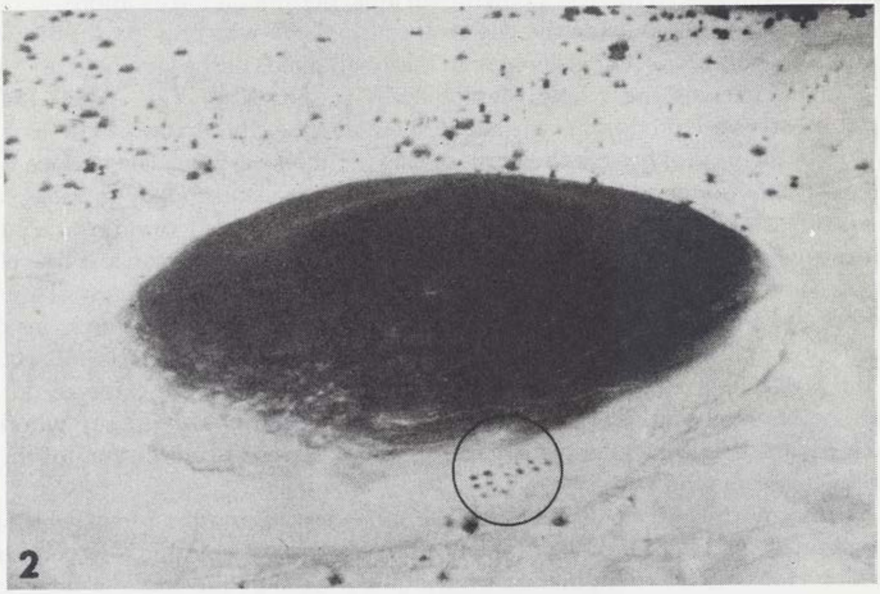


Fig. 4. Meidob land. Aerial views of fields of tumuli;
1: aerial view of major field of tumuli; 2: aerial view of group of tumuli at the foot of an inselberg, both situated along the western edge of the Meidob hills.

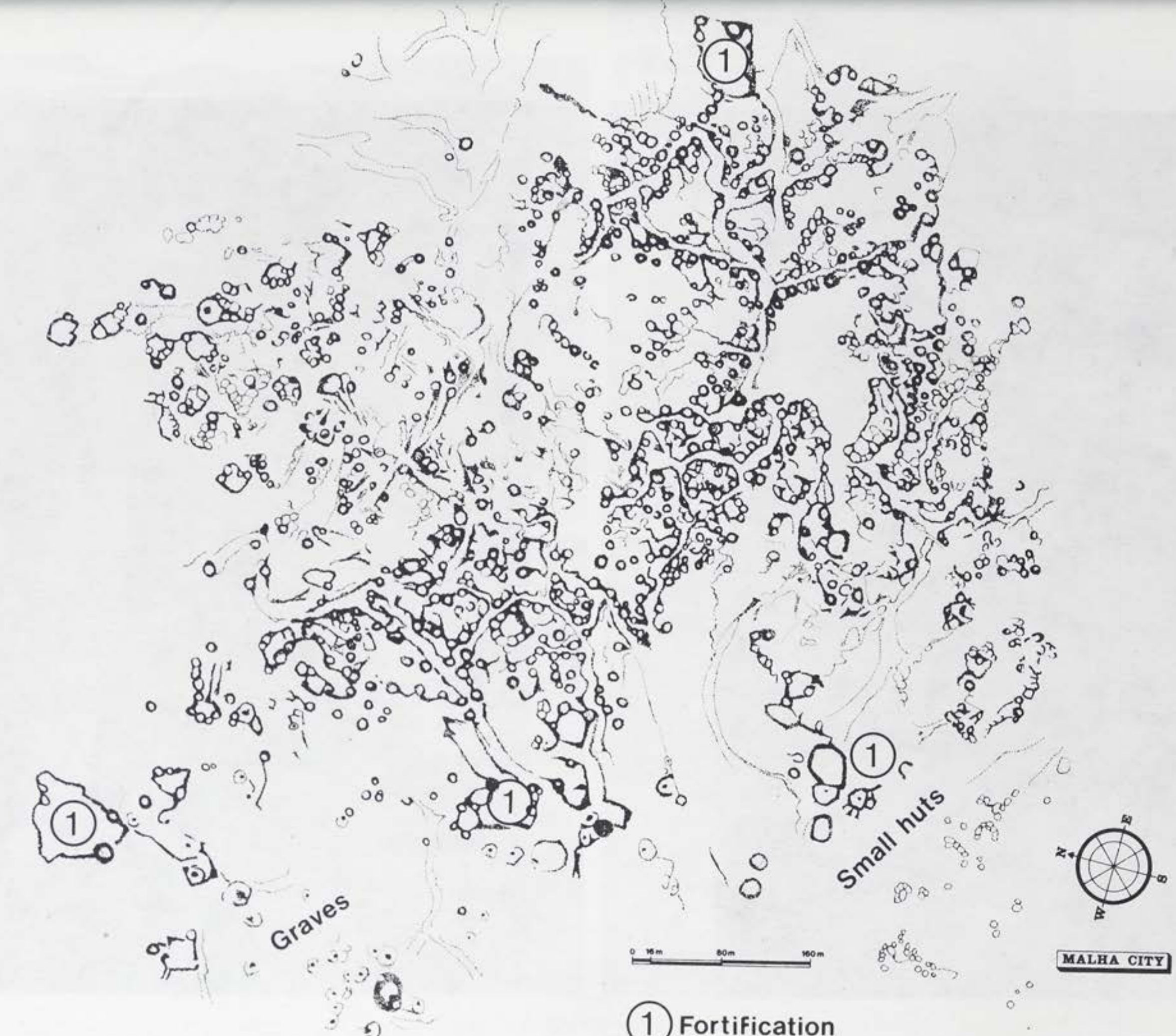


Fig. 5. Plan of Malha city.

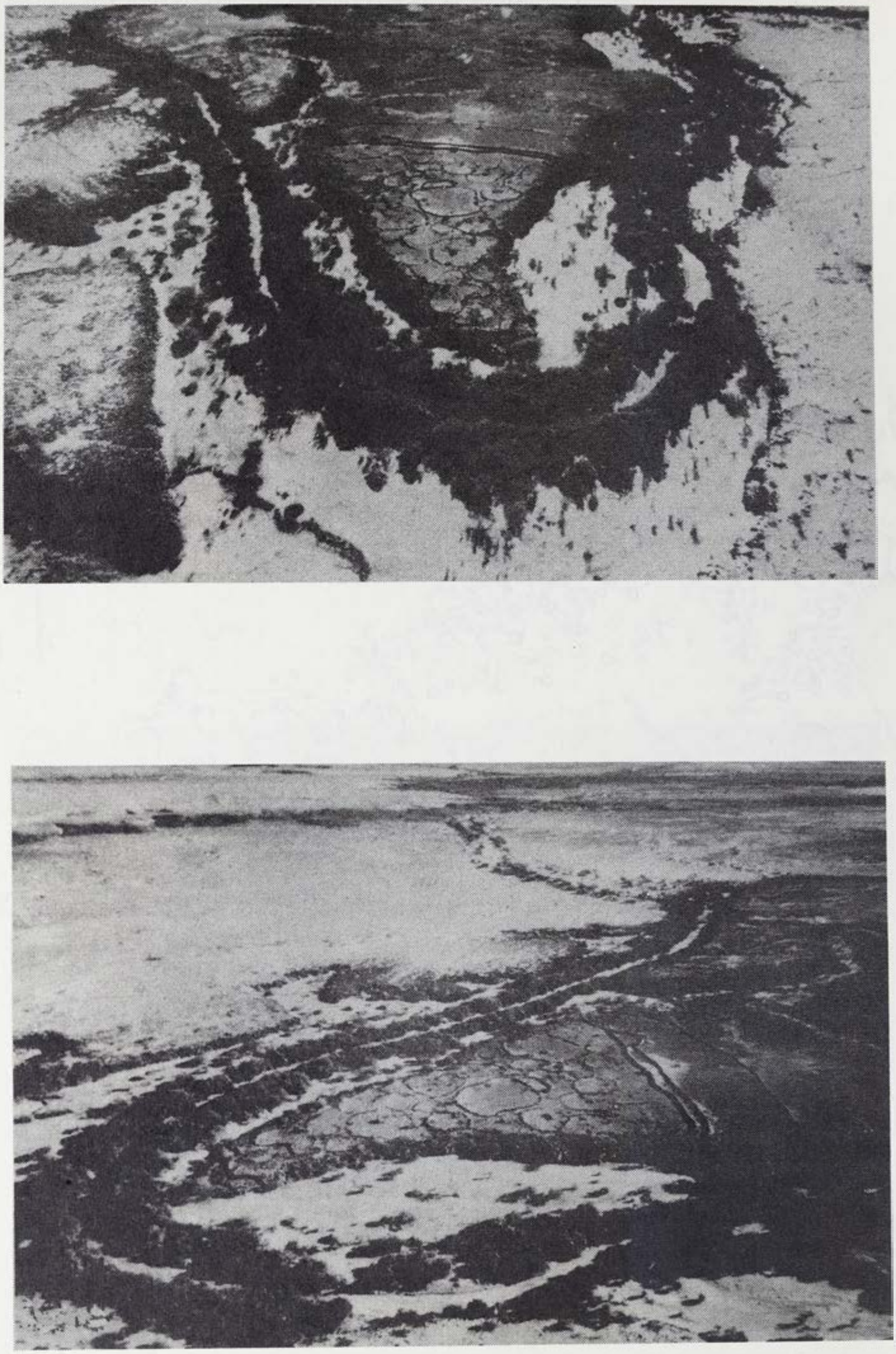


Fig. 6. Two aerial views of Seringeti.

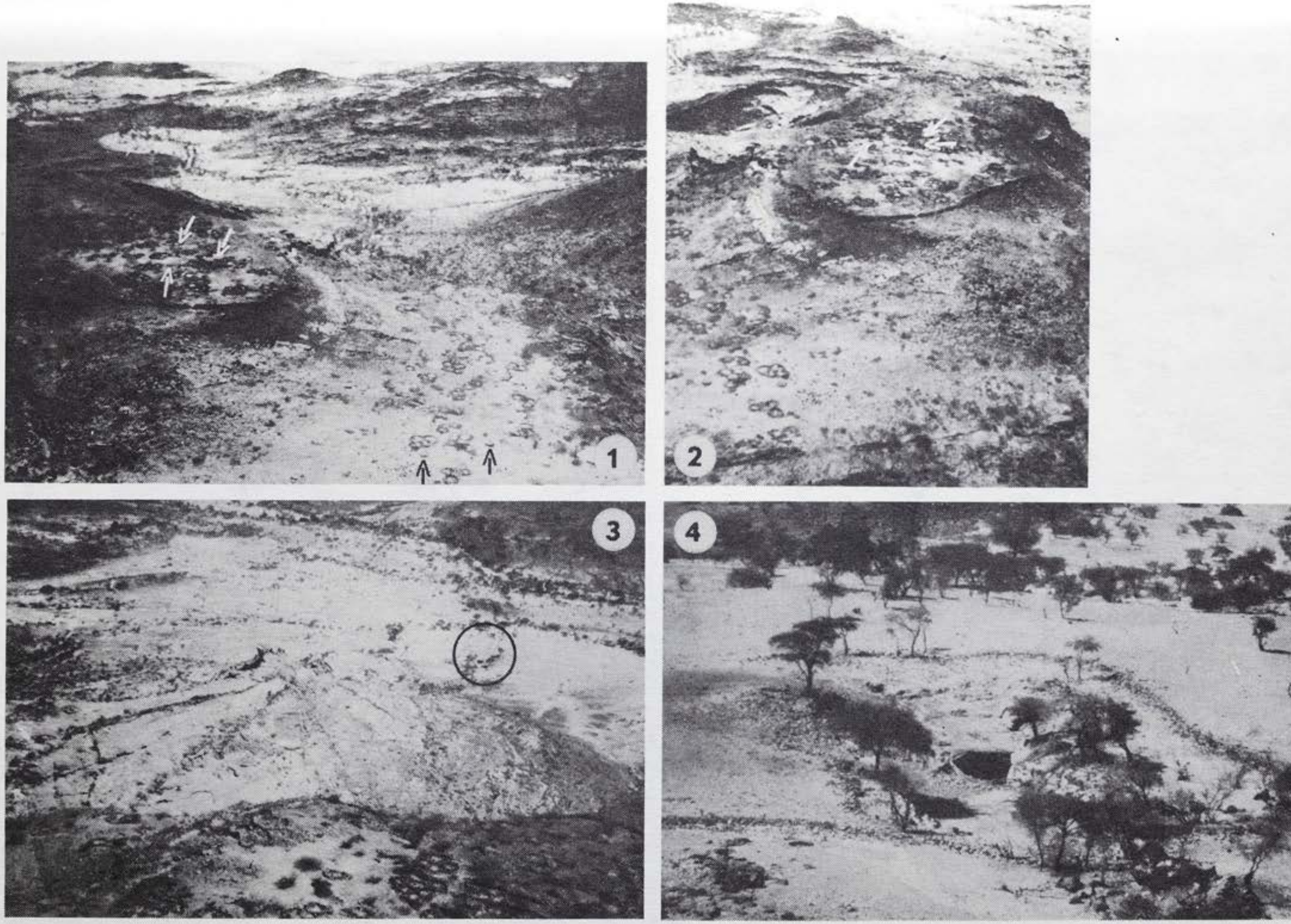


Fig. 7. Aerial views of Mao city;
1 - 2: aerial view of the upper (walled) and middle levels with clusters of stone huts. Arrows indicate circular, flat-topped graves; 3: view of the valley at the foot of Mao. Large well encircled; 4: well situated in a (dug-out?) depression and encircled by a wall.

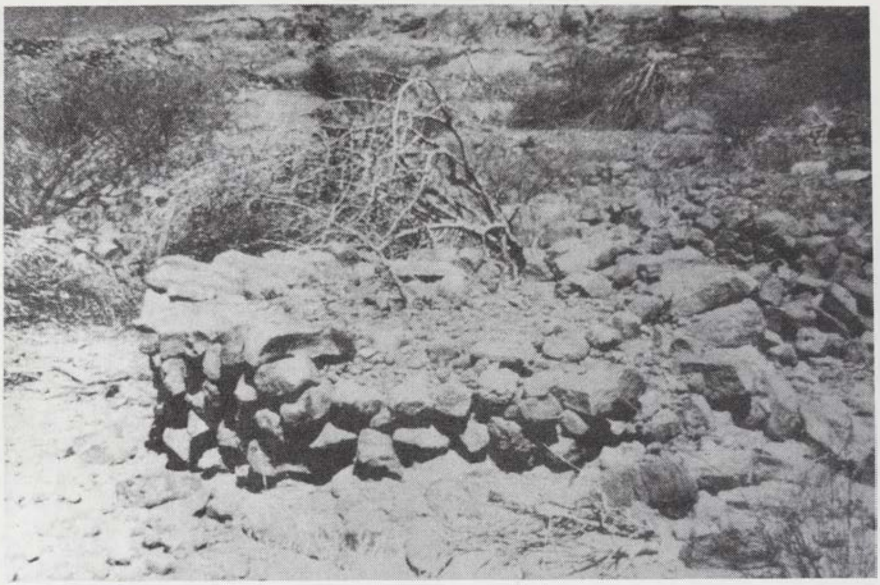


Fig. 8. Two graves at Mao.

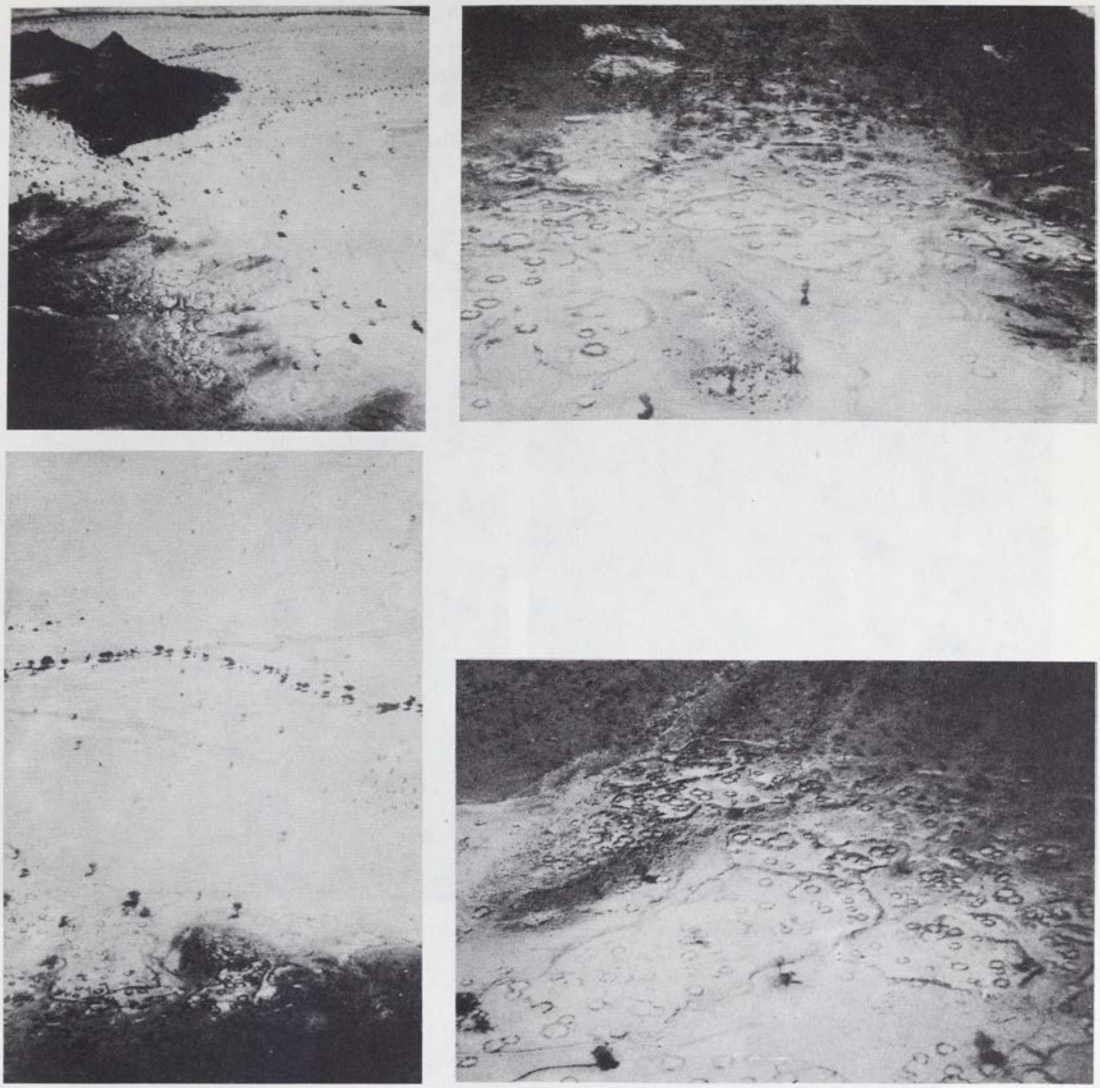


Fig. 9. Abu Garan. Various views of the site.

abound, and there is ample evidence for metal working and agriculture (contours of former agricultural plots – now buried under sand, could be identified from the air). The name given to this site by the Meidobi is Seringeti. Arkell (1951 - 1952) calls it Kerkera.

In the Tagabo Hills, two further "cities" were identified. The southernmost of the two is situated on an (artificially flattened?) hilltop (Fig. 7 - 8), and is walled. Stone huts, either solitary or in conglomerates also occur at two lower levels: one halfway the slope to the sandy valley of an oued (Wadi Mao? Wadi Borung?), and one on the floor of that valley, where a huge well is situated in the deepest part of a dug-out excavations. That depression, several meters deep, may originally have been a hafir or a similar type of water collector. The site probably corresponds to the "red city of Mao", mentioned but not visited by Arkell (1951 - 1952).

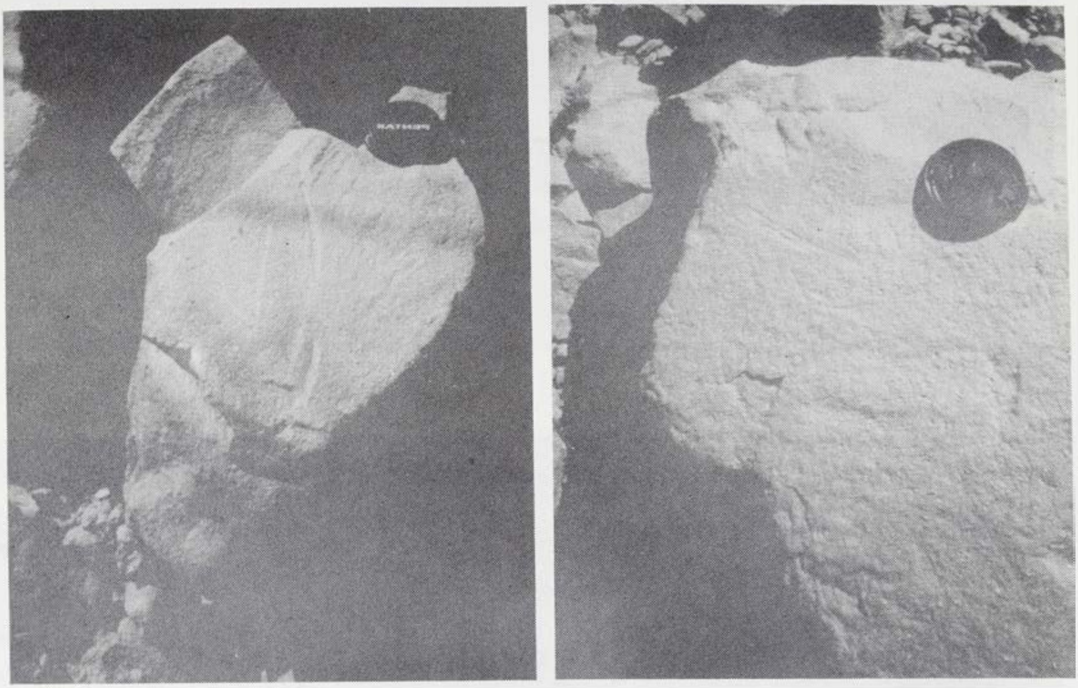


Fig. 10. Scratch-markings on rocks inside the ruins of Abu Garan.

Close to the north rim of the Tagabo Hills, a fourth and previously unrecorded city was discovered. From the dry floor of an oued (the Wadi Garad?), it runs up the steep slopes of a mountain to an altitude of more than 100 meters. Here, individual stone huts are carved out from the rock. A surface search revealed the usual pot sherds, stone implements, and strange markings on the rocks (Figs. 9 - 10). In a nearby rock shelter, primitive paintings represent human and camels, but it is not clear whether these are associated with the ruins (Fig. 11). The city is not walled, and there are no wells close to it. The local nomads call it Abu Garan (or Garad), and apply that same name to the mountain and to the oued. In northward direction, the Oued Garan joins the Wadi Magrur, which becomes indistinct in front of Jebel Tageru, but probably joins (or at least joined) the Wadi Howar.

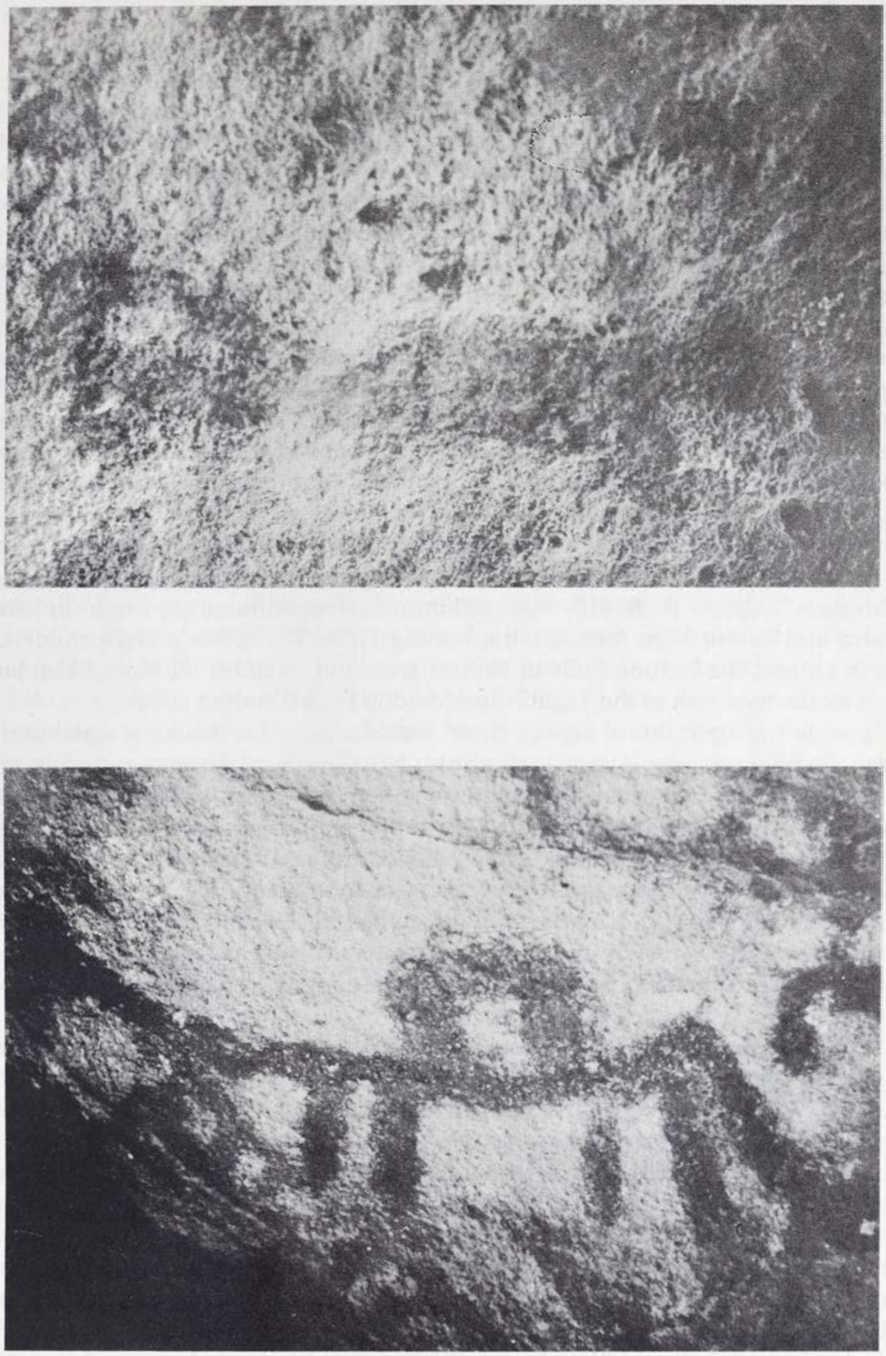


Fig. 11. Red ochre paintings, a human figure and a camel, in a rock shelter near Abu Garan.

Discussion

The history of Darfur, particularly the period after 1200 A.D. was discussed in an authorative way by Arkell (1951 - 1952). He assigns all desert stone-built cities of Jebel Marra, of Tagabo, and of Meidob to "medieval" and "post-medieval" periods. Explicitly included are the great town of Uri near Kutum, the "red-city" of Mao, Malha, and Kerkera (=Seringeti). From the sources examined by Arkell, there can be little doubt about his conclusions as far as Uri, and perhaps even Mao go, but we have serious problems to follow him for the sites of Abu Garan, Malha, and Seringeti. The former two had a capacity of about 6,000 inhabitants. The third, including the surrounding villages, was of the same order of magnitude. While the structure of Mao, with paved streets, hewn blocks of sandstone, circular graves with flat top, and an upper level separated from the lower levels by a wall indicates a peculiar form of social stratification, hence, perhaps a "recent" origin, such is not the case for the three northern cities. These, among other things, share a uniform, undiversified building style, and tumulus graves.

For cities of this size to evolve, rainfed agriculture with a low probability of crop failure would be necessary, and this requires an annual precipitation of minimum 300, and preferably 500 - 600 mm. Such conditions are found in Jebel Marra and its northern foothills, the Furung Hills. The 300 mm isohyet curves north around the Furung Hills in Kutum area, and includes the site of Uri, but runs distinctly south of the Tagabo and Meidob Hills (Ibrahim 1984).

Beside the agricultural aspect, there is also a need for drinking water for a large number of people and their cattle. No significant springs or wells are found near Abu Garan and Seringeti, while at Malha fresh water occurs in a number of springs inside the crater. This supply, however, is not even sufficient for the present population of the area. When, during our stay there, the pump of the government borehole broke down, a rush for water from the crater began. The springs ran dry in a matter of days, while the Ph values of the water extracted from the wells around the lake rose to over 9.0 and the water became saline, as lake water rather than groundwater was being drained towards the wells.

Our climate curve does not argue for a substantial increase in precipitation during the 1st and 2nd millennia A.D. Arguments in favor of such an amelioration by Nicholson (1981) were derived from Browne's (1799) writings, but are equivocal. Ameliorations, if any, may have occurred over periods of decadal length, but there is no evidence from the core that in historical times places like Malha ever received a precipitation of 300 $mm \cdot y^{-1}$ except in single wet years. Yet, the concentration of sizable towns (assuming these were inhabited simultaneously) in the Meidob and Tagabo Hills suggests the population which may have been sedentary, and a multiple of the present 2 - 3 inhabitants per square kilometer. A study of recent sedimentation rates in Lake Malha, derived from Pb dating (Richardson and Yates, unpublished data) provided no evidence for changes in sedimentation rates over the past two centuries, except since the

1930s. This, however, reflects the demographic explosion of the present time, and measures todays' man-made desertification.

The question remains how far back in time the origin of the towns should be situated. If they are older than the 2nd millennium A.D., they should also antidate the extremely dry period of 3,000 - 2,000 B.P. Periods I - IV, on the other hand, are acceptable candidates. In particular, period I seems attractive, since it was not only the most humid of all, but was felt as far north as Wadi Howar (Kuper 1988). This would push their roots back to pre-Meroitic times. Is such remote date possible? The present Meidobi have no traditions that link them with the cities, which they uniformly call "Abganaan". They trace their homeland back to the Dongola area of the Nile. This indicates that it was feasible to travel between the Nile and Darfur along the Wadi Howar–Wadi Magrur and the Wadi el Milk. However, this trip is still quite a normal one to-day, especially during the cool season. What is impossible here today, and has remained so for a few millennia, is the establishment of truly permanent settlements. Conversely, in the humid spells of the Middle Holocene (periods I - IV of Fig. 3), corresponding to a precipitation of 400 - 600 mm $\cdot$ y^{-1}, the rivers mentioned were running either permanently, or intermittently but in a predictable way. Sedentary people later retreating to the Nile Valley and Darfur would naturally have occupied these river valleys in such humid times. This is confirmed by McMichael's (1918) report on ruins composed of circular stone huts in the Wadi el Milk. Sites of a similar nature have recently been recorded in numbers in Nubia as well (Vila 1975; 1976; 1977; 1978). This seems to tell us that a building style similar to that of Jebel Marra, Tagabo, and Meidob was widespread between the Nile and Darfur during the humid Holocene, and that the towns in Wadi el Milk, Meidob, and most of Tagabo were deserted during the droughts of 3,000 - 2,000 B.P. but others continued to be inhabited, and were further elaborated upon as the "Tora" style, further south. In fact, the modern Fur villages on Jebel Marra are still constructed in much the same manner, in contrast to the *zaribas* of the Meidob and Berti tribes.

The Mid-Holocene ease of exchanges between the Nile and Darfur is also supported by the biogeographic argument. We analyzed the relict aquatic fauna of the surface waters of Meidob (the springs in Malha crater, the springs of Sjachacha, and the guelta of Sereif). There is today a complete absence of fish here, although fish were present as far north as Wadi Howar some 4,000 years ago (Kuper 1988). This reflects the effect of the severe dry spell of 3,000 - 2,000 B.P. The subsequent wetter period was not wet enough to permit fish to recolonize the area. Quite interestingly, among the extant invertebrate relicts, two Asiatic elements occur (the dragon-flies *Orthetrum sabina* and *Orthetrum taeniolatum*). These reached northern Darfur having first descended the Nile, while now dry wadis were still active. Needing much less water than fish for their larvae to develop, they may have survived where fish perished. On Jebel Marra fish are still plentiful (Bailey-Watts and Rogers 1970), indicating that the droughts never had a devastating impact on that area. The Jebel Marra aquatic fauna is still rich and largely Afrotropical. Its flora (Wickens 1976) has a similar composition: few palaearctic and oriental elements, but a wealth of tropical savannah and rain-forest species. All these data support the strongly increased, though northwardly declining, humid climates of the Early and Middle Holocene. With the advent of the extremely arid interval of 3,000 - 2,000 B.P., much human culture and animal and plant life was wiped out between the Wadi Howar and the Tagabo Hills, but not on Jebel Marra and only in part of the Furung Hills. The historical climate improvement was not sufficient to permit a complete restoration, even in the Meidob Hills.

Conclusions and recommendations

In order to resolve the apparent paradox between the network of stone sites of the Meidob and Tagabo Hills, the presumed early 2nd millennium A.D. age of these sites, and the climatic circumstances which argue against this recent origin, the founding of the towns should be pushed back in time to the Middle Holocene. If this could be confirmed, it would suggest a very early, common origin for the later Meroitic culture of the Nile Valley, and the Tora culture of Darfur. Proper excavations and dating will be necessary to test this hypothesis.

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ENVIRONMENTAL CHANGE AND HUMAN CULTURE
IN THE NILE BASIN AND NORTHERN AFRICA
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LOUIS CHAIX and ANNIE GRANT

Palaeoenvironment and economy at Kerma, Northern Sudan, during the third millennium B.C.: archaeozoological and botanical evidence

Kerma is situated in the north of Sudan, approximately 20 km south of the third cataract, on the right bank of the Nile (Fig. 1). Around 2,500 B.C. a unique culture developed in that region, for which Kerma seems to be the major site. It is placed at the crossroads of the main north-south route down the Nile Valley and the east-west desert route. It is very likely that the town was the capital of the powerful kingdom of Kush, a constant thorn in the flesh of the Egyptians (Bonnet 1984; Bonnet 1986). The origin of the Kerma civilization are to be found in the Sudanese and Egyptian Neolithic, whence various aspects of the funerary ritual can be traced. The most ancient settlement, named the pre-Kerma, has recently been discovered within the Kerma necropolis, and demonstrates this continuity (Bonnet 1986).

Excavations have been carried out in two main areas, at the ancient town, sited approximately 1.5 km from the Nile, and the necropolis, approximately 6 km to the east of the Nile (Fig. 2). In the centre of the town was a massive building of mud brick, known as a Deffufa. It was used as a temple, and investigations of this structure have revealed a complex history of building and modifications (Bonnet 1981). There are preserved remains of a large number of other structures, including defensive walls, further cult buildings, houses, workshops and bakeries, built with a range of ovens, clearly designed for the production of large quantities of bread (Bonnet 1988). The necropolis, which also contained a Deffufa, covers a large area of several kilometers, with the number of graves estimated at over 20,000. There seems to have been a chronological development in the use of the area and in its burial traditions from the north to south. The beginnings of the Kerma culture were around 2,500 B.C., thus contemporary

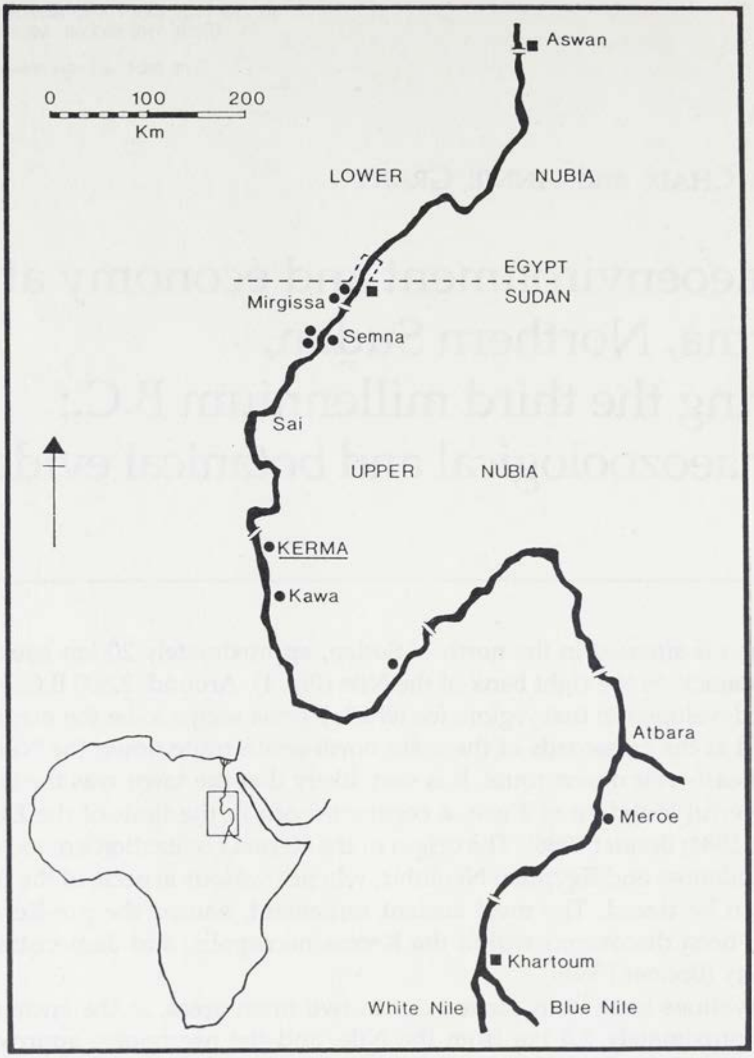

Fig. 1. Map showing the location of Kerma.

with the Old Empire in Egypt. It flourished for approximately a millennium, with its fall, around 1,500 B.C., after the conquest of the region by the armies of Thoutmosis I (Bonnet 1981). Our research has mainly involved the study of the animal and plant remains recovered from the two main areas of the site, and concerns both the environment and the economy of the settlement.

The environmental indicators present a somewhat conflicting picture. Kerma now lies within a desert zone, characterized by a rainfall of less than 50 mm of water per year, with vegetation confined to the banks of the Nile and the large

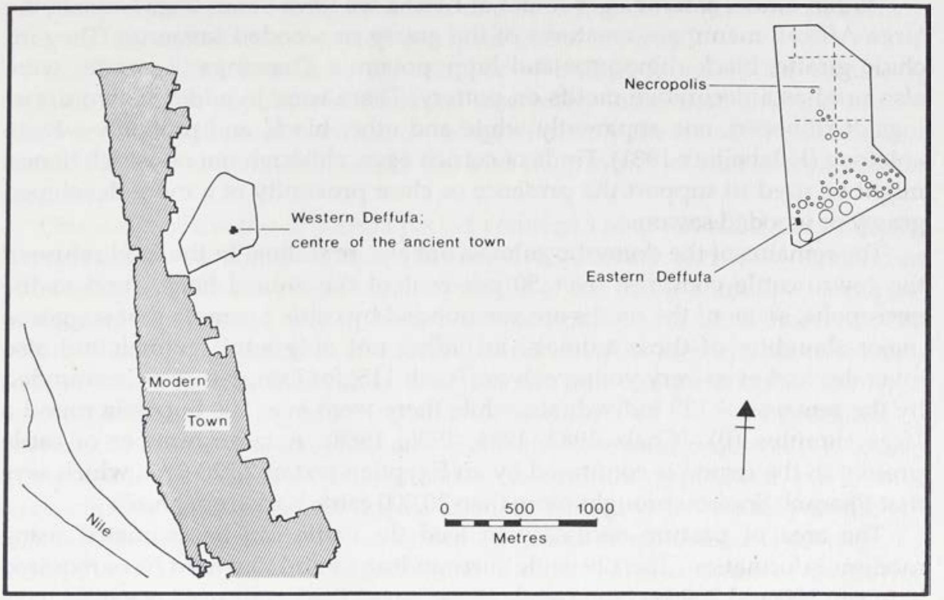

Fig. 2. Sketch map showing the location of the ancient town and the necropolis at Kerma.

wadis. The Nile acts as a permanent reservoir of water, with its banks forming a continuous oasis through the heart of the desert.

Supporting a view that the environment at the time of the occupation of the ancient town of Kerma was similar to that of the present day we have two main lines of evidence. Firstly there is the exceptional state of preservation of the organic remains in the tombs. Feathers, skin and hair, cloth and leather are frequently very well preserved. Often the skin, hair and even the guts of both the human burials, and of the sacrificial sheep found in the tombs have been naturally mummified by desiccation. It seems unlikely that these remains were ever exposed to moisture. We can in addition point to the good state of preservation of the mud brick Deffufas and the foundation of the houses in the town, which show little sign of erosion.

Attempts to recover preserved pollen grains were initially unsuccessful, but recent analysis carried out by David Taylor has demonstrated that they are sometimes preserved, if fairly poorly, in sheep and goat coprolites. The species so far identified all suggest flora very similar to that of the present day. We have pollen from several types of acacia, jujube and various *Urticaceae*, *Graminae* and *Cyperaceae*. Preserved macroscopic plant remains, such as the cassia seeds found in the sheep's stomachs, together with the wood charcoal also confirm this impression of an arid environment (Taylor, unpublished). We have, however, several lines of evidence to suggest more moist environment than at present.

Within faunal assemblages found at Kerma we have bones from some of the large African mammals, creatures of the grassy or wooded savannas. They include giraffe, black rhinoceros and hippopotamus. Drawings of giraffes were also used as a decorative motifs on pottery. There were in addition two drawings of rhinoceri, one apparently white and other black, and probably a Roan antelope (Hilzheimer 1931). Finds of ostrich eggs, although not of ostrich bones, might be used to support the presence or close proximity of a more developed grassy or wooded savanna.

The remains of the domestic animals are also revealing. In the food refuse of the town, cattle comprise over 50 per cent of the animal bones, and in the necropolis, some of the tombs are surrounded by cattle bucrania that suggest a major slaughter of these animals, including not only adult animals but also juveniles and even very young calves. Tomb 115, for example, was surrounded by the remains of 129 individuals, while there were over 500 bucrania round a large tumulus (B), (Chaix 1982; 1984; 1986; 1988). A large number of cattle present in the region is confirmed by an Egyptian text of 2,720 B.C., which says that Pharaoh Snefrou brought more than 20,000 cattle back from Nubia.

The area of pasture necessary to feed the cattle can be estimated using modern information. The 129 cattle surrounding tomb 115 would have required between 100 and 200 hectares, while those round the large tumulus would have required between 400 and 800 hectares. Comparison with the present situation in Nubia is telling. Cattle now form less than 5 per cent of the domestic animals, while sheep and goats account for nearly 90 percent. Palaeobotanical work carried out at several sites in the desert of the Northern Province has suggested that the limit of the true desert during the third millennium B.C. was 400 km further to the north than at present (Jackson 1957; Wickens 1975; Mawson and Williams 1984; Ritchie and Haynes 1987). Kerma would thus be situated in the shrubby savanna zone, with more plentiful food resources, which would support the larger African fauna as well as significant herds of cattle and of sheep and goats. Survey work in the eastern desert has also shown that settlements existed close to the courses of now dry rivers, and suggest that the cultivation of much more extensive areas of land was once possible. The presentation of the evidence must, in the context of this very brief paper, be rather simplistic. We clearly have a set of rather contradictory information but its interpretation depends not only on our views of the natural environment, but also on the nature of the economic, political and cultural situation at the town of Kerma. In relation to the environment, we should not forget the role of the Nile itself. The volume of water brought down during the annual Nile flood may well have been far greater than at present, allowing much larger areas of land to be cultivated and providing the moisture to support much more extensive areas of pasture for the feeding of the domestic flocks. Irrigation would be an obvious way of further exploiting the Nile waters, but no traces of any irrigation systems have yet been found.

A well developed agriculture, probably capable of producing a surplus beyond the subsistence needs of the population is suggested by the cereal remains found in the tombs, the bakeries with their batteries of ovens, and the very large numbers of bread moulds, found at Kerma, as at other contemporary sites, and thought to be connected to a ritual use of the bread.

The size of the town, and the number of burials found in the cemetery, suggest a sizable population. There are also many indications that the society was very hierarchical. In particular, we have not only the size of the tombs and the richness of some of the burials, but also the practice of human and animal sacrifice.

One tomb of the classic Kerma period contained over 600 subsidiary burials, interpreted as sacrificial victims (Reisner 1923). Sheep sacrifices, sometimes numbering over 20 in a single tomb, consisted of the whole animal, whereas the cattle were represented only by their horns and part of the skull. However, the killing of such large number of animals, particularly as they appear to include both breeding females and calves, suggests not only the production of a large surplus, but also the organization and social control of a large population to provide the animals for slaughter and to consume the meat produced. Of course it is possible that the cattle bucrania came not from a single herd, but from a large number of small herds, drawn together from a wide territory at the occasion of the death of a powerful leader. The cattle remains associated with the tombs may thus be as much an indication of the extent and nature of the power of some members of the Kerma population as of the numbers of animal kept in the immediate environment (Chaix and Grant 1992). However, the high percentage of cattle bones found in the ordinary domestic refuse of the town, does support the importance of local cattle keeping. It is difficult to imagine that in the unstable political climate of the Nile Valley in this period, Kerma could have maintained its position of importance if it did not have sufficient local resources to maintain its population, without a heavy dependence on trade or tribute for the essentials of life. However, in this context we must also consider the possibility that some of the more exotic faunal remains, perhaps at least the ostrich shell, may have been a trade item rather than a local resource.

The husbandry of sheep and goats, perhaps the most suitable animals for the local environment, was one with the clear aim of producing food, and in particular meat, with milk and skin products of lesser importance. In this respect, it is remarkable similar to that of the present day. The present environment supports fairly large numbers of sheep, which while providing a relatively small part of the total food consumed, are very important for the meals marking special events. At ancient Kerma the sheep, like the cattle seem also to have had a symbolic importance. In several of the tombs, some of the sacrified lambs, carry circular ostrich feather headresses attached by leather thongs to between their horns, and bead pendants hanging from the tips of the horns (Chaix and Grant 1987; Bonnet 1984; Chaix 1987).

It is clear that at this site, assessment of the role of domestic animals is complicated by our difficulty in separating their economic from their ritual and symbolic value. The work completed so far on the animal and plant remains from the site of Kerma has provided a tantalizing and often contradictory glimpse of the environment, economy and social complexity of this important site. We have the very good fortune to have remarkably well preserved animal remains from the cemetery, but the misfortune to have only very poorly preserved pollen with which to allow us to reconstruct the vegetation of the site. Continuing seasons of excavations are planned, and may produce further evidence to help us to resolve some of the issues raised in this paper.

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ISABELLA CANEVA

Pre-pastoral Middle Nile: local developments and Saharan contacts

The most common feature of the landscape in the Middle Nile Valley is an almost continuous string of small mounds along the banks of the Nile. These hillocks are grouped in irregular concentrations (from about 20 to more than 100) and their size varies considerably; some of them have been almost completely removed by human exploitation. They are the remnants of ancient tumuli cemeteries and probably belong to different cultures, mainly dating from the Meroitic period.

On the east side of the Nile, the tumuli follow the edge of the gravel terrace, along the ancient course of the river. Since the river bank was the most intensively inhabited land in this region in prehistoric times, most of the tumuli were built with the debris of prehistoric sites. For this reason, the area might not seem to be promising for prehistoric research, except for surveying surface monuments, but recent work has proved the opposite: no information could be obtained from the surface, where the archaeological materials have been collected and dispersed several times. Conversely, excavation of pure prehistoric deposits was possible underneath the tumuli and proved that they were better preserved than any others in the region, as they have been protected by a thick cover of earth for many centuries.

During the survey made in 1985 on the east bank north of Khartoum (Fig. 1), twenty one tumuli fields containing Mesolithic deposits were located. They were widely separated and the number, size and location of the original prehistoric sites were not clear. Materials diagnostic for Mesolithic attribution in broad terms were: wavy line and dotted wavy line pottery, microlithic stone tools, stone rings, grinding stones, *etc*. The deposits were considered as a whole in all cases and excavation was undertaken to give information on the extent of the sites.

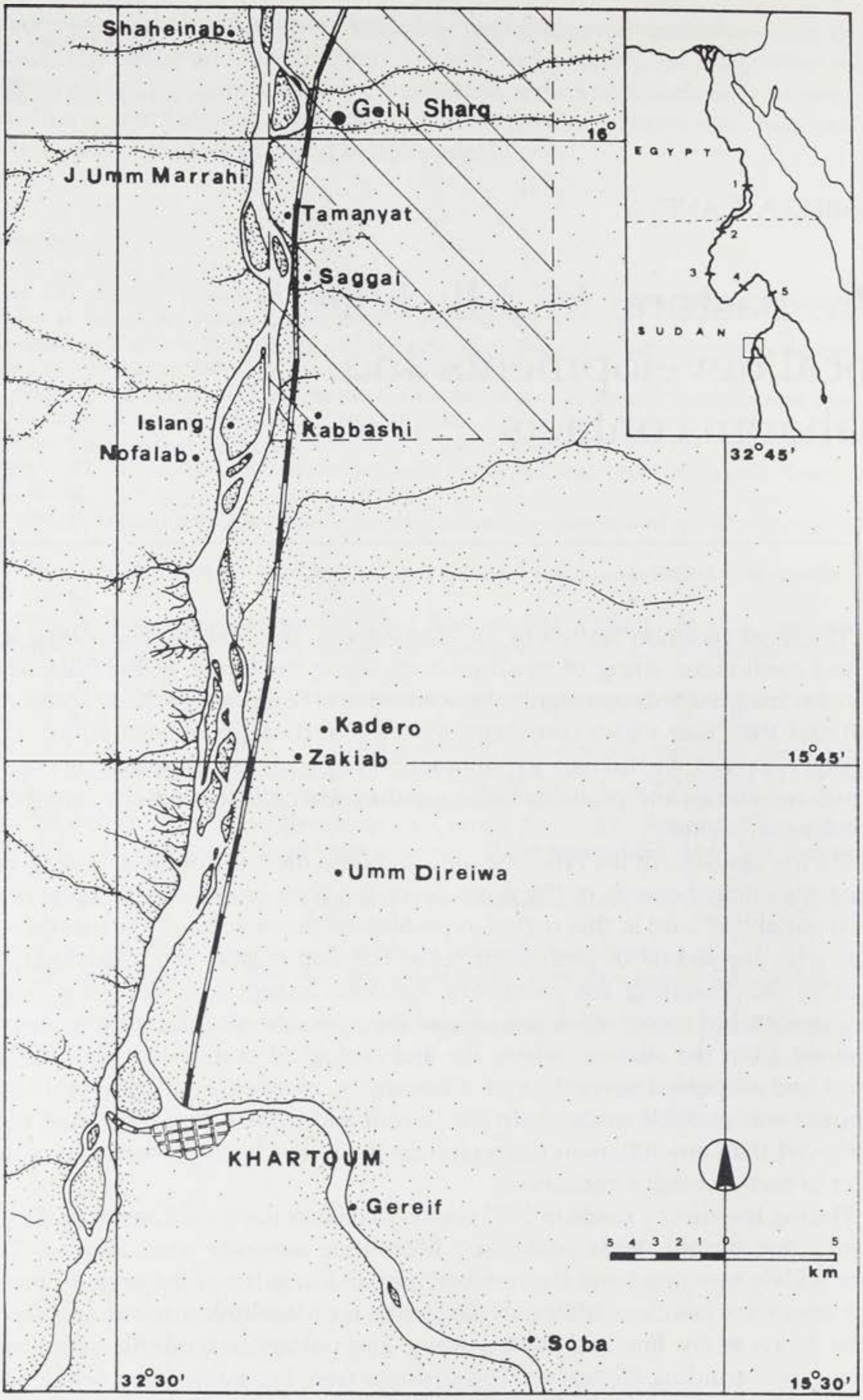
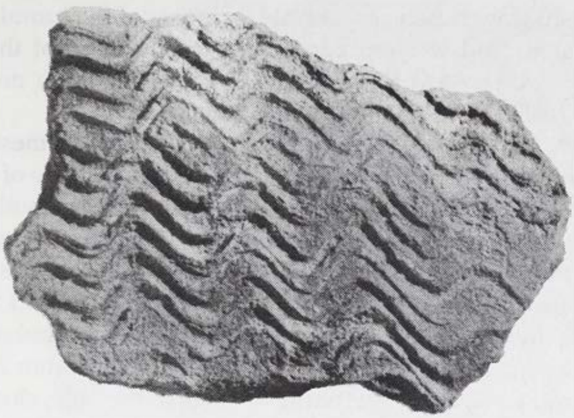


Fig. 1. Map of the Nile Valley north of Khartoum.



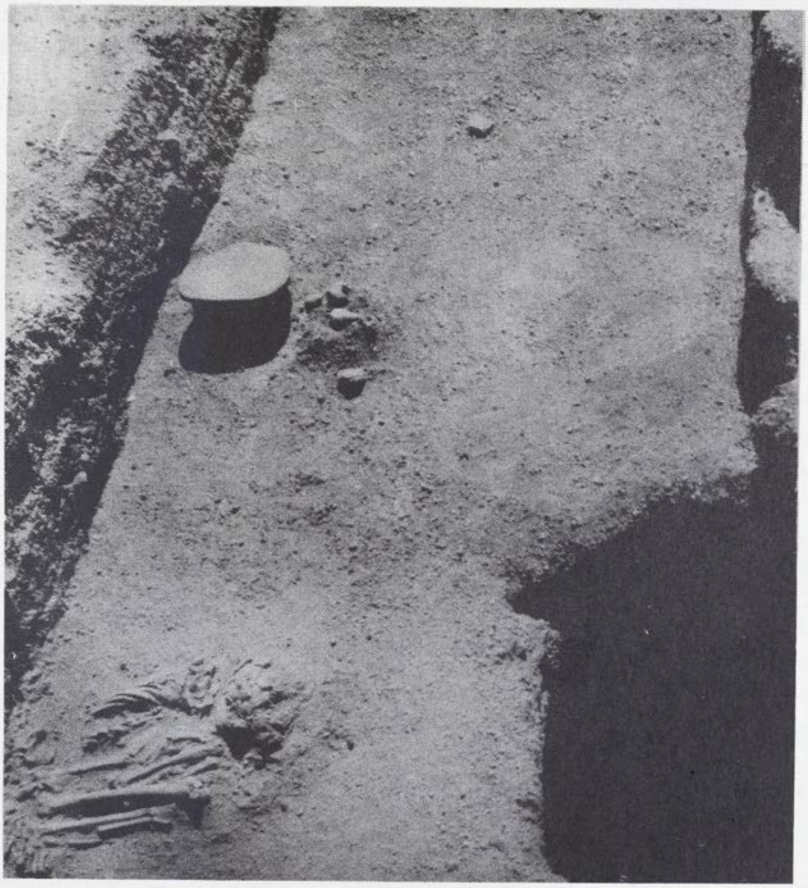


Fig. 2. Kabbashi, Sudan. Tumulus B: the wavy line site.

Kabbashi was chosen as a sample and three of the tumuli, located respectively at the eastern and western edge and in the middle of the field, were excavated during two seasons (Caneva 1987). The three earth mounds were dismantled and revealed different original landsurfaces.

Tumulus C, the easternmost mound, was the furthest from the river and was built over the natural, archaeologically sterile, surface of the gravel terrace.

Tumulus B, almost in the middle of the field, was built over a wavy line Mesolithic site which provided the same fine grey ware as Saggai. Remnants of living floors scattered with animal bones and grinding stones were discovered below the ancient surface, which was easily identified (Fig. 2). A Mesolithic burial was also discovered, only marginally touched by the tumulus burial pit. The assemblage is typically dated to the end of the 8th millennium B.P.

Tumulus A, at the westernmost edge of the field, closer to the river, was built over a pure dotted wavy line Mesolithic site, which was radiocarbon dated to the end of the 7th millennium B.P. (Caneva 1988). As expected, the prehistoric debris was still *in situ*, underneath the original tumulus, whereas in the surrounding area it had been removed down to the sterile gravel when the mound was built. Only traces of the Mesolithic deposits were found embedded in the sterile soil outside the perimeter of the tumulus. These traces are now covered by loose materials, which have rolled down the slopes of the mound.

The intact prehistoric site consisted of 45 cm deep deposits, rich in pottery, lithics and faunal remains. A living area was also discovered (Fig. 3). The lithic industry included a small number of lunates and abundant grinding stones. Faunal remains have not been examined yet but seem to include abundant fish and big herbivore bones, and molluscs, like those found at Saggai. A great amount of pottery was found. The ware is reddish-yellow, with rough stone temper. Vessels are globular, with pointed bottoms, and coil-built. Most of the potsherds are decorated with impressed patterns, made exclusively by the rocker technique (Fig. 3); plain wavy line decorations are absent. The most frequent design is the alternating of straight with wavy bands, but designs with several bands of the same type also occur. The same range of motifs, obtained by the same techniques, has been found in many sites in the Sahara, dating to 9,000 - 8,000 B.P. Dotted wavy line pottery has been found almost everywhere in the Sudan, but usually mixed with wavy line pottery, even where a kind of superposition of levels characterized by the two pottery decorations was hypothesized, as at el Qoz (Arkell 1953). Only recently has dotted wavy line pottery been found in pure contexts, lacking wavy line, at Aneibis, in the Atbara region (Haaland 1987a), at Shaqadud, near Shendi (Mohammed Ali, pers. comm.), and at Kabbashi. It is now clear that wavy line and dotted wavy line pottery characterize respectively two distinct aspects of the prehistory of North Africa.

The analogies between the so-called wavy line and the dotted wavy line contexts are impressive: the same environment was selected for settlements; the same subsistence basis, largely relying on aquatic resources; the same kinds of

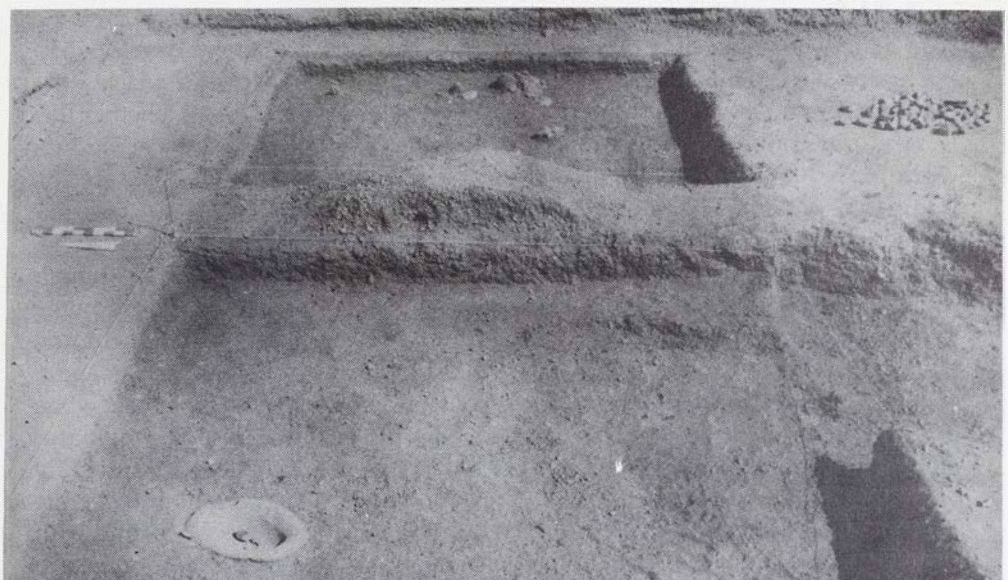


Fig. 3. Kabbashi, Sudan. Tumulus A: the dotted wavy line site.

archaeological materials, especially grinding stones; the presence of burials in the archaeological deposits; the same suggestions of settled life. These analogies, together with several common features of the lithics and pottery, suggest a substantial continuity between the two assemblages. However, pottery decoration, which is the basic difference, is also a diagnostic element: wavy line pottery, abundant in the Nile Valley, is absent in the Sahara, while dotted wavy line pottery occurs there since the 9th millennium B.P., about two millennia before the extensive occurrence of this decoration in the Sudan.

A new series of C-14 dates was obtained in the Khartoum region from the area surveyed in 1985 (Caneva 1988). Together with those obtained recently for Shaqadud and Sorourab, they now provide quite a reliable chronological sequence for the central Nile Valley, which seems to be paralleled in the Atbara Basin, although with slightly earlier dates (Haaland 1987b). These regions seem to have been inhabited, during the 8th millennium B.P. by hunter-fishermen producing wavy line pottery; during the 7th millennium by similar hunter-fishermen producing dotted wavy line pottery; and during the 6th millennium by pastoral people with burnished pottery. The greatest change is traditionally seen during the 6th millennium, when the subsistence basis changes from hunting to herding. Elements for this change, however, must be searched for in the cultures of the 7th millennium and may be expected to explain the mechanisms of development and the ways of diffusion of animal domestication into the Nile Valley. It is now clear that a strong influence from the Sahara developed in the Sudan during the 7th millennium B.P. and not before, slowly replacing the old traditions at least as far as pottery is concerned. It is hard to say whether this is due to migration of people towards the Nile Valley or to an intensified network of exchange, involving also a wider circulation of women, who are the traditional potters. Migration, however, might be excluded due to the observed continuity between these cultures and to a number of differences between the Saharan and the Sudanese dotted wavy line sites. Although some evidence of contacts still exists (e.g. at Shaqadud), during the following periods both the Sudan and the Sahara further west show independent cultural developments associated with the full adoption of pastoralism. It is apparently contradictory that there are more contacts between these two areas when a semi-permanent way of life is attested than when this is replaced by a pastoral, more nomadic, life-style. It is possible, however, that pastoral mobility was very local, with cycles of limited extent, and that territorial borders were more marked in the pastoral than in the hunting societies; the greater fluidity of hunter's groups is likely to have encouraged wider and more intensive changes.

In conclusion, any great cultural expansion from the Sahara into the Nile Valley seems to be limited to the 7th millennium B.P. and was associated with the latest hunter-gatherers. This expansion, therefore, dated slightly before the advent of animal domestication in Africa, and seems to have established the extensive network which later allowed the diffusion of the new economy.

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Animal exploitation between the fifth and the sixth Cataract *ca.* 8,500 - 7,000 B.P.: a preliminary report on the faunas from El Damer, Abu Darbein and Aneibis

Introduction

Faunal remains from Early Khartoum sites have contributed significantly to our understanding how hunter-gatherers exploited the Central Sudanese nilotic environment some 9,000 to 7,000 years ago (Bate 1949; see also Peters 1986; Gautier 1983). However, not all aspects of Mesolithic animal exploitation received equal attention. Indeed, emphasis has been laid on preliminary identifications (Cloudsley - Thompson 1966, Saggai; Clark 1989, Shabona) or quantification and archaeozoological interpretation (Bate 1949, Khartoum Hospital; Gautier 1983, Saggai 1) of the remains of terrestrial vertebrates, whereas the numerous fish bones, indicating that fishing must have been a major subsistence activity, were mostly discarded. With the exception of the preliminary report on the fish from Saggai by van Neer (Gautier 1983: 62 - 65), documentation of the species of fish caught, their relative abundancy, their size range *etc.* is almost non-existent. In this respect, the extensive faunal samples with appreciable amounts of fish bones, collected by members of the Atbara Research Project (Director Dr. R. Haaland) at El Damer, Abu Darbein and Aneibis, undoubtedly contributes to our knowledge of animal exploitation by mesolithic communities in Central Nubia.

The fauna

At El Damer, Abu Darbein and Aneibis remains of fish and mammals clearly dominate the samples (Table 1 and 2), aquatic reptiles are frequent, whereas birds form a minor component. Mollusc shells pertain to three major groups:

freshwater bivalves (*Aspatharia, Etheria*), freshwater snails (*Pila*) and land snails (*Limicolaria*). The freshwater bivalves and snails represent consumption refuse (Gautier 1983: 94). The taphonomic status of *Limicolaria* is not very clear but at Saggai 1 and younger Central Nubian sites (Gautier 1983: 95; 1989: 355), this land snail appears to be a penecontemporaneous intrusive. However, at El Damer and Aneibis, mixed accumulations of adult *Pila* and *Limicolaria* have been found, suggesting that both were used as food items.

Table 1

Fish genera present in faunal samples.

Family or genus	Site		
	KH	SA	AD, ED, AN
Polypterus (bichir)	+	F	F
Protopterus (African lung fish)	+	R	F
Mormyridae (elephant-snout fishes)			F
Hyperopisus		R	R
Gymnarchus (freshwater rat-tail)			R
Heterotis (thick-skinned fish)			R
Hydrocyon (tiger-fish)	+	R	R
Distichodus (rough cast fish)			R
Citharinus (moon fish)			R
Cyprinidae (minnows)			F
Labeo (Nile carp)	+		R
Clarias (eel catfish)	+	F	FF
Bagrus (Forskal's catfish)	+	R	F
Clarotes (spiny catfish)	+		R
Auchenoglanis (black spotted catfish)			R
Synodontis (shield head catfish)	+	F	FF
Lates (Nile perch)	+	F	FF
Tilapia (perch)	+	R	R
Tetraodon (striped Nile puffer)			R

KH – Khartoum Hospital; SA – Saggai; AD – Abu Darbein; ED – El Damer; AN – Aneibis.
+ – present; R – rare; F – frequent; FF – very frequent.
The vernacular names are taken from Amirthalingam and El Yasaa Khalifa (1965). The Saggai fish fauna has been studied by van Neer (1983).

The preliminary identification of the fish fauna was carried out by A. von den Driesch (Munich). The results are given in Table 1. Up to now, at least 22 species from 17 genera have been recognized in the samples. *Clarias, Lates* and *Synodontis*, the latter represented by at least three species (*S. schall, S. sorex, S. membranaceus*), dominate the ichthyofauna. The bulk of the fish bones are derived from medium sized to very large individuals, though it may be that some sampling bias against smaller individuals has occurred because sieving was carried out with a mesh of 1 mm.

Among the reptiles the following aquatic species could be recognized: Nile crocodile (*Crocodylus niloticus*), Nile monitor (*Varanus niloticus*) and Nile soft turtle (*Trionyx triunguis*). To these, we should add one snake species (*Python*) and a tortoise (*Testudo*).

Bird bones are rare in the samples. According to the late J. Boessneck (Munich), most of the remains belong to quinea-fowl (*Numida meleagris*). Bones of Clapperton's francolin (*Francolinus clappertoni*), Sudan bustard (*Ardeotis arabs*) and of riverine species such as grey heron (*Ardea cinerea*), great white egret (*Egretta alba*), night heron (*Nycticorax nycticorax*), pochard (*Aythya ferina*) and maybe purple heron (*Ardea purpurea*) are also present.

Table 2

Mammals from faunal samples.

Species	Site		
	AD	ED	AN
Porcupine (*Hystrix cristata*)		R	
Mongoose (*Herpestes/Mungo*)	R	R	R
Golden jackal (*Canis aureus*)		R	
Wild cat (*Felis silvestris*)		R	
Caracal/serval (*F. caracal / F. serval*)		R	R
African elephant (*Loxodonta africana*)	R	R	F
Black rhinoceros (*Diceros bicornis*)			R
Hippopotamus (*Hippopotamus amphibius*)	R	F	F
Warthog (*Phacochoerus aethiopicus*)	R	R	R
Giraffe (*Giraffa camelopardalis*)		R	
Wild bovids:	FF	FF	FF
Very small, incl. dikdik (*Madoqua saltiana*)	R	R	R
Small, incl. oribi (*Ourebia ourebi*)	FF	FF	F
Medium, incl. bohor reedbuck (*Redunca redunca*) kob (*Kobus kob*)	R	F	F
Large, incl. topi (*Damaliscus lunatus*)			
kudu (*Tragelaphus strepsiceros*)	F	FF	F
roan (*Hippotragus equinus*)			
Very large, incl. African buffalo (*Syncerus caffer*)	R	R	R

AD – Abu Darbein; ED – El Damer; AN – Aneibis.
R – rare; F – frequent; FF – very frequent.

Mammalian remains are abundant in the samples and are derived from many species (Table 2). The minor differences in species composition at the three sites are mainly related to sample size, which is rather small for Abu Darbein. Compared to El Damer and Abu Darbein, the faunal sample from Aneibis yielded quite a number of elephant molar fragments, derived from at least two individuals, as well as numerous bulky bone fragments which we cannot identify anatomically but must belong to that species because of their robustness. Butchering marks on the bones have not been observed and it is an open question whether we are dealing with kitchen refuse. At El Damer, Abu Darbein and Aneibis wild bovids of different sizes were frequently hunted. Generally speaking, the species composition is very similar to the one known from other Sudanese Mesolithic occurrences (Peters 1989b: Table 2), but for the first time we note the presence of a very small wild bovid, namely Salt's dikdik (*Madoqua saltiana*).

Palaeoeconomy and palaeoecology

The analysis of the archaeofaunas from El Damer, Abu Darbein and Aneibis indicate that the subsistence activities of the Mesolithic inhabitants focused on the Nile and its immediate surroundings. According to the ecological requirements of the species present, the archaeofauna can largely be divided into an aquatic and a riverine component. The aquatic component includes the freshwater bivalves, the numerous fish species and the soft shelled turtle *Trionyx*. The second component is made up by animals that dwell in or near rivers such as crocodile, monitor, water birds and mammals frequenting alluvial grasslands, *e.g.* hippopotamus, warthog, oribi, bohor reedbuck, kob, topi *etc.*, as well as those that must drink at regular intervals. As far as we can judge, the archaeofaunas do yield poor evidence for hunting outside the Nile and the Atbara river valleys. We therefore assume that neither the Butana and the Atbai, nor the area west of the Nile were included in the site catchments.

The preliminary quantifications of the faunal material stress the role of fish and mammals as a source of animal proteins. To what extent these contributed in the diet cannot be estimated because we do not know the importance of other food items such as vegetables, seeds, fruits, honey, eggs *etc.* Whether the site inhabitants practiced some form of fish or meat processing cannot be deduced from our preliminary data.

As already mentioned, Mesolithic sites in the Central Sudanese Nile Valley produced numerous fish bones, which, except for the preliminary analysis of the Saggai fish fauna by van Neer (Gautier 1983: 62 - 65), were left unstudied. Bate (1949) relates that "... fish were said to form the most frequent vertebrates at Khartoum Hospital". Dr. Trewavas examined these remains and described them to eight genera, still commonly found in the Nile (Table 1). Besides, Arkell distinguished spines of *Bagrus* during the excavation. To this list, we should add the African lungfish (*Protopterus aethiopicus*), recognized by van Neer in the Khartoum Hospital mammalian sample we restudied (Peters 1986: 13). As to the bone samples collected in 1973 at Shabona, Clark (1989: 405) notes that "The largest components of the fauna are the remains of numerous fish and tortoises, not yet specifically identified". Nevertheless, a model is proposed whereby fishing is considered to be an important dry season activity, that took place as follows: "Creeks would have been dammed and fish caught with spears and, possibly, basket traps or simply by reducing oxygen in the water by trampling the mud and so stupifying the fish" (Clark 1989: 409). However, when, where, and how fish can be captured are preliminary determined by the biology of the fish involved and only secondarily by the available equipment (von Brandt 1984: 32). This is illustrated by Gautier and van Neer (1989) for Late Palaeolithic ichthyofaunas from Nilotic sites in southern Egypt and Sudanese Nubia. Here, remains of *Barbus, Tilapia* and especially *Clarias* contribute to over 95% of the samples. On the basis of their biology in relation to the behavior of the Nile, *Barbus, Tilapia* and *Clarias* can be considered floodplain dwellers (van Neer 1989: 49). Therefore, fishing may have been especially rewarding at the beginning of the inundation when the fish (particularly *Clarias*) enter the alluvial plain to spawn, when the waters start to recede, or when the alluvial plain dries out, leaving a network of residual pools. In this case, simple fishing techniques such as hand grasping, the use of striking or wounding gear, cover pots, stupefaction of fish by stirring up the mud or with ichthyotoxic plant products may have been very adequate to catch the fish (van Neer 1989: 53).

Mesolithic fish bone samples from the Central Sudanese Nile Valley exhibit a very high species diversity (Table 1). According to the habitat preferences and the migrations in function of the water level (von den Driesch 1986; Gautier and van Neer 1989; van Neer 1989; and others), floodplain dwellers (*Clarias, Barbus, Tilapia*) as well as open water forms (*Bagrus, Synodontis, Lates*) are now present, whereby the second group clearly dominates in the samples from El Damer, Abu Darbein and Aneibis. This indicates that fishing focused on the main Nile channel and on the more extensive water bodies that existed after flooding. To catch fish in open waters, different techniques may have been used but direct evidence is limited. Harpoon fishing can be considered one possibility, since bone harpoons have been found in all Khartoum Mesolithic sites. At Aneibis, a number of potsherds showed traces of secondary use, and some of them were perforated. As suggested by the excavators, these may represent fishline sinkers. Hooks, made of shell and comparable to those known from the younger Khartoum Neolithic sites, are not recorded for the Mesolithic, but other raw materials may have been used for their manufacturing. Apart from harpoon and line fishing, the fish spectrum suggests that nets were also utilized (van Neer 1989: 54). In the latter case, it is not inconceivable that fish species that have well developed spines may have been more vulnerable to predation by man because they become more quickly entangled. To a certain extent, this may explain the abundance of *Synodontis* remains in our samples, although it may have simply been the most common species at the junction of the Nile and the Atbara. Finally, the species diversity as well as the large size of some individuals of *Bagrus* and especially *Lates* indicates that fishing with harpoons, lines and nets was not only practiced from the shore, but also from boats or rafts (van Neer 1989: 55). Unfortunately, direct evidence for the manufacturing of such crafts along the Central Sudanese Nile during Mesolithic times is lacking.

Most likely, harpoons and nets were also used to catch semi-aquatic vertebrates such as monitor and crocodile, whereas snares, traps, bow and arrow (with or without poison) and spears may have been utilized to hunt terrestrial mammals. So far, no trace of hunting implements has been found at El Damer, Abu Darbein and Aneibis.

As noted by the excavators, El Damer and Aneibis are situated on gravel ridges on the edge of the old Nile floodplain. Abu Darbein is situated on the east bank of the Atbara *ca.* 10 m above the present river course. From this, it becomes clear that the localities were chosen to avoid the sites being inundated. Potentially, the sites could have been occupied all year round, be it that an occasional very high water level may have rendered life somewhat more difficult and unhealthy (Gautier 1983: 107). However, if varied resources are available, hunter-gatherer subsistence is characterized by a careful scheduling of their exploitation in space and time. Therefore, the ecological requirements, habits and life cycles of the various biological resources may help to establish at what time of the year their exploitation by humans may have been most effective. In this respect, the preliminary results of the faunal analysis can be interpreted as follows. First, the fish fauna is dominated by open water forms, which may imply that fishing activities concentrated in periods when the deeper parts of the river were accessible. Second, the mammalian assemblage shows a high proportion of grazing species that are partial to alluvial grasslands (oribi, bohor reedbuck, kob, topi). Third, the freshwater snail *Pila* may have been most easily harvested in drying out swampy areas (Gautier 1983: 94). Therefore, it is likely that the Mesolithic people were present in the area after the floodwaters had started to recede, when fresh sprouting grasses may have attracted antelopes and other animal species. With the drying out of the floodplain, fishing in deeper water could become a major subsistence activity. If the present behavior of the Nile and Atbara rivers compares well with the one during the Early Holocene, El Damer, Abu Darbein and Aneibis may have been occupied from October till June.

The habitat and food requirements of terrestrial animals recognized in faunal samples provide us with information about the local landscape. For the Mesolithic sites above the 6th Cataract, it has been postulated that they were situated in some kind of low rainfall savanna (*sensu* Wickens 1982: Fig. 3, 4), more precisely in the transitional zone between thorn savanna and scrub and deciduous woodland, probably with a precipitation of some 450 to 500 mm of rain (Wickens 1982; Gautier 1983; Peters 1986; 1989a). An important observation in this respect was the presence of cane rat (*Thryonomys swinderianus*), today confined to the deciduous woodland areas within the low rainfall savanna, at Jebel Shaqadud, some 50 km east of the Nile (Peters 1989a; 1989b).

Below the 6th Cataract at El Damer, Abu Darbein and Aneibis, we did not find evidence for *Thryonomys*. Most likely, its absence is related to somewhat drier living conditions and we therefore assume that the area was situated in the thorn savanna and scrub. Between 8,500 and 7,000 years ago, the annual precipitation at the junction of the Nile and the Atbara may have been about 300 to 400 mm.

Our preliminary analysis indicates that there are also some quantitative differences between the Central Sudanese Early Holocene faunas north and south of the 6th Cataract. Whereas the faunas from south of the 6th Cataract are dominated by remains of kob (*Kobus kob*; at Saggai *ca.* 60%, *cf.* Gautier 1983: Table 8; at Khartoum Hospital *ca.* 45%, *cf.* Peters 1986), we noted that north of the 6th Cataract small antelopes (including oribi, *Ourebia ourebi*) and large antelopes (including topi, *Damaliscus lunatus*) were hunted more frequently by the site inhabitants. Differences in floodplain and river bank topography and vegetation may account for the discrepancy observed.

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KARIM SADR

Environmental change and the development of nomadism in the East-Central Sudan

This paper describes the transition to a nomadic pastoral adaptation in the Eastern Sudan during the early first millennium B.C. Palaeo-environmental reconstructions do not indicate any major ecological changes during this time of transition. Indeed, there is reason to believe the nomads inhabited landscape suitable for agriculture; a point which serves to cast doubt upon the popular notion that pastoral nomadism is strictly an adaptation to marginal lands. Data indicate that nomadism in the Southern Atbai may have come about not for ecological reasons, but as a result of macro-regional changes in the balance of political and economic power.

The analyses which follow are based on extensive surveys and excavations in the Southern Atbai (Fig. 1), in a study area between Khashm el Girba on the Atbara River and Kassala on the Gash River. Research in the Southern Atbai has been carried out by two separate teams: the Butana Archaeological Project (funded by the U.S. National Science Foundation), and the Italian Archaeological Mission in the Sudan Kassala (funded by the Italian Ministry of Foreign Affairs, Ministry of Education and National Research Council).

The Southern Atbai is today part of the easternmost Sahel. Receiving between 200 - 400 mm of rain *per annum*, it is classified as a low rainfall woodland savanna (Barbour 1964). Within this broad classification, the study area contains several different micro-ecological land use zones. These range from the prime agricultural lands of the inland Delta and lower reaches of the Gash River on the eastern boundary of the study area, to the steppe – a vast, open clay plain between the rivers which is today used as pastureland. On the western border of the study area, there are the badlands and narrow floodplains of the Atbara River valley.

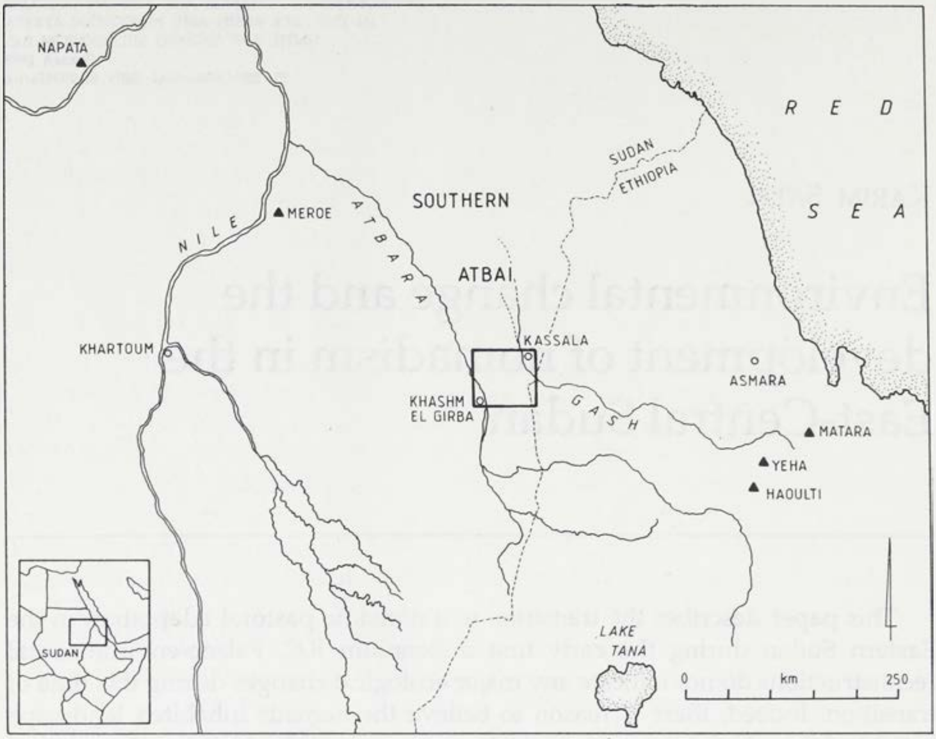

Fig. 1. The Eastern Sudan.

With the combined logistical support of both projects, the entire study area was surveyed by vehicle. For sampling purposes, the landscape from the Atbara to the Gash River was divided into eight ecologically specific sectors, which cover the various grades of agricultural lands, as well as the various types of pasturelands in the marginal zones. It was planned that each of the eight sectors should be surveyed if not completely, then at least more or less evenly. In the end, however, although all sectors were covered, unpredictable shortages of time and gasoline caused the extent of coverage to vary from one sector to the next (Table 1). Additional factors, such as urban development, intensive cultivation, and severe erosion imposed their own limitations on the survey of paricular sectors. By 1984, when surveys were terminated, over 650 sq. km of terrain had been covered: a figure which amounts to some 44% of the designated study area.

Within these 650 sq. km, 233 sites were recovered. Over 80% of these were surface collected for artefacts and another 15 (6%) were excavated by the members of the two projects. The materials recovered from excavations and surface collections allowed the reconstruction of a cultural sequence spanning some ten millennia, from about 8,000 B.C. to the late 18th century A.D. (Fig. 2). The

Table 1

The Southern Atbai survey.

Sector	Area (sq. km)	Coverage (sq. km)	Coverage (%)
Atbara	135	43	33.3
Abu Shosh	115	35	30.4
Hagiz	115	97	84.3
Qaradah	136	43	33.0
Malawiya	212	115	54.2
Sharab	280	135	48.2
Dilulayeb	349	166	47.2
Kassala	140	20	14.2
Total	1482	654	44.4

details of this sequence have already been published elsewhere (Fattovich, Marks and Mohammed-Ali 1984; Marks, Mohammed-Ali and Fattovich 1986). Here, we focus upon a small part of it: the period of transition from the Late Kassala to the Taka Phase during the early first millennium B.C. Analyses have shown that in this transition adaptative strategies changed from a sedentary mixed economy to a specialized nomadic pastoral one. This change in adaptation can be documented in several different aspects of the archaeological remains, including faunal, artefactual and settlement patterns.

Foremost, it is the faunal and macro-botanical remains which herald the shift to a strictly pastoral adaptation. Evidence from three excavated sites suggest that subsistence during the Late Kassala Phase was based on agriculture, pastoralism, hunting, and perhaps gathering, as well. Actual seeds of sorghum and their imprints in clay have been found in a Late Kassala Phase context (Costantini *et al.* 1983). Domestic animals including cattle, goat and sheep are among the most frequently recovered faunal remains (Peters 1986). In addition, some gazelle and giraffe bones have also been found (Peters 1986). In contrast, faunal remains are extremely rare on the mostly surface sites of the Taka Phase. The few bones which have so far been recovered predominantly belong to domesticated cattle (Peters 1986). No floral remains have yet been found in a Taka Phase context.

This apparent shift to more intense pastoral production is also reflected in the distribution of grinding stones. These artefacts are abundant on all Late Kassala Phase sites, but absent on the majority of Taka Phase sites (Sadr 1988). This suggest that the processing of plant foods was not an important part of the Taka Phase subsistence activities. Increased reliance on pastoralism during the Taka Phase apparently went hand in hand with a decreased reliance on agricultural production.

The change in focus of subsistence strategy towards more pastoralism was paralleled by a shift to a more mobile way of life, as is indicated by changes in settlement patterns. Of these, the most dramatic is a change from long term to ephemeral occupation of settlements.

In an evenly deflating landscape, such as obtains in the Southern Atbai, gross differences in surface artefact densities among different sites can reflect diffe-

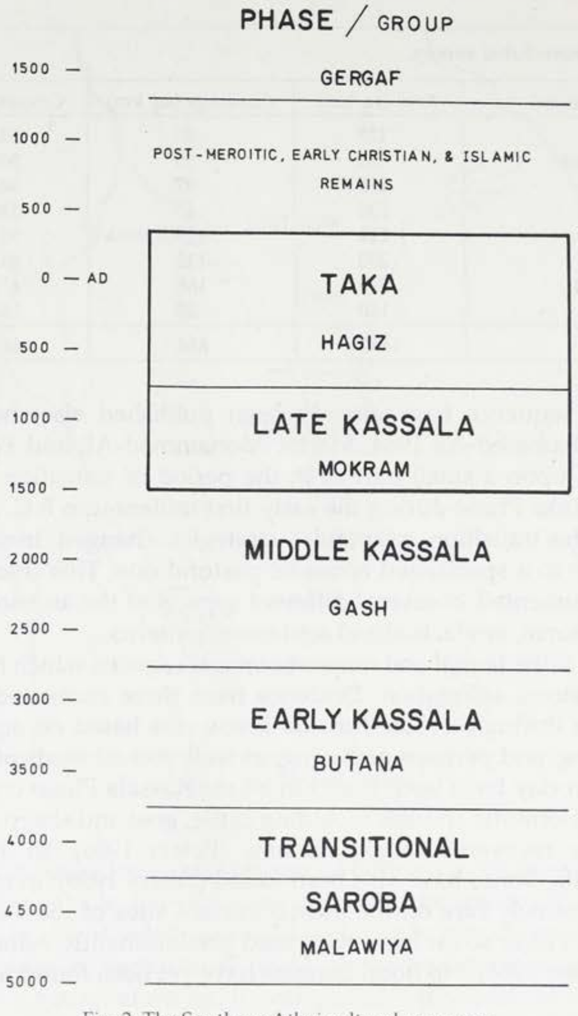

Fig. 2. The Southern Atbai cultural sequence.

rences in the duration of occupations at the sites: the longer the occupation, the more material will be left behind. In this light, a comparison of Late Kassala and Taka Phase sites by surface artefact densities (Table 2) suggests that there was a change to more ephemeral occupations after the early first millennium B.C.

Two high density sites – with over a 100 sherds per surface square meter, and over 35 cm of *in situ* deposit, interpreted as settlements with very long durations of occupations – are associated with the Late Kassala Phase, while none are known from the Taka Phase. Likewise, medium density sites – with 25 - 100 sherds per square meter, and 5 - 10 cm of *in situ* materials, suggesting a relatively long duration of occupation – are common in the Late Kassala Phase, but extremely rare in the Taka Phase. In contrast, low density sites – those with less than 25 sherds per square meter and no depth of deposits, interpreted as very short term occupation – make up 90% of the Taka Phase settlements. This predominance of short term occupations, suggests that the population of the Southern Atbai during the Taka Phase was considerably more mobile than that of the Late Kassala Phase.

Table 2

Sites by density.

Site Density	Late Kassala Phase *n*	Late Kassala Phase %	Taka Phase *n*	Taka Phase %
High	2	2.6	0	0.0
Medium	40	53.3	8	10.0
Low	33	44.0	72	90.0
Total	75	99.9	80	100.0

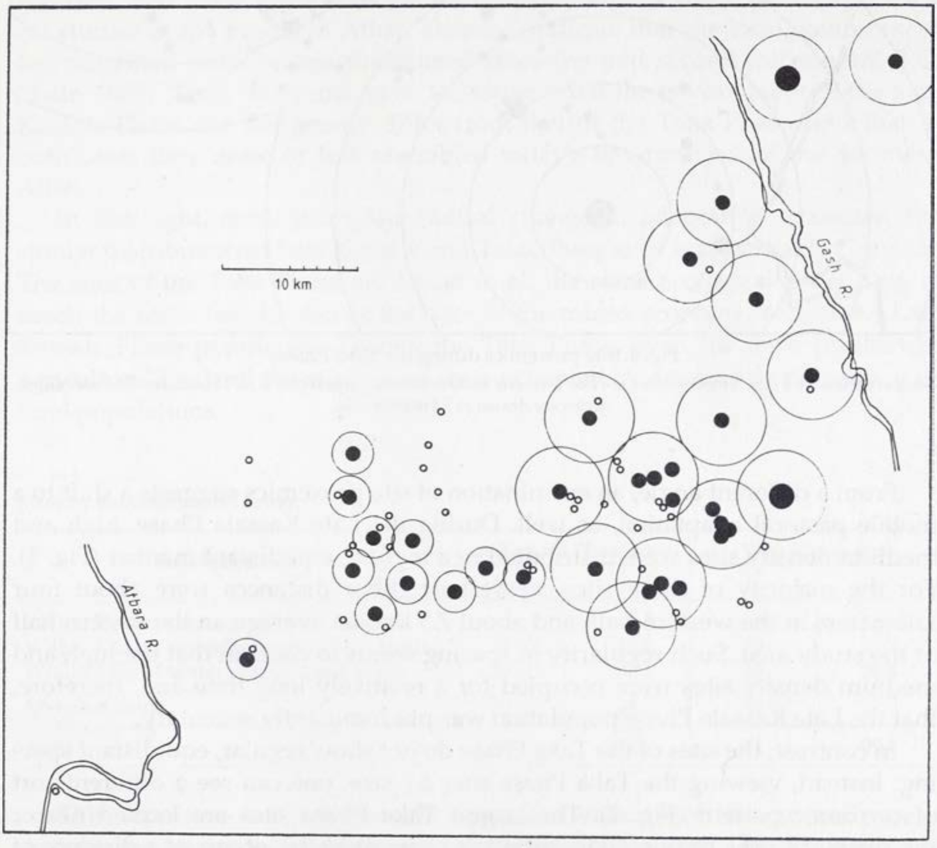

Fig. 3. Site proxemics during the Late Kassala Phase;
Sites are shown by surface artefact density: large filled circles = high artefact densities; medium filled circles = medium densities; small filled circles = low densities.

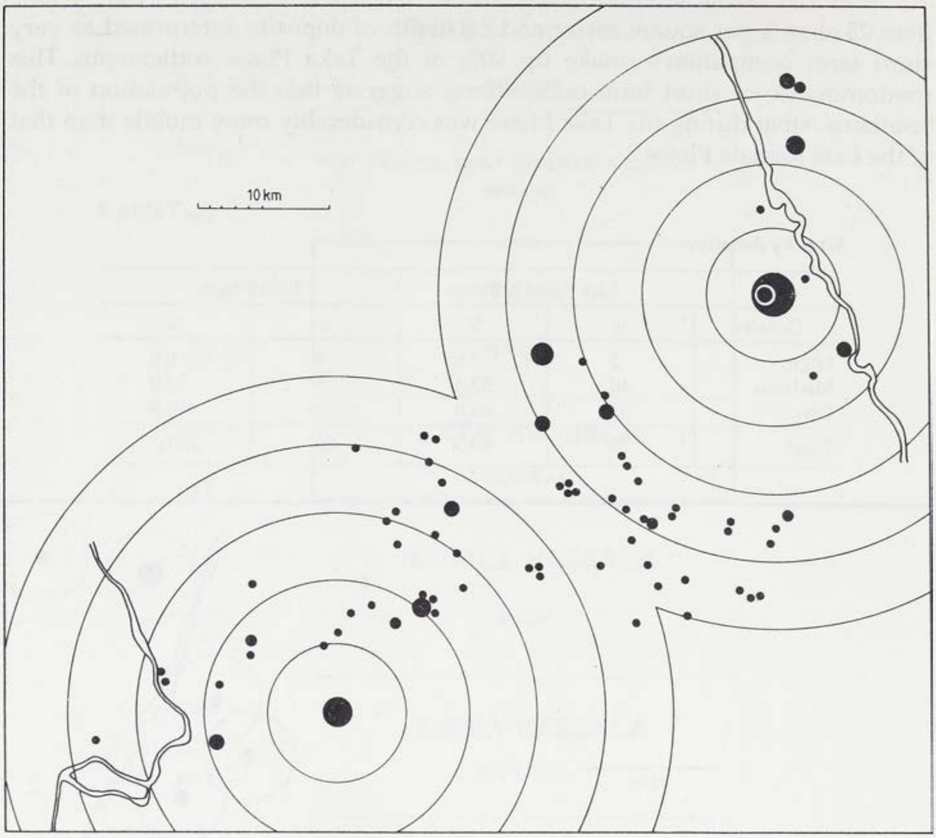

Fig. 4. Site proxemics during the Taka Phase;
Sites are shown by size. Smallest sites are less than one hectare in area, largest one is *ca.* 16 hectares. The concentric circles are drawn at 5 km intervals.

From a different angle, an examination of site proxemics suggests a shift to a mobile pastoral adaptation, as well. During the Late Kassala Phase, high and medium density sites were distributed in a regular, equidistant manner (Fig. 3). For the majority of these sites, nearest neighbor distances were about four kilometers in the western half, and about 7.5 km, on average, in the eastern half of the study area. Such regularity in spacing seems to confirm that the high and medium density sites were occupied for a relatively long time and, therefore, that the Late Kassala Phase population was predominantly sedentary.

In contrast, the sites of the Taka Phase do not show regular, equidistant spacing. Instead, viewing the Taka Phase sites by size, one can see a different sort of proxemic pattern (Fig. 4). The largest Taka Phase sites are located nearer the rivers, and the heaviest concentration of smaller sites occurs at a distance of 15 - 20 km from the largest ones. This pattern is especially clear in the eastern half of the study area but can also be vaguely discerned in the west.

Assuming that this pattern is not simply an artefact of incomplete survey coverage, it is interesting to note that it recalls a basic herding rule among modern Sudanese pastoralists. Herds taken out beyond half a day's walk from the main settlements – a half a day's walk for a herd being 15 - 20 km – have to be sheltered overnight, and thus herding camps must be set up (Evans-Pritchard 1927; Holy 1974). It is tempting to interpret the high concentration of the smaller Taka Phase sites, at just that distance from the largest ones, as a conglomeration of such temporary herding camps.

Overall then, the transition from sedentary mixed economy to nomadic pastoral adaptations in the Southern Atbai can be seen in several aspects of the data including faunal and artefactual remains, as well as settlement patterns. Surprisingly, however, one of the aspects of the data which does not reflect this transition is the distribution of sites by ecological zones.

Palaeoenvironmental reconstructions by Warren (1970) and Wickens (1982) from the Western and Central Sudan indicate that the climate of the Eastern Sahel has remained fairly stable over the past three thousand years. Geomorphological studies in the Southern Atbai, likewise, indicate that the local environment has remained more or less unchanged since the mid second millennium B.C. (Sadr 1988). Thus, it seems safe to assume that the environment of the Late Kassala Phase did not greatly differ from that of the Taka Phase, and that in both cases they more or less resembled today's environment of the Southern Atbai.

In this light, considering the radical change in adaptative strategies, the similar distribution of Late Kassala and Taka Phase sites is remarkable (Table 3). The sites of the Taka Phase are found in all the same ecological zones, and in much the same frequencies as the sites of the mixed economy, sedentary, Late Kassala Phase population. During the Taka Phase, even the most productive agricultural lands of the study area were occupied by apparently nomadic pastoral populations.

Table 3

Sites by environmental zones.

Land use zones	Late Kassala Phase sites		Taka Phase sites	
	N	%	*N*	%
Within 5 km of primary agricultural lands	6	7.4	9	12.6
Within 5 km of secondary agricultural lands	29	35.8	18	25.3
Within 5 km of tertiary agricultural lands	26	32.1	28	39.4
Marginal lands	20	24.7	16	22.5
Total	81	100.0	71	99.8

This serves to cast some doubt upon the validity of the currently most popular theory for the development of pastoral nomadism. The proponents of the ecological theory (Coon 1943; Lattimore 1967; Service 1975; Khazanov 1984) have long argued that pastoral nomadism was adopted by populations, who, as a result of environmental change and/or population pressure, had lost access to agricultural lands. Since they had no arable lands to cultivate, so the argument goes, the population turned to pastoral production, and since pastoralism in a marginal environment requires seasonal migrations, so the populations became nomadic.

The transition to nomadism in the Southern Atbai, however, does not fit this interpretation. Certain sectors of the Southern Atbai cannot, by any stretch of the imagination, be called agriculturally marginal. Even today, with Northeast African climates practically at their driest since the late Pleistocene (Muzzolini 1982) simple rainfall agriculture can support large sedentary populations in parts of the study area. During the Taka Phase these parts of the study area must have had the same agricultural potential. Even though, for several centuries, the Taka Phase nomads were the sole occupants of these fertile sectors, there is no evidence to suggest that they settled down to exploit the agricultural potential of the region. Thus, environmental change and lack of access to agricultural lands does not seem to have been a decisive factor in the transition to pastoral nomadism in the Southern Atbai.

But then, what was the decisive factor? A hint of an answer is provided by a cross correlation of historic events in the Eastern Sahel, which suggest that nomadism in the Southern Atbai may have developed in response to changes in the macro-regional balance of political and economic power.

If one steps back and observes diachronic developments at a scale covering all of the Central Sudan and Northern Ethiopia some suggestive patterns emerge. At the time of the Late Kassala Phase, that is before *ca.* 750 B.C., the Central Sudanese Nile Valley was apparently all but depopulated (Marks *et al.* 1985): in the stretch of the Nile from south of Khartoum to the north of the Atbara confluence, no sites have yet been found which date between *ca.* 1,500 - 800 B.C. To the east, in the Northern Ethiopian highlands, from the period between 1,500 - 500 B.C., only a few poor assemblages are known from the Godebra Rockshelter (Phillipson 1977) and in Begemder province near Lake Tana (Dombrowski 1972). These suggest a relatively low level of cultural complexity in that region.

If the poverty of archaeological remains in these neighboring regions is not simply an artefact of the amount of research carried out (a point which can be more easily argued in the Central Sudanese rather than Northern Ethiopian context) it can be said that during the late second and early first millennium B.C. the two regions neighboring the Southern Atbai were culturally, economically and politically peripheral zones. In contrast, at that time the Southern Atbai was something of a cultural and economic center. As the research of the Butana Archaeological Project and the Italian Archaeological Mission has shown, during the Late Kassala Phase a large sedentary population inhabited this region. Elsewhere, it has been shown that the Late Kassala Phase inhabitants of the Southern Atbai had contact with the cultures of the Nubian Desert, and imported exotic stones from the Red Sea Hills. Indeed, Fattovich (1985) has suggested that Southern Atbai of the second millennium B.C. may even have been a province of the Land of Punt, an important trading partner of Pharaonic Egypt. Thus, a political/economic map of this part of the Eastern Sahel during the time of the Late Kassala Phase would show the heartland in the Southern Atbai, flanked by the hinterland regions of the Central Sudan and Northern Ethiopia.

At the beginning of the Taka Phase, however, this center/periphery arrangement completely reversed itself. First, around 800 B.C., the Kushitic Kingdom established one of the major centers at Meroe in the Central Sudanese Nile Valley (Bradley 1984). Indeed, around 500 B.C., Meroe became the capital of the Meroitic Kingdom, and later established strong political and economic links with Ptolemaic and Roman Egypt (Shinnie 1967). At about the same time, in the Northern Ethiopian highlands of the mid-first millennium B.C., the Pre-Axumite Kingdoms established their centers at places such as Yeha, and Matara (Fattovich 1984; Anfray 1968). These Northern Ethiopian Kingdoms apparently had strong links to the Arabian cultures of that time. By the first few centuries A.D. the contacts of the succeeding Axumite Kingdom extended as far as India and Ceylon (Kobishchanov 1979).

While the Central Sudan and Northern Ethiopia were being elevated to political and commercial heartlands, the Southern Atbai – as the forgoing discussion has indicated – became a peripheral zone, sparsely inhabited by the nomads of the Taka Phase. Given the lack of significant environmental change during the early first millennium B.C., it cannot be argued that ecological factors turned the Southern Atbai into a peripheral region. On the contrary, the macro-regional sequence suggests that it was a realignment of the politico-economic axes which led to the reversals in the fortunes of the Southern Atbai. Nomadism apparently arose in the Southern Atbai when that region became politically peripheral, not when it became ecologically marginal. Thus, in this case, nomadism appears to have been an adaptation to the cultural, rather than the natural environment.

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Climatic and cultural changes in the Southern Atbai, Sudan, from the fifth through the third millennium B.C.

The relationship between regional climatic shifts and culture change has a powerful appeal to those archaeologists working in the climatically marginal zones of the world. Both theoretically and practically, there are expected covariations between increasing and decreasing precipitation and/or temperature and shifts in human adaptation, as reflected in patterns of economic exploitation, site locations, and even material culture inventories. Having recognized the truth of this general proposition, however, does not make a positive correlation between regional climate change and culture change explanatory, even under the most extreme conditions. Obviously, the shift from hyper-arid to pluvial conditions in the Southern Shara is powerfully correlated with man's entry into the region, although, as it must be admitted, the new potential for human exploitation there does not explain why man chose to do so, except on the most general principals.

In situations where climatic change is not so extreme, where man's presence is more or less continuous before, during and after the change, much care must be taken to avoid using regional climatic change as form of simple-minded environmental determinism. This is particularly true when one onset of regional climatic change seems to be positively correlated with apparent culture change. Such a situation exists in the Southern Atbai in the far eastern Sahel at the onset of the Mid-Holocene dry phase at about 5,000 B.P. (Wickens 1982) and, while regional climatic change undoubtedly play some role, local environmental variations well may have been more important than regional ones (Marks and Sadr 1988).

To examine this, it is first necessary to take a brief look at the Southern Atbai and its Early and Mid-Holocene prehistory. The Southern Atbai is located between the Atbara River and the Eritrean Hills of northern Ethiopia. It is the southern extension of the flatlands which lie to the west of the Red Sea Hills in northeastern Sudan, as well as being an eastern extension of the huge Butana grasslands which lie to the west of the Atbara River Valley. Unlike the Butana, however, which has some topographic relief and patches of fairly rich vegetation, the Southern Atbai (and particularly its western half) is almost devoid of significant topographic features and its heaviest vegetation consists of rather thick stands of thorn trees. Since it today receives over 300 mm of rain per year, it is likely that the presently barren landscape is in large part due to overgrazing and extensive deforestation for charcoal production. The same situation prevails along the Atbara River, only there is greater topographic relief because of very active erosion all along the eastern edge of the Atbai steppe. Between the steppe and the river itself is a highly eroded "badlands" where thorn trees prevail and the whole area is heavily grazed by domestic stock.

None of this area seems particularly inviting to man, although it is today used extensively after the summer rains. Yet, the area was rather different during the Early Holocene and well into the Mid-Holocene, based on faunal, floral and other evidence. In fact, during the Early Holocene the area is postulated (Wickens 1982) to have been covered with a deciduous savannah woodland, comparable to that found today some 175 km south of Kassala, its major town, and to have had a high level of rainfall in the catchment areas of its rivers (Adamson 1982).

During the Mid-Holocene, beginning at about 5,000 B.P., there was apparently little change in vegetational patterns, in spite of a drop in precipitation. It was only at about 3,000 B.P., according to Wickens (1982), that the present vegetational patterns, in climax form, appeared. In this context, it is possible to correlate major culture change with the onset of the Mid-Holocene dry phase, while at the same time recognizing that there was little vegetational change and, probably little change in megafaunal populations.

Overall, therefore, the pattern of climatic change in the Southern Atbai from the Early Holocene through the Mid-Holocene was one of gradual drying, with the onset of the Mid-Holocene dry phase seen essentially, at first, in a slow drop in precipitation. Thus, the Holocene climatic history of the Southern Atbai during this period provides only the most general of backdrops onto which the changing patterns of human settlement and adaptation may be projected. These regional climatic patterns, by their very nature, do not reflect accurately the variations in local conditions and their fluctuations through the time which, in one case, at least, appears to have had major impact on culture change.

In order to understand the Southern Atbai during the Holocene, one must realize that the major portion of its moisture comes from rivers, the waters of which originate well south of the central Sudanese climatic zone. The largest river is the Atbara but its deep incision into the landscape limits its effective water to its edges. The Gash River, on the other hand, which derives its highly seasonal flow from some 21,000 sq. km of Ethiopian hill slopes, has a very shallow bed which virtually guarantees wide scale surface inundation, as well as deposition of permeable sands over the local impermeable clays (Whiteman 1971).

The geomorphic history of the Southern Atbai has been dominated by the northeasterly shift of the Gash River to its present position along the hills of Eritrea. It appears from both archaeological and geomorphic studies that during the Early Holocene the Gash flowed into the Atbara River somewhat north of the town of Khashm el Girba. Because of its shallow bed and seasonally variable flow, its course tended to be braided and meandering and, through time, began to move away from the Atbara. Undoubtedly, part of the reason for this was the decreasing volume of flow brought about by lower rain levels in its catchment area as the Early Holocene waned. This probably accelerated during the early Mid-Holocene. However, as the Gash moved, the area of seasonal inundation moved with it and, as its delta moved to the northeast, the amount of local inundation to the west of the Gash depended upon the degree of local soil permeability, the amount of overbank flooding, and distance from the Gash channels. While the amount of overbank flooding is directly related to regional climatic conditions, the other factors are strictly local, and it is them which had direct local effects, at least, during the 3rd millennium B.C.

These effects can be seen most clearly in settlement pattern data, combined with information on diachronic economic adaptations. While this paper will focus only on the Early and Mid-Holocene, information is readily available for later periods (Sadr 1988).

Culturally, the Early Holocene is represented by a small number of sites located in the Atbara River Valley. At first, they were pre-ceramic and quite distinct from other pre-ceramic manifestations further north (Marks, Peters and van Neer 1987). Their economy was based on hunting and fishing, with a few sickle blades in the later sites, suggesting some plant processing.

By 6,200 B.P., there were ceramic producing peoples in the area, again apparently with their habitation sites limited to the Atbara River Valley (Marks 1987). These folk, too, were hunters and fishermen. They exploited both the riverine environments and the steppe edge, as seen by the diversity of megafauna hunted which included a good range of small to large antelopes (Peters 1986a). Their sites, less than one third of a hectare, contain minimally shaped grinding stones but no sickles. Their ceramics are abundant and well made. The pots have simple conical bottoms and banded zones of impressed decorations around their upper halves. The variety of impressed techniques, mainly comb impressed rocker-stamping, parallels that seen during the Khartoum Mesolithic in the central Nile Valley. The only exception is a series of pots with zoned bands of small knobs. These have the same position on the pots as do the more typical decorations but their technique of manufacture – pushing the clay out from the inside wall with the thick stick, filling the indentation with a small rock and then covering it with a bit of clay – is unknown in the central Nile Valley during both the Mesolithic and the Neolithic (Arkell 1949; 1953; Nordstrom 1972; Caneva 1988; Chłodnicki 1982).

The stone tools associated with this ceramic assemblage are uninspired, although there are a few elongated lunates, which are quite distinct in form from those lunates associated with the late pre-ceramic period. The marked differences between the lithic assemblages of the late pre-ceramic assemblages and those of these early ceramic-baring ones suggest that there was no developmental continuity between the two and, therefore, that these early ceramic sites represent newcomers into this area of the Atbara River Valley, although not from the central Nile Valley (Marks 1987).

Around 5,600 B.P. there was a marked change in the material culture, as well as in settlement pattern, in the Southern Atbai. First, it appears that the Atbara River Valley was no longer considered optimal for habitation, since all sites are now found on the western steppe, between the Atbara River Valley and the Gash Delta (Marks, Mohammed-Ali and Fattovich 1986; Marks and Sadr 1988), although none appears to have been located within 30 km of the present Gash channel (Sadr 1986; 1988). These sites of the Saroba Phase (Fattovich, Marks and Mohammed-Ali 1984), ranging in size from two tenths of a hectare to one hectare, are easily recognized by their ceramics. These are sand tempered, unburnished and unslipped; they have a very limited range of impressed motifs, apparently covering the complete vessels. These motifs are mainly made by rocker-stamping and are similar to some found in the Khartoum Mesolithic, although wavy-line and dotted wavy-line motifs are absent. Thus, only in a general way do they fit into the Khartoum Horizon style (Hays 1971).

Being located on the steppe, at least 10 km away from the Atbara River and more so from the Gash River, these folk apparently did not exploit the riverine environments to any extent but, instead, intensified their exploitation of the wooded savannah fauna – mainly small antelopes, although warthog and some larger antelopes were also hunted (Peters 1986a). Like those before them, they had relatively little equipment implicitly associated with plant processing, although some grinding stones are present at all sites.

At about 5,100 B.P., just at the end of the Early Holocene wet phase, we can see some significant changes in cultural inventory. Although only a single site is now known for this period, the Saroba/Kassala Transitional Phase (Fattovich, Marks and Mohammed-Ali 1984), it clearly indicates an increasing material complexity but, seemingly, within the same economic adaptation, emphasizing the hunting of steppe mammals and lacking any hint of domesticated stock (Peters 1986a). The known site of this period is 50% larger than the largest Saroba Phase site, has 30 cm of cultural deposit, as opposed to an average of 10 cm for the earlier sites, and there is a marked increase in the number of types of chipped stone tools, as well as ceramic wares.

The most obvious changes can be seen in the ceramics. Along with the typical Saroba Phase sherds, there are now both a rare black burnished ripple ware and, more importantly, large numbers of a fairly thin-walled, large vessels with unburnished and unsmoothed scraped interiors and exteriors. The size of the vessels alone suggest somewhat less mobility than before and the high density of sherds at the site indicates more intense occupation or reoccupations of the site than was seen at Saroba Phase sites.

The lithic materials show a shift away from backed microliths, often geometric, to a dominance of processing tools. For the first time since the pre-ceramic period, there were excellently made scrapers and scaled pieces, quite credible perforators, and even a range of finely made denticulate endscrapers. All this suggests, at least, more maintenance work and secondary production at this site than was seen at the earlier Saroba Phase sites.

Within about 500 years, at 4,500 B.P., only a few hundred years after the postulated beginning of the Mid-Holocene dry phase, there was a radical change in most areas of the local prehistory. Only four aspects remained essentially as contact between the transitional phase and the Butana Group of the early Kassala Phase which developed out of it (Fattovich, Marks and Mohammed-Ali 1984). There was a continuity in the dominance of unburnished, unsmoothed scraped wares; the chipped stone assemblages remained very similar; sites still occurred on the steppe; and, meat was still obtained only from wild animals.

On the other hand, a great number of changes are apparent. Among them, the following seem most striking:

– the presence of sites in both the Atbara River Valley and on the steppe to within 30 km of the present Gash Delta;

– an incredible increase of site size, from 1.5 hectares in area with 30 cm of cultural deposits at the transitional site to as much as 11 hectares in area and 260 cm of cultural deposits;

– the appearance of a number of site types, from large habitation sites to highly specialized sites for ceramic production or bifacial pick manufacture;

– a marked increase in the number of ceramic wares, from three in the Transitional Phase to as many as six in the Butana Group of the Early Kassala Phase;

– the production of very large, thick-walled scraped vessels, as well as a range of thin, black burnished and red topped/incised fine wares;

– the appearance in the early Kassala Phase of polished stone mace-heads, imported from the Red Sea Hills area, and the presence of locally produced agate lip plugs, both of which suggest increased social stratification;

– the appearance of a range of locally produced polished stone tools, including axes and adzes;

– a marked increase in the number of ground stone pieces.

All these changes took place within a context of continuity in faunal exploitation (Peters 1986a). All evidence points to the continued hunting of steppe animals. Not a single element of domestic fauna occurred in the lower levels of the Butana Group sites. While a very few did occur in their upper levels, perhaps 300 to 500 years after their founding, even then they were rare and suggest little economic importance. In this regard, the recent suggestion by Haaland that these large village sites were made by Cushitic speaking pasturalists who were "being forced to rely increasingly on cultivation" (1988: 230) is not only without empirical foundation but the available data, while not relevant to what these folk might have spoke, certainly documents that pasturalism was not present before or during the beginning of this explosion of cultural complexity. How then may we account for these radical changes, if not through shifts in economic adaptations? Why was there such an apparent development of marked social stratification and sedentism? There are some hints. While the faunal exploitation did not change, the increased number of ground stone pieces and the introduction of large bifacial and polished tools suggests that plants had become much more important than previously. Unfortunately, we have no direct evidence for the introduction of domestic cereals at this time but it is likely that they, in fact, played a crucial role in this cultural transformation. Yet, why then and not before, since both domestic animals and postulated cereal cultivation has been claimed for the central Nile Valley at comparable or somewhat earlier dates (*e.g.* Gautier 1984; Peters 1986b). Can the temporal correlation between regional climatic change and culture change be documented here?

If the timing of the major changes in settlement location and material culture complexity is matched against regional climatic change, it is apparent that only during the shift to the Mid-Holocene dry phase can one find a correlation; in the other two earlier cases marked changes took places within a single climatic period. In the latter case, can the onset of a dry phase be causative to any great extent? If so, it was not any essentially arbitrary line between the Early Holocene wet phase and the Mid-Holocene dry phase, but rather some long term regional trends which partly might be causative in this case.

In the broadest sense, the decrease in precipitation near the end of the Early Holocene wet phase, as it approached a level sufficiently low to recognize the onset of the Mid-Holocene dry phase, at about 5,000 B.P., undoubtedly played a role in lowering the volume of the seasonal Gash discharge and, in doing so, initiating the shift of its delta toward the northeast. Beyond that, however, it is unlikely that it had any direct effect on local culture change.

Rather, the shift of the Gash end the resulting and of heavy seasonal inundation in the drier western steppe, opened the area to increased plant exploitation. It appears that this was already under way during the Saroba/Kassala Transitional Phase – that is, still within the Early Holocene wet phase – but that it virtually exploded during the subsequent early part of the Kassala Phase. At that time, the large, deeply stratified sites were located on or adjacent to the permeable soils left by the earlier Gash overbank flooding. It seems likely, therefore, that the local opening up of arable lands was a primary factor involved and that this was not a regional phenomenon but was the result of strictly local microgeomorphological shifts in the Gash River channels.

Although this cannot yet be proven, it is highly likely that once the Gash Delta established itself essentially parallel to the Atbara River, with its northern end abutting the Red Sea Hills, it opened an avenue of contact between the Southern Atbai and Northeastern Sudan. This can be seen in the presence of polished stone artifacts which come from the Red Sea Hills and appear first during the Early Kassala Phase. Their presence might suggest that an important factor in the rapid growth of social cómplexity was this new economic interaction. In this case, it would mean that either the southern Red Sea Hills area contained societies already more complex than their contemporaries in the Southern Atbai or that development there was essentially parallel to that in the Southern

Atbai and that interaction accelerated the growth of complexity in both areas. Only additional field work in that area will resolve this but, without doubt, the extremely rapid growth of village life and social complexity in the Southern Atbai did not take place in a void.

In sum, we can find no good causative correlation between significant culture change in the Southern Atbai during the Early and Mid-Holocene and regional climatic change. At best, like Spinosa's God, it set a process into motion, but it was a local variations in microenvironmental conditions which played the central role in permitting acceptance and/or intensification of plant exploitation which, apparently, provided the impetus for the dramatic cultural changes seen at 4,500 B.P.

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The Gash Group of the Eastern Sudan: an outline

Definition

The Gash Group is a cultural unit typical of the Eastern Sudan, dating from the early third to the mid-second millennium B.C. It corresponds to the middle Kassala Phase of the cultural sequence made evident in the Kassala-Khashm el Girba region (Fattovich, Marks and Ali 1984; Fattovich, Piperno 1986; Marks, Ali and Fattovich 1986; Marks, Fattovich 1989; Fattovich 1990; 1991; Sadr 1988).

So far, 32 Gash Group sites have been recorded along the Gash Delta (Kassala Province) and in the alluvial plains to the south of it. They are located near Eriba Station in the northern delta (ES 1), around the Jebel Taka at the southern end of the delta K 1, K 2, K 4), along the palaeochannel of Shurab et Gash, about 35 km to the south of Kassala (JAG 1, JE 2, AG 1, AG 2, EG 1, EG 4, SEG 2, SEG 7, SEG 10, SEG 14, SEG 16, SEG 19, SEG 20, SEG 21, SEG 22, SEG 37, EG 39, SEG 51, SEG 55, SEG 56, SEG 59, SEG 64, SEG 65, SEG 66, K 7) and in the steppe to the west of Shurab et Gash (KG 52, KG 53, KG 93) (Sadr 1986, 1988).

The main site of this group is Mahal Teglinos (K 1), located in a natural basin at the northern end of Jebel Taka, near Kassala (Fattovich, Piperno 1986; Costantini *et al.* 1982; 1983; Coltorti *et al.* 1984; Cermaschi *et al.* 1986; Fattovich, Vitagliano 1987a; 1987b).

The occupation sites at Agordat, in the middle Baraka valley, can be also related to this Group (Arkell 1954; Fattovich 1989a). Moreover, some materials from Erkowit in the Red Sea Hills might be compared to those from Mahal Teglinos (Callow, Wahida 1981).

The Gash Group is identified by a ceramic assemblage dominated by scraped vessels (up to 75% of the decorated sherds in the upper levels at Mahal Teglinos; d'Alessandro 1985). The rest of the ceramics are mostly decorated with various rim band designs: simple dash rouletted, punctate zoned and horizontal zig-zag patterns. It exhibits some affinities with the Kerma and C-Group ware. In the uppermost levels at Mahal Teglinos, moreover, a wide rim band of horizontal parallel incisions, sometimes zoned with punctations is quite frequent (d'Alessandro 1985; Fattovich 1988; Sadr 1988).

The preliminary analysis of the flaked stone industry from Mahal Teglinos indicated that it is basically microlithic, with a practically insignificant blade index. Sometimes, the debitage shows the traces of "secondary" working: new flakes were obtained from other flakes, striking them with different orientations according to the thickness and surface size of the piece; this technique can be observed on flakes and chips. Among the flakes, primary flakes and those with partial cortical surface (sometimes obtained from hammer-stones, upper grinding stones and pestles) are more frequent than those without cortex. Some evidence of bipolar percussion and percussion on anvil can be recognized. The scaled pieces are another typical element of the debitage. Typical tools of this industry are end- and sidescrapers, denticulates, notches, rare burins, truncations, retouched flakes, perforators, very rare *mèches-de forêt* (microlithic or not), backed pieces and geometrics (crescents, and in minor quantities triangles and trapezoidal pieces). The geometrics are obtained mainly from flakes without the use of the microburin technique. The raw materials include quartz, agate, and in minor amounts flint, basalt, chert, greenstone and jasper (Fattovich, Vitagliano 1987b).

Polished and ground stone artefacts are quite common at Mahal Teglinos. They include fragments of lower grinding stones, upper grinding stones, hammerstones, pestles and abraders, usually made of local granite and basalt. Polished axes of basalt and sometimes of more valuable stone also occur (Fattovich, Vitagliano 1987b).

The minor artefact classes include lip-pluges, lip and/or nose-studs, stone, shell and ostrich beads and pendants, bone pins, anthropomorphic and animal figurines, miniaturized pots and other small objects.

Another recently discovered aspect of the Gash Group is the use of monolithic stelae to indicate the burial ground at Mahal Teglinos (Cremaschi *et al.* 1986; Fattovich, Vitagliano 1987a). About 60 stelae have been found so far. They are *ca.* 0.90 - 1 m high and can be distinguished into three main types: pointed stones, flat stones, small pillars. The burials associated with these monuments were not directly connected to the single stelae, suggesting that they indicated the funerary meaning of the area, rather than single graves (Fattovich 1991).

The following main types of burials have been identified:

1. Body lying on the back, legs bent on the left side, head to the west, face to the north, arms straight or flexed;

2. Contracted body on the right side, head to the west, face to the north, hands in front of the face, legs strongly bent;

3. Contracted body on the right or left side, head to the west or the east, arms flexed;

4. Body lying on the right side, head to the west, legs slightly flexed, right arm straight, left arm flexed;

5. Body lying on the back, head to the west, legs straight, right arm straight, left arm flexed;

6. Body lying in a straight posture on the frontal side, with the left arm flexed and the hand in front of the face, the right arm slightly flexed and the hand below the pelvis, legs with feet crossed.

No grave good have been found, save for some personal ornaments (Fattovich 1989a).

The excavation at Mahal Teglinos have made evident a stratigraphical sequence with five main archaeological levels, representing different stages of development of the Gash Group. They correspond to eight main phases of occupation of the site in this period (Coltorti *et al.* 1984; d'Alessandro 1985; Fattovich, Vitagliano 1987b). The upper levels I - IV can be ascribed to the typical Gash Group. Level V can be attributed either to a marginal facies of the Butana Group, identified in the Khashm et Girba area, or to a possible proto-Gash Group.

Level I includes scraped ware, with indented, pinched and direct rims, sometimes decorated with clay balls appliqued to the shoulder of the pots; linear carved or combed ware; straight line incised ware; simple dash roulette rim banded ware, with linear or wavy vertical impressions; black topped ware; black polished ware; red polished ware; stick red burnished ware.

Level II includes scraped ware, with direct, indented and pinched rims; simple dash roulette rim banded ware, with vertical wavy impressions; linear carved or combed ware; black topped ware; red polished ware; stick red burnished ware.

Level III is characterized by a fine pottery, often with a biotite black slip on the inside. It includes fine scraped ware, with direct and indented rims; fine ware decorated with rim bands of oblique engravings; black polished and red polished wares; black-topped ware.

Level IV includes scraped ware with direct rims; wiped ware; black-topped ware; black polished and red polished ware; stick red burnished ware.

Level V is characterized by a high frequency of undecorated ware. On the basis of the fabrics, two sub-levels can be distinguished. Level Va includes black-topped ware; black polished ware; stick red or black burnished ware; scraped ware; zig-zag rim banded ware. Level Vb includes black polished ware; stick red burnished ware; scraped ware; wiped ware.

On the basis of the cross-dating with the Kerma and C-Group pottery in Nubia and four radiocarbon datings from charcoal samples from the stratigraphical sequence in the trench K 1 BSKP/1987 (Fattovich, Sadr and Vitagliano 1988), the archaeological levels at Mahal Teglinos can be dated as follows:

Level I: 1,500/1,550 - 1,790/1,820 B.C.

Level II: 1,790/1,820 - 1,870/1,920 B.C.

Level III: 1,870/1,920 - 2,300 B.C.

Level IV: 2,300 - 2,500/2,510 B.C.

Level Va: 2,500/2,510 - 2,700/2,730 B.C.

Level Vb: 2,700/2,730 - 2,950/3,010 B.C.

In turn, the stelae can be mainly correlated to the level II and possibly III, suggesting a date to the early 2nd millennium B.C. (Fattovich 1989a).

Natural background

The reconstruction of the Gash Delta palaeoenvironment during the Holocene is still largely speculative. The available evidence suggests that the climatic fluctuations in this region followed the general trend outlined in the other regions of Northern Africa and the Horn (Marks, Sadr 1988; Sadr 1988; Fattovich, Sadr and Vitagliano 1988; Fattovich 1990). Therefore, we can assume that in the 3rd - 2nd millennia B.C. the climate of the region was wetter than to-day and the landscape was dominated by the deciduous savanna woodland.

However, at the regional level, the local hydrology was a more important environmental factor. In fact, the Holocene geomorphological history of the Kassala region was characterized by the slow northeasterly movement of the Gash Delta, from a possible Terminal Pleistocene/Early Holocene confluence into the Atbara river to the present bed (Durante *et al.* 1980; Coltorti *et al.* 1984; Marks, Sadr 1988). Between *ca.* 3,000 - 2,000 B.C. the river flowed most likely along the Shurab el Gash palaeo-channel. By around 2,000 B.C. it assumed its present course, as we can infer from the stratigraphic position of the appearance of riverine and aquatic fauna at Mahal Teglinos (Sadr 1988).

Another important environmental factor was the availability of natural resources particularly appreciated in ancient times, in the hinterland of Kassala: frankincense, other resins and gums, gold, ivory and ebony (Fattovich, Sadr and Vitagliano 1988).

Settlement pattern

The Gash Group sites range in size between less than 0.5 and 12 hectares. At present, five main hierarchical levels can be distinguished in the southern Gash Delta (Sadr 1988; Fattovich, Sadr and Vitagliano 1988):
13 sites with surface inferior to 1 hectare;
5 sites with surface between 1 and 2 hectares;
5 sites with surface between 2.5/3 and 4 hectares;
3 sites with surface between 6.5/7 and 8.5 hectares;
2 sites with surface of 10/11 - 12 hectares.

On the basis of the size, density of materials and thickness of the archaeological deposit they can be regarded as permanent villages or periodically reoccupied settlements over a long time, semipermanent settlements and temporary camps.

Subsistence economy

At the present stage of the research, we can suggest that the subsistence economy of the Gash Group people relied on cattle and sheep/goats breeding and most likely on plant cultivation (Marks, Sadr 1988; Fattovich, Sadr and Vitagliano 1988).

Domestic cattle and sheep/goats appeared at Mahal Teglinos in the early typical Gash Group layers, dating to *ca.* 2,500 - 2,000 B.C. (Geraads 1983). The occurrence of many lower and upper grinding stones in most assemblages of this group, and the size of the major sites, in turn, confirms that cultivation of domestic plants was practiced (Fattovich, Vitagliano 1987a; 1987b, Sadr 1988).

The settlement pattern, moreover, point to a location of the major sites in the optimal zones, and of the semipermanent and temporary camps in the marginal ones, suggesting a heavy reliance on pastoral production (Sadr 1988). It is interesting to remark that this pattern can be compared with that of the modern semi-nomadic Beni Amer of the northern Ethiopian-Sudanese borderland (see Fattovich, Sadr and Vitagliano 1988).

Craft activity

The evidence from Mahal Teglinos suggests that different craft activities were carried on at this site: the making of pottery; the working of flaked tools and ground stones, including axes; the manufacture of lip-plugs and studs, and discoidal beads, mainly of ostrich shell (Fattovich, Sadr and Vitagliano 1988).

Trade and external contacts

The available evidence suggests that the Gash Group people were included in a complex network of contacts and exchanges which linked Egypt and the Middle Nile Valley to the Upper Nile, the Horn and possibly Southern Arabia (Fattovich 1988; Fattovich, Sadr and Vitagliano 1988). Such contacts seem to have been particularly frequent in the first half of the 2nd millennium B.C.

The occurrence of Kerma elements along the whole stratigraphical sequence at Mahal Teglinos documents the continuity of contacts with this early stage during the whole period of development of the Gash Group (Coltorti *et al.* 1984; Fattovich, Vitagliano 1987a; 1987b; Fattovich 1988; 1989a).

Coiled and finger-nail impressed sherds, like specimens from Shaqadud Cave in the Northern Butana going back to the late 3rd - early 2nd millennium B.C., appear in the levels I, II and upper III (*ca.* 2,000 - 1,500 B.C.). Fragments of Jebel Moya type occur in the level I (*ca.* 1,800 - 1,500 B.C.). Fragments like the Terminal C-Group and Pan Grave ones occur in the Terminal Gash Group level overlapping the burial ground (*ca.* 1,600/1,500 - 1,400 B.C.; Cremaschi *et al.* 1986; Fattovich, Vitagliano 1987a; Fattovich 1989a). An Egyptian sherd of New Kingdom type has been collected in the upper level I (*ca.* 1,500 B.C.). Obsidian flakes of probable Ethiopian origin occur in the level I (*ca.* 1,800 - 1,500 B.C.). A fragment with wavy punctate decoration along the rim, comparable to specimens from Northern Yemen going back to the 3rd - 2nd millennium B.C., has been found in the level IV (*ca.* 2,500 - 2,300 B.C.). Red stick burnished sherds, like those from Mahal Teglinos, in turn, have been found in sites along the

Yemeni Tihama, going back to the 3rd - 2nd millennium B.C. (Tosi, pers. comm.). Finally, sherds like those from the Gash Group assemblages at Agordat have been collected at Subr, near Aden, in the Southern Yemen (Lankester Harding 1964).

On the whole, it seems that the radius of action of the Gash Group covered a very wide area stretching from the White Nile to the Red Sea coast and the cliffs of the Ethiopian plateau (Fattovich, Sadr and Vitagliano 1988). Therefore, the present evidence suggests that in the late 3rd - early 2nd millennium B.C. Mahal Teglinos was a node in the commercial routes connecting the Middle Nile and the Gezira to the Red Sea coast and the Ethiopian highlands. To this commercial activity we can relate most likely the occurrence of donkey remains in the levels I - II at Mahal Teglinos.

Social complexity

The clear cut hierarchy in size and wealth of the Gash Group sites suggests a social and economic complexity, may be at the chiefdom level of organization (Sadr 1988).

It is confirmed by the discovery of some administration devices at Mahal Teglinos (Fattovich, Sadr and Vitagliano 1988). They are:

8 stamp clay seals from the levels I and IV (*ca.* 1,800 - 1,500 B.C.; 2,500 - 2,300 B.C.);

2 tokens from the levels I and III (*ca.* 1,800 - 1,500 B.C.; 2,300 - 1,900 B.C.);

1 fragment of clay sealing from the upper level III (*ca.* 2,000 B.C.).

Two stamp clay seals have also been collected at the sites IAG 1 and SEG 19, suggesting an articulated administrative organization.

In turn, the creation of a formal burial ground marked with stelae at Mahal Teglinos might be related to the emergence of territorial descent groups with privileged access to some economic resources in time of scarcity, as Chapman (1981) has suggested for the European megaliths.

Processual analysis

The following process of socio-economic and cultural transformations, reflected by the Gash Group evidence, can be provisionally outlined:

Proto-Gash Group (*ca.* 3,000 - 2,500 B.C.)

The origins of the Gash Group are not yet perfectly understood. However, the available evidence suggests some degree of cultural continuity between it and the previous Butana Group located to the east of the Atbara along an Early to Middle Holocene palaeochannel of the Gash (Marks, Sadr 1988; Sadr 1988). It seems that in the first half of the 3rd millennium B.C., the region around Kassala was only marginally occupied by the Butana people (Fattovich, Sadr and

Vitagliano 1988). In any case, the thickness of the deposit (*ca.* 80 cm) in the level V at Mahal Teglinos might suggest a more stable occupation of this site than in a seasonal camp (Fattovich, Vitagliano 1987b). At this time, the subsistence economy of the people living in the southern Gash Delta relied on the hunting of wild species (Geraads 1983).

Early Gash Phase (*ca.* 2,500 - 2,000 B.C.)

In the mid-3rd millennium B.C. the people of the Butana Group apparently moved eastwards, following the shift of the Gash course, and settled mainly along the palaeochannel at Shurab el Gash (Sadr 1988). At the same time it was affected by some changes in the material culture, mainly due to the contacts with Kerma, emerging as the typical Gash Group culture (Fattovich 1988).

A stable village (SEG 56) 8.5 hectares in size, appears along the Middle Holocene system of Gash channels at Shurab el Gash. It may be regarded as a transitional Butana/Gash site (Sadr 1988). At the same time, another permanent village arose at Mahal Teglinos (Fattovich, Vitagliano 1987b). The earliest funerary stelae discovered so far, most likely go back to this period (Fattovich 1989a), suggesting that this site was a ceremonial center connected to the cult of the dead. Moreover, a large site (ES 1), *ca.* 10 hectares in size, appear near Eriba Station in the northern delta, about 140 km from Kassala, confirming that the Gash people spread also to the north towards the Red Sea Hills (Fattovich 1989b). The subsistence economy relied mainly on the cattle and sheep/goats breeding, but the hunting and gathering of wild forms represented an important component (Costantini *et al.* 1982; Geraads 1983). Cultivation was probably practiced, but actual evidence is still lacking.

At this time, the Gash people were certainly in contact with those of the Middle Nile Valley, as we can infer from the Early Kerma and C-Group elements occurring at ES 1 and Mahal Teglinos. The evidence of administrative devices in the levels IV and III at Mahal Teglinos suggests that a "chiefdom" arose in this period.

Classic Gash Group (*ca.* 2,000 - 1,500 B.C.)

In this phase the Shurab et Gash area was densely populated by Gash Group people. One or perhaps two main residential villages arose in this area (JAG 1, SEG 7/SEG 14). They were surrounded by a complex system of semipermanent villages and temporary households or camps, more directly connected to the subsistence activities (Sadr 1988). At the same time, Mahal Teglinos was occupied by a large residential village, about 10 - 11 hectares in size, mainly involved in craft and trade activities (Fattovich, Sadr and Vitagliano 1988). Moreover, in this period the Gash Group people most likely spread to the east and north, as far as the Red Sea coast, occupying the whole northern Ethiopian-Sudanese borderland. This can be inferred from the evidence at Agordat, Erkowit and Aqiq (Fattovich 1990).

Husbandry and cultivation were surely practiced and in particular, the dispersal of the settlements into more marginal lands in the southern Gash might suggest a shift in the subsistence economy to a more specialized agro-pastoral production strategy (Sadr 1988). At this time, the Gash Group people were included in the large circuit of economic interchange gradually evolving between the peoples of Egypt, Sudan, Ethiopia and perhaps Somalia and Southern Arabia. In particular, Mahal Teglinos probably became a basic node in the commercial routes connecting the Ethiopian highlands to the Red Sea coast, the Gezira and the middle Nile Valley. It might have been the gateway to the Land of Punt, maintained in the Pharaonic sources (Fattovich 1991). The social organization was most likely at the "chiefdom" level.

Terminal Gash Phase (*ca.* 1,500 - 1,400 B.C.)

This phase is still poorly documented. The scarce evidence from Mahal Teglinos suggests that at this time there were contacts with the Late C-Group and Pan-Grave peoples of Nubia and Eastern Desert (Cremaschi *et al.* 1986; Fattovich, Vitagliano 1987a; Fattovich 1991).

The major sites continued to be occupied, but apparently they reduced in size, suggesting a more marginal position for the Gash Delta within the trading circuits of the Nile Valley and the Horn. At this time, northern peoples related to the Pan-Grave Culture probably penetrated into the borderland and mixed with the Gash Group (Sadr 1987; 1988; Fattovich, Sadr and Vitagliano 1988).

Conclusions

The Gash Group represents the first evidence of a possible chiefdom to the south of Nubia in protohistorical times and environmental, economic and political factors were most likely involved in its development.

The northeastwards progressive shift of the Gash Delta, from its original confluence with the Atbara to the present course, in the Middle Holocene opened a new region favorable to the human settlement and caused the northwards movement of the Butana Group people from the Atbara to Shurab et Gash and Jebel Taka. At the same time it shortened the route from the middle Nile Valley to Northern Ethiopia and the southern Red Sea coast, more directly involving the local peoples in contacts with Nubia. In such a way the Gash Delta became the land gateway to the resources of the Eritrean western lowlands and Tigrean plateau.

With the inclusion of the Gash people in the circuit of interchange between Egypt and the southern regions of North-eastern Africa, it became an important commercial partner of the Kerma state. Such trade activity, in turn, caused the rise of a quite complex society, most likely at the chiefdom level, in the region.

The rise of a chiefdom probably affected the increase of the population and the shift towards a more specialized agro-pastoral economic strategy in the

Classic Gash Group. The Egyptian dominion of Nubia in the New Kingdom finally weakened the role of Kerma as an intermediary in the trade with the South, isolating the Gash Delta more and more from the main trading flow, as we can infer from the impoverishment of the final Gash Group occupation at Mahal Teglinos. Such isolation might have been increased moreover by the start of the direct South Arabian trade of frankincense in the 15th century B.C. (Fattovich 1991). However, the contacts with the Nile Valley were not completely interrupted, the nomads of the Eastern Desert probably acting as intermediaries (Saleh 1973).

At the end, the Gash people mixed with northern groups, originating the Jebel Mokram Group, which represented the following stage of socio-economic and cultural development in the region (Fattovich, Sadr and Vitagliano 1988).

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MUMIN MOHAMUD GHOD

Quaternary ecology in Northern Somalia: a preliminary field report

Introduction

The preliminary results here are based on two journeys to Northern Somalia in December 1987 and in March/April 1988 mainly to the Darror Valley and to the area of Bosasso. As a part of the Special Research Unit 69 at the Technical University of Berlin, sponsored by the German Research Foundation (DFG), they were performed to find out whether climate and landscape in Northern Somalia had changed during the Quaternary in a significant way and if so to what extent these changes had affected the country and at what time this had happened. The aim was to establish a chronological time table of Quaternary events and to compare it with the changes in the Saharan desert belt to the north or with Central and Eastern Africa.

Palaeoecological knowledge can be deduced from different kind of sources; reliable statements are expected not from a single type of argument but only from a whole interdisciplinary spectrum of available hints and as many indications and observations as possible have to be collected to contribute altogether to a true and veritable picture of the past. Nevertheless, because of limited time in the field and limited scientific specialists, there was a restriction to selected types of investigations.

Soil investigations

More than 50 soil sections were described and sampled in the field by K. Stahr, F. Alaily and B. Lassonczyk. Some of them, especially hydromorphic soils, were embedded within Quaternary sediments. Vertisols occurred here and there, but orthic solonchacs predominated on most surfaces. Detailed analyses in the laboratories shall provide an overview over climatic induced weathering types and soil forming processes during different times in the past.

Prehistoric archaeology

Prehistoric man left numerous relics, which show various periods of fairly good living conditions in that area. Lower Stone Age remains are rare, restricted to single handaxes of dubious origin (Fig. 1), but a Middle Stone Age complex is rather well represented. Stone artefacts of this type cover slopes and terraces or

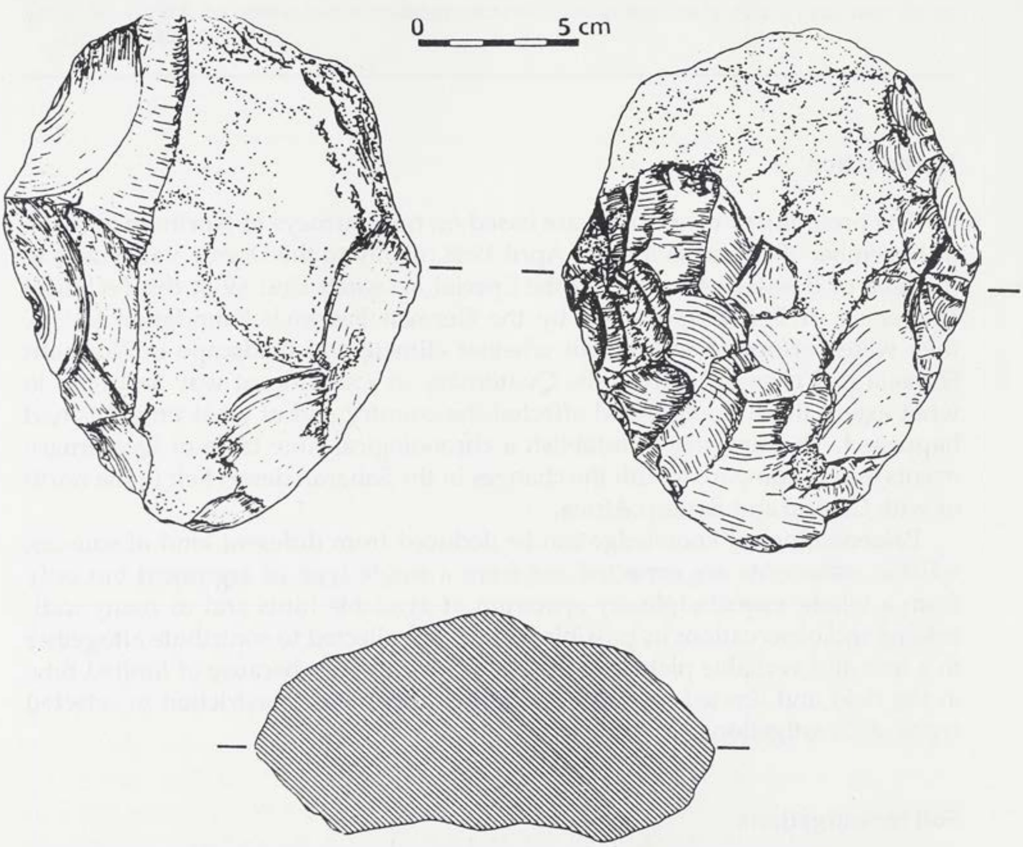

Fig. 1. Handaxe made of chert, found near the spring travertine of Lac, 20 km west of Karin, Bosasso area.

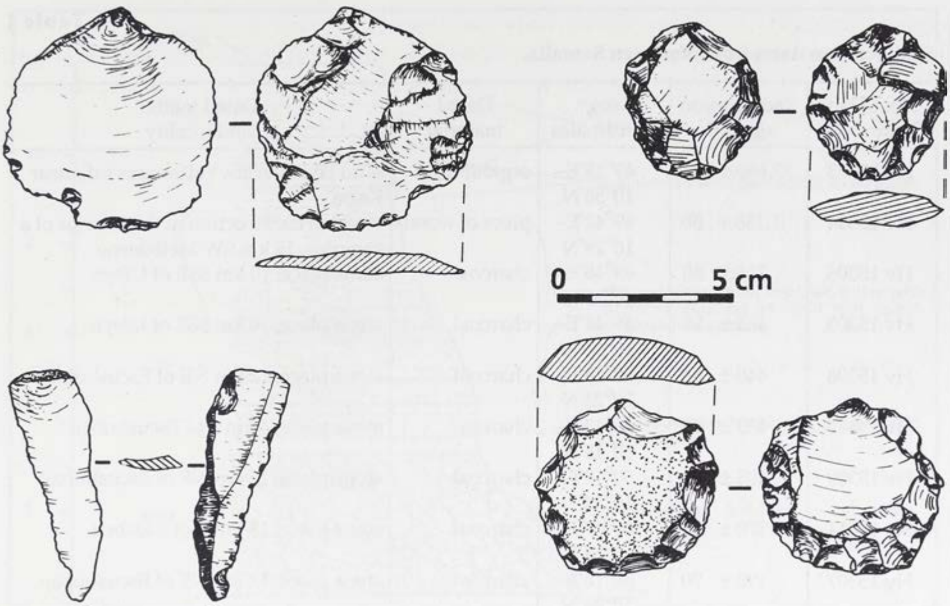

Fig. 2. Upper Palaeolithic artefacts made of chert, from the surface of the spring travertine of Lac, 20 km west of Karin, Bosasso area.

are even embedded in the base levels of fluvial deposits. In the middle and upper layers of several sections artefacts of Late Stone Age type are to be found (Fig. 2) and on the top of them Neolithic habitation sites with few ceramic sherds and ancient fireplaces; the latter, the so-called "stone places" (Gabriel 1987) occur still in modern times. The late Preislamic period is documented especially by large graveyards with dozens, sometimes hundreds of tombs of different types. They are called "Galla graves" (Lewis 1961, *cf.* Jönsson 1983), but in reality their ethnic origin and their age are unknown. A wooden piece of the inner construction of a destroyed tomb near Meledeene in the Darror Valley had the radiocarbon age of 1,130 ± 50 B.P. (Hv 15303, see Table 1). It seems that the graveyards represent a 1st millennium A.D. to medieval period of dense population with a sedentary way of life and better living conditions than today. Special architectural elements, like stone pavements and alignments with orientation east or south-east (Gabriel 1970; 1993), may indicate cultural relations to similar phenomena in the Sahara from where the immigration may have taken place (Brandt and Carder 1987; Clark 1980). The "stone places" on the other hand, cannot be interpreted in the same way as in the Sahara where they mostly are the fireplaces of Neolithic cattle herders (Gabriel 1977; 1987). Here in Somalia they originate from nomadic people during the last millennium. A series of charcoal data from the Darror Valley ranged between 715 ± 50 B.P. (Hv 15306) and recent times (Table 1).

Table 1

Radiocarbon dates from Northern Somalia.

No. of lab. (Hannover)	Radiocarbon age B.P.	Geogr. coordinates	Dated material	Dated matter and locality
Hv 15303	17,660 ± 300	49°15′E–10°58′N	organic mud	mud layers below calcareous tufa near Karin
Hv 15304	1,130 ± 50	49°42′E–10°29′N	piece of wood	wooden construction in the interior of a tumulus, 15 km SW Meledeene
Hv 15306	715 ± 50	49°46′E–10°35′N	charcoal	stone place, 10 km SSE of Ufeyn
Hv 15305	485 ± 55	49°46′E–10°35′N	charcoal	stone place, 10 km SSE of Ufeyn
Hv 15308	440 ± 60	50°18′E–10°23′N	charcoal	stone place, 12 km NE of Escushuban
Hv 15310	435 ± 60	50°13′E–10°15′N	charcoal	stone place, 4 km S of Escushuban
Hv 15309	405 ± 55	50°19′E–10°28′N	charcoal	stone place, 25 km NE of Escushuban
Hv 15311	370 ± 50	49°17′E–10°45′N	charcoal	stone place, 13 km E of Kalabeit
Hv 15307	195 ± 70	50°18′E–10°23′N	charcoal	stone place, 12 km NE of Escushuban
Hv 15312	110 ± 60	50°11′E–10°07′N	charcoal	fireplace besides a tomb, 10 km S of Escushuban
Hv 15313	(75 ± 55)	49°43′E–10°27′N	charcoal	stone place, 20 km S of Meledeene

Fluvial terraces

A sequence of at least three, sometimes four different fluvial terraces exists in many of the wadis (Clark 1954; Mussi 1975). They seem to indicate a changing climatic regime of erosion and accumulation, but they are difficult to date as they mostly consist of pebbles or gravel and sand and do not yield much palaeoecological information. Therefore it was more valuable to look for fossil bearing accumulations of fine material which had possibilities for dating by archaeological, radiocarbon and other isotopic methods; such deposits occur in several parts of the survey area.

The Karin Formation

Near Karin, some 40 km south of Bosasso, over more than 10 square kilometers the valley floor is covered by a sequence of Middle and Late Quaternary sediments (Fig. 3). They are well exposed in numerous sections and have a thickness of about 10 to 12 m. Pebbles at their base are consolidated by a calcareous matrix. This conglomerate is overlain sometimes by travertine, sometimes by calcareous crusts. Alternating sands, silts, marls, hydromorphic soils, sometimes rich in gypsum, follow in the middle part of the sections. The se-

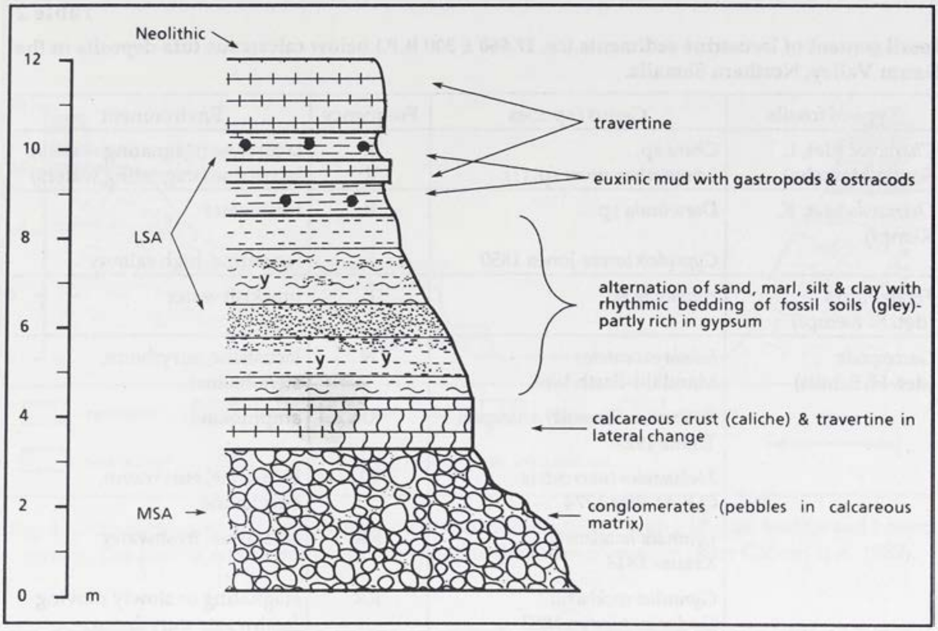

Fig. 3. Standard section of the Karin Formation. The euxinic mud layers at the base of the top travertine yielded a radiocarbon date of 17,660 ± 300 B.P. (after Gabriel *et al.* 1989).

quence continues normally with euxinic mud deposits, which are intercalated with thin layers of travertine. On top the sections are sealed by tufa or travertine which can reach a thickness of 4 m.

Usually the dark mud horizons are rich in organic matter. Apart from microfossils like ostracodes, foraminifera and charophytic remains they contain at least 7 different species of snails (Table 2). They indicate a lacustrine environment most likely with freshwater; the salt content may have changed laterally or vertically in the sequences. After the desiccation of the lakes or of parts of them, small snails (*Ceciliodes munzingeri* det. H. Schütt) intruded into the swampy soils and lived from organic matter in the subsoil up to a depth of 2 m. From some artefacts in several sections a Mid-Pleistocene age for the conglomerates at the base and an End-Pleistocene to Early Holocene age for the upper layers was estimated. On the surfaces of the accumulations Late Palaeolithic tools and potsherds of presumed Neolithic date marked the end of the sedimentation. The first radiocarbon date of one of the fossil bearing mud horizons 3.80 m below the top travertine had an age of 17,660 ± 300 B.P. (Hv 15303). This is astonishing when compared to previous results all over Central and Eastern Africa. Nearly all authors presume a cool and dry climate for that time until the beginning of the Early Holocene wet period at about 12,000 B.P. (Bonnefille and Hamilton 1986; Brook 1986; Flohn and Nicholson 1980; Gasse 1980; Gasse *et al.* 1980; Hurni 1981; Messerli and Frei 1985; Rognon 1976; van Zinderen Bakker 1982; Williams 1985).

Table 2

Fossil content of lacustrine sediments (*ca.* 17,660 ± 300 B.P.) below calcareous tufa deposits in the Darror Valley, Northern Somalia.

Type of fossils	Genus/species	Frequency	Environment
Characeae (det. I. Soulié-Märsche)	*Chara* sp. *Lamprothamnium* sp. (?)	R R	lacustrine (stagnating waters) lacustrine (stagnating waters)
Ostracoda (det. K. Kempf)	*Darwinula* sp.	R	freshwater
	Cyprideis torosa Jones 1850	F	lacustrine, high salinity
Foraminifera (det. K. Kempf)	*Ammonia* sp.	F	brackish water
Gastropoda (det. H. Schütt)	*Jubaia excentrica* Mandahl-Barth 1968	N	lacustrine, eurytherm, stenohaline)
	Assiminea (Eussoia) aethiopica Thiele 1927	RR	amphibian
	Melanoides tuberculata O.F. Müller 1774	N	lacustrine, eurytherm, euryhaline
	Lymnaea natalensis Krauss 1848	RR	lacustrine, freshwater
	Gyraulus cockburni Godwin-Austen 1883	RR	stagnating or slowly moving freshwater, eurytherm,
	Biomphalaria pfeifferi Krauss 1848	F	lacustrine, freshwater
	Ceciliodes munzingeri Jickeli 1873	RR	subterraneous (in humid soils)

R - rare; RR - repeated; F - frequent; N - numerous.

Similar deposits near Escushuban and Elayo

Very similar sequences are exposed south of Elayo, here and there intercalated with marine strata which include oysters; on a large scale they occur in the Darror Valley some 6 km west of Escushuban (Fig. 4). Here conglomerates at the base, dark mud horizons with snails of the same species as at Karin, and thick travertine deposits on the top, some layers with artefacts, show that this type of accumulation was not a local exception but was obviously linked with a certain climatic period; in some other regions (*e.g.* 23 km south of Las Daoué) at the same period, the content of organic matter, clay and calcium carbonate or other evaporites is much less.

Older travertine covers

West of the Escushuban as well as near Karin it is obvious that there exist much older but undated travertine layers. They occur as widespread, horizontal, deeply dissected covers on the top of red soils and fluvial deposits. We must wait for Uranium/Thorium determinations such as those which Brook (1986)

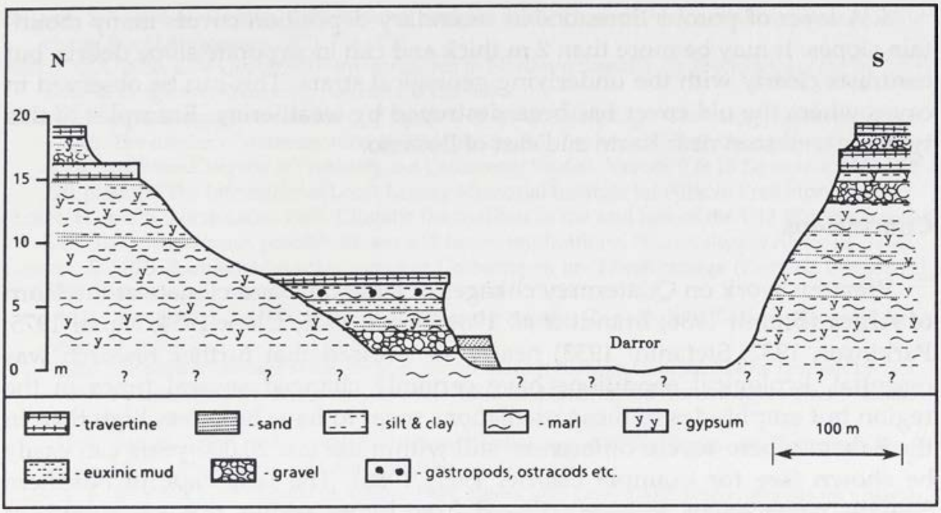

Fig. 4. Cross-section of the Darror Valley, 6 km west of Escushuban, with a Higher, Middle and Lower terrace. The Middle terrace seems to correspond to the Karin Formation (after Gabriel *et al.* 1989).

got from cave speleothems and spring tufa in Northern Somalia. The 16 dates ranged between 5,000 and 260,400 B.P. with distinct clusters around 255,000 B.P., 175,000 B.P., 80,000 B.P. and the Early Holocene. Surely there have been several periods of increased travertine formation in that area, and elevated outcrops near Karin and Escushuban may easily be of Early Pleistocene or Pre-Pleistocene age.

Other types of tufa and travertine formation

Besides the already mentioned horizontal sheets – the genesis of which is still to be explained – there exist at least four other types of calcareous deposits during the Quaternary:

1. One is linked to former springs, coming out of mountain slopes and leaving huge masses of spring travertine with snail shells and casts of plants and leaves. Examples of this type are found near Karin or near the small village Lac, 20 km west of Karin. The deposits there are about 30 m high and 100 to 300 m long;

2. Another type is a result of sinter dams developing across running water channels by precipiting calcium carbonate. Small lakes accumulated behind those barriers and with overflows the deposits grew higher and higher. Impressive examples of this type are to be seen in the valleys of Ufeyn, where one of the nearly vertical travertine walls has a height of about 40 m;

3. Cave speleothems are mentioned by Brandt and Brook (1984) and by Brook (1986) from the western part of Northern Somalia. In the area of Bosasso and in the Darror Valley they seem to be not very well represented;

4. A layer of porous limestone in secondary deposition covers many mountain slopes. It may be more than 2 m thick and can incorporate slope debris, but contrasts clearly with the underlying geological strata. This can be observed in caves where the old cover has been destroyed by weathering. Examples of this type are well seen near Karin and east of Bosasso.

Conclusions

Previous work on Quaternary changes of landscape and climate at the Horn of Africa (Brandt 1986; Brandt *et al.* 1984; Brook 1986; Clark 1954; Mussi 1975; Parkinson 1932; Stefanini 1933) nearly all stressed that further research was essential. Ecological conditions have certainly changed several times in the region but amplitudes of those oscillations seem to have been less high than in the Sahara where severe differences still within the last 20,000 years can easily be shown (see for example Gabriel 1977; 1986). The landscape of Northern Somalia never seems to have suffered from hyper aridity, nor are periods of high humidity discernible. Today the country is not a real desert and its semi-aridity sustains a relatively dense vegetation including many different woody species. No thick sediment series of pluvial lakes, as in the Sahara, have been found, nor did similar quantities and different types of prehistoric relics or faunal remains to the Sahara appear. The fossil soil record was poor as well. The changes are less obvious than in the Sahara and maybe were less intense. Brandt (1988) speaks of a "dramatic contrast" in respect to these climatic oscillations but this reflects the necessity of trying to quantify the results; this and exact age determinations of the different periods will be the main problems in the future.

Acknowledgements

We are very much indebted to Prof. Dr. M.A. Geyh from Niedersächsisches Landesamt für Bodenforschung, Hannover, for having dated our samples.

New results which modify the preliminary report in some details are published in: Gabriel *et al.* 1989; Schütt *et al.* 1991; Voigt 1992 and Voigt *et al.* 1990.

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Hunter-gatherers of the Middle Juba Valley, Southern Somalia, during the Early Holocene

Introduction

It is not always realized that the Juba, more than 1600 km long, is one of the major African rivers. It starts close to Dolo at the confluence of its three important tributaries: the Dawa, which for many kilometers is the boundary between Kenya and Ethiopia, the Ganale and the Weby. These rivers rise on the Ethiopian Plateau east of the Rift and of lakes Abaya and Awasa. The Uebi Scebeli River coming from the same region and draining a large part of Central Somalia and south-eastern Ethiopia joins the Lower Juba during exceptionally rainy years.

Archaeological surveys were started in 1982 in the Middle Juba Valley, an area almost unknown from a prehistoric point of view (Mussi 1982; 1984). A dam has been planned just north of the town of Baardheere and as a consequence, large stretches of land will be flooded. In 1985 we worked in the surroundings of Luuq. Many archaeological sites were discovered (Coltorti and Mussi 1987) and stereophotographical analyses of the area were carried out.

Geological background and landscape evolution

From the geological point of view, the Juba crosses the Luuq-Mandera Synclinoria in an almost straight north to south line. The youngest sediments outcropping are terrigenous rocks from the Lower Cretaceous lying over Jurassic and probably Triassic limestones more than 4,000 m thick (Burmah Oil Co. 1973; Carmignani *et al.* 1983). Eastward, in the Buur area and west in Kenya are cristalline basement outcrops (Abdirahim, Abdirahman *et al.*, in press).

The higher part of the region is characterized by a "planation surface", which rises progressively from the edge of the limestone outcrops towards the Ethiopian Plateau. The extraordinary smoothness of most of the area and the presence of senile soil profiles of laterite, calcrete and bauxite, are possibly evidence of the "African planation" developed between the Late Cretaceous and the Upper Eocene (King 1976). An important deepening of the river valley followed and inside it lies the "Faanweyn formation", built up by fluvio-lacustrine sediments connected with a lake more than 600 km^2 wide (Abdirahim, Abdirahman *et al.*, in press; Abdirahim, Ali Kassim *et al.*, in press). During a successive phase of downcutting the basin dried up and stream captures took place leading to the establishment of a water course not very different from the present one. Inside this thalweg the "prebasaltic continental formation" was deposited (Carmignani *et al.* 1983); fluvial and pyroclastic sediments were buried by a basaltic lava flow, the age of which is still uncertain (Ali Kassim *et al.*, in press). The establishment and evolution of the present day river valley followed this period and is probably pre-Quaternary. During the Quaternary the downcutting went on modelling a very gentle erosional glacis on evaporitic rocks around Luuq, while on more resistant rocks (*e.g.* Wajid Formation) deep gorges were formed. This progressive downcutting was interrupted, at least once, by the modelling of an alluvial terrace now standing 4 - 6 m above the thalweg. Close to Luuq Late Stone Age artefacts were discovered over these alluvial materials and suggest a Final Upper Pleistocene Age for the underlying sediments. There was a very important arid phase shortly before the end of Last Glacial (Rognon 1976; Gasse and Street 1978) when an increase in bed load probably prevented further downcutting. The subsequent terracing is connected with a climatic improvement and the progressive reforestation of the area.

The archaeological sites

Concentrations of prehistoric tools were regularly found on top of small residual hills inside the valley. They were discovered to the east of Luuq close to the long ridge of Goodobay-Kuredka (Buur Medow, Buur Ad, Buur Matacno north) as well as to the north, not so far from the left bank of the Juba (Buur Heela Shiid) (Fig. 1). The hills are usually capped by basaltic rocks, which are more resistant to erosion than the evaporites. They were shaped by fluvial erosion and remodelled by gullying and slope-wash which follow the main fractures of the basaltic covering. Locally continental prebasaltic fluvial sediments outcrop in between them, as at Buur Medow. Among them quartz and siliceous pebbles are present and were largely utilized during prehistory. Human settlement was possibly in part linked to the availability of raw materials. However, sites also occurred directly over evaporitic rocks (Buur Ad) or where basaltic rocks lie directly over the bedrock (Buur Heela Shiid). Dwelling on small hills close to the river presented other advantages: from there it was possible to monitor the movements of hunted species as well as to get some protection from the dangerous animals, such as the leopards, which still live in the residual forest along the valley (Varty 1988).

Due to the short time available, only one site, Buur Medow 1, was excavated, though similar deposits were discovered at Buur Heela Shiid and Buur

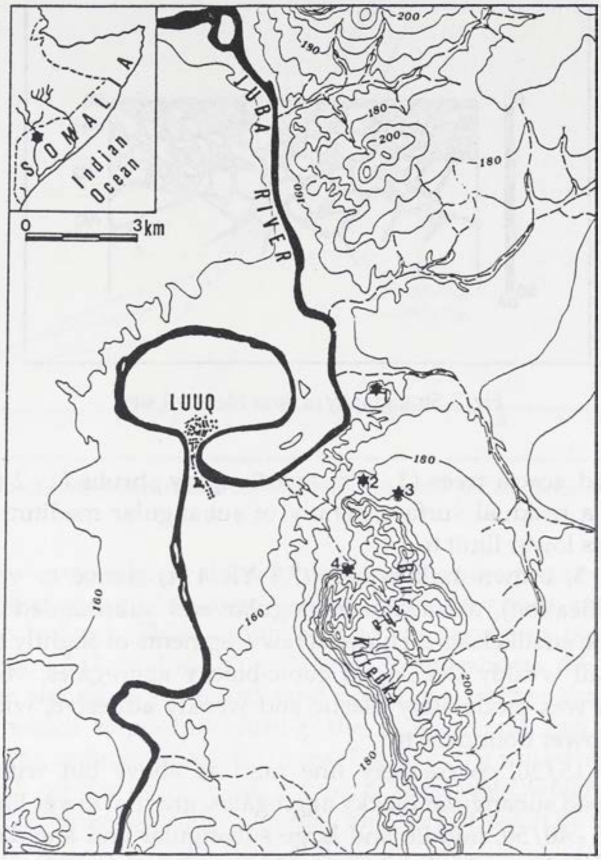

Fig. 1. Location of archaeological sites;
1: Buur Heela Shiid; 2: Buur Medow; 3: Buur Ad; 4: Buur Matacno north.

Matacno. At Buur Ad there was no soil horizon at all and the industry lay directly on bedrock. Only the lithic industry is usually preserved. We shall consider here Buur Medow 1 (3°47′20″N, 42°35′12″E (Mussi 1987) and Buur Ad (3°47′5″N, 42°35′42″E). A few eggshell fragments (most probably ostrich eggshell) as well as fossilized remains of a land snail (*Cyclostomus sulcatus)* were found at Buur Medow 1, and a small to medium size tooth of an unidentified ruminant Artiodactyl in each site.

Buur Medow 1 stratigraphy

On this hill scattered bedrock outcrops of columnar and massive basalts are present. There is no trace of active erosive processes except on the southern side where, in contact with fluvial sediments, some gullies have formed. The site stratigraphy shows from top to bottom (Fig. 2):

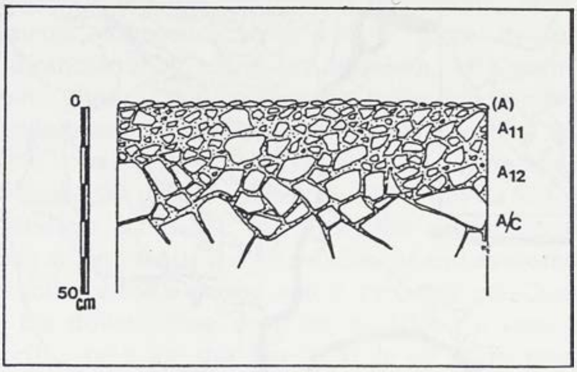

Fig. 2. Stratigraphy of Buur Medow 1 site.

(A): scattered acacia trees (3 - 5 m apart), spiny shrubs (1 - 2 m apart) and thick grass on a residual surface mainly of subangular medium size gravels, transitional at its lower limit to

A11: cm 0 - 5, brown-dark brown (7.5 YR 4/4) coarse to very fine sand (Doeglas classification), abundant subangular and subrounded medium and large debris. The small clasts included a few fragments of slightly cemented calcitic crust. Small weakly developed cubic-blocky aggregates, very thin, very scarce voids. It was moderately plastic and weakly adhesive, with thin scarce roots, gradual lower boundary to

A12: cm 5 - 15/20, coarse very fine sand, as above but with a very fine weakly developed subangular blocky aggregates, gradual lower limit to

A/C, cm 15 - 40/50, middle and large subangular and angular basalt fragments, few matrix between the clasts, whitish carbonate coating on the surface of the clasts, gradual transition to the weathered bedrock.

Inside the A11 horizon scattered pieces of charcoal and ash suggest an ancient fireplace. Flint implements were discovered mainly in the A11 horizon but a few of them even come from A12 and A/C layers:

Sample	Stones	Sand	Silt	Clay	Ph	$CaCO_3$	Organic carbon	Doeglas classification
A11–S.1	19.1	78.4	19.1	2.5	8.6	7.4	0.8	coarse sandy very fine sand
A12–S.1	15.5	64.5	31.3	4.2	8.5	6.3	0.7	coarse sand – very fine silt
A11–S.3	10.8	80.4	18.0	1.6	8.4	10.2	0.7	coarse sandy very fine sand

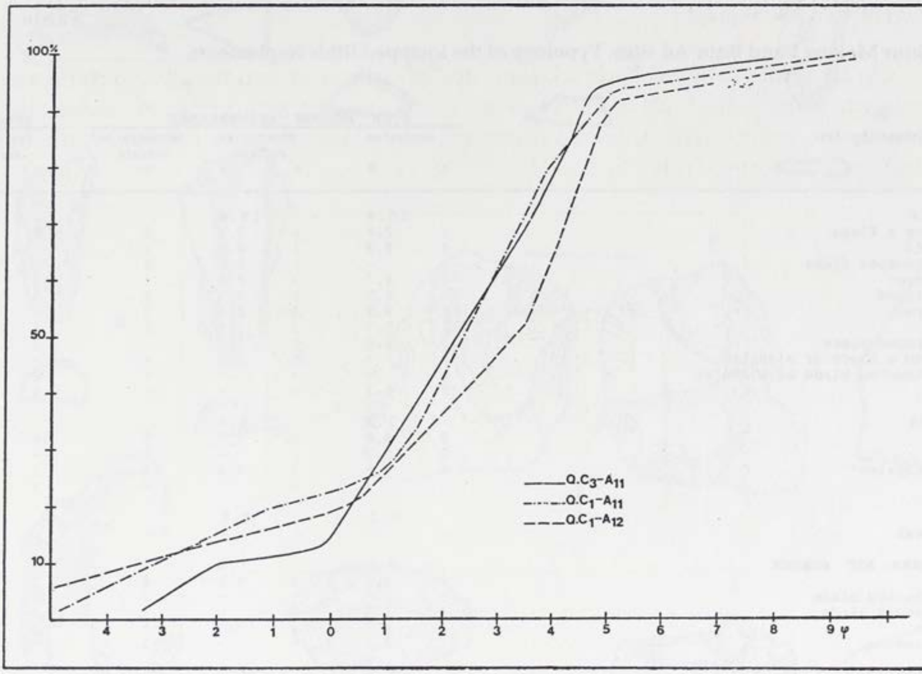

Fig. 3. Sedimentological curves of the horizons of square 1 and 3 at Buur Medow 1 site.

The sandy composition of the samples as well as the presence of carbonates and quartz round-mat grains suggest aeolian origins for parts of the fine fraction which rest on bedrock. This is supported by the increased percentages of silt and sandy from A11 to A12. It is difficult to investigate this evidence with palaeoclimatic significance: aeolian sand nowadays reaches the hill during the main rains, which happened during the survey, and can easily migrate downwards. The sedimentological curves (Fig. 3) of the upper horizon at square 1 and 3 reveal, on the other hand, a typical bimodality which testifies to the progressive enrichment in coarse material, following erosion by wind action.

The lithic industries

At Buur Medow 1, a 1 × 1 m grid controlled surface collection was made on 31 m^2, and 5 m^2 further were excavated. In all 3,358 lithic artefacts were collected within the grid, and more outside it. At Buur Ad, where there was no soil above the bedrock, 1,375 lithic implements were collected on 1,000 m^2 within 5 × 5 squares. We followed Tixier's (1963) typological list in our analyses (Table 1; Fig. 4 and 5; for further illustrations *cf.* Mussi 1987).

Notches and denticulates are the largest typological group. Being found at the surface, or close to the surface, trampling cannot be completely ruled out as a cause, but, it seems unlikely for: multiple notches are rarely found, while

Table 1

Buur Medow 1 and Buur Ad sites. Typology of the knapped lithic implements.

Type n° and description	BUUR MEEDOW ASSEMBLAGES Lxcavated n	%	Controlled surface n	%	Uncontrolled surface n	BUUR AD Controlled surface n	%
ENDSCRAPERS		15.4		18.4			17.8
1 single on a flake	4	2.7	4	3.3	6	5	3.3
1 thumbnail	3	2.0	1	0.8	1	-	-
2 on a retouched flake	-	-	1	0.8	1	2	1.3
4 nucleiform	7	4.7	3	2.6	-	8	5.3
5 denticulated	2	1.3	4	3.3	2	4	2.6
6 shouldered	1	0.7	3	2.6	3	-	-
6 nosed	1	0.7	3	2.6	1	1	0.7
7 on a notched piece	3	2.0	2	1.6	-	4	2.6
8 single on a blade or bladelet	-	-	1	0.8	-	-	-
9 on a retouched blade or bladelet	-	-	-	-	-	2	1.3
11 double	2	1.3	-	-	-	1	0.7
PERFORATORS		7.3		6.5			8.0
12 single	9	6.0	6	4.9	5	10	6.6
12 double	2	1.3	-	-	-	-	-
15 large "Capsian"	-	-	3	2.6	2	1	0.7
16 drill	-	-	-	-	-	1	0.7
BURINS		0.0		0.0			0.7
19 on a break	-	-	-	-	-	1	0.7
BACKED FLAKES AND BLADES		8.0		7.4			13.9
34 flake	2	1.3	5	4.1	6	5	3.3
37 curved backed blade	-	-	-	-	1	5	3.3
40 obtuse ended blade	2	1.3	-	-	-	2	1.3
42 fragment	7	4.7	4	3.3	1	9	6.0
- miscellaneous	1	0.7	-	-	3	-	-
BACKED BLADELETS		8.6		13.1			9.5
45 straight and pointed	-	-	-	-	-	1	0.7
46 straight and pointed with rounded base	-	-	-	-	-	1	0.7
47 straight and pointed with truncated base	-	-	1	0.8	-	1	0.7
55 with curved tip	-	-	3	2.6	1	1	0.7
56 with curved back	2	1.3	1	0.8	1	1	0.7
61 with narrowed base	-	-	-	-	-	1	0.7
63 partially backed	-	-	1	0.8	-	-	-
64 shouldered	-	-	1	0.8	-	-	-
66 fragment	11	7.3	7	5.7	2	5	3.3
71 with Ouchtata retouch	-	-	-	-	-	1	0.7
72 fragment with Ouchtata retouch	-	-	2	1.6	-	2	1.3
NOTCHES AND DENTICULATES		35.3		35.4			25.9
73 large notched or strangulated piece	-	-	1	0.8	1	-	-
74 notched flake	11	7.3	11	9.0	9	8	5.3
75 denticulated flake	29	19.3	23	18.9	25	24	16.0
76 notched blade or bladelet	4	2.7	4	3.3	1	2	1.3
77 denticulated blade or bladelet	8	5.3	3	2.6	-	4	2.6
78 saw	1	0.7	1	0.8	-	-	-
79 notched or denticulated piece with cont. retouch	-	-	-	-	-	1	0.7
TRUNCATIONS		14.0		9.0			11.3
80 truncated piece	21	14.0	11	9.0	9	17	11.3
GEOMETRIC MICROLITHS		2.0		0.0			2.6
82 segment	1	0.7	-	-	2	4	2.6
93 triangle with one convex side	2	1.3	-	-	-	-	-
VARIA		9.4		9.7			10.0
104 splintered piece	4	2.7	2	1.6	1	1	0.7
105 piece with continuous retouch	7	4.7	6	4.9	2	9	6.0
106 sidescraper	1	0.7	-	-	7	3	2.0
112 miscellaneous	-	-	2	1.6	1	-	-
112 miscellaneous bifacial tools	2	1.3	2	1.6	5	2	1.3
TOTALS	150		122		99	150	

denticulate edges have direct or inverse, usually semi-abrupt retouch; there is never the abrupt alternate and alternating retouch which is the rule on pseudo-tools. Notches and denticulates occur in the same percentages, in both excavated and collected tools. Generally speaking, implements have fresh edges; patina is

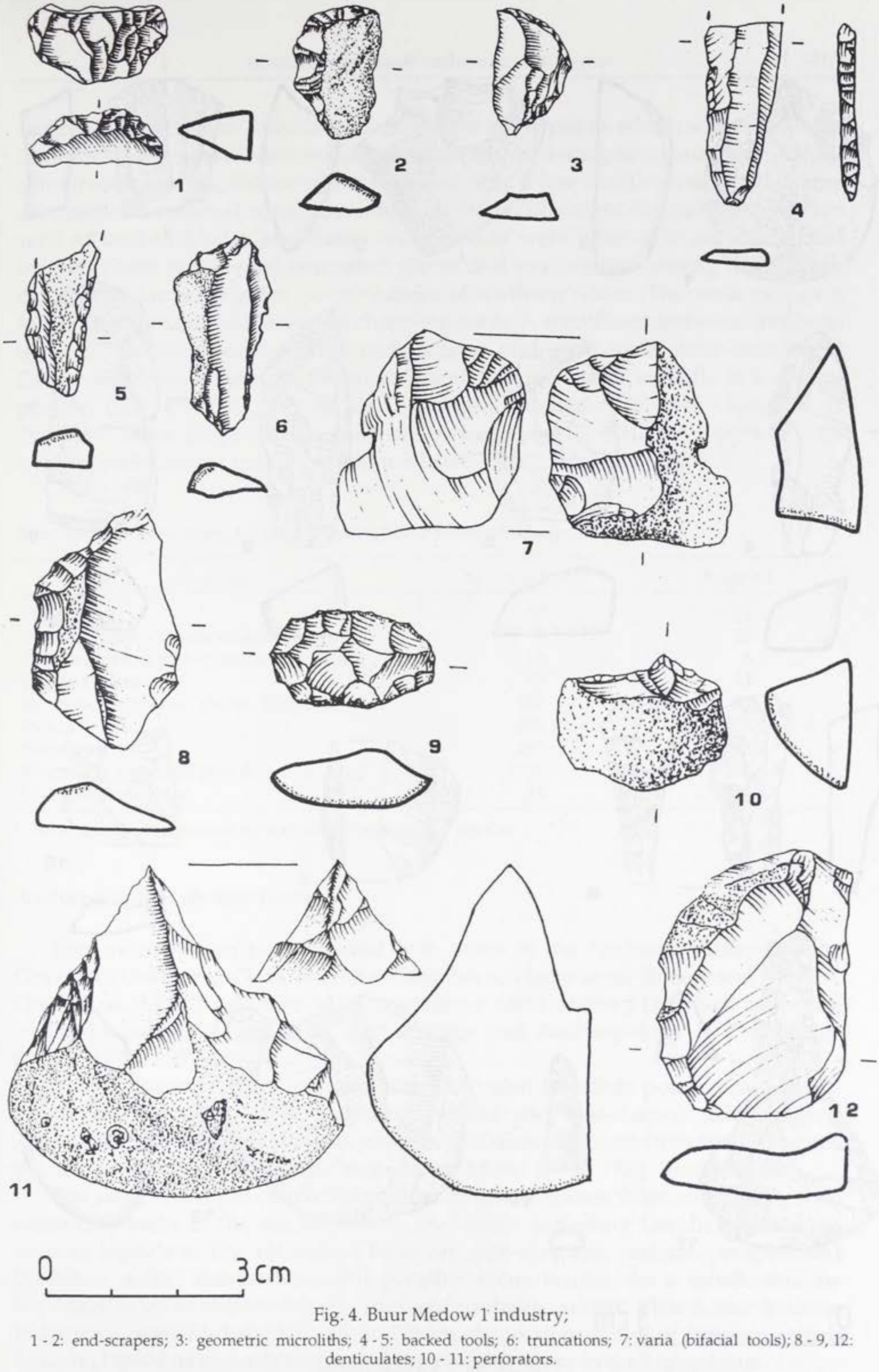

Fig. 4. Buur Medow 1 industry;

1 - 2: end-scrapers; 3: geometric microliths; 4 - 5: backed tools; 6: truncations; 7: varia (bifacial tools); 8 - 9, 12: denticulates; 10 - 11: perforators.

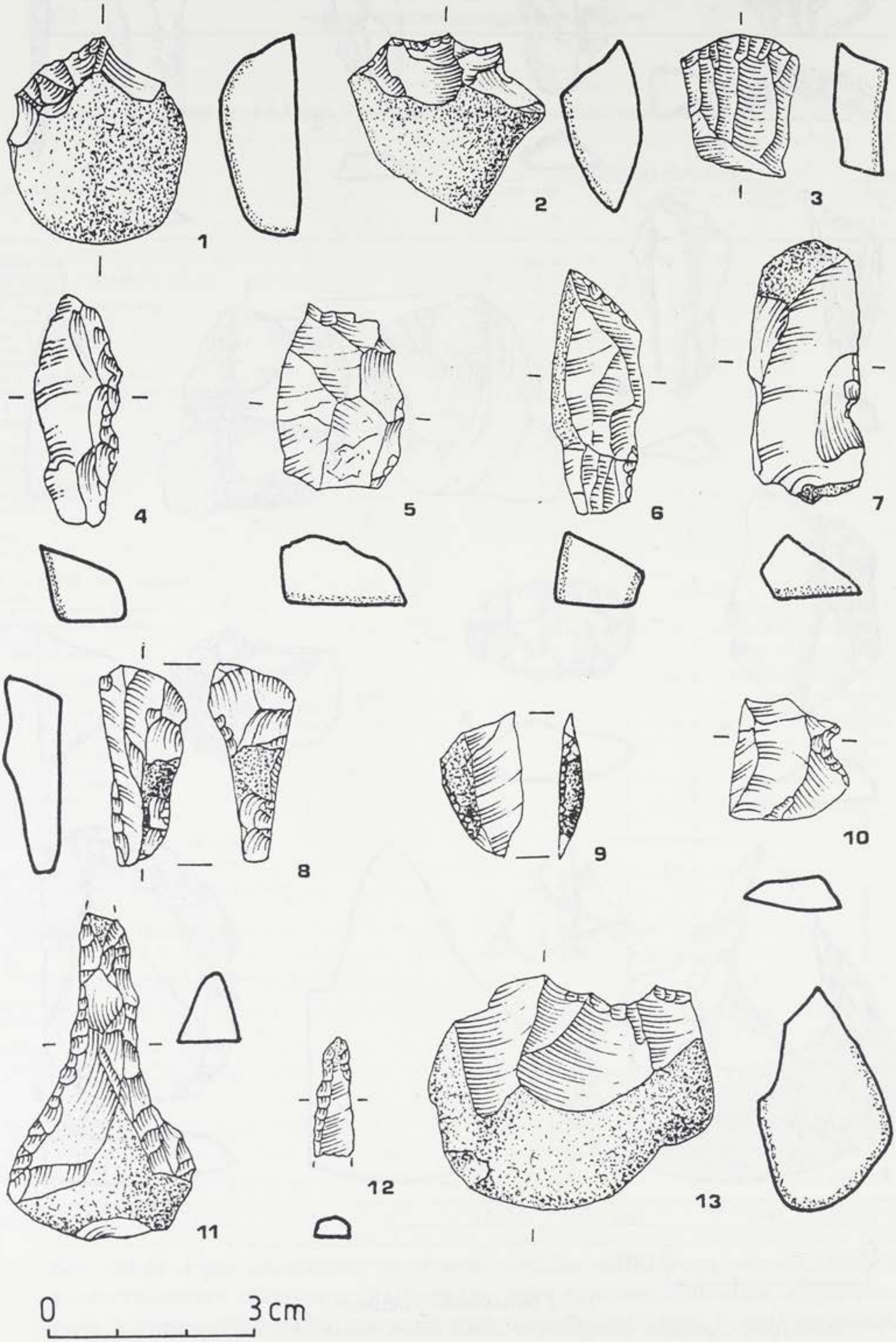

Fig. 5. Buur Ad industry;

1 - 3: end-scrapers; 4 - 5: denticulates; 6: truncations; 7, 10: notches; 8: backed tools; 9: geometric microliths; 11 - 12: perforators; 13: varia (bifacial tools).

lacking or very slightly developed, except for a few pieces which were apparently older and re-used. Next most common were end-scrapers, usually on flakes, often re-sharpening flakes, which included only a few short end-scrapers. Some are made on residual cores and a few on blade/bladelets. Backed bladelets, as well as backed blades and flakes were rare as were geometric microliths and burins. There are several truncated pieces and perforators, among them some closely similar to the *grand perçoir capsien* of northern Africa. The varia include a few distinctive bifacial tools and chopping-tools. A significant technical attribute is the frequency of denticulates, end-scrapers and other tools made on cortical flakes with inverse retouch: the smooth and compact cortex is oddly in a ventral positon (Fig. 4:9; 5:3, 5, 7). In the typological analysis we have classified as "blades" those larger than 1.2 cm following Tixier (1963), but they are only exceptionally longer than 5 cm and are listed with bladelets in Table 2.

Table 2

Buur Medow 1 and Buur Ad sites. Typology of the lithic debitage.

Debitage	Buur Medow 1*	Buur Ad
Flake cores	57	21
Bladelet cores with one striking platform	7	22
Bladelet cores with two striking platforms	13	8
Residual cores	39	17
Re-shapening flakes/blades/bladelets	148	52
Flakes	780	679
Bladelets	293	218
Fragments and chips (less than 1 cm long)	1726	200
Unmodified pebbles	24	7

* "Excavated" and "controlled surface" assemblages lumped together.

Archaeological comparisons

This industry can be compared with some of the "cultures" described by Graziosi (1940) and Clark (1954) as Magosian, Hargeisian, Eibian and Wilton. One of us (M.M.) has been able to examine most of the J.D. Clark collection in the University Museum of Archaeology and Anthropology at Cambridge (Mussi 1971 - 1972).

In the Magosian there are microliths, but also Levallois points, leaf-shaped points, many side-scrapers including bifacial and leaf-shaped side-scrapers. Apparently it is of Upper Pleistocene age, and quite different from the industries we are considering here (for a discussion *cf.* Mussi 1971 - 1972; Brandt 1986).

The largest sample of the Hargeisian industry comes from site H12R, with some fifty tools. In the debitage there are blades, including Levallois blades, as well as bladelets. The retouched tools are side-scrapers, end-scrapers, backed bladelets, a few denticulates and possibly some burins. As a whole this assemblage is quite different from ours and probably earlier. This is also true for industries from Midishi 2 Cave and from the surroundings of Bosasso which Brandt (1986) has recently suggested are possibly close to the Hargeisian.

The Eibian culture of Graziosi (later called Doian by Clark) is the best known Somali prehistoric culture and large samples were retrieved through excavation. Unfortunately, it has not yet been studied and published to modern standards, but S. Brandt has been re-excavating the main site of Buur Eibi for some years. After our personal examination of the sample stored in Cambridge, we suggest that this industry is characterized by a fine-parallel or sub-parallel retouch which is found on small pointed limaces (Doian points), some being bifacial and even leaf-shaped, as well as on bladelets (Doian bladelets) and perforators. There are also small Levallois points, leaf-shaped points, side-scrapers of several types, denticulates, segments and backed bladelets. The industries found by us at Luuq are quite different and most probably markedly later. In the higher layers of the cave excavated by Graziosi, now named Gogoshiis Qabe, the industry is also quite different, but largerly unpublished, and associated with some grindstones. There are two C-14 dates: 9,180 ± 100 (UGa-5) and 6,900 ± 350 (Beta-7474) B.P. (Brandt 1986) for it.

The so-called "Somaliland Wilton" is known through surface collections and small scale excavations. It includes industries with backed bladelets, segments, end-scrapers of several types, some being short and very short, thumbnail or circular ones; there are sometimes associated pot-sherds. The available data are not sufficient to properly define a culture and assemblages of very different age could posssibly be mixed together; the pottery means that some at least are of Holocene age.

In Kenya the Eburran is known to be 16,000 to 5,000 years old (Ambrose *et al.* 1980). It is only found in the Central Rift Valley, close to Lake Nakuru and Lake Naivasha. Tools are often made on a blade or on a bladelet and burins are more frequent than end-scrapers. There are many backed tools, including geometric microliths, while perforators, notches and denticulates are rare or completely missing; the microburin technique was used.

A "Kenya Wilton" was found in the same Central Rift Valley by Leakey (1931), who briefly described it as characterized by a large number of small thumbnail and circular end-scrapers.

In Ethiopia a number of sites is reported. At Laga Oda, at the northern foot of the Harrar plateau, lies a prehistoric settlement with a C-14 age of 15,590 ± 460 B.P. (SUA 475) in which most of the implements are unretouched tools (Clark and Prince 1978; Clark and Williams 1978). At Lake Besaka, in the Rift Valley, below a sterile volcanic deposits some 11,400 years old, an archaeological layer with obsidian tools was found (Brandt 1980; 1986). End- and side-scrapers, lumped together, are 46% of the industry, while burins are 19% and microliths 30%; they include a lot of backed and truncated pieces, but no geometric ones. In the later industry of the "Metahara Phase", with a suggested age between 11,000 and 7,000 B.P., there are more microliths, with a very high percentage of segments, while end- and side-scrapers, as well as burins, are less frequent; the microburin technique is in use. Pottery is known during the following "Abadir Phase" possibly some 7,000 to 6,000 years B.P. At Aladi Springs, another Rift Valley site, an industry with a few backed blades and end-scrapers is some 11,000 years old (Clark and Williams 1978).

In several sites of Melka-Kunturé, close to Addis-Abeba, undated obsidian industries are known, which apparently belong to the L.S.A. Some were illustrated by Bailloud (1965). There are not many implements, microliths are missing, as well as apparently notches and denticulates, while end-scrapers and burins are frequent. At Kella (Hivernel-Guerre 1976) and Wofi III (Hivernel 1976), on the contrary, there are plenty of notches and denticulates, as at Luuq, but also pottery. The latter is also found in the Rift Valley, at Omo 297 (Chavaillon and Boisaubert 1977) associated with a lot of backed tools (60%), which included many segments. In Gobedra rock-shelter, close to Axum, six layers were excavated but only in level IIa were there many retouched tools (Phillipson 1977a). Level IV is C-14 dated to 10,110 ± 140 B.P. (P-2238) while the upper levels IIb and IIa have a C-14 age of 6,825 ± 165 (GX-4680) and of 2,806 ± 53 B.P. (BM-1153). Pottery is found from level IIb upwards. The industry of level IIa included many backed tools (most of them being segments), end- and side-scrapers; some denticulates are illustrated.

Clearly the industries found close to Luuq cannot be easily compared with any of the published industries either from Somalia or from the surrounding countries.

Conclusions

Prehistoric settlements with lithic industries apparently similar to that of Buur Medow 1 and Buur Ad, were found on the top of all small hills we visited in the surroundings of Luuq. They were not observed during a brief survey of the ridge of Buuraha Kuredka, so there is some evidence that the hills were purposely chosen by prehistoric human groups. The similarities in lithics suggest that this happened during a well defined span of time.

The analysed industries at Buur Medow 1 and Buur Ad have several typological, technological and stylistic characteristics not found elsewhere. We therefore suggest calling them "Luuqian industries". Although it is not possible to define precisely their chronology, we can offer some evidence by comparing them with other East African lithic complexes.

"Mode 5 industries", *i.e.* industries with backed microliths which were sometimes parts of composits tools, are only rarely found at the end of the Upper Pleistocene. They rapidly increase in number, and expand into new areas, from *ca.* 10,000 B.P. onwards (Phillipson 1977b; 1985). This, and the characteristics of the Luuqian industries (scarcely laminar, with many notches and denticulates) suggest that they are Holocene in age. On the other hand, we found no pottery or grindstones. In Northern Kenya, at Gamble's Cave and Salasum, pottery is more than 8,000 - 7,000 years old (Onyango-Abuje 1980; Wandibba 1980) and in Ethiopia pottery was in use 5,500 years ago both in the Omo Valley (Brown 1975) and at Lake Besaka in the Ethiopian Rift, where it was associated with grindstones (Brandt 1986). Later on, by at least 3,000 years ago, Pastoral Neolithic groups were established in the East African Highlands, and flourished during more than one thousand years (Ambrose 1980) using pottery, polished stone axeheads, and had domestic animals. Human groups with pottery and domestic animals also lived east of Lake Turkana some 4,500 to 4,000 years ago (Barthelme 1985). In Somalia itself, in the Buur region, pottery was used more than 5,000 years ago (Brandt 1986). While it is not appropriate to draw strict parallels between archaeological assemblages, apparently similar, but found far away from each other, and made by human groups filling different ecological niches, we believe that a time later than the end of Pleistocene, but earlier than the diffusion of pottery, can be suggested for the Luuqian industries; it is assumed that they are between 10,000 and 5,000 years old.

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Probabilistic calibration of radiocarbon dates with specific examples from Northeastern Africa

Introduction

Radiocarbon dating relies on the assumption that the biospheric inventory of C-14 has remained constant during the past 100,000 years. This assumption was tested 40 years ago by Arnold and Libby (1949: 678) with the accuracy of *ca.* 10% by dating known-age Egyptian samples. However, with the improvement of the accuracy it was realized that this assumption is not precisely true. Systematic studies of discrepancies between C-14 and calendric dates, based on accurate C-14 determinations in dendrochronologically dated tree-ring samples have led to publication of numerous versions of calibration curves and tables (Suess 1970; 1979; Damon *et al.* 1974; Ralph *et al.* 1973; Switsur 1973; Clark 1975), but the real breakthrough in the calibration was achieved with publication of the "Calibration Issue" of *Radiocarbon*, with three high-precision calibration curves by Stuiver and Pearson (1986: 805), Pearson and Stuiver (1986: 839) and Pearson *et al.* (1986: 911).

Practical application of those high-precision calibration curves is, however, not simple, and the interpretation of obtained calendric ages is not straightforward. Because of numerous variations in calibration curves the correspondence between conventional C-14 dates and calendric ages is not exact, and, as a rule, there are several values of calendric ages corresponding to a given C-14 date. For example, calendric age corresponding to C-14 date 3,600 B.P. may be easily read as equal to 1,970 B.C., but for C-14 date 3,500 B.P. we obtain five values of calendric age, equal to 1,780, 1,795, 1,820, 1,835 and 1,880 B.C. Similarly, if the error of conventional C-14 date is taken into account, we have problem of multiple intervals. For example, for C-14 date 4,200 ± 50 B.P., we obtain there intervals of calendric age: 2,700 - 2,725 B.C., 2,770 - 2,810 B.C. and 2,865 - 2,890 B.C.

In order to overcome the difficulties caused by multiple intercepts with calibration curve we have introduced the concept of probabilistic calibration of radiocarbon dates and developed a set of appropriate computer procedures. The idea of the probabilistic calibration consists of transforming initial probability distribution of conventional C-14 date into calendric time scale and selecting appropriate parameters of resulting probability distribution as the measures of calendric age and its uncertainty.

Description of the computer procedure

The idea of probabilistic calibration was first introduced by Robinson (1985) and applied by Hassan and Robinson (1986) to calibration of a series of dates from Egypt, Nubia and Mesopotamia. The critique of this approach (Michczyńska *et al.* 1990) has led to more strict mathematical formulation of the algorithm of calibration, and the first version of calibration procedure was presented during the 2nd Symposium "Archaeology and C-14" in Groningen, September 1987, and an improved version was presented during the 13th International Radiocarbon Conference in Dubrovnik (Pazdur and Michczyńska 1989; *cf.* also Aitchison *et al.* 1989).

The system of calibration procedures was designed taking into account the specific tasks of archaeological application and includes three main options:

1. calibration of single date;

2. calibration of a set of arbitrary dates, representing same or different cultures/phases/objects;

3. calibration of a set of related dates obtained from a series of samples representing well-defined culture or phase.

Input data include: sample identifier (laboratory code and number, conv. B.P. date and its error); calibration output is presented on screen in form of graphs and numeric data. By pressing special function key <Prt Sc> it is possible to obtain hard copy of the screen on printer. In options 2 and 3 input data can be entered from diskette file, and also the screen output can be saved in a form of separate file and than retrieved at any time. Printed report including list of conventional and calibrated dates is also available.

Calibration is performed according to recently published high-precision calibration curves of Stuiver and Pearson (1986), Pearson and Stuiver (1986) and Pearson *et al.* (1986); range of conventional C-14 dates extends back to 6,210 B.P. Number of dates in series of input data for options 2 and 3 is not limited. Results can be presented in either B.P. or A.D./B.C. scale.

Examples

The possibilities offered by the development set of computer procedures and some difficulties involved in interpretation of results of calibration will be illustrated by several examples of C-14 dates in relation to NE Africa. Some dates are taken from the volume edited by L. Krzyżaniak and M. Kobusiewicz (1984), other are more recent results obtained in the Gliwice Radiocarbon Laboratory. First we will present problems connected with calibration of single C-14 dates. Two specific cases are selected for this purpose, first we consider calibration of medium-accuracy C-14 dates, (*i.e.* C-14 dates quoted with error of ± 50 to ± 100 yr), which, in general, do not cause significant interpretational difficulties. Second example presents the calibration of high-accuracy C-14 date (dating error of *ca.* 30 yr or less), and illustrates typical difficulties with interpretation of high-accuracy dates.

The following examples consider calibration of groups of C-14 dates, obtained on same or different sites or cultures, and show several ways of presentation of results of C-14 dating in terms of calendric ages.

Calibration of single medium-accuracy date from El Tarif

As an example we will consider a date obtained on charcoal sample from Nagadian level in El Tarif site: (Gd-689: 5,070 ± 60 B.P.), quoted by Ginter and Kozłowski (1984: 255). The results are presented in Fig. 1 and 2. Fig. 1 is a hard copy of the first screen of calibration output. Relevant input data (site and sample name, laboratory code and number, conventional B.P. date with 1σ error, range of calibration) are listed at the left-hand side. Plots show probability distribution of conventional C-14 date (upper left-hand side), appropriate part of calibration curve (upper right-hand side) and resulting probability distribution of calendric age (lower plot). Negative values of calendric age denote B.C.

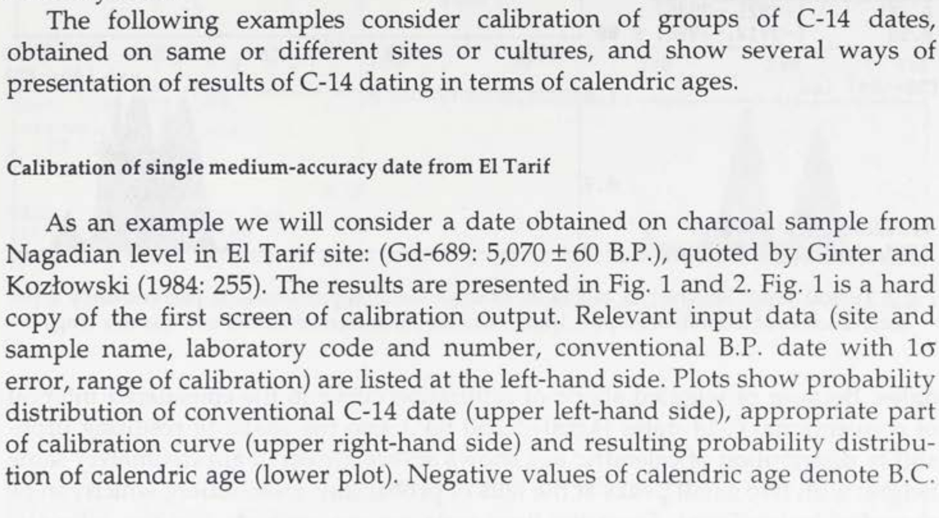

Fig. 1. Typical result obtained in calibration of single medium-precision date, part one (copy of the first screen of calibration output).

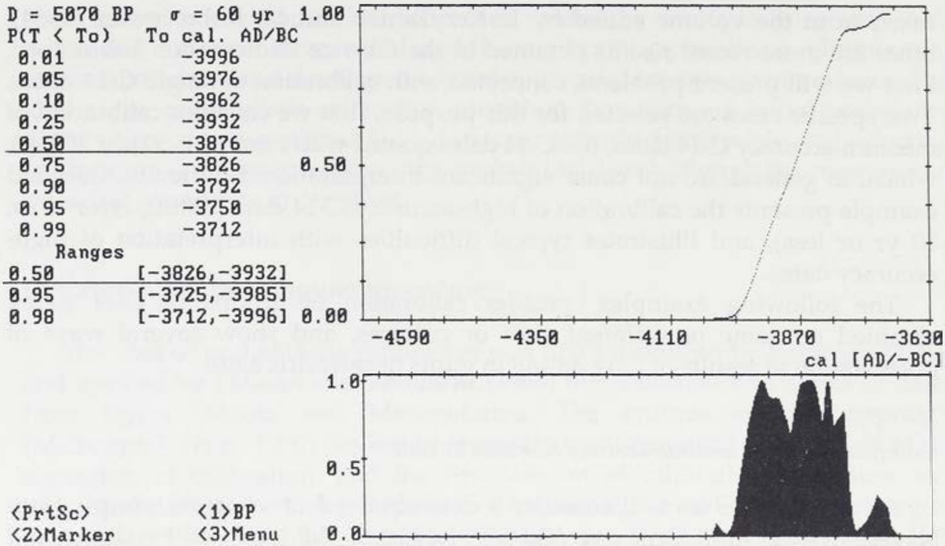

Fig. 2. Typical result obtained in calibration of single medium-precision date, part one (copy of the second screen of calibration output). Underlined are values of median and interquantile range.

dates. Because of wiggled shape of calibration curve in the considered interval of conventional C-14 dates (4,890 - 5,250 B.P.) also the shape of resulting probability distribution of calendric age shows several peaks of approximately same height, with two small peaks at the tails of probability distribution, which can be regarded insignificant. From the time scale we can estimate that the calendric age of dated sample should be confined with approximately constant probability within 3,780 B.C. and 3,950 B.C. Strict statistical measures are given in Fig. 2, which shows plot of cumulative probability (upper plot) and tables of selected quantiles and interquantiles. The centroid of probability distribution (the median) can be regarded as the most appropriate measure of calendric age. This value, equal to 3,876 B.C., is underlined in Fig. 2. As the measure of uncertainty of calendric age can be chosen the interquantile range (underlined). This range indicates the interval of calendric age which contains the real value of calendric age with probability of 50%. After rounding the numbers listed in Fig. 2 to the 10 years we can state that the calendric age of calibrated sample is equal to 3,880 ± 50 B.C.

Calibration of single high-accuracy date from Tell Atrib

As an example will be considered calibration of date obtained recently on charcoal sample from Tell Atrib (coll. and subm. by T. Górecki, National Museum, Warsaw). Calibration output is presented in Fig. 3 and 4. The resulting probability distribution of cal age reveals the presence of two pronounced peaks of approximately the same height. Their exact location on the calendric time

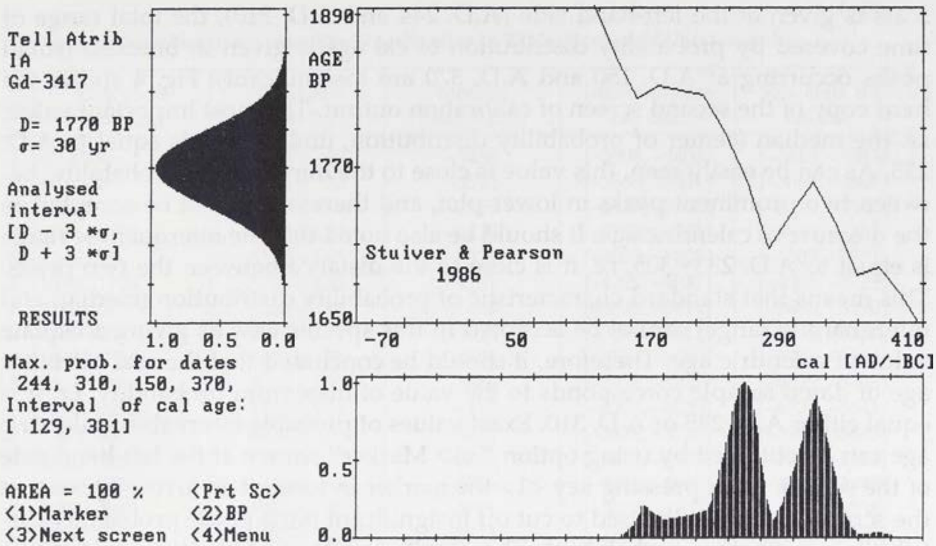

Fig. 3. Typical result obtained in calibration of single high-precision date, part one (copy of the first screen of calibration output).

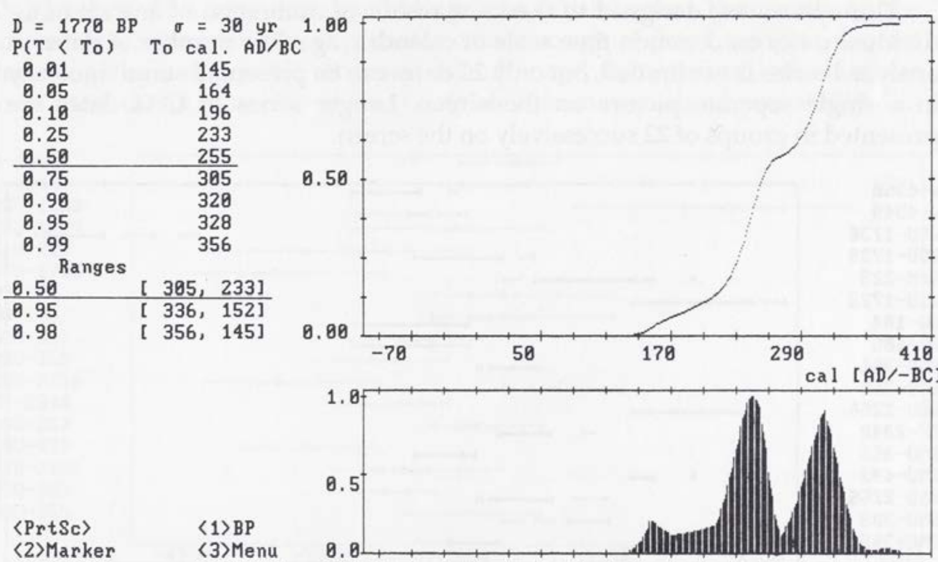

Fig. 4. Typical result obtained in calibration of single high-precision date, part two (copy of the second screen of calibration output). Underlined values (*cf.* Fig. 2) cannot be regarded as appropriate measures of calendric age and its uncertainty.

scale is given at the left-hand side (A.D. 244 and A.D. 310); the total range of time covered by probability distribution of cal age is given in brackets (small peaks occurring at A.D. 150 and A.D. 370 are insignificant). Fig. 4 shows the hard copy of the second screen of calibration output. The most important value, *i.e.* the median (center of probability distribution, underlined) is equal to A.D. 255. As can be easily seen, this value is close to the minimum of probability, between two prominent peaks in lower plot, and therefore cannot be accepted as the measure of calendric age. It should be also noted that the interquantile range is equal to A.D. 233 - 305, *i.e.* it is close to the distance between the two peaks. This means that standard characteristic of probability distribution (median and interquantile range) cannot be accepted in this specific case as giving adequate value of calendric age. Therefore, it should be concluded that the real calendric age of dated sample corresponds to the value of maximum probability, *i.e.* it is equal either A.D. 245 or A.D. 310. Exact values of probable intervals of calendric age can be obtained by using option "<1> Marker" shown at the left-hand side of the screen. After pressing key <1> the marker in form of an arrow appears at the screen and it can be used to cut off insignificant parts of the probability distribution (with low probability). The results is not explicit. With probability equal to *ca.* 65% the calendric age of dated charcoals is either A.D. 245+20–15 or A.D. 310+20–15.

Calibration of a set of arbitrary dates

This option was designed to show the results of calibration of any set of individual dates on common time scale of calendric age. The number of dates in analyzed series is not limited, but only 22 dates can be presented simultaneously in a single separate picture on the screen. Longer series of C-14 dates are presented in groups of 22 successively on the screen.

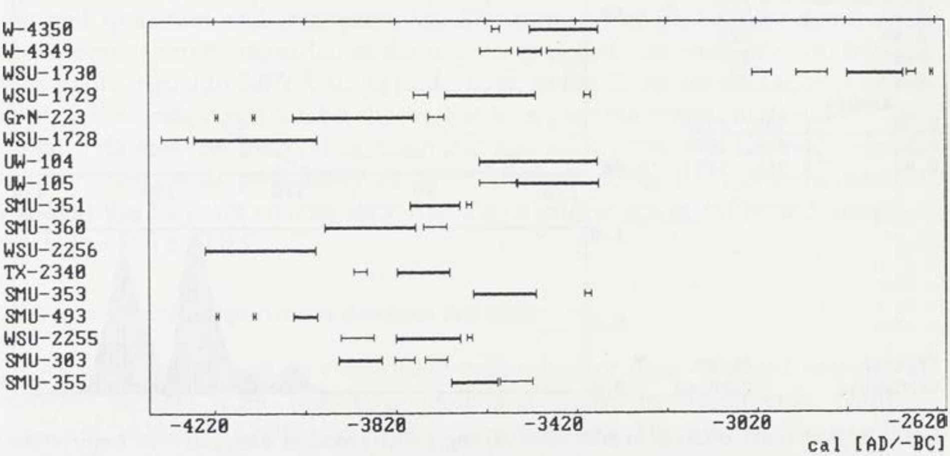

Fig. 5. Bar plot resulting from "cut-out" calibration performed on set of C-14 dates from El Khattara and Hierakonpolis (Hays 1984: 214). Intervals with maximum probability are marked as bold lines.

Table 1

Calibrated radiocarbon dates from Predynastic sites in El Khattara and Hierakonpolis.

No.	Lab. code and no.	Age C-14 conv. B.P.	Median cal. B.C.	Interquantiles cal. B.C.	95% conf. int. cal. B.C.
1	W-4350	4680 ± 60	-3458	[-3508, -3408]	[-3615, -3343]
2	W-4349	4730 ± 70	-3512	[-3585, -3431]	[-3667, -3369]
3	WSU-1730	4250 ± 130	-2858	[-2989, -2716]	[-3296, -2525]
4	WSU-1729	4830 ± 120	-3617	[-3705, -3521]	[-3919, -3357]
5	GrN-223	5110 ± 160	-3925	[-4053, -3808]	[-4302, -3571]
6	WSU-1728	5290 ± 130	-4131	[-4229, -4037]	[-4386, -3825]
7	UW-104	4720 ± 94	-3498	[-3583, -3414]	[-3688, -3190]
8	UW-105	4717 ± 94	-3495	[-3582, -3412]	[-3690, -3186]
9	SMU-351	4930 ± 70	-3738	[-3783, -3689]	[-3931, -3552]
10	SMU-360	5030 ± 100	-3847	[-3918, -3767]	[-4029, -3646]
11	WSU-2256	5270 ± 100	-4117	[-4203, -4039]	[-4328, -3841]
12	TX-2340	4970 ± 70	-3778	[-3876, -3725]	[-3949, -3645]
13	SMU-353	4780 ± 70	-3564	[-3621, -3509]	[-3705, -3384]
14	SMU-493	5214 ± 54	-4036	[-4122, -4005]	[-4217, -3848]
15	WSU-2255	4960 ± 100	-3771	[-3874, -3702]	[-3968, -3538]
16	SMU-303	5005 ± 69	-3823	[-3898, -3757]	[-3964, -3682]
17	SMU-355	4810 ± 80	-3592	[-3657, -3531]	[-3770, -3387]

Conventional C-14 dates see Hays 1984: 214, Table 1.

Three versions of presentation of calibration output are available in this option. First version shows the so-called "cut-out" calibration, *i.e.* the intervals of calendric age which are cut out of calibration curves by bands of width [D–σ, D+σ], where D is conventional C-14 age and σ is its error. The results on the screen shows the intervals of probable calendric age of dated samples. Second version gives interquantile ranges of calendric age, third version, which seems to be most useful, gives the almost complete information about probability dis-

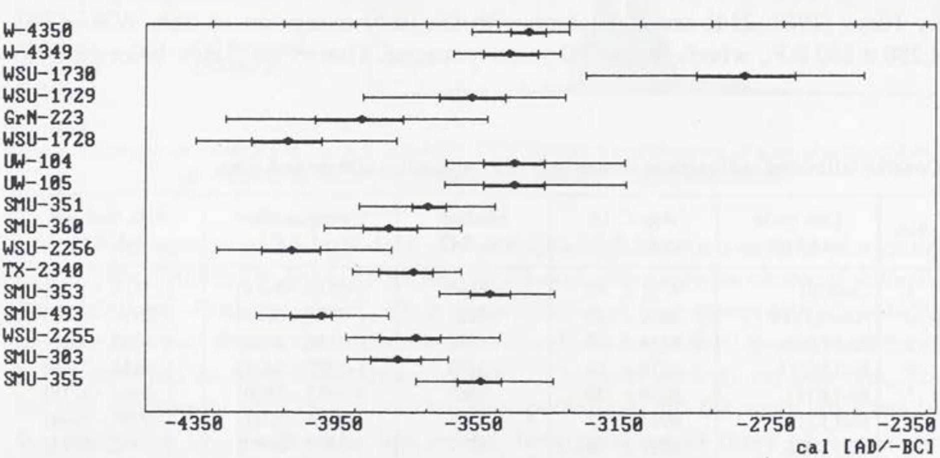

Fig. 6. Results of calibration of same data set as in Fig. 5 (El Khattara and Hierakonpolis; Hays 1984: 214) showing median (dots), interquantile ranges (bold lines) and 95% confidence intervals of calendric age.

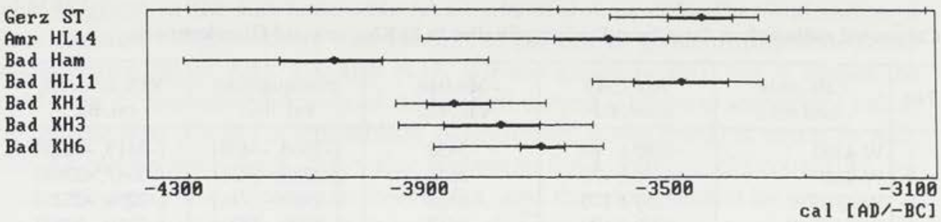

Fig. 7. Results of calibration of mean values of C-14 dates from indicated cultures and localities (after Hays 1984: 214);

Gerz: Gerzean; Amr: Amratian; Bad: Badarian;

ST: South Town; HL14: Hierakonpolis Loc. 14; Ham: Hamamiya; HL11: Hierakonpolis Loc. 11; KH: Khattara.

tributions of calendric age of all considered samples. In this version the plot shows values of centroid (median) and 50% and 95% confidence intervals of calendric age of all considered samples. Numerical values are available in form of a table.

As an illustrative example of this option we will consider calibration of the set of seventeen C-14 dates quoted by Hays (1984: 214) from Predynastic sites in El Khattara and Hierakonpolis. The results of "cut-out" calibration are shown in Fig. 5, while Fig. 6 shows results obtained using third version with indicated median values (dots), interquantile ranges (bold lines) and 95% confidence intervals of calendric age. Exact numeric data are listed in Table 1.

It seems that chronologic pictures presented in Figs. 5 and 6 are too sophisticated to lead to clear interpretation and definite conclusions. Dates obtained on samples from considered sites and cultures show significant scatter, the 50% and 95% confidence intervals overlap, covering interval from *ca.* 3,200 to 4,200 B.C. It can be noted, however, that conventional C-14 dates of each group quoted by Hays (1984: 214) are consistent with the only exception of date WSU-1730: 4,250 ± 130 B.P., which is *ca.* 500 years younger. Therefore, dates belonging to

Table 2

Concise calibrated radiocarbon chronology of Predynastic cultures and sites.

No.	Lab. code and no.	Age C-14 conv. B.P.	Median cal. B.C.	Interquantiles cal. B.C.	95% conf. int. cal. B.C.
1	Gerz ST	4701 ± 45	-3466	[-3519, -3414]	[-3614, -3374]
2	Amr HL14	4830 ± 120	-3617	[-3705, -3521]	[-3919, -3357]
3	Bad Ham	5218 ± 100	-4061	[-4150, -3985]	[-4305, -3812]
4	Bad HL11	4718 ± 66	-3498	[-3577, -3424]	[-3644, -3366]
5	Bad KH1	5038 ± 49	-3869	[-3913, -3809]	[-3964, -3719]
6	Bad KH3	4981 ± 77	-3794	[-3886, -3731]	[-3959, -3644]
7	Bad KH6	4921 ± 52	-3727	[-3762, -3690]	[-3902, -3628]

Hays 1984: 214, Table 1.

Gerz – Gerzean; Amr – Amratian; Bad – Badarian.

ST – South Town; HL14 – Hierakonpolis Loc. 14; Ham – Hamamiya; HL11 – Hierakonpolis Loc. 11; KH – Khattara.

same sites can be treated jointly, by the procedure of calibrating of mean value of several dates. The results, shown in Fig. 7 in the same form as in Fig. 6, give a clear insight into chronologic relations of considered cultures and their occurrence on excavated sites. Numeric data, listed in Table 2, can be interpreted as estimates of the duration of considered cultures.

Calibration of a set of related dates

This option is useful for calibration of groups of dates obtained on samples from definite site or culture. The result is presented as composite probability distribution of all dates in form similar to second screen produced by first op-

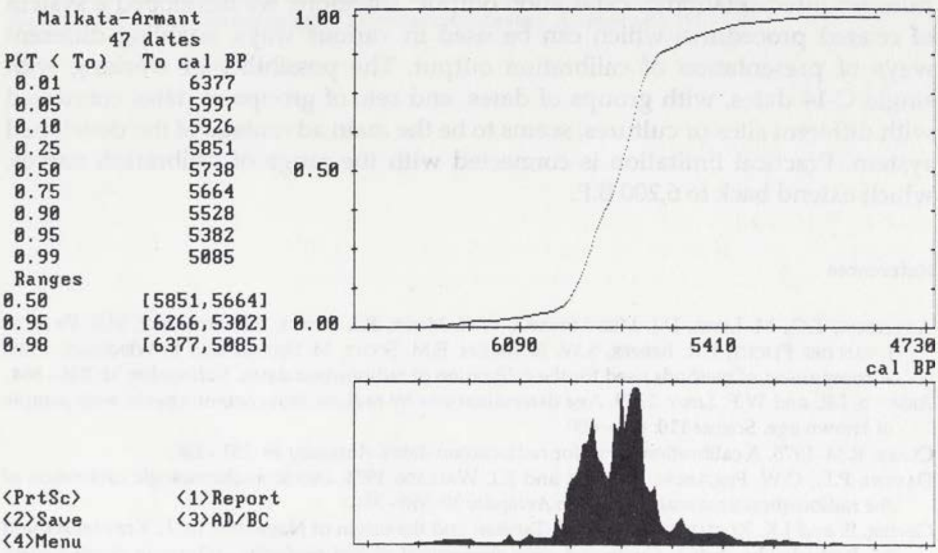

Fig. 8. Example of calibration output obtained with option for calibrating of a set of related dates (47 dates from site 21/83 in Malkata-Armant; *cf.* Ginter *et al.* 1985).

tion for calibration of a single date. An example of calibration output of a group of 47 dates obtained in the Gliwice Radiocarbon Laboratory on charcoal samples from Malkata–Armant (site 21/83) is shown in Fig. 8. The composite probability density function shows the presence of two well-distinguished peaks, which can be interpreted as resembling main phases of human activity on this site. The several seasons of excavation on this site, performed by the team directed by B. Ginter and J.K. Kozłowski, has led to distinguishing of three phases of occupation (Ginter *et al.* 1985). At that moment more than 20 samples from this region (including site 21/83) are being processed in the Laboratory, so the final conclusions cannot be stated.

Final remarks and conclusions

In the beginning of the radiocarbon dating the known-age Egyptian samples were used by W.F. Libby to test his idea. Now, after 40 years, almost all users of C-14 dates are aware of discrepancies between (conventional) C-14 time scale and calendric chronology. However, it seems that the need for comparing both C-14 and calendric chronology remains unchanged, and, moreover, such comparisons are of crucial importance for studies of the prehistory of Egypt and adjacent regions.

Described set of computer procedures is far from perfection, but, in spite of this, it enables presentation of results of C-14 dating in terms of calendric ages, using strict statistical concepts such as median, interquantile range, *etc.* The examples discussed in the text of this article show that there are no general rules for interpretation of calibration output. Therefore, we developed a system of related procedures which can be used in various ways, enabling different ways of presentation of calibration output. The possibility of working with single C-14 dates, with groups of dates, and sets of groups of dates connected with different sites or cultures, seems to be the main advantage of the developed system. Practical limitation is connected with the range of calibration curves, which extend back to 6,200 B.P.

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Studies of wear on grinding stones

It is well known how difficult it is to prove the cereal utilization from archaeological material. Finding grains *in situ* is the most reliable evidence but only when conditions are good for preservation the grains do survive. Even so seeds and grains are small in size and, therefore, they move easily through archaeological layers and it is often difficult to decide whether grains come from a sealed layer or are intrusive.

Studying wears on stone tools is another method used to suggest cereal utilization although it also has its limitations. Finding a gloss on flaked stone tools (often rashly called sickle-polish) can only indicate that these tools were used in the tasks related to plant utilization, especially *Gramineae;* it does not prove the utilization of the cereal grains.

Grinding stone tools (pestles, mortars, upper and lower quernstones) are generally thought to show the practice grinding of grain for consumption. However, the real function of these artefacts is not clear; it is certainly not proved but merely assumed. Considering the importance of the function of the grinding stones in archaeological research this author has investigated the traces of wear on these tools using an Olympus BHMJ-42KB metallographic microscope and microphotography. This microscope is composed of lenses, an incident light and movable eye pieces which provide enough distance between the lenses and studied specimens. However, as grinding stones are usually thick, a modification was necessary. The main body of microscope was attached to a binocular microscope stand with a magnification of less than 50; with this modification a distance of more than 30 cm between the lenses and specimen could be obtained. The stand was then fixed to a desk.

Observations of the traces of wear on grinding tools were then carried out, but due to the weight and dimensions of the specimens, their surface weathering, roughness and calcareous concretions it was difficult to compare the results with those carried out on flaked stone implements. In the case of specimens with lengths of less than 20 cm such as pestles and upper quernstones (rubbers), they were put on the sliding stage of the binocular microscope; the whole surface of larger and heavier specimens could not be observed. In spite of all these difficulties, wear marks and striations could be detected and on smooth surfaces a lustrous gloss was seen.

Some 200 specimens from the following sites have been studied:

1. Saddle querns from sites of the Iankov culture of the 2nd and 1st millennium B.C., excavated in the Peschanyi Peninsula, Maritime Region, Russia;
2. Saddle querns from the Neolithic site of Ta-T'ung, Shang-si Province, Northern China;
3. Saddle-querns, mortars, pestles, handstones and natural cobbles from the Neolithic sites in Northern Iraq;
4. Pestles and handstones from Neolithic sites in Iran.

It was found that a fairly large number of specimens have a gloss on their surfaces. Because these surfaces were usually heavily weathered or had calcareous concretions it was difficult to identify them further. Generally speaking, "peaks" in the harder parts of the surfaces had a lustrous gloss on their sides and, at the "summits", abrasions and striations. The lustrous gloss looked the same as that seen on the edges of "sickle-blades". In the "valleys" and on the softer parts of the surfaces, gloss was hardly visible.

Telul-eth-Thalathat

Most of the specimens investigated were the upper and lower components of saddle querns from the Ubaid layers of Telul-eth-Thalathat in the Northern Iraq (Fukai *et al.* 1970). They are made of basalt and calcareous sandstone. Gloss

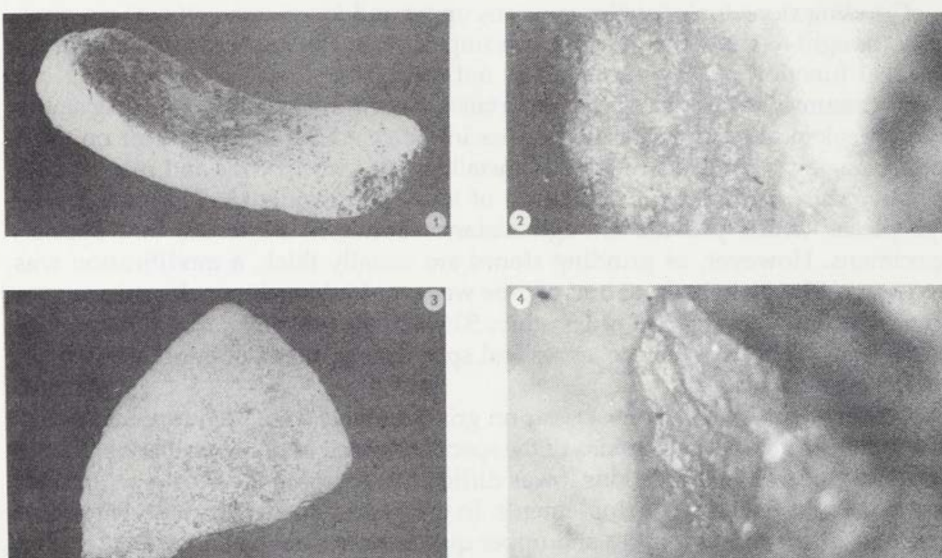

Fig. 1. Telul-eth-Thalathat. The lower stones of the saddle querns and microphotos of these querns.

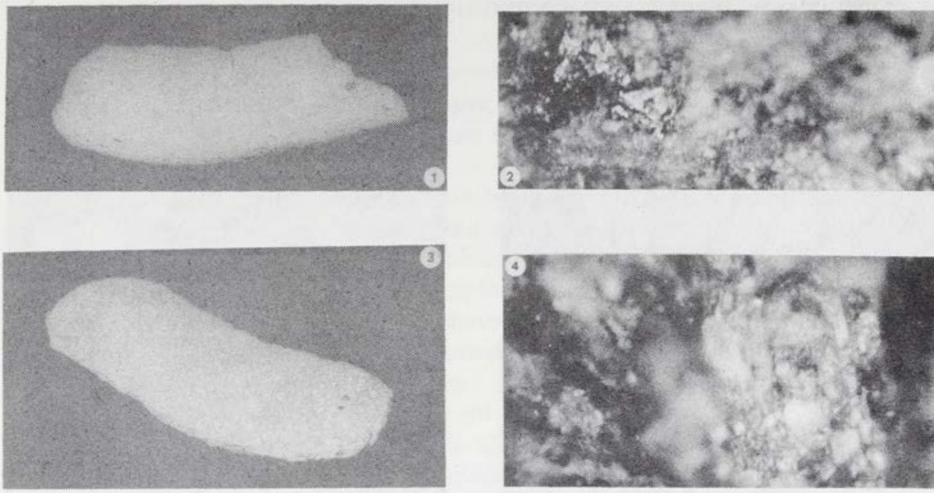

Fig. 2. Telul-eth-Thalathat. The lower stones of the saddle querns and microphotos of these querns.

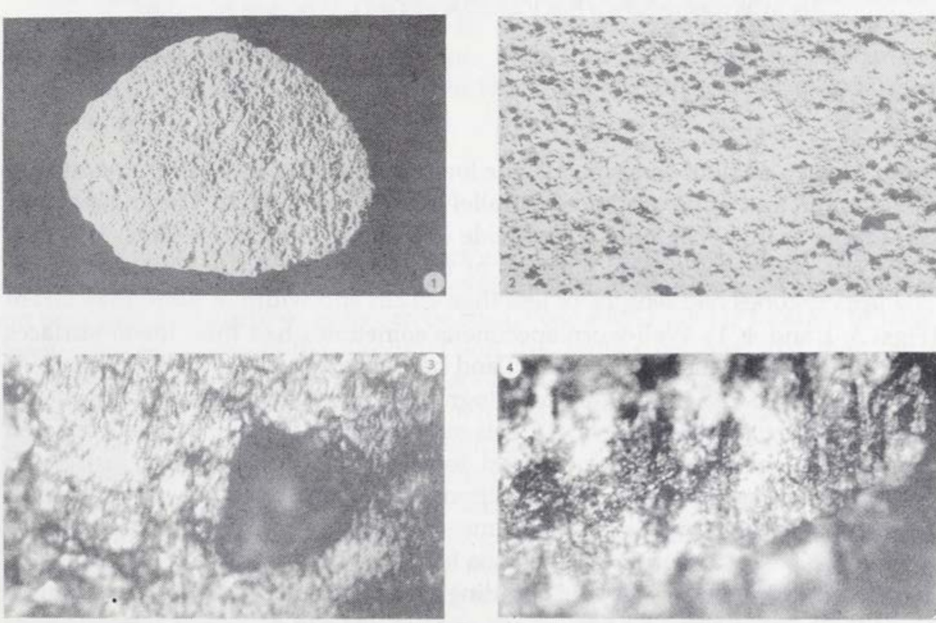

Fig. 3. Telul-eth-Thalathat. An upper stone of the saddle quern, a detailed view of the surface and microphotos of this quern.

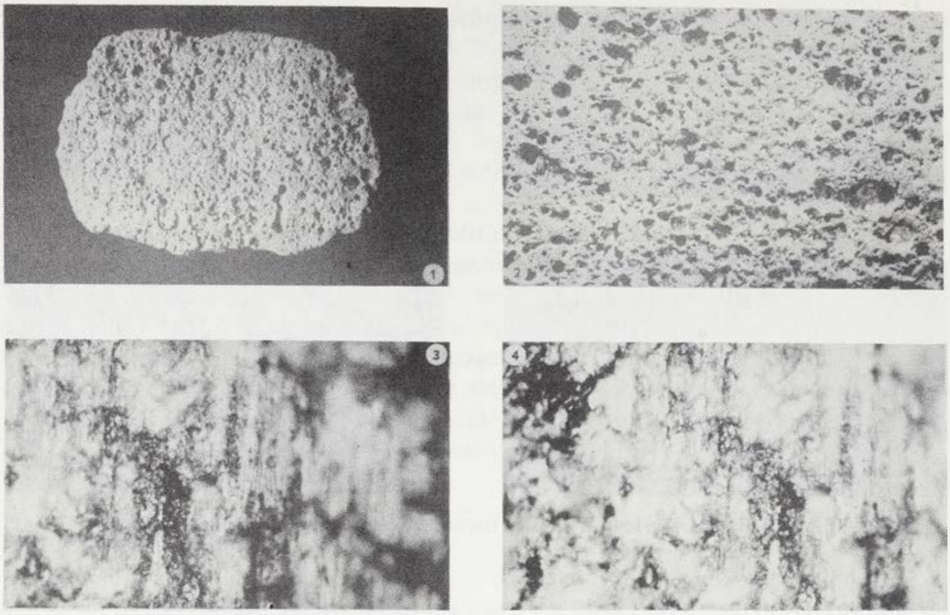

Fig. 4. Telul-eth-Thalathat. An upper stone of the saddle quern, a detailed view of the surface and microphotos of this quern;
The width of microphotos of Figs. 1: 2,4; 2: 2,4; 3: 3,4 and 4: 3,4 are about 500 microns.

could be seen on both components, the lower stones having striations parallel to their longer, and upper striations parallel to their shorter axis. The lower stones were more than 40 cm long, 20 cm wide and about 15 cm thick (Figs. 1: 1, 3; 2: 1, 3). The concave grinding surfaces of the lower stones were usually rough. The upper stones had lengths of less than 20 cm and width of more than 20 cm (Figs. 3: 1 and 4: 1). Well-worn specimens sometimes had their lower surfaces made smooth and lustrous (Fig. 4: 2) and here a definite gloss could be seen. At the "peaks" visible in the microphotography more dimly lustrous gloss and striations were detected (Fig. 1: 2). This may show that once the gloss appeared the abrasion between the upper and lower stones decreased its lustre and caused striations parallel to the directions of movement of the upperstone. If these processes are repeated many times a dimly lustrous gloss and striations remain. This is not seen on flaked stone blades. Grinding stone tools, it may be concluded, have a characteristic abrading gloss (Figs. 3: 3, 4; 4: 3, 4) and only a sporadic lustrous gloss.

On the sides of the saddle querns a sporadic gloss was also seen. It is not so lustrous as on the grinding surfaces and not abraded. It seems that it may have been caused by contact with plant remains during grinding. On the bottom of the lower components gloss is usually not seen. This may be explained by the fact that when the saddle quern was used this part was embedded in clay. On the other hand, both surfaces of the upper stones had sporadic gloss; this shows that when the upperstones were in use their both surfaces had contact with plant materials.

In all studied cases the upper and lower stones had gloss. On the other hand, on the lithic so-called door sockets, the natural cobbles and more than two-thirds of pestles and mortars from the same layer of the site, gloss was not visible. These observations suggest that the grinding stone tools without gloss had probably not been used to grind plants containing silica and that the saddle querns from the layers of the Ubaid culture of this site were the main grinding stone tool used to process plant remains.

At a lower layer of this site, thought to belong to the Hassuna Neolithic period, similar features could be seen. Only a small number of the grinding stone tools were found here, mostly saddle querns, pestles and mortars. On the saddle querns the gloss could be seen and was similar to that occurring in the succeeding Ubaid layers. Saddle querns were already, probably, the main grinding stone tool used for the processing of plants.

Tall-i-Mushuki

The specimens from the Neolithic site of Tall-i-Mushuki in the southern Iran (Fukai *et al.* 1973) are few and no saddle querns were among them. Gloss was sometimes seen on pestles and rubbers from this assemblage. As specimens were few this author was not able to study satisfactorily the grinding tools from this site.

Ta-T'ung

At the Early Neolithic site in Northern China many saddle querns were found (Fujimoto 1983; Henan Working Team No. 1 of IA 1984; CPAM 1981) and on their grinding surfaces gloss can be seen. Fox-tailed millet is thought to have been cultivated here in the Neolithic and this author believes that they were used for grinding its seeds; on the Neolithic sites of Southern China grinding stone tools for processing cereals are not found at all. It is interesting that during the Middle and Late Neolithic of Northern China stone grinding tools completely disappeared and that at the same time pottery vessels, which may have been used for steaming or boiling, suddenly increased in frequency. Some 4,000 years later, during the Han Dynasty, tools for grinding reappeared; they were rotary querns and they may have come from the Western Asia together with the cultivation of wheat. Saddle querns which had been used in the Early Neolithic of Northern China continued to be used further northeast as well as the Northern Inner Mongolia and in the Amur Basin; they may have been used there to grind the grains of fox-tailed millet.

General comments

It is interesting that in recent times the population of Northern China has been cultivating wheat and barley and grinding them into flour to make "mantou" and "baoz" (which are made of dough by steaming) and noodles. At the same time the population of Southern China has been cultivating rice and consuming its steamed or boiled. It seems then that two ways of processing cereals have been developing in China since the Early Neolithic times. In the north a change from using flour to whole grains occurred in the Early Neolithic and then, a change from whole grain use to flour took place during the Han Dynasty.

The ideas expressed in this paper are of only a tentative character. To make a further progress different experiments are needed, for example, we should experiment with the processing of grains by pounding with pestles in mortars and grinding with saddle querns. Results of these experiments should be compared with the archaeological artefacts in order to identify true "corn-gloss".

This author believes that much progress could be made in studying the corn-gloss on stone artefacts originating also from Northern Africa. However, it should be remembered that different human groups have had different approaches to the use of cereals and the traditions typical for the East or West Asia may not be found in Africa.

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Craft production in Lower Egypt during Late Predynastic times with special reference to Ma'adi

Among the Pre- and Protodynastic agricultural communities discovered in Lower Egypt, the most important and the most elaborately organized in its social structure is at Ma'adi. The first excavators (Menghin 1931; 1932; 1934) considered it to be a site-type of a wide cultural pattern that had been developed in Lower Egypt, characterized by completely different elements to those found in Upper Egypt. Its geographical situation on a Pleistocene terrace extending east-west between the mouths of Wadi Digla and Wadi El Tih was especially favorable for the development of agriculture. Menghin's and Amer's research (1932 - 1953) emphasized the importance of the settlement due to: its great size, long-continuous occupation, the wealth of artefacts and to the knowledge of copper technology. Professors Puglisi and Palmieri in many campaigns discovered elements of its social organization. Clear evidence of the agricultural activity that took place in Ma'adi was shown in our recent excavations here. The equipment consisted of grinding stones in various shapes. Oval shapes were commonest with the faces flat or slightly concave; the bigger ones were of limestone, some being found on the original landsurface close to fireplaces. We found also a large quantity with central depression in dark and light limestone, and traces that they had been used for grinding wheat with circular movements (Fig. 1). The round and flatter objects with only a slight center depression seem to have been used for grinding ochre or other softer materials; some had handles. The grinding, pounding or crushing was done with pestles or hammerstones of flint, granite or sandstone which were found also in various shapes: cylindrical, convex, cubic, fanshape, globular and oval. In some cases they showed, on different sides or on the same side, signs of grinding, pounding and percussion and it is clear that they were used for different purposes.

One object found seems to confirm the hypothesis of a connection with Upper Egypt, this was a rhombic slate grinder palette with engraved decora-

Fig. 1. Ma'adi. Grinding stones.

tions at one end depicting two unidentifiable animals. This type of palette is common in the burials of Upper Egypt, dating back to Early Predynastic times. It is clear that the palette was a luxury object imported from Upper Egypt, which was broken and used later as a hammerstone, traces of percussion being clearly visible.

Spindlewhorls of limestone, whole or fragmentary, and other stone rings were present in great quantity, as were potsherds with perforators; study of the use of this object is continuing.

The bone industry in the settlement is characterized (Fig. 2) by awls, points and spatulae which were probably used for decorating ceramics. Similar objects were found at nearby settlements like Helwan, El-Omari (Debono 1948), Merimde and Heliopolis, but Ma'adi offers a much greater concentration and a far higher level of technology, probably due to the greater wealth of the site. Bone combs with short teeth and concave back also occur. This type of comb dates back to the Gherzean period and is also among the grave goods of Nagadian times.

The need to produce a bigger number of tools could have contributed to the specialization of the craftsmen. They, in fact, were able to use hard stones in the construction of every-day's tools. This may have brought about a more progressive social organization at Ma'adi than in other settlements of Lower Egypt.

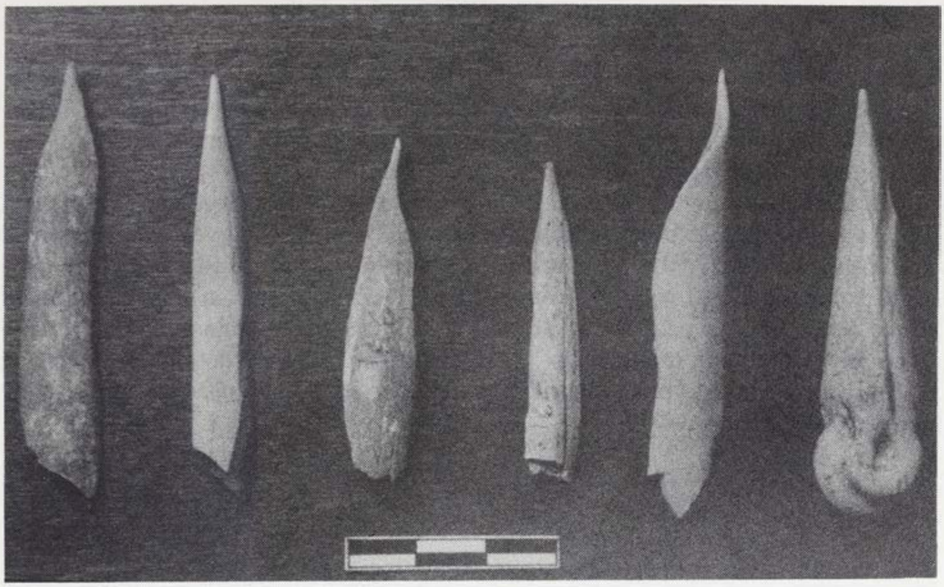

Fig. 2. Ma'adi. Bone tools.

We should also like to emphasize the presence in the settlement of stone vases of various shapes and stones. During our recent work a whole basalt vase was found *in situ* in a hut foundation, close to a fireplace, on the original landsurface. Its truncated conical "Lybian" shape, with flat everted rim was recorded at Marsa Matruh (Bates 1915) and in an Early Predynastic grave in southern Upper Egypt. A general connection with Upper Egypt is also indicated by the presence of stone vases in Tura, Heliopolis, Halwan and El-Omari. In the Fayum's ateliers were found where vases in basalt and alabaster were made with stone drills and this workmanship is present in the tombs of Saqqara and Abydos (El-Khouli 1978). Usually stone vases have been found in cemeteries, as grave goods, but at Ma'adi they were found in the settlement being used for exchange, circulating from Upper Egypt towards Sinai and from there, along the Wadi Tih to the Ma'adi region.

A pendant was also found in the settlement, that must have originated in Upper Egypt: an engraved plaster plaque in the form of a baboon in profile with a hole for hanging. The animal's body is engraved with great precisions, the tufts of hair looking like triangles. The same animal is widely depicted on pendants of faience, ceramic and stone at Hierakonpolis (Quibell 1900).

A craft that was developed only at Ma'adi in Predynastic times is confirmed by small copper objects. They seem to be made locally since smelting is present in the settlement. The presence of metal at Ma'adi might mean relations with the mines of Sinai, but in the Wadi Hammamat in the Eastern Desert copper could also be found.

The analysis of luxury present in the Ma'adi settlement, of their quality, workmanship and shape may in future confirm exchange activity amongst peoples who moved over the Eastern Desert and who left traces of their presence in the rock graffiti of Wadi Hammamat and in other areas (Winkler 1938). It is probable that the wealth of the Ma'adi settlement could have encouraged that exchange.

At the same time the hypothesis that stone vase production had its center in Lower Egypt should be examined – this could explain the great production of stone vessels during the first three dynasties for burials at Saqqara. It is only right to suggest that such an important industry inherited a long tradition of stone working such as is found at Ma'adi. Such local craftsmanship could have been increased and included in the State organization when its seat was at Memphis, and would have formed a group of specialized workers supported by the State.

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The idea of the organization of continuous Dymaczewo symposia was obvious to all who attended our 1980 and 1984 conference. In 1984 the participants decided that these symposia should be held every four years. The subject of the 1988 symposium was discussed during the meeting of the Board of the International Commission of the Later Prehistory of Northeastern Africa in Cologne in 1986. It was felt that after discussing the main lines of cultural development in the later prehistory of Northeastern Africa at the two previous symposia, it would be useful to have a review of recent evidence on the natural environment as a background to the cultural processes.

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