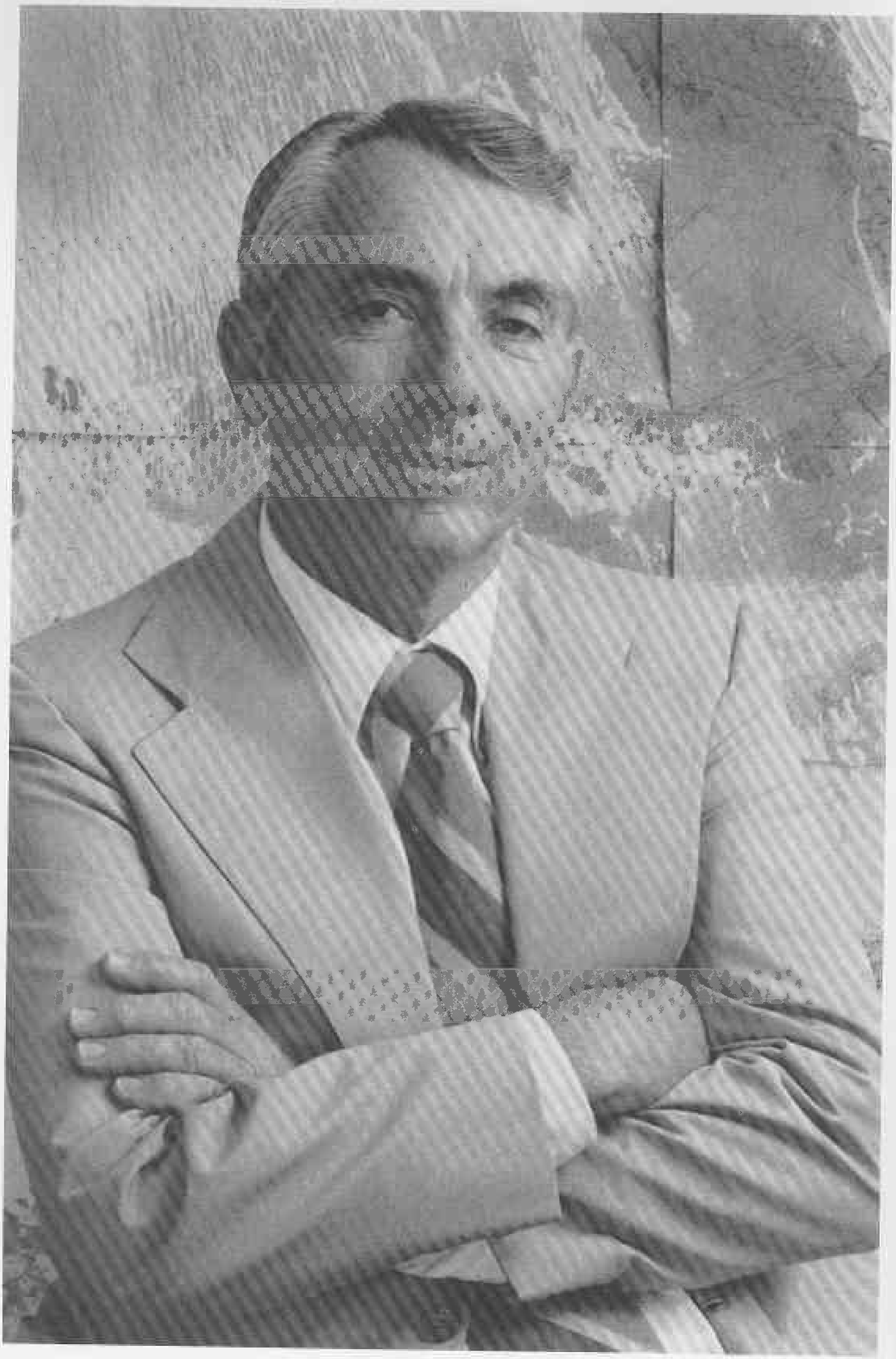
Prehistory of Arid North Africa

Essays in Honor of Fred Wendorf



Fred Wendorf

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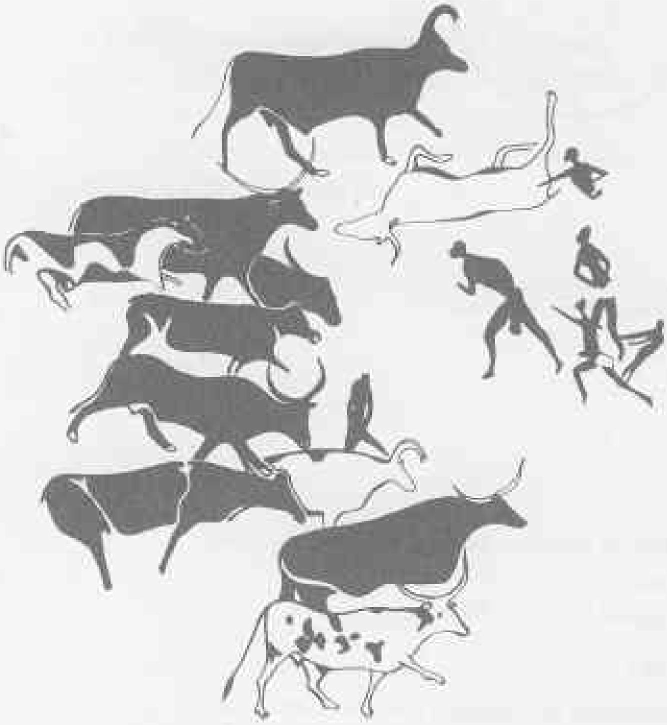

Edited by
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Southern Methodist University Press
Dallas

Cover art adapted from an illustration in *The Search for the Tassili Frescoes* by Henri Lhote, published by Dutton in 1959.

Printed in the United States of America

First edition, 1987

Library of Congress Cataloging-in-Publication Data

Prehistory of arid North Africa

Bibliography: p.
Includes index.
1. Man, Prehistoric—Africa, North.
2. Africa, North—Antiquities. 3. Wendorf, Fred.
I. Close, Angela E. II. Wendorf, Fred.
GN865.N67P74 1987 939′.7 86-31510
ISBN 0-87074-222-1
ISBN 0-87074-223-X (pbk.)

This volume is dedicated to Fred Wendorf,
Director of the Combined Prehistoric Expedition,
on the occasion of the quarter-centenary
of his initiation into North African archaeology.
Sto lat.

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PREFACE

Fred Wendorf began his work in Northeast Africa in 1962, in connection with the salvaging of the prehistoric sites to be destroyed by the flooding of Lake Nasser. His experience in African archaeology was non-existent and his interest in it was no greater than in any other region about which he knew nothing at all. He came, instead, as one of the few people in the world with experience in running large-scale rescue archaeology projects, and he expected to complete the project and then return to his beloved Southwest. The effect of his permanent defection on Southwestern archaeology is unknowable, but the effect on the archaeology of Northeast Africa has been revolutionary. Twenty-five years ago, Northeast Africa was almost unanimously relegated to the status of a prehistoric backwater, a reserve archaeologically fit only for Egyptologists and others of the Classical persuasion. Today, the area is a hot-bed of prehistoric research, much of it developed from the initial stimulus of the Nubian campaigns. The Southwest's loss has been Africa's immeasurable gain.

The purpose of this volume is to mark and honor the first 25 years of Wendorf's research, as Director of the Combined Prehistoric Expedition, into the prehistory of North Africa. The volume does not arise from his contributions as a teacher and is not, therefore, a compendium of papers by his students. It is not a *Festschrift* (such a terminal word) expressing a wish that he would retire from archaeology, and so does not include valedictory papers by all his archaeological friends and colleagues. It is a celebration of his continuing career of active research into North Africa prehistory, and the contributors to it are, therefore, his peers, active in research in the same field.

The chapters gathered together in this volume present syntheses of much of the research currently being conducted into the prehistory of North Africa. The single, most glaring, omission is the work of Fred Wendorf himself, for reasons which should be apparent, but most other scholars seem to be represented, either directly or indirectly. The volume is not a synthesis of North African prehistory as a whole, primarily because the overall advance of research is not systematic but rather resembles a random walk: while most ground is eventually covered and re-covered, the pattern at any one moment tends to be somewhat uneven.

The Appendix is the exceptional contribution, in that it is historic rather than prehistoric, and documents the when, where, what and who of the Combined Prehistoric Expedition over the last quarter of a century. Those of us who have been privileged to work with, or even only to visit, the Expedition realize that its work is rarely a tidy sequence of goals achieved one after another, but that opportunism plays a major role and the congenial interplay of personalities an even greater one. The following unofficial (and unverifiable) history of one of the Expedition's surveys into Sudan will sound familiar to some and will help to flesh out the bones for others.

The 1982 survey was intended to have been along the Wadi el Milik, in northern Sudan. The area is almost impossible to reach from Khartoum and very difficult from every other direction, so driving across the Egyptian Sahara seemed the most promising approach, and fuel-dumps were set at strategic points along the way. However, the fuel-shortage in Dongola was rumored to be such that, while we might succeed in getting there, we would be unlikely to drive out again and so the Wadi el Milik was regretfully abandoned. The fuel-dumps, on the other hand, were not to be abandoned and a trip to somewhere in Sudan was therefore in order.

What with all of this, our being late into Cairo, running into the Coptic Christmas and the Prophet's Birthday all at the same time, leaving Cairo early on account of there was no plane on the day we had intended to leave and what with everything else that has since been blocked from our minds, we were not at all sure where we were going, and were not even quite sure where we were supposed to be going, which is, of course, not at all the same thing. However, after considering the merits and demerits of areas to the east, west and south, it was finally decided that we would base ourselves near Merga, one of the major oases in northwestern Sudan, while the fuel was recovered.

We began by flying from Cairo to Kharga, where we spent the night in the Geological Survey rest-house. Kharga's only serious claim to fame is based on the size and voracity of its mosquitoes. Let us, therefore, pass rapidly from Kharga.

Early on the morning of January 10th, we set off to drive down to Merga in four Russian "jeeps": Fred Wendorf, Vance Haynes, Angela Close, Bahay Issawi, Mohamed el Hinnawi (the latter two then geologists with the Geological Survey), four driver-mechanics and a couple of miscellaneous bodies for any miscellaneous tasks. The Russian "jeeps" are modelled after World War II U.S. Army jeeps. They are cheap, sturdy, uncomplicated and usually reliable vehicles, and they are not built for comfort. Four of us rode in one jeep—Wendorf, Issawi, Aïd Maariif and myself.

Aïd Maariif is the headman of our band of laborers and has worked with Wendorf for 25 years. As a desert guide, he is probably without peer, but on this occasion he was also driving and Aïd, as a driver, is unusual. The excitement of Aïd's driving stems from his being so good as a guide. Most drivers are content to look at where they are going, but Aïd has to devote equal amounts of time to looking at where he has been, as well as at what he is passing on either side. If the road should be a completely new one to him, then where he has been is by far the most important thing about it and is treated accordingly—he drives hanging out of the window looking backward. (The Russian jeep is too basic a vehicle for luxuries like mirrors.)

In addition, everything that moves in the desert leaves a track and Aïd has to account to himself for every track he passes. Gazelle tracks were not too bad: Aïd simply had to make sure which rock the gazelle was leaving and which bush it was going to, and then peer under every other bush in the area to see if there were any more gazelle. If there should happen to be one, it would have to be flushed out, on the chance that it might flee into open ground where it could be run down with the jeep and we could all have fresh meat for dinner. An old camel trail would take a little longer since it was necessary to drive along it for some distance, so that Aïd could be sure which oases it linked and whether or not it had been used recently. Fresh camel tracks were rather more exciting, since he had to count the camels and determine their size, the number of people with them, whether or not they were loaded, where they were going from and to, and how many days or weeks ago. And car tracks could bring the entire expedition to a halt, while all the usual things were determined, plus the names and purposes of the drivers. In 1982, it was still possible to identify with some confidence almost every car track made in northwestern Sudan in the last fifty years, although the value of such an exercise is not immediately apparent.

Driving with Aïd is, therefore, highly informative, but it is also very uncomfortable and, in the back seat of a Russian jeep, it can sometimes be quite excruciating. It is not simply the pain of driving over a meter-high sand-sword at 80 kph; it is the horrible anticipation that comes of seeing the sand-sword from half a kilometer away when Aïd is in one of his retrospective periods, or his I-wonder-where-that-fifth-camel-wandered-off-to mode.

And so we set out. We went about 60 km west from Kharga along the surfaced road that leads to Dakhla, and then turned south and went over sand and rocks for the rest of the day and saw not another soul. We got about 450 km south on the first day, which is not inconsiderable across the desert and in Russian jeeps. We stopped for the night in the extreme south of Egypt at Bir Misaha.

Bir Misaha has a dug well, but cannot really be counted as an oasis. Oases should properly have palm-trees and flies and camel-ticks, and Bir Misaha has none of those. It is a wide, shallow depression in the middle of an endless sand plain. It has a well, which was dug by the British who had to go down 60 m to find water. Around the well is a roofless hut of corrugated iron so the well is now almost full of sand. There are also various items of rubbish scattered around—old bottles, bits of wood, the winch for the well. . . . Bir Misaha was probably the last place God made and it is utterly without redeeming features. A bottle of Scotch had been brought along to celebrate the beginning of the season and should have made even Bir Misaha seem a little more rosy, but we had hardly begun to celebrate when it started to rain, and continued to rain for the better part of an hour. This is, of course, in the hyperarid part of the Sahara where it may rain every 20 or 30 years if the weather is *very* wet.

The following morning we continued generally southwards. One of our fuel-dumps was just into Sudan at a major (British) army camp of the last war. The skeletons of the tents are still standing, and just below the surface of the sand are old cigarette packets, beer bottles (among the enlisted men's quarters), and rum (Indian, of course) and Scotch bottles (among the officers' quarters). There was even most of a canvas tent left, but it was too rotted to be salvaged (as well as a lorry's radiator-grill which proved invaluable in grilling the gazelle). The camp is now also one of the most vital resources in the Eastern Sahara, since it was a major dump of empty five-gallon (Imperial) petrol drums. Everyone who moves in the desert uses five-gallon drums: for carrying water, for sitting on, for wind-breaks, for landmarks and even for ovens. There is almost nothing you cannot do with a five-gallon drum, and exploration of the desert would probably cease without them.

And so onwards. We travelled 400 km on January 11th, which was a little less than the day before but 100 km of the distance were across a field of boulders and large rocks (the interstices, curiously, being filled with small rocks). It took five hours to cross and we dreaded the return journey. We finally set up camp in Wadi Hussein, about 40–50 km from Merga and in a group of small hills. (A certain amount of local topography is vital in a camp with ten men and one woman.)

January 12th was devoted to the problem of water. There was known to be a small well, Bir Bidi, a few kilometers from camp although no one was sure exactly where it might be. Aïd found it by searching the entire area for the densest concentration of camel-droppings, and then going over the concentration until he found a small circle in the middle that was completely clear. That was the well. It had been dug out by the last camel-caravan to come through, who had camped all around it, and it had since filled up again with new, blown sand. The well was re-excavated (it was only about a meter deep) and cleaned and declared to be too sulphurous even to stand downwind of; drinking was out of the question. So we went on to Merga, which was a long and difficult drive and we never did find a good road there. (However, since Wendorf insisted that we keep trying new and possibly better routes, we became well acquainted with a surprisingly large number of bad ones.)

Merga is everything that an oasis ought to be. It is a huge depression (some of us were always lost in it), there are hundreds of palm trees, there are gazelle and birds and lots of camel-ticks, and sweet water can be had by digging less than a meter down. In the middle of the depression, there is even a lake—a lovely green in color and densely surrounded by reeds and trees. Unfortunately, the evaporation rate is so high that the lake is extremely salty and it is also heavily infested with mosquitoes. From a distance, it is an attractive lake.

Merga proved to be very useful. We would drop by every three or four days to get water for the camp, and Wendorf and I could take the opportunity to disappear behind a clump of palm trees with a jerry-can (Arabic: *el jerican*) and have what locally passed for a bath. They were not very pleasant, or thorough, baths. A very cold and very strong North wind blew without ceasing for our entire stay, one of us was always on tick-kicking duty (camel-ticks like people too) and prancing around wet and naked on a sand dune was not too much fun. It may be observed, however, that after the initial expressions of astonishment and hilarity, the entire group started taking soap and towels to Merga.

It was also at Merga that we were to encounter the only other human beings we saw on the trip. We met a group of about 20 Sudanese boys and were at first almost as frightened of them as they were of us. However, it was inconceivable to Aïd that he should see someone else in the desert and not exchange life histories, so he chased them down with a Russian jeep and established contact whether it was wanted or not. It transpired that their worldly possessions were the clothes they stood up in, and they were on their way to Libya to become laborers. They were crossing the Sahara on foot, each carrying a water bottle that held about 2 liters, and they faced a walk of six days to the next well, at Uweinat. The well at Uweinat is not particularly reliable and it is a further six days to the next well. We passed their tracks a couple of times afterwards, about two days' walk from Merga, but we do not know whether or not they made it.

So much for our social life. The actual archaeological work was good, although it involved too many hours in the back of a Russian jeep. We spent a long week surveying, leaving camp at 7:30 in the morning and returning at sunset, and, inevitably, developed a routine. Aïd checked to make sure that our jeep set off every morning equipped with a large bag of peanuts (roasted, but unshelled). This was tied to the emergency bar in front of Wendorf and was never broached before nine o'clock. On some mornings, nine o'clock took a very long time to come. At ten o'clock, the granola bars were solemnly shared out; Aïd regarded them as some kind of camel-food, but ate them anyway. On cold mornings, or when the archaeology was nonexistent, the granola bars came out at 9:30, but if the weather and the archaeology were good, they would sometimes be saved until almost 10:30. Lunch was at noon and consisted of a sardine, a piece of cheese, a potato that had been boiled within the previous week, bread that was so hard to begin with that even two weeks in the desert could make it no harder, and green onions. This was followed by as many tangerines as Hinnawi could persuade us to eat, because he had brought too many and they would start rotting soon. And, of course, tea—boiled to the consistency of soup and served over sugar. (Ten people consumed 20 kg of sugar in ten days, using it for tea and nothing else.) The only calamity was on the day when one of the miscellaneous bodies forgot the teapot and Hinnawi was forced to go cold turkey; he trembled all afternoon. All of the world's more serious problems were resolved after lunch, while the caffeine was still running strong, but people began to wind down again by about three o'clock. The conversation would flag, there would be a certain amount of silent peanut-chomping and a few muffled groans, and by 4:30 all teeth were firmly clenched and all eyes gazed fixedly at the road ahead (except for Aïd, who was still trying to work out where that fifth camel could have gone). By the time we returned to

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camp, the entire Russian army could not have persuaded us to go any farther in one of their jeeps.

The surveys revealed little to the north or to the south, but to the west we found a large valley that is marked on no map and that we named the Wadi Mahgur, the "abandoned valley." Here was a series of Early Holocene sites, some of them *in situ*, that were exactly what we had hoped to find. Unfortunately, we also discovered some rather fresh tracks, going from west to east, of 15 large lorries and several smaller vehicles, all of them carrying large numbers of boot-shod men to push when the vehicles stuck in the sand. It was obviously military, probably not Sudanese and suddenly the archaeology did not seem to be quite so urgent.

To the east, we found a large, unmapped depression which we called the Wadi Gamamiis, because of the large granite outcrops in the bottom that looked like water-buffalo (Arabic: *gamoosa*) and because Issawi likes to name places. The edges of the depression were cliffs about 150 m high, and we entered by driving the jeeps down a falling dune. We quickly discovered Neolithic sites in the bottom and then spent the rest of the day trying to find a way out again. In the Wadi Hidwa, the "horseshoe valley" (that being its shape), we discovered thick lake-beds with associated archaeology, forming a sequence that probably goes from the Early Holocene almost up to modern times. This was sufficient to keep the archaeologists crawling across the ground there for several days after the geologists had decided that they really had to get back to Cairo.

We set off back to Kharga on January 21st, and, much against Aïd's will, travelled by a different route, going west and then north to avoid the 100 km of boulders. The boulders were avoided but the area was completely new to everyone, which was particularly traumatic for Aïd. There were occasional camel-roads across the early part of our path, and Aïd derived a great deal of comfort from driving from one dead camel to the next. Eventually, even the dead camels petered out and all we saw were more military tracks, and two German petrol-drums from the last war.

As the day progressed, Aïd became more and more unhappy and our path gradually bent farther and farther towards the right; finally, he had us heading southeast and, as far as could be told, directly back towards Merga. An argument might have developed, had not one of the jeeps then developed a flat tire, which sobered everyone. It was a particularly sobering flat tire because it led to the discovery that of the three, almost-new Russian jeeps still with us, not one was equipped with a jack. Worse still, the episode took place on cemented silt and our only digging tools were tent-pegs, so that we could neither prop the jeep up nor dig a hole underneath it. It took a long time to change the wheel that afternoon.

Thereafter, Aïd had his way. He proceeded directly to where he could pick up our old tracks and happily started to follow them back to the north. Despite protestations from the Egyptian contingent, who seemed to like the place, we took care not to get into Kharga until late on the morning of January 23rd, thus avoiding having to spend two nights there. By that time, we had set an Expedition record of 3518.3 km in a Russian jeep in 14 days. When we finally arrived, we spent over an hour scrubbing off the accumulated dirt, did nothing but drink tea all afternoon and then were awakened at midnight by the howl of mosquitoes. Welcome back to civilization!

As Editor, my first debt is to the contributors to this volume. The chapters speak for themselves in terms of scientific value. I can speak for the authors in terms of their patience, cooperation and helpfulness, and for almost all of them in terms of the surprising (for archaeologists) understanding they showed of the word "deadline." The idea of such a tribute to Fred originated in a conversation with Abbas Mohammed-Ali, to whom I am grateful for the stimulus. On behalf of all of those involved in the creation of this volume, I would like to thank Fred Wendorf for being of the calibre to deserve it. For myself, I would like to thank him for much, much more.

I am indebted to Dedman College, the University Lecture Series' Fund for Faculty Excellence and to the Institute for the Study of Earth and Man, all of Southern Methodist University, for funds provided to me to publish this tribute to Fred. The camera-ready copy was prepared with astonishing competence, speed, good humor and moral support by Chris Christopher.

Angela E. Close

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Fred Wendorf: A Critical Assessment of His Career in and Contribution to North African Prehistory

J. DESMOND CLARK

It gives me very great pleasure to have this opportunity, in the volume of essays in honor of Fred Wendorf, to acknowledge something of the debt which we all owe to him for the way in which he has opened up our understanding of Northeast African prehistory with a thoroughness, set out in ten major volumes and some forty other publications, that few could hope to emulate. His is, indeed, a great achievement.

For the past 25 years, Fred Wendorf has continued to work in some of the most inhospitable and difficult parts of this planet, in the deserts of Northeast Africa, and has done so with a panache and success that are both the admiration and envy of those of us who have experienced some of the problems of working in the many-faceted environments of a continent such as Africa. That he has been so successful is in part due to his great organizational prowess, his choice of colleagues and his ability to number them among his close friends. Also contributing to his success is the thoroughness of his field- and laboratory-work, and his perseverance in ensuring that the findings and interpretations are as sound as current methodology and concepts permit. Especially noteworthy are the phenomenal speed and regularity with which he and his associates publish their findings in definitive form. Add to all this, boundless energy, enthusiasm and imagination, and success is inevitable.

There are few who can match his achievements over this quarter of a century of prehistoric research in what was, when he started, one of the least known parts of the African continent in terms of prehistory. Apart from the Egyptian protohistoric period, the Predynastic, which was studied at the beginning of the century by Sir Flinders Petrie, there was only a handful of publications on the immensity of time that extends back into the Lower Paleolithic. Most of these were pioneer researches, such as those of Caton-Thompson and Gardner on the Fayum (1934) and Caton-Thompson on Kharga Oasis (1952), of Ball (1939) and Sandford and Arkell (1933, 1939) on the Nile valley terraces and paleoenvironments. There was the work of Vignard (1934) on Kom Ombo and the volume by Huzzayin (1941) pulling much of this together. These works provided a valuable basis from which to begin but they all suffered from the limited horizons and concepts of how prehistoric peoples behaved, from which, indeed, all of us suffered who worked in Africa during those pre-war years. Much more was known about the prehistory of Northwest, East and South Africa than about the Northeast. Although the ancient Nile Valley was one of the first parts of the continent to be investigated systematically and scientifically (Jomard 1809–1813), the focus, quite naturally, was on the monuments and tombs of dynastic Egypt. The investigations of the past 25 years have done much to even the balance and to show something of the importance of the Nile Valley and the Sahara for African prehistoric studies. No one has done more to make this known than Fred Wendorf and his international and interdisciplinary team of colleagues.

Today, we are all too often subjected to the theoretical constructs of people who are overeager to criticize, from the comfort of their armchairs, the work of others, without themselves having experienced the discomforts and readjustments often necessitated by recovery work in the field (although, at the same time, they forego the elation and excitement of discovery and the quiet satisfaction of survey or excavation well done). Such critics also never perceive the understanding that derives from becoming one with the terrain, the ways it can change, the problems of extracting a livelihood from it and the ways these are successfully overcome by the local populations. To few of us is given the ability really to identify ourselves with an alien region and its people, but we can go far towards attempting to understand them through the time we spend in the field with them, trying to appreciate the topography, the plants, the animals, the people and the preciousness of water in a desert environment. New discoveries originate from fieldwork and from them come new concepts and broadened horizons. As more discoveries are made, so our concepts and premises of human behavior in prehistory will also change and those we hold today will tomorrow be as outdated and unacceptable as are those of 50 years ago for us now. Since concepts must inevitably change, it behooves us to ensure that the data base, which does not change, is investigated and recorded in as much detail and with as much precision as possible, since it will always remain an essential part of the evidence for new theoretical constructs. The situation is perhaps not unlike that of Kipling's garden.

> Such . . . are not made
> By saying "Oh, how beautiful!"
> And sitting in the shade
> While better men than we go out
> And start their working lives
> By grubbing weeds from gravel paths
> With broken dinner knives.

Not that I would imply that this useful prototype of the prehistorian's trowel was ever used by Fred or any of his associates!

Fred Wendorf has been an active field archaeologist *par excellence* for the past 39 years, 25 of these in Northeast Africa, and there is no one who has contributed more to our understanding of human adaptive behavior and cultural evolution in the Nile Valley and the Eastern Sahara. Wendorf began his research in Nubia in the early 1960s, in association with the rescue operations necessitated by the construction of the New High Dam at Aswan. Before that time, the accepted view of prehistoric occupation of the Nile valley was that Egypt and the Nile were backwaters to which Upper Paleolithic blade technology penetrated only slowly and with much modification. Today, by this writer at least, they are seen as centers of innovation and dispersal.

When he began work in Nubia in 1962, Fred Wendorf had already had several years' experience in field archaeology. In 1950, when he was still at Harvard, he was selected to direct the salvage archaeology along a pipeline in New Mexico and Arizona. This was one of the first large-scale salvage programs, and the first pipeline salvage program, ever carried out in the United States. Other and similar projects followed. One of these, with the New Mexico Highway Department, became the model on which the national program for highway salvage archaeology is now based. Following his representation, safeguards for archaeological and paleontological remains were included in the Federal Highway Act of 1954.

Shortly after obtaining his doctorate, he became involved in the discovery and excavation of Midland Man in Texas, still the oldest human remains in the New World. The collaboration in this investigation and the ensuing publication (Wendorf *et al.* 1955) with geographers and physical anthropologists fed a growing interest in past environments and paleoecology and resulted in several important and pioneering studies of Late Pleistocene environments in the High Plains of the Southwest and their effect upon the contemporary human populations. His knowledge of geomorphology and stratigraphy contributed to the building of a framework of geological units, within which contextual studies of the evolving cultural sequence in the Nile valley could be made and dated and interpretations attempted.

Heeding the call of the Egyptian and Sudanese governments and of U.N.E.S.C.O. for foreign assistance in saving the Nubian antiquities that would disappear under the waters of Lake Nasser with the completion of the New High Dam in Egypt, Fred Wendorf formed the Combined Prehistoric Expedition in 1961–1963. The Expedition has continued ever since to undertake fieldwork in Egypt, the Sudan and, briefly, also in Ethiopia. This is a truly international team of scientists. The collaborating individuals and institutions have changed from time to time, but it is the close relationship of the team from Southern Methodist University, geologists from the Geological Survey of Egypt and archaeologists from the Polish Academy of Sciences, that has made the Expedition's contribution to Egyptian prehistory so outstanding. Not a few of those who received their introduction to fieldwork in Africa on one of Fred's expeditions are among these now most active in research there. It says much for Fred's leadership that some of those who were members of the original Nubian team are still working with him today.

The greater part of what is now known about the Pleistocene and Early Holocene archaeology of the upper Nile Valley is the outcome of the surveys and excavations of the Combined Prehistoric Expedition. The geomorphological and paleoclimatic history of the Nile in Nubia and Upper Egypt is known from the work of several different expeditions and is securely correlated and dated so that it forms a reliable framework within which the prehistoric assemblages can be studied. However, the most complete and continuous survey and correlation are those of the Combined Prehistoric Expedition and they have led to a number of important publications. *The Prehistory of Nubia* (Wendorf 1968), in two volumes with an additional folio of maps, sections and tables, is the most important of these and is still the definitive study of Nubian prehistory before the Neolithic. Most of this was quite unknown before the Aswan Dam research, so Wendorf and his team set out to describe and define the cultural entities they found in their study area, which overlapped the international boundary.

It was possible to place these cultural entities in their paleoenvironmental setting because of the stratigraphic and geomorphological studies of the fluvial silts, aeolian sands and escarpment scree formations carried out by the geologists Albritton, de

Heinzelin, Paepe, Issawi and Said. The radiocarbon method of dating meant that these could all be placed sequentially. Studies of vertebrate and invertebrate fossils, notably by Gautier, provided the basis for reconstructing the prehistoric economies, especially from the bone food-waste not infrequently present at the prehistoric activity areas. The archaeologists, and there were twenty or more of them, often had to deal with heavily deflated sites, as is generally the case in desert regions. Sites were gridded, distributions of artifacts and fauna plotted and sometimes significant associations established. Preferred localities were identified: channel banks, spring-mounds, edges of floodplain ponds, gravel platforms and limestone plateaux. The areas of sites were determined and found to vary with different industrial entities, as also did the nature of the settlements—large, single aggregates of cultural remains, a number of small concentrations representing contemporary households or seasonal reoccupation, and so on. Technological studies showed the variability resulting from preferences for different raw materials and from other causes; some quarry sites were excavated and techniques of primary flaking and retouch were defined. While the Acheulean and Mousterian industrial complexes appeared to predate the Nile silt phases and were usually without faunal associations, studies of assemblages dating from about 20,000 B.P. amply make up for the paucity of associated data with earlier assemblages which, incidentally, later researches have done much to rectify.

Within the Late Pleistocene–Early Holocene time-range, a number of cultural entities, sometimes regionally distinct, sometimes contemporary and sometimes sequential, were identified and distinguished, mainly on the basis of their technology and retouched-tool components, and were named for the localities where the characteristic assemblages were first found. Some of these probably represent distinct ethnic populations, others the evidence of specific activities and seasonal variability in exploitation strategies. More precise understanding of the meaning of this variability is one of the most pressing needs of Quaternary archaeologists today.

The Nubian survey also showed that, in this part of the upper Nile, Middle Paleolithic technology was sometimes replaced more slowly by blade technology than was the case further north along the Nile, where true Upper Paleolithic blade industries are now known to have made their appearance >30,000 years ago (Vermeersch *et al.* 1982). The merging of these two technologies, as can be seen in the Halfan, and the ultimate replacement of prepared-core technology by a fully microlithic one based on bladelets, as shown for example by the Qadan, are more likely to reflect technological and stylistic preference on the part of the makers of the stone industries, than basic genetic differences between the populations themselves, since the modern phenotype is now known to have been present in Africa by at least 100,000 years ago (Bräuer 1984).

One of the most important results of the Nubian survey has been the light it has thrown on the economy of the Late Pleistocene populations. Besides the hunting of large mammals, much use was made of freshwater fish and, from about 18,000 years ago, of ground plant-foods; this is some of the earliest evidence from anywhere for the use of these two resources. The latter is especially well seen in the numerous upper and lower grinding-stones on some sites of that time and, as at Tushka and the Isnan sites, in the flint artifacts with silica gloss on their cutting-edges. Wendorf's findings suggest that the edible, wild plants of the valley are likely to have been brought into use during a time of adversity, such as obtained over most of the continent during the maximum of the last glaciation (*ca.* 22–12,000 B.P.) and would have been especially pronounced in a restricted region like the Nile Valley. This might be seen as one outcome of increasing stress, competition and conflict between regionally distinct, cultural groups for the available resources of the valley. Resources such as aquatic- and plant-foods would have been of even greater significance when more extensively exploited, and they can be seen as a vital clue to man's survival in the valley during the Late Pleistocene hyperaridity.

There are two very good indications of adversity of this period. One is the extensive burned horizon, presumably from bush fires, found in the Nile silts of the Sahaba-Darau aggradation from Nubia to Dishna and dating to 12,600–12,000 B.P. Second is the evidence from the Nubian cemeteries in the vicinity of Wadi Halfa, dating to around 14,500 B.P., of some of the earliest, organized, group conflict. One such large cemetery, at Jebel Sahaba, was extensively excavated and studied by Fred himself. Not only do the cemeteries imply the existence of relatively permanent, even if seasonally occupied, settlements, as do also the contemporaneous ones in the Maghreb, but there was a direct association of various kinds of stone artifacts with some of the skeletons—some were actually found sticking into the bones. These are seen as the armatures of projectiles and as having been the cause of death. Some 40% of the burials had such artifacts associated with them, men, women and children alike. More recently, the report on the Wadi Kubbaniya burial (Wendorf *et al.* 1986) shows that this young man, dating to about 20,000 B.P., also met his end violently.

The cemetery burials are some of the best Final Pleistocene skeletal collections recovered from Nubia and their descriptions by Anderson (1968) and Greene and Armelagos (1972) show them to be related to the Mechta-Afalou populations of the Maghreb, a generalized physical type that now seems to have been widely spread throughout much of northern Africa during the Late Pleistocene.

With the completion of the New High Dam and the flooding of the reservoir, Fred Wendorf's party divided into two: one group went south to the region round Dongola and into the Butana, and Fred took a team north in 1967–1968 into Upper Egypt to survey the region between Aswan and Armant, and then into the Fayum in 1969. The resulting volume (Wendorf and Schild 1976) shows that the aggradation of Nile silts had begun earlier than was thought from the Nubian evidence, with remnant sediments in the region of Dandara that date back to the Late Acheulean. At El Kilh were found two facies of an industry named Idfuan, one a Levallois facies and the other a non-Levallois or blade facies. These date between 17,800 and 17,000 B.P. and show resemblances to the Halfan in Nubia. They again demonstrate the growing importance of blade technology for the manufacture of more standardized primary forms.

Various other industrial entities have been identified in this stretch of the Nile in the period 17–12,000 B.P.: the Fakhurian, the Afian, the Isnan and other occurrences still unnamed. Most artifacts are of small blade or microlithic proportions and the industries differ in the kinds and percentages of backed bladelets, Ouchtata retouch, perforators, burins, scrapers and other forms, including grinding-stones. Some of these aggregates show similarities to Epipaleolithic industries in the Maghreb and Cyrenaica. However, while Epipaleolithic technology and typology exhibit a generalized pattern that enjoyed a wide distribution in northern Africa at this time, each major region can be distinguished by its peculiar, stylistic preferences. The Afian, for example, has been the subject of a separate monograph (Close *et al.* 1979), that attempts to provide a new approach to understanding the structure of prehistoric society by using proven stylistic traits to determine the extent to which the same or different social groups are represented.

In the Fayum, Wendorf turned his attention to the identification of the pre-Neolithic, high lake-stands and to dating and identifying more precisely the "Fayum B" entity recognized by Caton-Thompson in 1934. He showed that this backed bladelet industry is older than the Fayum Neolithic (*ca.* 6000 B.P.) and occurs *in situ* in the silts of the Premoeris lake. It is now dated to about 8000 B.P. and has been renamed the Qarunian. Of interest is the occurrence of naturally serrated bone points made from the modified and obliquely truncated pectoral spines of catfish; these are identical to points mounted as arrowheads, found in the First Dynasty tomb of Hemaka at Saqqara.

In 1971 and 1972, Wendorf and Schild turned their attention to the headwaters of the Nile and, when exploration of the Takkaze proved impracticable, moved to the Lake Ziway region of the Ethiopian Rift. Here, Late Pleistocene micro-blade occurrences in obsidian were excavated belonging to an Ethiopian blade tradition that extends back, as we now know, to at least 27,000 years ago. The main thrust of the work in Ethiopia was, however, directed to Middle Stone Age quarry and occupation sites on the slopes of an extinct volcanic complex, Gademotta-Kulkuletti. Although the Middle Stone Age technology was strongly influenced by the Levallois method, the production of long blades was also a significant feature, in part, no doubt, induced by the nature of the raw material. This was the first definitive description of a Middle Stone Age industry from Ethiopia (Wendorf and Schild 1974), but it was chiefly important for its extreme antiquity. At one locality, the occupation horizon is overlain by ashes that have been dated by the potassium-argon method to 181,000 B.P. ± 6000 years and 149,000 B.P. ± 13,000 years (Wendorf *et al.* 1975). This was almost the first time so early an age had been proposed for a Middle Stone Age industry, but there is no reason not to accept it. Dates of comparable age are now known from East and South Africa and, as the stratigraphic sequence at Melka Kunturé shows (Hours 1973), the only difference between the Final Acheulean and the Middle Stone Age assemblage immediately above it is the absence in the latter of bifaces. The work in Ethiopia also begins to show that there are similarities to Late Paleolithic and Epipaleolithic industries along the Upper Nile, perhaps due to the prevalence of obsidian, a raw material that is not unlike flint in homogeneity and size and that favors a technology based on blades.

Wendorf now turned his attention to the Western Desert of Egypt. Dakhla Oasis and the adjacent desert were explored and sites located and excavated that have given much increased understanding of the Upper Acheulean in association with spring-mounds, like the site previously excavated by Caton-Thompson at Kharga Oasis. These appear to be very special industries, comprising handaxes (some diminutive) with untrimmed butts, cleaver-bifaces and backed bifaces or knives, to use the East African Acheulean terminology of Kleindienst. Light Duty artifacts are rare but include denticulates, notched pieces and burins; the Levallois technique is minimally present. Biface-trimming flakes show that some of the bifaces were made, or further modified, at the springs, and these are by far the most representative artifacts of spring sites. It is unfortunate, but perhaps significant, that faunal remains are very rare.

This is not the case, however, with the Middle Paleolithic occurrences (Denticulate and Typical Mousterian and Aterian) from the southern parts of the Eastern Sahara. The Bir Sahara basin was excavated in 1973, Bir Tarfawi in 1974 and 1986 and Kharga Oasis in 1976. Mousterian and Aterian butchery sites were studied in relation to the large Ethiopian fauna then present in the Desert and it has now been shown that the Aterian did, in fact, reach to the Nile at Wadi Kubbaniya, near Aswan. Their findings were published in a major volume of synthesis (Wendorf and Schild 1980) and in a monographic work dealing with the Acheulean and Mousterian at Bir Sahara (Schild and Wendorf 1981).

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All these localities lie within a region that has undergone important fluctuations in rainfall, from complete aridity to times when there was sufficient open water and grazing to support the large Ethiopian fauna. Five such episodes of climatic amelioration have been recognized in the later Quaternary, intercalated with hyperarid episodes. Mousterian sites occur adjacent to open water and at least one of them appears to have been a butchery site with high percentages of denticulates. The Aterian is found stratified above the Mousterian and is, again, associated with open water and butchery. All the sites lie beyond the range of radiocarbon dating and are the only good evidence, with that from Kharga, of the nature of later Pleistocene occupation in the Eastern Sahara.

The Neolithic of the Eastern Sahara is best known from the Nabta and Kiseiba areas. The latter still has water close to the surface and may also have been a somewhat less inhospitable locality than Nabta during the earlier Holocene, when there is evidence for the occasional presence of striped hyena. Otherwise, the wild faunas of Kiseiba and Nabta are very similar and are all small. The Final Pleistocene and Early Holocene climatic history of hyperarid deposits, preceding and separating the three playa formations that are contemporary with the Neolithic, is the same at both localities and correlates well with that from other parts of the central and southern Sahara. At best, these were not particularly hospitable areas for settlement, which is almost always likely to have been seasonal. The vegetation was a xerophytic scrub of Sahelian type with *Acacia* and *dom* palm, and *Phragmites* in the bottoms of the playas when there was open water.

The development of the Neolithic in the Eastern Sahara is very well documented and dated. The earliest (parts of which were at first thought to be Epipaleolithic) is dated between 9500 and 8000 B.P. There are several facies of Early Neolithic followed by the Middle (7700–6200 B.P.) and Late (6200–5800 B.P.) Neolithic, both representing significant changes from what went before. The flaked stone industries in all the Early Neolithic stages are based on a small-blade technology with straight-backed bladelets and geometric microliths (trapezes and triangles), and sometimes the microburin technique or Ounanian stemmed points. This shows, on the one hand, a relationship with industries in other Saharan oases that have antecedents in the local Epipaleolithic (such as Ouargla and Siwa Oases) and, on the other hand, a similarity to assemblages from sites along the Nile in Nubia (such as the Arkinian) and Upper Egypt (the Elkabian [Vermeersch 1978]).

The economy appears to have been based on the hunting of small game and, by Middle Neolithic times if not before, on the herding of ovicaprids and cattle. The evidence from the food-waste of this stage shows an increase of hare and a reduction in large gazelle, possibly reflecting more regular occupation of the basins. Several chronologically separated, taxonomic units of Early Neolithic have been recognized. These show variability in evolved bladelet technology, and numerous grinding-stones are present throughout, although there are no ground stone axes or evidence of bifacial technique. Rare, but distinctive, ceramic wares occur and this pottery is some of the earliest found anywhere. Some of the ceramics resemble those of the Nilotic "Khartoum Tradition," such as the micaceous ware and the dotted wavy-line and comb-impressed motifs (Arkell 1949).

Most of the Early Neolithic is devoid of any surviving evidence of dwelling structures, which must have been light and easily portable or no more than windbreaks built of local scrub. The later Early Neolithic sites, however, cover a larger area and one of them is a large settlement with two parallel lines of dwelling-floors, hearths (sometimes stone-lined) and storage pits that have yielded plant-remains (including barley spikelets) and walk-in wells. Food-remains consist of hares, rodents and gazelle, all indicative of an arid habitat, but at most of these sites there are also a few bones of a large *Bos,* believed to be from domesticated rather than wild cattle. If so, then at about 9000 B.P. or earlier, these would be the oldest domestic cattle from Africa. However, the ascription, although quite acceptable, is open to question until further evidence is forthcoming. More certain is the evidence from the Middle and Late Neolithic settlements, with ovicaprid and *Bos* remains, and spikelets of emmer wheat as well as barley. The sites themselves are now quite large encampments. Microliths are much rarer and are replaced by denticulates and notched pieces. Ground stone axes, bifacial points and arrowheads make their appearance, together with new ceramic wares, although still with connections to the Khartoum Tradition of the Nile.

Wendorf and his colleagues make a very good case for the *Bos*'s having been domestic, used for their milk and, perhaps, blood. They suggest that the animals were brought seasonally into the basin, when rainfall and other factors ensured some year-round surface water and grazing, as is inferred for most of the wetter episodes of the Holocene. Convincing analogs are provided for this kind of seasonal occupation and occasional use of playas in the Western Desert by modern nomadic Bedouin in the Sudan and southern Egypt, both for raising crops and stock-herding (Wendorf and Schild 1980:271). Long journeys from the Nile Valley or the major oases (such as Dakhla and Kharga) might similarly be projected for Early Holocene use of the southern Western Desert basins. In this respect, the exotic faunal elements (a Red Sea cowry shell in a Middle Neolithic occupation) and the Nilotic, freshwater bivalves and fish vertebrae present throughout the Neolithic sequence may be direct evidence of Nilotic connections and of the expedient use of desert resources. In any case, the Neolithic playa-basin sites in the southern part of the Western Desert are a fine example of the growth of an incipient food-production economy, the main emphasis being on nomadic pastoralism.

The antiquity of the sequence in the Eastern Sahara and the probable early date for the domestication of cattle are perhaps strengthened by the close association with wild cattle to be seen at a number of Terminal Pleistocene sites along the Nile and the occasional, deliberate placing of horn-cores in burials there. A comparable early date of 9000–8000 B.P. for possible domestic cattle with an Early Neolithic occupation also comes from the Acacus Mountains in the Fezzan (Barich 1974).

These findings show the paramount importance of paleoenvironmental reconstruction for understanding prehistoric life-ways, especially where no modern analogs survive. They provide us, also, with an insight into the timetable, nature and economy of the recolonization of the Eastern Sahara, probably from the Nile Valley, after the Late Pleistocene hyperaridity. The very complete evidence recovered suggests to the investigators, as to this writer, that the Holocene Sahara was not an area of great innovation, since the livestock and ceramics are most likely to have come from elsewhere, but as "an area of adaptation, it is perhaps unsurpassed" (Wendorf *et al.* 1984:428). This adaptation by Epipaleolithic hunters, fishers and gatherers may not have been unlike that of the San hunter-gatherers in the Kalahari today, who are taking to herding and some agriculture when ecological or cultural pressures become too great and make it expedient to change from their traditional way of life (Brooks *et al.* 1984; Cashdan 1984; Hitchcock and Ebert 1984).

Wendorf's team returned to the Nile in 1978 and 1981–1984 to work at the very rich Late Paleolithic sites in the lower reaches of the Wadi Kubbaniya, on the west bank of the Nile just north of Aswan. (Their initial findings are published in Wendorf *et al.* 1980, and subsequent papers.) These occupations were probably seasonal, on the forward edges of aeolian dunes and in the floodplain silts. With the former were many grinding-stones (upper and lower) and some pestles and mortars. The occupations are dated between 19,000 and 14,000 B.P. during which period the flooded Nile would invade the lower part of the wadi to the foot of the dunes, leaving fish trapped in the interdunal ponds when the water receded. The sites occur in various microenvironmental settings and appear to have been occupied at different seasons. A range of economic activities is reflected, although the small-blade technology remains largely unchanged and there appear to be strong similarities between it and that of the Halfan assemblages.

It is for the evidence of seasonal activities and scheduling that the Wadi Kubbaniya sites are so important. Faunal and topographic features suggest that the dune sites were occupied in the autumn after the maximum flood and in the winter, while the sites on the floodplain were used in the late spring and early summer during the period of maximum dryness. These foragers were hunters, gatherers and fishers who may have dried and stored their fish. The numerous pieces of grinding equipment show the importance of ground plant-foods and provide some of the earliest and best evidence of grinding equipment from Pleistocene contexts.

At one time, carbonized remains of barley and wheat were thought also to be contemporary with the Late Pleistocene occupation and to suggest some form of incipient cultivation, or intentional conservation and harvesting. Subsequent meticulous examination, screening and re-examination of the dated material, however, have showed that these remains were intrusive and probably no earlier than about 5000 B.P. (Wendorf *et al.* 1984). It was only Wendorf's persistent investigations that showed conclusively that the cereals were intrusive, thus heading off a long and otherwise insoluble controversy. It is a measure of his commitment to scholarship that he continued to seek the truth when it would have been far easier, and ostensibly more rewarding, to have accepted the initial findings.

The record of the Combined Prehistoric Expedition, directed and master-minded by Fred Wendorf over the past 25 years, has provided insight as never before into human occupation and behavior along the Nile and in the Desert, enabling us to appreciate something of the evolving adaptive strategies used there by the prehistoric populations from the Upper Acheulean to the Late Neolithic. The innovative influence of the ecologically rich Nile Valley can now be reassessed, and the nature of the human response and reoccupation of the Desert that accompanied each climatic amelioration have now been more precisely documented. The way in which these behavioral adaptations have been set within the context of paleoclimatic change and the perception of the stresses these induced, made possible in part through the recovery of organic remains where none was thought to survive, are providing one of the most complete pictures of later Quaternary life-ways and economies from anywhere in the world. This is a record of carefully and competently planned and meticulously executed research—survey, excavation and laboratory analysis—directed by someone with the vision to perceive what is needed, where it can be obtained and how it might be interpreted.

It is also a record that is the outcome of close collaboration of teams of specialists from the First, Second and Third Worlds. The collaboration of friends of long standing, with common enthusiasms, interests and specialized expertise, has made these first 25 years of outstanding research in Northeast Africa some of the most rewarding in their results that can be found anywhere. Of course, much still remains to be done; those most aware of this are the investigators themselves. But a solid corpus of informatio now exists on which future research can build. I follow his research with the greates interest and wish Fred Wendorf and his associates continued success in the work tha lies ahead. African archaeology is already greatly in their debt.

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2

Unchanging Contrast? The Late Pleistocene Nile and Eastern Sahara

ROMUALD SCHILD

INTRODUCTION

The last two decades of research into Quaternary environmental changes in Africa have yielded a large body of new data that have considerably altered our understanding of the climatic interdependence of various geomorphic phenomena in that continent. Among the most interesting results are those dealing with Late Quaternary environmental changes in the Sahara, the Ethiopian highlands, the equatorial lake-basins and the Nile Valley. Since the sources of the Nile lie thousands of kilometers upstream from its desert section and since scarcely a drop of water falls for more than 2000 km of its course, the Nile is an excellent example of remote climatic control, exercised by the rains of equatorial and eastern Africa. Nevertheless, there were periods when the desert surrounding the Nile was not so arid as today and when local discharge along the course of the river made a significant contribution to its flow. This raises the possibility that the river might have behaved differently when not flowing through an arid desert and that these phenomena might be part of a more general, global climatic pattern. Hypotheses put forward relating to these problems will be briefly reviewed in the following sections.

THE NILE

It is a part of conventional wisdom that the Nile is a very old river, probably older than many European and North American rivers, since, after all, it flows in a very old structural system that was probably formed during the rifting of Africa and parts of which may date back to the Precambrian (Adamson 1982:221). This does not, however, necessitate that an integrated system of Ethiopian and equatorial drainage, like that of the modern Nile, should be equally old. The age of the integrated drainage-system has been a subject of speculation since the early 1920s (Blackenhorn 1921), but remains controversial.

There are two principal schools of thought in the literature. The first includes a number of scholars who would prefer to see a more or less integrated system, but certainly including the Blue Nile, dating back as far as the Tertiary (Adamson 1982; McDougall *et al.* 1975; Williams and Williams 1980). The second group believe that the integrated Nile is a very recent phenomenon, which is not older than the Upper Pleistocene and may even be rather late in the Upper Pleistocene (de Heinzelin 1968; Issawi 1983; Issawi and Hinnawi 1980; Issawi *et al.* 1978). Several scholars have taken an intermediate position and argue for some link between the desert Nile and the Ethiopian highlands by the Early Pleistocene (Butzer 1980a; Chumakov 1967:104) or the upper Early Pleistocene (the Prenile [Q_2] of Said [1975, 1981]).

To judge by the speed at which these problems are approaching resolution, it may well be several centuries before they actually arrive there. We have very little geomorphic, stratigraphic or chronological control of sediments in the Nile Valley earlier than the Late Pleistocene. The situation is a little more promising for good paleoclimatological and geomorphological records in the equatorial and Ethiopian catchment-areas of the modern Nile (Bishop 1978; Butzer 1971; Cohen 1981; Coppens *et al.* 1976). Nevertheless, the existence of a cohesive system, integrating the Ethiopian headwaters with the desert Nile before the upper Late Pleistocene, is unlikely to be demonstrated soon.

The prospects are somewhat better for an improved understanding of the interdependence of the main Nile, its catchment-areas and the desert during the Late Pleistocene, particularly the more recent parts of it. The climatic record is much more complete, and chronological control varies between poor and excellent. The available data are derived from work along the desert Nile, the Blue and White Niles, in the lake-basins of the Ethiopian highlands and equatorial Africa, the Western Desert of Egypt and the Chad basin.

Several groups have conducted work in the Nile Valley between the Second Cataract and the Fayum (Butzer 1980a; Butzer and Hansen 1968; Ginter *et al.* 1980; Irwin *et al.* 1968; Kozłowski 1983; Paulissen *et al.* 1985; Vermeersch 1978; Wendorf 1968; Wendorf and Schild 1976; Wendorf *et al.* 1980). Most of the data recovered pertain to the Late Pleistocene history of the desert Nile and, since almost all of them were associated with human occupations, they are chronologically very well controlled by radiocarbon dating or by archaeology, or both. In spite of this, there remains considerable diversity of opinion concerning the lithostratigraphy and behavior of the Nile, which is believed to have been fully integrated at that time with its modern Ethiopian and equatorial sources.

It has been suggested by several of the scholars noted above that the permanent link between the main Nile and its modern headwaters was not established before the Late Paleolithic. It has also been proposed that the bed of the Nile underwent a number of aggradations during the Late Pleistocene, apparently involving a higher river-discharge, -flow and -competency, presumably because of increased run-off in the headwaters; these aggradations were separated by recessions, or periods of reduced river-flow. It is apparent from lithostratigraphic data that, except on the eastern bank, the aggradations were coeval with extreme aridity in the Desert and that any lateral discharge was either of Holocene age or else preceded the earliest recorded Nilotic aggradation (Butzer and Hansen 1968:328–329).

There have been several versions of the chronology of these events, particularly since it became apparent that the Khormusan, which was associated with the earliest aggradation in Sudanese Nubia, is much older than originally thought and lies, in fact, beyond the range of conventional radiocarbon dating: it has a date of >41,490 B.P. (SMU.107) at Site 34D (Wendorf *et al.* 1979; compare also the dates for the Khormusan given by Irwin *et al.* 1968).

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Somewhat strained efforts to reconcile the inconsistencies between the proposed schemes have led to the construction of elaborate nomenclatures and of complex, and very local, stratigraphic sequences (Wendorf and Schild 1976:307–309). It is of greater significance, however, that recent work on the climates of the Ethiopian highlands and equatorial lake-basins and along the Blue and White Niles shows that this model for the behavior of the main Nile is not compatible with the climatic record. It is very unlikely that an aggradation and an apparent increase in the flow and competence of the desert Nile would coincide with the greatly reduced rainfall recorded in the headwaters and with extreme aridity in the surrounding desert. Instead, it is now evident that the aggradations of the river's bed, which actually coincided with a very low Mediterranean base-level, simply indicate an increased rate of deposition of sediment by an overloaded, braided and very seasonal stream (Schild and Wendorf 1980:45). Very similar models have been suggested by scholars working along the Blue and White Niles in central Sudan (Adamson 1982; Adamson *et al.* 1980, 1982).

The chronology and behavior of the main Nile have been further elucidated by the work of the Combined Prehistoric Expedition at the mouth of Wadi Kubbaniya. Wadi Kubbaniya is the northernmost wadi draining the western Kalabsha Plain and reaches the Nile Valley some 12 km north of Aswan. The Expedition's work there has yielded a large body of lithostratigraphic data concerning the two cycles of Nilotic alluviation identified, as well as 52 radiocarbon dates and eight thermoluminescence dates.

Wadi gravels and slope-washes always occur below the first traces of the earlier Nilotic alluviation. They never interfinger or are interbedded with the deposits of either alluviation, nor do they occur between them.

Deposition of the first series of Nilotic sediments and associated phytogenic dunes on the left bank of the wadi occurred in a bay cut into the Nubia Sandstone during earlier periods of wadi activity. On the right bank, however, the floodplain silts rest on a raised sandstone bench, which is covered by slope and wadi deposits. These silts are almost 5 m thick and have been altered since deposition by vertisol-related pedogenesis. Their top has been truncated by deflation and is covered by remnants of a post-aggradational dune.

In the fossil bay on the left bank, there are three layers of floodplain silts interbedded with three beds of phytogenic, aeolian dunes and reaching a total thickness of >8 m. The uppermost dune-bed has been truncated and is overlain by an aeolian sandsheet, which was sometimes washed and redeposited in the bay during the highest Nile floods. The sandsheet in its turn was truncated by deflation during the period of down-cutting that occurred between the two Nilotic alluviations (Figure 2.1).

The base of the sandsheet contains a number of small and poor lithic concentrations which are clearly Mousteroid in character (Site E-82-5), while Khormusan-like artifacts occur on the surface of the uppermost bed of phytogenic dunes and have been dropped from a higher level (Wendorf *et al.* 1986). Since the floodplain and aeolian deposits of this episode are clearly associated with late Middle Paleolithic material, it has been named the Middle Paleolithic Alluviation (Schild and Wendorf in press). The highest sediments of this alluviation reached an elevation of some 20 m above the modern floodplain, and there were several minor fluctuations in the level of the river-bed observable within the sequence.

In spite of the uncertainties associated with the thermoluminescence method of dating, some indication of the age of the Middle Paleolithic Alluviation is given by the eight dates measured on aeolian sediments within and postdating the alluviation. The dates extend almost from the base of the Middle Paleolithic Nilotic sequence to the dune on top of it and can be placed in the correct stratigraphic order as follows (Figure 2.1):

8. Post-Middle Paleolithic dune: 31,000 B.P. ± 8000 years (Gd.TL32);
7. Sandsheet: 89,000 B.P. ± 18,000 years (Gd.TL33);
6. Base of upper dune: 53,000 B.P. ± 8000 years (Gd.TL113);
5. 1 m below top of middle dune: 45,000 B.P. ± 7000 years (Gd.TL114);
4. 2 m below top of middle dune: 62,000 B.P. ± 10,000 years (Gd.TL115);
3. Base of middle dune: 66,000 B.P. ± 10,000 years (Gd.TL116);
2. Top of lower dune: 61,000 B.P. ± 9000 years (Gd.TL117);
1. Base of lower dune: 61,000 B.P. ± 9000 years (Gd.TL118).

The Middle Paleolithic Alluviation in Wadi Kubbaniya is most probably the same as de Heinzelin's (1968) Dibeira-Jer Formation, which contained the Middle Paleolithic, Aterian-related and Khormusan settlements between the First and Second Cataracts in Sudanese Nubia. The dates available from the Khormusan sites and those from Wadi Kubbaniya indicate that the Middle Paleolithic Alluviation in the Nile Valley began a little before 60,000 years ago and ended before 30,000 years ago, perhaps 40–45,000 years ago. A period of lowered discharge in the Blue and White Niles has a number of finite, but minimal, radiocarbon dates and two infinite dates of more than 40,000 B.P. on evaporites and allochthonous carbonate nodules (Adamson *et al.* 1982:172, 201). This lowered discharge may, therefore, have coincided with the Middle Paleolithic Alluviation of the main Nile.

The Middle Paleolithic Alluviation in Wadi Kubbaniya is separated from the succeeding alluviation by a down-cutting of the Nile, associated with a considerable lowering of the groundwater level and pronounced deflation. The second aggradation is associated with Late Paleolithic archaeology. The earliest recorded sediments of the Late Paleolithic Alluviation are about 12 m above the modern floodplain and the latest are 27–28 m above it. In Wadi Kubbaniya, the episode has been dated by more than 50 radiocarbon dates to 20,000–12,400 B.P. However, at about 20,000 B.P. the floodplain silts were already being deposited on top of the truncated Middle Paleolithic sediments at least 15 m above the modern floodplain, which clearly indicates that the beginning of the Late Paleolithic Alluviation was well before 20,000 B.P. There seem to be no radiocarbon dates associated with this episode which are older than about 20,000 B.P., except perhaps for the date of 25,700 B.P. +2500/–3700 (GXO.410) from the Halfan site of 6B32 in Sudanese Nubia (Irwin *et al.* 1968:16).

Almost nothing is known of the Nilotic sediments falling between the Middle Paleolithic Alluviation and 20,000 B.P. In this respect, the discovery of an apparently old, Late Paleolithic industry buried in Nilotic silts on the eastern bank at Shuwikhat, near Qena, is of the greatest interest (Paulissen *et al.* 1985). The industry seems to be typologically more archaic than both the Kubbaniyan and the Fakhurian. It was found buried in the upper part of the brown silts, at about 2–2.5 m above the modern floodplain. A disconformity separates the Shuwikhat brown silts from the overlying, fine slope deposits and from the younger floodplain silts, which have several radiocarbon dates ranging from about 13,400 B.P. to 12,100 B.P. (Paulissen *et al.* 1985:12). These younger silts are comparable in age to a late section of the Late Paleolithic sequence in Wadi Kubbaniya. The earlier Late Paleolithic(?) silts at Shuwikhat lie on top of fine Nile sands, which rest on slope and fan deposits containing redeposited Middle Paleolithic artifacts.

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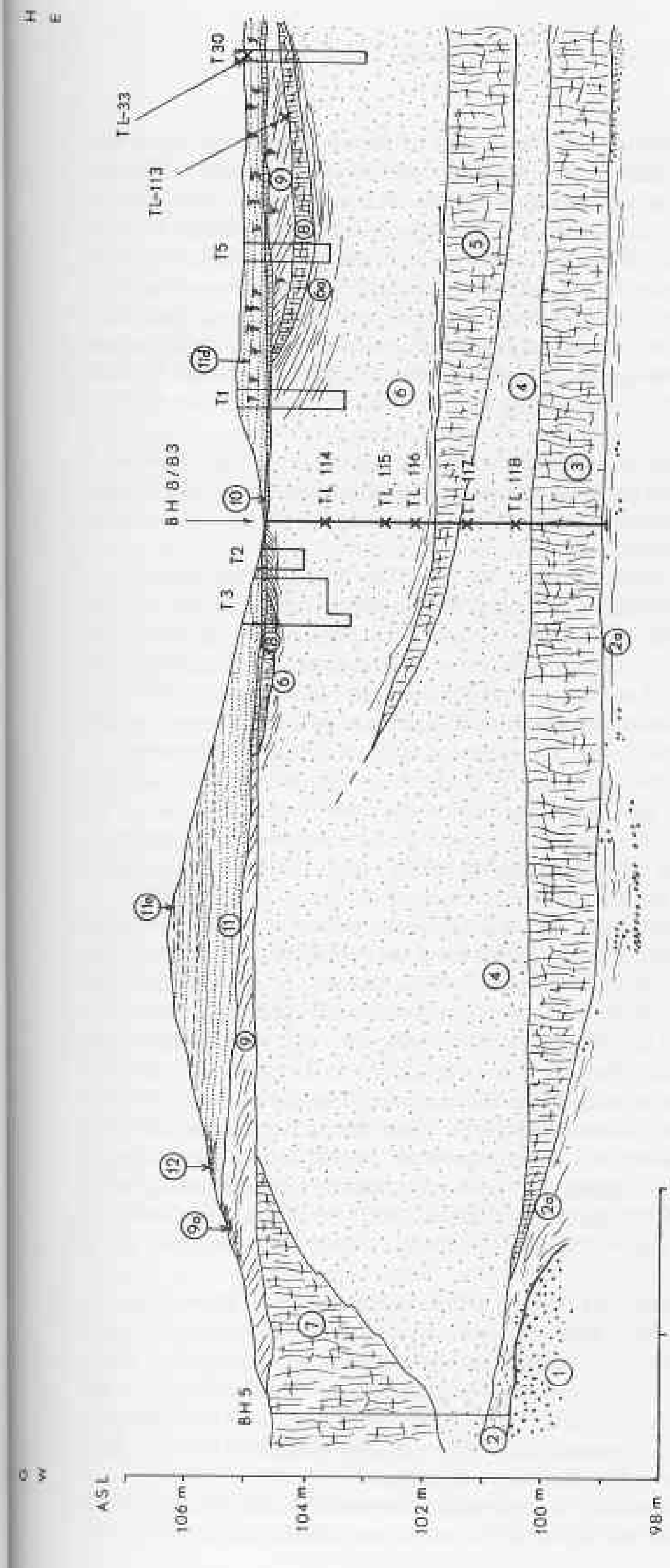

Figure 2.1 Eastern part of the Northern Section of Wadi Kubbaniya: the Middle Paleolithic Alluviation.

Key: 1. Nubia Sandstone.
2. Wadi and slope deposits.
3. Lower Basin Silt.
4. Lower Dune.
5. Middle Basin Silt.
6. Middle Dune.
6a. Beach zone of Middle Dune.
7. Floodplain Silt.
8. Upper Basin Silt.
9. Upper Dune.
9a. Duricrust.
10. Lower Stabilization Zone.
11. Sandsheet.
11d. Sandsheet with gley characteristics and vertical rhizo-concretions.
11e. Sandsheet with thin, platey duricrusts.
12. Upper Stabilization Zone.

Provenance of dated thermoluminescence indicated by TL numbers of Gliwice chronometric laboratory (Gd).

The Late Paleolithic deposition at the mouth of Wadi Kubbaniya essentially consists of large, phytogenic dune-fields interfingering with floodplain silts. Fluctuations in the rate of aggradation are marked by interdunal ponds, belts of calcified tree trunks and rhizoconcretions, and vertisols. The vertisols and calcified trees indicate stabilization of the valley floor, while expansion of the dunes, which resulted from the drowning of the tree-seedlings by floods, indicates a rising high-water level and a faster rate of floodplain deposition. At least nine phases of faster and slower floodplain accumulation can be recognized in the Late Paleolithic Alluviation in the wadi. Periods of faster accumulation of sediment occurred before about 19,500 B.P., at about 19,500–18,500 B.P., at about 18,000–17,800 B.P., at about 16,700 B.P. and at about 13,000–12,400 B.P.

The associated archaeology and radiocarbon dates show that the Late Paleolithic Alluviation in Wadi Kubbaniya was contemporaneous with the Ballana and Sahaba Formations of de Heinzelin (1968) and with the Darau Member of the Gebel Silsila Formation of Butzer and Hansen (1968).

Although there are differences between the two, the suites of minerals in the sediments of both Nilotic alluviations in Wadi Kubbaniya fall well within the range of variability of suites believed to be derived from the Ethiopian and equatorial catchment-areas (Shukri 1950, 1951). However, the indices of minerals in the sediments of the Middle and Late Paleolithic Alluviations show significantly lower amounts of iron than do those of deposits in the High Dam and Shelal areas, which Chumakov (1967:46) assigned to the Pliocene and Early to Middle Pleistocene.

Late in the aggradation, the dunes finally blocked the entrance of the wadi and seepage led to the formation of a large lake behind the dune-barrier. The fall of the water-table at the beginning of the Nile dissection resulted in the breaching of this dam. A radiocarbon date of about 12,400 B.P. (SMU.1032) from the base of the lake's recessional beach indicates the age of the beginning of the down-cutting phase.

There are several archaeological sites buried in the near-shore and floodplain deposits of the recessional Nile that succeeded the Late Paleolithic Alluviation. One of these is a late Isnan site (E71P5), near El Kilh, located on a recessional bar deposited in a channel cut into older and higher Late Paleolithic silts. *Unio* shells from this site gave a radiocarbon date of 11,560 B.P. ± 180 years (I.3760; Wendorf and Schild 1976:279). In the Arkin area, between the First and Second Cataracts, is a series of rich archaeological sites, which can be associated in sequence with the down-cutting Nile (Schild *et al.* 1968). Pretreated samples from the earliest of these, DIW-1, have yielded two radiocarbon dates in the region of 10,600 B.P. (Wendorf *et al.* 1979:221). From oldest to youngest, the remaining sites have the following radiocarbon ages: DIW-51, *ca.* 8900 years (SMU.582); DIW-53, *ca.* 7900 years (SMU.4); DIW-50, *ca.* 5900–5400 years (WSU.174, SMU.1, SMU.2) (Wendorf *et al.* 1979:220–221).

Although the Mediterranean base-level was then rising, Terminal Paleolithic and Early Neolithic sites in the Nile Valley, dating between about 12,500 and 6000 B.P., seem to have been associated with a competent and powerful down-cutting river. There were doubtless fluctuations in this overall pattern, but they are very difficult to see in the valley of the main Nile. Catfish Cave, in Egyptian Nubia (Wendt 1966), is unusually high (16 m) above the modern floodplain and may indicate a period of exceptionally high floods about 7000 years ago (7060 B.P. ± 120 years; Y.1646).

The Fayum depression, which lies in the desert to the west of Cairo, is today fed by Nile waters reaching the lake through the Hawara Channel and can, therefore, be

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expected to reflect changes in the amount of water discharged into the Mediterranean by the main Nile. Recent work in the depression has revealed a complex sequence of Holocene lake-deposits and associated archaeology. At least four lake maxima have been identified (Wendorf and Schild 1976:223), of which the youngest has been divided into two separate events (Ginter *et al.* 1980:131; Kozłowski 1983).

The chronology of the lake transgressions and regressions in the Fayum is based on only 23 radiocarbon dates; because of this and other limitations, the lithostratigraphic record is not complete. The oldest transgression, the Paleomoeris, is not dated, although it is known to be older than 9000 B.P. The second transgression, the Premoeris, reached its peak at about 8000 B.P. or slightly later. The highest transgression, the Protomoeris, probably reached its maximum a little before 7000 B.P. (Wendorf and Schild 1976:223). The Neolithic lake peaked at about 5800–5700 B.P., and the historic Moeris lake attained its highest levels about 3700 B.P. (Ginter *et al.* 1980:131; Kozłowski 1983:121). The Moeris lake, which reached *ca.* 24 m above sea-level, was almost as high as the Protomoeris lake and may reflect either the very high floods recorded for the years 1840–1775 B.P. (Ginter *et al.* 1980:156), or the work done on the Hawara Channel during the reign of Amenemhat III. The maximal stands of all the lakes in the Fayum depression were immediately followed by very pronounced regressions, indicating that these cycles were rather short. During some of the regressions, such as that which followed the peak of the Protomoeris lake in the seventh millennium B.P., the level of the lake fell by more than 15 m.

THE HEADWATERS

Research during the last two decades has also yielded a great deal of new evidence pertaining to the climatic records of the lake-basins in the Ethiopian highlands and equatorial Africa. Geomorphological and diatom studies have shown that there were dramatic changes in all of the lakes during the Late Pleistocene. Inevitably, there is some controversy about the synchroneity of particular phases of lake transgressions (Adamson 1982; Gasse 1980; Street and Grove 1979), and some of them may have been out of phase with others. Nevertheless, a number of trends are apparent, and some of the contradictory data may result from the low number of radiocarbon measurements and, more particularly, from the fact that most of the dates have been obtained on carbonates, which are very susceptible to secondary rejuvenation.

Lake-level fluctuations in the Ethiopian highlands and in equatorial Africa are as old as the lakes themselves (Butzer 1971; Cohen 1981). As always, the precision of climatic reconstruction is inversely proportional to its age, so that lake-level fluctuations of the early Middle and lower Late Pleistocene are much more poorly dated than are those of the upper Late Pleistocene. The variations in level of Lake Abhé, in the central Afar, are probably the best known for the earlier Late Pleistocene (Gasse 1977, 1980; Gasse *et al.* 1980). There were at least four transgressions between about 100,000(?) B.P. and 17,000 B.P., and low lake-levels can be seen between about 70,000(?) B.P. and 65,000(?) B.P. and between about 17,000 B.P. and 10,000 B.P. In the Ziway-Shala basin, on the other hand, there are only two poorly dated, Late Pleistocene transgressions: one before about 27,000 B.P. and another between about 26,000 B.P. and 22,000 B.P. (Street 1980a:143).

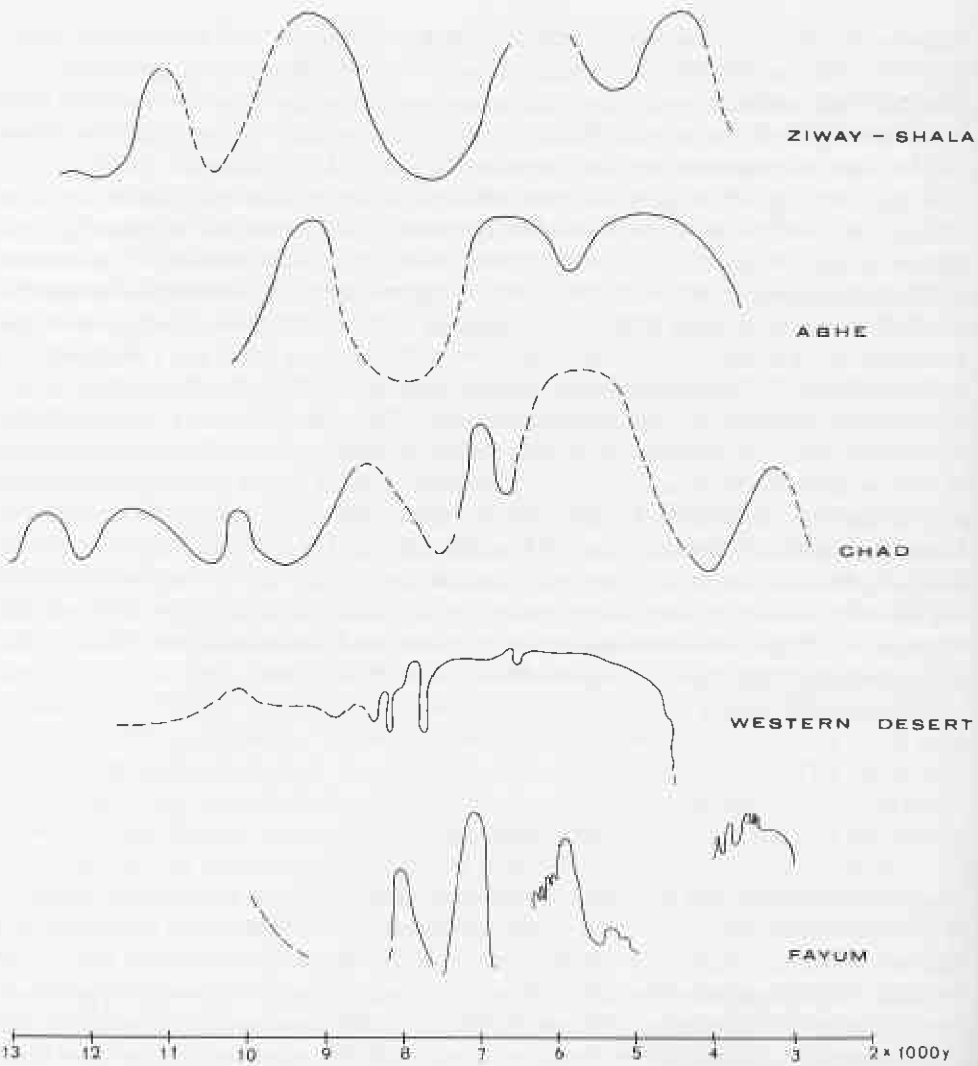
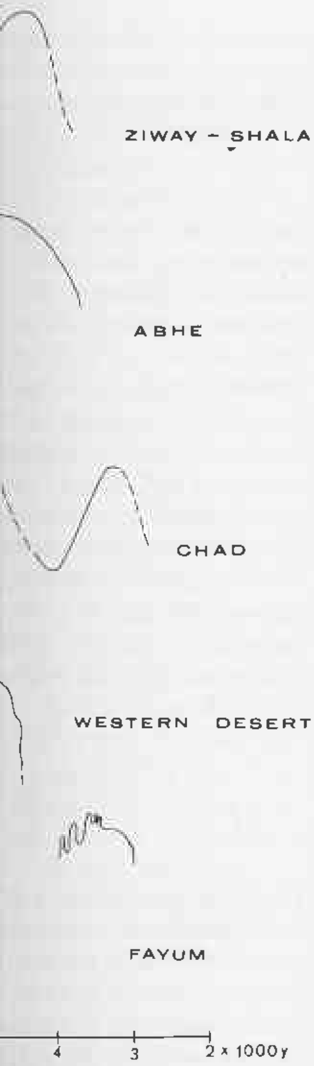


Figure 2.2 Approximate lake-level curves in Ethiopia and Chad and rainfall fluctuations in the Eastern Sahara, according to Gasse (1977, 1980), Ginter *et al.* (1980), Maley (1981), Schild and Wendorf (1984), Street (1980a, 1980b), Wendorf and Schild (1976). Not to scale.

Almost all of the Ethiopian and equatorial lakes that have been studied show a pronounced period of low water immediately before the Final Pleistocene-Early Holocene transgressions, which began between 12,500 and 10,000 B.P. As would be expected, there are several lake-level fluctuations within the Holocene (Butzer 1980b; Cohen 1981; Gasse 1980; Street 1980b), but the very limited radiocarbon dating of them means that they can be only very roughly compared with those of the Fayum or with the record in the Eastern Sahara (Figure 2.2). It is also virtually impossible to compare the Holocene fluctuations in lake-levels with the behavior of the Nile, since there is almost no record of the latter. However, the high Nile of Catfish Cave at about 7000 B.P., is known to have been contemporaneous with marked lake transgressions in the Ethiopian highlands and equatorial Africa.



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THE SAHARA

The Eastern Sahara (indeed, the whole Sahara) underwent dramatic changes of climate during the Pleistocene. The latest wet period in the Eastern Sahara is quite well dated (Schild and Wendorf 1984), but the chronology of the earlier ones is essentially speculative (Schild and Wendorf 1981; Wendorf and Schild 1980), although it has recently become apparent that the penultimate wet period is beyond the range of traditional radiocarbon dating (Wendorf and Schild 1980). The thermoluminescence dates for the Middle Paleolithic Alluviation in Wadi Kubbaniya suggest that run-off in the Eastern Sahara ended between 70,000 and 60,000 years ago, in which case, the penultimate period of aridity there should fall between about 60,000 B.P. and about 11,000 B.P., when the first rains of the last wet period began.

These estimates are in complete conflict with a series of radiocarbon dates from the central and western Sahara, which suggest the occurrence of a humid phase between 40,000 and 20,000 B.P. in the Chad basin (Pias 1970; Servant and Servant-Vildary 1972, 1980), the appearance of lakes in Erg Chech and the lowlands of Ahnet (Algerian Sahara) between about 34,000 and 10,000 B.P. (Conrad 1969:445–446), and the occurrence of intensive alluviation at about the same time in the Saoura basin (Conrad 1972). Similarly, the beginning of the wet period in the Tibesti has been dated as early as 16,000 B.P. (Flohn and Nicholson 1980; Hagedorn 1980; Jäkel 1980; Messerli *et al.* 1980), and radiocarbon dates on deep, fossil groundwater in the Sahara seem to indicate that a long, humid period began before 50,000 B.P. and ended just before 20,000 B.P. (Sonntag *et al.* 1980). The number and clustering of these radiocarbon dates would appear overwhelming, but one must remember that almost all of the sedimentary dates between 40,000 and 20,000 B.P. were measured on carbonates or on snail shells and must, therefore, be regarded as minimal. Also, the dates run on organic samples are often infinite, such as the I.1761 and I.7887 samples from the middle Saoura (Conrad 1969:445), and not enough is known about the inflow into deep-water reservoirs for the radiocarbon dating of water-samples from them to provide a basis for the chronology of wet periods in the Sahara.

In contrast with these radiocarbon dates is a series of age-determinations, based on ionium disequilibrium in *Cardium* shells, from the fossil lakes of the Wadi esh-Shati in the Fezzan, Libya (Petit-Maire 1982; Petit-Maire *et al.* 1980). Age-estimates derived from 21 shell samples suggest that there were considerable bodies of water in the depression between 170,000 and 120,000 B.P. (15 dates within one standard deviation of each other), at about 90,000 B.P., 80,000 B.P. and 40,000 B.P.

The penultimate humid period in the Eastern Sahara is clearly associated with the Middle Paleolithic Aterian technocomplex. Recent, and unpublished, work in the Bir Tarfawi basin has shown that there was a period of deflation between the formation of the light grey and of the olive-green silts (compare Wendorf and Schild 1980:37) at Site Bir Tarfawi 14 (BT-14), which indicates a brief, but pronounced, recession of the lake and the possible division of the Aterian humid period into two phases. In addition, recent stratigraphic work in the neighboring Bir Sahara basin has revealed an Aterian site (BS-13B) buried in the top of a dune overlying the freshwater limestones under which all of the sediments of Site BS-13A are buried (Schild and Wendorf 1981: Figure 27). This is the first time that the presence of a typical Aterian assemblage has been demonstrated above the lower lake in the Bir Sahara basin, and it now seems likely that there was an earlier Middle Paleolithic lake, or even two lakes, before the Aterian lakes. From the known complexity of the Holocene wet period in the Eastern Sahara, one may hypothesize that the earlier wet periods were of at least equal complexity. Since the Middle Paleolithic lakes of the region were associated with a much richer and wetter environment than occurred during the Holocene, it is likely that the penultimate wet period was, in fact, much more complex.

The work of the Combined Prehistoric Expedition in the Eastern Sahara indicates that the Middle Paleolithic lakes were preceded by several humid periods contemporaneous with the Acheulean technocomplex. Acheulean lakes and springs have been recorded in the Bir Sahara and Bir Tarfawi basins (Schild and Wendorf 1981; Wendorf and Schild 1980), and wadi and playa deposits at Dagdag Safsaf, an enclosed basin near Bir Safsaf, have yielded at least three typologically different Acheulean assemblages, ranging from perhaps a Middle or early Late Acheulean to a Final Acheulean. Acheulean sites also occur embedded in slope-washes and shallow runnels in the basin-fills of Wadi Arid in the southwestern part of the Western Desert of Egypt.

These Acheulean sites represent several periods of lake- and alluvium-development, resulting from episodes of local rainfall within a period of perhaps a million years. The chronological relationships between the Acheulean humid periods are impossible to ascertain on the simple basis of artifact typology, while only the youngest Acheulean episodes can be stratigraphically related at the moment.

In view of the Acheulean lake-developments recorded throughout much of the Sahara, the results of research on particle accumulation-rates in deep-sea cores from off the coast of northwestern Africa are very interesting. In particular, the accumulation-rate for quartz grains is believed to be a good indicator of the intensity of aeolian transport from the African continent. It has been correlated with the oxygen isotopic stages and shows depressions at about 60,000 B.P. at the base of Stage 3, at about 85,000 B.P. in Stage 5a, at nearly 100,000 B.P. in Stages 5b and 5c, and at about 125,000 B.P. in Stage 5e. The peaks in the quartz-grain accumulation-rate occur, in order of increasing age, in Stage 2 (the largest), near the top of Stage 4 and near the top of Stage 6 (Thiede *et al.* 1982).

The best-known humid period in the Eastern Sahara is, of course, the latest one, which began at about 11,000 B.P. in the Final Pleistocene and ended slightly before 4000 B.P. (Schild and Wendorf 1984). The evidence of more than fifty stratigraphically controlled radiocarbon dates indicates that there were three major wet fluctuations in the Eastern Sahara, called Playas I–III (Haynes 1980, 1982; Haynes *et al.* 1979; Schild and Wendorf 1984; Wendorf and Schild 1980), as well as several minor pulsations. Superb pollen-records from Selima Oasis in northern Sudan and from Oyo depression in northwestern Sudan (Ritchie *et al.* 1985) have permitted detailed evaluation of the climatic curves of the last humid period.

CONTRAST OR COVARIATION

Comparison of approximate Holocene lake-level curves from the Ethiopian highlands and equatorial Africa with the data from the Eastern Sahara (Figure 2.2) reveals considerable similarity in pulsations. Some parts are obviously out of phase, particularly in the Abhé, Ziway and Chad curves, but we do not know if this indicates real dissimilarities or if it results from the distributions of the rare radiocarbon dates. There is a remarkable correspondence between pulsations in Chad and in the Eastern Sahara, for which the chronological boundaries of the cycles coincide almost perfectly.

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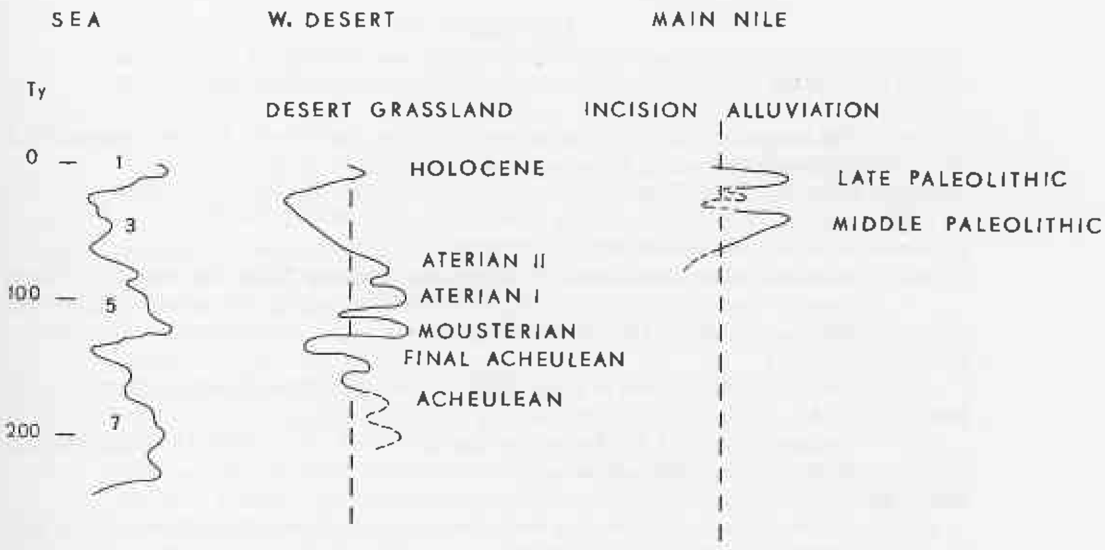

Figure 2.3 Hypothesized chronological correlation of oxygen-isotope stages, climatic pulsations in the Eastern Sahara and the behavior of the Nile.

There is also an astonishing degree of similarity between the Eastern Sahara curve and the fluctuations in the Fayum lake-levels. The few differences between the two in the dates of phases are less than one standard deviation of the relevant radiocarbon dates. The virtual identity of the two curves may indicate that local rainfall was the most important factor in the feeding of the Fayum lakes, which is also suggested by sedimentological studies there (Kozłowski 1983:119). We must, on the other hand, bear in mind the synchroneity of the high Nile witnessed at Catfish Cave with the peak of the Protomoeris transgression.

On a much larger scale and at the level of climatic cycles, it is apparent that the alluviations of the main Nile were contemporaneous with extreme aridity in the Desert, with glacial atmospheric circulation and with low rainfall over the Ethiopian highlands and equatorial Africa. The incisions of the river seem to have coincided with an interglacial, or major interstadial, circulation (Figure 2.3), although this tends to be masked by a delay in the replacement of climatic phenomena (such as in the movement of the inter-tropical convergence zone) or by variation in their intensity. The periods of down-cutting seem always to have begun while the Desert was still very arid, and, if the climatic cycle was of low amplitude, it was possible for the Desert to remain extremely arid throughout the down-cutting phase, as it did during the episode of down-cutting which separated the Middle and Late Paleolithic alluviations. It is believed, although it cannot be demonstrated with the data at hand, that the post-Middle Paleolithic down-cutting coincided with an increase in rainfall over the catchment-area of the Nile.

Today, the desert Nile and the Eastern Sahara appear to us as two very stable, but brutally different, environments, perhaps because they have entered an early phase of a new glacial cycle. This contrast, however, has never been immutable. The Nile and the Desert have seen periods when rain was an element common to both, and when the River was as generously fed by run-off from the surrounding deserts as by its headwaters.

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3

Earth, Man and Climate in the Egyptian Nile Valley During the Pleistocene

ETIENNE PAULISSEN
PIERRE M. VERMEERSCH

INTRODUCTION

Perhaps no valley in the world has received so much attention in the scientific literature as the lower part of the Nile Valley in Sudan and Egypt. Most reviews are based on a few original contributions containing an astonishing quantity of geological and archaeological observations, which were the outcome of research projects lasting several years. The work of Sandford (1934) and of Sandford and Arkell (1929, 1933, 1939) is now classic, but the publications resulting from the Nubian Salvage Campaigns (Butzer and Hansen 1968; Wendorf 1965, 1968a) are invaluable. There have also been smaller-scale studies of Nilotic prehistory, such as those of Bovier-Lapierre (1926) in Abbassia, of Vignard (1923) and of Smith (1966, 1967) in the Kom Ombo area, of Caton-Thompson (1946), of Debono (1973) near Luxor and of Vermeersch (1978) in Elkab (Figure 3.1).

The early 1980s were exceptionally rich in scholarly publications concerning the Nile Valley. These included reports on Wadi Kubbaniya (Wendorf *et al*. 1980, 1986), Williams and Faure's (1980) compendium of Quaternary environments and prehistoric occupations in the valley and in the Sahara, Said's magisterial work on the geological evolution of the Egyptian Nile (1981; see also Said 1975) and the alluvial history of the Blue and White Niles in central Sudan (Williams and Adamson 1982). These comprehensive accounts of the geological and geomorphological evolution of the Nile Valley might give the impression that the Nilotic sequences are well established for most periods in the past. Even the well-documented Late Pleistocene, however, has been the focus of considerable revision of general concepts both by the Combined Prehistoric Expedition (Wendorf and Schild 1976a; Wendorf *et al*. 1980) and also in the critical comments of other scholars (Butzer 1982; Hassan 1982).

The series of publications on Nilotic prehistory, which began with the Nubian Campaign, has radically altered our perception of the subject. Earlier researchers had believed that this was an isolated part of North Africa and remained outside the general current of evolution of lithic industries as known in Europe and southwestern Asia. Wendorf was able to conclude in 1968 that this whole concept of stagnation in the lithic

Figure 3.1 Map of Egypt.

sequence, which had supposedly evolved from a local Acheulean to Middle Paleolithic Levalloisian into Epi-Levalloisian and Sebilian flake industries, bore no relation to reality (1968b:1054). The Combined Prehistoric Expedition's subsequent work on the Late Paleolithic in particular has revealed a very dynamic complexity with enormous variability in technology and typology.

The Belgian Middle Egypt Prehistoric Project (B.M.E.P.P.) was begun in 1976 and still continues. Our research objective is a general study of prehistoric sites that are geologically *in situ* (that is, buried within or under other layers, but not necessarily in primary archaeological context), and our study area is between Qena and Asyut

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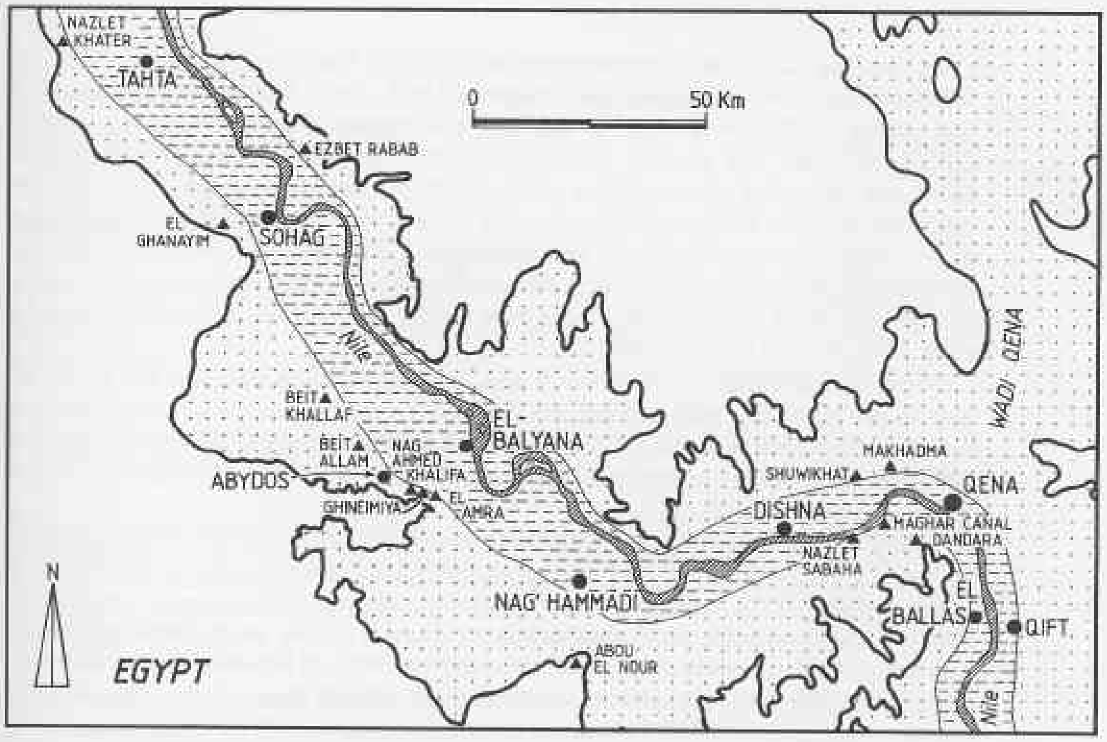

Figure 3.2 Locations of sites in the areas of Qena, Abydos and Sohag-Tahta.

(Figure 3.2), which was a direct extension of those parts of the valley most recently studied when we began. Considerable time has been invested in surveys to obtain a general impression of the area of study and to select the most appropriate sites for detailed excavation, so that as many artifacts as possible can be recovered in stratigraphic context. Thus far, we have excavated one Acheulean, five Middle Paleolithic and four Upper and Late Paleolithic sites. Detailed geomorphological and geological studies of the surrounding areas have revealed a very complex stratigraphy, which we have not been able to relate to the known Nile sequence. Nevertheless, the stratigraphic framework of these sites sheds new light on environmental and paleoclimatological models for the Nile Valley, and the results of the radiometric dating of the Upper Paleolithic sites were most unexpected (Paulissen *et al.* 1985; Vermeersch *et al.* 1982a, 1982b, 1984a, 1984c, in press b).

In this chapter, we will evaluate the detailed observations upon which more general concepts have been developed by several authors, and will add our own observations. Finally, we will develop conclusions and working hypotheses for further research in the Nile Valley.

STRATIGRAPHIC POSITION OF LOWER PALEOLITHIC ARTIFACTS

The human origin of the supposedly Pebble Culture artifacts recovered by Debono (1973) in local terraces near Luxor is questionable. Other stratigraphically very old artifacts are culturally non-specific.

Most of the Acheulean artifacts reported in the Nile Valley are derived surface fi (Chmielewski 1968; Guichard and Guichard 1965, 1968; Sandford 1934; Sandf and Arkell 1929, 1933, 1939), although the surface concentrations sample Sudanese Nubia did provide some information on the typological evolution handaxes. Since the classic studies of Sandford and Arkell, we have known that bottom of the Nile Valley was already quite close to its modern position in Acheule times. They reported "Chellean" and Acheulean artifacts within gravel deposits th described as Nile or wadi terraces at elevations of 30 m and 15 m (respectively) ab the modern floodplain throughout the Nile Valley, with an additional discontinu terrace at 22 m in Egyptian Nubia.

The basic observations of Sandford and Arkell have been elaborated in Nubia Butzer and Hansen (1968) and Butzer (1980). They introduced the following inform names for the alluvial gravel units with Acheulean artifacts: the Dakka stage (older) 30–35 m, with a valley margin pedimentation, and the Wadi Korosko stages (younge at 23–25 m and 12–15 m.

All these gravel deposits containing Late Acheulean are called the Abbassia grave by Said (1981), and were deposited during his Prenile/Neonile interval (Q_2/Q_3). It worth noting that the archaeological content of the deposits has not been restudied, s that their relation with the Acheulean is still based purely on the finds of Bovie Lapierre (1926) at Abbassia, near Cairo, and on those of Sandford and Arkell.

Butzer (1980:260) places the "Late Acheulean artifacts contained in a matrix of re gravels" (Kleindienst 1967:111) in the Adindan stage at 40–42 m, which predates th major paleosol in Nilotic Quaternary deposits (Butzer 1980:258).

The Qena Formation, as defined by Said (1981:51–58), represents deposits of the Middle Pleistocene Prenile (Q_2); the only datable elements included in this formatio were some late Acheulean implements in its top part (Said 1981:58).

It is unfortunate that we have no further details about the finds in these two olde deposits, since artifacts of such stratigraphic importance should be carefully documented. Experience has taught us that clear profiles are essential to distinguish between an *in situ* formation and overlying slope deposits reworked from the original material. In our own surveys, we have not found any artifacts *in situ* either in gravel deposits overlain by the major paleosol or in the Qena Formation. We believe that the Qena Formation is much older. In the Qena area, the inverted gravel deposits overlying the formation show heavily weathered soil profiles such as we have observed only in very old terrace deposits. The limestone cobbles within these gravels show clear solution phenomena with subsequent drop formation and *in situ* limestone redeposition.

Most Acheulean bifaces were found at the surface, but only a very few clusters of Acheulean artifacts were recovered *in situ*. These observations support the hypothesis, to which we subscribe, that the Late Acheulean sites occur within sediments associated with a wadi of relatively modern morphology (Wendorf and Schild 1980b:227).

The site of Arkin 8 (Chmielewski 1968:111) is indeed situated near the edge of the lower wadi terrace and is covered by 20–30 cm of wadi deposits. At Nag Ahmed Khalifa near Abydos, a cluster of locally derived Middle to Late Acheulean artifacts is situated within a weathered wadi fan (Figure 3.3) composed of gravels and cobbles, a few meters above the wadi bed and very close to, but 11 m above, the Nile floodplain (Vermeersch *et al.* 1977, 1979, 1980a). This site is covered by the red paleosol already noted at the top of the Late Acheulean levels by Said (1981) and classified by Butzer (1980) as a Haplargid.

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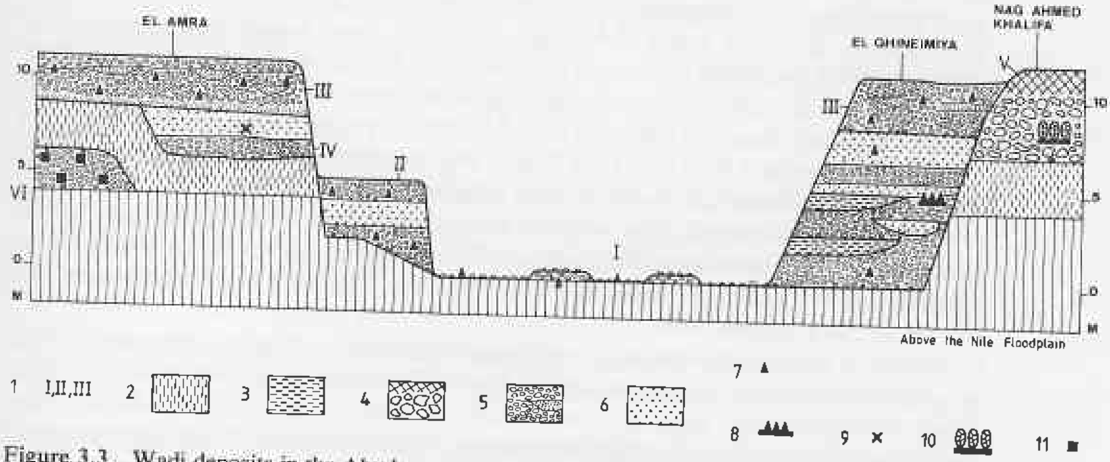

Figure 3.3 Wadi deposits in the Abydos area, as exemplified in Wadi Himeil. Key: 1, important wadi stages ordered from younger to older; 2, heavily weathered Nile silts occurring locally up to +23 m, attributed to the Dandara Formation; 3, Nile silts intercalated in a Middle Paleolithic wadi fan deposit; 4, very coarse wadi deposits with red soil on top, containing Nag Ahmed Khalifa Acheulean site; 5, wadi deposits, very gravely in a sandy matrix; 6, sandy wadi deposits; 7, derived Middle Paleolithic artifacts; 8, Middle Paleolithic site of El Ghineimiya; 9, Levallois point; 10, Acheulean site of Nag Ahmed Khalifa; 11, derived flakes in wadi deposits underlying Dandara silts.

The Dandara Formation is made up of a lower bed of grey, calcareous silt and an upper unit of brown weathered silt with thin limestone interbeds (Said 1981:112). Hassan (1976) has shown that this formation is the oldest known Nile deposit of Ethiopian origin. In the type-area, the Dandara silts can still be seen at 25 m above the modern floodplain (their top is estimated to be at +27 m). Their base is at +12 to +14 m and the silts overlie a unit of Nile cobble deposits with a thickness of at least 9 m. Near Ballas, we have observed a Nile gravel terrace with its top at 26–27 m and its base at 21–22 m above the modern floodplain, eroded into the Dandara Formation. There is a second, well-preserved terrace postdating the Dandara Formation in an old meander bend on the eastern bank, about 15 km downstream from Qena. The flat surface of the terrace is close to +20 m, but the base of the gravel is very irregular, consisting of a succession of different channels with uneven bases. No artifacts were recovered *in situ*, but derived slope deposits yielded one biface.

This observation is of the utmost importance, since it shows the intercalation of Ethiopian flood-silts of the Dandara Formation between older cobble terraces, many of the cobbles being of local origin, and younger gravel terraces, the gravels originating from the Red Sea Hills, Nubia and Sudan.

In the type-section at Dandara (Site E61O1), the truncated top of the Dandara silts is at +15 m (our measurements) and is covered by a wadi wash about 1 m thick with a red paleosol on top. The artifacts recovered from the red wadi deposits and overlying the Dandara Formation are interpreted as Late Acheulean with Levallois technology (Wendorf and Schild 1976a:95 and 1980b:227); a single core was found *in situ* within the silts. We also have studied the type-section and have found numerous Late Acheulean handaxes *in situ* within the wadi gravels, as well as flakes in the very top of the silts. During our 1984 survey, we found numerous handaxes throughout the Dandara area, but always in the slope deposits overlying the truncated Dandara Formation, or on top of older gravel terraces.

On the western bank of the Nile between Nag Hammadi and Tahta, we mapped several exposures of transgressive and heavily weathered Nile silts reaching elevations of +23 m. At El Amra, south of Abydos, these silts cover a wadi deposit with rolled artifacts, which precludes a Pliocene age; no *in situ* artifacts have been recovered from the silts. There is, however, clear morphological evidence that both the Dandara silts in the type area and these old Nile silts near Abydos are younger than the gravel terraces mentioned above and than the Qena Sands. We therefore tentatively correlate the old silts in the Nag Hammadi-Tahta stretch with the Dandara Formation.

At Nag Ahmed Khalifa, near Abydos, the gravel fan with a red paleosol, containing *in situ* Middle to Late Acheulean, is deposited in a wadi mouth eroded in the Dandara Formation. We conclude from this that the Nag Ahmed Khalifa Acheulean site postdates the Dandara silts.

In light of what is known about the high age of human presence in Africa and Europe, it is likely that human occupation of the Nile Valley is very old and could well be of Early Pleistocene age. Apart from some culturally non-specific flakes and cores from wadi deposits below the Dandara Formation, the earliest clear evidence for human presence in the Nile Valley postdates the Dandara Formation and can be attributed to a Middle or Late Acheulean industry.

MIDDLE PALEOLITHIC AND RELATED DEPOSITS

Hassan (1980) gives a good review of the Middle Paleolithic sites which have been studied along the Nubian Nile. Several groups have been defined on technological and typological grounds: the Nubian Mousterian, the Denticulate Mousterian (Marks 1968a) and the Nubian Middle Stone Age (Guichard and Guichard 1965, 1968). The sites give no evidence for clear stratigraphic superposition of the various industries, nor was there any other evidence which would permit a chronological seriation (Hassan 1980:428).

Wendorf and Schild (1976a, 1976b) have made important revisions to the chronology developed in Nubia, and these revisions have been supported by new radiocarbon dates (Wendorf *et al.* 1979). First, the Khormusan is considered to be a Middle Paleolithic industry on technological grounds, a point of view we fully share. In their evaluation of the Middle Paleolithic of Nubia, Wendorf and Schild (1976b) proposed a sequence, from older to younger, of Mousterian (Nubian Mousterian and Denticulate Mousterian), Aterian and Aterian-related industries, such as the Nubian Middle Paleolithic, and Khormusan. Second, the radiocarbon chronology for some prehistoric sites in Nubia has been revised drastically, especially in relation to the Khormusan, and a new absolute chronology has been proposed (Wendorf and Schild 1976a:238; Wendorf *et al.* 1979). It is now believed that the Khormusan is much older than was originally thought and lies beyond the range of conventional radiocarbon dating.

As far as we know, not a single Middle Paleolithic site was known *in situ* in the Egyptian Nile Valley downstream from Aswan before the work of the B.M.E.P.P. Derived artifacts, however, are quite common. Most are related to local deposits, and only a few occur in Nilotic deposits. The B.M.E.P.P. has located several *in situ* Middle Paleolithic sites and has thus far excavated five of them. Before discussing their general

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characteristics, we will first consider the geographical position of the surface sites and then the stratigraphic position of the main Middle Paleolithic sites and of the most important derived Middle Paleolithic artifacts.

SURFACE SITES

Our survey of the lower desert, mainly on the western bank, has shown that Middle Paleolithic artifacts can be found throughout the area, both scattered over wide surfaces and in many local terrace deposits. Unfortunately, sites with material in underived stratigraphic position are extremely rare. From this, we may conclude that Middle Paleolithic occupation was very extensive and important, but that most of the sites have been destroyed by erosion since their occupation. This erosion prevents any detailed study of site locations, but we have been able to collect some information about site distribution in the valley.

Accumulations of Middle Paleolithic material over large areas (>1000 m^2) could be observed on higher terraces and pediments, and on the edge of the limestone plateau bordering the valley. Some of them, like that at Abou el Nour (Vignard 1921), were already known, and others were discovered by us, such as El Ghanayim (ME76/16 and ME76/17) and Beit Khallaf (ME76/25). All of these sites are related to the exploitation of local chert; few real retouched tools were produced.

Comparable geographical situations, but not directly related to chert occurrences, have yielded smaller artifact concentrations, such as Site ME76/26 near Beit Khallaf. The number of artifacts is sometimes very low (<100 artifacts), but refitting is still possible. Other sites are larger and contain several thousand artifacts. These surface sites always lack small chips. The huge concentration of artifacts could imply that the original artifact scatter, as created by prehistoric man, has been largely preserved and that probably only the very small pieces have been removed by deflation. These sites are always in geomorphological situations that suggest they were located on good observation points. This may mean that they were related to hunting, and the scarcity of tools may indicate some specialized, short-term activity.

STRATIGRAPHIC POSITION OF *IN SITU* MIDDLE PALEOLITHIC SITES

Nubian Sites

The geological and archaeological results obtained by the Combined Prehistoric Expedition in Egyptian and Sudanese Nubia have been fully published by Wendorf (1965, 1968a), but it is mainly the geological work of the joint Yale University-Canadian National Museum group, in Egyptian Nubia and the Kom Ombo Plain, which has been published (Butzer and Hansen 1968). The geologists of both groups introduced their own lithostratigraphic sequences with different terminologies. However, the general frameworks of both systems were identical, and were based upon aggradations of Ethiopian flood-silts at different levels, separated by periods of Nile dissection. Even in the earliest publications of their results, nearly identical lithostratigraphic correlations (Figure 3.4) were proposed for most of the Late Pleistocene formations deduced (de Heinzelin 1967:324; Butzer and Hansen 1968:323–324).

Since all the Nubian Middle Paleolithic sites were excavated by the Combined Prehistoric Expedition, we will relate them to the lithostratigraphic column originally proposed by de Heinzelin. Apart from the Khormusan sites, only one site is in relation to Nilotic deposits.

Ikhtiariya Formation. Two prehistoric occurrences, Site 440 (Shiner 1968:636) and Site 34A (Marks 1968b:318), are reported to be related to the Ikhtiariya Formation in Sudanese Nubia. Site 440, in the Khor Musa, consists of a lower and an upper archaeological level (de Heinzelin 1968: Atlas Figure 15, Industries 6 and 7) in a sand unit, which is interpreted as aeolian in origin. The sand unit is part of the Ikhtiariya Formation and is covered by Nile silts (de Heinzelin 1968:46). According to Shiner (1968:636), the industry of Site 440 has some resemblances to the early Khormusan assemblages and affinities with the Denticulate Mousterian. Wendorf and Schild (1976a:237) classify the site as Denticulate Mousterian with an Aterian affiliation. The Khormusan Site 34A lies within the top of a large dune 30 m above the floodplain and is covered by fluviatile sands and silts. These dune sands are the type-section of the Ikhtiariya Formation.

Dibeira-Jer Formation with Khormusan. The Khormusan industry, of which several sites are *in situ*, seems to be limited to the Nubian Nile Valley. Marks states (1968b:321) that there is no Khormusan site beyond the limits of the Dibeira-Jer Formation, and that no Mousterian artifact was ever found within or directly under it. The Dibeira-Jer Formation was originally defined (de Heinzelin 1968:46) as a Nile aggradation with regular and rapidly accumulating silt layers and sand-bars up to about 156–157 m asl, or 34–35 m above the floodplain in the type area. It lies over the Ikhtiariya Formation and under the Ballana Formation; an important vertisol developed on its top.

Site 1017, the type-locality of the Khormusan (Marks 1968b:343–352), is considered to be a living-floor included within the Dibeira-Jer aggradational phase. A charcoal sample from this site was originally dated at 20,900 B.P. ± 280 years (WSU.203), but redated as >36,750 B.P. (SMU.245, after incomplete pretreatment; Wendorf *et al.* 1979). Another Khormusan site, 34D, is *in situ* near the top of the Dibeira-Jer at +28 m, and yielded a date of >41,490 B.P. (SMU.107; Wendorf *et al.* 1979).

Ballana Formation with Khormusan. A Khormusan site, ANW-3, has also been reported from the overlying Ballana Formation. At ANW-3 (Marks 1968b:320), Khormusan artifacts are reported on and in the formation, which is banked against a remnant of Dibeira-Jer silts. The site has a date on charcoal of 17,800 B.P. ± 500 years (WSU.215), which must be considered suspect; unfortunately, the sample was too small to be redated (Wendorf *et al.* 1979). The Khormusan Site 2004 is situated at +8 m, but it is not certain whether it belongs to the base of the Sahaba Formation or to the final phase of the Ballana Formation (Marks 1968b:321).

Comments on the Nubian Sites. The reassessments of the Nubian Middle Paleolithic have had major consequences on the presumed ages of some lithostratigraphic units established by de Heinzelin. The Dibeira-Jer aggradation, the underlying Ikhtiariya Formation and even part of the overlying Ballana Formation, which contains *in situ* Khormusan, should all date from before 40,000 B.P.

Both de Heinzelin and Butzer and Hansen correlated the Dibeira-Jer with the Masmas Formation (Figure 3.4), on the basis of their identical morphological position, nly one site is in relation

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de Heinzelin	Butzer and Hansen	
QADRUS Formation	GEBEL SILSILA FORMATION	(?) KIBDI Member
ARKIN Formation		(?) ARMINNA Member
BIRBET Recession		(Downcutting)
SAHABA Formation		DARAU Member
BALLANA Formation (Aeolian)	(Downcutting)	
DIBEIRA-JER Formation (ex-Khor Musa F)	MASMAS Formation	
IKHTIARIYA F. (Aeolian)	(Downcutting)	
	KOROSKO Formation	

Figure 3.4 Lithostratigraphical correlations for Late Pleistocene Nile deposits proposed by de Heinzelin (1967) and Butzer and Hansen (1967, 1968).

lithological field characteristics and the superposition of an important vertisol. No archaeological remains are known from the Masmas Formation. Two marl samples from Kom Ombo have radiocarbon dates of 18,300 B.P. ± 310 years (I.2060) and 17,100 B.P. ± 400 years (I.2178). (For discussion of these dates, see Butzer and Hansen 1968:496; it is important to note that only Sample I.2060 was taken *within* the Masmas Formation.) Because of the type of material dated, we consider these readings to be highly questionable, and the chronostratigraphic position of the Masmas Formation not to be established. This is something which has not been reconsidered in the literature since the real minimum age of the Khormusan became apparent.

Sites Studied by the B.M.E.P.P.

All the sites we will discuss here are in the lower desert on the western bank of the Nile, except for Makhadma-6 which is on the edge of Wadi Makhadma on the eastern bank. All wadi and slope evolution at these sites is the result of very local rains, so that the wadi evolution is complementary to that of the wadis on the eastern bank upstream from Qena (Butzer and Hansen 1968; Vermeersch 1978), where wadi discharge originates from rains falling in the Red Sea Hills. The lithic industry of these sites, which is being studied by P. Van Peer, can be generally described as having a predominantly Levallois technology. Tools are rare and are essentially restricted to a few denticulates.

Qena Area. Site Makhadma-6 is a rather well-preserved Middle Paleolithic site, 11 m above the Nile floodplain on the lower slope of Wadi Makhadma, some 12 km downstream from Qena. The Qena Sands are covered with 0.5-m thick slope-wash of coarse sands and gravels mixed with rolled Middle Paleolithic artifacts. At one spot, a small concentration of about 200 fresh artifacts was found within the top of the slopewash. Many of these artifacts could be refitted, but there were no chips. Stratigraphically, the site predates the deposition of the Shuwikhat silts (Paulissen *et al.* 1985).

A Middle Paleolithic, but otherwise undated, chert-exploitation site has recently been discovered at Nazlet Sahaba, downstream from Dandara (Vermeersch *et al.* in press a). No dated Middle Paleolithic Nile deposits are known in this area.

Abydos Area. The Abydos area yielded some *in situ* Middle Paleolithic material. The most important site is Beit Allam, 8 km north of Abydos (Vermeersch *et al.* 1978a). It is on a small, isolated surface, 1 m above the wadi floor and 8 m above the Nile floodplain. Layers of wadi material, with a total thickness of 0.5 m, disconformably overlie a core of very coarse sands and gravel of Nilotic origin. The rich archaeological material is embedded within the wadi deposits. There has been considerable erosional wadi activity since and probably during the occupation of the site. Chert cobbles were available in the nearby wadi bed at the time of occupation.

Numerous Middle Paleolithic artifacts have been recovered from all levels of a huge wadi-fan deposit at El Ghineimiya, 7 km south of Abydos (Vermeersch *et al.* 1980a). This deposit is separated from the modern floodplain by an 11-m scarp, which provides a large profile (Figure 3.3). Two silt layers of Nilotic origin, at 3 m and 5 m above the floodplain, interfinger with the wadi deposits. The matrix is predominantly of sand in the upper part, while the lower part of the fan deposit contains a larger amount of gravel. A cluster of very fresh artifacts was recovered from within the lower unit. Many of the artifacts could be refitted, indicating that they were nearly archaeologically *in situ*. The Middle Paleolithic occupation of the site is believed to have been contemporaneous with an important episode of wadi activity.

Sohag-Tahta Area. Nazlet Khater, some 12 km west of Tahta and close to the valley scarp, is very rich in Middle Paleolithic sites (Vermeersch *et al.* 1978a, 1978b, 1980b, 1982a). This is probably due to the presence of derived chert cobbles of good quality and to the protection of the sites from subsequent Nile erosion by a magnificent, protruding, limestone valley-cliff.

The Middle Paleolithic site of Nazlet Khater-1 lies on a small elevation adjacent to the edge of the cultivated zone. Nile sediments (gravels, silts and clays) form the core of this rise. The uppermost, Nilotic, gravel deposit, which is 5 m above the floodplain and partially covered by Nile silts, contains numerous (>100 per m^2) Middle Paleolithic artifacts. The upper part of the rise, consisting of local wadi-slope deposits, is also very rich in Middle Paleolithic artifacts (>600 per m^2), and both occurrences could be derived from the same site.

Nazlet Khater-2 has a stratigraphy similar to that of Nazlet Khater-1. The top of the Nilotic deposits, gravels and coarse sands is at about 10 m above the floodplain and some 10 m lower than the truncated top of the weathered Dandara silts. Limited areas of the locally derived gravels contained large quantities (>500 per m^2) of Middle Paleolithic artifacts. This attests to an important erosional activity with rapidly moving channels. Charcoal collected from one of these channels gave a date of >35,700 B.P. (GrN.10578).

Nazlet Khater-3 consists of an isolated rise at +4 m. The very dense concentration of material (up to 1200 pieces per m²) results from an accumulation of lithic material in a wadi channel and slope deposits. Part of the site was washed away by later wadi gullying.

The sites of Ezbet Rabab, some 12 km north of Sohag on the eastern bank, and of Rifa, 5 km south of Asyut, are in similar stratigraphic positions: in slope deposits covering a core of Nilotic deposits at elevations of +6 m and +4 m, respectively. At Ezbet Rabab, artifacts are probably also included in the upper part of the Nilotic gravel deposits, which are more than 8 m thick. These sites are rich in Middle Paleolithic artifacts but have not yet been excavated.

Wadi Kubbaniya Sites

Middle Paleolithic has been recorded at Sites E-78-11 (Singleton and Close 1980), E-82-4, E-82-5 and E-82-6a (Wendorf *et al.* 1986).

Site E-82-5 is the most important from a stratigraphic point of view. It was still slightly *in situ* in the surface of a Stabilization Zone, developed in the truncated top of the Upper Dune Sands (see below) and in the very base of the overlying aeolian Sandsheet. This Sandsheet, of which the lower part has been dated by thermoluminescence to 89,000 B.P. ± 18,000 years (Gd.TL33), completes the preserved portion of the first cycle of aggradation in the basin, which is termed the Middle Paleolithic Valley Filling Episode (Schild and Wendorf 1986). Schild (this volume) gives seven new thermoluminescence dates from below the Sandsheet. During this sequence, Nile silts, sands and intercalating aeolian deposits aggraded from at least 98 m to 110.5 m asl, or from 8 m to 20.5 m above the modern floodplain. No artifacts were found beneath the Sandsheet.

The lithostratigraphic sequence of this episode consists of an alternation of three (Lower, Middle and Upper) Silts with three Dune Sands (Lower, Middle and Upper) in the mouth of a tributary wadi, while areas close to the Nile received fine sands and silts. Typical floodplain silts and clays are the only sediments of this episode found farther inside the mouth of Wadi Kubbaniya.

A thin, but extensive, scatter of Khormusan-related artifacts (Site E-82-4) was found at about 105 m asl in lag position on the surface of the Middle Paleolithic floodplain silts. Elsewhere, dune deposits seem to postdate the highest Middle Paleolithic siltation. The base of these dune sands has been dated by thermoluminescence to 31,000 B.P. ± 8000 years (Gd.TL32) (Schild and Wendorf 1986). Schild and Wendorf believe that the Middle Paleolithic sequence at Wadi Kubbaniya postdates the last Late Pleistocene episode of local rainfall and resultant wadi activity.

DEPOSITS WITH DERIVED MIDDLE PALEOLITHIC ARTIFACTS

Derived Middle Paleolithic artifacts occur within pediment and wadi deposits of various ages. The geomorphological evolution shows that they cannot all be incorporated into a single event, so that the artifacts give only a *terminus postquem*. For completeness, we refer the reader to the Nilotic sequence and position of the Middle Paleolithic artifacts as described in the surveys of Sandford and Arkell and summarized by Caton-Thompson (1946:68).

Korosko Formation

The Korosko Formation (Butzer and Hansen 1968:87–96, 266–272) is described as a marly, sandy sediment, which is essentially fluvial in origin; mollusca are fairly common. According to de Heinzelin (1967:324), this formation is very patchy in the Wadi Halfa area, and we have not yet been able to recognize similar deposits downstream from Qena. There are no true archaeological sites within this formation, but Butzer and Hansen mention the presence of unpatinated, water-worn flakes of Middle Paleolithic type in the upper part of the formation at two localities at Wadi Or, Nubia. A sample taken from a marl within the lower half of the Korosko Formation in this wadi has a radiocarbon date of 27,200 B.P. ± 950 years (I.2061). The significance of this date is questionable, since the history of the marl is unknown.

Nag el Amra Section

In the profile of Nag El Amra mentioned above (Figure 3.3), one typical Levallois (Nubian) point has been collected from a unit of wadi deposits composed entirely of rubified sands (7.5YR 6/4). This deposit includes numerous shells of *Zootecus insularis*, lies over the presumed Dandara silts and is covered by a unit of coarser wadi bed with rolled Middle Paleolithic artifacts, similar to the nearby wadi deposits at El Ghineimiya. All of the younger wadi levels contain rolled Middle Paleolithic implements.

Makhadma Formation

The Makhadma site E61O4 (Wendorf and Schild 1976a:113–119) is designated by Said (1981:67) as the type-section of the Makhadma Formation. The Makhadma Formation is defined here as the lower slope-wash under the dark silts. This relatively thin slope-wash includes derived archaeological material of Middle Paleolithic tradition and is attributed to the wet Mousterian-Aterian interval (Said 1981:126). Subsequent research at the site, which was kindly assigned to us by F. Wendorf, has revealed, however, that the lower slope-wash also contains derived Middle and Upper Paleolithic artifacts and, in fact, represents a Late Paleolithic slope evolution (Paulissen *et al.* 1985; Vermeersch *et al.* in press b).

SOME CONSIDERATIONS ON MIDDLE PALEOLITHIC SITE FUNCTION

Activities at the Middle Paleolithic sites that have been studied seem to have been related mainly to the exploitation of chert. The chert occurs in the form of cobbles in coarse-grained Nile terraces, which, as in the Abydos region, are preserved banked up against the valley wall. The cobbles are often reworked as bedload in wadi deposits and as Nile deposits in the lower desert, like the cobble deposits near the modern Nile, along the Maghar Canal downstream from Dandara. At the time of occupation, almost all of

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the Middle Paleolithic sites were beyond the Nile floodplain (this assumes that the Nile was a silt-Nile) in what was then the lower desert and was eventually transformed into a dry savannah; sites were rarely very close to or in the floodplain itself (Nazlet Khater-1).

The Levallois or Nubian techniques, or both, are always present at these sites, and retouched tools are always rare; only denticulates are ever frequent. Furthermore, it is quite possible that many of the "tools" are the result of non-human activity, such as trampling, or the shrinking and expansion of clay. Even the isolated artifacts scattered throughout the lower desert are rarely retouched. Instead, what is always found is simple debitage (flakes and chips) and cores. In terms of the models currently favored in Southwest Asia and Europe, the Egyptian sites would be considered to be quarry and workshop sites, where domestic activities were only occasionally carried out. This implies that the lower desert was not very attractive for Middle Paleolithic man, and that hunting, gathering and domestic activities were done in what was then the floodplain, which is now destroyed by erosion or buried under more recent deposits. It also implies that most human activities were related to the Nile Valley and that the potential food-resources of the lower desert were probably not very rich, despite a somewhat wetter climate.

This situation appears to contrast with that of the Middle Paleolithic sites in Nubia, where the Nubian Mousterian and the Nubian Middle Paleolithic in particular are characterized by rather high numbers of sidescrapers. These high frequencies could, however, result from the bias of the "enriched collections" (Guichard and Guichard 1965:66). Moreover, even in Nubia most of the sites were quarries and workshops (Wendorf 1968b:1043–1044).

For Wendorf and Schild (1976b), the association of the Khormusan with riverine deposits is an indication that these occupations are of a different period from the Middle Paleolithic sites in the adjacent desert. However, these differences might also have been influenced by site function. The Khormusan sites could be domestic sites with an economy based primarily on hunting large animals of both savannah and Nilotic forms, plus some fishing (Gautier 1968). Unfortunately, such an economic orientation is not apparent in the lithic materials, especially the tools. Even though specific tools, such as burins, occur in the Khormusan, there are no sidescrapers, which are characteristic of Middle Paleolithic sites in Southwest Asia and Europe. The burins and the somewhat more typical denticulates may have had domestic functions, but this remains speculative.

As a whole, the lithic industry of the Egyptian Middle Paleolithic sites is characterized by the use of Levallois technology, with a predilection for the Nubian style of debitage. It appears, however, that some sites are characterized by Nubia Type I debitage (Guichard and Guichard 1965), whereas this technique is lacking at other sites and is replaced by a traditional Levallois technique. Some sites, such as Beit Allam, have both the Levallois technique and blade production (Vermeersch *et al.* 1978a). Van Peer (1986) has observed that the Nubian technique occurs in many Aterian assemblages beyond the Nile Valley, but only additional research will demonstrate if there is a relationship between this technique and the Aterian. Aterian artifacts are completely absent from our region, nor can Khormusan be recognized. Bifacial foliates occur in surface scatters of artifacts, mostly with handaxes, but we have never found them in our sites.

At present, therefore, we are unable to confirm the existence within the Middle Paleolithic of our region of the three major entities (Mousterian, Aterian and Khormusan) recognized by Wendorf and Schild (1976b).

LATE PLEISTOCENE DEPOSITS AND RELATED LATE PALEOLITHIC SITES

Even the simple enumeration and definition of the Late Pleistocene deposits of the Nile Valley is not easy. This is primarily due to the complexity of Nilotic evolution and to the sporadic evidence available for paleogeographical reconstruction. Consequently, several changes in interpretation and correlations of lithological units have been proposed in the literature. The complexity of the known Nile system continues to be regularly increased by new field observations (and by the revision of the Nubian radiocarbon chronology). We will therefore critically review the main results of earlier publications and then add the most important of our own observations.

NUBIAN VIEWS

This review is based on the general lithostratigraphic correlations established by de Heinzelin and Butzer and Hansen (Figure 3.4).

Dibeira-Jer and Masmas Formations

The Dibeira-Jer and the homologous Masmas Formations are defined as a Nile aggradation of regularly accumulating silt layers and sand-bars. Their total thickness exceeds 31 m in Nubia and 20 m (possibly 43 m) in the Kom Ombo Plain. Butzer and Hansen (1968:103) mention the occurrence of only three minor lenses of wadi wash in a 13-m vertical profile located in front of a wadi; both they and de Heinzelin mention an important vertisol at the top. No artifacts were found in the Masmas Formation but the Dibeira-Jer Formation contains Khormusan sites.

Ballana Formation

The Ballana Formation comprises local deposits of dune sands and wadi fans from a period of Nile recession (de Heinzelin 1967:323). Butzer does not mention any similar deposit. The prehistoric Site 8899 (Wendorf 1968c:807–822) is of the utmost importance; this site had two Sebilian levels within the Ballana Formation, although, unfortunately, no absolute dates are available. All of the Halfan sites, except Site 1020 which is on top of a Nile silt, are on top of a sand deposit, interpreted as a dune sand and classified into the Ballana Formation (Marks 1968c; Wendorf 1968c). From this, it is clear that the Ballana Formation is earlier than the occupation of the Halfan sites. Even for Site 8859 (at Ballana in Egypt), Wendorf (1968c:797) concluded that "the occupation of the site occurred at the time when the Ballana dune was being reworked. The deposition of the Ballana sand occurred well before 19,000 B.P." The stratigraphic positions of the three Ballanan sites (8956, 8957, 8863; Wendorf 1968c:831–832) are all quite similar: all are on the contact between the Ballana aeolian sand at the base and the overlying remnant of Sahaba silts.

Sahaba Formation and Darau Member

The Sahaba Formation and the Darau Member, with a thickness of >18 m, are widely distributed in Nubia. The Darau Member is the only part of the Gebel Silsila Formation occurring in the Kom Ombo Plain. The facies of this deposit is heterogeneous and consists of floodplain and bedload deposits, rich in fluviatile mollusca. The original publications give more than 20 radiocarbon dates, on charcoal and shells, related to the Sahaba Formation and the Darau Member (Butzer and Hansen 1968:114; Wendorf 1968c:941, Table 25). A reasonable estimate for the time-range of the aggradation is between 16,500 B.P. (Site 8905; WSU.315) and 12,000 B.P.

Arkin Formation

The Birbet Recession (Formation) of de Heinzelin was a short recession, with renewed encroachment of windblown sands, preceding the Arkin Formation. The Arkin Formation and the Arminna and Kibdi Members (Butzer 1980:268) represent an aggradation characterized by mainly overbank deposits: Nile silts and fine micaceous sands. De Heinzelin estimated that the Nile in Nubia fell to less than 8–9 m above the modern floodplain at about 11,000 B.P. The Arkin Formation attained its highest level, +13 m, at about 9500–9000 B.P. and receded in stages during the next five millennia.

COMMENTS ON THE NUBIAN VIEWS

All of the Nubian sequences are now drowned beneath Lake Nasser and the sequences and cultures mentioned above are the only evidence we will ever have of Late Pleistocene human occupation and geomorphological evolution along the Nubian Nile. No sites can be rechecked and no new information can be gathered.

Two of the most important results of the work in Nubia have been a complete revision of the geological history of the River Nile and the establishment of a framework for all later contributions. An important aspect of this geological framework is that two independent teams recognized comparable geological sequences in the Nile silts (Figure 3.4), consisting essentially of periods of silt aggradation separated by periods of Nile down-cutting. The sequences are based primarily on geomorphological and secondarily on lithostratigraphic criteria. From our own field evidence, however, we believe that uneroded Nile terraces are extremely rare and that most Nile deposits have lost their original morphology; most of the terrace deposits have been transformed by various processes into gentle sloping surfaces dipping towards the Nile. Although the basic Nilotic sequence is sound, several correlations of low-lying silt spurs and Nile gravel ridges are speculative. Archaeological sites and radiometric dates have contributed significantly to establishing correlations between terrace remnants.

The Nile sequence as established in Nubia must be seen as a simplification of the real evolution of the Nile. It is highly likely that every period of aggradation or down-cutting was composed of different phases, like those which can be seen in the evolution of the Nubian Nile during the last 12,000 years, since the aggradation of the Sahaba silts.

Butzer concentrated on wadi behavior and de Heinzelin on aeolian deposits. De Heinzelin's association of Nile down-cutting with the extension of aeolian deposits does not mean that there was no aeolian activity during periods of Nile aggradation. On the contrary, it is very likely that Nile aggradations were contemporaneous with the build-up of aeolian sands within the floodplain. This can be observed today at several places on the western edge of the floodplain, such as north of Asyut, and the invasion of such dune sands is, of course, determined by environmental conditions beyond and independent of the floodplain. Dune deposits within the floodplain are lithologically distinct, but it is doubtful that their extension during phases of Nile down-cutting was as important as de Heinzelin suggested. We believe that the lithostratigraphic characteristics of these aeolian formations and the number of associated radiometric dates are too scanty for them to be considered as real chronostratigraphic markers. The aeolian deposits are independent of the Nile and were laid down during Nile aggradations and recessions.

POST-NUBIAN VIEWS

After the Nubian Campaign, part of the Combined Prehistoric Expedition continued work in the Nile Valley downstream from Aswan towards Sohag in 1967 and 1968, and then in the Fayum in 1969. According to Wendorf and Schild (1975:127), this work must be regarded essentially as a preliminary reconnaissance to determine the potential of the Paleolithic materials; the project was terminated in late 1969 due to political events. We will discuss here only the most recent publications of this research (Wendorf and Schild 1975, 1976a), and especially those concerning the Late Pleistocene silt deposits, which Said (1975, 1981) attributes to the Neonile.

Wendorf and Schild's new interpretations of the silt deposits are based on two major areas: El Kilh, near Idfu, and a location just north of Isna. Local sequences established for each of these areas were compared on the basis of radiometric and archaeological data, and an informal terminology was drawn from those of both de Heinzelin and Butzer and Hansen (changing the original significance of the formational names). Wendorf and Schild (1975, 1976a) introduced two important events of silt aggradation for the Nile Valley: the Ballana-Masmas aggradation and the Sahaba-Darau aggradation, separated by the El Fakhuri Recession.

The Ballana-Masmas event is characterized by a silt aggradation accompanied by extensive migration of aeolian sands, and is dated between 19,000 and 17,000 B.P. (There are eight radiocarbon dates within this time-range on *Unio* shells from sites in the Idfu-Isna area.) There are problems in correlating the Idfu-Isna sequence with parts of the Dibeira-Jer in Nubia and with the Masmas Formation in the Kom Ombo Plain. This revision of stratigraphy is based only on reinterpretations of the Nubian observations (Sites 8859 and 2014). New correlations have been proposed without any firm lithostratigraphic evidence and with only the one radiometric date from Site 8859 (18,600 B.P. ± 550 years; WSU.318), itself a questionable date in light of the new Nubian chronology. The dates for the Dibeira-Jer are minimal and substantially older. There are no dates from within the Ballana Formation and only one questionable date on marl from within the Masmas Formation. According to Wendorf and Schild, the lower part of the Nubian Sahaba Formation and the Darau Member should also belong to the Ballana-Masmas aggradation.

The Sahaba-Darau event (Wendorf and Schild 1976a:273–303) is characterized by a silt aggradation and should correspond to the upper part of the Sahaba Formation in Nubia. It is dated from slightly before 14,000 B.P. to slightly after 12,000 B.P. Two new dates pertaining to the Sahaba-Darau aggradation are 12,500 B.P. ± 230 years (I.3424) on carbonaceous sand near the so-called burned layer within the dark silts at Kimbelat, near Qena, and 12,690 B.P. ± 240 years (I.3421) from a pond-sediment in the Isna area. The Sahaba-Darau aggradation was followed by a major recession of the Nile. The beginning of the recession is dated at Site E71P5 (El Kilh) to 11,560 B.P. ± 80 years (I.3760) and to 11,200 B.P. ± 285 years (I.531) at the base of the Arkin aggradation in Nubia (both on *Unio* shells). It is called the Birbet recession in Nubia and the Dishna-Ineiba Formation (Said 1981:73) in Upper Egypt.

Schild and Wendorf later suggested (1980:39–41) that all of the Late Paleolithic Nile sediments in the mouth of Wadi Kubbaniya (about 15 km north of Aswan) were deposited during a single Nile aggradation, in which numerous interfingerings of Nile silts, dunes and lacustrine sands could be observed. The radiocarbon dates indicate that the aggradation began shortly before 18,300 B.P. and lasted until about 12,000 B.P., which includes the entire time-span attributed to both the Ballana-Masmas and Sahaba-Darau aggradations as defined earlier (Wendorf and Schild 1976a). There are now 52 radiocarbon dates available from the numerous archaeological sites in the mouth of Wadi Kubbaniya (Wendorf *et al.* 1986; see also Close 1984), confirming a Late Paleolithic Alluviation (or "Valley Filling Episode" of Wendorf *et al.* 1986). The earliest recorded sediments of this episode, dating from about 20,500 B.P. (Site E-81-4) are at +12 m and the latest, dating from about 12,500 B.P. (Site E-81-5), are at *ca.* 27–28 m above the modern floodplain.

In his geological history of the Nile, Said (1981:61–80) groups all the silts of Ethiopian origin into the Neonile (Q_3). The Neonile deposits, structured silts with interfingering dune sands, were laid down during four aggradational episodes: the Dandara Formation (see above), the Masmas-Ballana Formation, the Sahaba-Darau Formation and the Arkin Formation. All Said's conclusions concerning these deposits are based on the studies mentioned above. He uses Masmas-Ballana and Sahaba-Darau Formations in the same sense as did Wendorf and Schild (1976a), and thus with the Deir el Fakhuri Formation related to the recessional interval between them. The dating of these events is also identical, except that the beginning of the Masmas-Ballana aggradation is estimated at about 30,000 B.P., while radiocarbon dates for its middle layers cluster between 21,000 and 17,000 B.P. (Said 1981:69).

Butzer's account of the Pleistocene geology of Egypt and Lower Nubia (1980) is based on his earlier work (Butzer and Hansen 1968) and no new observations are added. The terminology for the Nilotic events is the same as that in Figure 3.4. The correlations with the lithostratigraphic units of de Heinzelin are confirmed. The age of the Korosko Formation is estimated to be >32,000–27,000 B.P. for the upper member and >40,000 B.P. for the lower. The subsequent Masmas Formation falls between about 25,000 B.P. and 18,000 B.P. (based on radiocarbon dates on marl). Butzer reasserts the identity of the Masmas and Dibeira-Jer in Sudanese Nubia, without considering the new chronology for the Khormusan industry.

COMMENTS ON THE POST-NUBIAN VIEWS

From the evidence from Wadi Kubbaniya and the reassessment of the Masmas-Ballana and Sahaba-Darau aggradations by Schild and Wendorf (1980:39–41), it becomes clear that both units refer to a single aggradational event. We could wish that Wendorf and Schild (1976a) had introduced only informal local names for the events in the Isna-Idfu area. The new definitions of old names will be a source of confusion, especially since Said (1981) has used the names as formal lithostratigraphic units.

In fact, following the original Nubian concepts, both the Sahaba-Darau and the Masmas-Ballana aggradations can be classified with the Sahaba Formation of de Heinzelin or within the Darau Member of Butzer and Hansen. In spite of redefinition, we feel that the term "Sahaba-Darau aggradation" can still be used for the Nile silts deposited during one episode between about 20,000 and 12,000 B.P. The best solution in the long run, however, is to introduce a new name for this event and its related deposits, and to choose the name in relation to the most complete and best-dated section at Wadi Kubbaniya.

The last episode within this Sahaba-Darau event is extremely important. It is characterized by a thin suite of dark silts, found during the post-Nubian campaigns, which we have named the Sheikh Houssein silt at Makhadma (Paulissen *et al.* 1985; Vermeersch *et al.* in press b). It contains the "burned layer" as a key horizon and lies well above and outside the normal floodplain of the Sahaba-Darau aggradation. The Deir el Fakhuri Formation of Said can also be considered as a local deposit, which was not necessarily associated with a (minor) Nile recession. The important Nile recession after the Sahaba-Darau aggradation dates from about 12,000 to 11,000 B.P. and is followed by the various stages of the Arkin aggradation.

The use of the term Sahaba-Darau aggradation in its original Nubian sense means that the term Masmas-Ballana has no significance. Two deposits of different origin and from widely separated areas were put together without any firm lithostratigraphic or chronostratigraphic support for such a correlation. For the moment, we propose to retain the original local terms for the older silt deposits, namely the Dibeira-Jer Formation with Khormusan industry for Nubia and the Masmas Formation for the Kom Ombo Plain; correlations between them remain unproven. Elsewhere, it would be preferable to introduce other local names for Nile deposits which are older than 20,000 years or which are not dated.

UPPER PALEOLITHIC SITES OF THE B.M.E.P.P.

Sohag-Tahta Area

Our most important site is the early Upper Paleolithic site of Nazlet Khater-4, which has been dated to about 33,000 B.P. by nine radiocarbon dates on charcoal (Vermeersch *et al.* 1982b, 1984b, 1984c). The position of the site, at about 10 m above the modern floodplain, places it beyond the reach of all Nile influence both during its occupation and since then. The site is a typical chert-exploitation site, using simple mining-techniques (Figure 3.5). The tool-inventory is restricted and no Ouchtata blades were found. Some similarities exist between this material and the Dabban of Cyrenaica (McBurney 1967). We also discovered there a burial of a human skeleton, which we named the Nazlet Khater Man (Thoma 1984; Vermeersch *et al.* 1984a, 1984b, 1984c). Although he has not been dated directly, we believe for several reasons that he was a member of the cultural group who exploited the mines.

The trenches dug by the Upper Paleolithic groups were filled with rubble at the base and with aeolian sands in the upper part. The occurrence within this sand unit of an *in situ* hearth (32,100 B.P. ± 700 years; GrN.11,297) indicates that the site was still occupied during this stage. The later morphological evolution of the site consisted of the formation of a salt crust with desiccation wedges and the establishment of the overall gentle slope, dipping toward the Nile.

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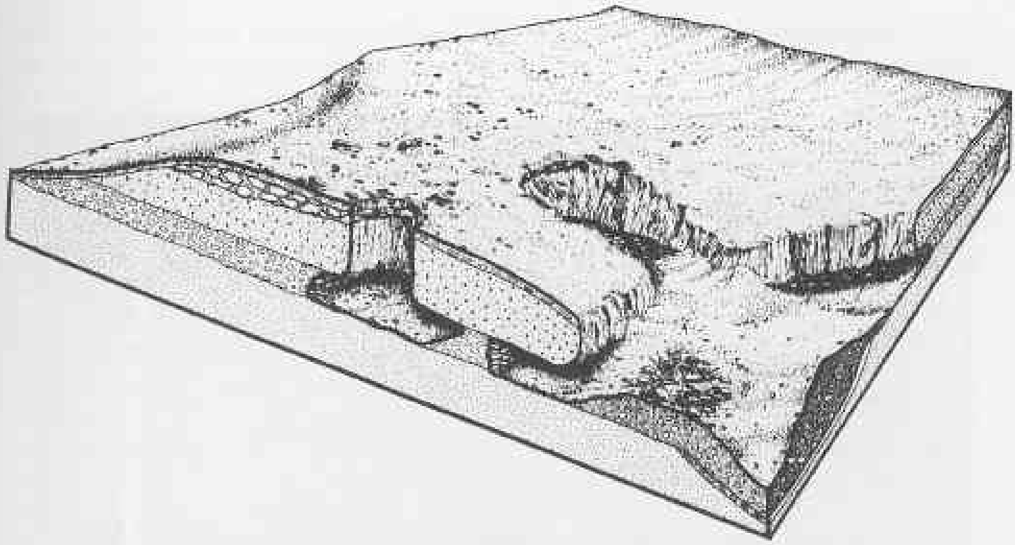

Figure 3.5 Reconstruction of chert-mining site of Nazlet Khater-4 (drawn by M. Van Meenen).

Qena Area

The *Shuwikhat Silts*, the top of which is about 4 m above the modern floodplain (Paulissen *et al.* 1985), form a continuous terrace in the Makhadma area, and are identical to the "dark-grayish-brown, sandy silt" underlying the Makhadma site of Wendorf and Schild (1976a:115). Even when situated in a wadi mouth, no wadi deposits were recognized within a thickness of about 6 m of these silts. On stratigraphic grounds, the Shuwikhat silts are older than the dark silts of Upper Egypt, which include various archaeological industries dating from about 21,000–20,000 B.P. onward (Wendorf and Schild 1976a, 1980a; Wendorf *et al.* 1986).

Shuwikhat-1, on the east bank some 14 km downstream from Qena, is an early Upper Paleolithic site within the Shuwikhat silts, which represent the former floodplain (Figure 3.6). Faunal remains are abundant; aurochs, hartebeest, gazelle and one fragment of catfish have been recognized. A thermoluminescence date of 24,700 B.P. ± 2500 years (OxTL.253) has been obtained on burned clay fragments buried in the silts. Technologically, the artifacts from this living-site are undoubtedly of Upper Paleolithic technique, but differ from the Upper Paleolithic materials recovered by the Combined Prehistoric Expedition, except, perhaps, for the non-Levallois Idfuan site of E71K9 (Wendorf and Schild 1976a). For the latter site, a thermoluminescence date of 21,590 B.P. ± 1520 years (Oxford Laboratory for Archaeology, 161-C-1) has been obtained, also on burned clays (Wendorf and Schild 1975:138). This date is consistent with a younger radiocarbon date on a calcareous root-cast from the base of pond sediments overlying the brown silts near Site E71K9 (Wendorf and Schild 1976a:84). This date of 16,830 B.P. ± 250 years (I.3420) must be regarded as minimal because of the material dated.

At Makhadma, four Upper Paleolithic sites occur in a similar position on the lower part of the eroding slope of the Qena Sands and overlying the Shuwikhat silts. Makhadma-2 and 4 have been excavated (Vermeersch 1983; Vermeersch *et al.* in press b) and are middens, comparable to the *escargotières* of the Maghreb but composed of

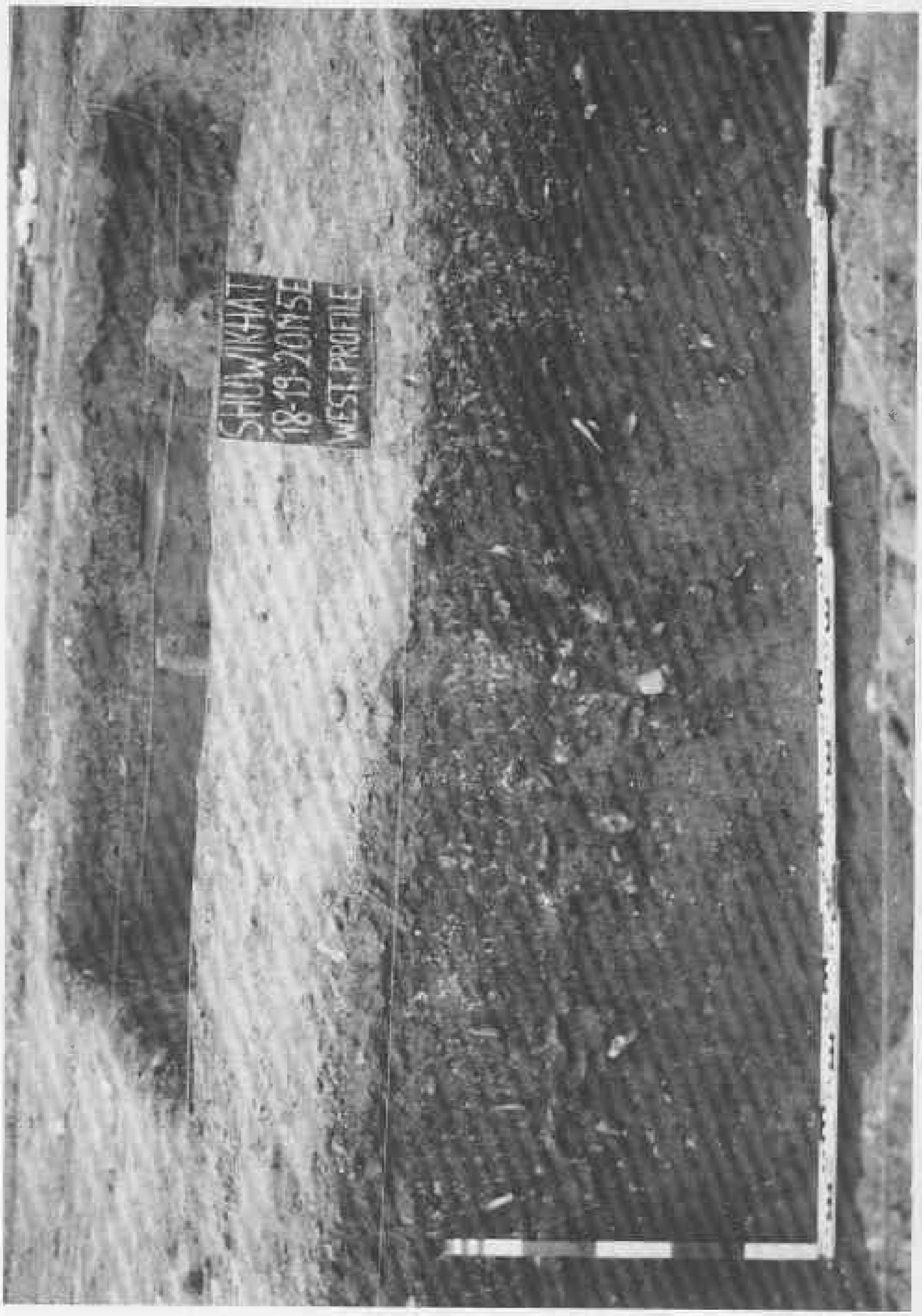

Figure 3.6 Early Upper Paleolithic site of Shuwikhat-1, just under a truncated fossil soil within Shuwikhat Silts.

fish-bone rather than snail-shells. Makhadma-2 and 4 are rare examples of sites where the occupation and the corresponding Nile deposits have been dated independently. The lithic material shows similarities to the Silsilian (Vermeersch *et al.* in press b), and we now have eight radiocarbon dates on charcoal, ranging from 13,400 to 12,100 B.P. The sites are related to the thin layer of dark Nile silts which we have locally named the Sheikh Houssein silts (see above). They were deposited during the "Wild Nile" stage (Adamson *et al.* 1980; Butzer 1980:272) when floods at Makhadma reached 6 m above the modern floodplain, the highest level recorded in this area apart from the Dandara silts. All the evidence from the Egyptian Nile Valley suggests that this catastrophic period was between about 13,000 and 12,000 B.P. It was noted above that the "burned layer" of Wendorf and Schild (1975:136; 1976a), an important marker horizon at about 12,500 years ago, is intercalated within the Sheikh Houssein silts. There are no wadi deposits within them. Landscape evolution was very limited during the interval between the Shuwikhat and Sheikh Houssein silts; subsequent wadi and slope evolution has been more important. A charcoal sample from a hearth *in situ* near the top of the sandy wadi deposits has a radiocarbon date of 6320 B.P. ± 75 years (Lv.1379). This date is very close to the end of this later, wetter episode.

LITHIC TRADITIONS OF THE UPPER PALEOLITHIC

Concerning the Origin of the Upper Paleolithic

In this section, we will not attempt to review the extreme richness of the Upper Paleolithic which has emerged from the work of the Combined Prehistoric Expedition. Such a review has been made by Roubet and el Hadidi (1981–82), who cite more than 20 prehistoric "cultures" for the last 20,000 years. We agree with them that it is not yet possible to place the complex Upper Paleolithic record of the Nile Valley in an orderly cultural and chronological perspective.

The surveys of the Combined Prehistoric Expedition did not locate any sites attributable to the early Upper Paleolithic period, before 20,000 years ago; such sites are extremely rare throughout northern Africa (Wendorf 1968b; Wendorf and Schild 1976b). This was unexpected, since it left apparent technological continuity between the Middle Paleolithic and the Levallois industries of the Late Paleolithic but a temporal hiatus of probably more than 20,000 years. This raises the question of what happened in Egypt during this long period, which in other regions, such as the Negev and Cyrenaica, coincides with the Middle to Upper Paleolithic transition.

At the site of Boker Tachtit, in the Negev, it is possible to follow a gradual transition from the essentially Levallois-oriented core-reduction in Level 1, dated to about 47,000 B.P., to the dominant single-platform blade technology in Level 4, dated to about 42,000 B.P. (Marks 1981), from which the Levallois method has disappeared (Hietala and Marks 1981). Both in Level 4 of Boker Tachtit and in the two earliest occupations at the site of Boker (Boker D, Levels 1 and 2), the core-reduction methods were Upper Paleolithic even though some of the secondary reduction techniques led to the production of points which are morphologically identical to Levallois points. Boker A, which can be dated to about 38,000 B.P. may be seen as the earliest classic Upper Paleolithic known in the Negev, and the earliest representative of the Ahmarian tradition (Gilead 1981), which also includes the Lagaman of northern Sinai (Bar Yosef and Phillips 1977).

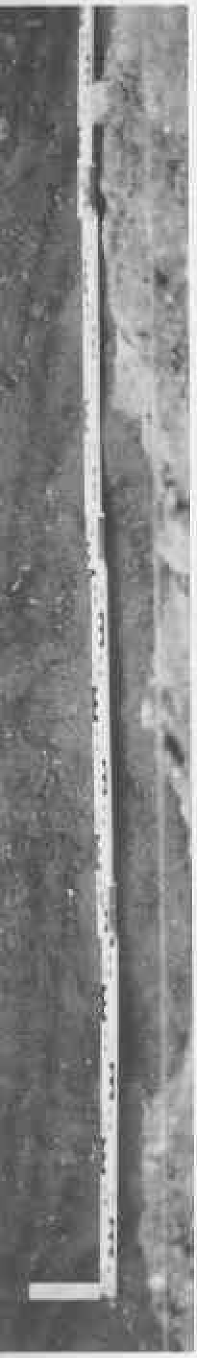

Figure 3.6 Early Upper Paleolithic site of Shuwikhat-1, just under a truncated fossil soil within Shuwikhat Silts.

The latest use of Levallois technology at the Haua Fteah is in Level XXV, which dates to about 42,000 B.P. (McBurney 1967:131).

There is no known lithic sequence in the Egyptian Nile Valley, which shows a transition from the Levallois technology of the Middle Paleolithic into an Upper Paleolithic blade technology. Only the sites of Nazlet Khater-4 (Vermeersch *et al.* 1982b, 1984a, 1984b, 1984c) and Shuwikhat-1 (Paulissen *et al.* 1985) fall within the 40,000–20,000 B.P. gap in the Egyptian prehistoric record. Even with these sites, the record remains poor, but neither has any use of the Levallois technique.

It seems anomalous that the Upper Paleolithic of the Egyptian Nile Valley on the one hand appears progressive and evolved (Roubet and el Hadidi 1981–82), but, on the other, the occurrence of the Levallois technique within it is archaic when compared with the circum-Mediterranean world. This anomaly is even more marked since the discovery of early Upper Paleolithic sites (Nazlet Khater-4 and Shuwikhat-1) with non-Levallois technologies.

Upper Paleolithic Sites with Levallois Technology?

Since the Levallois technique did not exist in the Upper Paleolithic of other parts of the circum-Mediterranean world, we will examine the sites where this technique was extensively utilized (ILty > 10). These sites are assigned to the Sebilian, the Idfuan and the Halfan, and we must consider if they really belong to the Upper Paleolithic, and how their ages are affected by the revision of the Nubian chronology (Wendorf *et al.* 1979).

Older Sebilian. The Sebilian, as defined by Vignard (1923), was divided into three chronological phases, of which the oldest is clearly of Levallois tradition. None of Vignard's sites has been well dated. Butzer and Hansen (1968:181 *et seq.*) emphasize that information on the stratigraphy of the sites is scanty and inconclusive. All well-documented sites in Sudan and Egypt discovered since Vignard most closely resemble his Lower Sebilian (Hassan and Wendorf 1974).

According to Marks (1968d), the Sudanese sites, with an ILty between 16.4 and 31.8, occurred in stratigraphic positions which exclude the possibility of an early Upper Paleolithic age. However, Marks was writing at a time when it was generally agreed that all younger silt deposits were contemporaneous with Late Paleolithic sites. Subsequent rethinking of the Khormusan and related deposits and the evidence that several Nile silt deposits were contemporaneous with Middle Paleolithic sites have led to important changes in these views. Most of the Sudanese sites were surface concentrations. According to Marks (1968d:483), Site 1042 rested on the deflated fluviatile sands of the Sahaba Formation, 12 m above the modern floodplain. However, no evidence has been presented to support the assumption that the sands belong to the Sahaba Formation; their height above the floodplain is not conclusive.

Only three sites, 1024A, 1024C and 2013, showed a minimum of deflation. Site 1024 was too far from the Nile to link it directly with Nile silts. Charcoal from two hearths gave dates of 10,925 B.P. ± 140 years (WSU.188) and 11,000 B.P. ± 120 years (WSU.144); even in 1968, Wendorf (1968c: 831) believed these dates to be too recent. Site 2013 rested on a sandstone outcrop just above the highest level of the Sahaba silts.

Farther north in Egyptian Nubia, Site 8899 (Wendorf 1968c:807) is of the utmost importance for determining the age of the Sebilian. The two Sebilian occupation horizons are stratified in sands that are correlated with the Ballana event, but, unfortunately, no absolute dates could be obtained from this site. At Site ANW-3 (Marks 1968b:318), Khormusan artifacts have been found in sands of the Ballana Formation. Charcoal from ANW-3 gave a date of 17,800 B.P. ± 500 years (WSU.215), but a revised age of more than 42,000 years for the Khormusan industry (Wendorf *et al.* 1979) would suggest that the sands at Site ANW-3 and Site 8899, as well as the Sebilian at the latter site, might be placed in an earlier time-range.

The sites on the Dishna Plain (Hassan 1972, 1974), such as E61M1, Area B, were almost completely destroyed by local salt-quarrying, and the artifacts were found in the back-dirt of the quarry-pits (Wendorf and Schild 1976a:133). The sites are related to artifacts found in a small trench, from just below the top of a silt to a depth of 25 cm; the silt is undated but is considered to be coeval with the final silts of the Sahaba Formation (Wendorf and Schild 1976a:148). Our own survey in the Dishna Plain was equally unsuccessful in dating the various silt deposits of this bend; we have, however, serious doubts about their presumed age of 15,000–12,000 B.P. (Connor and Marks 1986).

Neither Vignard's sites, nor the Nubian sites, nor those of the Dishna plain have been well dated.

Levallois Idfuan. According to Wendorf and Schild (1976a:243), the technological characteristics of the Idfuan industry suggest a clustering of the assemblages into two main groups, one containing a high frequency of the Levallois technique and the other entirely lacking in Levallois. Three sites, E71P1, E71K8 and E71K10, are representative of the Levallois group, of which only one, E71P1 with an ILty of about 15, has been studied in some detail. Most of the collected material came from the surface, but trenches revealed artifacts *in situ* within a very loose, friable, sandy silt unit and the underlying, soft, slightly consolidated silt.

Five radiocarbon dates of about 17,500 B.P. have been obtained from *Unio* shells from Site E71P1, although the association of the shells with the industry is not well established. Moreover, according to Mook and Waterbolk (1985:25), the dating of freshwater shells is rather unreliable. We would therefore prefer to await the results of new research at these sites before accepting an age of 17,500 B.P. for an industry with such a high ILty.

Halfan Stage II. The age and the homogeneity of some Halfan sites are questionable. In the original publication of the Halfan (Marks 1968c:365), five evolutionary stages were defined, the first of which was hypothetical. Levallois debitage is never important and is confined to Marks' second stage. The manufacture of Levallois-related Halfa flakes was also important in the second stage but became less common in the later stages. In general, Levallois technology was much less important in the Halfan than in the Older Sebilian and the Levallois Idfuan. According to Marks, the Late Khormusan and Stage II of the Halfan were broadly contemporaneous; however, this opinion was based upon the then-available radiocarbon dates from the Washington State University laboratory and these appear to have been unreliable for the Nubian sites (Wendorf *et al.* 1979).

DISCUSSION

From this review, we conclude that the data presented in the site-reports do not conclusively demonstrate that the sites are of the ages originally suggested for them. We must also stress, however, that neither is there absolute proof of an older age for any one of the sites reviewed here. It is our opinion that extensive use of Levallois technology by Upper Paleolithic groups in the Egyptian Nile Valley has yet to be demonstrated; in this, we differ from the scholars who actually investigated the sites discussed. All recent work has tended to show that sites are older than had been thought and, supported by this general trend, we suspect that all of the Levallois-rich sites—the Older Sebilian, the Levallois Idfuan and Stage II of the Halfan—are, indeed, much older than was thought.

The scattered data now available from the Nile Valley downstream from Aswan show that there was a fully developed blade technology current at about 33,000 (Nazlet Khater-4), at 25,000 (Shuwikhat-1) and at 20,000 years ago (Early Kubbaniyan, or Fakhurian-related). None of these sites has any evidence of Levallois technology.

The Levallois technique is occasionally, but clearly, attested in the Kubbaniyan from about 18,000 B.P. on (A. E. Close *in litt.* 1986), and this may also be true of other Upper Paleolithic groups. The impact of the technique was very modest, but it poses the question of how this reappearance is to be interpreted. A first hypothesis would be that Kubbaniyan groups reinvented the Levallois technique for some special purpose; such a hypothesized reinvention is, properly, not fashionable in archaeological models. Alternatively, the reappearance could be viewed as intrusive. Since there is no Levallois technology known in the Upper Paleolithic of regions to the north, east and west of the Nile Valley, the south would seem to be the only possible source. In fact, the Levallois technique appears to have continued well into the Upper Paleolithic in parts of East Africa, as, for example, at the site of Kalambo Falls (Clark 1974). This hypothesis would imply that such southern groups had some influence on the Upper Paleolithic of the Nile Valley after 18,000 B.P.

A similar hypothesis might also be proposed for the Sebilian. If additional dates were to show that the Older Sebilian was indeed late, then the problem would arise that its technology simply does not fit into the local development of Upper Paleolithic industries in the Egyptian Nile Valley. In that case, it might well be regarded as an intrusive phenomenon (Marks 1975) that could have come only from the south. In the present state of knowledge, however, and in the absence of any real indications to the contrary, we would prefer to align the Older Sebilian with the late Middle Paleolithic of Egypt, in accordance with its technology, thus reintroducing Caton-Thompson's (1946:117) suggested age for Sebilian I.

The chronological positions of the Levallois Idfuan and of Halfan Stage II in the Egyptian Nile Valley are difficult to ascertain. Technologically and typologically, these industries might best be placed in the Middle-Upper Paleolithic border-zone, and we would suggest an age of about 40,000–30,000 years for them. Later stages of the Halfan tradition appear to have lingered on in the Nile Valley in Nubia, from where they might have influenced the Kubbaniyan; these stages appear to be absent, however, from the Egyptian Nile Valley.

If, on the basis of their technology, some sites of the Older Sebilian, the Levallois Idfuan and the Halfan Stage II are to be viewed as Middle Paleolithic, then we must consider their relationship to the traditional Middle Paleolithic. According to Wendorf (1968b:1048), the Khormusan, Sebilian and Halfan were primarily based on the hunting of large savannah mammals; Khormusan and Halfan sites also have indications of the hunting of Nilotic mammals and of some fishing. The economy of the Idfuan sites is less well known since the fauna was poorly preserved (Gautier 1976). Geomorphologically, these sites are more closely related to the Nile floodplain than are the traditional Middle Paleolithic sites. As was argued above for the Khormusan, some of them could be regarded as more domestically oriented sites, since, in addition to the

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We believe that the Middle Paleolithic of the lower Nile Valley was very complex. It covered a long period of time, and included different technological traditions and different facies, developing in response to environmental factors. It comprises sites which have been attributed to the following industries: Nubian Mousterian, Denticulate Mousterian, Nubian Middle Paleolithic, Khormusan, Aterian, Older Sebilian, Levallois Idfuan and probably some sites attributed to the Halfan. We do not yet understand the chronological or cultural position of these different traditions in the Egyptian Nile Valley.

PALEOCLIMATIC RECONSTRUCTION IN UPPER EGYPT: AN ESSAY

The available data on which to base a paleoclimatic reconstruction are of uneven quality and usually poorly calibrated. There are no palynological records, and most interpretations rest on the study of alluvial and colluvial deposits, many of them dated only by the archaeological remains they include. Paleoclimatic reconstruction is not equal for all periods; the later ones appear to be much more complex than the earlier, although the actual complexity of the earlier periods was probably at least as great.

Our reconstruction will be limited to a climatological evaluation of water as a geomorphic agent, but there are still important difficulties. First, in any paleoenvironmental reconstruction, non-climatic factors must be considered before drawing conclusions about the paleoclimate. As Rognon (1980) has shown for arid regions, the water available at a site is not only a function of rainfall, but is determined by a number of non-climatic factors. Second, high run-off peaks in response to high, but short-term, precipitation are very characteristic of arid conditions. It is very difficult to decide whether a deposit is related to a few events of high magnitude or to a longer period of steady development. Third, the Nile has a very large catchment, and Nile aggradation and down-cutting are not necessarily related to climatic events in Upper Egypt. Local climatic events are better reflected in wadi behavior, slope evolution and soil-types. The fluviatile deposits we have chosen for this paleoclimatic reconstruction are all of very local origin, so that the processes they represent originated from local rains. All generalizations put forward in this section should therefore be viewed only as working hypotheses.

The paleoclimate of the Nile Valley has been reviewed by Butzer (1980), who states that deposits associated with Early and Middle Paleolithic artifacts indicate an essentially semi-arid climate, while the climate was usually hyperarid during the Late Paleolithic. Said (1981:95) introduced new names for the five pluvials he recognized in the Quaternary of southern Egypt, which remained, nevertheless, mostly arid.

Lower Paleolithic Climatic Fluctuations

Since none of the Acheulean sites is archaeologically *in situ*, we must emphasize that all paleoenvironmental and paleoclimatological hypotheses concerning the Acheulean are based on the assumption that there was only a limited period of time between the occupation of a site and its subsequent erosion.

Said (1981:95) has introduced the term "Abbassia Pluvial" for a Middle Pleistocene pluvial which led to the deposition of polygenetic gravels. Butzer (1980) characterized the same period as semi-arid. Nearly all deposits and paleosols in the Nile Valley indicate wetter climatic conditions, although evidence from the Eastern Sahara (Wendorf and Schild 1980b:227) suggests that the Late Acheulean climate was very complex and included more than one period of moister climate and intervening semi-arid and arid phases. The Early and Middle Paleolithic sequence at Bir Sahara-Bir Tarfawi (Wendorf *et al.* 1977; Wendorf and Schild 1980b), about 300 km west-northwest of Abu Simbel, can be usefully considered in relation to the Nile Valley.

Two different lacustrine sediments and subsequent spring-mounds, underneath Middle Paleolithic levels, are considered as clear evidence for wetter phases in the Eastern Sahara; they are dated to the Acheulean by the association of the sediments with Late Acheulean artifacts. On the basis of the Bir Sahara-Bir Tarfawi sequence, Wendorf and Schild (1980b:225–226) concluded that there were three moister episodes during the Acheulean, separated by two minor episodes of aridity. It is not possible to correlate the Bir Sahara-Bir Tarfawi data with those of the Nile Valley.

Beneath the Dandara silts south of Qena are Nile cobble deposits at least 6 m thick and with their top at +12 to +14 m. They are very rich in chert cobbles derived from the limestone cliffs, and probably represent one of the most recent bedload deposits of the very competent Nile which we know from the older cobble terraces. This first stage, of a very competent, bedload Nile depositing cobbles, is succeeded, as we saw above, by a suspended-load Nile aggrading the Dandara Formation (Stage 2) and then by a bedload Nile (Stage 3) depositing gravels—a finer bedload material than in Stage 1. The only possible explanation for these enormous changes in the behavior of the Nile is that they were related to climatic changes. We are tempted to correlate the changes in the bedload competence of the Nile with the long-term, mid-Brunhes changes in global climate, which were superimposed on the glacial and interglacial cycles at about 0.4–0.3 mya (Jansen *et al.* 1986). All the available, well-documented marine and continental records from a wide range of latitudes at this period indicate a more northerly position for the early Brunhes oceanic fronts, coincident with intensified atmospheric and ocean-surface circulation in the southern hemisphere. This is a climatic pattern that has never been repeated.

Our interpretation of the global, lithological units of the River Nile is, then, as follows:

1. A highly competent, bedload Nile deposited mainly cobbles during early Brunhes and probably during earlier (>0.4 mya) periods as well. The climate was very humid throughout the entire Nile basin, including Egypt; this type of climate subsequently disappeared.
2. A competent, bedload Nile deposited mainly gravels during late Brunhes (see below), when conditions were humid over most of the Nile basin but drier in Egypt.
3. The Dandara Formation, the first influx of Ethiopian silts, lies at the mid-Brunhes climatic change from (1) to (2), and should be related to a glaciation at about 0.4–0.3 mya. At this time, the bedload Nile disappeared and was replaced by a suspended-load river, which implies arid conditions over the Nile basin as a whole and hyperarid conditions over Egypt. We propose to name this stage the *Dandara Crisis*.

From the Nag el Khalifa evidence, we infer that the Dandara silt aggradation was a major arid episode before the Abbassia pluvial, not later than it as Said stated (1981:62). The Acheulean wadi fan deposits on the western edge of the valley are related to a later wet phase, since they erode the Dandara Formation. Most of the wadi

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fans are coarse-grained, predominantly of cobbles, and reflect competent channels. The characteristics of the River Nile during the deposition of the Khalifa wadi fan are unknown. We know only (from metrical characteristics of the fan) that the river in the Abydos area was <8 m above the modern floodplain, so it was probably still a gravel-bedload river.

MIDDLE PALEOLITHIC CLIMATIC FLUCTUATIONS

The wadi fans which contain *in situ* Middle and Late Paleolithic artifacts are much finer grained than the earlier ones, which may indicate that there has been no humid period like that of the Acheulean in more recent times. This is also suggested by the red paleosols. As was observed in Nubia and Kom Ombo by Butzer (1980:258), the red soil on top of the Late Acheulean slope and fan deposits represents the last weathering of that type, and lies stratigraphically at the transition from a semi-arid to a sub-arid climate.

In post-Acheulean times, the Nile became a typical suspended-load river with a dominance of floodplain deposits, and its behavior was governed by climatic changes in the headwaters. It is not known when this transition occurred, but we are able to relate the event to deposits including Middle Paleolithic material. The Nile deposits with *in situ* Middle Paleolithic artifacts were in a small Nile channel of bedload and channel-fill deposits at Nazlet Khater-1 (Tahta), at 5 m above the modern floodplain. These deposits indicate a braided Nile system, but now with an influx of Ethiopian silts. The interfingering of Nile silts and typical overbank deposits within wadi deposits with an almost *in situ* Middle Paleolithic site (El Ghineimiya) indicates that the suspended-load river was fully established at that time. The Nubian Dibeira-Jer deposits, with *in situ* Khormusan, and the Middle Paleolithic Alluvation in Wadi Kubbaniya reflect a similar river-system, while the Ikhtiariya dune sands are clear evidence of an arid climate in Nubia and Upper Egypt.

Local climate may be deduced from wadi and slope evolution. The coarseness of the wadi deposits with almost *in situ* Middle Paleolithic at Ghineimiya implies wet climatic conditions, but less so than in pre-Dandara times and during the deposition of the Acheulean fans. We assume that the Middle Paleolithic sites of Nazlet Khater-1, 2 and 3 and of Beit Allam were partially destroyed during this period.

The position of the Middle Paleolithic site of Makhadma-6 (Qena) supports this hypothesis. The site, which is almost archaeologically *in situ*, is situated on a slope of more than 10% and on top of slope deposits containing rolled Middle Paleolithic implements. This implies that Makhadma-6 was occupied after the destruction of the Middle Paleolithic sites mentioned above, and also after the wet phase(s) that aggraded the wadi fan at Ghineimiya. The Acheulean humid phase at Nag el Khalifa is separated from the wet Middle Paleolithic episode by a sandy wadi deposit, containing *Zootecus insularis* and a Levallois point of Nubian technique, sandwiched between the two coarser deposits under consideration. Said (1981:95) named the Middle Paleolithic humid phase in the Nile Valley the Korosko-Makhadma Pluvial (but see below).

From all available evidence and in agreement with Schild and Wendorf (1986:30), we may conclude with some confidence that the final shift towards aridity in the

Egyptian Nile Valley dates from the Middle Paleolithic. The Middle Paleolithic Nilotic sequence in Wadi Kubbaniya postdates the last Late Pleistocene episode of local rainfall and resultant wadi activity (Schild and Wendorf 1986:30) and is thus later than El Ghineimiya wadi deposits. The stratigraphic positions of the Wadi Floor Conglomerate and of the Korosko Formation with derived Middle Paleolithic artifacts (Butzer and Hansen 1968) are still not fixed in our scheme. The Korosko Formation might be older than or coeval with the Middle Paleolithic Valley Filling Episode at Wadi Kubbaniya. The second possibility has been suggested by Schild and Wendorf (1986:30), while the first is suggested by the intercalation of Nile silts with wadi deposits in the Korosko Formation. It is of interest here to note that, north of Luxor, we have mapped pale brown, indurated, marly silts, which are younger than the Dandara Formation and are covered by important wadi deposits. Unfortunately, these silts have not been dated and did not yield any *in situ* artifacts.

The Bir Sahara-Bir Tarfawi area provides a unique sequence for the reconstruction of paleoenvironments associated with Middle Paleolilthic (Wendorf and Schild 1980b). The evidence from Bir Sahara indicates a succession of two humid and two arid phases after the Final Acheulean occupation. The age and duration of these phases are, however, uncertain and the age of the lacustrine sediments involved is believed to be beyond the range of conventional radiocarbon dating techniques (Wendorf and Schild 1980b:234). The Older Dune and the Older Lacustrine Deposits have been dated by the Mousterian artifacts and sites they contain. The occurrence of similar Mousterian archaeology within clayey deposits at the Dyke site, some 100 km north-northeast of Bir Tarfawi (Wendorf and Schild 1980b), indicates true pluvial conditions in the area during Mousterian times. The Upper Lacustrine Series is dated by the presence of Aterian artifacts, and the two wet phases are separated by an arid episode.

The numerous vertebrate remains studied by Gautier (1980:371) give considerable information about the paleoenvironment. The fauna hunted in the Eastern Sahara during the Mousterian-Aterian wet phase(s) is characterized mainly by herbivorous species which live in herds or small groups in open biotopes of savannah or steppe type. The vertebrate species recorded in the two basins are identical except for the absence of warthog from Bir Tarfawi. The presence of camel and red-fronted gazelle indicates generalized dry steppic conditions. Gautier (1980:325) argues that the white rhinoceros (*Ceratotherium simum*) is a good indicator of a landscape dominated by rich grassland, where trees, bushes and shrubs played only a minor role.

The hyperarid period which began during the Middle Paleolithic occupation of the valley continued for most of the Late Pleistocene and throughout the Upper Paleolithic occupation. During this period, the Eastern Sahara appears to have been devoid of water, fauna and any evidence of human activity (Wendorf *et al.* 1977). This lasted until the Epipaleolithic-Neolithic transition and is well documented in Nabta playa (Wendorf and Schild 1980b) and El Adam playa, near Bir Kiseiba (Wendorf *et al.* 1979).

The climatic deterioration towards hyperaridity more than 60,000 years ago must have had a tremendous impact on all human groups living in the Sahara. We believe that this was a period of migration for the various Middle Paleolithic groups, and the Nile Valley must have been a refuge area for many of them. We suspect that the movement of these various groups into the Nile Valley may have led to the cultural changes that later become apparent in the various evolved cultures with Levallois technology, such as the Khormusan, the Levallois Idfuan, the Halfan and the Sebilian.

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UPPER PALEOLITHIC HYPERARIDITY

The early Upper Paleolithic site of Nazlet Khater-4 at 33,000 years old is at present the oldest site with precise radiometric dates. Arid conditions are deduced from the filling of the mine-trench and -pits by aeolian sands. The undated Nile silts of Masmas and the Upper Paleolithic silts of Shuwikhat and Wadi Kubbaniya only very rarely contain intercalations of wadi deposits, thus indicating a hyperarid climate. We have no evidence of a wet interval before the end of the Shuwikhat aggradation, of which the top part has a thermoluminescence date of 24,700 B.P. ± 2500 years (OxTL.253). After this aggradation, the Nile receded and cut a smaller valley.

Thus far, we have not found any evidence for the Sahaba-Darau aggradation north of Qena, except for the Sheikh Houssein silts, which are related to the "Wild Nile" stage and date between 13,000 and 12,000 B.P. At Makhadma, these silts separate two units of slope deposits. The lower slope deposit, less than 1 m thick, is the type-section of the Makhadma Formation, which was erroneously attributed to the Mousterian-Aterian interval by Said (1981:126). In fact, this deposit, being intercalated between the Shuwikhat and the Sheikh Houssein silts, represents all the slope evolution between about 25,000 and 12,000 B.P. This period must, therefore, be considered as generally hyperarid with short wetter spells, or, eventually, with events of higher amplitude caused by local rainfall. Further research is needed to detail the slope evolution. It is possible that this slope deposit was formed during a much shorter span of time, reflecting an episode of wetter climate during the hyperarid Upper Paleolithic. If this should prove to be correct, then this wetter interval would date from *ca*. 23,000 to 21,000 B.P. and would lie between the end of the Shuwikhat silt aggradation and the beginning of the Kubbaniya silt aggradation, both of which were coeval with hyperarid periods.

The detailed characteristics of the Nile regimen have yet to be worked out (see also Schild and Wendorf 1980:43). According to Butzer and Hansen (1968) and to Butzer (1980), there were vigorous, braided Nile channels during the Darau substage, which they date to 17,000–12,000 B.P. These bedload deposits included exotic pebbles, which implies significant fluvial transport from Ethiopia and Sudan. According to Adamson and others (1980), this channel-type was typical for the Nile during the intertropical dry phase from 20,000 to 12,500 B.P. It is, however, not certain that such a braided river-system would be compatible with the important overbank aggradation of silts occurring in Wadi Kubbaniya at the same time. It might be that the braided Nile system preceded the Kubbaniya silts and was related to the wetter interval postulated for the 23,000–21,000 B.P. interval.

A better understanding of the slope evolution at Makhadma might also help us to understand the significance of the Nile down-cutting which occurred at some time between 25,000 and 20,000 B.P. This slope deposit might correlate with the Malki Member of the Ineiba Formation of Butzer and Hansen (1968:117–119), which is described as broadly coeval with the Darau Substage of the Nile. Cold and dry conditions prevailed in the Nile headwaters (Adamson *et al.* 1980).

The "Wild Nile" stage also seems to represent a turning-point in paleoclimatological history, since a new humid episode began afterwards with conspicuous wadi activity resulting in the deposition of very sandy fans. These fans can be clearly seen on LANDSAT images of areas where the older silts are under cultivation. The wadi deposits related to this episode are called the Sinqari Member (Ineiba Formation) by Butzer and Hansen (1968:119–122). In Upper Egypt, the episode ended some time after 6320 B.P. ± 75 years (Lv.1379), based on a date on charcoal from a hearth *in situ* in the top part of a sandy fan.

CONCLUSIONS AND PERSPECTIVES

In this chapter, we have critically reviewed the relevant literature concerning earth, man and climate in the Egyptian Nile Valley during the Pleistocene and have added to this the principal results of the Belgian Middle Egypt Prehistoric Project, although only the sections including archaeological elements or radiometric dates have been discussed. The final chronostratigraphy for the Late Pleistocene is based on radiocarbon dates on charcoal and on a few thermoluminescence dates; the stratigraphy for the older periods is still only relative. The current state of the art is presented in Figures 3.7 and 3.8, which summarize the deposits, industries and climate for the older periods and for the Upper Paleolithic.

Early Paleolithic deposits with *in situ* artifacts are very rare. This long period was principally characterized by a bedload Nile depositing cobble and gravel terraces, except for the interval of the Dandara Formation, when a suspended-load Nile aggraded floodplain silts originating in Ethiopia. Dandara silts are very common downstream from Luxor but have not yet been reported upstream from that city. A single, man-made core is reported from the Dandara Formation and a few rolled artifacts have been found in older wadi deposits.

A very important observation for this time-period is the chronological succession of three stages, attested by different Nilotic deposits, which are believed to relate to global climatic evolution in the Nile basin. The first stage is primarily characterized by the deposition of cobbles by a bedload Nile. Various step-like terraces were formed and, by the end of this stage, the valley was incised to <20 m above the floodplain north of Luxor. The exact position of the Qena Sands is not well established: they lie above Pliocene silts and below several cobble terraces. Overall, the Nile of this stage was the most competent of all the Niles ever to have flowed through Egypt.

The second stage is characterized by the first massive influx of Ethiopian silts into Egypt, deposited by a suspended-load river, which implies more arid conditions in the Nile basin as a whole and hyperarid conditions in Egypt. We believe that the Dandara Formation was aggraded during a period of pronounced climatic change and propose to refer to it as the *Dandara Crisis*.

During the third stage, the Nile once more became a bedload river, although less competent than during the first stage. The main deposits were gravels at several terrace levels varying from +23 m near Qena to +5 m in the Sohag area.

These three stages have not been dated in Egypt, but we would suggest that they correlate with the long-term climatological changes described by Jansen and others (1986). Thus, the Dandara Crisis would be the East African response to the mid-Brunhes climatic event, which is dated to 0.4–0.3 mya.

The most important Acheulean materials are found in local deposits of the gravels and cobbles of competent wadis, overlying the truncated Dandara Formation. These gravel deposits have a red soil and represent the wettest climate since the Dandara Crisis. The situation in which they occur north of Luxor indicates that the base-level of the wadis was not more than 15 m above the modern floodplain.

Our knowledge of the Middle Paleolithic and its related deposits is still poor. Since the revision of the Nubian chronostratigraphy and the discovery of early Upper

Paleolithic sites, it is apparent that the Middle Paleolithic industries of the Egyptian Nile Valley are more than 40,000 years old. The numbers of known sections and archaeological sites are growing, but there are still many significant hiatuses and no Middle Paleolithic sites or related Nile deposits are known downstream from Asyut. In Figure 3.7, we have correlated the known information from several areas, using the probably rather simplistic assumption that there was only one principal climatic change during the period in question—from wetter to drier.

In the early part of the Middle Paleolithic period, the Nile was still a bedload river. The bedload deposits downstream from Qena consist of fine gravels of which the top is no more than about 10 m above the modern floodplain. However, in the Sohag area later in the Middle Paleolithic, a suspended-load river aggraded to a height of about +6 m. This old floodplain interfingered with prograding wadi fans and slope deposits indicative of a much higher competence than in any subsequent stage and related to more humid climatic conditions than presently obtain in Upper Egypt. Nevertheless, this event was not of sufficiently great amplitude to restore the Nile to full bedload conditions.

One of the most important paleoclimatological conclusions is that the shift to hyperaridity in the Egyptian Nile Valley dates from well before 40,000 B.P. and clearly occurred during the Middle Paleolithic. The last episode of humidity co-occurring with a phase of significant wadi activity is represented in the Ghineimiya fan, which includes a Middle Paleolithic site that is almost archaeologically *in situ*. The first evidence for the deterioration of the climate towards hyperaridity falls within a period that includes the occupation of the Middle Paleolithic site of Makhadma-6, which was almost archaeologically *in situ* in the lower part of a rather steep slope, and the beginning of the Middle Paleolithic aggradation of the Nile silts (Figure 3.7). The age of this dramatic change of climate can be estimated only on the basis of the thermoluminescence dates for the Middle Paleolithic Nilotic sequence at Wadi Kubbaniya, which suggest that the shift toward aridity may have taken place before 60,000 B.P. (A. E. Close *in litt.* 1986; Schild, this volume; Schild and Wendorf 1986).

Once arid conditions had become well established, new Middle Paleolithic silt aggradations began: the Dibeira-Jer, which includes the Khormusan industry, in Nubia and the Middle Paleolithic Valley Filling Episode in Wadi Kubbaniya. It is not yet clear whether the Masmas Formation in the Kom Ombo Plain dates from the Upper Paleolithic or from the Middle Paleolithic. These youngest, Middle Paleolithic aggradations are very similar to later aggradations, and also interfinger with aeolian sands on the western bank of the Nile. No trace of them has been found north of Luxor.

All of the Middle Paleolithic sites north of Aswan, except for the Aterian site at Wadi Kubbaniya, are functionally oriented toward the exploitation of chert. Retouched tools are rare, so that the existence of different complexes can be deduced only on the basis of the debitage technology, suggesting variants with a traditional Levallois technology, with a predominance of Nubian Type 1 cores, and with a blade technology based on single-platform cores combined with the Levallois technique. The typological characterization of the sites is not good enough to permit recognition of the various Middle Paleolithic cultural traditions which could be identified in Nubia.

Except at Makhadma-6, the environmental indicators at these sites are always of a wetter climate than that of today. Their stratigraphic positions suggest a considerable age, which we estimate to be 60,000 years or more.

There is no known lithic sequence from the Egyptian Nile Valley which covers the transition from a Levallois Middle Paleolithic to a blade-producing Upper Paleolithic.

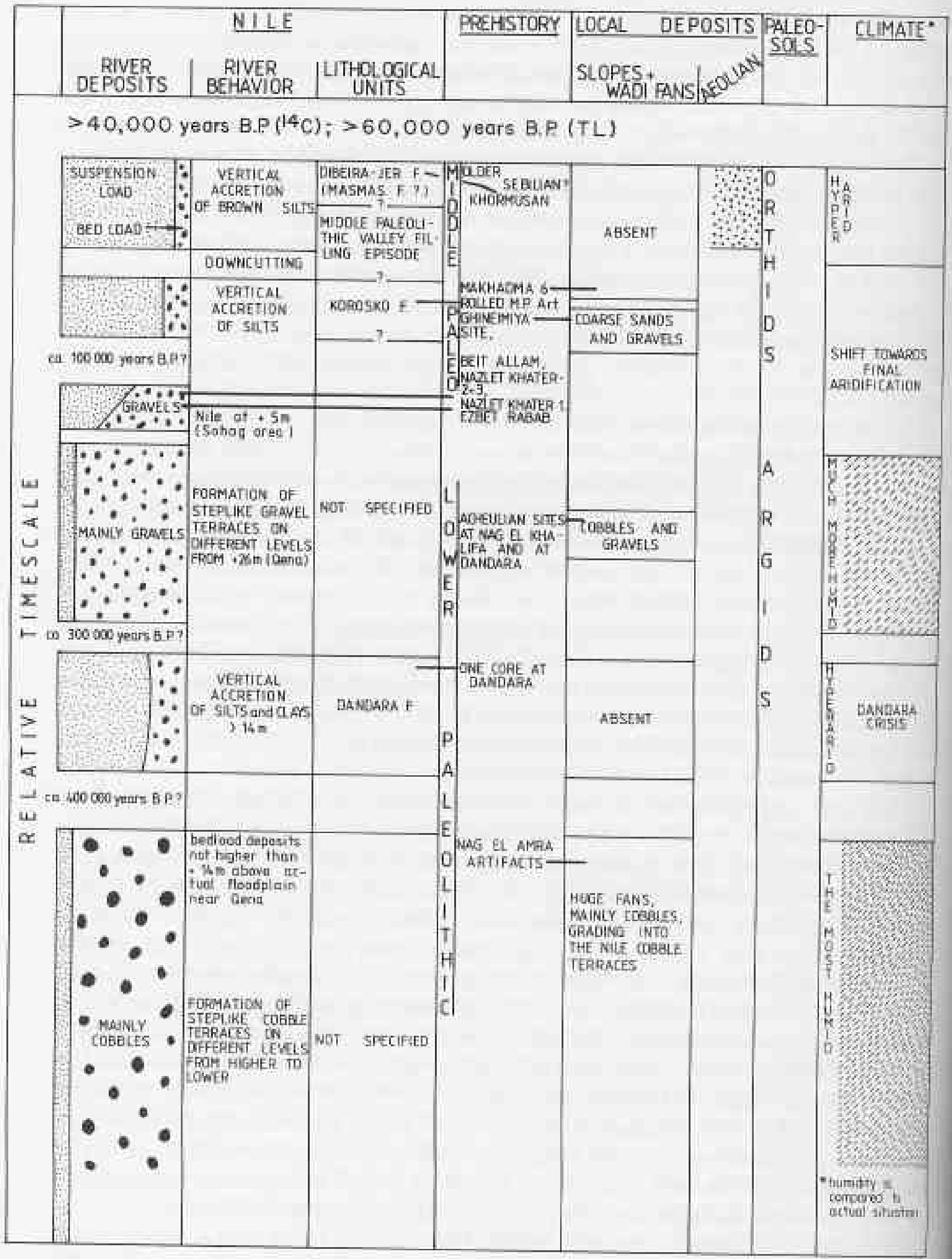
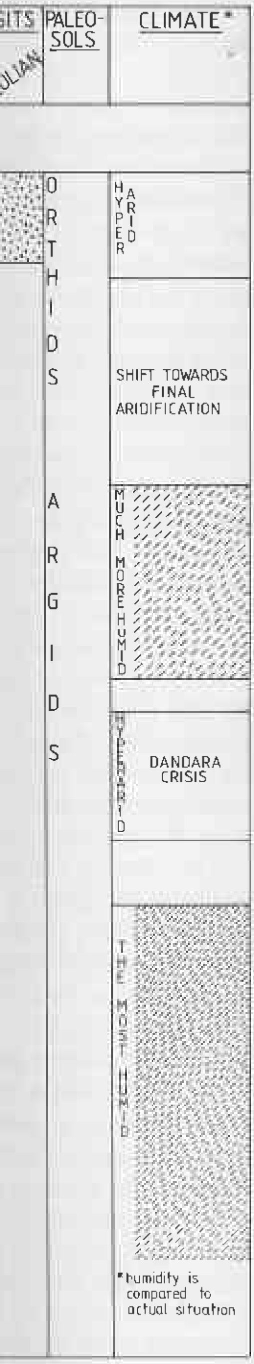


Figure 3.7 Summary of Nile and wadi behavior, lithostratigraphy, paleoclimates and prehistoric sites in Upper Egypt during the Early and Middle Paleolithic.



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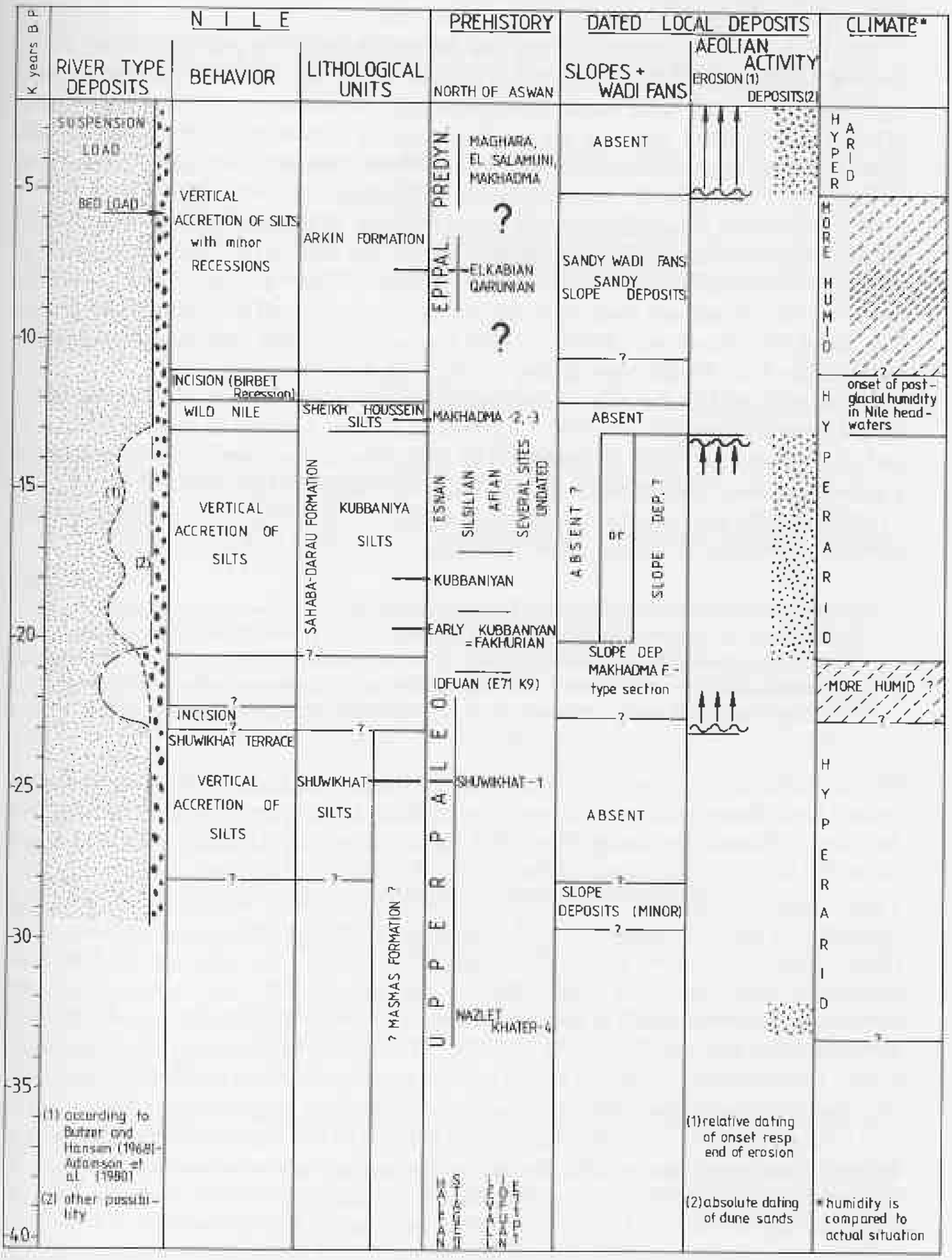

Figure 3.8 Summary of Nile and wadi behavior, lithostratigraphy, paleoclimates and Upper Paleolithic industries in Upper Egypt during the last 40,000 years.

Our knowledge of the Upper Paleolithic period is the most detailed and covers almost the entire Nile Valley in Upper Egypt and Nubia (Figure 3.8). We know nothing of the Nilotic sediments of the period north of Nag Hammadi, since they are now buried beneath more recent silts or are under cultivation.

The climate was hyperarid during this period, except for a possible, short, wetter interval at about 23,000–21,000 B.P. The Nile was a suspended-load river and was aggrading silts over wide floodplains, although, according to Butzer and Hansen (1968:115), bedload deposits are as important as suspended-load deposits in the Sahaba-Darau aggradation of the Kom Ombo Plain. The chronostratigraphic position of these bedload deposits merits further investigation.

The Shuwikhat silts, with their top dated to about 25,000 B.P., are the oldest dated Upper Paleolithic silts. They are separated from the silts of the subsequent Sahaba-Darau or Kubbaniya aggradation (about 20,000–12,000 B.P.) by a period of Nile down-cutting. Slope and wadi deposits are extremely limited throughout this period. The Wild Nile floods at 13,000–12,000 B.P. were the most important catastrophic event in the Late Pleistocene history of the Nile.

In our own work in the Nile Valley, we have excavated two sites attributable to the early Upper Paleolithic (>20,000 B.P.): Nazlet Khater-4, dated to about 33,000 B.P., and Shuwikhat-1, at about 25,000 B.P. The assemblages from these sites, as well as the Fakhurian-related assemblages from Wadi Kubbaniya which are firmly dated to 21,000–19,000 B.P., are characterized by a fully developed blade technology and are completely lacking in the Levallois technique. According to Marks:

> The post-Mousterian industries may be grouped into two basic technological traditions: those where the Levallois method or some modification of it persists, and those where a leptolithic technology either develops rapidly or seems to appear full-blown at the end of the Mousterian. The former situation is clearly present in the Maghreb and the Sahara, while the latter describes what apparently took place in the Levant and Cyrenaica (1975:446).

We have noted above that those sites in the Egyptian Nile Valley which are attributed to the Upper Paleolithic industries of the Levallois Idfuan, Stage II of the Halfan and the Older Sebilian are poorly dated. We suggest that these sites are much older and might fall within a late phase of the Middle Paleolithic (Sebilian) or in the Middle-Upper Paleolithic border-zone (Levallois Idfuan and Halfan Stage II). The principal argument for this hypothesis is that the Levallois technique does not occur in the early Upper Paleolithic sites in the Egyptian Nile Valley. The absence of Levallois technology from the lower Nile Valley by perhaps 35,000 years ago would make technological development in this region consistent with that known from Cyrenaica and the Levant and would place the lower Nile Valley within the circum-Mediterranean world. The Levallois technique seems to have persisted in more southerly parts of the Nile Valley, indicating a different evolution of technology. It is not clear whether this is also true of the Sahara and the Maghreb, as Marks (1975) suggested. We suspect that the border between these two Nilotic regions was somewhere near the First Cataract. It is possible to see some influx from the industries of the southern Nile Valley in some of the industries of the late Upper Paleolithic, such as the Kubbaniyan.

The only wetter period after the Middle Paleolithic for which there is good evidence is that of the Early Holocene. The beginning of this period is not directly dated in Upper Egypt but is estimated to have been at about 11,000 B.P.; the end of the wetter period is estimated to have fallen at about 6,000 radiocarbon years ago.

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ACKNOWLEDGMENTS

We gratefully mention the discussions we have had with Fred Wendorf and Romuald Schild and their having permitted us to work on some of the sites they discovered. Many thanks are due to Angela E. Close, Anthony E. Marks and P. Van Peer for their critiques and comments on earlier drafts of this paper. Angela E. Close was so kind as to improve our English text.

The members of the various expeditions of the Belgian Middle Egypt Prehistoric Project contributed significantly to the results obtained. This project was funded by the Belgian Nationaal Fonds voor Wetenschappelijk Onderzoek, the Onderzoeksfonds van de Katholieke Universiteit Leuven and the Comité voor Belgische Opgravingen in Egypte. The collaboration of the Egyptian Antiquities Organisation has always been very efficient and fruitful.

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4

Holocene Migration Rates of the Sudano-Sahelian Wetting Front, Arba'in Desert, Eastern Sahara

C. VANCE HAYNES, JR.

INTRODUCTION

The recent discovery of laminated algal sapropels, marls and diatomites, representing relatively deep stratified lakes, in what is now perhaps the driest region on earth is making possible a new understanding of the climatic cycles that characterized the early and middle Holocene of North Africa (Mehringer 1982; Ritchie *et al.* 1985). The lacustrine beds occur in wind-scoured depressions within an area of the Eastern Sahara that has been named the Darb el Arba'in Desert (Figure 4.1); this name is used to distinguish the most hyperarid region (receiving < 10 mm of rainfall per annum), with its peculiar geomorphology, from the rest of the Sahara (Haynes 1982a). This chapter will briefly describe the lake deposits, discuss their radiocarbon chronology and present a hypothesis for their origin which, if substantiated, will provide a better understanding of Sahelian climate during the early and middle Holocene.

SELIMA

Selima is an uninhabited oasis in northern Sudan, 90 km south of the border with Egypt (Figure 4.1). It is a vegetated depression at the base of an escarpment of Paleozoic sandstone, which, before the end of the slave trade in 1898, was a major watering-place on the Darb el Arba'in, the ancient caravan and trade route from Asyut on the Egyptian Nile to Darfur (Shaw 1929). The ruins of what may be an early Christian monastic building attest to a permanent occupation during historic times (Leach 1926).

The lake-beds were first recognized in 1932 (Sandford 1936) and a cursory examination of them was carried out in 1976 (Haynes *et al.* 1979). Their potential for pollen analysis and geochronology was demonstrated in 1979, when a systematic study began (Haynes 1982b; Mehringer 1982). Stratigraphic sections up to 4 m deep were examined and sampled at several locations in the vegetated part of the main basin, where the groundwater is less than 1 m below the surface. Two sub-basins, which form a

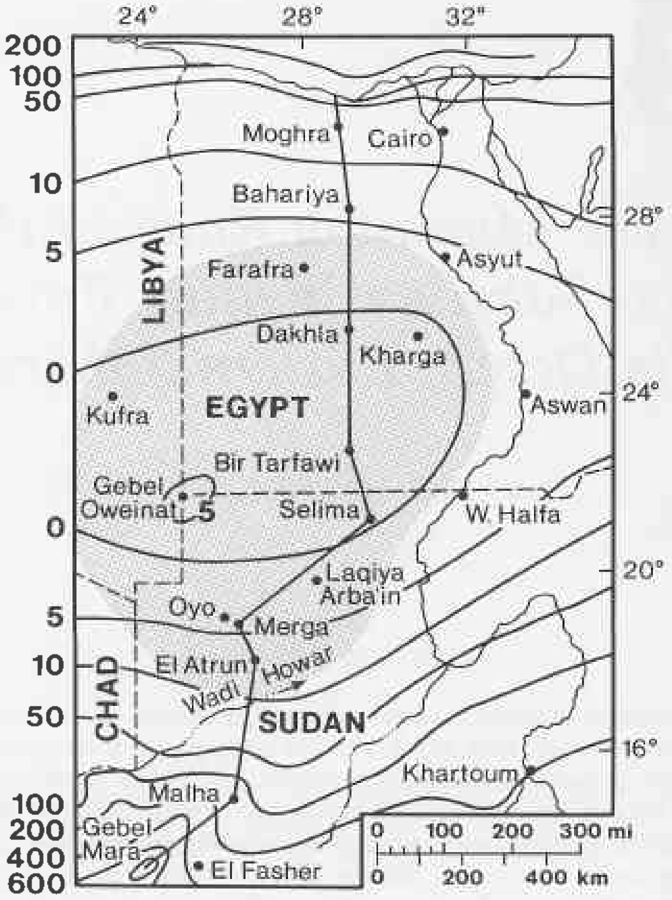

Figure 4.1 Map of the Darb el Arba'in Desert (shaded area) showing isohyets (modified after Dubief 1963, Oliver 1965 and Long *et al.* 1985) and profile-line of Figure 4.7.

chain along the northwesterly trending escarpment, contain crystalline layers of evaporites overlying and interbedded with sapropelic muds. The basal organic layer in all of the basins is of charcoal, 1–5 mm thick, consisting mostly of charred reed-mats resting directly on the loose, saturated sand that overlies the sandstone (Figure 4.2).

At Hole-6 Pit in the main basin, two meters of moist, laminated, calcareous, algal and diatomaceous beds are overlain by 1.5 m of dry, diatomaceous marl. Above these are oolitic or pelletized calcium carbonate beds which are interbedded with the marl beds on the shoreward side. The quantity of organic and inorganic carbon throughout the section was more than adequate for radiocarbon dating, but it has undergone dilution by old carbon due to the "hard-water effect" which is frequently observed in lakes in closed basins (Deevey *et al.* 1954). The discrepancies in both the algal and carbonate fractions have been determined by radiocarbon dating small fragments of charcoal or subaerial plant remains, using the tandem accelerator mass spectrometer (TAMS) at the University of Arizona (Donahue *et al.* 1983). As would be expected, the discrepancies generally increase with the more evaporative facies and with decreasing age (Table 4.1).

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Figure 4.2 Basal charcoal layers of the Hole-6 Pit lacustrine section, Selima Oasis. Basal 3-mm dates to 9700 B.P. ± 200 years (A.2251); charcoal flecks in underlying sand date to 9640 B.P. ± 700 years (SMU.1223).

The basal charcoal dates of 9700 B.P. ± 200 years (A.2251) and 9640 B.P. ± 700 years (SMU.1223) refer to the beginning of the earliest Holocene pluvial so far recognized at Selima (Haynes 1982b). Additional TAMS dating is expected to determine the full time-span of the 3-mm thick charcoal layer at the base and to provide greater precision. As shown in Table 4.1, the carbonate fraction in the charcoal layer yielded a date of 9060 B.P. ± 810 years (A.2250), which is statistically the same age as the charcoal dates.

Between 6000 and 7000 B.P., the discrepancy between the sapropel and carbonate fractions is as much as 700 years, indicating an evaporating lake. Sedimentological analyses show a significant increase in grain-size 0.5 m above the basal charcoal, which correlates with more xeric pollens (Mehringer 1982); this indicates the shoaling of the lake in the main basin before 8000 B.P.

In the adjoining sub-basins, the basal charcoal layers gave dates of 8350 B.P. ± 210 years (A.3397) and 8550 B.P. ± 380 years (A.2953). These suggest desiccation and deflation of the earlier lake-beds before about 8500 years ago, which marks the beginning of a second lacustrine phase. The date most probably applies to the initial rise of the second high stand in the main basin as well, where the analyses indicate that there was at least one more cycle from a low to a high stand. In Hole-6 Pit, however, there is no visible evidence of complete desiccation and deflation between the Holocene pluvials.

The youngest radiocarbon date so far obtained from the bottom sediments is 4090 B.P. ± 500 years (SMU.1024), on humic acids from a fragment of charcoal found in the marl zone 2.5 m above the basal sand (Haynes 1982b). The charcoal was inadvertently

TABLE 4.1

Radiocarbon Dates from Holocene Lacustrine Sequences, Selima Oasis, Northern Sudan

Depth (m)	Charcoal	Organics	Carbonate
Hole-6 Pit			
0.41–0.45			5120 ± 120 (A.2267)
1.18	4090 ± 500 (SMU.1025)		6320 ± 70 (SMU.1022)
1.90–1.92		7470 ± 380 (A.2867)	
2.04–2.05		6510 ± 120 (A.2871)	6460 ± 90 (WSU.2599)
2.11–2.15		6070 ± 290 (AA.102)	6810 ± 130 (A.2265)
2.15–2.16		6620 ± 170 (A.2868)	7180 ± 90 (WSU.2614)
2.91–2.95		20,560 ± 120 (A.2258)	7980 ± 160 (A.2257)
3.03–3.05		8350 ± 140 (A.2866)	7680 ± 130 (WSU.2610)
3.41–3.44	7460 ± 210 (AA.104)	8200 ± 190 (A.2874)	
3.45–3.47	7710 ± 300 (AA.252)	10,280 ± 220 (A.2873)	9850 ± 90 (WSU.2603)
3.58–3.60		9650 ± 200 (A.2872)	9090 ± 110 (WSU.2601)
3.61–3.62		9340 ± 200 (A.2253)	10,060 ± 300 (A.2252)
3.62–3.63	9700 ± 200 (A.2251)		9060 ± 810 (A.2250)
3.63–3.64	9640 ± 700 (SMU.1223)		
East Side Beach Trench			
		7330 ± 200 (A.2864)	7680 ± 120 (WSU.2606)
		6650 ± 300 (A.2869)	7070 ± 100 (WSU.2595)
	4300 ± 200 (AA.106)		
	4490 ± 280 (AA.105)	6930 ± 350 (A.2870)	8680 ± 130 (WSU.2597)
		7070 ± 230 (A.2865)	8680 ± 120 (WSU.2608)
Surface Tufa Deposits in Order of Height above Top of Hole-6 Pit			
7.9		4450 ± 210 (A.2102)	6800 ± 130 (A.2101)
6.8		7300 ± 170 (A.2255)	7470 ± 170 (A.2254)
4.3			5870 ± 160 (A.2103)
2.2			3750 ± 130 (A.2194)
1.3			4490 ± 90 (A.2108)

lost in the laboratory; however, tests have shown that soluble organic fractions of charcoals from the Eastern Sahara commonly yield radiocarbon dates within one sigma of the insoluble carbon residues (Haas and Haynes 1980). The marl carbonate gave an apparent age of 6320 B.P. ± 70 years (SMU.1022). The discrepancy of 2230 years suggests severe evaporation at this time. The sapropel 1.5 m above the basal sand dated to 6620 B.P. ± 170 years (A.2868), whereas the corresponding carbonate fraction was dated to 7180 B.P. ± 90 years (WSU.2614), or 560 years older. There was a major discrepancy 0.75 m above the basal sand, where the sapropel produced an apparent age of 20,560 B.P. ± 120 years (A.2258) compared with a carbonate date of 7980 B.P. ± 160 years (A.2257). At 0.65 m, the sapropel date of 8350 B.P. ± 140 years (A.2866) is still 670 years older than the associated carbonate date of 7680 B.P. ± 130 years (WSU.2610).

In those cases where the sapropel fraction is older than the carbonate, the most logical explanation is the reworking and redeposition of older sapropel, although the reading of 20,560 B.P. would seem to be much too old for this explanation. However, there are remnants of a late Pleistocene lake in the main basin (see below) and the limestones, which cap the mesas about 20 m above the floor of the basin, have yielded an organic fraction date of 20,670 B.P. ± 450 years (AA.101) and carbonate fraction dates of 27,010 B.P. ± 1400 years (A.2100), 25,310 B.P. ± 950 years (A.2098) and asis, Northern Sudan

Carbonate
5120 ± 120 (A.2267)
6320 ± 70 (SMU.1022)
6460 ± 90 (WSU.2599)
6810 ± 130 (A.2265)
7180 ± 90 (WSU.2614)
7980 ± 160 (A.2257)
7680 ± 130 (WSU.2610)
9850 ± 90 (WSU.2603)
9090 ± 110 (WSU.2601)
0,060 ± 300 (A.2252)
9060 ± 810 (A.2250)
7680 ± 120 (WSU.2606)
7070 ± 100 (WSU.2595)
8680 ± 130 (WSU.2597)
8680 ± 120 (WSU.2608)
6800 ± 130 (A.2101)
7470 ± 170 (A.2254)
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3750 ± 130 (A.2194)
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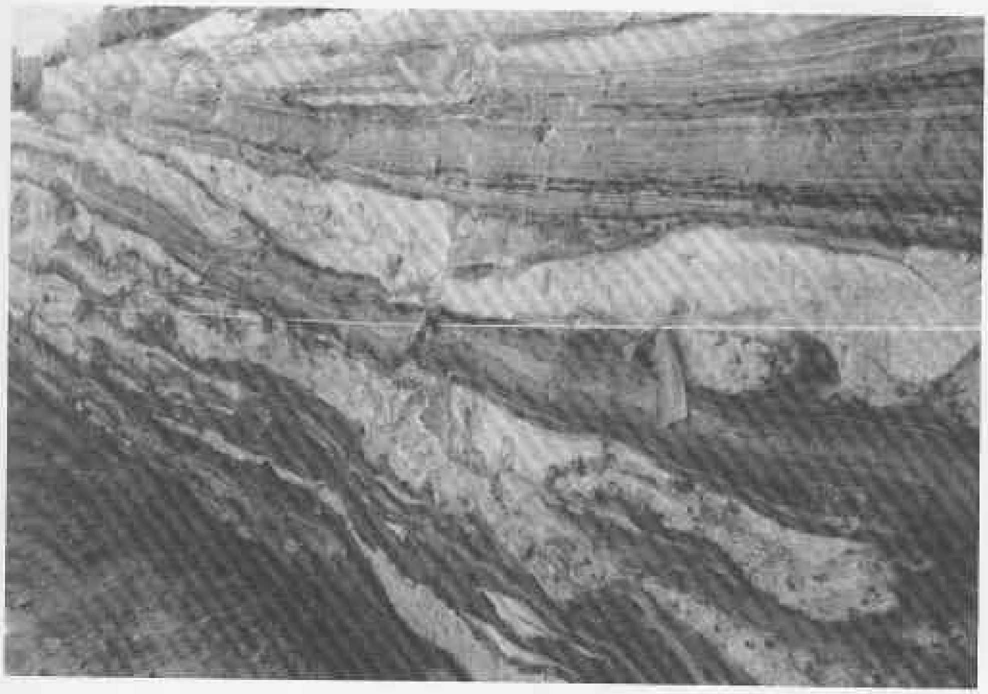

Figure 4.3 Selima beach trench showing layers of laminated sapropels separated by reworked aeolian beach sand; some layers show soft-sediment deformation structures. (Flags are 0.5 m apart.)

21,580 B.P. ± 2060 years (A.2106). This suggests that a remnant of the late Pleistocene sapropel was reworked by Holocene lake-action about 8000 years ago and redeposited at our sample locality.

A stratigraphic trench excavated at the eastern edge of the main basin revealed a 1.5-m thick sequence of laminated sapropels and micrites, interbedded with dune sands reworked from the shore (Figure 4.3) presumably during times of greater wave-, and therefore wind-, action. The laminated beds extended a further 4 m below the bottom of the trench. A band of laminated sapropel, 50 cm below the surface and lying between two 15-cm thick bands of sand, yielded two small pieces of charcoal separated from each other by 5 cm of sand. TAMS analysis produced a date of 4490 B.P. ± 280 years (AA.105) for the lower piece and 4300 B.P. ± 200 years (AA.106) for the upper. Sapropel stratigraphically equivalent to the lower sample gave dates of 6930 B.P. ± 350 years (A.2870) for the organic fraction and 8680 B.P. ± 130 years (WSU.2597) for the carbonate. These results indicate that a saline lake, with considerable near-shore reworking of sediments, persisted in the main basin until after about 4000 B.P.

The levels of the high stands are minimally indicated by algal tufas, which formed moulds of reeds (*Phragmites*) marking the strand-lines but which have been severely truncated by wind-action during subsequent hyperarid intervals (Figure 4.4). The tufas provide only minimal indications of the high stands because the maximum development of tufa may occur after the lake has already begun to decline and when evaporation rates are higher than at the time of the high stands.

Tufa carbonate commonly yields erroneous radiocarbon dates because of a combination of two opposing factors: the hard-water effect which makes the apparent age too old, and chemical exchange with later atmospheric carbon dioxide which makes

Figure 4.4 Sand-blasted tufa moulds (formed by precipitation of calcium carbonate on *Phragmites australis*) mark approximate former stands of pluvial Lake Selima. (Lens case is *ca.* 55 mm in diameter.)

it too young (Rubin *et al.* 1963). Most algal tufas contain sufficient amounts of organic carbon for radiocarbon dating. Radiocarbon analysis of this fraction avoids the exchange problem, but not necessarily the hard-water effect, because some of the algae may metabolize carbon dioxide released from bicarbonate ions in their aquatic environment (Damon *et al.* 1964; Haynes *et al.* 1966). The carbon dioxide is partly derived by precipitation of calcium carbonate from the same biocarbonate ions that suffer the hard-water effect. However, the exchange problem is insignificant and the apparent age of the algal organic fraction is, therefore, a maximal value; the true age could be younger but is not likely to be older.

Apparent ages for the Selima tufas are presented in Table 4.1. All appear to relate to the younger phases of the Holocene lake, older tufas presumably having been destroyed by erosion during the interpluvials. Concordance in the two fractions at about 7300 B.P., 6.8 m above Hole-6 Pit (Table 4.1), suggests that the hard-water effect was minimal at this time, indicating a lake approaching its highest stand. The decline of the lake soon afterwards is indicated by a Neolithic fireplace at a somewhat lower elevation that has a charcoal date of 6590 B.P. ± 170 years (SMU.766).

An additional problem in radiocarbon dating the Selima tufas is their microstratigraphy. Polished sections commonly show concentric growths of successive generations of tufa. Using TAMS technology, we are attempting to radiocarbon date individual generations, on the assumption that they represent fluctuations of lake-levels across the tufa strand.

According to Bradbury (pers. comm.), the diatoms in the Selima main basin are dominated by *Cyclotella caspia* and interlaminated with algal sapropel and calcium carbonate, and thus represent seasonal fluctuations in salinity and evaporation; this

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result is confirmed by the pollen studies (Mehringer 1982). The final evaporation phases are represented in the more northwesterly sub-basin, here called the halite basin, by a dense mass of coarsely crystalline halite, overlying gypsum crystals which are interbedded with sapropel and micrite. In the intermediate basin, here called the thenardite basin, they are represented by a similar occurrence of coarsely crystalline thenardite. Secondary mineralization includes natrojarosite (J. W. Anthony, pers. comm.).

THE MERGA REGION

Another occurrence of laminated, diatomaceous, Holocene lake clays and micrite was discovered in 1980 in the Oyo depression, 40 km northwest of Merga Lake (Figure 4.1). They are found underneath a meter of aeolian sand containing crystalline masses of trona that are mined by caravan people from Egypt and Chad every winter (Haynes 1985). After being mined, which is referred to by the Bedouin as "harvesting," the trona is seasonally regenerated by evaporation of the capillary fringe of the water-table.

Approximately 3.3 m of laminated lake-beds lie below the aeolian sand and are separated from a basal sand, which is presumably reworked aeolian sand, by 5–10 mm of charcoal and compressed plant remains. The charcoal has provided two radiocarbon dates of 8900 B.P. ± 120 years (A.2836) and 8720 B.P. ± 170 years (A.2951). Although the sediments, upon cursory examination, are similar to those of the main basin at Selima, the basal dates are closer to those from the sub-basins. Organic fractions from 10-cm thick sections of the intermediate and upper layers at Oyo have yielded dates of 8490 B.P. ± 90 years (SMU.1230), 6100 B.P. ± 80 years (SMU.1231), 5880 B.P. ± 80 years (SMU.1233) and 4920 B.P. ± 200 years (SMU.1232). These dates indicate that the Oyo section represents the last phase of the middle Holocene pluvial with no obvious evidence for an intervening hyperarid period.

The climatic zones represented by the pollen assemblages range from Sudano-Sahelian (≥400 mm of precipitation per annum) in the basal zone (I) at about 9000–6500 B.P., to Sahelo-Saharan (±300 mm) in the intermediate zone (II) at about 6500–6000 B.P., to Saharan (≤300 mm) in the top zone (III) which dates to about 6000–4500 B.P. (Ritchie *et al.* 1985). A fragment of charcoal from the same part of Zone I as was dated to 8490 B.P. produced a TAMS date of 8030 B.P. ± 300 years (AA.253), which suggests that apparent dates on the algal sapropels may be as much as 460 years too old, due to the reworking of older sapropels, or to algal metabolization of old carbon, or to both. However, the basal dates are on charcoal and so are not affected.

In 1983, a third section of finely laminated lake-beds was found by augering at Maaten, a caravan well 35 km east-southeast of Oyo in Wadi Hussein (Haynes 1985). TAMS analysis on charcoal, from the base of the section and on top of saturated aeolian sand, yielded a date of 8910 B.P. ± 200 years (AA.319). This is identical to one of the basal charcoal dates from Oyo and at essentially the same latitude. The pollen, diatom and sedimentary analyses in progress will provide useful comparative data for both Selima and Oyo.

Laminated lacustrine sediments representing the early Holocene pluvial, like those at Selima dating between 10,000 and 8500 B.P., have not been found at either Oyo or Wadi Hussein, but the search continues since there is little doubt that they once existed. If remnants cannot be found, this would suggest that the early Holocene interpluvial period was one of extreme aridity and intense aeolian erosion.

Wadi Hidwa, 20 km east of Maaten, contains remnants of marly lacustrine beds which overlie a dark grey, carbonaceous zone at the top of a basal sand (Haynes 1985). The bones of elephant and rhinoceros were found in the overlying beds. The very fine-grained carbon, presumably charcoal, yielded a radiocarbon date of 7220 B.P. ± 190 years (A.3243). The lack of agreement between this date and the basal dates from the other stratified lake-sections may be due to an episode of desiccation and deflation which was not apparent at Oyo and Maaten, perhaps because of an unrecognized erosional hiatus. Alternatively, at Oyo it is possible that there was no desiccation because of a higher piezometric surface that kept the sediments saturated even during an arid interval. Today, Wadi Hidwa is completely dry whereas the capillary fringe at Oyo lies within a meter of the surface. In the main basin at Selima, a dry interval is indicated at 1.25 m above the basal sand between sapropel dates of 8350 B.P. ± 140 years (A.2866) and 6620 B.P. ± 170 years (A.2868) (Haynes 1982b). Also, the possibility of contamination in the Wadi Hidwa sample cannot be precluded since the carbon represented less than 0.1% of the dry sample weight. However, it would require approximately 10% of modern carbon (130% M) to bias the dates, and there is virtually no organic source of modern carbon at Wadi Hidwa. The date of 7220 B.P. may, therefore, be valid for the beginning of the third Holocene pluvial, which was also apparent at Selima. Comparison of pollen analyses of the marly beds with the data from Oyo and Selima should resolve this issue.

Wadi Karambaru, 75 km southeast of Merga Lake, contains a salt pan and remnants of diatomaceous, marly lake-beds which are separated from the underlying sand by 1 cm of black charcoal (Haynes 1985). The charcoal has a date of 9300 B.P. ± 160 years (A.3246), which is statistically different from all of the other basal charcoal dates mentioned above. The date is unlikely to refer to the beginning of yet another pluvial, since the frequency of pluvials would then be greater than is indicated for the Holocene elsewhere in Africa (Butzer *et al.* 1972; Street and Grove 1976). A possible explanation is suggested below.

BASAL LAKE-BED CHARCOAL

Four basins in the hyperarid Arba'in Desert are now known to contain finely laminated sapropels, marls and diatomites, representing relatively deep, stratified lakes during the early and middle Holocene. The first stratigraphic unit in each basin is a 1–5-mm thick layer of granular charcoal, or compressed, carbonized plants (notably *Typha*; Figure 4.5), or both, that provides ideal materials for radiocarbon dating the beginning of the rise of each lake in each basin or sub-basin. It has thus been possible to date the beginnings of two, or perhaps three, Holocene pluvials, although the actual presence of the basal charcoal and plant layers has yet to be explained.

Direct precipitation into a relatively unvegetated basin would cause an influx of sediment washed from the adjacent slopes. This would result in the deposition of interbedded clastic sediments ranging from graded sands to clays, depending on the distance from the shore, the available sediments and the depth of the lake. The Holocene playa deposits of the Arba'in Desert are typical of this type of basin-fill. They are predominantly of silts and fine sands resulting mostly from slope-wash, presumably with some aeolian input, and the filtering effect of vegetation around the catchment-area (Hassan 1983; Haynes 1980; Pachur and Braun 1980).

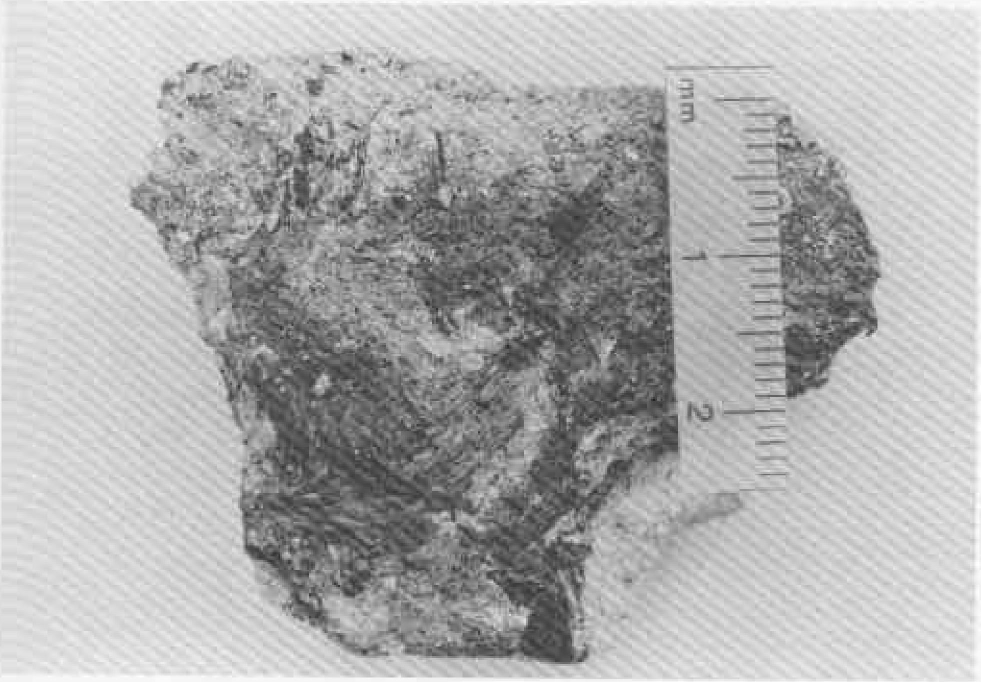

Figure 4.5 Carbonized leaves of *Typha* revealed by splitting of basal charcoal layer (Figure 4.2).

The sediments of deep-water stratified lakes differ markedly in that they consist mainly of laminated, anaerobic, organic remains alternating with chemical precipitates and, at some sites, the siliceous remains of diatoms. These deposits are typical of groundwater-supported lakes (Eugster and Hardie 1978; Stephenson 1971), the paucity of clastic sediments being due either to a vegetative filter in the catchment-area, or to reduced aeolian activity, or to both. The laminations result from seasonal variations in the size, depth and temperature of the stratified water.

The basal charcoal layer is anomalous in light of the otherwise limited quantity of organic sediments. The integrity of the charred *Typha* leaves and the absence of interbedded sand suggest that the charcoal was not being washed in from the adjacent slopes by precipitation and run-off. A possible explanation might be the formation of a reed-covered marsh in the lower parts of the deflational basin as the rising groundwater emerged at the beginning of a pluvial episode. The periodic burning of the reeds might have had natural causes or could have been the work of groups of prehistoric people intent on easier access to water. Depending on the specific size and shape of the basin, the expansion of the lake would eventually reduce the proportion of the reed-mat relative to the size of the lake. *Typha* would give way to *Phragmites*, and the creation of open-shore areas by encroaching dunes would end the need to burn off the reeds. Merga Lake, 40 km southwest of Oyo, is the only extant analog of a groundwater-supported lake in the region (Figure 4.6). Most of the shore at Merga is covered by a dense growth of *Phragmites*, but the water is easily accessible through open areas created by active dunes (Haynes *et al.* 1979). (The water is, however, too saline for human consumption.) That some burning was still taking place throughout the existence of the Holocene lakes is indicated by the several bands of charcoal in the basal 5–10 cm and by the flecks of charcoal which are scattered throughout the sediments.

Figure 4.6 Merga Lake, in rainless (<1 mm) Darb el Arba'in Desert, is supported only by groundwater and almost surrounded by reeds (*Phragmites*). Basal parts of reeds in water are coated with hydrated sodium carbonates.

The rarity of clastic materials in the basal charcoal layers indicates that the initial rise of the groundwater-supported lakes may have preceded actual rainfall in their catchment-areas. The groundwater initially emerged in the lower-lying areas where it supported aquatic reeds rooted in aeolian sand. As the groundwater rose, it would promote the development of a vegetative filter around the lake even before the onset of local rainfall, which, when it finally began, would have enhanced development of the filter still further. Alternatively, rains during the early part of a pluvial could have been sufficient to permit the establishment of a vegetative filter, but too gentle to cause runoff. Such conditions would, however, have led to the development of a terrestrial vegetation and to pedogenesis on the floors of the depressions, instead of which we find aquatic vegetation resting directly on aeolian sand. In any case, the result was a stratified lake with deep-water sediments that are relatively low in clastic grains, except for the aeolian-derived sand and silt that increased significantly in quantity as the pluvial waned.

MIGRATION OF CLIMATIC WETTING FRONTS

The nature of climatic changes in the Sahel is poorly understood because of uncertainties about several of the parameters essential for an accurate understanding of the combined hydrological and energy budgets (Hastonrath and Kutzback 1983; Nicholson 1984). Nevertheless, there is some agreement that increased precipitation in the early Holocene was due to a northward migration of the monsoonal circulation (Wickens 1975), and the simplest version of this model proposes a latitudinal shift of

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the isohyets (Wickens 1982). The rise of the groundwater lakes ahead of or coincident with local rainfall can be illustrated by a topographic profile extending northward through western Sudan and Egypt, upon which is superimposed a cross-section through the present-day isohyets and the hydraulic gradient (Figure 4.7). The rapid rise in rainfall both to the south and to the north of the Arba'in Desert is readily apparent. The steep precipitation gradient is essentially a wetting front, along which rainfall rises from <10 mm per annum to >100 mm in a distance of less than 200 km (Dubief 1963; Oliver 1965). The steepest part of the front may have a slope of 1–2 mm per km (Wickens 1982).

With the onset of pluvial conditions, the southern wetting front moved northward, down the hydraulic gradient of the Nubian aquifer, and increased the gradient ahead of itself by recharge through local depressions and wadis which fell under the front. Sandford (1935) has suggested that Wadi Howar, an extinct river which forms the southern boundary of the Southern Libyan Desert (Arba'in Desert), was a major recharge area for the shallow aquifers. The wadi is more than 500 km long and is almost parallel to the isohyets (Figure 4.1); during pluvials, it undoubtedly extended farther to the northeast. Once the wetting front reached the southern catchment of the Wadi Howar, the recharge would have increased by at least an order of magnitude so that a "recharge front" would then advance northward. The lake basins themselves would be additional places of recharge (Muller and Haynes 1984).

The model of the northward migration of the monsoonal circulation is supported by the south-to-north trend of decreasing age among pluvial lakes of the Arba'in Desert. The rate of northward movement of the wetting, or recharge, front may be estimated from the radiocarbon dates on the basal charcoal layers, when they are related to the same pluvial in two or more basins at different latitudes. As a first approximation, we can assume that the Wadi Karambaru basal date of 9300 B.P. ± 160 years is the beginning of the same pluvial as began at Oyo at 8900 B.P. ± 120 years; that is, 400 ± 280 years later. Oyo is approximately 100 km north of Wadi Karambaru, so that the mean ages indicate a rate of 0.25 km per annum, with a maximum rate of 0.83 km per annum being allowed by the standard deviations. The slowest allowed rate (0.15 km per annum) is probably unrealistic, as it would require a greater difference of time over several degrees of latitude than is indicated by presently available data (Butzer *et al.* 1972; Street and Grove 1976). Comparison of the basal date of 8550 B.P. from the Salt basin at Selima with that of 8900 B.P. from Oyo produces the somewhat faster rate of advance of 0.63 km per annum (for the mean dates), which is comparable to the faster rate calculated for the advance from Karambaru to Oyo.

It is not certain whether the rise of the isohyets on the northern side of the Sahara moved southward similarly, in phase with each pluvial (Nicholson 1984). However, there is no doubt that, as the southern wetting front moved northward, the distance between the two fronts decreased so much that isohyets below approximately 100 mm disappeared altogether, and the center of the hyperarid Darb el Arba'in Desert became merely arid or semiarid (Figure 4.6).

As a pluvial period began to end, the southern wetting front would move southward until there was no longer any significant rainfall in the lake basin. The lake itself would remain for some time as an evaporating residue (discharge point) of earlier precipitation and then finally become dry. The evaporites it left behind would be eroded by aeolian action to a greater or lesser degree, depending on the resistance of the evaporite minerals to sand-blasting. In the main basin at Selima, the time lag between the end of local precipitation and the final desiccation of the lake is probably represented by the influxes of sand apparent in the sedimentological analyses (Mehringer 1982). These sands are the first indication that the vegetative filter, or aeolian shelterbelt, had been significantly diminished. A marked reduction in local rainfall is probably represented by the increased bioturbation and coarser lamination of the marls and carbonate pellets, which overlie the finely laminated sapropel and micrite beds.

To a large extent, the timing of these events in individual basins and the variations in stratigraphy from one basin to another are determined by the basins' specific hydrogeological conditions, such as the permeability of the underlying beds, elevation, slope, various structural factors and the catchment-area. As a result of these differences, it cannot be expected that the model should fit all of the basins in the same way. For example, the Arba'in Valley, which is halfway between Selima and Wadi Hussein, does not contain finely laminated sapropels, diatomites, or marls in spite of the considerable depth of the several sub-basins along the base of the high escarpment. Instead, the sub-basins contain typical playa muds overlying thin basal layers of sand and fine gravel. Augering through four of these playa deposits revealed a layering of reddish brown muds with varying proportions of sand, which presumably reflect variations in the amount of aeolian input (Haynes 1985). At Laqiya Umran, the basal sand and gravel are saturated with water that rose overnight 3.65 m to the surface, indicating a piezometric surface somewhat higher than the present floor of the basin.

It is not clear why there are playa muds in the Arba'in Valley, instead of the chemical and organic precipitates of stratified lakes, but it could be due to an aquaclude below the floor of the valley, or to a lack of underground flow-paths to the floor. The artesian head may result from the infiltration of rain from the surface of the adjacent slopes into the permeable beds beneath the playa muds during the last pluvial phase. However, bicarbonate ions in the water yielded an apparent radiocarbon age of 12,840 B.P. ± 130 years (SMU.754), which suggests a mixing with older water and, therefore, does not accord with this interpretation (Muller and Haynes 1984). It is possible that the piezometric surface is supported by fossil water coming in from a structurally controlled source, as was suggested by Sandford (1935), and mixing with Holocene recharge. In contrast, at Laqiya Arba'in, 30 km to the northwest of Laqiya Umran, the apparent age of the water only 50 cm below the surface is 1930 B.P. ± 40 years (SMU.752), indicating either more recent recharge or less mixing with older water (Haynes and Haas 1980).

OLDER LAKE-BEDS

In addition to the Holocene lake deposits, the Selima, Oyo and Wadi Hussein depressions all contain deposits of late Pleistocene lake marls, diatomites and limestones, in the form of mesa-like erosional remnants standing several meters higher than the surface of the Holocene lake-beds. In Oyo, these beds overlie reworked sand and gravel which contain sand-blasted Late or Final Acheulean artifacts. Their stratigraphic positions suggest that the lakes probably existed during one or more of the pluvial phases associated with Middle Paleolithic archaeology in the Bir Tarfawi area (Wendorf and Schild 1980). Some of the lake-beds at Bir Tarfawi also have an oxidized, black, organic layer at their base, suggesting the emergence of the groundwater before the accumulation of run-off. On the other hand, there is no carbon layer at the base of the corresponding deposits at Selima, Oyo or Wadi Hussein, and the

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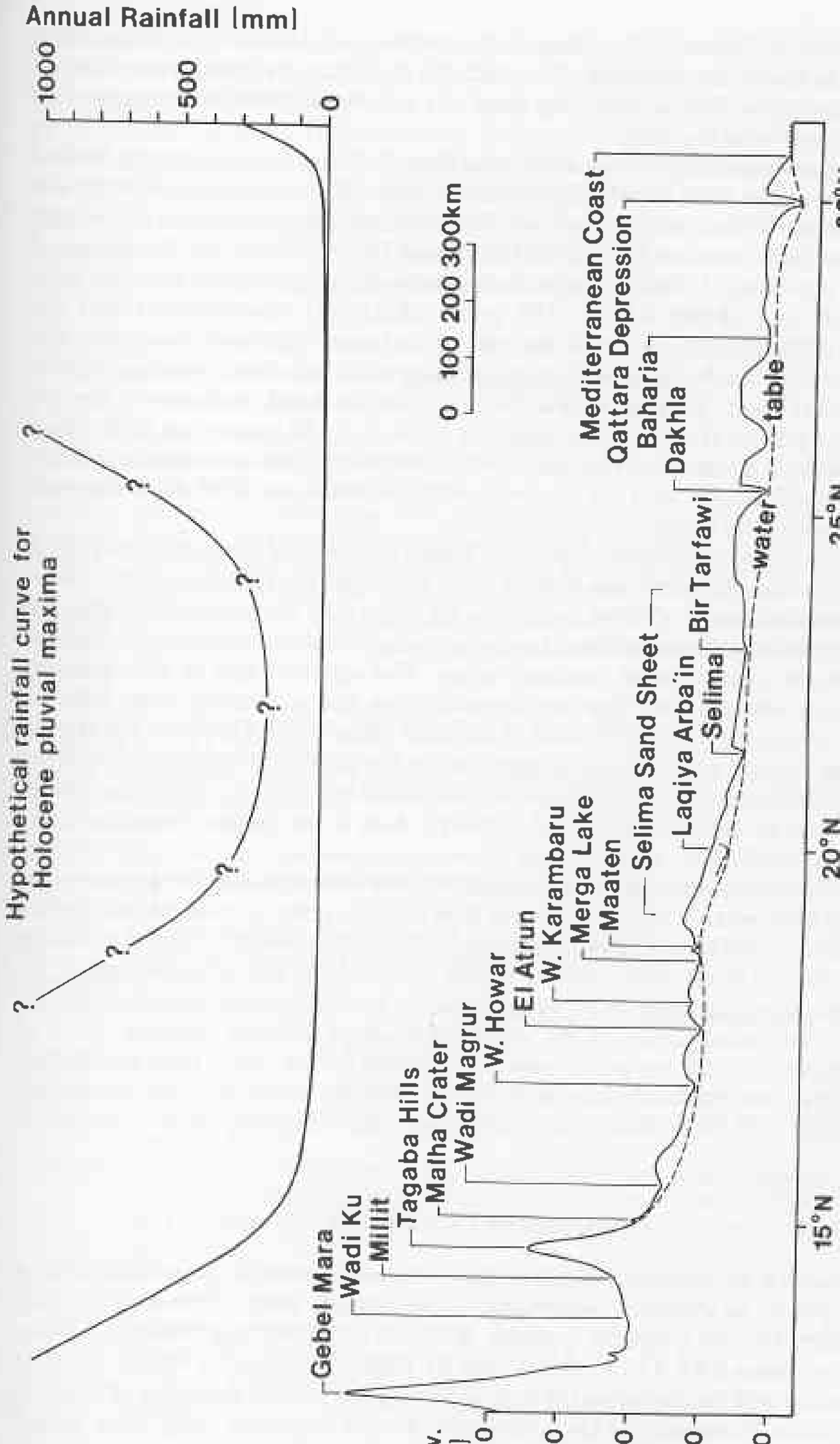

Figure 4.7 Topographic profile from Jebel Marra to Mediterranean coast in relation to profile of modern isohyets and to profile inferred for a Holocene pluvial (queried curve). Water-table extrapolated between points of emergence.

basal sand and fine gravel at Oyo show current-bedding and contain colluvial fragments of quartzite (including artifacts) which indicate derivation by slope-wash from the edges of the basin. This suggests that there was little or no effective vegetative filter before the arrival of the rains.

The radiocarbon dating of shell carbonates from the Pleistocene lakes in the Tarfawi area indicates that all of the Middle Paleolithic deposits are more than 44,000 years old. However, the hard-water effect may have made the apparent ages too old because dates on organic residues from Bir Tarfawi and Tarfawi West (the Bir Sahara of Wendorf and Schild [1980]) have produced finite dates of 21,950 B.P. ± 490 years (SMU.214) and 28,000 B.P. ± 1250 years (SMU.108), respectively (Haas and Haynes 1980). The infinite values obtained on carbonates are more compatible with the archaeology but the finite dates are more compatible with dates mentioned above. On the other hand, a small organic fraction from the basal mudstone of the late Pleistocene lake at Oyo yielded a date of 6740 B.P. ± 180 years (AA.459), which clearly indicates contamination by younger organic matter. The accurate dating of the Middle Paleolithic pluvial of the Darb el Arba'in Desert is one of the more important problems still to be solved.

In summary, the radiocarbon dates from Selima indicate that the organic fractions of sapropels produce apparent ages that are older than equivalent charcoal dates. This is due to metabolization of older carbonate by algae and to redeposition after the reworking of older lake-beds. Since they are not subject to chemical exchange, they can confidently be interpreted as maximal values. The apparent ages of the carbonate fractions are always older than the charcoal dates and are usually older than the sapropel values, presumably because of the hard-water effect. However, the reverse may occur and this can probably be attributed to the significant redeposition of older sapropel. Chemical exchange between the carbonates and younger, post-depositional, water cannot be definitely excluded, although there is no obvious example of this phenomenon at Selima.

The charcoal layer and the compressed reed-mat at the base of the groundwater-supported lake-beds are believed to result from the emergence of groundwater in some of the basins ahead of an east-west wetting front, which moved northward across the Sahelian belt of North Africa during pluvial periods. The rate of movement of the groundwater recharge front, or of the precipitation front if so it was, may be estimated from the radiocarbon dating of the basal charcoals at different latitudes. Rates of approximately 0.5–1.0 km per annum are indicated for the major pluvials. Modern shifts of the isohyets have been observed to move at a rate of 9 km per annum (Winstanley 1973), which suggests that episodic rates can be an order of magnitude greater.

ACKNOWLEDGMENTS

This research is an outgrowth of that of the Combined Prehistoric Expedition and has been supported by National Geographic Society grants 2087, 2258 and 2790-84, Smithsonian Foreign Currency Program grant FC10215300 and National Science Foundation grants EAR 82-16725 and EAR 83-12651. The research was carried out in collaboration with the Egyptian Geological Survey and Mining Authority (EGSMA) and the Sudan Department of Geological and Mineral Resources (SDGMR), both of which provided administrative support. Participants in the fieldwork between 1976 and 1984 were L. Boulos (University of Cairo). B. Issawi, M. Said, R. Said, A. Swedan and

El S. Zaghloul (EGSMA), D. L. Johnson (University of Illinois), P. J. Mehringer, Jr. (Washington State University), A. B. Muller (Atomic Energy Agency), J. Olsen (University of Arizona) and A. G. El Shafie (SDGMR). Radiocarbon dating was performed by A. Long (University of Arizona), H. Haas (Southern Methodist University) and J. C. Sheppard (Washington State University). Tandem accelerator ^{14}C dates were provided by D. Donahue, T. Jull, T. Zabel and L. Toolin (Arizona-NSF Regional Facility for Accelerator Mass Spectrometry). The comments and suggestions of P. J. Mehringer, Jr. and J. C. Ritchie are appreciated, and I must blame Fred Wendorf for getting me hooked on the Eastern Sahara.

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5

Resources and Subsistence During the Early Holocene at Siwa Oasis, Northern Egypt

FEKRI A. HASSAN

G. TIMOTHY GROSS

> The quiet camps, the glorious silence, a clean and undisturbed world, the dry crisp air, glorious dawns and sunsets and the everchanging colour of the desert, make it one of those experiences worth remembering and that is where one's heart is lost for ever.
>
> Alec Ralli (1938)

INTRODUCTION

Siwa Oasis (Figure 5.1) was famed in classical antiquity for its oracle. It was visited by Alexander the Great and mentioned by Herodotus, Strabo, Diodorus, Plutarch and Pliny among others. However, by the end of the Ptolemaic period, the Oracle had almost disappeared and Europe subsequently lost notice of Siwa. The oasis continued to be mentioned by Arab scholars for its gardens and trade relations, but it was not until Siwa was visited in 1792 by John Browne, an English explorer, that it was rediscovered by Europeans. Thereafter, it was visited by many scholars. Among the notable early visitors were Gerhard Rohlfs, the great German explorer, in 1869 and 1874, and G. Steindorf, the eminent Egyptologist, in 1899–1900 (Fakhry 1973; Walker 1921).

These early explorations drew attention to the Temple of Amon and other antiquities in Siwa, but the prehistory of the region remained largely unknown. Prehistoric information was mostly based on unsystematic collections made by H. W. Seton-Karr (parts of them are now in the Museum of Alexandria) and by C. Willett-Cunnington (his large, but extremely biased, collection is now in the Museum of Archaeology and Ethnography in Cambridge, England). A small collection was also made by Oric Bates (Fakhry 1973:71). Until recently, the only scientific description of the prehistoric lithic artifacts from Siwa was one by McBurney (McBurney and Hey 1955) of Willett-Cunnington's collection.

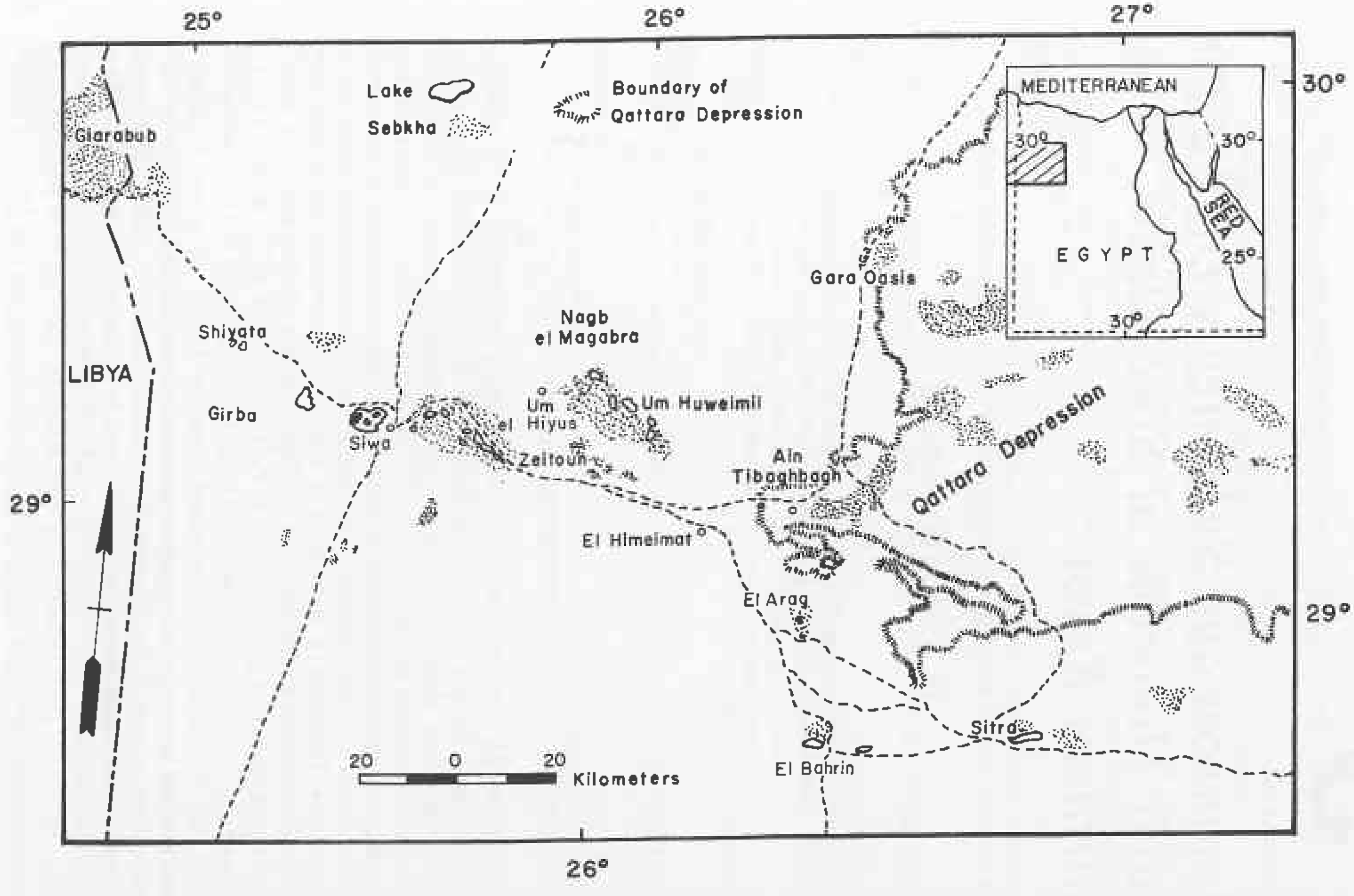


Figure 5.1 Map of the region of Siwa Oasis.

Figure 5.1 Map of the region of Siwa Oasis.

In 1975 and 1976, systematic investigations of the prehistory and Quaternary geology of the region of Siwa Oasis were initiated by the senior author (Hassan 1976, 1978).

Siwa Oasis (29°0′–30°30′N, 25°0′–26°0′E) lies in the northwestern corner of the Western Desert of Egypt, close to the Libyan border. It is approximately 560 km west of the Nile Valley and 274 km south of the Mediterranean coast. In addition to the main oasis, there are several smaller oases in the vicinity, including Gara, El Areg, Bahrin and Sitra (Figure 5.1). These oases are situated in a depression, a few meters below sea level, at the southern edge of the Marmarica Plateau (Said 1962). The floor of the depression contains several small salt-lakes surrounded by sebkhas, mud-pans and agricultural fields dotted with palm groves. The soils are entisols and aridisols (Fathi *et al.* 1971). The depression is bordered on the south by the dune fields of the Great Sand Sea, where an army dispatched by Cambyses lost its way in 525 B.C.

Siwa today is a very dry region. The mean annual rainfall is no more than 9 mm, with maxima in February and May. The mean monthly maximal temperature ranges from 19.7°C in January to about 38°C in July and August (Hecht and Kniesel 1968; Kassas 1955). It was during the summer months that most of our work was conducted.

The present aridity in Siwa was preceded by a period of increased rainfall during the early Holocene, as indicated by the sediments in the Um el Hiyus mudpan, 30 km east of Siwa. Most of the sites located at Um el Hiyus and elsewhere date from the ninth to the seventh millennia B.P. (Hassan 1978).

Sites were discovered in several different areas and geomorphic settings in the Siwa Oasis region. The archaeological remains consist almost entirely of lithic artifacts and fragments of ostrich eggshell; no mammalian or plant remains were recovered. The raw material utilized was mostly local chert and silicified limestone of varied quality. Most of it was obtained from bedrock exposures and lag deposits. The most common variety of core is the double-platform type, followed by three-platform and single-platform cores. The majority are exhausted cores from which both flakes and blades were detached. The flakes often outnumber blades by a ratio of about 2.5:1, ranging from 1.2:1 to 4.6:1. Apart from simple retouched pieces, the most common tool-classes are backed bladelets and burins. Other, less common, tool-classes include perforators, endscrapers, notched and denticulated pieces, and points (Table 5.1; Figures 5.2–5.4); geometrics and microburins are very rare. The assemblages also contain grinding-stones, fire-cracked sandstone and ostrich eggshell beads. Potsherds were found at sites 76/4 and 76/24, but they were very rare and could not be definitely assigned to the prehistoric occupations (Gross 1980).

The assemblages from Siwa most closely resemble the "Libyco-Capsian" and the earliest Neolithic at the Haua Fteah in Cyrenaican Libya, which date from about 10,000–7000 B.P. (McBurney 1967). The Haua Fteah assemblages, like the Siwan, contain backed macrolithic and microlithic blades, burins and scaled pieces, and have low frequencies of notched and denticulated pieces, endscrapers and geometric microliths. They are characterized, however, by a very high frequency of backed pieces (Close 1986). The Siwan assemblages are also similar to the Terminal Pleistocene (Qarunian) assemblages from the Fayum, which date from about 8100 to 7140 B.P. (Wendorf and Schild 1976).

There is a great deal of similarity between the assemblages from the various oases of Siwa. The Siwan industry thus represents a distinct prehistoric province with affinities with other northern regions both to the west in Libya and to the east in the Fayum.

TABLE 5.1

Tool-Classes from Some Holocene Sites in the Siwa Oasis Region

	Um el Hiyus				Gara				El Arag					
	75/5		75/31		75/24		75/27		76/4		76/24A2		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Perforators	4	5.8	4	6.3	1	8.3	5	2.3	1	2.3	5	6.0	20	4.0
Endscrapers	1	1.4	4	6.3	1	8.3	18	8.1	3	6.8	5	6.0	32	6.5
Burins	11	15.9	18	28.1	1	8.3	18	8.1	5	11.4	35	41.7	88	17.8
Backed blades and flakes	0	-	1	1.6	0	-	13	5.9	1	2.3	2	2.4	17	3.4
Backed bladelets	37	53.6	9	14.1	3	25.0	72	32.6	2	4.5	5	6.0	128	25.9
Notches and denticulates	3	4.3	3	4.7	2	16.7	17	7.7	12	27.3	8	9.5	45	9.1
Ret. pieces	7	10.1	8	12.5	1	8.3	37	16.7	9	20.5	11	13.1	73	14.8
Sidescrapers	2	2.9	12	18.8	0	-	11	5.0	5	11.4	12	14.3	42	8.5
Truncations	0	-	0	-	0	-	3	1.4	0	-	0	-	3	0.6
Points	0	-	1	1.6	2	16.7	13	5.9	3	6.8	1	1.2	20	4.0
Geometrics	0	-	2	3.1	0	-	2	0.9	0	-	0	-	4	0.8
Bifaces	0	-	2	3.1	0	-	1	0.5	2	4.5	0	-	5	1.0
Others	4	5.8	0	-	1	8.3	11	5.0	1	2.3	0	-	17	3.4
Total	69		64		12		221		44		84		494	

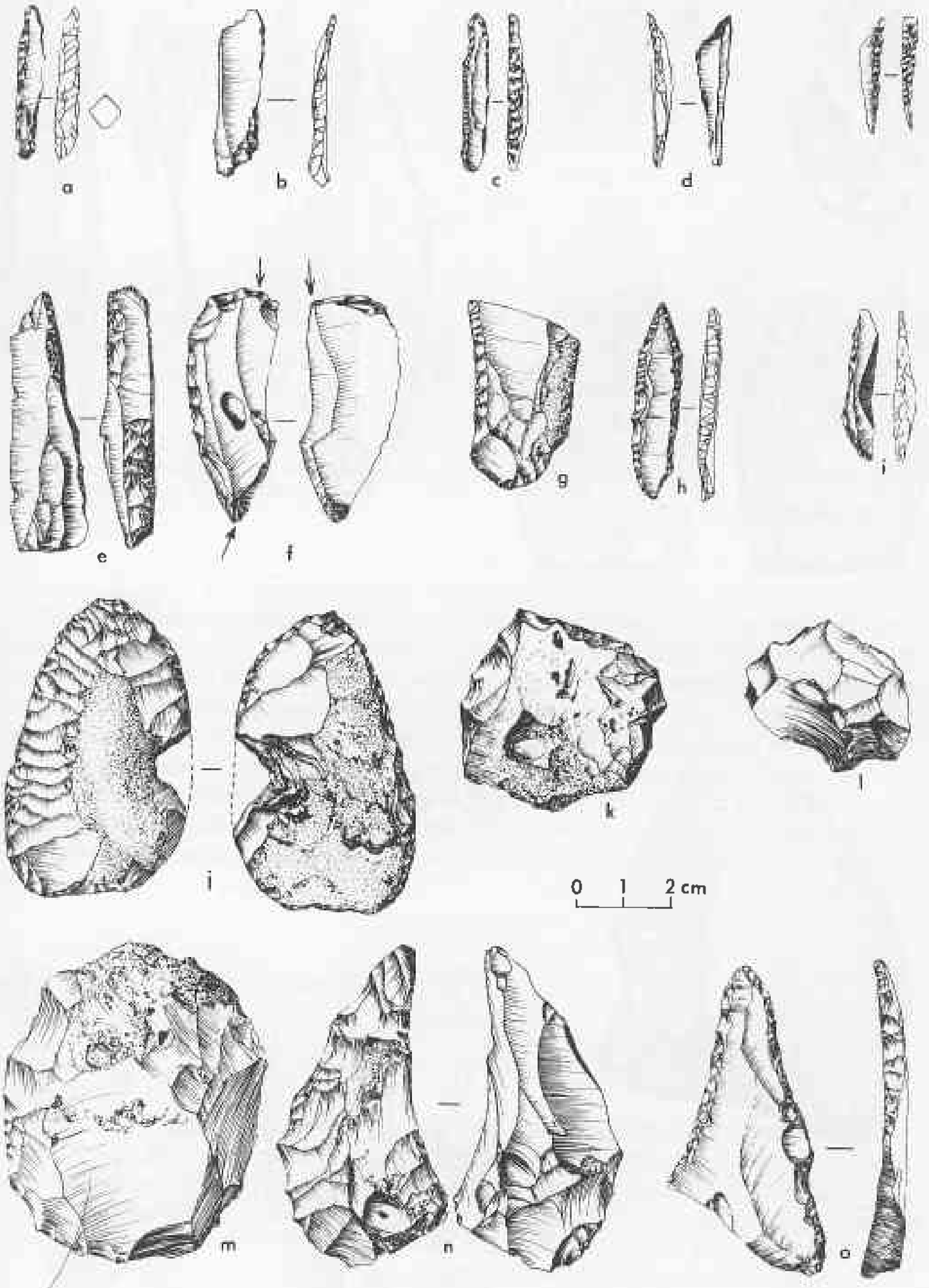


Figure 5.2 Lithic artifacts from site 75/31, Hatiet Um el Hiyus.

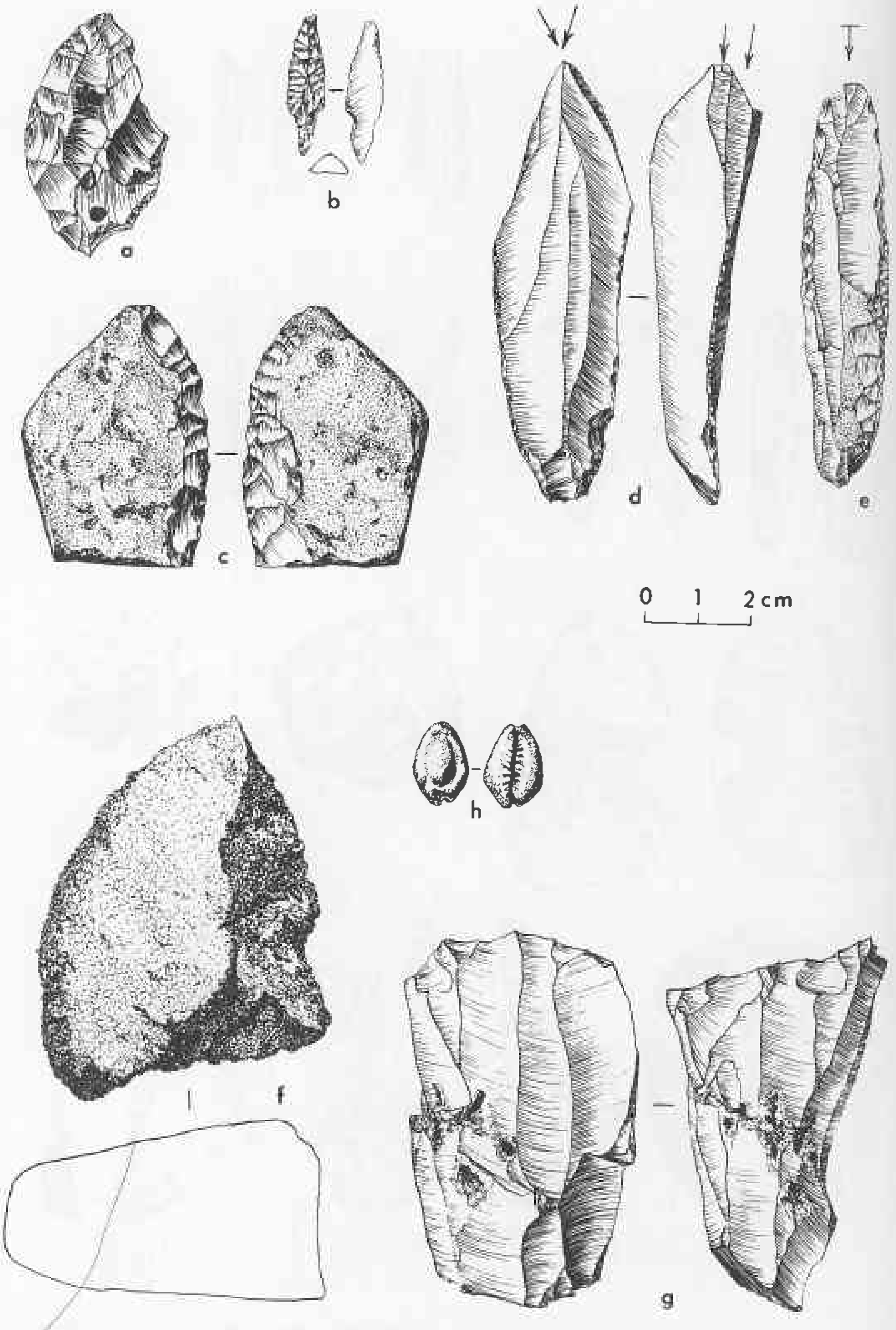
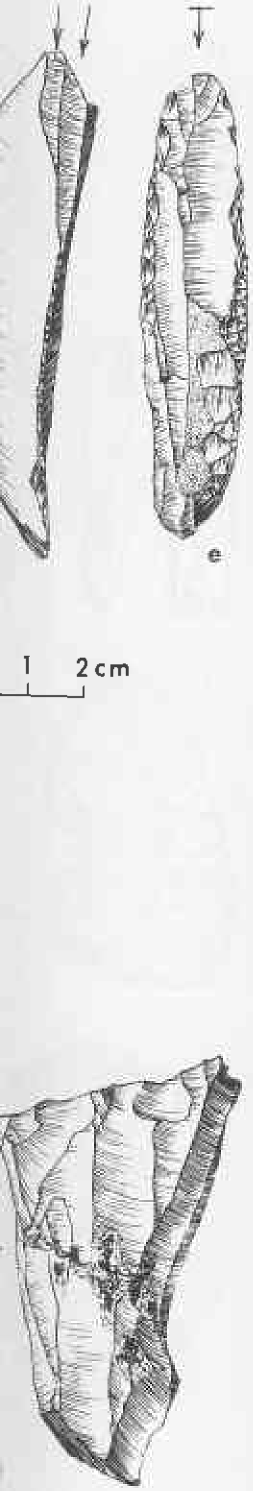


Figure 5.3 Artifacts from Hatiet Um el Hiyus. a–e, site 75/12; f, 75/11; g, 75/32; h, 75/32 Trench.



75/32; h, 75/32 Trench.

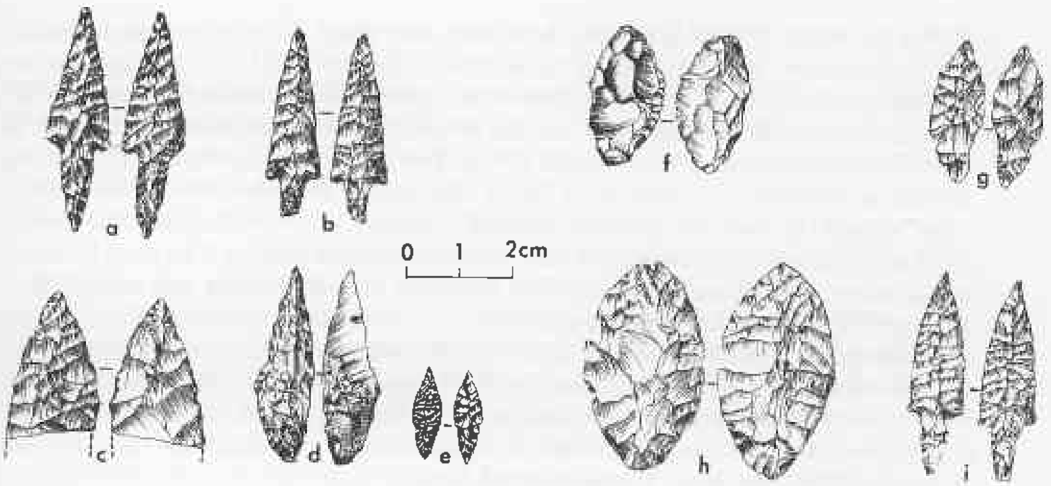


Figure 5.4 Bifacial points from Hatiet Um el Hiyus, Siwa Oasis region. a–e, surface finds; f–i, site 75/15.

The early Holocene sites of Siwa were most probably those of hunter-gatherers and may be compared with Final Paleolithic groups elsewhere in the Western Desert of Egypt at that time. The lack of pottery and the absence of any evidence for domesticates suggest that there was not an agricultural mode of production. This is corroborated by the low density of artifacts, by the relatively small size of the sites and by the lack of architectural remains, storage pits or large, non-portable objects. In this study, we will try to provide an assessment of the potential range of resources that would have been available to the prehistoric Holocene inhabitants of the Siwa Oasis region, and to explore the probable subsistence regime employed by them and its implication for population size and mobility.

RESOURCES

WATER

Water is the limiting factor in desert habitats. The meager amounts of rain that fall in Siwa today are not adequate to sustain its inhabitants, who depend on the flow of natural springs and wells for their water supply. During the early Holocene, the annual rainfall was far greater than at present, but it was probably only in the range of 50–100 mm, compared with 200–300 mm farther south (Hassan 1986, in press).

This increase in rainfall in the early Holocene is likely to have been associated with an expansion of the saline lakes and sebkhas, as well as a relatively greater flow of spring water. The groundwater from which both the lakes and springs are fed consists of Pleistocene (50,000–20,000 B.P. and post-14,000 B.P.) and Holocene water (Haynes and Haas 1980; Knetsch 1962; Sonntag *et al.* 1980a, 1980b). There are at present 200–300 springs in the Siwa region. Historical Islamic accounts refer to 1000 springs during the better days of Siwa, but there were only about 20 good springs during the fifteenth century, as described by Al Marqrizi (Fakhry 1973:95). Old springs are frequently re-excavated by the modern inhabitants of the oasis. Unless drained, the springs form marshes around them, and the presence of drains is often used as a clue to identify older, defunct springs (Wakid 1956). The native Siwans actually classify the springs as "defunct" or *matmousa* (those that can be identified from their traces), "dry" or *gaffa* (extant, but dry) and "running" or *garia.* It is very likely that the springs were far more numerous during the early Holocene than at present. The late Holocene aridification would have led to a severe reduction in their number and rate of flow, although there would have been greater water-flow and relatively more springs during the moist spells dated to 3900–3500, 2950–2900 and 2000–1500 radiocarbon years B.P. (Hassan 1986). The last of these moister intervals corresponds to 75 B.C. to A.D. 480 in calendrical years and coincided, in part, with the late Roman and Ptolemaic occupations. Many of the springs show evidence of masonry work from Greco-Roman or earlier, Pharaonic times (Omer-Cooper 1947).

The estimated total flow for the entire depression is 190,000 m^3 per diem or about 70,000,000 m^3 per annum (Parsons 1963:4–22). Not all of this water is available for drinking, since the water from the springs is of relatively poor quality and contains large quantities of salts. The electric conductivity (EC) of the water ranges from 2500 to 5000 micromhos per cc (the maximum range recorded is 2300–10,000). Water ranging in EC from 2300 to 2800 is acceptable for drinking and has no pronounced unpleasant taste (Parsons 1963). No more than 80 of the 200–300 springs in modern Siwa are used for irrigation and drinking.

In addition, there is a very shallow water-table, occurring within 30–50 cm of the ground-surface. This level is primarily maintained by upward seepage of artesian groundwater (Parsons 1963:4–12), but most of the water is salty (Maghrabi 1977).

The poor quality of water in many of the springs is recognized by the inhabitants of Siwa who therefore value rainwater. Cline (1936:21) reported that when a rare shower falls in the area, men hurry out to the high desert, a trip of about 40 minutes on foot, where rainwater "with its cream of brown silt" is collected in jars and transported back to the village. When we were in Gara, we were asked if we would make a trip to get water from an oil-exploration well that had produced sweet water (and warm) from the Nubia Sandstone aquifer.

We may thus conclude that water was more abundant during the early Holocene and, because of the higher rainfall, also less saline in many places. In addition, water would have been available from ephemeral pools in desert depressions and mud-pans after the rain (supplemented, of course, by the brown silt cream!) In the absence of ceramic water-jars, water was probably transported and stored in animal skins (*guerbas*) and ostrich eggshells. The historical use of animal skins for the transport of water has been reported by Gautier (1928) for the area west of Siwa. The use of ostrich eggshells as water-containers is widely known. The distribution of drinking water at certain springs would have provided an incentive to visit those springs for this valuable resource, especially during the dry months of the year. During the rainy periods, the distribution of rainwater would have been erratic in both time and space, and must have been exploited opportunistically, allowing for an expansion of subsistence and other activities beyond the zone where spring water was available. Blood and water squeezed from the stomach of game animals are also known to provide a substitute for water for native hunters in North Africa (Briggs 1960:30).

PLANTS

Vegetation in the region of Siwa oasis is sparse and restricted to the depressions where surficial sources of water are available, and to the small depressions (*hatiet*, pl. *hatayia*) where the water-table is near the surface. There are four basic plant-communities in the oases of Egypt (Hassib 1951), which are as follows:

1. The aquatic plant-community in lakes and springs.
2. The marsh plant-community in wet soils. This community is found bordering lakes and springs, as well as wells and irrigation ditches.
3. The halophytic plant-community associated with saline soil conditions.
4. The uncultivated plant-community which consists of those plants that were likely to have existed prior to agriculture in non-marshy, non-saline areas of the depression. Plants in this community include *Tamarix arborea*, which is common in many of the *hatayia*. Phytogenic dunes also form around this tree.

The plants that are known to occur in Siwa today, and those that are likely to be present, can be identified using data from Bates (1970), Fathi *et al.* (1971), Kassas (1952, 1953, 1966), Muschler (1912), Omer-Cooper (1947) and Täckholm *et al.* (1956). Of these plants, those that are edible are listed in Table 5.2.

The higher precipitation during the early Holocene must have led to both an expansion of vegetation associated with springs and lakes, and also to an increase in the number of *hatayia*, or mini-oases, scattered across the low desert surrounding the main depression.

ANIMALS

The prehistoric, Holocene inhabitants of Siwa probably supplemented their diet of plants with whatever animals they were able to capture. The only remains that have survived in the archaeological record are those of ostriches, represented by their eggshells. In general, bones are rare or absent from most sites in the Western Desert of Egypt. This seems to result from several factors, including the short-term occupations of most of the sites, the small size of the animals, the removal and destruction of bones by dogs and other carnivores, as well as their destruction by surficial desert weathering processes. The reconstruction of the early Holocene fauna of the Siwa Oasis region given here is based on accounts of animals in the region (Bates 1970; Misonne 1970; Omer-Cooper 1947; Osborn and Helmy 1980; Osborn and Krombein 1969), and on the prehistoric faunal assemblages recovered from other areas in the Western Desert (Gautier 1980, 1984) and from Cyrenaican Libya (Klein and Scott 1986).

Animals captured and consumed by the prehistoric Siwans are likely to have included terrestrial and freshwater molluscs, worms, lizards, fish, birds and larger mammals. Among the wild animals reported to be eaten by modern Siwans, Wakid (1956:366) includes foxes, jackals, gerbils and rats. During our visit to Gara Oasis, we observed landsnails in association with Greco-Roman marsh deposits; landsnails were widely exploited in other areas of North Africa. Caillaud (cited in Cline 1936:21) reported that freshwater molluscs were eaten historically by the Siwans. They have also been said to eat lizards (Cline 1936), fish (Cline 1936:28; Jennings-Bramly 1897:607) and birds (Cline 1936:28; Wakid 1956). Bates (1970) reported the presence of jerboa in the Siwa region. The "water worms" of saline lakes (actually

TABLE 5.2
Edible Plants of the Siwa Oasis Region

Plant	Source
Edible Leaves or Shoots	
Centaurea calcitrapa	Hedrick 1919:156
Cichorium pumilum var. *endiva*	Hedrick 1919:166
Sonchus oleraceus	Hedrick 1919:551
Plantago coronopus	Hedrick 1919:445
Apium graveolens	Hedrick 1919:55
Medicago sativa	Hedrick 1919:358
Brassica nigra	Hedrick 1919:107
Silene villosa var. *ismaelitica*	Hedrick 1919:534
Stellaria media	Hedrick 1919:557
Portulacca oleracea	Hedrick 1919:450–451
Asphodelus fistulosus var. *tenuifolius*	Täckholm and Drar 1954:49
Edible Fruits	
Colocynthis vulgaris	Hedrick 1919:169
Vitis vinifera	Hedrick 1919:603
Capparis spinosa	Hedrick 1919:133
Hyphaene thebaica	Hedrick 1919:310
Edible Roots	
Daucus carota var. *boissieri*	Hedrick 1919:232–236
Geranium dissectum	Hedrick 1919:286
Phragmites communis var. *stenophylla*	Hedrick 1919:430
Edible Seeds	
Colcynthis vulgaris	Hedrick 1919:169
Acacia albida	Menninger 1977:88
Vicia sativa var. *angustifolia*	Hedrick 1919:596
Tribonella foenum graecum	Hedrick 1919:576
Edible Exudate (*mana*)	
Tamarix aphylla	Hedrick 1919:562
T. nilotica var. *mannifera*	Monod 1963:194
Alhagi maurorum	Hedrick 1919:30
Acacia albida	Menninger 1977:88
A. arabica	Hedrick 1919:18
Phragmites communis var. *stenophylla*	Hedrick 1919:430
Potherbs	
Chorchorus trilocularis	Hedrick 1919:190
C. olitarus	Hedrick 1919:189
Zygophyllum coccinium	Hedrick 1919:623 & Menninger 1977:85
Oxalis corniculata	Hedrick 1919:401
Antiscorbutic	
Veronica anagallis	Hedrick 1919:591

k 1919:156
k 1919:166
k 1919:551
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1919:169
1919:603
1919:133
1919:310

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1919:591

Artemia salina, a primitive kind of shrimp) may have been collected. Near Mourzouk in the Fezzan, these worms are collected and pounded together with a little salt until the mixture becomes a black paste, which is then rolled into balls about the size of a large orange and set out to dry in the sun; they apparently taste like very bad caviar (Briggs 1960:27). Both gerbil and jerboa are present in the Siwa Oasis region and are easy to collect. Birds reported from the region include cranes, flamingoes, ducks, geese, pelicans, doves, pigeons, wagtails, hawks, crows, ravens, owls and the night-heron (Belgrave 1923; Jennings-Bramly 1897).

The ostrich must have been very common in the Siwa region during the early Holocene and was, in fact, still present well into the nineteenth century. Reports of the ostrich from the surrounding area and from between Siwa and Alexandria were made in 1743 by Pococke, in 1799 by Saint-Hilaire and in 1806 by Browne (Goodman *et al.* 1984). In 1856, Heuglin stated that ostriches were not to be found north of Cairo, and, writing in 1873, he noted that the ostrich still lived around the oases of middle Egypt, from the Fayum southward and westward to the oases of Dakhla and Kharga (Goodman *et al.* 1984). The latest report was by Al Hussaini in 1959, who was informed that a bird had been caught at "Abou-al-Oql," somewhere between Kharga and Dakhla Oases (Goodman *et al.* 1984). The ostrich was then said to have become locally extinct, but Goodman and others (1984) collected an adult male bird, a chick and two fresh eggs from Wadi Hareitra, west-southwest of Gebel Elba.

Among the larger animals, gazelle are still common and are hunted by some Siwans and Bedouin. We have frequently chanced upon one or two gazelle in the *hatayia,* and their tracks and droppings are often seen on the mud-pans. Bates (1970) and Osborn and Krombein (1969) suggest that *Oryx dammah* and *Addax mesomaculatus* were probably present in historic and prehistoric times. The latter has been reported from many Libyan localities (Osborn and Krombein 1969:12) and was formerly widespread throughout the entire Sahara. They are typically desert-dwellers and may often be found far from any water-hole in both the sandy and the stony deserts (Dorst and Dandelot 1969:200). The scimitar-horned oryx (*Oryx dammah*) lives in Sahelian and semi-desert habitats, and formerly ranged over most of northern Africa. It is a favorite game animal for the desert Bedouin and the oil-workers (Dorst and Dandelot 1969:201). At the Haua Fteah in Cyrenaica, Klein and Scott (1986) have reported relatively large numbers of gazelle and hartebeest and a marked predominance of Barbary sheep. Barbary sheep inhabit rocky mountains and broken country, and are not likely to have been common in the Siwa region, except, perhaps, in the hilly areas far from the depression proper. The abundance of gazelle and relatively low frequency of Barbary sheep at Hagfet et Tera (Iberomaurusian) indicate proximity to the desert, as suggested by Higgs (1967) and Klein and Scott (1986). From this we can conclude that Barbary sheep may not have been a very common element in the late Quaternary fauna of the Siwa region. Hartebeest, which was common along the Nile Valley (Gautier 1976) and in the Fayum (Brewer 1986), was also most probably absent from Siwa, since it inhabits open country and light bush rather than the subdesert borders of the Sahara (Dorst and Dandelot 1969:220).

Gazelle and hare were probably the most common game animals hunted, as may be surmised from the faunal assemblages of early Holocene sites of the southern part of the Western Desert (Gautier 1980, 1984). The most frequent gazelle is the dorcas gazelle (*Gazella dorcas*), a small gazelle (20–22 kg) that lives on sand dunes and stony desert and prefers flat country. Gautier (1976, 1980, 1984) has often reported red-fronted gazelle (*Gazella rufifrons*) in association with dorcas gazelle in late Quaternary sites in

Egypt. This also is a small gazelle (25–30 kg) that inhabits open arid country with thorn-bushes. The difference between the dorcas and red-fronted gazelles is slight (Gautier 1984:57). A larger gazelle, the dama (*Gazella dama*), has been reported from the Bir Kiseiba region (Gautier 1984:57). This animal weighs about 70–75 kg, and often lives side by side with the dorcas gazelle. It browses on various desert shrubs and acacia trees and can survive for long periods without drinking, but its water-requirements are greater than those of the dorcas. In Siwa, the dama gazelle may have been less common than it was farther south, where rainfall was presumably greater. There are also reports of some Loder's gazelle (*Gazella leptoceros*) from the area west and northwest of Bahariya Oasis, and of large numbers of them farther north, on the southeastern fringe of the Qattara depression (Ralli 1938:75).

The hare usually reported from the Nile Valley and the Western Desert is the Cape hare (*Lepus capensis*), which is very common in the northern part of the Desert. In a narrative characteristic of a sportsman, Ralli (1938:76–77) provides the following account of the hares of the northern part of the Western Desert:

> These hares are a pale sandy colour which blends with their surroundings, and they give quite good sport when walked up; but being exceedingly wary, they often bolt from afar giving no chance to the gun. Beating is therefore usually resorted to and guns are posted in a semi-circle facing some biggish area of low bushes which are found like green islands in the stony desert. The beaters work their way towards the guns, creating the usual din characterising any beat. As many as fifty hares have been shot by six guns in two days.

Other animals, which are less common in the faunal assemblages of the Western Desert, include desert hedgehog (*Paraechinus aethiopicus*), lesser gerbil (*Gerbillus gerbillus*), grass rat (*Arvicanthis niloticus*), lesser jerboa (*Jaculus jaculus*), porcupine (*Hystrix cristata*), golden jackal (*Canis aureus*), Rueppell's fox (*Vulpes rueppellii*), birds including quails, purple heron, and garganey (*Coturnix coturnix, Ardea pupurea* and *Anas querquedula,* respectively), lizards, and toads or frogs.

Ralli (1938) also notes that among game animals found wherever some form of vegetation exists, such as low brush, small shrubs and herbs, are the lesser bustard, sand grouse, foxes and striped hyena. Wild cats have also been reported from the rocky hills around Bahariya Oasis, and may have been present farther north. Remains of the African wild cat (*Felis sylvestris*) have been reported from early Holocene sites in the southern part of the Western Desert (Gautier 1984).

SUBSISTENCE

Various aspects of subsistence will be considered in this section, including hunting practices, subsistence technology, seasonality and the spatial patterning of subsistence activities.

HUNTING PRACTICES

With the exception of points, which may have been used to arm spears or arrows, there is no information available on hunting or other food-procurement practices. However, the study of hunting practices by the Tuareg (Nicholaisen 1963:157–173) and other information from modern Siwa throws some light on the likely modes of hunting.

Gazelle are the principal game animal for the Tuareg of the Ahaggar and are obtained by means of spears or traps. Spear-hunting occurs during the hottest time of the day, when the animals are killed as they hide in the shade of rocks or shrubs. Traps consist of either a circular device with spikes protruding into the center, which is secured to the ground by means of a rope tied to a stake, or a torsion trap. The former type has been observed in Bahariya and is also represented in ancient Egyptian art.

Other animals trapped by the Tuareg include hare, jackal, fennec and rodents. Birds are also trapped by various kinds of snares (leather or hair), falling-stone traps and basket-traps; the falling-stone trap is a flat stone propped up by a baited stick. A bird trap observed in Gara (by Hassan) consisted of a rope woven around a wood frame propped up by a stick. Basket-traps have been reported from Siwa by Cline (1936:21). Lizards are taken by hand or with the aid of a stick; in Gara, according to Cline (1936:21), lizards were also trapped.

The successful hunting of animals also depends on a knowledge of their behavior. For example, swinging a sandal above one's head causes a hare to remain motionless in its hiding-place—supposedly because it believes it is being hunted by a bird of prey. Gazelle may be taken without weapons if the animal can be stalked while hiding in the shade. This method is practiced by the Tuareg (Nicholaisen 1963:163) and was also described to Hassan by Ragab, a foreman from the Ababda of the Red Sea Hills.

SUBSISTENCE TECHNOLOGY

Flaked stone points and grinding-stones are the hunting and food-processing equipment most likely to survive in the archaeological record. Other possible tools, such as points made of hardened wood or bone, traps of thorns, sticks, leather rope, digging-sticks, throwing-sticks and seed-beaters, if they existed, have left no trace. The lithic assemblages from Siwa are suitable for wood- or bone-working, hide-processing, cutting, scraping and perforating, and may have thus been used in making wooden and bone implements, leather ropes and water-skins.

SEASONALITY

A study of seasonality in the Kom Osheim region (Boulos and Eissa 1973) provides an analog for desert regions. Mammals were found to be active throughout the entire year, reptiles were active in the spring, summer and autumn, while insects and birds were found to be relatively abundant in spring and autumn; winter was the season with the fewest available animals. Migratory birds are often available during spring and autumn (Omer-Cooper 1947:12); duck-hunting in Egypt is best from November to mid-February (Henn 1938:21). Ostrich eggs were probably a seasonal resource, since ostriches in the Sudan breed from October to January (Mackworth-Praed and Grant 1952:2).

The distribution of large animals is also likely to have been affected by seasonal changes in rainfall. Gazelle, for example, may wander over long distances in search of pasture, so that, during the rainy season, they are likely to disperse over the open desert in *hatayia*. During the rainless months, they tend to congregate close to springs.

Among the plant-foods, shoots, buds and greens were probably most abundant in the spring. Fruits were probably available in June and July, while nuts and seed crops would be available from August through November. In general, spring and autumn seem likely to have been the easiest seasons in which to make a living.

SPATIAL PATTERNING OF SUBSISTENCE ACTIVITIES

Water must have been the most restrictive of all resources. According to Woodburn (1968:50), the Hadza usually settle within a mile (1.6 km) of a source of water and consider 3–4 miles (5–6 km) to be the maximum acceptable distance over which water can be transported. Lack of water in the desert fringe of the depression during the dry months precluded extended visits there during that period. During the rainy months, on the other hand, the pools of water in desert *hatayia* would have allowed the pursuit of large game farther away from permanent springs. Hunting camps in the desert are thus likely to have been short-term occupations during the rainy season. The encampments were probably not very far from the rim of the depression where more dependable resources, especially plants, would have been available. In fact, the rim of the depression would provide access to the resources both of the depression and of the desert margin. The resources used in the depression are likely to have been those located close to springs, which would have included water, snails, plants, small and large game, and waterfowl in the surrounding marshes. Camps were most probably placed some distance (1–5 km) from the marshes to avoid frightening the game and to keep a distance from the notorious mosquitoes.

None of the marshy or desert *hatayia* would have provided enough food for a minimal band (15 persons) for more than a few months at most. Prehistoric groups must have exploited a large variety of food-resources since none of the resources is sufficiently plentiful to have served as an exclusive base within a specialized subsistence strategy. In addition, since none of the resources is highly productive, is found over a large area, or has a predictable occurrence in space and time, sedentism and large co-residential units are not likely to have occurred. The game animals yielded much less food and were even more unpredictable and widely scattered than the plant-foods, so the latter must have been very important parts of the diet. Furthermore, if one considers the difficulty involved in the successful hunting of large game animals (mostly gazelle and an occasional antelope), it is likely that much of the animal protein in the diet was derived from more readily available sources, which would include rodents.

These inferences concerning subsistence and those below concerning population suggest that the encampments were mostly seasonal and short-lived, and were located either near the fringe of the depression close to springs and marshes, or in *hatayia* within a day's journey of the depression, or, perhaps at most, within three days' walking-distance of the edge of the depression. The actual distribution of archaeological sites in the Siwa region is consistent with this model. Most of them are located either at the rim of the depression (56%) or around *hatayia* (41%); at Gara, the sites were within 2 km of a spring and at El Areg within a distance of 5 km.

In general, the sites are very small, with about 74% of them being less than 200 m^2 in area. A few sites are large (12% of the sites are >800 m^2 in area), but these consist of distinct concentrations indicating multiple encampments. Thus, certain places—specifically, the sites close to permanent springs and large *hatayia*—may have been more favored than others for repeated occupation.

SUBSISTENCE AND POPULATION

The population of Siwa during the Terminal Paleolithic must have been rather limited. Using Birdsell's (1953) formula for estimating population from rainfall, the 50-mm level derived from paleoenvironmental analysis of the early Holocene would indicate that the population density would have been about 0.026 persons per km² (or 40 km² per person). If we take into account the greater abundance of game in Africa than in Australia, where Birdsell developed his formula, and the presence of water in springs, we would expect the maximum potential population density to have been close to 0.05 persons per km², or perhaps slightly more.

Using the method developed by Hassan (1974, 1980:29–37), which is based on estimates of the biomass of the herbivores, we obtain a range for the population density of 0.036–0.054 persons per km². These figures are consistent with those obtained from Birdsell's method and also with those for hunter-gatherers in desert habitats (Hassan 1980). Application of this model to the Nile Valley provided a minimal estimate of 0.11–0.27 persons per km² during the Final Paleolithic.

The figure for Siwa is based on a value of 80 kg per km² of herbivores, a figure similar to that for the semi-desert steppe of Chad. According to Bourlière (1963:48), the ungulate biomass in an area of 30×40 km, west of Oum Chalouba (Chad), consisted of 1500 dorcas gazelle, 400 oryx, 300 dama gazelle and 15 addax, providing 80 kg per km². By comparison, the erg (sandy) desert of Mauritania supports 4–17 kg of ungulate biomass per km². A much lower figure of 0.3 kg per km² is estimated for the *Salsola* reg (stony) desert of Rio del Oro, mostly consisting of dorcas gazelle.

The population density estimate for Siwa is also based on several other assumptions (for additional details see Hassan 1980).

1. The percentage of plants in the diet was about 80%.
2. Small animals (birds, fish, snails, lizards and so forth) provided 75% as much meat as was obtained from large game—that is, about 42% of the total meat intake.
3. The edible portion of an ungulate is about 60% of the live-weight.
4. Meat provides 3000 kcal per kg and plants provide 1500 kcal per kg.
5. Average caloric intake was 1800 kcal per person per day.
6. The culling rate (the percentage removed from the biomass) was 10%.
7. The effective upper limit of population size for long-term survival is placed at 40–60% of the mean estimate of the carrying capacity, taking into account the considerable fluctuations in rainfall from year to year (Hassan in press).

Using a range of one day's walking-distance from water-resources, we estimate that the total usable area of the Siwa region was about 7000 km², which would have supported about 350 people at 0.05 persons per km². This population size is adequate for maintaining a regional mating network (Wobst 1974). If our estimate is in error by as much as ±50%, then the population of the Siwa region would have been between 175 and 525 people, which is still within the possible range of a single regional group. A survey of the size of regional groups or band aggregates among hunter-gatherers (Hassan 1980:51) indicates a modal range from 200 to 800 persons, with an average of 500 persons. If the range of the regional group were from 175 to 525 with an average of 350 persons, and the band-size were about 15 persons (three families), then the number of bands at any one time would have been about 20, with a possible range of 12 to 35. If the bands were larger (25 persons), the number of bands would have ranged from 7 to 21.

Spatial mobility in response to the seasonal shift in resources and to the scarcity of food at any one locality must frequently have brought local groups into contact with each other. This demographic arrangement, and the scarcity and sparsity of resources, would inhibit the formation of large local groups and dictate frequent interchange of mates between bands. This pattern is typical of other desert groups, which have been characterized by Hassan as one of four general types of hunter-gatherers. Desert hunter-gatherers are usually distinguished by "small, nonlocalized, low density, great fluctuations in group size, common periodic aggregations, exogamy, patrilocality with matrilineal alliance, bilateral or amorphous kinship systems" (1980:185).

Demographic flux and the great rate of spatial mobility provide the best explanation for the great similarity in the composition of the lithic artifact types over the greater Siwa region. Similarities between the Siwan assemblages and the Qarunian and the Libyco-Capsian of Libya are less than those within Siwa, but greater than those between the Siwan assemblages and the assemblages from farther south. We suggest that this reflects relative degrees of contact and interaction as a function of effective geographic distance. We further suggest that the interplay between resources, subsistence and population can provide a reasonable basis for interpreting intra- and inter-regional variability in lithic artifact assemblages—a major concern for most archaeologists in North Africa.

ACKNOWLEDGMENTS

Archaeological investigations in the Siwa Oasis region were supported by grants from the Smithsonian Institution (FR5-5002 and FR6-50007), the National Science Foundation (SOC-00222 and BNS7876-21606), and the Ira Mantooth Foundation. We are grateful for this support. We are also indebted to the officials of the Egyptian Antiquities Organization and the Geological Survey of Egypt for permits and logistical support. We owe special thanks to our field associates Sayed Zaghloul, Arlene Miller (now Rosen), Lewis MacNaughton, L. Peters, Afifa Afifi and Pat Cratty, as well as to Pat Podzorski and Anna Runnings for laboratory assistance and illustrations.

Fred Wendorf, by venturing away from the fresh food and luxurious hotels of the Nile Valley, although rarely without a supply of ducks to supplement the stale bread and onions, has pioneered a new phase in exploring the prehistory of the Egyptian Sahara. This contribution owes much to his leadership, support and encouragement.

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6

Sinai During the Paleolithic: The Early Periods

JAMES L. PHILLIPS

INTRODUCTION

This chapter is concerned with the nature of human occupation in the Sinai peninsula during the Upper Pleistocene. I will discuss the history of research in terms of similarities and differences between various regions within the peninsula, as they are reflected in the cultural, ecological and geomorphological systems. The quality and quantity of the data used by various authors (including myself) will be questioned and the results of the recent intensive surveys and excavations will be discussed.

HISTORY OF SURVEY AND EXCAVATION

The first recorded work in Sinai was that of the Petrie group at the turn of the century. Currelly (1906) excavated a Neolithic site near Mount St. Catherine, while Petrie excavated the Middle and New Kingdom site of Serabit el Kadem, in the Wadi Maghara of west-central Sinai. Most of the early studies, however, took place in the northeastern region of Sinai, especially near Qadesh Barnea and Quseima on the Negev frontier (Anati 1958; Buzy 1927, 1929; Neuville 1952).

After the Combined Prehistoric Expedition's work in Nubia and Wendorf's subsequent research in Upper Egypt, Marks began a similar project in the central Negev. This, in turn, stimulated Bar-Yosef and myself to begin our project in Gebel Maghara (Bar-Yosef and Phillips 1977) and the project of Bar-Yosef and Gilead in Qadesh Barnea (Gilead 1981a). When Sinai was returned to Egypt, Gladfelter and I began a project of exploration and excavation in southern Sinai, following a project by Bar-Yosef oriented toward the Early Holocene. All of these later projects have been concerned with settlement systems and hunter-gatherer adaptations, and have thus combined intensive survey of a small region with the excavation of selected sites.

THE SINAI LANDSCAPE

The Sinai peninsula covers some 60,000 km² of rugged territory and can be divided into three principal, morphological units (Goring-Morris 1985:19–20).

1. The northern plain extends from the Mediterranean through a low-relief area of dunes, to the south of which it is broken by a series of calcareous domes and anticlines running west to east: Gebel Yalliq (1094 m), Gebel Maghara (776 m), Gebel Libni (464 m) and Gebel Hallal (892 m).
2. El Tih plateau occupies approximately 60% of the peninsula. It consists of Mesozoic and early Tertiary limestone and dolomite, and dips toward the north from an elevation of about 1600 m at Gebel Egma.
3. The southern massif is composed mostly of metamorphics and granites, and includes many peaks above 2000 m, the highest being Mount St. Catherine at 2637 m. An east-west strip of Nubia Sandstone separates the crystalline mountain area from El Tih plateau.

The peninsula is bounded by the Mediterranean on the north, the shallow Gulf of Suez on the west and the deep Gulf of Aqaba (Elat) on the east. Northwestern Sinai is part of the eastern Nile system and has Nile sediments below the modern dunes. Eastern Sinai grades into the lowlands (in the north) and highlands (in the south) of the western Negev. Because of structural patterns and the local geomorphology, the drainage system of Sinai is primarily oriented toward the north; most of the wadis drain into the Wadi el Arish and debouche into the Mediterranean. Southern Sinai, however, contains major east-west drainage systems, such as the Wadi Feiran and the Wadi Kid (Figure 6.1).

The Sinai is a desert varying from arid to hyperarid with some Mediterranean influence in the north. Vegetation is of the Saharo-Arabian type with occasional Irano-Turanian features in the southern Sinai massif (Shmida 1977; Shmida and Orshan 1977). Summers are hot and dry and winters are cool. Rainfall occurs in the late winter and early spring but there are very few actual days of rain. Rainfall can be torrential so that consideration simply of the annual rate of precipitation can be deceptive. Almost 80% of the Sinai receives <100 mm of rain per annum, and more than half receives >50 mm (Goring-Morris 1985:23). The amount of atmospheric moisture varies with altitude, and the southern Sinai massif usually has more rainfall than the northern Sinai plain.

PALEOECOLOGY AND CHRONOLOGY

One of the first problems we must consider is to what extent the present topography, ecology, rainfall and wind patterns reflect those of the Upper Pleistocene. In fact, it is necessary to question the very nature of the evidence used for interpreting or predicting change in these variables. The following discussion is based on the work of Goldberg (1984, 1986; Goldberg and Bar-Yosef 1982), who has studied the geomorphology of Gebel Maghara, Qadesh Barnea, the Wadi Feiran and the Negev. Within the sedimentary record of each area, Goldberg views coarse sediments as indicative of wet

Figure 6.1 Locations of Ahmarian sites in the Levant and Sinai. Key: 1, Wadi Feiran; 2, Gebel Maghara; 3, Qadesh Barnea; 4, Nahal Zin; 5, Erg el Ahmar; 6, Mazaraq an Na'aj; 7, El Quseir; 8, Qafza; 9, Kebara; 10, Gebel Qalkh; 11, Wadi Fazael. (After Gilead 1981b)

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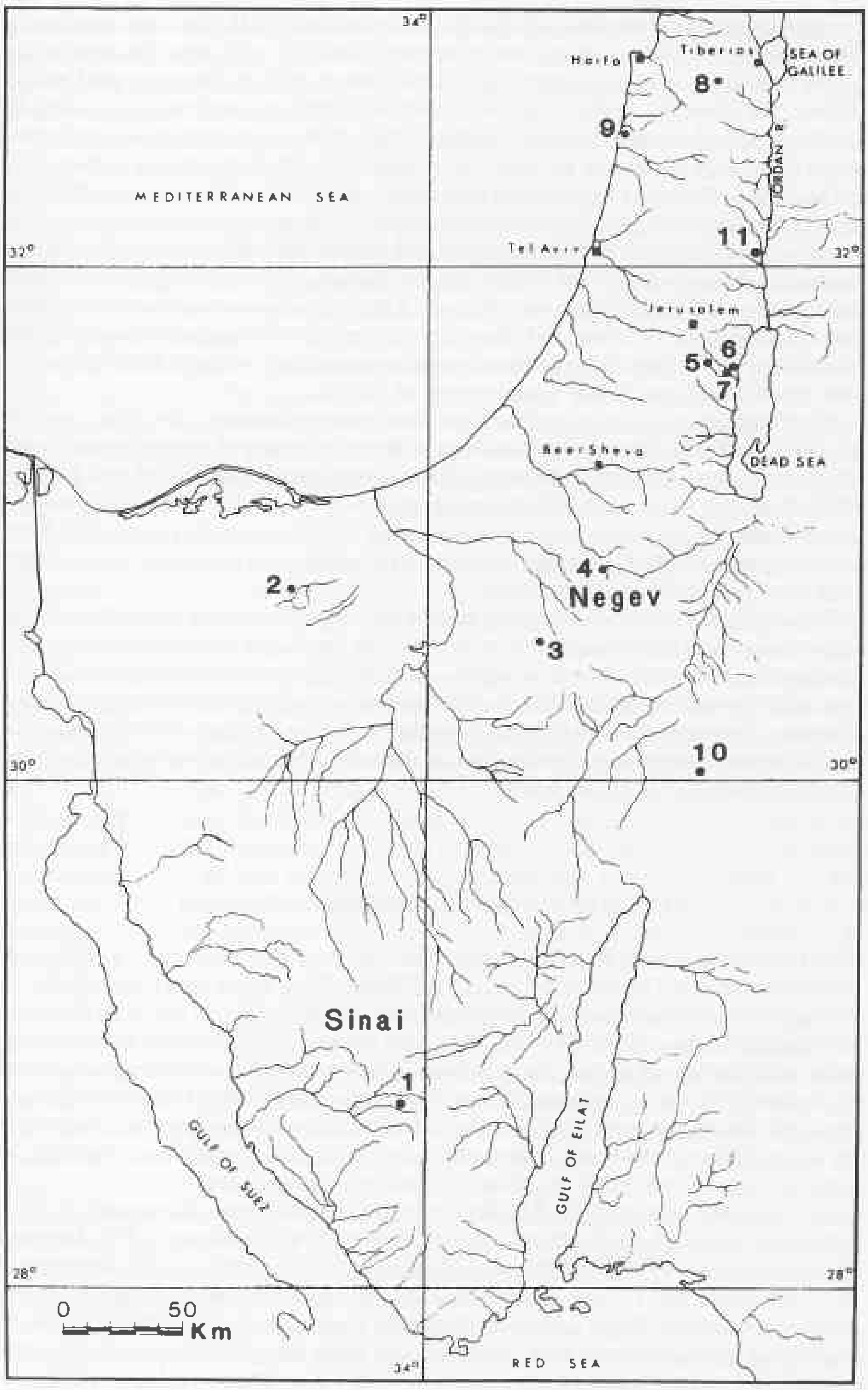

conditions and fine sediments as indicative of dry conditions. He thus sees a pattern of alternating wet and dry periods, some of them lasting for millennia, throughout the Upper Pleistocene and Early Holocene. The sequences in Gebel Maghara and Qadesh Barnea, for example, begin with coarse alluvial sediments and thus, according to Goldberg, would represent wetter conditions than do the later parts of the sequence, where fine sandy sediments are found in conjunction with down-cutting and erosion.

One of the difficulties with this interpretation is the quality of the data on which it is based. The extrapolation from sedimentological inferences to climatic cycles is hazardous, but there are in addition significant gaps in the sedimentological record in northern and eastern Sinai. The interpretation is further compromised by a lack of dated material from the earlier sediments. No early Upper Pleistocene sediments have been dated in Sinai itself; Goldberg and others have attempted to reconstruct the early Upper Pleistocene chronology of the peninsula only by comparison with the Th/U travertine dates from the central Negev (Schwarcz *et al.* 1979).

No pollen has ever been recovered from Quaternary sediments in the Sinai, and it is not until the Final Pleistocene that there is direct evidence of vegetation at Gebel Maghara (juniper berries) and Qadesh Barnea (root-casts) (Bar-Yosef and Phillips 1977; Goldberg 1984, 1986). Repeated efforts have been made to recover micro- and macro-botanical evidence, but with remarkably little success. The same has been essentially true of microfauna; not until the 1986 season were we able to recover them from good contexts in southern Sinai.

This means that although Goldberg and his colleagues have done an excellent job of paleoenvironmental reconstruction based on the available evidence, their reconstruction can be no better than the evidence itself, which is open to other interpretations. Our work in southern Sinai is based on a continuous sedimentological sequence and indicates a pattern somewhat different from theirs. The importance of the quality of the data becomes even greater when we turn to the nature of Pleistocene hunter-gatherer adaptive strategies in the peninsula.

THE PALEOLITHIC OCCUPATION OF SINAI

The Paleolithic record in Sinai begins with the presence in various localities of Acheulean bifaces (Malez and Cronolatac 1966). They occur near Gebel Libni in northern Sinai, and several have been discovered in eastern Sinai in the Wadi Quderat, near Qadesh Barnea (Neuville 1952). No actual Acheulean site has been found and it is not possible to determine from the existing evidence whether there was true occupation or whether there was simply an ephemeral use of the area by late Middle Pleistocene hominids passing across the northern plain. There might well have been occupation but the sediments could have been destroyed or they might not yet have become exposed. In any case, our knowledge of the Middle Pleistocene is very scanty.

Information concerning the Middle Paleolithic of the Upper Pleistocene is little better. One possible site has been reported by Henry and Goldberg (1974) between Gebel Maghara and Gebel Hallal, and Gilead has briefly reported on a Mousterian site near Qadesh Barnea. In light of the number of *in situ* occurrences that are known in the central and western Negev and in southwestern Jordan, the lack of sites in the Sinai might be a result of survey bias. Alternatively, there may have been only selective exposure of early Upper Pleistocene sediments. In southern Sinai in 1982, we discovered two Mousterian workshop-sites at the base of dioritic dykes near Mount Sinai. The Mousterian is, therefore, represented in northern and southern Sinai, albeit rarely. The nature of the occupation and the use of the landscape during that period cannot at present be reconstructed.

It is only with the Upper Paleolithic that we can begin to discuss hunter-gatherer occupation, exploitation and adaptation within the Sinai landscape. Due to the recent intensive survey and excavation programs, our knowledge of this period has become increasingly sophisticated and quite provocative. During the Upper Paleolithic, there is clear evidence, to be presented below, for regionalization and specialization in terms of mobility strategies, hunting patterns and technology. The regions occupied also have different sedimentary sequences, which, in turn, has implications for paleoenvironmental reconstruction.

Two archaeological technocomplexes have been recognized for the Upper Paleolithic in the Levant. The more dispersed one, recently named the Ahmarian (Gilead 1981b), is defined after the Judean desert site of Erg el Ahmar that was originally excavated by Neuville (1951). Gilead characterizes the Ahmarian as being a blade-bladelet tradition, where blade production was more important than flake production. Typologically, it has relatively low endscraper and burin indices and very high indices of blade-bladelet tools: *ca.* 77% of the tools are on blades at Qadesh Barnea, and *ca.* 40% are on blades and 35% on bladelets at the Ahmarian (or Lagaman) sites in Gebel Maghara (Bar-Yosef and Belfer 1977). There is a scatter of Ahmarian sites from Galilee (Qafza) and Mount Carmel (Kebara) to Sinai, but they occur in clusters in the Judean desert (Erg el Ahmar, El Quseir and Mazaraq an Na'aj), the central Negev (Boker A, Boker BE and Ein Aqev East), northern and northeastern Sinai (Gebel Maghara and Qadesh Barnea) and in the Wadi Feiran basin of southern Sinai (Figure 6.1).

The second technocomplex, the Levantine Aurignacian, is found in the more northerly areas of the Levant, except for two sites in the central Negev (Marks 1976, 1977). The Levantine Aurignacian is characterized by a technological predominance of flakes over blades, the latter also being generally rather thick. Endscrapers and burins are the most important tool-classes (>50% at some sites). Steep and carinated endscrapers occur in high frequencies and multiple and polyhedral burins are also common. When retouched, the blades most often have a stepped retouch. There is no backing in this technocomplex, but finely retouched El Wad points are present in its early phase, such as in Level 12 (Phase VII) of Ksar 'Akil, which is dated to 32,000 B.P. ± 1000 years (Tixier and Inizan 1981:360).

The radiocarbon and geological chronology of the Levantine Upper Paleolithic indicates that the two technocomplexes appeared at about the same time, and coexisted for some 20,000 years (Figure 6.2). The earliest dated Ahmarian site is Qafza, where Levels 7–9 date to 39–32,000 B.P. (Ronen and Vandermeersch 1972). The early Levantine Aurignacian is confined to Lebanon and northern Israel, but the early Ahmarian has a wider geographical distribution, occurring in both the northern and southern regions of the Levant. However, at about 26,000 B.P., the Levantine Aurignacian is found stratified above the Ahmarian at Kebara, Erg el Ahmar and Boker BE (Gilead 1981b; Marks 1977); it is thus possible that Aurignacian groups may have replaced Ahmarian populations in these areas. In Sinai, the Ahmarian is the only Upper Paleolithic tradition that has been recognized so far.

In the northern Levant, the Upper Paleolithic is always found in rockshelters not far from the Mediterranean coast or the Sea of Galilee, or in the Judean Hills. Analysis of fauna indicates that the animals taken for food were locally available forms, such as

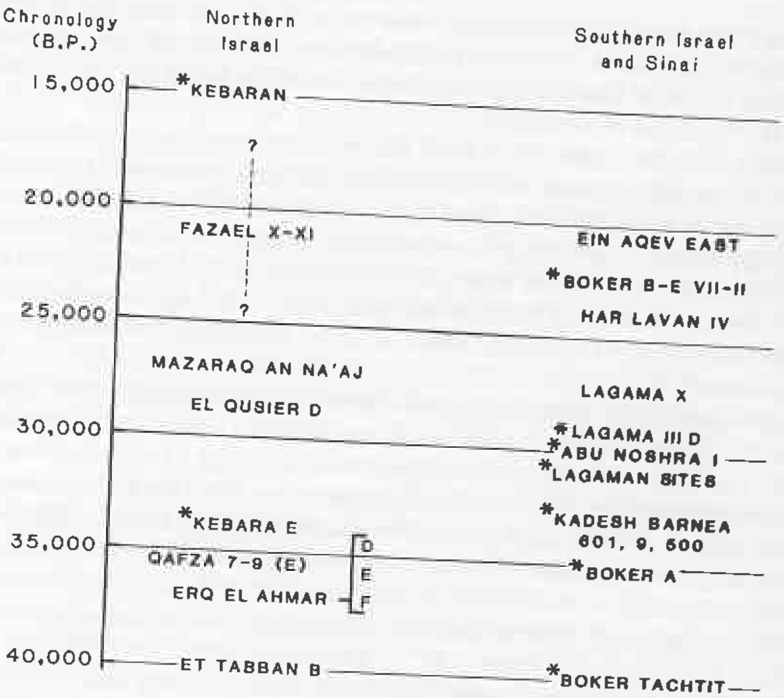

Figure 6.2 Inventory of Ahmarian Sites. * = Site for which radiometric dating is available. (After Belfer-Cohen and Bar-Yosef [1981])

various cervids, pig, cattle, gazelle and ibex. The relative frequencies of these species vary, however, with the landscape and with the specific period of the Upper Paleolithic when the sites were occupied. This variation is attributed to changes in climate and environment rather than to changing adaptive strategies (Bar-Yosef 1980).

Macrobotanical remains have not been recovered from any of the Upper Paleolithic sites, so our knowledge of resource availability and procurement strategies for the primary food sources (plant-foods) is minimal. The excavation of the rockshelters generally takes the form of a vertical shaft; no complete living-surface has been excavated. Archaeological analysis has been oriented towards lithic technology (in the narrowest sense) and typology, using an assemblage approach (see Tixier and Inizan 1981:367 for comments). Only Bar-Yosef has ever tried to analyze these northern Levantine sites from the perspective of hunter-gatherer adaptive or resource-procurement strategies.

Work in the central Negev (Marks 1976, 1977, 1983b) and in northern and northeastern Sinai (Bar-Yosef and Phillips 1977; Gilead 1981a) has recently shown us that open-air Upper Paleolithic sites are numerous. Although many of them have been deflated, a good number are still *in situ*. Excavation and evaluation of these sites have been approached with the intention of understanding not only the lithic typology, but also spatial patterning within and between sites. The results, however, are limited because very few sites have been completely excavated (Bar-Yosef and Belfer 1977;

Marks 1976, 1977, 1983b), and only parts of an economic system may be represented (Marks 1983a; Marks and Freidel 1977). Marks' ideas concerning a circulating system of movement, which might have covered the entire Levant, cannot be demonstrated archaeologically at the present time and most probably did not exist in the form which he suggests.

THE NATURE OF THE UPPER PALEOLITHIC TRADITION IN SINAI

There are more Ahmarian sites in Sinai than in all the rest of the Levant. In Gebel Maghara, the sites have been grouped together under the rubric "Lagaman" (Bar-Yosef and Belfer 1977). The Lagaman consists of a cluster of small sites (10–100 m²) at the foot of Gebel Lagama. Two fossil springs appear to have been the features attracting the inhabitants, although easy access to good flint was probably also a factor. The nature of the lithic assemblages and the size of the sites indicate that occupation was short-term. Several of the hearths have yielded radiocarbon dates of 34,000–30,000 B.P. (Bar-Yosef and Belfer 1977). No faunal remains have been recovered with the Lagaman except for ostrich eggshell. The lithic assemblages are dominated by retouched blades and bladelets, El Wad points, endscrapers and burins. Ocher was observed on some of the artifacts.

During a survey of the Qadesh Barnea area, 100 km east of Gebel Maghara, Bar-Yosef and others discovered several sites which Gilead has assigned to the Ahmarian (1981b). The sites were found in clayey deposits with root-casts of vegetation, above gravels containing Middle Paleolithic artifacts (Goldberg 1986:230). Goldberg interprets this geomorphic sequence as suggestive of a wetter period during the Ahmarian occupation. Two sites were partially excavated (Gilead 1981a, 1981b) yielding radiocarbon dates of 33,800 B.P. ± 940 years (Pta.2819) from Qadesh Barnea 500 and 32,470 B.P. ± 780 years (Pta.2946) from Qadesh Barnea 601B. The evidence suggests that there was repeated occupation of the area, probably because of the availability of water from the perennial springs nearby.

The lithic assemblages are dominated by long, narrow, pointed, backed blades, some of them >10 cm long (my own measurements), El Wad points, some retouched blades and bladelets, endscrapers and burins. Ocher is present on a number of the artifacts. Faunal preservation is poor, the only identifiable element being the numerous fragments of ostrich eggshell.

THE UPPER PALEOLITHIC OF THE WADI FEIRAN BASIN

In November and December of 1984 and in March and April of 1986 the University of Illinois at Chicago South Sinai Project began the excavation of several Upper Paleolithic sites in the Abu Noshra basin of the Wadi Feiran (Figure 6.3). Several of these sites were discovered and surface collected in our 1982 survey, and three were found in 1984 (Figure 6.3).

The sites are in beds which are at least 50 m thick and which represent a major depositional phase covering perhaps 40,000 years of the Upper Pleistocene. The terminal aggradation dates to about 12,000 B.P. (unpublished data), while a date of >34,000 B.P. has been obtained about 12 m above the base of the exposed thickness of

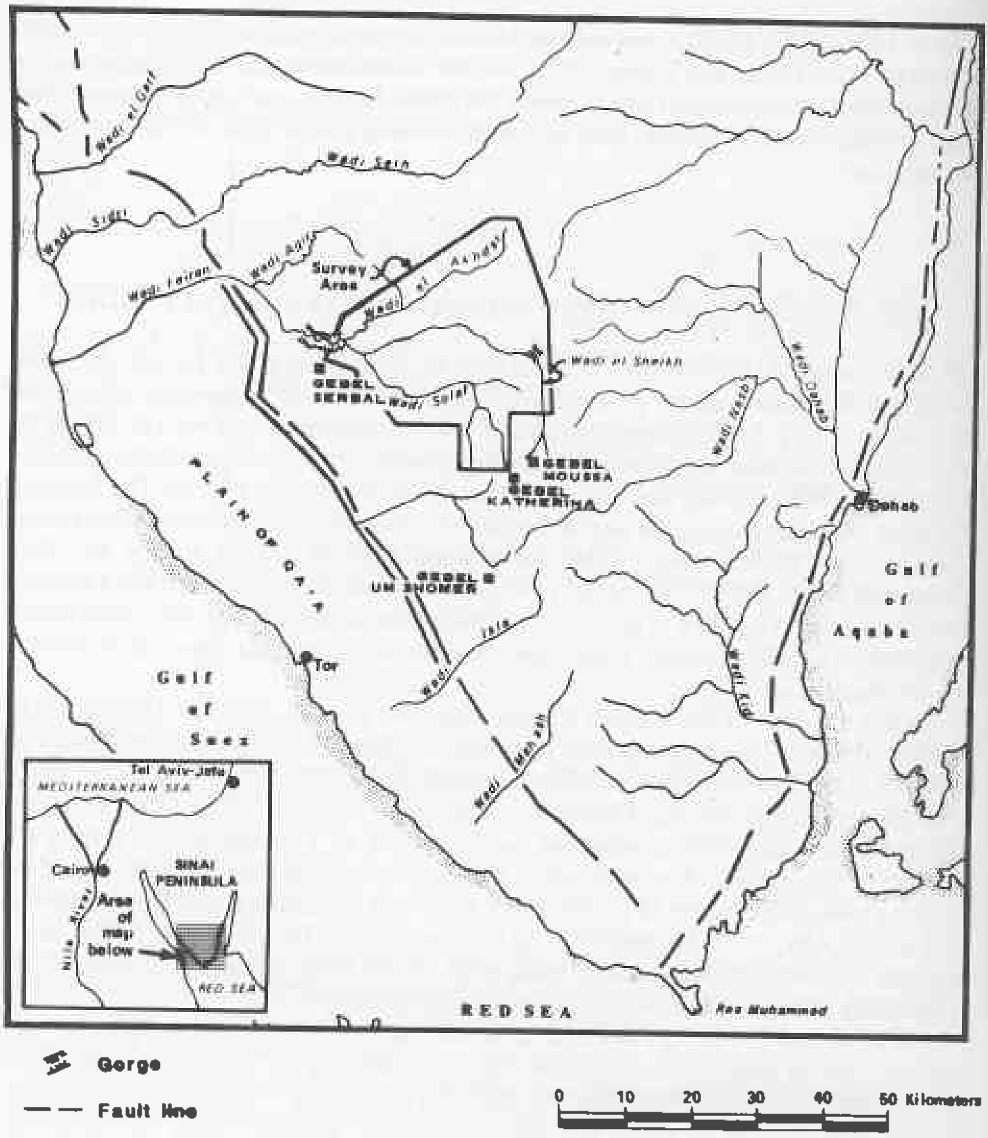

Figure 6.3 Map of southern Sinai. (After Awad 1951)

the beds, in the vicinity of Tarfat Quidrein Oasis in the Wadi Sheikh (Phillips in press). We estimate the beginning of the aggradation to have been approximately 50,000 years ago. Although there are fluvial and colluvial facies present within the sections, Gladfelter (pers. comm.) suggests that there was a low-energy regimen throughout the period of deposition, without any climatically induced cut-and-fill cycles. Some of the marly facies of the beds at Tarfat Quidrein contain archaeological sites belonging to the Ahmarian technocomplex, and the sites of Abu Noshra I-VI were found eroding out of these sediments. The area was occupied when there were perennial ponds or marshes nearby.

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Three sites have yielded substantial information concerning chronology, hunter-gatherer subsistence and mobility strategies, and technology. The site of Abu Noshra I was found buried at a depth of 1 m in an eroded remnant of the beds near the eastern edge of the Wadi Abu Noshra basin. The site covers approximately 22 m², of which 18 m² have been excavated. Four hearths were found, two of which yielded radiocarbon dates. Burned and unburned artifacts, burned earth, charcoal, faunal fragments and a few seeds have been recovered, mainly from around the hearths. Hearth 1 consists of four pieces of granite arranged in a circle, with a profusion of small bone fragments, an entire rib, several intact teeth and hundreds of artifacts surrounding it. A charcoal sample from this hearth gave a date of >30,440 B.P. (Beta.12125). Hearth 2, 1.25 m northeast of Hearth 1, was in a shallow basin excavated into the sediment; charcoal from it yielded a date of 29,580 B.P. +1610/−1340 years (Beta.13898). The third hearth, 0.5 m south of Hearth 1, is unique in the Upper Paleolithic of the Levant. It consists of a series of stones surrounding a circular burned area, lying above a pit that is rectangular in cross-section and 0.55 m deep. The contents of the pit are now being analyzed to determine the pit's function. The preliminary data suggest only that the pit was excavated, subsequently refilled with cultural material and then a circular, stone-ringed hearth was built on top. Reed (pers. comm.) has identified teeth of the Nubian half-ass (*Equus hemionis*), a rib which is unidentified at the species level but which, for contextual reasons, probably belongs to the same equid, remains of a fox and ribs from another carnivore.

The artifacts are extremely fresh and unabraded, with little edge-damage that can be attributed to soil movement (L. H. Keeley, pers. comm.). They are made from a chocolate-colored flint and consist predominantly of blade and bladelet debitage, opposed- and single-platform blade cores, debris and retouched tools. Much of the debitage can be refitted, and initial results point to three core-reduction sequences. Tools are not numerous and fall into two main categories: finely retouched (or backed) blades and bladelets, and dihedral burins and burins on truncations (Figure 6.4).

Preliminary edge-wear analysis by Adams and Keeley indicates bone or antler polish on the burins and meat polish on the blade and bladelet tools. Whether the blades and bladelets were used as points or knives remains to be determined. No engraved bones were recovered, nor bones with cut-marks.

The site of Abu Noshra VI was discovered eroding out of the beds approximately 200 m northeast of Abu Noshra I. It is slightly higher in elevation than the other sites, covers an area of 17 m² and consists of a series of hearths arranged in a line (six have so far been uncovered). Samples from the hearths have been submitted for dating and the fauna is currently being analyzed. The lithic assemblage is similar to that of Abu Noshra I in raw material, typology and technology.

Abu Noshra II lies approximately 50 m northwest of Abu Noshra I and covers an area of at least 240 m². It was found eroding out of an uncapped remnant in the soft sand of an old channel deposit. Thus far, 114 m² of the site have been excavated. Eleven hearths have been found, varying from one with a circular arrangement of stones to several that are represented only by areas of burned earth and charcoal specks. Charcoal samples from some of the hearths have been submitted for dating. Hundreds of lithic artifacts, a bone point and faunal remains representing a number of species have been recovered from around and between the hearths. The fauna so far identified includes the fish-eagle, a fish, *Bos, Dama*, onager, ibex and gazelle (C. A. Reed, pers. comm.). Microfauna has also been recovered and is in the process of being identified.

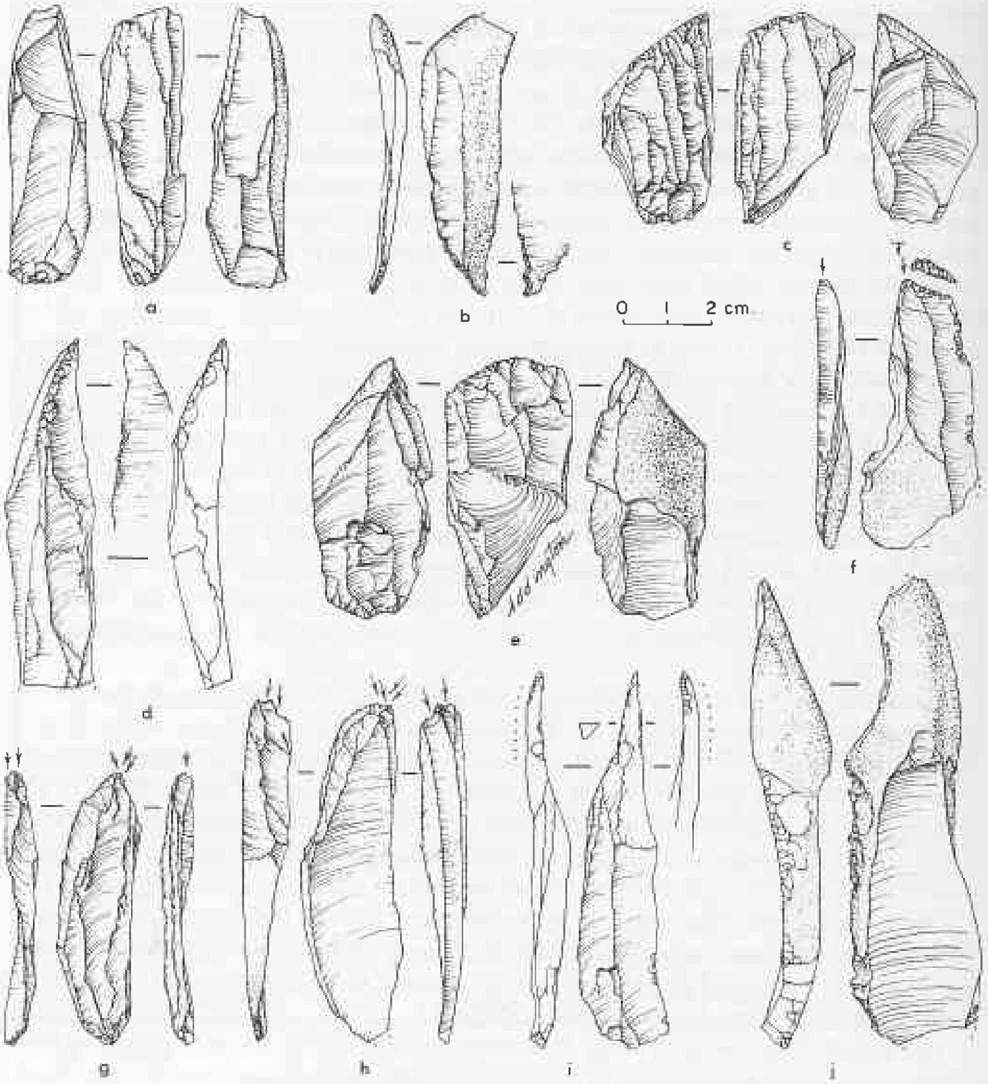
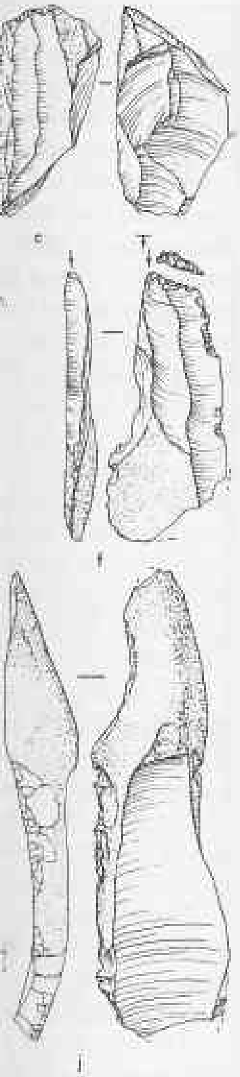


Figure 6.4 Artifacts from Abu Noshra I. a, c, e, cores; b, d, meat knives; f–h, burins; i, perforator; j, denticulate.

There were also two handstones and two slabs of porphyritic rock smeared with ocher; one of the handstones had ocher smeared on its working edge.

The artifacts are unabraded and are made from several flint nodules of different colors, including the chocolate variety found at Abu Noshra I. The most important type of flint here, however, is a grey, banded or speckled type. Blade and bladelet debitage, opposed- and single-platform blade cores, debris and retouched tools were recovered from the areas surrounding and between the hearths. Numerous artifacts that could be refitted to each other were found within an area of about 70 m² of the excavated site, including refits between surface finds and the excavated material. At least four complete, blade-production sequences have been established from these refits, including core-rejuvenation procedures. One such activity area contained several



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backed blades and endscrapers, associated with a hammerstone. Ocher has been observed on a number of artifacts.

The tools from this site are much more varied than those from the other sites (Figures 6.5 and 6.6). The tool-assemblage consists of partially backed blades, blades with ogival bases, finely retouched blades and bladelets, endscrapers on blades, truncated blades and bladelets, points made by two oblique truncations, dihedral burins and burins on truncations (on blades) and one endscraper-burin. Edge-wear analysis indicates that the endscrapers were used on dry hide, the burins on bone or antler, and the backed or retouched blades on meat. A few unretouched blades were used for perforating dry hide and as meat-knives. According to Keeley (pers. comm.), the "endscraper" part of the endscraper-burin may represent the hafted end of the piece.

HUNTER-GATHERER MODELS AND THE UPPER PALEOLITHIC OF SINAI

Several models have been developed by ethnographers and prehistorians to explain hunter-gatherer subsistence and mobility behavior. Mobility patterns of hunter-gatherers are intricately linked to the spacing or seasonal distribution of primary (plant) and secondary (animal) resources (Kelly 1983), and it is generally agreed that there exist at least two patterns of hunter-gatherer life-ways (Binford 1980, 1982; Gould 1982; Testart 1982; Woodburn 1980; Yellen 1976). One, which is usually found in semi-arid to arid environments, is characterized by high mobility, opportunistic hunting, a fluid social composition, a highly developed gathering economy based on a thorough knowledge of all the edible plants in the area, high procurement but low processing costs, and a highly developed sharing ethic, which Gould (1982:70) feels is part of a risk-minimization apparatus.

The second hunter-gatherer pattern may be called seasonally mobile. It is characterized by a subsistence based on several highly nutritious meat and plant staples, such as salmon and acorns in northwestern California (Gould 1982; Testart 1982), the storage of staples as a means of risk-minimization, low procurement but high processing costs, single-family procurement systems, and an environment with a wide variety of resources. The families generally gather together seasonally at the procurement site to process their harvest or catch and to participate in activities which promote social cohesion. In Gould's terminology, hunter-gatherers of this type can be viewed as resource maximizers rather than risk minimizers (1982:74). This pattern is never found in semi-arid or arid environments.

The assumption usually underlying these models is that the environment, in the broadest sense, affects exploitation and social organization in such a way that only one of these patterns can exist in any particular case; only Binford and Yellen do not regard the models as mutually exclusive. That is, in semi-arid to arid environments, where the pursuit of potable water is a major concern, high mobility will obtain; in more productive and dependable situations, the logistical mobility model will apply. The models generally do not take into account local variability in terrain, resource distribution, biomass, carrying capacity, or population density. It seems more likely that all hunter-gatherers practice both mobility systems, switching between the two as conditions may dictate (Binford 1980; Kelly 1983).

Understanding that the models are heuristic devices, we will now turn to the occupation of Sinai during the Upper Paleolithic. The three major areas where Ahmarian sites occur all have permanent water and two of them, Gebel Maghara and

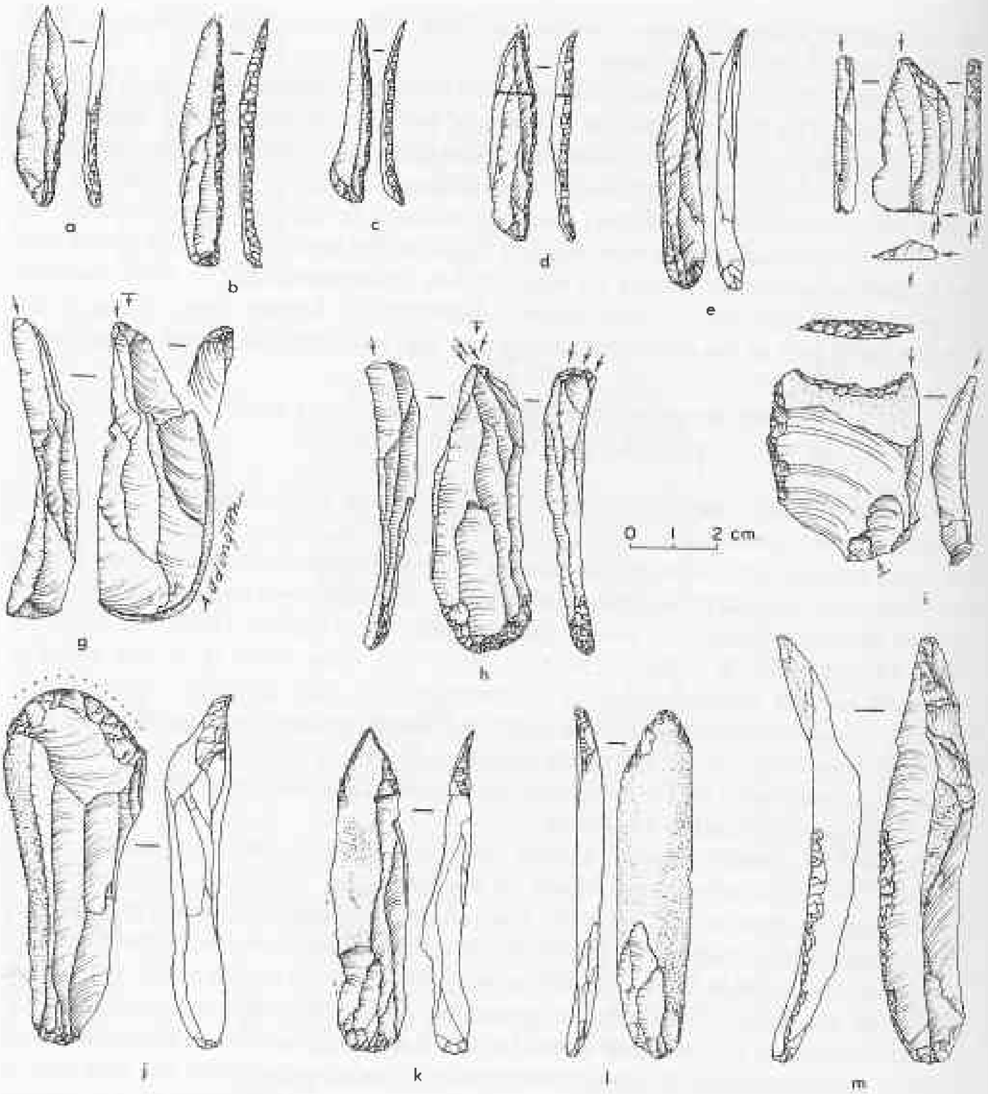
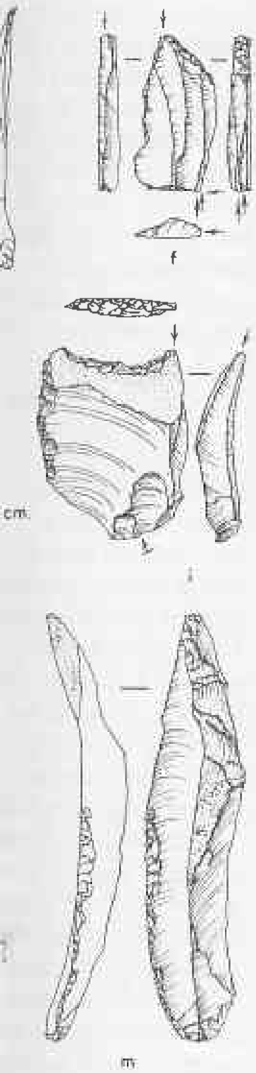


Figure 6.5 Artifacts from Abu Noshra II. a–e, backed blades; f–i, burins; j, dry-hide scraper; k, l, points; m, meat knife.

Qadesh Barnea, are adjacent to sources of flint. In the Wadi Feiran, on the other hand, the closest source of flint is 12–15 km to the north, at the foot of El Tih escarpment, and there is a second source located some 60 km down the wadi, to the west. Preliminary evidence indicates that flint from both of these sources is represented at Abu Noshra, although the flint from the mouth of the Wadi Feiran is very rare.

The nature of the source of water is very important to our understanding of the subsistence and mobility patterns of the Ahmarian groups. Gebel Maghara and Qadesh Barnea have springs, around which groups congregated, whereas the Abu Noshra sites were located within a marsh or pond biome. This latter type of biome characteristically has a high concentration and variety of resources, and is therefore much more productive in terms of vegetable and animal products than are areas around springs or



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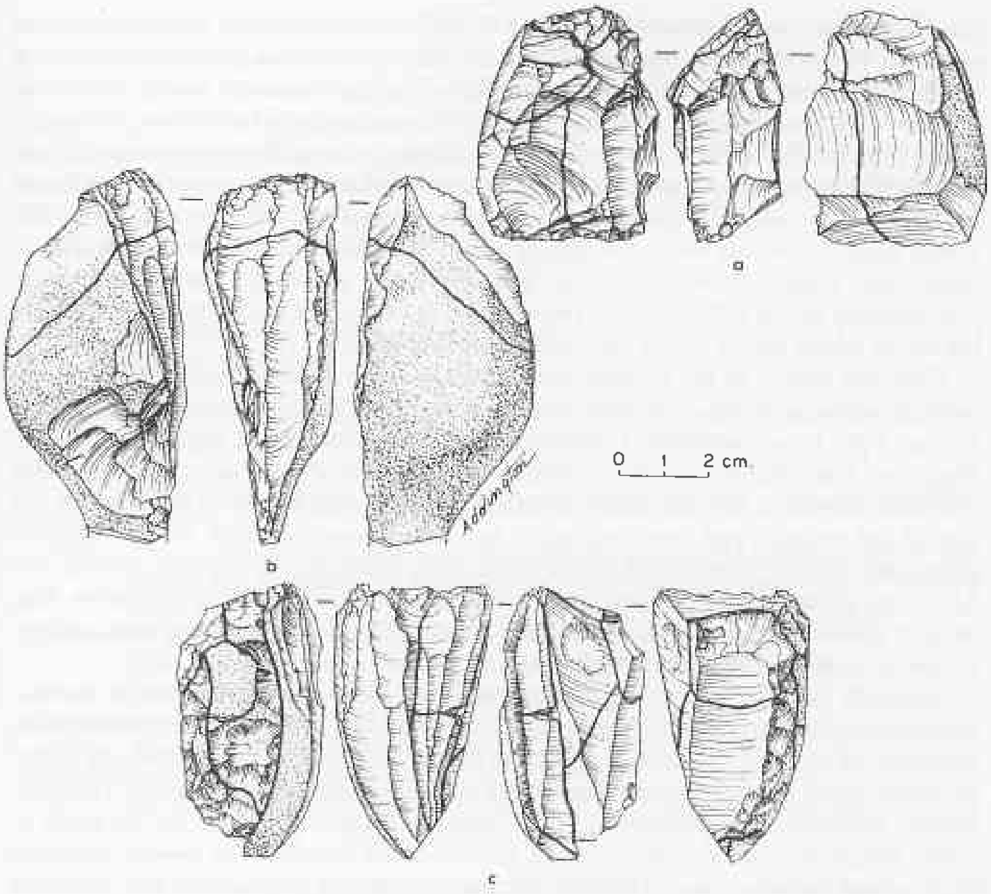

Figure 6.6 Artifacts from Abu Noshra II. a, core-scraper; b, c, refitted cores.

lakes. It might thus be predicted that the settlement and land-use patterns in areas of high resource concentration would be different from those in the less favored areas.

We should also keep in mind the overall climate in Sinai during the Ahmarian period some 35,000–28,000 years ago. All of Sinai was cooler than it is today, and Goldberg's and Gladfelter's work indicates that parts of it were also wetter. The cooler winters and summers would result in a shorter growing season. However, in the absence of pastoralism, which is a major cause of erosion and of depletion of the vegetation, much of the vegetational cover would have been more dense and more productive than it is now. This would have allowed the Ahmarian groups to pattern their movements in manners different from what might be expected if the Sinai were as arid as it is today.

In light of all this, the ephemeral nature of the sites in Gebel Maghara must represent a mobility pattern different from that of the richer and reoccupied sites of Qadesh Barnea, although a case might also be made that the Lagaman sites belong to the Ahmarian groups at Qadesh Barnea. The group of sites in Abu Noshra might represent yet another pattern. Abu Noshra II can be seen as a base camp. It is larger than any other Ahmarian site in Sinai or, for that matter, in the Levant. It contains evidence of a number of activities related to maintenance, procurement and production, indicating a more protracted period of occupation than at any of the other sites of this period in

Sinai. The sites surrounding Abu Noshra II can then be viewed as parts of a system whereby Ahmarian groups moved within a smaller territory than did the inhabitants of northern and eastern Sinai. It is even possible to give a preliminary assessment of the function of some of the sites in Abu Noshra. For example, Abu Noshra I contains burins used for the working of bone or antler, but no burin spalls were recovered from the site, despite both dry and wet sieving. This means that there was no resharpening of the burins at the site and, therefore, that the burins were not actually used there. We would suggest that this was a kill-site at which the hunters discarded their worn-out burins and manufactured new ones, perhaps to be rehafted. This suggestion is corroborated by the refitted cores: two of them have gaps in the refits, conforming to blades on which burins could have been manufactured.

Thus, the nature of the regional biome had a direct effect on the settlement and mobility systems of the Ahmarian hunter-gatherers. The rich ecology of the Wadi Feiran must have permitted a greater population-density than did that of Gebel Maghara. The evidence for the seasonal reoccupation of the Qadesh Barnea sites should be viewed as a result of the presence of an enormous source of flint (both in the size of the nodules and in the quantity available) combined with the presence of permanent water. If seasonal pools were also available during this period, the Ahmarian groups might, perhaps, have been more like those of the Wadi Feiran than those of Gebel Maghara. In fact, the lithic typology of the Qadesh Barnea sites is closer to that of Abu Noshra than to that of the Lagaman.

Although the lithic assemblages from the three areas fall within a single techno-complex, the Ahmarian, in both technology and typology, there is also evidence for the existence of regional facies. For example, the El Wad point is ubiquitous in Gebel Maghara, much rarer at Qadesh Barnea and virtually absent in Abu Noshra. The long, narrow, pointed, backed blades of Abu Noshra and Qadesh Barnea do not occur in Gebel Maghara, while the ogival-based, backed blade found in Abu Noshra is absent from both of the other areas. This last type has been identified as a point and may have been used for hunting a particular animal species.

In conclusion, the recent intensive surveys and excavations in three areas of Sinai have allowed us to develop a picture of the Upper Paleolithic which is quite different from that of the northern Levant. The excavation of entire open-air sites, begun in the Wadi Feiran, will help us to refine further the emerging scenario. In terms of hunter-gatherer adaptive strategies as they are reflected in site location, distribution and function, and lithic technology and typology, it is apparent that the Ahmarian groups in Sinai interacted dynamically with their environment in regionally specific ways undocumented for other areas of the Levant.

ACKNOWLEDGMENTS

I would like to thank Bruce Gladfelter for his comments on this paper. The University of Illinois at Chicago South Sinai Project is funded by the National Science Foundation. Previous grants for start-up and survey were awarded by the L. S. B. Leakey Foundation, the Office of Social Science Research of the University of Illinois at Chicago and the National Science Foundation.

Twenty years ago I arrived at SMU to become the student of Fred Wendorf. He decided that it was important that I learn lithic typology, and for six months, from 6:30 a.m. until 11 p.m., seven days a week, he sat beside me teaching the basics of typology

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and the Egyptian lithic sequences. If I got up to go to the facilities or to get coffee, he asked where I was going. If I wanted to go out to eat, he asked why I had not brought a sandwich. Fred believed, and still does, that hands-on experience is extremely important, and that commitment and discipline are vital to a would-be archaeologist. I value that approach and the training I have received from him in the laboratory and in the field. This essay is offered out of respect and admiration to a fine scholar and warm friend.

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7

The Neolithic of Central Sudan: A Reconsideration

ABBAS S. A. MOHAMMED-ALI

EARLY RESEARCH IN THE CENTRAL NILE VALLEY: A. J. ARKELL

Modern research into the Holocene archaeology of the central Nile is founded upon the pioneering work of A. J. Arkell who, during the fifth decade of this century, conducted investigations, including selective excavations, at several of the major archaeological sites in the area around Khartoum (Arkell 1949, 1953).

The first site to be studied lay at the confluence of the Blue and the White Niles within the limits of the modern city of Khartoum. It was a large settlement, on an old bank of the river, and is known in the literature both as the Khartoum Hospital site and as Early Khartoum. Arkell regarded the site as having been a semi-permanent settlement, occupied by a group of people whose economy was based on the gathering of wild seeds, the hunting of wild animals, fishing and the collecting of other aquatic resources. The faunal and floral remains recovered from the site indicate a rich and varied, local habitat. The site also yielded a microlithic flake industry, in which the dominant tool-classes were lunates, scrapers and a variety of geometrics. Fishing-gear consisted of harpoons and net-sinkers, and there was a variety of ground stone implements. A characteristic feature of the assemblage was a well-made and well-fired type of pottery, which was unburnished but was decorated with a wide range of combed and impressed designs; these included wavy line, dotted wavy-line and zigzags. The dead were buried in a contracted position within the settlement. The absence of domestic animals amd plants suggested to Arkell that this represented a "Mesolithic" stage, and the industry was so named (Arkell 1949). The radiocarbon technique of dating was not yet in use at the time of the excavation.

The second major site excavated by Arkell was located about 50 km north of Khartoum, on the west bank of the river at the village of Shaheinab (Figure 7.1). It is the type-site of the Khartoum Neolithic, or the "gouge culture" as it was first called (Arkell 1949). It was a relatively large settlement, situated on a ridge that had formed an old bank of the Nile, and had occupational deposits to a depth of 0.7 m. The occupants of Shaheinab kept domestic stock, including sheep or goat (Arkell 1953) and cattle (J. Peters, pers. comm.). Nevertheless, the faunal remains and the frequency of fishing-gear, such as harpoons and fish-hooks, indicated that hunting and fishing were still significant components of the economy. No direct evidence for cultivation was recovered but plant-processing tools were abundant. Stone tool manufacture was based upon the production of microlithic quartz flakes, although microliths themselves show a clear decrease in frequency when compared with the Khartoum Hospital site. This seems to have been due to the introduction of a new tool-type, the gouge, which became predominant among the larger tools. Most of the gouges were made on rhyolite, which resulted in the relatively low index of quartz among the raw materials. The pottery was now burnished and most of the decoration consisted of incised and pivoted zigzag lines. The radiocarbon dates for the site fell within the later part of the fourth millennium B.P. (Arkell 1953).

Arkell (1953) also tested a third locality, Al Qoz on the outskirts of Khartoum (Figure 7.1). This was a small and, unfortunately, very disturbed site, but it yielded both of the archaeological components known from the larger sites, and the materials diagnostic of Shaheinab lay stratigraphically above those of Early Khartoum. It was principally this stratigraphic relationship that led Arkell to assume that Early Khartoum predated Shaheinab and developed into it.

Before Arkell's work, the prehistoric archaeology of the central Nile Valley was virtually unknown and the area was a blank spot on archaeological maps. In fact, the whole of the Nile Valley was believed to have been a cultural backwater, which had made little or no contribution to the global development of prehistoric culture. Arkell's work in the central Nile Valley presented a challenge to such views and, for the first time, provided a body of data on which to build at least a partial reconstruction of central Nilotic prehistory. It was a very significant contribution to our understanding of an important stage in Sudanese and African prehistory and also established a framework for research into the development of later prehistoric cultural manifestations in the area. His work has been the basis for all subsequent archaeological research in the region, but is not without flaws.

It was generally accepted that Arkell's findings established a sequence for the later prehistory of the central Nile Valley, wherein the Mesolithic industry of the hunter-gatherers at Early Khartoum developed into, and was directly followed by, the Neolithic industry of the food-producers at Shaheinab. It was believed that these two industries formed a continuum: the Khartoum Mesolithic was seen as the progenitor of the Khartoum Neolithic and, apart from a few foreign elements attested at Shaheinab, the tradition was completely indigenous to the central Nile (Arkell 1953, 1972). The Khartoum Mesolithic and Neolithic were viewed as having had the same geographical distributions and as having lasted for similar lengths of time.

However, even the evidence from the central Nile which was then available to Arkell does not completely support this reconstruction. The stratigraphic relationship of the two components at Al Qoz showed that the one was earlier than the other, but it did not demonstrate how the Mesolithic might have developed into the Neolithic, or even that such a development took place. Moreover, very few radiocarbon determinations were available and there was no information on the spatial distribution of the sites, so that hypotheses concerning the distributions of the two industries in time and space were completely unfounded.

Arkell's terminology has also been problematical. There has been considerable dispute as to what precisely is meant by the terms "Khartoum Mesolithic" and "Khartoum Neolithic" (summarized in Mohammed-Ali 1973). "Mesolithic" has a rather precise meaning in the prehistory of northern Europe, for which it was first

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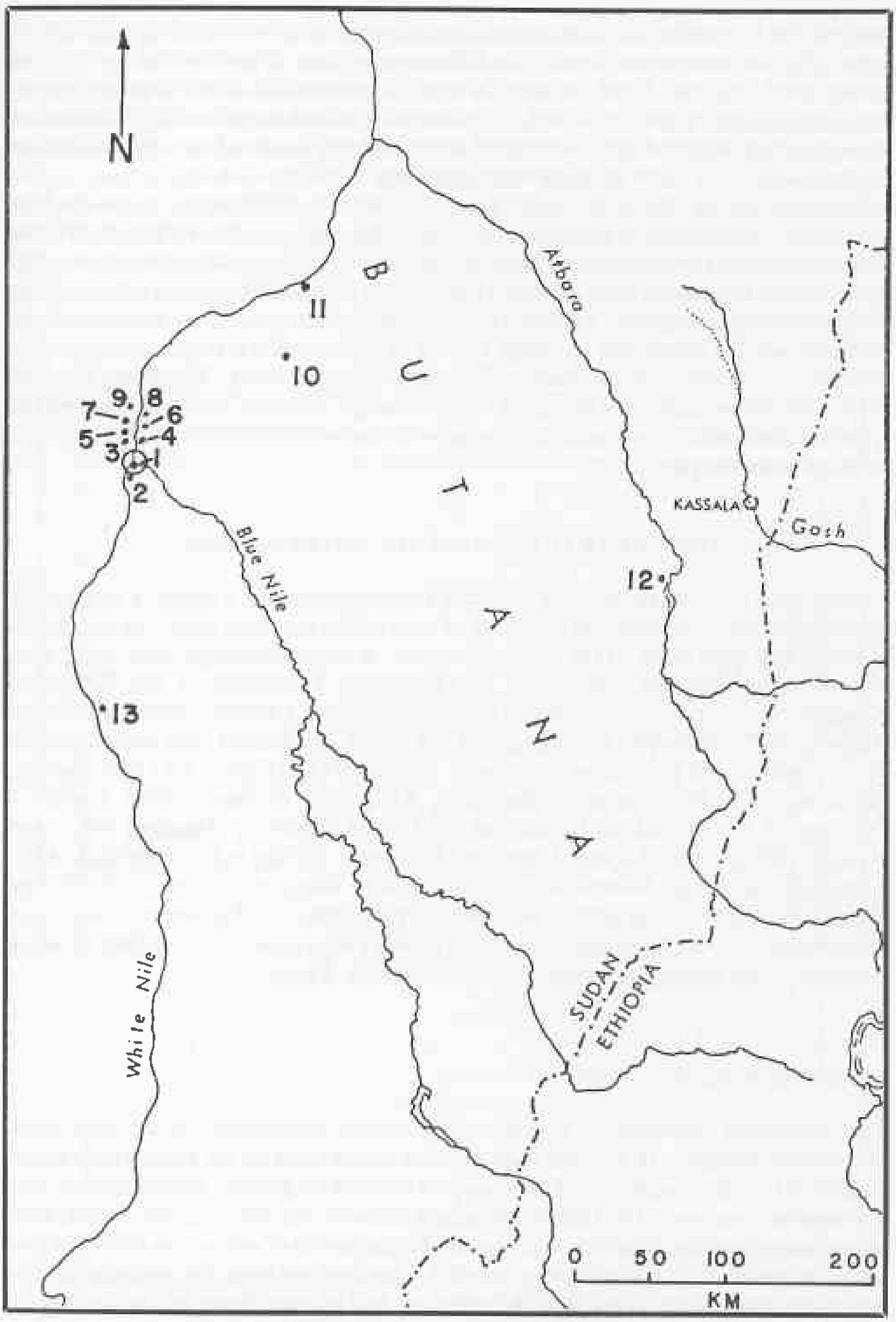

Figure 7.1 Central and eastern Sudan, showing the location of the principal Mesolithic and Neolithic sites. Key: 1, Khartoum Hospital (Early Khartoum); 2, Al Qoz; 3, Nofalab-1; 4, Kadero-1; 5, Sorourab-1; 6, Um Direiwa-1; 7, Um Morihi-1; 8, Geili; 9, Shaheinab; 10, Kadada; 11, Shaqadud; 12, Khashm el Girba; 13, Shabona.

devised, but there is no truly corresponding phenomenon in the central Nile Valley, or, indeed, in the entire prehistory of the African continent. "Neolithic" is much more widely used, and useful, but the specific term "Khartoum Neolithic" has never been precisely defined or precisely used; it has not only served to confuse the relationship between Shaheinab and the Khartoum Hospital site, but has also been applied to other assemblages which have no apparent relationship to either of them.

Research into the Neolithic of the Sahara has also been influenced by results from the central Nile Valley. Investigations west of the Nile, in the African Sahel and Sahara, revealed numerous sites sharing a series of elements similar to those recovered by Arkell on the central Nile (Camps *et al.* 1968), including wavy-line pottery, bone harpoons and stone gouges. Vaufrey (1969) suggested an east-to-west spread of these elements and the whole belt has been viewed as representing a single, homogeneous culture area. Terms such as "Saharo-Sudanese Tradition" and "Khartoum Horizon Style" are widespread in the literature. Such concepts, however, are based only on the apparent similarities in material culture and take no account of the regional variations between assemblages.

THE CENTRAL NILE VALLEY AFTER ARKELL

Two decades after the publication of Arkell's pioneering study, a series of small-scale excavations were conducted at a number of sites within the same area. The diagnostic features, and even some of the general features, of the assemblages from these sites showed close affinities with either the Khartoum Mesolithic or the Khartoum Neolithic, and every site was assigned to one or the other of Arkell's categories. Saggai (Caneva 1983), Sorourab-1 (Mohammed-Ali 1982), Um Morihi (still under analysis by the author and others) and Shabona (Clark 1973) (Figure 7.1) had features characteristic of the Khartoum Mesolithic, while Geili (Caneva 1984), Kadero-1 (Krzyzaniak 1978), Zakiab-1 (Haaland 1981), Um Direiwa-1 (Haaland 1981) and Nofalab (Mohammed-Ali and Abdelmagid in press) yielded material typical of the Khartoum Neolithic. Several other sites are now being excavated, such as Abu Darbein and Aneibis near Atbara (R. Haaland, pers. comm.). Analyses of them are not yet complete, but the preliminary reports (Haaland 1986) again attribute them to one or the other of the two main groups in the central Nile Valley.

KHARTOUM MESOLITHIC SITES

The Mesolithic settlements appear to have been permanent, or at least semi-permanent, villages. All of them were located on the bank of the river which would suggest a riverine adaptation. The abundant remains of aquatic species and of wild mammalian species in the faunal collections indicate that hunting and fishing were important parts of the subsistence economy. The gathering of wild plants and fruits also seems to have made a contribution to the diet. The direct evidence for this is limited to a few plant-impressions baked into the ceramics and to even fewer actual carbonized seeds; however, there was also a considerable quantity of plant-processing equipment. The undisturbed cultural deposits at the sites varied in depth between 0.5 and 1.5 m, but none had any evidence for dwelling structures. Most of the sites yielded contemporaneous, contracted, human burials.

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The lithic industry was dominated by microlithic flakes made from quartz pebbles; rhyolite, sandstone and petrified wood were also used. The main tool-classes were lunates, scrapers and denticulates. The overall tool-kit also included a variety of artifacts made of raw materials other than stone, among which bone harpoons were the most common. On the whole, the tool-kits were closely similar in both the variety and proportions of types to that from the Khartoum Hospital site. The ceramics also resemble those recovered from the Hospital site. The pottery was well made and well fired, tempered with crushed quartz or mica and decorated with a variety of motifs of which the wavy line was the most characteristic. More than a dozen radiocarbon dates have been obtained from these sites. They range from the ninth to the seventh millennium B.P., with a clear concentration in the ninth and eighth millennia (Figure 7.2).

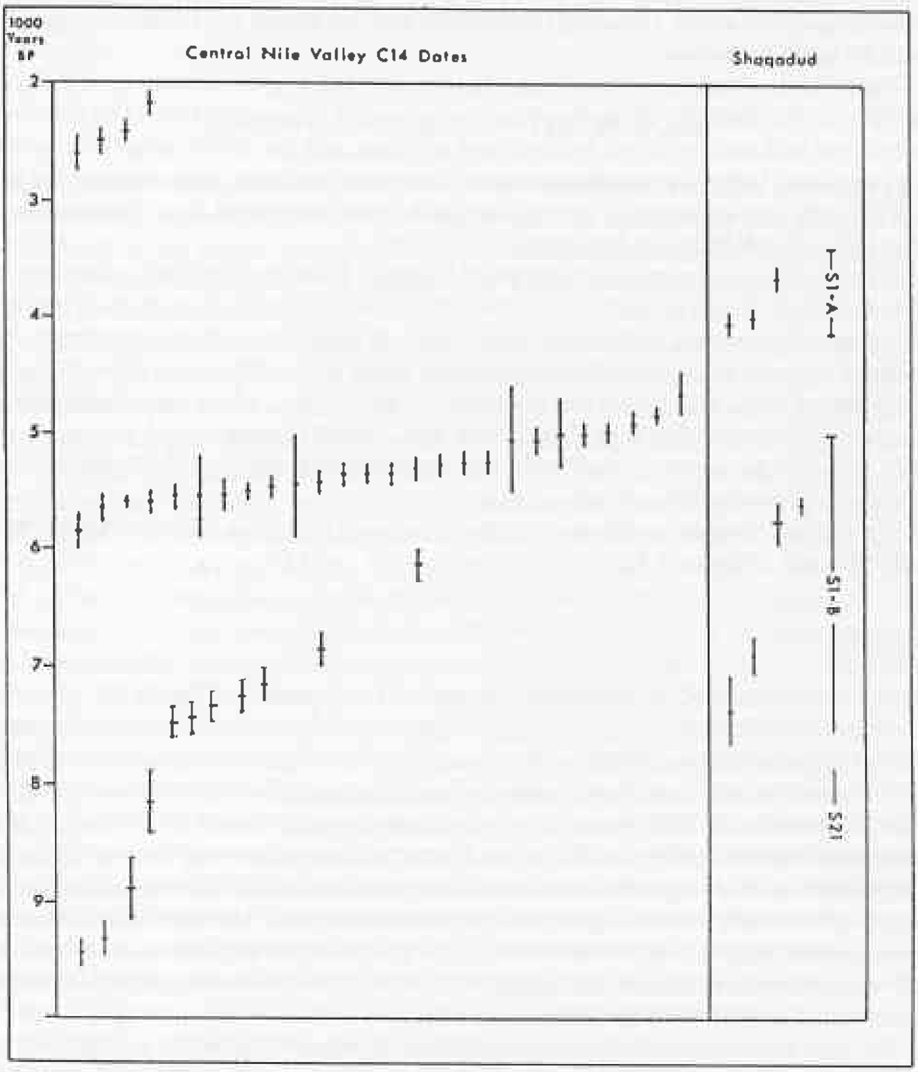

Figure 7.2 Radiocarbon dates from central and eastern Sudan. 10th–8th millennia B.P.—Mesolithic; 6th millennium B.P.—Neolithic; 5th millennium B.P.—Kadada; 3rd millennium B.P.—Meroitic.

KHARTOUM NEOLITHIC SITES

Sites attributed to the Khartoum Neolithic have been reported from a number of localities in the central Sudan (Figure 7.1). I will summarize the evidence from all of these sites together.

The sites themselves are quite large, covering areas of up to 40,000 m², but the cultural deposits are rather shallow and rarely more than 0.5 m deep.

Quartz was the principal raw material and was dominant among the microlithic tools. Rhyolite was used for the manufacture of large stone tools, while sandstone and petrified wood were favored for grinding implements. The flaked stone industry was primarily based on the production of microlithic flakes. The tool-kit included a wide variety of retouched tools, among which lunates, scrapers, denticulates and retouched pieces were the most common. However, the diagnostic artifacts in the industry were stone gouges and adzes. Grinding implements and fish-hooks were numerous but there were no bone harpoons.

The ceramics were quite consistent. The fabric was fine-grained with crushed quartz inclusions. The majority of the sherds were burnished, slipped, or both. The decorative techniques included combing, incising and pivoting, and the motifs range from straight lines to zigzag lines to triangular patterns. Again, the various components of the lithic and ceramic industries were compatible with those recovered from Shaheinab, the type-site of the Khartoum Neolithic.

Very few floral remains were recovered from the Khartoum Neolithic sites but they included seeds of wild sorghum and some carbonized seeds of tropical fruits. The faunal collections, in contrast, included a wide range of mollusca, fish and mammals, and, although some of the swamp-dwelling species found in the Khartoum Mesolithic sites were absent here, the fauna still indicate a rich habitat. Most significant was the recovery of domestic forms of *Bos*, *Capra* and *Ovis*. Although their frequencies vary from one site to another, their ubiquity demonstrates that a full Neolithic, food-producing economy was already in practice.

The radiocarbon dates obtained for the Khartoum Neolithic fall between 6000 B.P. and 5000 B.P. (Figure 7.2).

DISCUSSION

This second phase of investigation, which covers a period of about 15 years, has resulted in the recovery of a large body of data and a substantial quantity of material. This has shed at least some light on the nature of some of the early ceramic assemblages in the central Sudan, including information on the utilization of the environment and on settlement-patterns. This phase of research has provided broad confirmation of the framework established by Arkell in the 1940s but has added very little to it, and the established cultural sequence still shows hiatus and disjunctions between episodes. The origins of the early ceramic assemblages remain obscure. The Mesolithic-Neolithic development has not been demonstrated. The abrupt end of the Khartoum Neolithic is still unexplained, as is also the apparent hiatus of over two millennia between the Khartoum Neolithic and the Meroitic.

The data recovered during the second phase of research failed to resolve these and other similar problems, largely because the research was not designed to resolve them. Instead, research was conducted in piecemeal fashion and most of the sites were studied in isolation. The lack of any strategy or co-ordination in almost all of the research carried out severely limited the possibilities of solving such problems and of gaining a better understanding of the nature of the prehistoric communities under study. In this respect, it is well to recall Clark's statement in an overview of a recent conference on Northeast African archaeology: "We need the empirical evidence . . . that will give insight into the life-style of individual groups and communities, but the way to obtain this . . . is not through opportunistic digging, just because a site happens to exist in one's study area" (1984:498).

Moreover, the archaeology of the central Nile has never yet been studied within a regional context. Both past and present investigations into the Neolithic of the area have been essentially Nilocentric. The logistical difficulties involved in working away from the Nile Valley have long restricted research in more remote areas (Fattovich *et al.* 1984; Marks *et al.* 1985; Mohammed-Ali 1981; Shiner 1971), and the lack of information from these areas has, in turn, colored our understanding of the situation in the Valley.

RECENT RESEARCH IN THE BUTANA

A joint Sudanese-American mission has recently conducted a number of surveys and excavations in the Butana, a region due east of the Nile in central Sudan (Figure 7.1). The findings of this project have significant implications not only for the Butana itself, but also for the Neolithic of the central Nile Valley under consideration here. The evidence is summarized below.

Our investigations in the Butana were carried out in two key areas: around Shaqadud in the western Butana, 50 km east of the Nile, and around the town of Khashm el Girba, on the Atbara river in the eastern Butana (Figure 7.1). It was expected that the site of Shaqadud would prove to be archaeologically significant, because of its location away from the river and because surface finds there had included materials showing close affinities to the Mesolithic and Neolithic of the central Nile (Otto 1963, 1964).

Shaqadud was a complex of sites rather than a single locality (El Amin and Khabir 1986; Mohammed-Ali and Marks 1984). The main site, S1, comprises two localities: S1-A, which is a large cave at the back of a canyon, and S1-B, a midden located in front of the cave. There are also numbers of small surface sites on top of the surrounding plateau and along its slopes. Shaqadud cave and midden revealed a stratified sequence of nearly 7 m of cultural deposits. The lower levels of the midden correspond to the Khartoum Mesolithic and yielded a microlithic industry based on the production of flakes from small quartz pebbles. Typologically, the industry is dominated by lunates, scrapers and geometrics. The ceramics, which are more diagnostic, are a hard, well-made and well-fired ware, tempered with crushed quartz and difficult to break. The ware was not burnished but was decorated by combing, pivoting and impressing with zigzags, wavy lines, bands and dotted straight lines. Near the middle levels of the midden, the wavy-line motif is replaced by the dotted wavy-line but the decorative techniques and motifs otherwise continue as before; the fabric, however, shows a very clear and abrupt shift from the hard ware of the lower levels to a friable and easily broken ware, tempered with sand (Figure 7.3). Near the end of this part of the Shaqadud sequence, there is a gradual but clear shift in fabric, surface treatment and decoration from the styles of the Khartoum Mesolithic to those of the Khartoum Neolithic. This shift occurs between depths of 1.75 and 1.25 m in the Shaqadud midden but seems to be virtually unknown in the central Nile Valley itself.

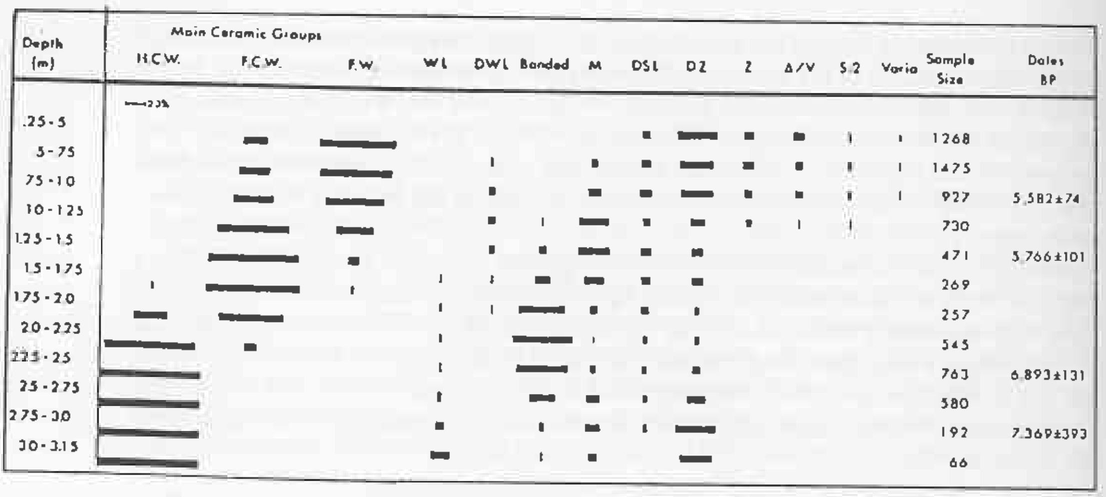

Figure 7.3 Ceramic types (fabric and motif) varying through the stratigraphy of Shaqadud midden.

The Neolithic phase at Shaqadud midden is essentially consistent with that of the central Nile. The lithic industry was based on microlithic quartz flakes. The workmanship tended to be poor and there is only a very limited variety of tool-types. Lunates, scrapers and retouched pieces predominate, but the gouges and adzes that were popular in the Nile Valley are lacking here. The shift in ceramic types from those of the Khartoum Hospital site to those of Shaheinab can best be seen in the fabric, the decoration and, most clearly, the surface treatment. The friable fabric gives way to a fine fabric with thin walls. The previously unburnished surfaces are now burnished, slipped, or both. Decorative motifs, such as zigzag lines, straight lines, triangles and fish-net patterns, become popular (Figure 7.3). There is, as yet, no evidence for domestic stock (Marks *et al.* 1985).

The nearby Shaqadud cave, S1-A, is dated to about 4000 B.P. and yielded material that does not obviously correspond to anything from the central Nile Valley with which we were already familiar. However, this statement may have to be modified after the final reports on Kadada (Geus 1976–84) and Rabak (Haaland 1984) become available. The chronological and cultural links between the top level of the Shaqadud midden and the bottom level of the cave have not yet been firmly established. The deposits in the cave have a depth of 3.35 m and the radiocarbon dates indicate that they accumulated during a relatively short period of time. The ceramics from the lowest part of the sequence had fine fabrics with smoothed, but rarely burnished, surfaces. Decorated sherds were initially rare but became more frequent towards the top. The lithic industry was poor. The faunal remains suggest the presence of domestic stock (J. Peters, pers. comm.), but the floral collections indicate the use of wild forms only, including *Pennisetum* (A. Abdelmagid, pers. comm.).

Our second area of investigation lay about 500 km to the east, around Khashm el Girba (Figure 7.1). Some 120 sites were found, ranging from Lower Paleolithic to historic in age, which could be placed in a provisional sequential order on the basis of the radiocarbon dates (Fattovich *et al.* 1984). The early ceramic sites, called the Pre-Saroba and the Saroba, have been dated to the seventh and sixth millennia B.P. They are small sites, located on the river bank and on the steppe east of the river, with economies based on riverine resources during the Pre-Saroba and on the hunting of savannah mammals during the Saroba. Apart from a few sherds with wavy-line decoration, the sites share only a few, very general, ceramic decorative motifs with sites in the central Nile Valley; most of the motifs are peculiar to this area.

The Butana industry succeeded the Saroba early in the fifth millennium B.P. This industry flourished along the river and on the steppe and was characterized by large villages, ranging between 40,000 m² and 120,000 m² in area and with cultural deposits as much as 2 m deep. The ceramics can be very broadly linked with those of the Saroba, but they are primarily characterized by a thick scraped ware. It has not yet been possible to trace the development of these villages but their upper levels show clear domination of domestic stock among the faunal remains.

The Butana industry appears to have disappeared suddenly from the area by about 3000 B.P. and was replaced by the Jebel Mokram and Taka group of sites. These sites are small in area and have very shallow cultural deposits. By the early third millennium B.P., the Napatan-Meroitic Kingdom was flourishing in the Nile Valley, while the region of the Butana was evidently left to be exploited by nomadic groups who, as our evidence indicates, created small sites and settled for only short periods of time.

DISCUSSION

This recent work has contributed significantly towards a better understanding not only of the later prehistory of the Butana but also of a number of issues and obscurities in the later prehistory of the central Nile Valley. Some of these will be discussed below.

The Saharo-Sudanese Neolithic

Arkell introduced the term "Khartoum Mesolithic" to designate the assemblages recovered from the Khartoum Hospital site, and he justified its applicability by the lack of direct evidence for domestication there. The term has been criticized but has also been widely used, and its use has continued to proliferate in the literature. The extent to which it is justifiable to label the cultural manifestations recorded at the Hospital site as Mesolithic is debatable. The term has not elsewhere been used to indicate sites that combine a lack of evidence for food-production with a well-developed ceramic technology, and such a use would require redefinition of the Mesolithic itself and of the boundaries between it and the Neolithic. It is apparent that the term does not really correspond to any African phenomenon. It has been pointed out elsewhere (Mohammed-Ali 1973) that, in this part of the Nile Valley, we must differentiate between the evidence for domestication *per se* and the evidence for the occurrence of species domesticated in Asia—sheep, goat, wheat and barley; the phenomenon of domestication is quite possible without the presence of Asian domesticates. It is understandable (although still regrettable) that Arkell was so much influenced by the European sequence at the time when he was working along the central Nile Valley. Use of the European sequence and its divisions has resulted in the imposition of several inappropriate preconceptions on central Nilotic prehistory.

The history of the term "Khartoum Neolithic" has not been any more felicitous, and it has been applied, rather indiscriminately, to a number of assemblages which share a few general features with that of Shaheinab but lack any evidence for food-production.

The effects of this confusion have extended beyond the central Nile. The Khartoum Variant, one of the Neolithic industries of Sudanese Nubia (Mohammed-Ali 1982;

Shiner 1968), was so named on the basis of a few broad similarities in ceramic motifs to the Khartoum Mesolithic but not to the Khartoum Neolithic. However, it lacks the features that are diagnostic of either and there is no evidence for food-production in the Khartoum Variant, which is usually considered to be a necessary criterion for a Neolithic classification.

Similarly, assemblages recovered from the African Sahel zone, west of the Nile, have been classified as Saharo-Sudanese Neolithic on the basis of certain affinities in ceramics (Hugot 1963) and, more recently, as the Khartoum Horizon Style (Hays 1971). The concept underlying the use of terms such as these implies the existence of a culture area (Kroeber 1944; Willey and Phillips 1958), and the validity of this concept for the African Sahel is decidedly questionable. When the early ceramics of the eastern Butana are compared with those of the central Nile Valley, the two areas may be seen to share very little in common, apart from a few generalized features. The concepts of a "horizon style" or of a "culture area" do not seem to be applicable in this region. Furthermore, one would expect to observe a certain amount of inter-regional variation across the Sahel, in addition to any broad similarities that might exist. It would appear, however, that such variation has thus far been ignored or completely overlooked. If the archaeology of the Sahelian zone is to advance further, then archaeologists working in the area must agree on a terminology that will permit the definition and categorization of assemblages without creating the philosophical and taxonomic confusion of the present system.

The Khartoum-Shaheinab Transition

During the last 15 years, the area of the central Nile Valley around Khartoum has been the subject of intensive archaeological investigations (Caneva 1983; Haaland 1981; Krzyzaniak 1978; Mohammed-Ali 1982; Mohammed-Ali and Abdelmagid in press). Initially, Arkell's established sequence, of the Mesolithic industry at Khartoum evolving into the Neolithic industry at Shaheinab, was generally accepted as valid, but the evidence that has been recovered from the central Nile does not actually support the sequence. The major point of difficulty is that no site has been found in the Nile Valley that records a transition between the two. The diagnostic features of the Khartoum Neolithic, whether in ceramic manufacture or lithic technology, cannot be genetically linked to those of the Khartoum Mesolithic. The chronometric dates now available from the central Nile Valley show a cluster of Mesolithic occurrences in the ninth and eighth millennia B.P. with a very few dates in the seventh millennium, while those of the Neolithic fall in the sixth millennium B.P. (Figure 7.2). Consistent with this, the evidence from Shaqadud clearly shows that while the Mesolithic lasted for about 2500 years, the Neolithic was a relatively short-lived phenomenon of not more than a thousand years. However, Shaqadud also shows a developmental sequence from the Mesolithic into the Neolithic (Figure 7.3). The hiatus within the archaeological record of the central Nile Valley still remains, but, in light of what is known from Shaqadud, we would expect that the Nilotic hiatus may eventually be filled by future work in the area.

The Neolithic-Meroitic Hiatus

The radiocarbon dates obtained from Neolithic sites in the central Nile Valley indicate that the Neolithic phase ended rather abruptly by, or shortly after, 5000 B.P. Between

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the end of the Neolithic and the establishment of the Napatan-Meroitic state at about 2800 B.P., there is an apparent hiatus of 2000 years during which we have no evidence for settled life in the central Nile Valley (Mohammed-Ali 1984). The evidence currently available for this period is not sufficient to explain the hiatus, but a number of hypotheses have, nevertheless, been proposed (Haaland 1984; Marks in press).

The hiatus might primarily be the result of a sampling problem, in that not enough surveying has yet been carried out in the area to locate sites dated to this phase.

Deposits and, with them, the sites of this period might have been selectively affected by natural agents of destruction, such as erosion, thus biasing the archaeological record.

Alternatively, the marked decrease in the number of settlements might be due either to a shift of emphasis from aquatic resources to the hunting of steppic forms, or to a radical change in the entire mode of subsistence from hunting and gathering to pastoralism.

In fact, most of the area in question has been rather thoroughly investigated, and the complete range of sites from Paleolithic to modern has been identified. It seems most unlikely, therefore, that only those of the post-Neolithic and pre-Meroitic interval should have been missed. On the other hand, the available paleogeographic data do not permit us to exclude the possibilities that environmental conditions during this interval might have caused a depopulation of the area, or that later local geomorphic processes might have destroyed the settlements.

The Khartoum Neolithic of the central Nile Valley reached its greatest florescence by 5000 B.P. At that time, domestic stock made up over 80% of the mammalian fauna, as seen at Kadero-1 (Gautier 1984), and aquatic and steppic species, although utilized, were not significant elements of the diet. It was at this highest stage of its development that the Khartoum Neolithic apparently vanished from the central Nile.

Chronologically, this coincided with the extensive nucleation of the Butana and the appearance of the Butana industry. It was noted above that, in size, depth and distribution, the Butana sites reflect a marked increase in population density compared with those of the preceding Saroba. It is possible that the explanation for this rapid nucleation may not lie solely within the internal dynamics of the Butana itself, but, unfortunately, the available evidence does not permit us to determine whether the two phenomena were linked or whether they were simply coincidental.

Culturally, the Butana sites show no obvious affinities with the Khartoum Neolithic, although, in light of the behavior-patterns of pastoralists, this would not necessarily exclude all possibility of population movement between the two. The economy of the Neolithic communities on the central Nile was based upon cattle pastoralism, which, as it developed and became increasingly important, could well have resulted in pressure to expand settlements away from the river bank. Although the Nile Valley proper was a rich environment, it was also an areally restricted one that was not suitable for pastoralism on a large scale. Under these circumstances, the Butana would offer a better alternative. Pastoralists may move eastward across the steppe without any natural or environmental constraints or barriers to their movement. In addition, the Butana is ecologically different from the central Nile, even though it lies due east of it; the isohyets are skewed by the Ethiopian plateau and the Red Sea hills so that the vegetational belts of the Butana are actually much more suited to pastoralists than are those of the Nile. Finally, the Butana is absolutely much larger than is the central Nile Valley and, therefore, much better able to withstand pressure on its resources that might result from intensive grazing.

The final resolution of the question of relationship between the Khartoum Neolithic and the Butana industry depends upon further work at and analyses of the Butana sites and investigation in the plains of the central Butana. A similar problem is involved in the apparently sudden disappearance of the Butana groups coincident with the establishment of the Napatan-Meroitic state in the Nile Valley.

CONCLUSION

Although our picture of Neolithic adaptations in the central Nile Valley is far from complete, the need now is not simply to excavate more sites in the area. Instead, we need to proceed according to an explicit strategy designed to find solutions to the current problems. It also remains quite possible that the answers to these problems may lie outside the immediate Nilotic area and that, no matter how many data are gathered from the central Nile Valley, they will add very little, if anything, to our present picture and to our understanding of cultural change and development in the area.

ACKNOWLEDGMENTS

The author is greatly indebted to Angela E. Close for polishing the English of this paper.

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Late Pleistocene and Early Holocene Occupations in the Upper Atbara River Valley, Sudan

ANTHONY E. MARKS

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WIM VAN NEER

INTRODUCTION

During the past sixty years, many Late Pleistocene and a few Early Holocene sites have been discovered in the Nile Valley of Upper Egypt and Nubia, as far south as the Second Cataract in the Sudan (Vermeersch 1978; Vignard 1923; Wendorf 1968a; Wendorf and Schild 1976). These sites are not evenly distributed along the valley, but tend to be common in areas where major wadi systems enter the Nile Valley, such as at Ballana (Wendorf 1968b) and Wadi Kubbaniya (Wendorf *et al.* 1980), or where a meander of the Nile has left major expanses of Late Pleistocene silts more or less intact, as at Kom Ombo (Butzer and Hansen 1968). A comparable density of sites is also known at the Second Cataract, with its embayments and wide terrace remnants (Irwin *et al.* 1968; Marks 1970; Wendorf 1968a) (Figure 8.1). Yet, as one moves south from the Second Cataract, the number of Late Pleistocene sites drops markedly and rapidly. Only a handful are known from the edges of the southern end of the Cataract (Marks 1970; Shiner 1968a) and these belong technologically and typologically within those traditions that characterize the areas to the north. It is almost as if the Second Cataract formed as marked a barrier to the southern expansion of Late Paleolithic hunters and gatherers as it did to the later political and military aspirations of the Egyptian Old Kingdom (Adams 1977).

The paucity of Late Pleistocene sites in the area immediately south of the Second Cataract well may be explained by the radically different topography and geology. The Second Cataract marks the northern boundary of a Precambrian wilderness of weathered granites cut by metamorphic dykes, the Batn el Hajar (Belly of Stone), where it meets the softer topography of the Nubia Sandstone region (Figure 8.1). The Nile deposited little sediment as it cut through the Batn el Hajar, and the river is often directly bordered by cliffs of Precambrian rock. Only small patches of riverside vegetation exist; the potential for life is limited at best.

However, the Batn el Hajar extends only about 125 km along the river. To the south, the open topography of the Nubia Sandstone reemerges, the river terraces broaden and run unbroken for long distances and the vegetation along the edges of the Nile and at the smaller cataracts once again becomes lush although still not extensive. Nevertheless, there is almost no sign of any Late Paleolithic occupation. Between Dal, at the southern edge of the Batn el Hajar, and Khartoum some 625 km to the south (Figure 8.1), there is not a single known aceramic site that may be attributed to the Late Pleistocene, in spite of the extensive surveys that have been undertaken between Dal and Khartoum and the presence of large exposures of Upper Pleistocene Nilotic sediments north of Khartoum (Geus 1976–79; de Heinzelin 1971; Marks *et al.* 1968; A. Mohammed-Ali, pers. comm.).

The absence of preceramic Late Paleolithic occupation is particularly strange because of the rather extensive distribution of early ceramic Khartoum Mesolithic-related sites between the Second Cataract and Khartoum (Arkell 1949a; Caneva 1983; Shiner 1968b), the earliest of which well may date to the very beginning of the Holocene (Khabir 1985). At the moment, it seems as if the central Nile Valley, south of the Batn el Hajar, saw no significant Late Pleistocene human occupation and that the Khartoum Mesolithic peoples, with their distinctive ceramics and their undistinguished stone tools, arrived as immigrants from some adjacent region.

While the region from south of the Batn el Hajar to well above Khartoum was arid during the Late Pleistocene (Wickens 1975, 1982; Williams 1982), this cannot in itself account for the absence of populations along the Nile, since it was equally arid north of the Batn el Hajar where there was continuous occupation until almost the very end of the Pleistocene (Connor and Marks 1985). These climatic conditions, however, suggest that the origins of the Khartoum Mesolithic are not likely to be found in the desert or steppe areas paralleling the Nile but, rather, in some better-watered area. One such possible area is along the Atbara River which flows from Ethiopia into the Nile north of Khartoum (Figure 8.1). Recent work there has brought to light some Late Pleistocene and Early Holocene occupations that may help narrow the search for the preceramic origins of the Khartoum Mesolithic and also provide some insight into the Late Pleistocene environments and human adaptations to an arid northeastern Africa outside the Nile Valley.

HISTORY OF THE WORK

Although detailed examination of the upper Atbara River Valley has been carried out only recently (Marks *et al.* 1982a, 1982b), it is more than thirty years since Arkell (1949b) noted Lower Paleolithic artifacts along the river near the present town of Khashm el Girba (Figure 8.2). In 1966, during a month-long survey of the river valley and the adjacent steppe near the same town, a project under the direction of Dr. J. Shiner located a large number of prehistoric sites which mainly seemed to fall into one of two periods: Lower Paleolithic or early ceramic (Shiner 1971). Unfortunately,

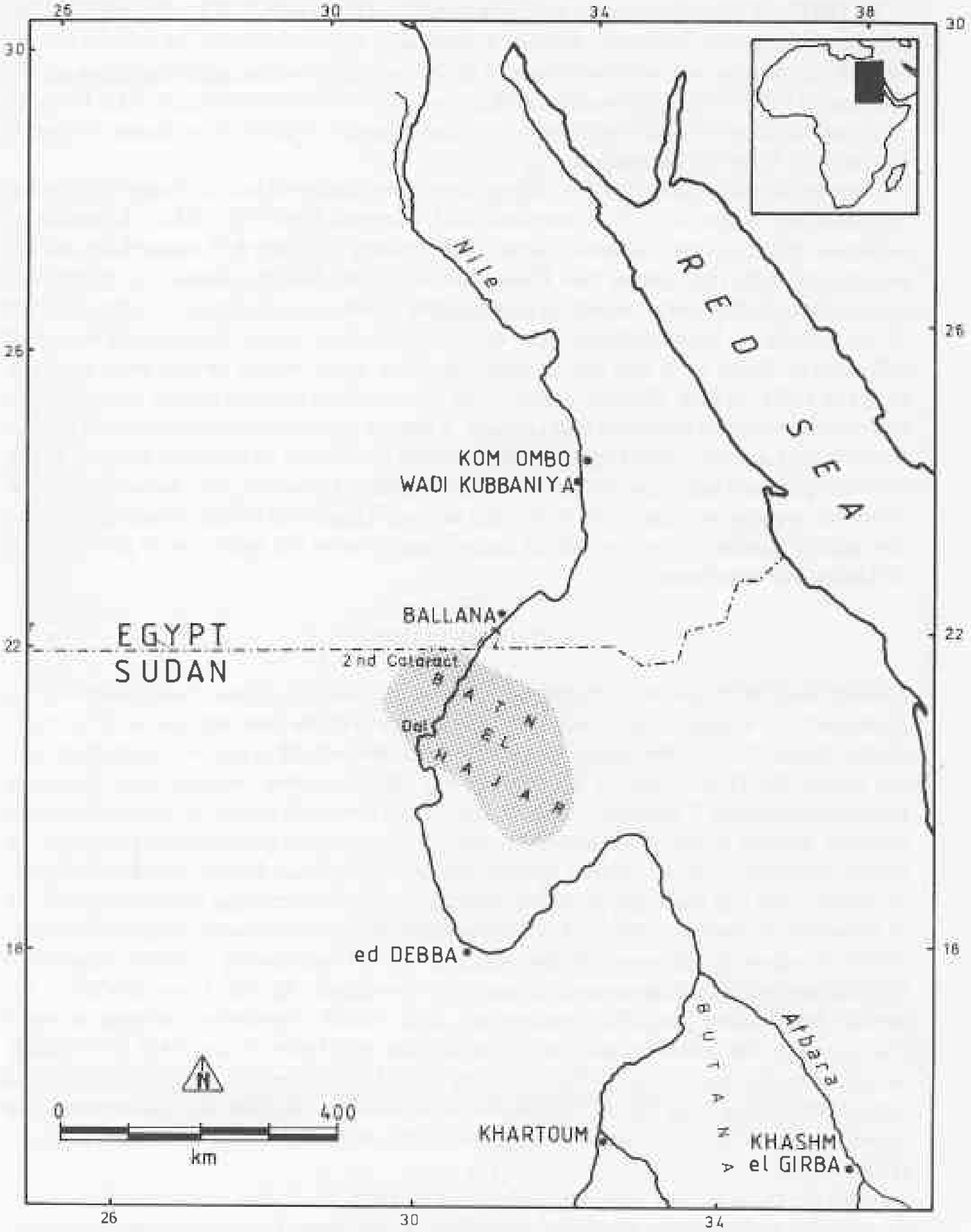

Figure 8.1 Map of northeastern Africa, showing places mentioned in the text.

although some surface collections were made and some small test-excavations carried out, no detailed reports have appeared, particularly on the preceramic materials, and little concerning them has passed into the literature.

In 1981, the Joint University of Khartoum/Southern Methodist University Archaeological Project was initiated, of which a major aim was to elucidate the culture history of both the eastern and western fringes of the Butana grasslands—that huge area east of the central Nile Valley and west of the Eritrean Hills in Ethiopia (Figure 8.1). Because of Shiner's pioneering survey, the area around Khashm el Girba was chosen as part of the eastern fringe to be studied.

Among the many sites noted by Shiner were a few clustered just northeast of Khashm el Girba that appeared to be preceramic and, perhaps, Late Paleolithic. Although no radiometric dates were available, the surface artifacts included well-made tools usually associated with the end of the Paleolithic—backed blades, geometric microliths, endscrapers and so forth—made on good quality chert or, more rarely, on agate (Shiner 1971:308–312). Most of these sites were described as being in advanced stages of deflation in 1966, so it was not certain that all or some would be still even partially intact in 1981. In fact, because of the rough nature of the original survey notes and the intervening years of deflation and erosion, it cannot be established whether or not the sites located in 1981 were those originally noted by Shiner. In the most general sense, the sites he found and those we found are very similar. However, they do not seem to be identical, and the ever-evolving landscape around Khashm el Girba brings new sites to the surface almost every year before destroying them by the rather rapid processes of deflation and sheetwash.

THE SETTING

Most of the Late Paleolithic sites reported by Shiner and all of those located in 1981 are clustered near a bend of the Atbara River, 8 km north of the new dam above Khashm el Girba (Figure 8.2). A few kilometers north of the dam, which is built in a narrow, water-cut gorge, the river makes a 90° turn to the east and then returns to its generally northerly direction 7 km later. This portion of the river still shows an earlier meander channel, slightly north of but parallel to the present, active river-channel (Figure 8.2). North of the old meander, earlier Atbara silts and gravel-bars form a rectangular block, 12 km^2 in area and inset into probable Middle Pleistocene deposits which rise some 25 m above the modern floodplain. The approximate center of this inset of fluvial deposits, which is about 2 km west of the present, northward-flowing Atbara, reaches a maximum elevation of just over 12 m above the floodplain. At this (12-m) elevation, the surface has a minor basin-like topography, with a small depression, perhaps no more than a square kilometer in area and no more than 4 m below a low ridge that slightly accentuates the depression on the riverward side. The depression is less marked on the inland side, being only about 3 m below an expanse of flat silts and gravel-bars that extend west and north to the eroding slopes of the higher Middle Pleistocene terraces (Figure 8.2).

With the exception of a few trees along the modern floodplain, the riverside slope of the alluvial sediments is devoid of significant vegetation. There is a scatter of small thorn-trees in the one moderately developed drainage but, for the most part, the surface of the ground is bare and featureless. In the depression, however, there is fairly dense vegetation, mainly thorn-trees but also sparse remnants of annuals missed by the herds of goats which graze the area. Thus, even today the depression receives and holds more moisture than the surrounding sediments, although there are small clumps of thorn-trees scattered across the area between the depression and the Middle Pleistocene sediments to the north and west.

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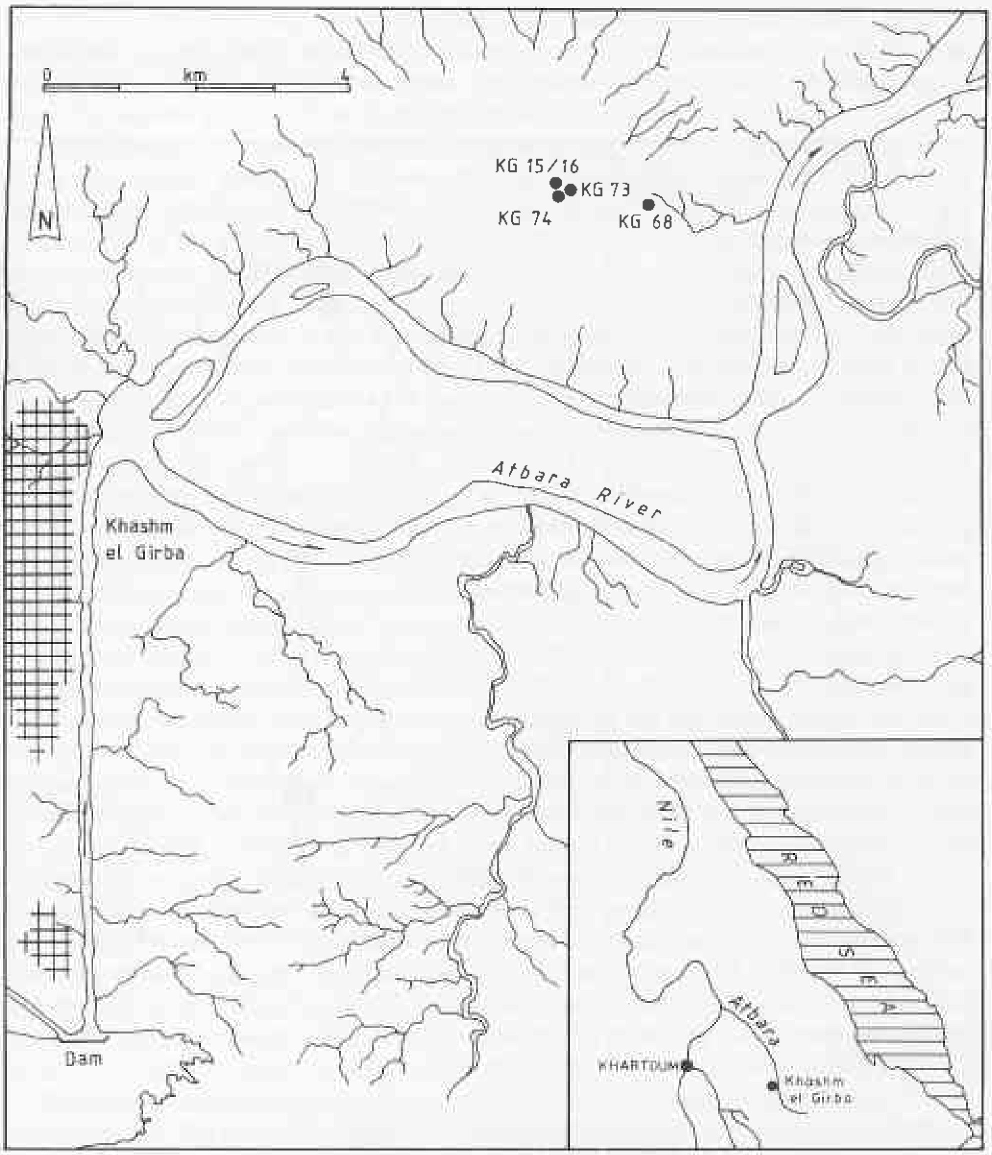


Figure 8.2 Map of the Khashm el Girba area, showing the depression.

THE SITES

Most of the preceramic sites are located near the low ridge which borders the depression on the east. Additional sites occur farther to the east on the gentle slope leading down to the modern floodplain (Figure 8.3). No sites were located on the western side of the depression or within it.

The sites near the depression were of two kinds: those still partly *in situ* with dense surface concentrations of chert artifacts and those fully on the surface with low densities of mainly quartz artifacts. Although all sites were either test-excavated or systematically surface collected, or both, it was the former group of sites that were of most

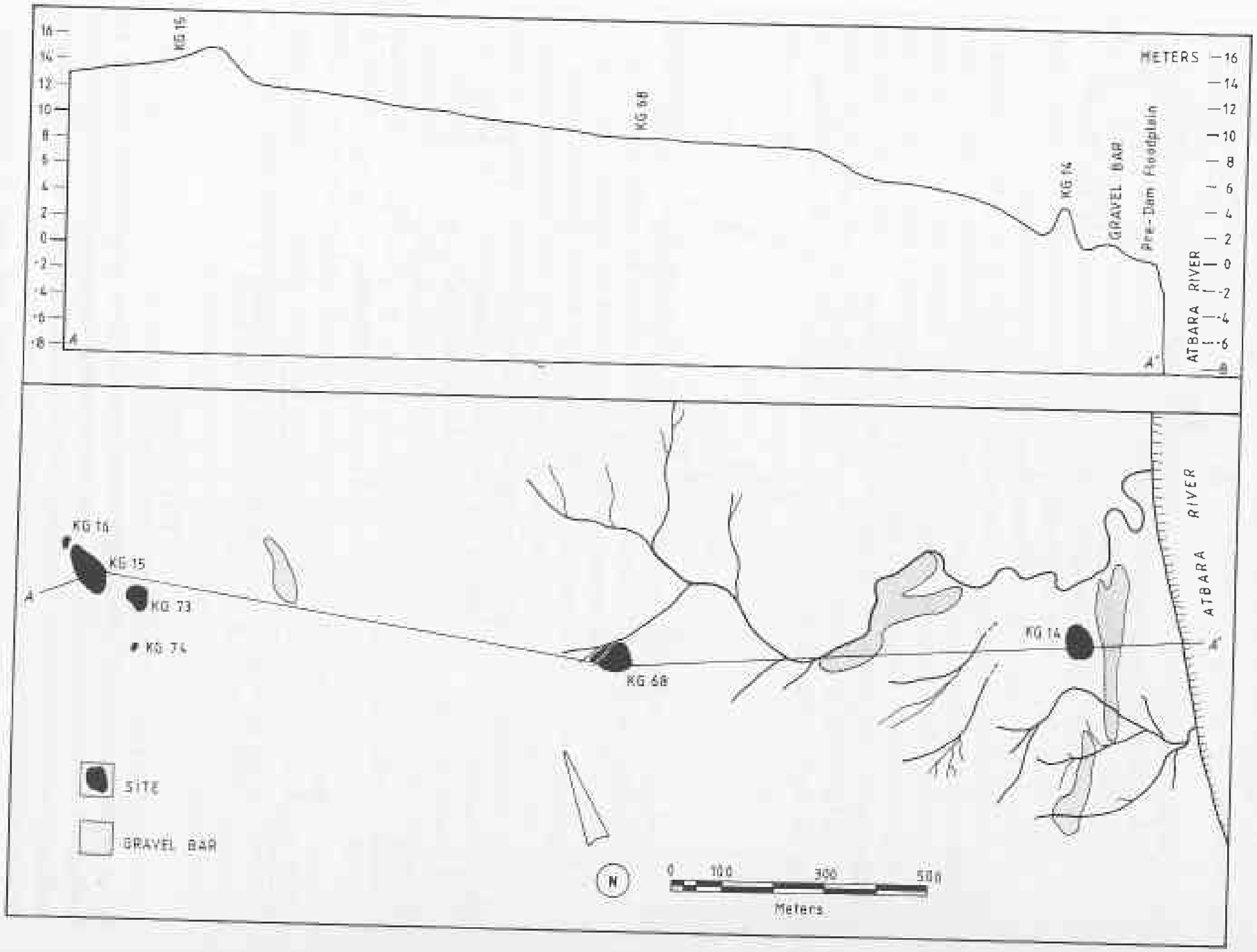


Figure 8.3 Map of the eastern part of the depression with the spatial relationship between sites, gravel-bars and the Atbara River. The upper section shows the elevational changes along the transect

Figure 8.3 Map of the eastern part of the depression with the spatial relationship between sites, gravel-bars and the Atbara River. The upper section shows the elevational changes along the transect

interest. Not only can they be tied geologically to the alluvial sediments but they also contained a good range of faunal materials, significant numbers of artifacts and, occasionally, datable organic materials. This paper will deal only with this group of sites; the second group will be published elsewhere by Dr. Y. El Amin.

All but one of the *in situ* sites are clustered on or near the low ridge on the eastern side of the depression. They occur on both sides of the ridge: KG15 and KG16 are on its western slope, while KG73 and KG74 are on the flat surface of the sediments just at the eastern edge of the slight rise which forms the crest. The final site, KG68, lies about 1 km east-southeast of the ridge and has been exposed by the recent advance of a shallow erosional system (Figure 8.3). This system has uncovered several sites but only KG68 was sufficiently large and *in situ* to warrant more than a systematic surface collection. Also, it is the only site in this portion of the sediments that seems to relate to the cluster of *in situ* sites adjacent to the depression. The other sites were sometimes rich with artifacts, but had very few retouched tools of any kind and the raw material was almost exclusively quartz.

The sites chosen for detailed study exhibited considerable variability in size and internal structure. The largest, KG15, had been exposed by a short, but marked, erosional channel which divided it into two distinct areas. The northern area provided *in situ* material and charcoal samples to a depth of 20 cm. Artifact densities were not high, so an adjacent area of 50 m² was collected to increase the sample. This was called KG16, but, in reality, is an extension of KG15. It has been kept separate here because its tool assemblage shows some significant differences from the KG15 sample. The differences are clearly seen in the test-excavations of the two areas and so are not a result of artifact-loss due to slopewash. On the southern side of the erosional cut, a large area of surface artifacts was brought to light by minor secondary erosion. A large excavation area was placed just above this erosional zone which provided a good sample of *in situ* artifacts, as well as some faunal remains. However, none of the excavations revealed dense concentrations of artifacts, although clusters did occur. The initial excavations in 1981 were limited to 16 m² on the northern side and 10 m² on the south. The southern excavations were greatly expanded in 1982 but this paper will deal only with the sample recovered from the southern area in 1981. The larger artifact sample will be published by Dr. Y. El Amin in the future. The overall size of KG15 could not be determined accurately, since so much of it may have been completely buried. A rough estimate, based on surface indications, would be at least 3100 m².

The second largest site near the depression is KG73 which has surface artifacts over an area of some 1700 m². Although there was no evidence for water-erosion, the artifacts had been exposed by deflation and by a slight disturbance of the surface in recent times. The surface concentration was dense across the entire site, and subsequent excavations indicated that the cultural deposits were less than 15 cm deep. Rare faunal remains were found on the surface and even fewer *in situ*. The site was mixed, since a scatter of crude ceramics, metals and fine china occurred with the lithic artifacts on the surface. While the metal and china could be excluded, the very crude ceramics were a problem since they might have been the earliest ceramics in the Sudan. After the discovery of a complete sneaker at a depth of 10 cm, questioning of the local inhabitants brought forth the family who had camped on the site for a few years around 1940. The ceramics were theirs, all of them. The crude pieces were not the earliest locally made ceramics but among the most recent, and the surface impressions were truly fabric impressed—with burlap and sheet cotton! In any case, the intrusive elements could be recognized easily and the sample described here can be considered a single component.

Site KG74, although close to the others, was structurally somewhat distinct. Again, it was deflated with no indication of any artifact-movement due to slopewash. Like KG73, the artifact density was very high but formed an oval of somewhat less than 60 m². *In situ* material reached a depth of less than 15 cm and only occasional artifacts were found below 7 cm. Test-excavations confirmed that the surface site area corresponded closely to the true site area. The artifacts were not only extremely fresh but most still had a hard silt crust, indicating that they had been exposed very recently. A burned area about a meter in diameter lay under some of the artifacts, and a few were incorporated into the hardened matrix. A large charcoal sample was recovered from the center but, unfortunately, the fireplace was intrusive and dated to the seventeenth century A.D. Few faunal remains were found, mostly *in situ*.

Site KG68 covered a large area of at least 1200 m² on top of and down a gentle slope (a drop of 0.9 m in a 55-m transect) leading to the main drainage-system flowing toward the Atbara (Figure 8.3). Initially, the site looked like a series of small, possibly unrelated concentrations. Scattered across the surface were clusters of large mammal bones, often articulated, small dense concentrations of chipped quartz or agate, a pile of seemingly burned river-pebbles and a rather loose scatter of other small river-pebbles. Two areas were excavated for a total of 32 m², and the areas around the animal bones were also cleared and collected. These often had small numbers (rarely more than a dozen) of associated lithic artifacts.

The excavations uncovered seven piles of burned pebbles, measuring from as little as 25 cm in diameter to as much as 52 cm. Most had small fragments of bone among the pebbles but there was no charcoal, even though all the pebbles were thermally cracked or crazed. Deflation had clearly scattered the tops of these piles but some were still as much as 30 cm deep. Lithic artifacts also occurred near the pebble piles but only a single tool was actually recovered from the bottom of one of the piles. Around the piles were quantities of fish bone and larger mammal bones.

Much of the lithic material was found in tight clusters less than a meter in diameter; each apparently represented an individual reduction sequence, since in each case the raw material was homogeneous and retouched tools were never found in these concentrations. The retouched tools tended to occur scattered thinly across the excavated portions of the site, without marked spatial association with either the piles of burned pebbles or the concentrations of animal bone. However, the general spatial associations between all three elements and the specific associations in several cases made it clear that all belonged together.

Based on the spatial distributions of the artifacts and bone, this site might well have seen numerous repeated occupations by small groups who used the area for fishing, gathering, butchering and as an ephemeral, all-purpose camp-site. The discrete nature of the concentrations argues against long-term occupation, while a very thin scatter of megafaunal remains over a wide area above the slope suggests that the site area may be much larger than estimated from the somewhat deflated area that was tested.

DATING

Since all of the sites were only slightly *in situ*, with no artifacts found below 20 cm, it was impossible to arrive at any chronological seriation of even the closely clustered sites through their relative stratigraphic positions within the sediments. Also, the ridge sediments and those in front of it were identical in structure and color. Only the presence of numerous root-casts and a somewhat greater cementation at KG15, on the depression side of the ridge, differentiated it from the other deposits.

In spite of the stratigraphic limitations, a sample for radiocarbon dating was acquired from site KG15, producing a date of 10,230 B.P. ± 270 years (SMU.1149). From their stratigraphic position, KG73 and KG74 cannot be of a very different age, although technologically and typologically they should be somewhat older.

A shell sample from KG68 permitted a single date of 7700 B.P. ± 90 years (SMU.1607), which is consistent with the site's stratigraphic position within the inset (8.2 m above the floodplain). It seems likely that the Atbara began to incise its bed about the beginning of the Holocene and continued to down-cut, with short episodes of stability, until the present day. In fact, an early ceramic site, the Pre-Saroba KG14 (Fattovich *et al.* 1984), is situated at 3.75 m above the floodplain and has an appropriately younger radiocarbon date of 6215 B.P. ± 75 years (SMU.1139). While additional dates would be desirable, it is still reasonable to believe that the occupations near the depression were Terminal Pleistocene, while KG68 was visited during the Early Holocene.

THE ASSEMBLAGES

While a separate, detailed description of the technology and typology of each assemblage might well be justified, since assemblages of this type have never been described before, those from the clustered sites of KG74, KG73, KG15 and KG16 are sufficiently similar in all ways that they may be treated together. They are not identical but clearly belong to the same industry. The KG68 assemblage, however, is distinct in a number of ways from the others and will be treated separately. Nevertheless, there are enough points of congruence between it and the other assemblages to postulate that it represents a more recent phase of the same industry.

RAW MATERIAL UTILIZATION

The assemblages, as sampled, consisted mainly of chipped stone, although four pieces of ground handstones were found *in situ* at KG15 and a fragment of a grinding-stone was recovered from KG68. All of these were made on rough volcanic rock commonly available in the gravels of the river. The chipped stone at all sites has the same range, although some very significant differences exist between the clustered sites and KG68 (Table 8.2). Virtually all the stone at all of the sites came as pebbles or small cobbles from the nearby Atbara gravel-bars. All of the gravel-bars examined contained a wide range of raw materials, including agate, chert, quartzite, quartz, greenstone and volcanic rock, but the gravel-bars above 8 m are dominated by cherts, while those below 8 m are largely made up of quartz pebbles. Agate and greenstone are never common. The specific gravel-bar source of raw material for any one site is unknown, since there are many remnants in the sediments which, like the sites, are now being exposed by deflation. It seems clear, however, that the acquisition of raw material was not a problem and that enough of any kind of raw material present in the gravels could be collected with little effort. Thus, differences in raw material utilization would reflect cultural decisions.

TABLE 8.1
Tool and Debitage Raw Material Utilization as Percentages

	KG74	KG73	KG15	KG16	KG68
Tools					
Chert	88.9	89.0	79.2	71.7	16.8
Quartz	0.5	0.9	1.9	4.4	1.0
Agate	8.7	10.1	14.2	23.0	81.7
Greenstone	1.9	-	-	0.9	0.5
Other	-	-	4.7	-	-
Sample size	416	109	106	113	197
Debitage					
Chert	88.3	91.2	90.3	60.9	9.5
Quartz	1.1	5.3	0.9	6.5	38.3
Agate	9.4	3.2	8.7	31.7	45.1
Greenstone	-	0.4	-	0.2	-
Other	1.1	-	0.4	0.7	6.6
Sample size	995	2434	793	1178	1309

Chert was the favored raw material at sites KG74 and KG73 and raw material selection for tool-production directly reflected the overall proportions of raw materials brought to the sites (Table 8.1). A slight shift can be seen at KG15, even more strongly expressed at KG16, where there is a proportionately greater use of agate for tool-production than in the selection of raw material brought to the site. However, chert remains the dominant raw material. This shift can be correlated with two factors: chert pebbles tend to be significantly larger than those of agate and its flaking qualities permit greater control in blade-production than is the case for the more brittle agate. On the other hand, both raw materials are suitable for the production of flake-tools. It is not surprising, therefore, that the percentage of flake-tools increases from sites KG73 and KG74 to KG15 and KG16.

This shift to increasing utilization of agate in tool-production is markedly accentuated at KG68, but there is also a major increase in the amount of agate brought to the site (Table 8.1). In addition, for the first time, quartz is found in significant proportions in the debitage. This is hard to explain, since quartz flakes were almost never chosen for retouch. Its presence is certainly linked with its increased availability in the gravel-bars near KG68, as compared with those near the clustered sites, but the paucity of retouched quartz tools suggests either that it was not highly valued or that quartz flakes were used without formal retouch. In spite of the drop in the frequency of chert in both the debitage and overall tool-production, there was a positive selection of it (Table 8.1).

Part of any explanation regarding shifting raw material preferences must also be seen in light of changes in basic core-reduction strategies which can be traced from KG74 to KG68. Again, KG68 stands apart from the others but does so by an accentuation of already existing trends.

TECHNOLOGY

The assemblages from KG74, KG73, KG15 and KG16 were dominated by a simple blade-producing strategy. Rather large chert pebbles were selected, one end was struck off more or less perpendicular to the long axis of the pebble and blades were then struck off around the face. There appears to have been no special core-preparation, no

TABLE 8.2
Retouched Tool Assemblages

	KG74		KG73		KG15		KG16		KG68	
	No.	%	No.	%	No.	%	No.	%	No.	%
Simple endscrapers	11	2.6	7	6.5	4	3.9	30	26.5	3	1.5
Thumbnail scrapers	13	3.1	2	1.8	6	5.8	2	1.8	0	-
Denticulate endscrapers	6	1.5	2	1.8	1	1.0	1	0.9	1	0.5
Microdéjeté scrapers	12	2.9	2	1.8	2	1.9	2	1.8	0	-
Sidescrapers	2	0.4	0	-	1	1.0	0	-	0	-
Perforators	3	0.7	0	-	1	1.0	0	-	2	1.0
Burins	2	0.5	0	-	0	-	0	-	2	1.0
Scaled pieces	0	-	3	2.8	3	2.9	6	5.3	82	41.6
Denticulates	7	1.7	10	9.1	5	4.9	4	3.5	3	1.5
Notches	37	8.9	3	2.8	7	6.8	8	7.1	6	3.0
Retouched pieces	58	14.0	21	19.3	11	10.7	14	12.4	22	11.2
Truncated flakes	0	-	0	-	0	-	2	1.8	3	1.5
Truncated blades	51	12.3	10	9.2	10	9.7	0	-	1	0.5
Trapezes	5	1.2	1	0.9	2	1.9	0	-	0	-
Backed trapezes	38	9.2	7	6.4	9	8.7	8	7.1	0	-
Triangle	0	-	1	0.9	0	-	0	-	0	-
Lunates	7	1.7	3	2.8	0	-	5	4.4	1	0.5
"Orange wedges"	12	2.9	12	11.0	9	8.7	7	6.2	18	9.2
Backed and truncated blades	80	19.2	14	12.8	17	16.5	9	8.0	0	-
Backed and truncated flakes	0	-	0	-	0	-	0	-	3	1.5
Backed blades	58	14.0	11	10.1	13	12.6	10	8.8	0	-
Backed flakes	1	0.2	0	-	1	1.0	2	1.8	42	21.3
Denticulate backed flakes	0	-	0	-	0	-	2	1.8	3	1.5
Backed blades with modified base	4	0.9	0	-	0	-	1	0.9	0	-
Double-backed blades	4	0.9	0	-	1	1.0	0	-	0	-
KG74 point	5	1.2	0	-	0	-	0	-	0	-
Varia	0	-	0	-	0	-	0	-	5	2.5
Total	416		109		103		113		197	

production of *lames à crête*, no faceting of the platforms. The cores tend to have broad, slightly convex flaking-surfaces (Figure 8.4: b), although the flaking-surface may go much of the way around the pebble (Figure 8.4: d, e). A few exhibit opposed-platform reduction but this was mainly a shifting of the striking-platform to the opposite end of the pebble when the original flaking-surface could no longer be used because of either a crushed platform or hinge-fracturing (Figure 8.4: f). A few core-tablets were found, but this rejuvenation technique was apparently rare, perhaps because of the already rather small size of the available pebbles. Most blade cores were of chert but agate was also used occasionally.

While blade-production was the dominant technique, two other reduction strategies were used: simple flake-production from roughly faceted or unfaceted cores and, more rarely, bipolar reduction. The latter technique is absent at KG74, represents 19% of the cores at KG73 (only four examples!) and has about equal percentages at KG15 and KG16 (±25%). At KG68, bipolar reduction accounts for 49%, while blade cores are virtually absent. This shift in reduction strategies is reflected in the shift in raw material selection, since a bipolar technique can produce flakes much more efficiently from agate than from chert.

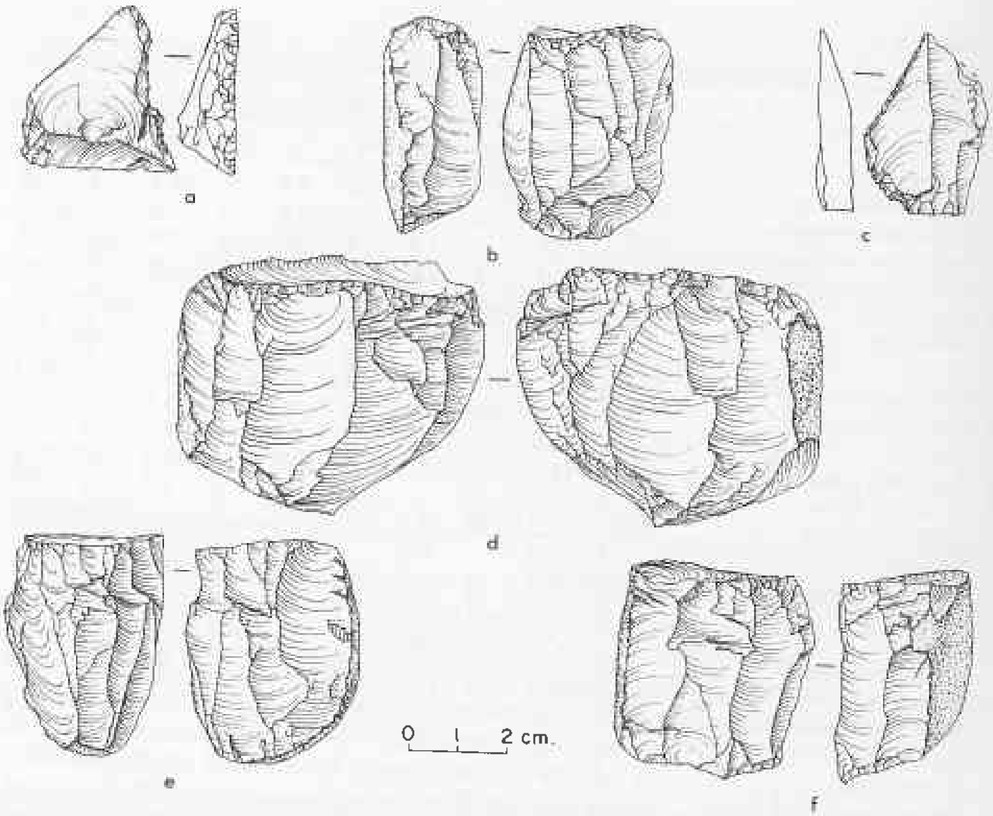


Figure 8.4 Cores and Tools from KG74. a, inverse denticulate; b, single-platform core with wide flaking-surface; c, retouched flake; d, e, single-platform cores with blade-removal around almost the whole circumference; f, opposed-platform core.

Finally, the relative importance of blade-production as a means of producing tool-blanks also shows a shift. Blade-tools dominate the assemblages from KG74 and KG73 (65.6% and 61.5%, respectively). At KG15 and KG16 they range between 56.7% and 46.9%, while they fall drastically to only 3.6% at KG68. This is consistent with the other technological changes: the shift to more brittle raw material for flaking, the increased use of bipolar reduction to produce both blanks and finished tools (scaled pieces), and the apparent use of unretouched quartz flakes as tools.

While it might be expected that these strong technological changes would be reflected in important typological changes, the latter tend to be fairly limited and, on the whole, predictable.

TYPOLOGY

As with most Late Paleolithic assemblages in the northern Nile Valley, these assemblages from near Khashm el Girba contain a good range of backed tools, including geometrics, backed blades and backed and truncated blades (Table 8.2). However, unlike the tool-assemblages in the Nile Valley, the backed elements here are made exclusively on blades *sensu stricto*; not a single backed blade-tool from any of these assemblages falls within the metric parameters of a bladelet-tool(≤8 mm wide). In fact, not only are they on blades but they also tend to be exceptionally large. Perhaps as a balance to this, the well-represented scrapers tend to be extremely small—much smaller than in any other assemblage in northeastern Africa. Together, these tendencies give a very curious aspect to the assemblages. The tool-assemblage from KG68 is again somewhat different but it, too, has aspects unknown elsewhere in the Sudan and Egypt.

The tool-assemblages from the clustered sites KG74, KG73, KG15 and KG16 will be described first, and then those from KG68.

The Clustered Sites: KG74, KG73, KG15 and KG16

As noted above, endscrapers tend to be very small, rarely exceeding 40 mm in length. The majority in each assemblage are on either small flakes (Figure 8.6: l) or primary flakes; only a very few are on blades. They tend to be well made, with symmetrically rounded scraping-edges formed by semi-steep retouch. A small number have regular, finely serrated scraping-edges but the two outstanding types are the thumbnail scrapers and those that must be considered *microdéjeté*. The former are similar to normal endscrapers but tend to be smaller, rarely exceeding 30 mm in length, and always have a finely rounded scraping-edge (Figure 8.5: h, k, l; Figure 8.6: o); a single example is circular (Figure 8.6: m). The *microdéjeté* scrapers are different from any scraper so far reported from northeastern Africa. They tend to be extremely small (15–25 mm in length) and take one of two forms: they may be fairly flat with a slightly convex transverse scraping-edge and two shorter, lateral scraping-edges (Figure 8.5: f, g) or, more commonly, they are relatively thick and tend to have strong semi-steep to steep retouch on three edges. The scrapers are, thus, triangular (Figure 8.5: j) or somewhat irregularly ovoid (Figure 8.5: i), or, rarely, may be rectangular and resemble minute double-sidescrapers (Figure 8.6: n), depending on the shape of the individual scraping-edges. In all cases, the bulb of percussion has been removed by retouch, so that the entire circumference is retouched. Nevertheless, there are no circular examples.

The sidescrapers are essentially lateral endscrapers but the arch of the scraping-edge is not well developed and its length exceeds the width of the blank.

Perforators and burins are very rare and poorly made. Apart from a single burin on truncation, the other examples may result as much from the typologists' sorting as from any intentions of the inhabitants of the sites.

While scaled pieces are rare, they are present in three of the four sites; only KG74 lacks them, as it also lacked bipolar cores. Unlike most other tools, scaled pieces are normally made on agate, although one each from KG73 and KG16 is made on quartz. Scaled pieces are very common at later, ceramic-bearing sites, but these were recovered *in situ* and there can be no question as to their association.

Simpler tools, such as retouched pieces, denticulates and notched pieces are common at all sites. The denticulates are mainly simple lateral pieces (Figure 8.4: a; Figure 8.6: q), although occasionally more than one edge was retouched (Figure 8.5: q). Continuously retouched pieces tend to have good retouch (Figure 8.4: c; Figure 8.6: a), and merely lack the morphology or strength of retouch that would place them in some other tool-type (Figure 8.5: r). As with the scrapers, the majority of all these forms are made on flakes rather than blades.

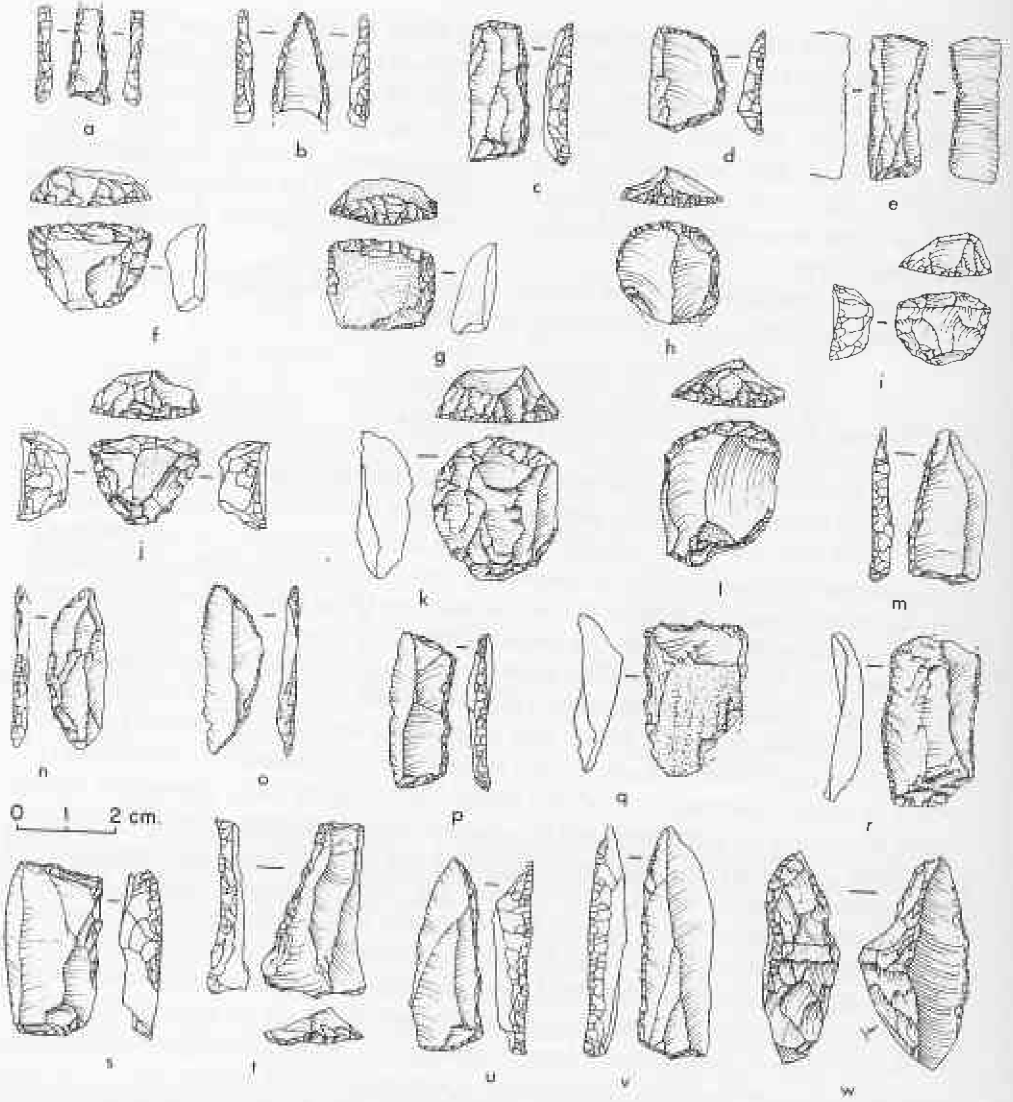
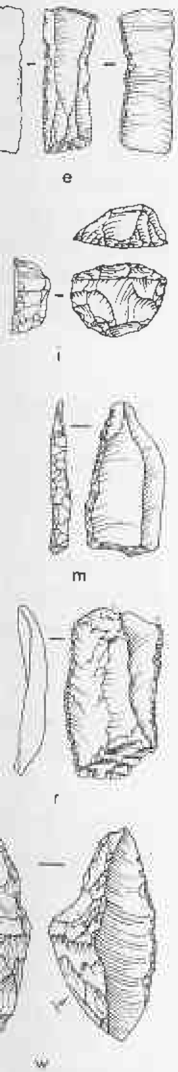


Figure 8.5 Tools from KG74. a, b, double-backed blades; c–e, p, s, t, backed trapezes; f, g, i, j, *microdéjeté* scrapers; h, k, l, thumbnail scrapers; m, u, v, KG74 points; n, o, lunates; q, denticulated flake; r, bilaterally retouched piece; w, "orange wedge."

The remaining tools, the backed or truncated forms, are almost all produced on blades. Only at KG16 are there two truncated flakes, and backed flakes are almost equally rare (Table 8.3).

The numerically most important backed tool-groups are those with truncations and backing, those with only truncations and those with only backing. The last is made up almost exclusively of fragments that may be parts of more complex retouched tools. However, occasional simple backed blades were found (Figure 8.6: j). The tools with truncations alone also tend to be fragmentary (Figure 8.6: f) and may also be portions of other tools.



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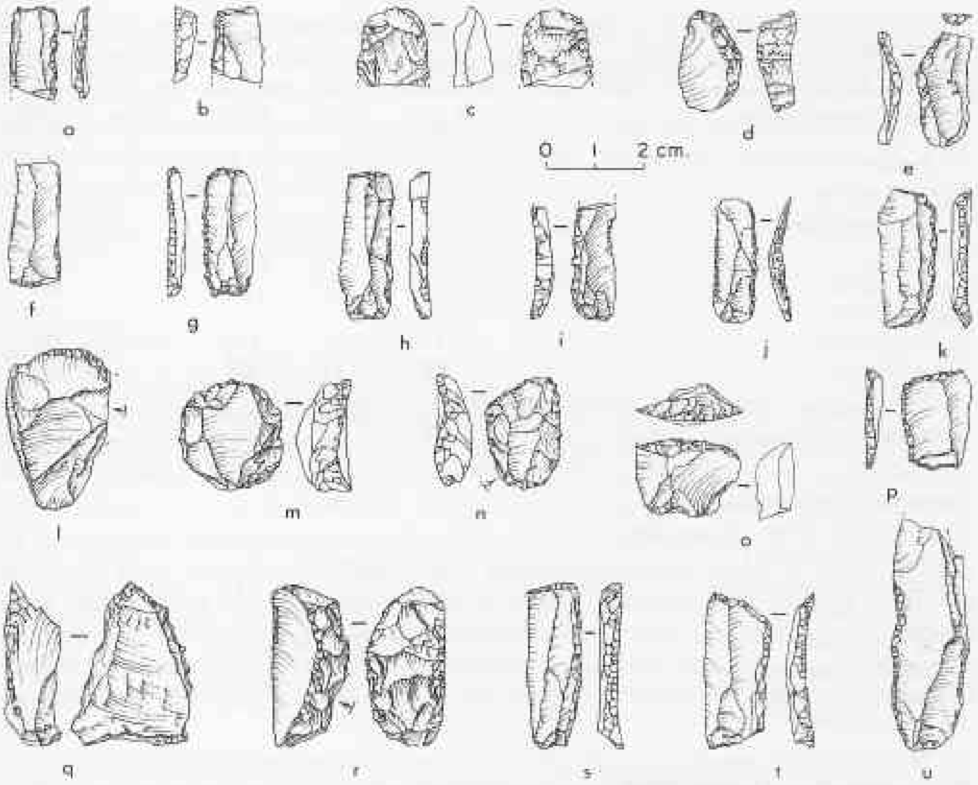


Figure 8.6 Tools from KG15. a, b, g–i, backed and truncated blades (b is partially backed); c, bifacially retouched fragment; d, r, small "orange wedges"; e, backed and obliquely truncated blade; f, basally truncated blade; j, the smallest backed blade; k, p, s, t, backed trapezes; l, the largest endscraper; m, circular scraper; n, *microdéjeté* scraper; o, thumbnail scraper; q, denticulate; u, bilaterally retouched blade.

The dominant backed tools are those that are backed and truncated. They take a number of forms: truncated blades with partial backing (Figure 8.6: h), backed and truncated blades that approach elongated rectangles but lack clear basal retouch (Figure 8.6: g, h), backed trapezes both short (Figure 8.5: d; Figure 8.6: p, t) and elongated (Figure 8.5: c, e, p, t; Figure 8.6: i, k, s), partially backed trapezes (Figure 8.5: s) and pointed, straight-backed blades with slightly convex basal truncations (Figure 8.5: m, u, v). The last are restricted to KG74 and are listed as "KG74 points" in the typology, since their specific form has not been observed elsewhere in the Sudan. A number of the backed and truncated pieces are too fragmentary to classify in detail (Figure 8.6: a, b) or are atypical (Figure 8.6: e).

There is a second group of tools, not as numerically important, that help to link all the sites together. These range from rather atypical lunates made on large blades and incompletely backed (Figure 8.5: n, o), to what have been called "orange wedges." Although crescent-shaped, they are not true lunates. They are roughly made on large, thick blanks, and their backing is usually *sur enclume*, although unidirectional and alternating backing are known. It is their size, however, that sets them apart (Figure 8.5: w; Figure 8.6: d, r). They range in length from 30 to 58 mm and their backs are always thicker than 15 mm; the largest from KG74 is 21 mm thick. They are certainly not microliths, although they have a geometric shape.

TABLE 8.3
Absolute Frequencies of Non-Mammalian Remains

Animal Group/Species	KG15	KG16	KG73	KG74	KG68
Marine gastropods					
Cypraea moneta			RR		
Freshwater Molluscs					
Pila sp.			RR(+)		(+)
Spathopsis sp.					RR
Mutela dubia					RR
Etheria elliptica	F	(+)	(+)	R(+)	RR
Large bivalves	RR	(+)	RR		RR
Landsnails					
Limicolaria cailliaudi	RR		RR(+)		R
Fish					
Polypterus (*Polypterus* sp.)					9
Elephant-snout fishes (Mormyridae)					1
Minnows (Cyprinidae)					29
Catfishes: *Synodontis* sp.	2		3		4
Bagus sp.					1
Others					364(76)
Nile perch (*Lates niloticus*)					52(2)
Tilapia (*Tilapia* sp.)					36
Percomorphi *indet.*					6
Reptiles					
Bell's eastern hinged tortoise (*Kinixys belliana*)					4
Hinged tortoise (*Kinixys* sp.)					1
Terrapin (*Pelusios* sp.)					1
Cyclanorbine turtle (*Cyclanorbis elegans*?)					1
Monitor (*Varanus* sp.)					1
Snake (Serpentes *indet.*)			1		
Birds					
Bird or prey (*Accipitridae* sp.)			1		
Ostrich (*Struthio camelus*)[a]			5(7)		

Note: The absolute frequencies are based on specimen counts. Numbers in brackets indicate surface material, the rest was *in situ*. The symbols used to describe the molluscan assemblage are as follows: +, present; RR, ≤5 specimens; R, 6–20 specimens; F, 21–100 specimens.

[a] Ostrich is represented only by fragments of eggshell.

A small number of the backed trapezes show traces of light sickle sheen (Figure 8.5: e). The number of these recognized is probably too low, since tools on agate are already so shiny that it is usually impossible to recognize sickle sheen. Thus, no absolute frequencies are given for pieces with sheen; they are present and possibly numerous.

There are also a few backed blades with inversely or obversely modified bases, a few fragments of double-backed blades (Figure 8.5: a), one of which is pointed (Figure 8.5: b), and two denticulate-backed flakes from KG16.

Although the assemblages are very similar in most ways, there are some trends that seem important. The appearance of scaled pieces at KG73 and their greater presence at KG15 and KG16 might point toward the KG68 assemblage. The presence of truncated and backed flakes at KG16 forms another typological link with KG68.

There is one trend that seems to be unrelated to the KG68 assemblage: a diminution in blade-size and, thus, in backed tool-size from KG74 to KG15. In the former, backed tool-width ranges from 10 to 22 mm, with a mean of 14.3 mm, while in the latter the range is 9 to 13 mm, with a mean of 10.9 mm. It is not at all clear what this might mean in terms of technological development, since blade-production *per se* all but disappears by the KG68 assemblage.

Site KG68

The tool assemblage from KG68 looks quite different from those of the other sites. Two aspects stand out most clearly: the use of agate rather than chert in tool-production and the replacement of blades by flakes as tool-blanks. The shift in raw material was clearly a deliberate choice on the part of the makers, since chert was available locally. The use of flakes as tool-blanks, however, reflects the kinds of blanks produced by the reduction strategies used. Simply, few blades were produced on either agate or quartz, which were the dominant raw materials brought to the site. While the production of blades on quartz is very difficult, blades can be produced on agate cores, and some sites have good numbers of them (Marks 1970). Here, however, not only was agate a preferred raw material but it was often reduced with the bipolar technique which never produces blades.

The bipolar technique is not only reflected in the high percentage of bipolar cores but is also the technique by which scaled pieces were produced. Chert was not used as a raw material for bipolar reduction, so all scaled pieces, with one quartz exception, are on agate. This alone strongly influences the proportional importance of agate among the tools, since scaled pieces account for 41.6% of them.

In spite of these strong differences, the tendency for backed tools remains. Instead of backed and truncated forms, however, the majority of KG68 backed tools are either straight-backed or arch-backed flakes. In most cases, the backing affects only a single edge and convex backing is twice as common as straight backing. The backed pieces are rarely elongated and usually have length:width ratios approaching 1:1 (Figure 8.7: d, h, n, o); only those on chert tend to be more elongated (Figure 8.7: q). On several examples the backing is inverse (Figure 8.7: i) and might be thought of as resulting from core-rejuvenation rather than retouch; however, the cores show no evidence for this type of rejuvenation. Rather, it would seem that the position and direction of the backing and even the ultimate shape of these pieces were all quite flexible. There are also a number on which partial backing and a naturally blunt edge combine to form a wholly blunted back (Figure 8.7: l). A variation of these backed flakes can be seen in the three pieces with denticulated backs, two with normal backing and one inverse (Figure 8.7: b).

A few of the simple backed flakes have clear sickle sheen along the sharp edge (Figure 8.7: a). As noted for the other sites, this is very difficult to see on agate tools and there may be much more than can be identified securely.

A group of tools related to backed flakes ranges from true "orange wedges," indistinguishable from those found at the other sites (Figure 8.7: s), to somewhat smaller examples which are still too large and thick to be lunates and, as well, have intact bulbs of percussion (Figure 8.7: p).

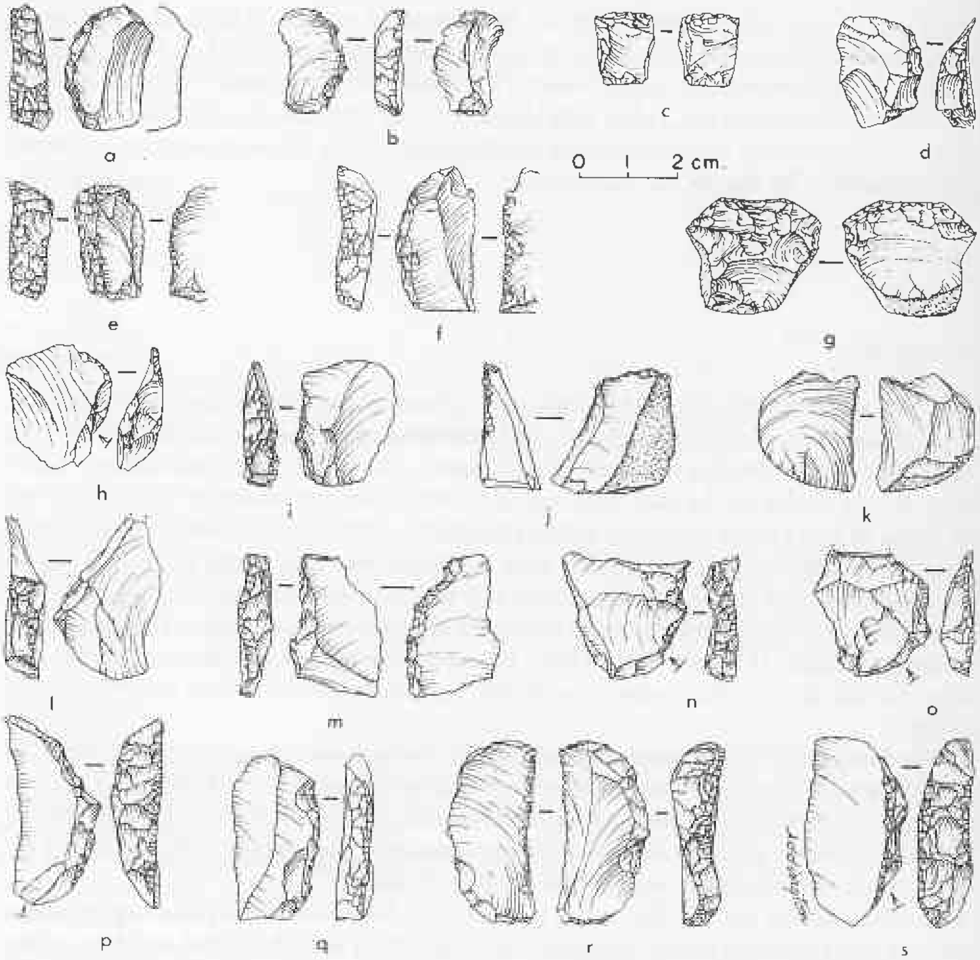
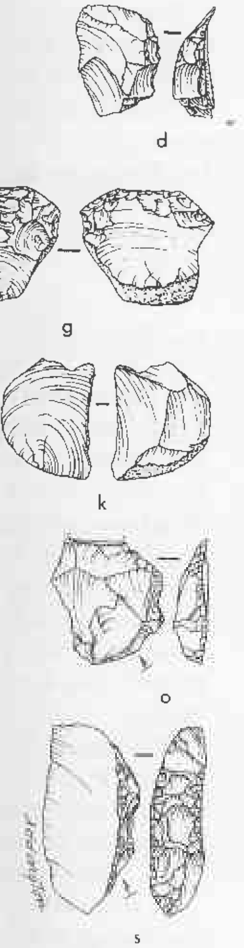


Figure 8.7 Tools from Site KG68. a, d, h, i, l, n, o, q, backed flakes; b, inversely denticulated backed flake; c, g, scaled pieces; e, f, arch-backed flakes with serrated cutting-edge and sheen; j, k, retouched flakes; 1, partially backed flake; m, alternately backed flake; p, atypical "orange wedge"; r, "orange wedge" with serrated cutting-edge; s, typical "orange wedge."

A final group of backed tools incorporates the concept of the "orange wedge" but tends to be smaller and to have additional, inverse serration along the sharp edge. The largest ones fall within the range of the smaller "orange wedges" (Figure 8.6: r), but most are both too small to be considered "orange wedges" and too thick and ill-shaped to be considered geometrics. Their bulbs of percussion are intact, they have a convex-backed edge and are either somewhat pointed (Figure 8.7: f) or blunted by steep retouch which falls between backing and truncation (Figure 8.7: e). All of the illustrated examples have noticeable sheen along their cutting edges.

Although all these forms have been separated into discrete types, many of them could be classified in more than one way. There seems to be less real difference between them than was the case for the backed tools from the other sites. This is largely due to the use of squat, amorphous flakes rather than standardized blanks like the blades used at the other sites.



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Of the remaining tools, simple retouched pieces are the most common, including both inversely (Figure 8.7: k) and obversely retouched pieces (Figure 8.7: j); of the 22 recorded, only two are on blades. There are a few poorly made endscrapers and one nicely retouched denticulate endscraper. The burins are poor but one on truncation is certainly intentional. The simple truncations are atypical but one is on a chert blade. There is a small pebble chopper and a few *varia*, which include some fragmentary flakes with alternate backing (Figure 8.7: m), as well as two notched and retouched flakes.

FAUNAL REMAINS

The faunal remains, like the lithic artifacts, come from two sources: surface collections and the dry-screening of excavated sediments through 4-mm mesh. Because of the limited size of the excavations and the low faunal yield of most sites, surface material was collected to enhance sample sizes; all bone collected from the surface was taken from fully within the surface scatter of the lithic material.

The faunal material from the clustered sites, KG74, KG73, KG15 and KG16, was rather heavily degraded and fragmented, and moderately fossilized. This condition applies to both the surface and *in situ* material, suggesting that the non-mammalian groups of bones from these sites may be under-represented in the available collections; however, this cannot be estimated quantitatively.

The faunal material from KG68 was in considerably better condition, being less degraded, fragmented and fossilized. In light of the very large sample of small fish bones, it is likely that there was no significant loss of smaller bones at this site to weathering and other factors.

As the lithic assemblages from the clustered sites go together, so do the faunal samples from them. These samples are dominated by mammals such as hippopotamus (*Hippopotamus amphibius*), Soemmerring's gazelle (*Gazella soemmerringi*) and aurochs (*Bos primigenius*). There were also some large antelopes, equids, a few *Synodontis* catfish remains and single elements of a bird and a snake (Tables 8.3 and 8.4).

The faunal material from KG68 is quite different, consisting mainly of fishes but also including good numbers of large mammals (Tables 8.3 and 8.4). Compared to the clustered sites, the fish remains are both numerous and varied with clariid catfish (*Synodontis* and *Bagus*), Nile perch (*Lates niloticus*), tilapia (*Tilapia* sp.) and minnows (Cyprinidae) in some numbers and with rare examples of polypterus (*Polypterus* sp.) and elephant-snout fishes (Mormyridae). Mammalian remains are dominated by giraffe (*Giraffa camelopardalis*), unidentified large antelopes and hippopotamus (*Hippopotamus amphibius*); there are also remains of African elephant (*Loxodonta africana*), African buffalo (*Syncerus caffer*), waterbuck (*Kobus ellipsiprymnus*), greater kudu (*Tragelaphus strepsiceros*), roan antelope (*Hippotragus equinus*) and various small and medium-sized antelopes (Table 8.4). A range of smaller animals is also represented but generally with only a few identifiable bones of each (Table 8.4). The bones classified as the unidentified large antelopes most probably belong to those species recognized at the sites rather than to some other forms, but could not be classified to the species level.

In spite of rather good samples, no bird bones were found and, while a number of different species of turtle and tortoise are present, they were mainly identified by single elements (Table 8.3).

TABLE 8.4
Absolute Frequencies of Mammal Remains

Species	KG15	KG16	KG73	KG74	KG68
Baboon (*Papio cynocephalus*?)					3
Small cercopithecid (Cercopithecidae *indet.*)					3
North African porcupine (*Hystrix cristata*)		(1)			1
Jackal (*Canis* sp.)					1
African wild cat (*Felis silvestris*)					1
Medium carnivores					2
African elephant (*Loxodonta africana*)					(1)
Equid/African wild ass? (*Equus africanus*)	5(4)	(1)	(3)		
Suids (Suidae *indet.*)					2(1)
Hippopotamus (*Hippopotamus amphibius*)	(5)	(1)	3(18)	(2)	11(9)
Giraffe (*Giraffa camelopardalis*)					25(20)
Small gazelle (*Gazella dorcas*?)	1				
Small antelope					2(3)
Bushbuck (*Tragelaphus scriptus*)					2(1)
Reduncine antelope (Reduncinae *indet.*)					(1)
Soemmerring's gazelle (*Gazella soemmerringi*)	9		2		
Large gazelle (*Gazella soemmerringi*?)		(4)	3(2)		
Medium antelope	4	(2)	11(2)	5	5(4)
Greater kudu (*Tragelaphus strepsiceros*)					3
Waterbuck (*Kobus ellipsiprymnus*)					5(1)
Alcelaphine antelope (Alcelaphinae *indet.*)	(3)	(1)			5(3)
Roan antelope (*Hippotragus equinus*)					(1)
Large antelope	2	(2)	(1)	(1)	22(13)
African buffalo (*Syncerus caffer*)					1(8)
Very large bovid, aurochs (*Bos primigenius*?)	51(49)	(55)	55(110)	46(19)	

Note: The absolute frequencies are based on specimen counts. Numbers in brackets indicate surface material; the rest was *in situ*.

Both faunal samples, from KG68 and from the clustered sites, reflect exploitation of two environmental zones: part of the eastern Butana plain for the mammals and the Atbara alluvial plain and river bank for the hippopotamus, freshwater turtles and catfish. In addition, the people at KG68 exploited the Atbara itself for other fish and molluscs (*Lates* and *Etheria*).

In order to interpret the faunal assemblages and the differences between them, it is useful to place together those specimens that appear to have comparable death-to-discovery histories into taphonomic groups. There are two such principal categories: the remains that arrived at the site through conscious human activity and those for which the inhabitants of the site were not responsible. Nearly all specimens from these sites fall into the first category, although they may have been brought to the sites for different reasons, such as food, decorative purposes (ostrich egg?), clothing and so on. On the basis of comparison with faunal assemblages from other Sudanese sites, it is believed that the shell-fragments of *Limicolaria cailliaudi* are intrusive and fall into the second group, but all the other remains appear to have been brought to the sites by man. The cowry at KG73 is problematical because of the mid-twentieth century intrusions into the site. While it may be related to the original occupation, such shells

73	KG74	KG68
		3
		3
		1
		1
		1
		2
		(1)
		2(1)
3)	(2)	11(9)
		25(20)
		2(3)
		2(1)
		(1)
)		
2)	5	5(4)
		3
		5(1)
		5(3)
		(1)
	(1)	22(13)
		1(8)
0)	46(19)	

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are today used for decoration and are commonly found on sites less than 200 years old. In either case, it points to connections with the Red Sea, which are well established for recent times but not for the Late Paleolithic.

The remaining faunal elements can be used cautiously to give a tentative sketch of the paleoecology of the surrounding terrain and of the paleoeconomy of the peoples who occupied the sites.

At the sites clustered along the eastern edge of the depression, the hunting of game (mammals), some mollusc-collecting and fishing seem to have been the major subsistence activities. Given the small sample of fish bone (five fragments of *Synodontis*), it is difficult to make any statement on fishing technology or on the place where fishing was practiced. The catfish may have been taken in the depression itself, since it probably held water both from seepage and from seasonal flooding of the Atbara during the late summer. Although the regional climate was arid, the Atbara derives its water from the highlands of Ethiopia which, even during the Late Pleistocene, received relatively good precipitation (Butzer *et al.* 1972). It is quite possible that the depression acted as a waterhole even during periods of low Atbara flow and it was probably a favorable micro-evironment all year round.

The range of species present at the sites around the depression—aurochs (*Bos primigenius*), Soemmerring's gazelle (*Gazella soemmerringi*), and, probably, African wild ass (*Equus africanus*), hartebeest (*Alcelaphus buselaphus*) and dorcas gazelle (*Gazella dorcas*)—clearly indicates an arid, open environment with quite dry living conditions. The remaining species—the hippo, the catfish and the molluscs—relate to the Atbara and to its very edge.

The aurochs remains in these assemblages are quite unexpected because the nearest area where fossil specimens have been found before is in the Nile Valley near Wadi Halfa, Sudan (Gautier 1968), some 950 km northwest of Khashm el Girba. The large hiatus between these finds, however, may reflect nothing more than the absence of known sites of comparable age. There is no doubt about their identification; the distinction between the bones of aurochs and of African buffalo is clear and is based on an extensive, comparative study of recent *Bos* and *Syncerus* which will be published separately by the second author.

The faunal assemblage from KG68 presents a quite different picture, both of the paleoecology and of the paleoeconomy of the inhabitants of the site. The better bone preservation resulted in a larger sample of fish bones, among which the predominance of clariid catfish indicates that fishing was most frequently practiced on the alluvial plain. The gentle slope on which KG68 lies may have been a suitable spawning-ground for clariids during the yearly floods. Spawning clariids are an easy prey since they are found in shallow water. Depending on the micro-topography, residual pools might have formed as the Atbara receded, and clariids often occur in large numbers in such deoxygenated pools. The presence of large Nile perch, however, indicates that fishing was also practiced in the main channel. The hunted mammals were now mainly giraffe and antelopes, which are generally smaller than the mammals taken at the other sites. However, the hunters were still quite capable of hunting hippo and African buffalo, neither of which is a small or passive animal.

The diversity of antelopes hunted undoubtedly indicates a change in the regional environment from an arid steppe to a grass savannah with stands of trees. This is confirmed by the presence of baboon and the African buffalo. It was altogether a better place to live during the occupation of KG68 than it had been while the other sites were occupied.

CONCLUSION

Although information from these few sites is limited, the sites are the only available source of data and they do hint at a broader picture. The occupation of the edge of the depression took place at the end of the Pleistocene, during a period of regional aridity. The faunal assemblages show striking parallels with those from Late Pleistocene sites north of the Second Cataract, indicating a similar environmental setting with little, if any, local precipitation. It is not surprising, therefore, that known settlement was tied to the river edge and to nearby ponds fed by seepage and flooding.

Even given these limitations, however, there appears to have been some significant change in adaptation, particularly at the very end of the arid phase. If the occupations can be seriated on the basis of an increased use of the bipolar technique, an increased use of agate at the expense of chert and an increase in flake-tools, then the earliest site should be KG74, followed by KG73. Both of these are typified by overall heavy artifact densities, without any noticeable intrasite patterning. KG74 is only 60 m² in area and simply could not have accommodated many folk, but its high artifact content suggests, at least, very intensive episodes of core-reduction and tool-production. KG73, is 28 times larger but still has a high and unpatterned artifact density; either the residential group was much larger or the site was revisited a number of times. The two sites might represent two extremes of the same settlement-type, the smaller produced by a microband and the larger by a macroband, within a more general pattern of intermittent reoccupation.

In view of the regional aridity, any real residential stability would have been unlikely in even such a seasonally good micro-environmental setting as around the depression. Not only man utilized the water of the seasonal ponds, but so did the megafauna which would have found the ponds more accessible than the river with its often steep banks. Too long a human occupation near a pond would have resulted in its abandonment by the megafauna in favor of other water-sources up or down river. Thus, it is not likely that any of the sites were long occupied but, since the number of favorable localities must have been limited, reoccupation of them must have been common.

Some change in settlement patterns might be seen at KG15. The site is large but artifact density is low and patchy, and there is evidence for differential tool-distributions (Y. El Amin, pers. comm.). This suggests quite ephemeral occupations, each with relatively low intensities of flaking and tool-production. This occurred, if the radiocarbon date is accurate, just at the time when the climate was ameliorating (Wickens 1982). This is not yet reflected in the faunal assemblage but the large number of root-casts, missing from the nearby earlier sites, suggests that the depression was now an actual swamp, perhaps with perennial vegetation along its margins. In addition, the apparently more ephemeral occupations and reoccupations could indicate an increasingly large exploitation area, so that the depression was visited less often and for less time than had been the case earlier.

KG68 seems to be similar to KG15 in terms of intrasite patterns. The site was occupied fully within the Early Holocene humid phase (Wickens 1982) and exhibits very strong evidence for highly ephemeral, multiple occupations. The fauna indicates a grass savannah with trees and shrubs, of a kind never seen north of the Second Cataract. Not only were most of the hunted species different from those of the earlier occupations but there were also significantly more of them. By comparison, the hunters of the Terminal Pleistocene seem highly specialized and one might be inclined to think in terms of increasingly broad-spectrum adaptation—that species of animals long present were added to the diet. However, this would be far from the case: there was a true increase in the number and variety of mammalian species present in the area, as a direct response to ameliorating regional climatic conditions and the resultant shift from a dry grassland to a grass savannah with trees and shrubs. The Terminal Pleistocene hunters took what was available, as did the Early Holocene hunters. Even the exploitation of plant-foods can be placed as early as KG74 with its trapezes with sickle sheen.

It appears that the processing of some foods changed. The numerous piles of burned pebbles at KG68 point to a cooking technique not seen previously. In fact, the use of such pebble piles, with pebbles 8–13 cm in length, as a surface for the cooking of strips of meat and vegetable-stuffed sausage is still current. A quite typical pebble pile is used nightly by the local restaurant in Khashm el Girba!

On a broader level, the assemblages from these sites have little in common with those north of the Second Cataract. While blade-technology is present at Terminal Pleistocene sites in the Nile Valley, it is markedly oriented to bladelet-production (Marks 1970; Schild *et al.* 1968; Vermeersch 1978). True blade-production is unknown. In addition, the range of tools is quite different. Along the Nile Valley, the lunate is important but the trapeze and the backed and truncated blade are very rare at this time. Thus, not only distance separates these assemblages from those north of the Second Cataract. Although all fall within a very broad Epipaleolithic technocomplex, specific historic or generic connections seem unlikely.

The trends seen between KG74 and KG68 appear to be restricted to the Atbara Valley. The increasing use of the bipolar technique foreshadows its local importance during the mid-Holocene, but separates it from contemporary developments along the Nile. It is true that by the mid-Holocene all kinds of blades had long disappeared from throughout northeastern Africa, but this alone does not argue for specific connections.

By the time KG68 was occupied, the Khartoum Mesolithic, with its developed ceramic technology, was already beginning to appear in the central Nile Valley. Its lithic technology emphasized the selection of quartz as a raw material and the production of lunates and double-backed perforators; rather amorphously retouched flakes complete the tool-assemblages. This has little in common with the KG68 assemblage or with the earlier ones from in front of the depression. Thus, the evidence indicates that the Khartoum Mesolithic did not have its preceramic origins along the Atbara River but that they must be sought elsewhere, in some other reasonably well-watered region.

ACKNOWLEDGMENTS

The work reported here was carried out under National Science Foundation Grant BNS 8102649 to the senior author, with additional support of the University of Khartoum. The collections and test-excavations reported were carried out under the field supervision of the authors and Dr. Y. El Amin. Dr. El Amin supplied the data on the lithics from site KG15. The fish, turtle, and bird remains were identified respectively by Dr. W. Van Neer (Leuven), Dr. F. de Broin (Paris) and Mrs. D. Matthiesen (Gainesville). The remaining specimens were identified by the second author with the aid of comparative collections from the laboratories in Ghent, Brussels and Tervuren. The faunal analyses have been carried out with the aid of a research grant from the I.W.O.N.L. (Brussels).

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9

Prehistoric Men and Cattle in North Africa: A Dearth of Data and a Surfeit of Models

ACHILLES GAUTIER

Errare humanum est sed perseverare diabolicum.

INTRODUCTION

The following paper is a critical evaluation of the available data on the earliest occurrences of domestic cattle in North Africa. As a matter of principle, it does not take into account the non-faunal evidence, whether stone tools, ceramics, rock pictures (Muzzolini 1983), "stone places" (Gabriel 1973), tethering stones (Pachur and Röper 1984a, 1984b) or whatever; we wish to let the bones speak for themselves. The sources used are our own reading of the published data as far as they are known or accessible to us. Recent review papers by Smith (1980a, 1980b, 1984a) and the very thorough analysis of cattle in North African rock-art by Muzzolini (1983) served as useful guides to those data with which we are less well acquainted. For the most part, we present the evidence translated into our own terms. The biological nomenclature used is that found in Haltenorth and Diller (1979), which is based on Meester and Setzer (1971–78). Changes of identification are based upon our own appreciation of the paleosynecological context, the modern geographical distribution of the animals involved and personal experience, by which it is sometimes possible to evaluate the work of others in a field one knows well in a fair but rather synesthetic way. *Honi soit qui mal y pense!*

We must first consider the problem of *Bos ibericus* (Pomel 1894), a term that has been applied to bovid remains smaller than those of typical North African wild cattle, or aurochs (*Bos primigenius*). To us, assuming the generic attribution of *Bos* is correct, faunal remains labeled *Bos ibericus* pertain either to female aurochs or to domestic cattle, be they short- ("*brachyceros*") or long-horn. Muzzolini (1982, 1983, 1984) has done his utmost to banish *Bos ibericus* from the prehistoric scene. However, werewolves are hardy creatures and so is the werecow, *B. ibericus*. We will therefore present a separate paper on the history and misdeeds of this obnoxious creature (Gautier in preparation) in which we will try to lay it finally to rest.

In many instances, we estimate heights at the withers of cattle on the basis of the published measurements. As a standard we have used the extensive osteometric data on the Iron Age cattle of Manching in Bavaria (Boessneck *et al.* 1971). These estimates are exactly that (i.e. estimates), and we are aware of the possible differences in habitus of Central European and North African prehistoric cattle; the Saharan cattle were probably more gracile. Since, in addition, our comparisons are based primarily on measurements of bone widths, our estimates may therefore systematically underestimate the size of the Saharan cattle samples being analyzed.

The various areas and sites referred to are indicated in Figure 9.1. In the text, the evidence has been grouped from north to south and from west to east, into groups loosely linked by geographical and other criteria. Thus we end in the area of Nabta and Bir Kiseiba. But where else should we end, if not there, since this paper is dedicated to the main excavator of the problematic domestic cattle of Nabta and Bir Kiseiba? Be that as it may, the careful reader will note that our evaluations vary in scope and depth. This reflects the nature of the evidence and, of course, the fact that we are not equally acquainted with all the available materials, since they are often not easily accessible or interpretable. The bibliography also is far from complete, and some of the data hidden in the vast literature may have been missed. We hope, however, that the critical summaries presented here justify the conclusions which form the final part and overall purpose of this paper.

AVAILABLE DATA

ATLANTIC SAHARA, CHAMI (RIO DE ORO, MAURITANIA)

Neolithic sites on the coast and immediate hinterland (Chami) of the Atlantic Sahara have been studied extensively by various French missions (Petit-Maire 1979, 1980). The sites date from the so-called Tafolian stage, which was characterized by increasing aridity (4200–2000 B.P.) and which followed the transgressive Nouakchottian period (6000–4000 B.P.). The sites north of Cap Blanc typically have simple burials, few ceramics and few artifacts for personal adornment, while those south of Cap Blanc are much richer in such objects and also yield numerous grinding-stones. The reports on the vertebrate faunas, however, are somewhat confusing and what follows is our own evaluation of the publication by Bouchud and others (1981), combined with suggestions made by Dr. N. Petit-Maire (*in litt.*) and by Dr. C. Guérin (*in litt.*). (This confusion arises in part from Figure 2 in Petit-Maire 1980, in which the symbols

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Figure 9.1 Locations of most of the sites discussed in the text.

A	Asselar
AB	Adrar Bous
AM	Amekni
AR	Arlit
AS	Atlantic Sahara, coast of Cap Bojador and Cap Juby
AT	Adrar Tiyouine
AZ	catchment of the Upper Azouak, Taferjit, Tamaya Mellet
B	Bir Kiseiba
C	Chami
CA	Cap Ashakar, Mugharet el Khail, Mugharet el Saifiya
D	Dhar Tichitt
DA	Daima
DE	Délébo, Soro Kézénanga
E	Erg Ine Sakane
EA	Erg d'Admer
EB	Enneri Bardagué
EK	Early Khartoum
ET	East Turkana
F	Fayum
G	Grotte Capéletti
GA	Gabrong
H	Haua Fteah
HI	Hierakonpolis
K	Karkarichinkat
KA	Kadero, Geili, Saggai
KD	Kadada
KH	Khattara
KI	Kintampo
KO	Kharga Oasis
M	Meniet
MB	Merimde-Benisalâme
ME	Menaka
N	Nabta
Nt	Ntereso
SH	Shaheinab
T	Taoudenni Basin
U	Uan Muhuggiag, Ti-n-Torha
W	Wadi Bakht

Note: Numbers following site designations are earliest dates/100 years B.P., at which domestic cattle were or may have been present, as deduced from the data reviewed.

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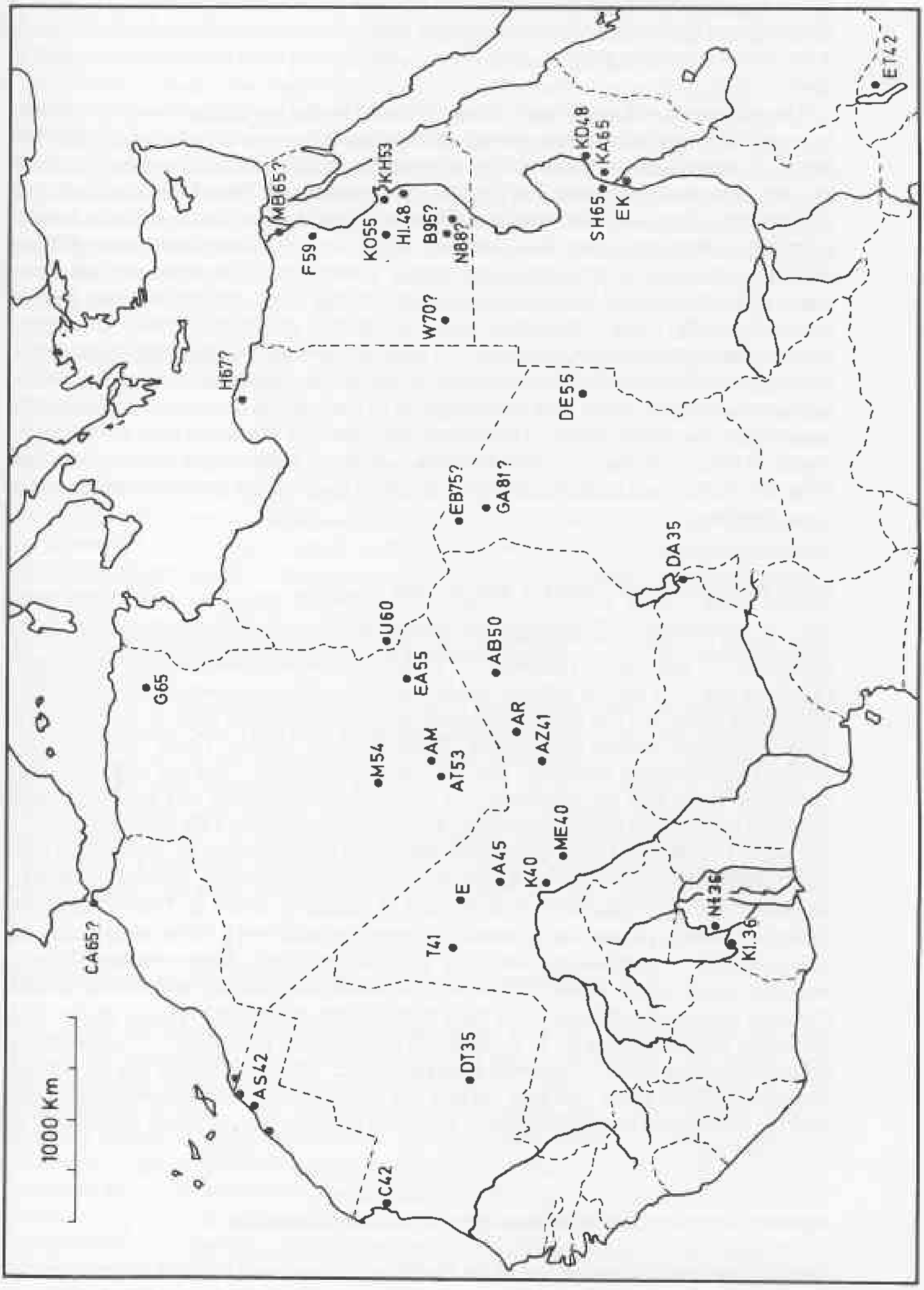

indicating *Bos ibericus* in the modern distribution should be replaced by symbols for *Oryx algazel* [= *O. dammah*], as has been pointed out to us by Petit-Maire [*in litt.*]. Also, the symbols for *Bufo* sp. [toad] and *Geochelone* [turtle] should have a central dot.)

The sites north of Cap Blanc yielded restricted faunal assemblages, each including some of the following animals: hare (*Lepus capensis*), an equid, a bovid labeled *Bos ibericus*?, dorcas gazelle (*Gazella dorcas*), monk seal (*Monachus monachus*) and one or two cetaceans (dolphin and whale). Sites south of Cap Blanc yielded rich assemblages dominated by warthog (*Phacochoerus aethiopicus*), scimitar-horned oryx (*Oryx dammah*) and *Bos ibericus*. Other species present are hare, African elephant (*Loxodonta africana*), an equid, rhinoceros (*Ceratotherium simum*), hartebeest (*Alcelaphus buselaphus*), scimitar-horned oryx, perhaps African buffalo (*Syncerus caffer*) and red-fronted gazelle (*Gazella rufifrons*); lower vertebrates include a turtle and a toad. One fragmentary phalanx was attributed to *Ovis* sp. and may represent small livestock. We are fairly certain that the material called *Bos ibericus* represents domestic cattle, perhaps brought in by pastoralists moving out of the Sahara as a result of increasing aridity. The present-day rainfall in the region does not normally reach 50 mm. Petit-Maire (1980) assumes a northward shift of the Sudano-Sahelian belts which increased rainfall to at least 150 mm in the southern part of the region under consideration.

DHAR TICHITT (SOUTH-CENTRAL MAURITANIA)

This region has been investigated in detail by Munson, who incorporated the results into his Ph.D. dissertation (Munson 1971); summaries have been published elsewhere (Munson 1981). A period of higher precipitation resulting in lacustrine deposition was tentatively dated to 3700 B.P. ± 130 years, but could go back at least to 4500 B.P.; it is associated with human occupation of the Akreijit phase. There is no "hard" osteological evidence available, but near-shore occupation, rock-art with representations of game and the occurrence of many projectile points and grinding-stones suggest a subsistence pattern combining hunting and collecting. This was followed by a dry phase (4500–3500 B.P.), after which the region was colonized by pastoralists with cattle and small livestock (in the Khimiyia and subsequent phases). Fishing was still an important activity, apparently concentrated on catfish (*Clarias* sp.) and *Tilapia* sp. Other vertebrates present are crocodile (*Crocodylus niloticus*), turtle, marsh cane rat (*Thryonomys swinderianus*), sand fox (*Vulpes pallidus*), hippopotamus (*Hippopotamus amphibius*), white rhinoceros (*Ceratotherium simum*) and dorcas gazelle (*Gazella dorcas*). Cultivation may have begun in the subsequent Naghez phase. The mammals were identified by P. F. Turnbull but were not published, so that we know nothing about the types of domestic animals present. Dhar Tichitt now has an average annual rainfall of about 100 mm. During the Akreijit wet phase, it would have been perhaps three times as high (300 mm), and in the early pastoralist phase about twice as high (200 mm).

GROTTE CAPELETTI (NORTHERN ALGERIA) AND THE MAGHREB

Grotte Capéletti is a typical site of the Neolithic of Capsian Tradition, situated on the northern flanks of the Aurès Mountains. The results of its excavation have been published in detail by Roubet (1979), but the fauna did not receive all the attention it deserves; only two short reports (Carter and Higgs 1979; Clutton-Brock 1979) and an evaluation by the excavator herself (Roubet 1979) have appeared.

The fauna includes the typical Capsian landsnails, turtles, some birds, hare (*Lepus capensis*), desert hedgehog (*Erinacaeus algirus*), fox (*Vulpes vulpes*), pig (*Sus scrofa*), a large antelope, gazelle, perhaps Barbary sheep (*Ammotragus lervia*) and small livestock, which form the major component (70–90%). Canids are also present and may be either jackal (*Canis aureus*) or dog. The status of the large bovids, the second most important group at the site, is not completely clear. According to Carter and Higgs (1979: Figure 191), the lengths of the four third lower molars that could be measured fall within the range of wild cattle. Photographs (Carter and Higgs 1979: Figures 178–182) illustrate large bovid specimens most of which fall within the size range of large domestic cattle; one distal humerus (Figure 178:2), however, seems rather to represent wild cattle. This situation can be explained in two ways. People may have acquired livestock from other pastoralist groups, even while their own game-bag still included some wild cattle, which was a typical and frequent prey of Capsian hunters (Lubell *et al.* 1975; Vaufrey 1955). Alternatively, the cattle may have been domesticated. In support of the latter hypothesis, Smith (1984a:86) cites the increase in the number of larger bovids during the course of the occupation. However, the cave was occupied for some two millennia, from about 6500 to 4400 B.P., which would make the process of cattle-domestication a rather elaborate business even under primitive conditions. Moreover, it is only during the fourth and final phase of occupation that large bovids become of any importance (Roubet 1979:Table XCIV). Only further detailed and quantified study can help to solve this problem. For the moment, we can say that apparently both small and large livestock were known in the Aurès at about 6500 B.P.

Other data on the appearance of livestock in the Maghreb are very difficult, if not impossible, to evaluate. They refer to older excavations, which were not well dated and from which the faunas were never studied in detail. A recent publication (Gilman 1975) indicates that small livestock were important in the Early Neolithic of Mugharet el Khail and Mugharet el Saifiya, near Cap Ashakar in northern Morocco. Domestic cattle (*Bos ibericus*, of course) might have been present in the same context at Mugharet el Khail, and appear to be present in both caves in the later Neolithic. Unfortunately, the Early Neolithic is poorly dated (seventh to fifth millennia).

ERG INE SAKANE AND THE TAOUDENNI BASIN (NORTHERN MALI)

Petit-Maire and Riser (1981) have described fossiliferous lacustrine deposits between the Erg Ine Sakane and Jebel Takabart, about 200 km east of Tessalit. The vertebrates associated with these sediments, and above all with the Neolithic settlements, include large amounts of fish, turtles, Nile crocodile (*Crocodylus niloticus*), a robust caprine (possibly Barbary sheep [*Ammotragus lervia*] or small livestock), African elephant (*Loxodonta africana*), dorcas gazelle (*Gazella dorcas*) and an equid. The most numerous among the artiodactyl remains are those of a large bovid said to reach a height of at least 150 cm at the withers. The length of its metapodials would apparently exceed 200 mm, but, unfortunately, the authors do not specify if they are referring to anterior or posterior cannon-bones (metacarpals or metatarsals). Moreover, the metapodials of the rather small Manching cattle vary in size between 155 mm (mc cow) and 223 mm (mc male animal)! Radiocarbon dates on freshwater and terrestrial molluscs from the margin of the lacustrine deposits are 7520 B.P. ± 50 years and 6540 B.P. ± 130 years; charcoal from one of the archaeological sites gave a date of 3750 B.P. ± 100 years.

The results of a geoarchaeological study at the southern border of the Taoudenni, northwest of Arawan, have been published in much greater detail than were the Erg Ine Sakane finds (Petit-Maire and Riser 1983; see also Decobert and Petit-Maire 1985), and the collected mammalian fauna has been described by Guérin and Faure (1983). There were two markedly humid phases in the region, dated to 9500–6400 B.P. and 5400–4000 B.P. The major geological evidence for these events is the extensive lacustrine deposits, which formed in paleolakes primarily fed by deep aquifers, which were being recharged by rainfall. The vertebrate fauna collected in these deposits and from Neolithic settlements near the lakes comprises various fish, freshwater turtles, Nile crocodile (*Crocodylus niloticus*), golden? jackal (*Canis aureus*), lion (*Panthera leo*), marsh cane rat (*Thryonomys swinderianus*), *Meriones* sp., probably both the black and the white rhinoceros (*Diceros bicornis*; *Ceratotherium simum*), an equid, hippopotamus (*Hippopotamus amphibius*), warthog (*Phacochoerus aethiopicus*), African buffalo (*Syncerus caffer*), six antelopes of medium to large size including kob (*Kobus kob*) and giant eland (*Taurotragus derbianus*), and a small gazelle.

The samples are limited and not always well dated, but do not show significant faunal changes between the two lacustrine periods. Today, the rains in the region are confined to the period between mid-July and mid-September and the annual average is about 60 mm. The prehistoric fauna certainly suggests a much higher rainfall, and, in fact, the general faunal assemblage compares favorably with those found at Saggai and other sites in the central Sudan (Gautier 1983, 1986, in press b, in press c). The estimated rainfall for Saggai approaches 450 mm. However, in the case of the Taoudenni basin, we must remember that we are dealing with faunas collected from around extensive lakes. Domestic animals may have been present during the second humid phase, since one site (dated to 7000 B.P.) yielded an apparently intrusive upper jugal tooth row of domestic cattle. This may be related to the second lacustrine phase, although a site that is dated between 4100 and 3400 B.P. produced only wild game.

Roman (1934, 1935a, 1935b) described and illustrated faunal remains from two sites near Arawan and south of Guir, with marsh cane rat (*Thryonomys swinderianus*) a viverrid, hippopotamus (*Hippopotamus amphibius*), ratel (*Mellivora capensis*), bushbuck? (*Tragelaphus scriptus*), hartebeest (*Alcelaphus buselaphus*) and cf. *Bos brachyceros*. Smith (1980b) erroneously cites the last find as *Bos* cf. *ibericus*; in our view, it is most probably domestic cattle. From Arawan, Roman (1934, 1935a, 1935b) also records an antler fragment of a small cervid! Unfortunately, this strange find is not illustrated; perhaps it is a badly preserved fragment of an antelope horncore.

KARKARICHINKAT, TILEMSI VALLEY (CENTRAL MALI)

Karkarichinkat refers to two pastoralist sites (south and north: KS and KN) analyzed by Smith (1974), but not published *in extenso* (Smith 1975, 1979a, 1979b). Both sites are "mounds" in the alluvial plain of the lower Tilemsi Valley. Radiocarbon dates bracket the occupations in the period between 4000 and 3700 B.P.; a date of about 2300 B.P. was obtained on surface material (KS). If we understand correctly, only one faunal sample (KN2A) has been studied in any detail. It yielded a landsnail, several freshwater molluscs, a freshwater crab, some insect remains, various catfish, freshwater

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ous catfish, freshwater

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turtle, some birds, jerboa (*Jaculus jaculus*), hare (*Lepus* sp.), aardvark (*Orycteropus afer*), a medium-sized carnivore, warthog (*Phacochoerus aethiopicus*), giraffe (*Giraffa camelopardalis*), various antelopes of large to small size including oribi (*Ourebia ourebi*), dorcas gazelle (*Gazella dorcas*) and perhaps red-fronted gazelle (*G. rufifrons*). Most of the mammalian remains are those of cattle (42.4%) and of "caprines"—that is, sheep and goat (21.8%). A later list (Smith 1980a) cites additional game animals for sites of the Karkarichinkat type: black rhinoceros (*Diceros bicornis*), elephant (*Loxodonta africana*), hippopotamus (*Hippopotamus amphibius*), oryx (*Oryx* sp.), jackal or dog, and others. Little can be said about the cattle remains, but clay figurines found at the sites suggest a humpless breed. Some measurements on the Tilemsi cattle (Smith 1980b and pers. comm.) indicate animals within the size-range of the Manching cattle, with heights at the withers between approximately 95 and 125 cm. The cattle finds referred to as Menaka (Smith 1980b) were obtained from two sites, Tecoufit and Telataye, some 200 km southeast of Karkarichinkat, but apparently belonging to the same tradition (Smith 1980a:Figure 18.9 and pers. comm.).

Older work in the Tilemsi Valley (Gaussen and Gaussen 1962; Mauny 1955) has been summarized by Smith (1980a and pers. comm.). Two archaeological facies are known, which are different from the Karkarichinkat facies. The first is in the Tilemsi Valley, more specifically at the famous site of Asselar (facies A); the second (B) is in the lower Tilemsi Valley with its type-site at In Begaouen. Both yielded more limited faunas than did the Karkarichinkat facies, but they both appear to contain domestic cattle, called *Bos* sp., and small livestock are present in facies B. Neither facies has been well dated but there exists a radiocarbon date for "Asselar man" of about 4500 B.P. (Camps 1974:241). The date for the Neolithic cemetery between Tessalit and Bidon 5 on the Algeria-Mali border (4750 B.P. ± 80 years; Mauny *et al.* 1968) would refer to the terminal use of the Sahara by pastoralists. The facies distinguished may illustrate a southward movement of the Saharan pastoralists along the major water-courses (such as Tilemsi and Azaouak) into West Africa under the influence of increasing aridity, the gradual southward shift of the savannah belt and, perhaps, a concomittant retreat of the tsetse fly (Smith 1979b).

NTERESO AND KINTAMPO (GHANA)

Ntereso and Kintampo Rockshelter 6 are the first sites to have yielded evidence of domesticates within the Kintampo Neolithic (*sensu* Davies 1964). Ntereso is situated about 50 km west of Tamale, in dry savannah woodland on a ridge above the White Volta; radiocarbon dates bracket the occupations between 3600 and 3200 B.P. The fauna published by Carter and Flight (1972) comprises fish, turtle, tortoise, snakes, monkey (*Cercopithecus* sp.), elephant (*Loxodonta africana*), hippopotamus (*Hippopotamus amphibius*), several antelopes of various size including kob (*Kobus kob*), marsh cane rat (*Thryonomys swinderianus*), some small rodents and carnivores; the domestic component consists of dwarf goat.

Kintampo is a rockshelter in the sandstone uplands around Kintampo on the fringe of the high forest, which is indirectly dated as belonging to the same period as Ntereso. The less varied fauna contains a dwarf antelope (*Neotragus pygmaeus*?), another small antelope and two small carnivores; the domestic component is recorded as dwarf goat and *Bos* cf. *longifrons*. The latter name is an obsolete designation for certain prehistoric short-horn cattle. The cattle measurements given cluster near the lower limit for the

Manching bovines, suggesting small animals of some 100 cm or a little more at the shoulder. For the so-called dwarf goats, the only evidence presented is a measurement of the length of a mandibular tooth row from Kintampo, which the authors found to be only slightly greater than in recent goats from Malakal in the Sudan; that is, Nilotic dwarf goats (Epstein 1971:211). This breed has shoulder-heights of 40–50 cm, while normal goats grow to heights between 50 and 70 cm. We compared the Kintampo measurement with those of various "normal" goats in our collection and found no real difference. Therefore, the status of the dwarf goat at Kintampo (or Ntereso) is far from established. In addition, cattle are also probably present at Ntereso, as is indicated by the mention of a slender horncore provisionally identified as "*Bos aegyptiacus*" (Davies 1964:244), or long-horn cattle. A second phalanx from the same site was tentatively attributed to buffalo (*Syncerus caffer*), but, in view of its dimensions and the paleosynecological context, we think it also represents cattle, somewhat larger than that known from Kintampo (perhaps a male animal).

AMEKNI, MENIET, ADRAR TIOUYINE AND IN RELIDJEM (HOGGAR, TASSILI N'AJJER AND EASTERN ALGERIA)

Amekni is situated about 40 km west-northwest of Tamanrasset. Its faunal assemblage was studied by Bouchud (1969), Camps (1969) and Gasc (1969); more recently, the present author has presented a critical review of it (Gautier in press a). The assemblage contains freshwater bivalves, fish (*Clarias* and *Lates*), three species of birds, Nile monitor? (*Varanus niloticus*), snakes, small rodents, marsh cane rat (*Thryonomys swinderianus*), North African porcupine (*Hystrix cristata*), genet (*Genetta genetta*), Egyptian mongoose (*Herpestes ichneumon*), dassie (*Procavia capensis*), warthog (*Phacochoerus aethiopicus*), dorcas gazelle (*Gazella dorcas*), hartebeest (*Alcelaphus buselaphus*) and three other bovids discussed below. Four radiocarbon dates are known, of which the extremes are 8670 B.P. ± 150 years for the base and 5500 B.P. ± 250 years for the upper deposits.

Since the fauna is rather poor, it has all been lumped together, which means that a detailed evaluation of it is not possible. However, the Amekni people seem to have had access to permanent riverine resources, as is indicated by the high frequency of catfish, the presence of *Lates*, which needs well-oxygenated water (Gautier and Van Neer 1982:119–121), and the presence of larger freshwater bivalves. The mammalian fauna is dominated by dorcas gazelle (*Gazella dorcas*), bohor reedbuck (*Redunca redunca*) and giant buffalo (*Pelorovis antiquus*).

Bohor reedbuck, a grazing antelope of open to less-open biotopes with high grass, never lives more than 8 km away from drinking water. Today, it occurs in most of the more humid Sudano-Sahelian belt and the interior of East Africa. Camps (1969:202, see also Camps 1974:225) states that "*les cobes* (Redunca redunca) *ont une prédilection pour les forêts galéries ou les savanes à fonds marécageux.*" However, such a statement would refer rather to reduncines such as *le cobe de Buffon* (*Kobus kob*), or, even better, *le cobe defassa* (*Kobus ellipsiprymnus*). These reduncines are larger than the one identified at Amekni and much more dependent on water. The Amekni reduncine therefore suggests that conditions around the site were more humid than those of today, but it does not suggest gallery forests or large expanses of swampy terrain. The giant buffalo is also an indicator of good grazing grounds, but the precise requirements of this large and strange bovid are still poorly known. The most frequent antelope at Amekni, however, is the dorcas gazelle, which is a typical inhabitant of dry Sahelian savannah and of any suitable locality within the Sahara, but prefers biotopes with stoney soil. Amekni is situated in granite country with granite inselbergs and boulder fields; such a habitat suits dorcas gazelle very well. On the basis of the present distribution of bohor reedbuck and African buffalo (as a substitute for giant buffalo), the annual precipitation during the occupation can be estimated at some 250–330 mm. A recent estimate for the average present-day rainfall in the region around Tamanrasset is 46 mm (Messerli *et al*. 1980:Table 5.2).

Meniet, another site in the Hoggar situated north-northwest of Tamanrasset, yielded a fauna which was identified by Arambourg (Hugot 1963), but, unfortunately, no quantitative data are given. The following species seem to be present: freshwater fish, turtle, Nile monitor? (*Varanus niloticus*), Nile crocodile (*Crocodylus niloticus*), an unknown rat-sized murid, marsh cane rat (*Thryonomys swinderianus*), striped hyena (*Hyaena hyaena*), bohor reedbuck (*Redunca redunca*), oryx (*Oryx gazella*), giant buffalo (*Pelorovis antiquus*), dorcas gazelle (*Gazella dorcas*), a canid, either golden jackal (*Canis aureus*) or dog, and a medium-sized bovid identified as *Bos ibericus*?. This last bovid probably represents domestic cattle. Camps (1969:201) also lists *Capra* sp., which may be small livestock. Meniet has a radiocarbon date of 5400 B.P. ± 150 years, so the midden could be contemporaneous with the upper part of the Amekni sequence. The adoption of pastoralism, with both cattle and small livestock, appears to have begun but the lack of precise data precludes a more definite evaluation.

Adrar Tiouyine lies on the western edge of the Hoggar near the border of the Tanezrouft. The site was excavated in 1968 and has been succinctly described by Camps (1974), according to whom fishing was a major subsistence activity. Smith (1980a, 1980b), however, refers to the presence of *Bos*, no doubt meaning domestic cattle. Radiocarbon dates bracket the occupation between 5300 and 5150 B.P.

In Relidjem, in the Erg d'Admer, lies 75 km southwest of Djanet in the Tassili n'Ajjer. According to Smith (1980a, 1980b), it also yielded *Bos* remains. The site has a radiocarbon date of 5420 B.P. ± 130 years. The presence of green vitric tuff, normally found in the Aïr and used at Adrar Bous, suggests contacts with the Ténéréan people.

ADRAR BOUS, ARLIT, TAFERJIT AND TAMAYA MELLET (NORTHERN NIGER)

Faunal remains are also known from several Neolithic sites (Ténéréan) in the Adrar Bous, near the eastern end of the northern Aïr Mountains (Carter and Clark 1976; Clark *et al*. 1973). The descriptions are rather vague, but it would appear that domestic cattle are predominant. The wild fauna includes catfish (*Clarias* sp.), perch (*Lates* sp.), hippopotamus (*Hippopotamus amphibius*), rhinoceros, gazelle and some medium-sized to large antelopes. One bone concentration has been dated to 4910 B.P. ± 135 years, and a complete skeleton of domestic cattle has a date of 5760 B.P. ± 500 years. Smith (1979b) estimates the mean rainfall during the pastoralist phase to have been up to about 300 mm. A critical review of the Adrar Bous cattle skeleton is presented elsewhere (Gautier in press a). Its height at the withers would have been between 104 and 107 cm. A few other measurements published by Smith (1980b) are for cattle remains from a kitchen midden and suggest animals with heights between about 100 and 125 cm. Nothing definite can be said about the horn characteristics of the Adrar Bous cattle, since the horncores of the complete skeleton are not well preserved. The small size of the animal suggests identification as a cow perhaps with poorly developed horncores, as in the case of the so-called *Bos brachyceros* bucranium from Uan Muhuggiag (see below). (Recent excavations in the region of Adrar Bous are dealt with elsewhere in this volume by Dr. J.-P. Roset, but the faunal remains from them, including a large bovid, have not yet been published.)

Lhote has studied five sites (Aoukari, Tagoudalt and three sites northeast of Arlit) on the western side of the Aïr Mountains. The limited information available to us concerning these sites comes from Smith (1980b) and Muzzolini (1983). According to Smith, the stone artifacts are very similar to those of the Ténéréan of Adrar Bous, and the faunas include fish, birds, warthog (*Phacochoerus aethiopicus*), hippopotamus (*Hippopotamus amphibius*), medium-sized antelope, gazelle, possibly dog and small and large livestock. Smith (1984a) even gives absolute frequencies for the small and large livestock at "Arlit" (6.3% and 84.9%, respectively). Radiocarbon dates bracket the sites between 5400 and 4800 B.P., but one date, on burned bone from the upper deposits, is as late as 2700 B.P. (Camps *et al.* 1973). On the basis of measurements given by Smith (1980b and pers. comm.), we estimate the size of the Arlit cattle to be 100–115 cm (Gautier in press a). The sites yielded several, more or less complete, cattle skeletons, the significance of which is not clear (Lhote 1976:Photograph 61 [of Tagoudalt]). They might provide invaluable information on the type and origin of the Arlit cattle (see Lasota-Moskalewska 1985), but were unfortunately left in storage in Niamey.

Muzzolini (1983; see also Vaufrey 1969) draws attention to the sites of Taferjit and Tamaya Mellet, in the reaches of the upper Azaouk catchment and originally described by Lhote (1936). These and other similar sites in the same region contain a fauna with numerous freshwater bivalves, fish, crocodile, elephant (*Loxodonta africana*), hippopotamus (*Hippopotamus amphibius*), warthog (*Phacochoerus aethiopicus*), rhinoceros, giraffe (*Giraffa camelopardalis*), antelope and *Bos* sp. (Joleaud 1934). Taferjit yielded a radiocarbon date on freshwater shell of about 4100 B.P., but Tamaya Mellet has a date on burned bone of about 9400 B.P.; the value of this date has been questioned (Close 1980). Comparable sites seem to be present further south along the Azouak-Dallol-Bosso catchment, again with *Bos* sp. (Joleaud 1936).

TI-N-TORHA AND UAN MUHUGGIAG (ACACUS, SOUTHWESTERN LIBYA)

These rockshelter sites in the western valleys of the Acacus have been investigated by several Italian archaeological missions (Barich 1974; Mori 1965). Preliminary paleontological analyses (Cassoli and Durante 1974; Pasa in Mori 1965; Pasa and Pasa-Durante 1962) have recently been completed by a detailed analysis (Gautier 1982b, in press a; Gautier and Van Neer 1982). The Acacus now provides us with the most complete archaeozoological sequence in the Central Sahara.

The first subsistence pattern is documented at Ti-n-Torha East and Two Caves, two rockshelters occupied in the tenth and ninth millennia B.P. which yielded radiocarbon dates between 9350 B.P. ± 110 years and 7730 B.P. ± 80 years. The occupants of the cave at this time were fishing, fowling and hunting, and the most important animal resource was apparently Barbary sheep (*Ammotragus lervia*). Other faunal elements comprise various intrusive smaller micromammals, a varied bird fauna, baboon (*Papio cynocephalus*), hare (*Lepus capensis*), North African porcupine (*Hystrix cristata*), various carnivores including golden jackal (*Canis aureus*), Rueppell's fox (*Vulpes rueppellii*), lion (*Felis leo*) and others, dassie (*Procavia capensis*), wild ass (*Equus *africanus*), dama gazelle (*Gazella dama*) and dorcas gazelle (*G. dorcas*). Remains of a large bovid were tentatively ascribed to African buffalo (*Syncerus caffer*) and hartebeest (*Alcelaphus buselaphus*) but the possibility was not excluded that they might represent large domestic cattle; this view has now been abandoned.

During the late eighth and seventh millennia (the radiocarbon dates are between 7440 B.P. ± 220 years and 5260 B.P. ± 130 years), the rockshelter of Ti-n-Torha North was occupied by pastoralists, who are much better represented at Uan Muhuggiag. The lower sequence (pre-rockfall) of the latter site has a faunal assemblage dominated by small livestock and cattle (in a ratio of 3:1). Sheep predominate among the small livestock (the sheep:goat ratio is 2.5:1). The wild fauna is an impoverished version of the Ti-n-Torha East and Two Caves assemblages.

A third period is represented by the upper Uan Muhuggiag sequence, probably of the late fifth millennium B.P. with two dates of 4730 B.P. ± 310 years and 3770 B.P. ± 200 years (B. Barich pers. comm.). Again, there is a pastoralist faunal spectrum, this time dominated by small livestock (>90%), most of which seems to be goat.

This sequence can be interpreted as reflecting deteriorating ecological conditions. The average rainfall during the first period has been estimated at about 200 mm following Pasa and Pasa-Durante (1962:diagram *in fine*); the rainfall in later periods was at best 150 mm. Re-analysis of the cattle sample suggests that the cattle belong to a long-horn breed and that the famous *Bos brachyceros* bucranium (from Level III at Uan Muhuggiag) is probably that of a cow; in size, its horns were probably near the rather uncertain limit between short-horns and long-horns. The height of the cattle is estimated at 110–120 cm.

DAIMA AND RELATED SITES IN THE CHAD DRAINAGE BASIN
(NORTHEASTERN NIGERIA AND NORTHERN CAMEROON)

Daima was referred to by Carter and Clark (1976) in their discussion of the origin of domestic cattle in Africa; our own summary here is largely based on the critical evaluation in Muzzolini (1983) of the most pertinent literature (Connah 1976, 1981; Quéchon 1974). The site is one of a series of mound settlements in the seasonally inundated flats in the Bornu region of the Chad basin. The oldest site may go back to the fourth millennium B.P. but the most complete evidence comes from Daima, beginning at about 2600 B.P. (or perhaps 2800 B.P.). The populations of all these sites were fishermen and herders with both small and large livestock. A comparable site in northern Cameroon is also reported to yield small and large livestock (Quéchon 1974). Figurines show that the cattle were humpless, except in the final phase of Daima (750 B.P.), from which one figurine of a humped animal has been excavated.

TIBESTI AND SERIR TIBESTI
(NORTHERN CHAD AND SOUTHERN LIBYA)

Fauna has also been reported from Tibesti (Gabrong), Jebel Eghei (Nuqay), the southern Serir Tibesti and the Serir Calanscio (Gabriel 1972, 1976, 1977). The contexts are not always firmly established and the identifications are disconcertingly vague. Nevertheless, we would note two localities potentially of great interest for future research.

Gabrong, a rockshelter in the Enneri Dirennao, yielded a fairly large faunal assemblage although, unfortunately, most of it was not collected *in situ*. Gazelle and buffalo (*Syncerus caffer*) were identified in the basal layer d, dated to 8065 B.P. ± 100 years. More bone seems to be present in layer b, postdating a clayey deposit dated to 6130 B.P. ± 90 years, among which a large bovid was identified. Surface finds, most of which may be derived from layer b, may include gazelle, Barbary sheep, two smaller carnivores, cattle and small livestock.

The second faunal assemblage was collected from prehistoric sites with pottery and burials, in and on the fossil terminal fan (*Endpfanne*) of the Enneri Bardagué in the southernmost Serir Tibesti. Here, the fauna apparently contains gazelle, a large antelope, African buffalo (*Syncerus caffer*), giraffe (*Giraffa camelopardalis*), elephant (*Loxodonta africana*), cattle and perhaps small livestock. Radiocarbon dates for this assemblage are 7455 B.P. ± 180 years (on animal bone), 6930 B.P. ± 370 years (on human bone) and 5220 B.P. ± 160 years (on ostrich eggshell).

These data suggest that pastoralism was almost certainly adopted in the Tibesti massif soon after 6130 B.P. ± 90 years, and might already have been practiced during the first occupation at 8065 B.P. ± 100 years. Pastoralism in the Serir Tibesti may go back to about 7500 B.P. In his recent summary of the climatic history of the Late Quaternary in southern Libya, Pachur (1980) estimated the minimum annual rainfall in the Serir Tibesti around 8000 B.P. to have been about 200 mm. Gabriel (1977) had earlier suggested amounts ranging between 600 and 1000 mm for the Tibesti mountains, according to elevation. Modern precipitation levels in the Tibesti vary between 50 and 100 mm, while almost no rain falls in the Serir Tibesti.

DELEBO AND SORO KEZENANGA II (ENNEDI, CENTRAL CHAD)

Our summary is based primarily on Banks (1984:126, 225; see also Camps 1974), who evaluates the faunal identifications given by Bailloud (1969). Both sites are rockshelters, from which the oldest radiocarbon date (Délébo zone III) goes back to 7180 B.P. ± 300 years. The faunal assemblage includes catfish, frog, freshwater turtle, ostrich (eggshell), jackal, hyena, bushpig (*Potamochoerus porcus*) and hippopotamus (*Hippopotamus amphibius*). Banks (1984) records the presence of warthog (*Phacochoerus aethiopicus*), apparently confusing two wild suids with quite different ecological requirements: bushpig prefers very wooded terrain and warthog more open terrain. The fauna is dominated by one or several unidentified antelopes, followed by gazelle and a large bovid ("*boeuf ou buffle*?"). A later occupation found in Soro Kézénanga II and earlier than 5000 B.P. yielded antelopes and a domestic fauna with dog, goat and cattle ("*boeuf*"). On the basis of the paleosynecological context, we do not feel inclined to identify the large bovid in the older occupation as large domestic cattle.

HAUA FTEAH (COASTAL CYRENAICA)

This famous cave was excavated by McBurney (1967) and the fauna given a semi-detailed analysis by Higgs (1967a, 1967b). On the basis of a sharp decrease in the size of bones attributable to caprovids or ovicaprines (Barbary sheep [*Ammotragus lervia*], sheep and goat) and a sharp increase in the frequency of young animals in this group in the Early Neolithic, Higgs decided that small livestock were present. No specific identifications (goat vs. sheep) were attempted and the collection contains "only two fragments of horncore, one of which has a subtriangular section and may be goat" (Higgs 1967b:314). A comparable analysis of the large bovid bones, which might theoretically include wild cattle (*Bos primigenius*), giant buffalo (*Pelorovis antiquus*) and domestic cattle, did not yield conclusive results, but the Early Neolithic sample of identified large bovids is very small (probably less than 30 specimens) and only two pieces (a lower M3 and a second phalanx) could be measured; they are suggestive of quite large animals. The dating of the archaeological sequence is rather imprecise and the beginning of the Neolithic is placed somewhere between 7000 and 6400 B.P. (Clark 1976:Figure 2; Higgs 1967a). A curious feature of the faunal sequence is the marked drop in the Neolithic and later phases of the frequency of large bovid bones compared with that of caprovid bones. It might be argued that it reflects the different uses of small and large livestock, whereby cattle provided milk and small livestock both milk and meat (cf. Merimde-Benisalâme). In our opinion, a detailed reanalysis of the upper Haua Fteah archaeofauna would show that both large and small livestock are present in the Neolithic.

MERIMDE-BENISALAME (NILE DELTA)

Predynastic faunas from the Nile Valley have not received much attention thus far, and older studies contain only short and very general faunal descriptions (Gautier 1984a). Fortunately, a recent, detailed publication deals with the fauna of Merimde-Benisalâme. This site is situated north of the Rosetta canal, about 45 km northwest of Cairo (von den Driesch and Boessneck 1985). Five phases of occupation have been recognized and the radiocarbon dates of the oldest one cluster around 5850 B.P.; this date could, however, be too young (Hassan 1984b:Figure 2 and pers. comm.). The anthropogenic component of the mammalian fauna in the oldest phase is dominated by domestic mammals (99%) with about 18% pig, 19% domestic cattle and 83% small livestock. The measurements would suggest cattle of about 120 cm, or somewhat more, at the shoulders.

PREDYNASTIC KHATTARA AND HIERAKONPOLIS (EGYPTIAN NILE VALLEY)

We have recently studied the fairly extensive samples of fauna from Predynastic El Khattara (Gautier in press d; Hassan 1984a). As at Merimde-Benisalâme, the sample consists almost entirely of the classic domestic trio: pig, cattle and small livestock. Small livestock are the most frequent group, but decrease somewhat in favor of pig and cattle in the course of time; this led to the suggestion that the subsistence became less desert-oriented through time. The cattle are fairly large, with animals between 105 and 135 cm. Their heads are not known, but, on the basis of evidence from other sites (Pia 1941) and of representations, they can be assigned to a long-horn form comparable to the so-called *Bos africanus* of the Pharaonic period. Radiocarbon dates place the earliest occurrence of these various domesticates at about 5300 B.P. and the youngest at about 4400 B.P. Faunal remains from Predynastic Hierakonpolis (Hoffman 1982) have been studied by McArdle (1982); they also show a predominance of small livestock and date from about 4750 B.P.

FAYUM AND KHARGA OASIS (EASTERN SAHARA)

Caton-Thompson and Gardner (1934) called the Neolithic sites in the Fayum "Fayum A." They list fish, crocodile, turtle, hippopotamus (*Hippopotamus amphibius*), pig, sheep, goat and jackal or dog from the type site of Kom W. Later research by Wendorf and collaborators (Wendorf and Schild 1976) included a site (E29G3) assigned to the Fayum A complex with faunal remains that have been tentatively attributed to domestic cattle of fairly large size (Gautier 1976). Other faunal elements are a small but as yet unidentified, carnivore, jackal (*Canis aureus*) or dog, hippopotamus (*Hippopotamus amphibius*), dorcas gazelle (*Gazella dorcas*) and dama gazelle (*G. dama*). Most of the remains are of small livestock, which make up 85% of the domesticated fauna. A reanalysis of the cattle material indicates that there is a sharp difference in size from wild cattle from older sites and we are now convinced that the Fayum A cattle pertain to a quite large domestic form (perhaps 110–130 cm at the shoulder). A radiocarbon date puts the site at about 5900 B.P. Re-excavation of the type-site (Kom W, or E29H2) produced a mammalian fauna including many remains of small livestock and some game (hippopotamus, dorcas gazelle and jackal or dog).

The faunal evidence from Kharga is very limited. Two late prehistoric concentrations, excavated by the Combined Prehistoric Expedition (Wendorf and Schild 1980), yielded remains of a large and a medium-sized bovid. The large bovid is represented by an upper molar row, most probably derived from large domestic cattle. The smaller bovid remains are either gazelle (*Gazella dorcas*) or small livestock (Gautier 1980:339). The concentrations belong to the Late Neolithic (Wendorf and Schild 1980:180–181, 265), formerly referred to as Peasant Neolithic (Caton-Thompson 1952); a radiocarbon date on ostrich eggshell from one of them is about 5500 B.P. More recently, fauna has been reported from playa-like deposits in the Red Desert, 70 km west of Kharga (Pachur and Röper 1984a). Identifications by H.-P. Uerpmann, of Tübingen, indicate the presence of dorcas gazelle, dama gazelle (*Gazella dama*), Barbary sheep (*Ammotragus lervia*) a medium- to large-sized bovid (could this be cattle?) and Caprinae (small livestock?). Radiocarbon dates on charcoal collected in the immediate vicinity are 9260 B.P. ± 370 years and 7790 B.P. ± 340 years. More precise information on this faunal assemblage and its context would be very welcome.

WADI BAKHT (GILF EL KEBIR), NABTA AND BIR KISEIBA (SOUTHERN EASTERN SAHARA, EGYPT)

Prehistoric sites in the Gilf el Kebir were first investigated by Myers in 1938 (Bagnold *et al.* 1939), who collected some faunal remains now housed in the British Museum (Natural History). Various groups have visited the region in more recent times (Kuper 1981; McHugh 1982; Pachur and Röper 1984a, 1984b; Wendorf and Schild 1980). The archaeozoological harvest, however, remains meager. A small faunal assemblage from the large site in playa-like sediments behind the fossil dune that blocks Wadi Bakht has been studied by us (Gautier 1980, 1982a) and yielded dorcas gazelle (*Gazella dorcas*) and small and large livestock. A carnivore was first identified as large dog, but we now believe it is probably striped hyena (*H. hyaena*). Ostrich eggshell collected from the surface of the site was dated to about 7000 B.P. (Wendorf and Schild 1980), while dates on charcoal from within the sedimentary series range between 8700 and 4100 B.P. (Pachur and Röper 1984a, 1984b)! The small faunal samples collected by Myers are thought to have come principally from the Wadi Bakht site and seem to include small and large livestock, jackal (*Canis aureus*), dorcas gazelle (*Gazella dorcas*) and addax (*Addax nasosulcatus*); they are now being restudied by J. Peters, of Ghent.

Numerous sites have been excavated by the Combined Prehistoric Expedition at Nabta and Bir Kiseiba, farther east in the Western Desert of Egypt (Wendorf and Schild 1980; Wendorf *et al.* 1984). The faunal collections are quite extensive and comprise molluscs, toad or frog, lizard(s), turtle, various birds, desert hedgehog (*Parechinus aethiopicus*), ground squirrel (*Euxerus erythropus*), field rat (*Arvicanthis niloticus*), porcupine (*Hystrix cristata*), five wild carnivores, perhaps scimitar-horned oryx (*Oryx dammah*) or addax (*Addax nasosulcatus*) and dama gazelle (*Gazella dama*). Most numerous, however, are the remains of dorcas gazelle (*G. dorcas*) and hare (*Lepus capensis*). As a whole, the faunal spectrum is suggestive of a rather poor environment, perhaps comparable to the northernmost Sahel, with an annual rainfall of about 200 mm.

The most remarkable aspect of both the Nabta and Bir Kiseiba assemblages is the presence at most of the sites of small quantities of remains attributable to a large bovid, which we tentatively identified as domestic cattle (Gautier 1984c). In Middle and Late Neolithic contexts at Nabta, the cattle are accompanied by small livestock. Most scholars can probably accept our cattle identifications for material from the later period (Middle and Late Neolithic—7000 B.P. and later) without too much reluctance. However, our putative domestic cattle go back to 8840 B.P. ± 90 years at Nabta (Site E-75-3) and even to 9500 B.P. at Bir Kiseiba (E-79-8)! Consequently, our identifications have been questioned (Smith 1984b). Wendorf and others (in press) have restated and elaborated upon the reasons behind our identification of the large bovids found at Nabta and Bir Kiseiba as domestic cattle. These include size and morphological criteria, by which it is possible to exclude African buffalo (*Syncerus caffer*), giant buffalo (*Pelorovis antiquus*) and "normal-sized" wild cattle (*Bos primigenius*). The paleosynecological argument states that only man could be responsible for the presence of a large bovid in faunal spectra which are otherwise essentially confined to hare and gazelle. A third argument may be added. In a recent revision of the pre-Neolithic (Predynastic) archaeofauna of the Nile Valley, we concluded that hartebeest (*Alcelaphus buselaphus*) and wild cattle were the predominant game duo in the Nile Valley because they probably had overlapping requirements, hartebeest being the "drier" of the two (Gautier and Van Neer in press). Thus, one can argue that if indeed our large bovid in the Western Desert is wild cattle, then it is curious that we can find no trace of its partner, which we can normally identify without difficulty.

SHAHEINAB, KADERO AND RELATED SITES (CENTRAL SUDAN)

The faunas from the classic sites of Early Khartoum ("Khartoum Mesolithic") and Shaheinab ("Khartoum Neolithic") (Arkell 1949, 1953) were briefly described by Bate (1949, 1953). In the last ten years, several other sites of the same periods have been investigated: Saggai, Geili (Caneva 1983, 1984), Kadero (Krzyzaniak 1984), Nofalab, Umm Direiwa and Zakiab (Haaland 1981), and a small new excavation has also been carried out at Shaheinab (Haaland 1981). Several faunal reports, varying in scope and detail, have been published on these various new ventures (Gautier 1983, 1984a, 1984b; Soboçinski 1977; Tigani el Mahi 1981, 1982), which we have recently tried to reassess and to summarize (Gautier in press b).

The older sites (Early Khartoum and Saggai) are characterized by an extensive African fauna, with molluscs, fish, other lower vertebrates and some forty non-intrusive mammals, among which kob (*Kobus kob*) predominates. The younger Khartoum Neolithic sites (Shaheinab, Geili, Kadero and others) are characterized by the presence of small and large livestock and dogs. Most samples show clearly that pastoralism with an emphasis on cattle was a major subsistence activity, and that the adoption of pastoralism may go back to perhaps about 6500 B.P. Special mention should also be made of the fact that the so-called African buffalo (*Syncerus caffer*) identified at Shaheinab (Bate 1953) is cattle. Moreover, the so-called dwarf goat from the same site does not differ from the present-day, "normal-sized" goats in the region. As to the size and horns of the cattle, the measurements suggest animals between about 100 and 125 cm at the shoulders, while cattle bucrania found in graves at Kadada and pertaining to a somewhat younger Neolithic phase (Gautier 1986; Geus 1984; Reinold 1982) indicate that the central Sudanese prehistoric bovines were long-horn.

CONCLUSION

We should not be deceived by Figure 9.1, which summarizes the main evidence presented above. It depicts in a very simplified form an intricately moulded landmass more than 1,500,000 km^2 in area, and we should have depicted our sites on it with microscopic dots and not with the rather expansive symbols we have used. The inevitable conclusion is that data on prehistoric cattle pastoralism in North Africa are limited. Furthermore, most of these data are tantalizingly incomplete and vague, even in many recent publications. Apparently, investigators did not and do not easily seek the co-operation of specialists in the analysis of anthropogenic (archaeological) faunas; that is, of archaeozoologists (or whatever one wishes to call them, so long as one does not confuse them with classical paleontologists). Some archaeologists have felt or still feel sufficiently qualified to deal with faunal remains themselves; a few may even have been suffering from mild cases of the one-man-band syndrome. Alternatively, we might invoke logistical or financial problems which could preclude a close co-operation between field archaeologists and faunal analysts. Be that as it may, most faunal collections need to be restudied, but their whereabouts are frequently not given or, worse, not well known. If we add to this the vicissitudes faunal remains may suffer once they enter storage facilities, we can predict that if programs for reanalysis are not set up quickly, then many samples will become irretrievably lost to science. It is true that the Sahara is no longer the inaccessible region it used to be and that we can now go back much more easily and collect new data, but we also wonder how rapidly the evidence is being destroyed by all kinds of modern development projects, including tourists.

Several authors have dealt more or less extensively with the history and spread of cattle in North Africa (Banks 1984; Clark 1976; McHugh 1974; Shaw 1981; Smith 1980b, 1984a, 1984b). It is not possible to discuss all of these endeavors here, but it does seem to us that they tend to be hampered by a lack of insight into modern biological systematics, into the status of domestic animals and breeds and into the processes of domestication, to name but three. If an archaeozoologist were to start juggling with inorganic artifactual data in the same way as archaeologists do with the archaeozoological evidence, storms of protest would drown the poor devil. Interdisciplinary co-operation, which includes archaeozoologists, is just as much needed to produce acceptable syntheses as it is for the basic processing of faunal data. However, it is our contention that the available raw data are still too incomplete to allow overall reconstructions; such attempts are at best heuristic devices. This does not, of course, mean that we cannot draw a few more-or-less pertinent conclusions from the above review of the evidence.

One reconstruction proposes that small livestock entered Africa from the Near East, unaccompanied by cattle, and that they triggered the domestication of the autochthonous aurochs. This view relies heavily on the incomplete faunal evidence from the Haua Fteah, where cattle are said to be lacking. Our reading of the evidence now available suggests that both small and large livestock were probably present at the Haua Fteah, so that both small and large livestock could have entered Africa together. It has always seemed strange to us that only small livestock would have been brought in, unless the large livestock either had already been introduced at an earlier date or were present as a result of a domestication process in Africa. A careful reanalysis of the upper faunal sequence of the Haua Fteah, perhaps combined with new excavations, should be a priority in any reanalysis program of North African archaeofaunas.

As Muzzolini (1983) has already argued on other grounds, there is no trace of the so-called *Bos brachyceros* (or, better, short-horn cattle) in the faunal records we have reconsidered. On the contrary, the evidence, although admittedly incomplete, points to the widespread presence of long-horn cattle and thus is in agreement with what "bovidian" rock-art shows us. The various short-horn breeds could have developed out of these.

The spread of cattle from the Central Sahara to the west (Dhar Tichitt) and to the south into the Sahel and beyond seems to be quite well documented. The same can probably be said about the spread of cattle and small livestock into the central Sudan at about 6500 B.P. East of Lake Turkana at Dongodien (GaJi4) (Figure 9.1), there is evidence for both small and large livestock back to about 4000 B.P. or somewhat earlier (Barthelme 1984; Marshall *et al.* 1984). It is not clear how the cattle reached the Atlantic Sahara, because there are no data available for most of the westernmost Sahara. They could have come from the Sahara or along the coast from the Maghreb; the dates suggest the latter route.

As to the very early appearance of domestic cattle in the Eastern Sahara, this remains hypothetical. It is in accord with the climatic gradient recently defined by Pachur and Röper (1984a, 1984b); according to this, the humidity decreased from west to east in early Holocene sites in the Sahara, and the Eastern Sahara itself was further marked by a south-north gradient of increasing humidity. Nabta and Bir Kiseiba lie within the very driest zone, as is also indicated by their resticted faunal spectra. Thus, as has been suggested elsewhere (Gautier 1984c; Wendorf *et al.* in press), ecological stress could have favored any early experiments in domestication being made there with cattle brought in from the Nile Valley. Unfortunately, the data to support this hypothesis still come only from Nabta and Bir Kiseiba. However, the earliest finds of domestic cattle in the Sahara, other than our putative examples from Nabta and Bir Kiseiba, could have come from the region between Nabta and Bir Kiseiba and the central Sahara: Wadi Bakht, Gabrong, Enneri Bardagué and Uan Muhuggiag. This suggests a diachronic spread of cattle from east to west, corresponding nicely to the gradient in humidity.

Pastoralism appears to have been practiced along the Mediterranean coast by the seventh millennium B.P., but how the known sites relate to the Saharan hinterland remains obscure, since there is no information concerning the northern Sahara.

Moreover, the evidence for a south-to-north movement of cattle from the Eastern Sahara, in accordance with the early Holocene south-north climatic gradient (Pachur and Röper 1984a, 1984b), is far from convincing. It would lead to a model in which cattle were brought to the Mediterranean as an allochthonous domesticate and were there economically combined with small livestock brought in from the Near East. It might also be argued that both small and large livestock are immigrants from Asia, while cattle were also domesticated independently in the Sahara. In theory, one could further imagine domesticates being introduced from southern Europe into, for example, the Maghreb!

Concerning the size of the cattle, we can say that the cattle in the Mediterranean sites, the Fayum and the Nile Valley appear to be larger than the cattle in the Sahara. No doubt this size difference primarily reflects ecological differences between the Mediterranean belt and the Nile Valley and environs on the one hand, and the Sahara with its poor grazing on the other. (We hope that it has already been sufficiently stressed that the ecological conditions of the early Holocene in the Sahara were generally far from excellent.) Because of this, it is difficult to use size-changes as an argument to relate these groups of cattle, as Smith (1980b) has tried to do. The early cattle of Nabta and Bir Kiseiba are also large, but if we are dealing with an early phase of domestication, then the decline in size in response to poor ecological conditions may not yet have begun.

As a final conclusion, we can only repeat once more that there is a dearth of reliable data and refined chronological frameworks, which no amount of theorizing and model-building can overcome. Where possible, existing faunal samples should be re-evaluated carefully, but many new ones must also be collected from well-defined contexts. Thus, for those prehistorians who like the Sahara, there is still a great deal of work to be done, preferably in real international and intergroup co-operation and a true interdisciplinary spirit.

ACKNOWLEDGMENTS

Several colleagues have provided offprints or other information and we would like to thank in particular Dr. B. E. Barich (Rome), Dr. C. Guérin (Lyon), Mr. H. Lhote (Paris), Dr. P. Munson (Bloomington), Dr. J. Nenquin (Ghent), Dr. A. Muzzolini (Toulouse), Dr. N. Petit-Maire (Marseille) and Dr. A. B. Smith (Cape Town) for their kind help. To Dr. A. E. Close (Dallas), I owe thanks mainly because I would never have sat down to write the foregoing evaluation without her invitation to participate with it in this book dedicated to Fred. To the latter, I owe thanks for keeping me well provisioned with bones, including the exciting although troublesome large bovids from Bir Kiseiba and Nabta. *Ad multos annos.*

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10

Adaptation in Archaeology: An Example from the Libyan Sahara

BARBARA E. BARICH

ADAPTATION: A CURRENT PARADIGM IN ARCHAEOLOGY

In the last ten years, the theme of adaptation has become increasingly more important in archaeological theory. This concept, derived from the fields of evolutionary theory and ecology, was accepted into the discipline within the framework of the "new archaeology," where it came to be regarded as a new theoretical paradigm and as a substitute for the diffusion-oriented models of the cultural-historical school. Thus, current studies are primarily concerned with differences and reasons for change, rather than with the investigation of similarities.

The equation of adaptation with "state of fitness" within a specific environment means the deliberate selection of an evolutionary, ecological approach (Kirch 1980:103; Pianka 1974). The "state of fitness" definition seems to be the most useful of all those that have been suggested since adaptation first began to be debated in the field of anthropology in the 1950s. The definitions given by Steward (1955) and White (1959) provided the bases for the concept of cultural adaptation as formulated by Sahlins and Service (1960) and subsequently reviewed by Vayda and Rappaport (1968). These formulations still form the basis of present-day cultural ecology (Bennett 1976). Anthropology has also adopted the study units of ecology (populations, communities and ecosystems). Buckley (1968) developed one of the earliest models of culture as a "complex adaptive system" and used the concept of feedback control loops in its definition. Culture has now come to be regarded as the system governing the relationships between human groups and their natural environment. This arrangement may be diagrammed in the following manner:

Community <———> Culture <———> Environment

Clarke (1968) and Binford (1962) reformulated many of the ecological and anthropological aspects of adaptation specifically for the field of archaeology. According to Binford, variability is the crucial point of culture, which is conceived as an evolutionary process; this has been a central theme in his own research (Binford 1964, 1968a, 1968b). Other studies have viewed culture as an open system of elements that interact with the environment, the physical population and the relevant genetic system. It follows that study of the interactions between elements is just as important as the study of the elements themselves (Flannery 1968, 1977; Renfrew 1971). In light of the forms of feedback that exist between culture and environmental systems, cultural adaptation can be seen as an alteration of the elements of the original cultural system and of the relations between these elements, in response to change occurring within the combined environmental-human system. A changing environment brings about types of behavior that result in a greater degree of adaptedness for the human population (Kirch 1980:108).

The adaptational paradigm is particularly well suited to the study of territories where frequent changes in the environment have profoundly affected the life of human beings, as is the case in desertic areas. However, useful application of the concept to the study of extinct societies requires a methodological basis which can translate the theoretical foundation underlying it into a working base (Hardesty 1983).

Compared with other social sciences, such as sociology and even anthropology, archaeology has available to it the most powerful instruments for the study of human behavior in time and space. The greatest difficulty facing the student of change is the need to relate the static reality of the archaeological record to the dynamic reality of the original system (Binford 1965). Adaptation was a dynamic interaction among the various components of the contextual system (community, culture and environment), while the archaeological record presents the same dynamics in the form of static documents. Consequently, archaeological reconstruction should not be limited to recording the basic paleontological, paleobotanical and paleoanthropological data and to the study of archaeological materials, as is frequently done in multidisciplinary or integrated research. Instead, research should aim specifically at the reconstruction of the relations that once existed between the different elements that were parts of the overall dynamic system.

The explanatory formula used by Binford and later authors is hypothetico-deductive. It involves a number of approaches, including identification of the specific space-time context, reconstruction of behavioral changes in response to specific stresses and analysis of the conditions of stability, growth and decline in a population. These inductive processes lead to the formulation of a model of the relationships between specific variables from which one may infer a number of consequences to be later tested by the available data (Figure 10.1).

The procedure may also make use of models generated independently of archaeological data and founded on the operating principles of other disciplines. These are models of universal application, unlike those used to account for specific instances or resulting from empirical generalizations (Binford 1978, 1983), and are generally applied in ethnoarchaeological contexts. In such cases, the observation of how selective pressures affect present behavior permits us to hypothesize about adaptive responses in the past. In a recent paper, I have outlined the theoretical assumptions underlying the explanation of past events through the principles that regulate modern ecosystems (Barich 1985). This approach is implicit in the adaptational paradigm itself and the consequent recognition of the ecological principles regulating the real world.

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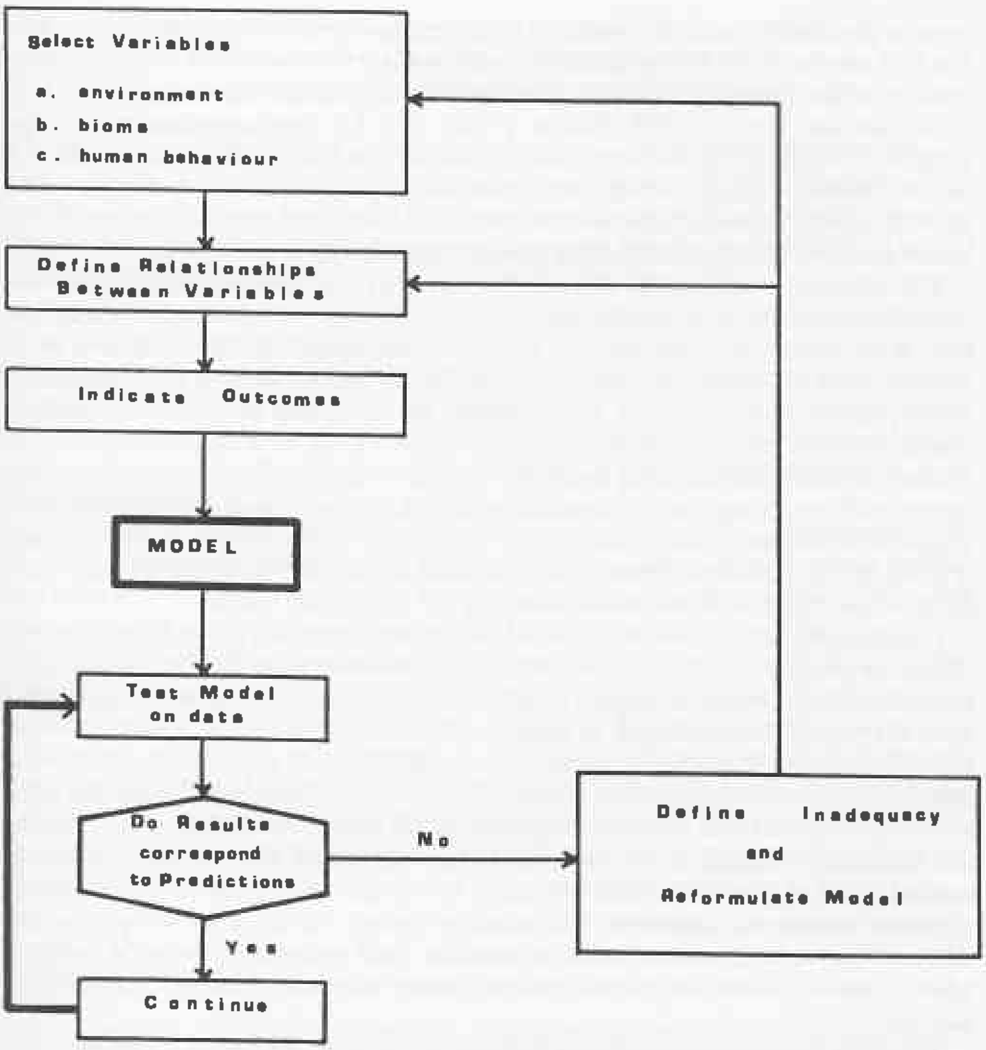

Figure 10.1 Construction of a model for the archaeological study of adaptation (modified after Kirch 1980).

MAXIMIZATION OF RESOURCES AS AN ADAPTIVE STRATEGY

In this paper, the transition from hunting and gathering to pastoralism within the Sahara is examined by means of models that apply biogeographical and economic, adaptive configurations to the human environment. Within these general explanatory models, the phenomenon of pastoralism may be viewed as an adaptation of groups with purely extractive economies to a period of recurrent climatic deterioration.

Research into hunter-gatherer societies has recently entered a critical stage because of the inadequacy of the models of conventional ethnology and the still-unsophisticated state of the new explanatory tools (Bettinger 1980:255–256). The ambiguity of ethnographic descriptions can be avoided only by developing quantitative patterns to create a descriptive-normative model of hunter-gatherer requirements and ways of life. The first results of this have included the outline of various aspects of hunter-gatherer societies with reference to economic, demographic and sociopolitical spheres (Birdsell 1968; Lee and Devore 1968; Sahlins 1968). This has been supplemented by the application of other formal instruments, such as the concepts of subsistence settlement pattern (Struever 1968) or of site-catchment (Roper 1979; Vita-Finzi and Higgs 1970; Zvelebil 1983). Recent efforts have succeeded in developing more general models of hunter-gatherer societies functioning as interconnected systems.

The environmental models derived from ecology use generalizations about the variability in the physical environment to predict biogeographical, adaptive configurations in the human environment. The environmental features are selected so as to be applicable to all situations and, consequently, to permit comparative studies of geographically dissimilar areas. For example, the distinction between environments characterized by low and high degrees of stability is a useful level of generalization. In practice, unstable environments tend to be characterized by small and quickly growing species and have a high rate of population growth to compensate for the death rate. They are defined as "*r*-selected," where *r* represents the rate of population increase (Pianka 1970). Holocene resources are included among the *r*-selected species, while those of the Pleistocene are included among the *K*-selected species.

Among environmental models, the one suggested by Hayden (1981) to explain the change in prehistoric American societies from Paleo-Indian to Archaic seems to be particularly appropriate for making predictions concerning the societies being studied here. Hayden links the change in adaptive strategies between the Pleistocene and Holocene periods precisely to the environmental difference just noted, and draws a parallel between the organization of Paleolithic/Paleo-Indian groups on the one hand and Mesolithic/Archaic groups on the other. In his model, the depletion of resources and consequent change in the exploitable base during the Pleistocene is taken as a major cause of change and diversification among different societies. The response of human groups was a resource maximization strategy, designed to diversify exploitation of the resource base as much as possible. Such a strategy involved a series of adaptive modifications that affected various cultural subsystems and led, in the end, to change.

The most sophisticated studies of hunter-gatherer societies have focused on areas that were inhabited by historically known hunter-gatherers who seem to have been the direct descendants of local prehistoric hunter-gatherers. Other studies have concentrated upon the classification of archaeological materials, an approach which tends to treat segments of time as unchanging entities. I believe that we should try to avoid this separation between the documentary and theoretical levels. The data present in the archaeological record should be used to create general transformational models. In the following section, I will try to show how the resource-stress model and consequent principle of maximization may provide an explanation of the essentially economic changes observable among the Saharan societies of the Holocene. By means of this explanatory paradigm, supplemented by consideration of other factors, such as the cost-effectiveness of different strategies and selection of them based on the principle of least effort (Lightfoot 1983; Reidhead 1980), it is possible to trace the shift from Paleolithic-type contexts to those of incipient production without recourse to stimuli coming in from outside the system.

SYSTEMS PRE-ADAPTED TO FOOD-PRODUCTION IN THE SAHARAN ENVIRONMENT: THE TADRART ACACUS MODEL

The actual data to be related to the principles discussed above are derived from the archaeological record of the Tadrart Acacus, one of the massifs of the Central Sahara and the author's area of fieldwork. The testing mechanism works in two directions: on the one hand, the archaeological record itself becomes more integrated and light is shed upon the areas of missing information, and, on the other hand, the basic data are used to test the hypotheses. One of the areas of missing information that may be effectively integrated by this methodology is the social and political sphere, for which it is always necessary to fall back on deductive arguments because of the extreme scarcity of direct evidence. This overall approach has permitted the creation of a model of change specifically for the Acacus massif, which can then be adapted to a more general model of the transition from hunting and gathering to early forms of food-production, to be discussed below.

The Tadrart Acacus provides an excellent opportunity for understanding the evolutionary changes that occurred within Saharan societies, because of the number and good state of preservation of the archaeological deposits, the presence of stratified sequences that allow cultural changes to be traced through time, and the existence of prehistoric art which casts an ethnological light upon the archaeological study. The economic systems can be seen to have been developed gradually. From the tenth millennium B.P. onwards, two important aspects of Saharan life contributed to the continuous process of development: a non-food-producing, but semi-sedentary, context and a pastoral, but nomadic, context (Barich 1984a, 1984b). The specific case under consideration is not purely one of adaptation to aridity, since this environment, like others in the Sahara, witnessed rapid alternations of climate throughout the Holocene.

OBSERVATIONAL DATA

Reconstruction of the adaptive strategies adopted by human groups is possible through the study of the various components of the cultural system, or subsystems. The environment is the given condition with which activities must cope, through the development of special technology. Furthermore, the organization of activities requires the creation of specific patterns of settlement systems and land-use. The configuration for the hunter-gatherer level of Tadrart Acacus societies therefore involved the following elements: (1) land-use and subsistence; (2) settlement patterns; and (3) technology.

Land-Use and Subsistence

The Tadrart Acacus is an extensive archaeological territory in the southwestern part of Libya, near the Algerian border (Figure 10.2). The geolithological structure of the massif consists of various formations of sandstones, the oldest of which (Devonian) have been considerably eroded by the action of meteorological agents. While this process did not result in true caves, there is a large number of rockshelters where prehistoric groups have left traces of their presence. The mountain chain is rather

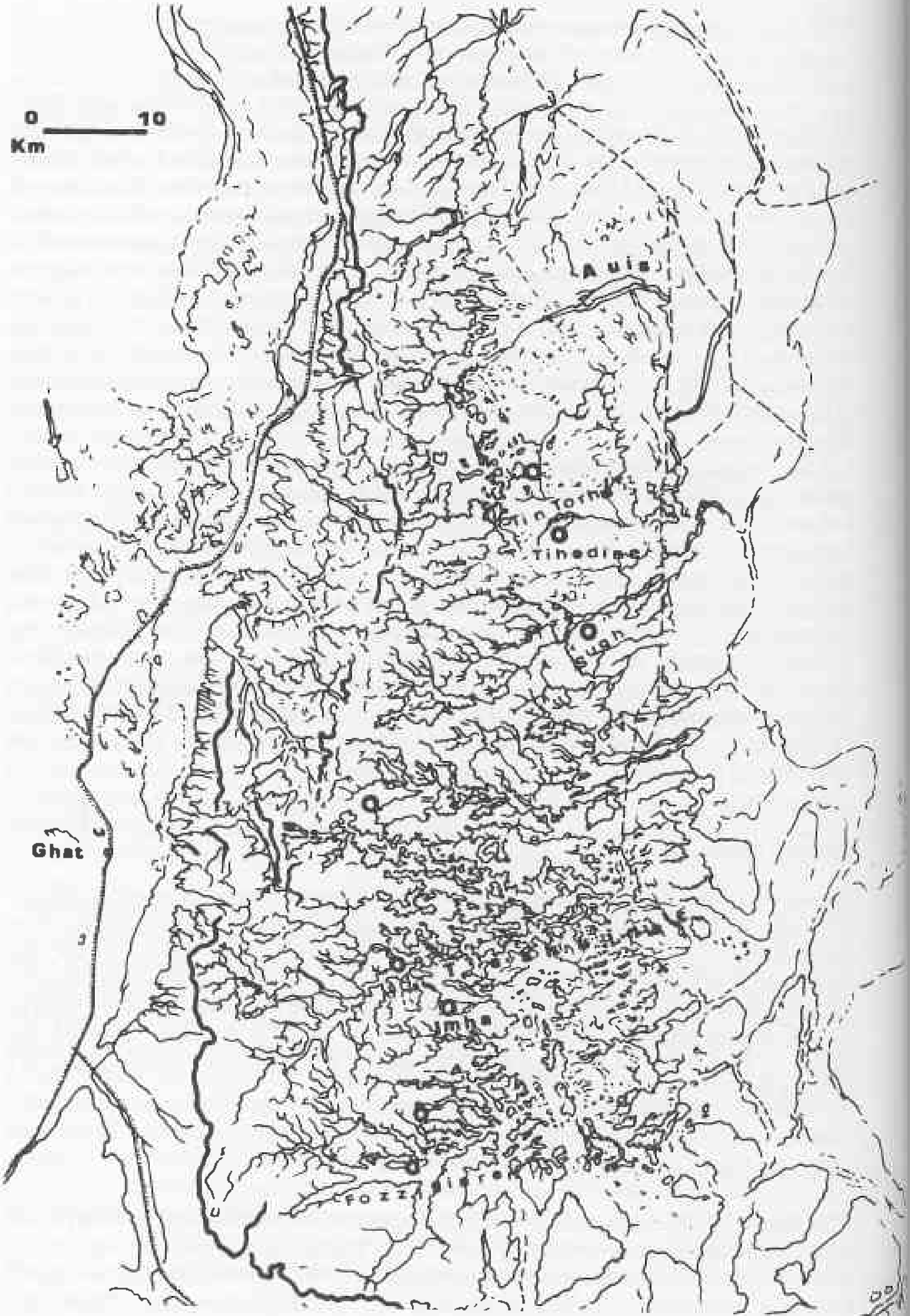

Figure 10.2 Map of the Tadrart Acacus (Libya) with locations of major archaeological areas.

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clearly divided into two very different ecosystems, corresponding to the eastern and western parts of the massif.

The Early Holocene hunter-gatherer-fishers, who represent the pre-food-production and semi-sedentary level of occupation, occupied the eastern slope of the massif. In fact, the marked asymmetry of the two slopes of the Acacus means that conditions favoring penetration by human groups, who always moved along water-courses, really existed only on this slope, which is characterized by a well-developed drainage pattern. Furthermore, the peculiar hydrogeological structures reported along the eastern slope (Marcolongo in press), particularly the shallow groundwater, were critical both for the availability of water and for the creation of conditions favorable to human occupation. On the western slope, on the other hand, conditions of this type have been reported only in the Tasbat Valley (a tributary on the right side of the Wadi Tanezuft, close to Tahala). Even within the eastern slope, one may distinguish two separate sectors. The northern sector had shallow groundwater and a relatively undeveloped drainage pattern, which, nevertheless, permitted easy access to the western slope which was equally rich in water. The southern sector had a more developed drainage pattern but offered fewer opportunities for communication with the west.

The subsistence pattern appears to have been diversified into several complementary activities. Hunting involved a variety of small-sized species (hare, porcupine, hedgehog and several species of birds), and particular emphasis was placed on the Barbary sheep (*Ammotragus lervia*) and gazelle. The restudy of the Ti-n-Torha East fauna (Gautier and Van Neer 1982) suggested the possibility of primitive cattle, of the type found at Bir Kiseiba, from Level CII onwards; Gautier (in press) has, however, subsequently questioned this possibility. The finding of two types of fish shows that fishing was practiced either *in situ* or in nearby waterholes, while the high frequency of grinding-stones bears witness to the gathering of indigenous plants. The resultant type of hunting-fishing-gathering exploitation involved the intensive utilization of the local site-catchment areas. Consumed resources were either immediately available or easily accessible, so that human groups did not have to move over long distances, but were semi-sedentary.

Settlement Patterns

Settlements consisted of rockshelters situated on ledges jutting out from mountain walls; true caves are extremely rare, especially in this outer part of the Tadrart Acacus. An archaeological typology of the settlements reveals several geomorphological and environmental constants: a southerly or southeasterly exposure; a location 4–5 m above the wadi bottom; the presence of Devonian sandstones of the Tadrart Formation; and the immediate availability of water-resources noted above. These characteristics have been observed at the site of Fozzigiaren, in the wadi of the same name, where there are two separate levels, of which the earlier has dotted wavy-line pottery and a radiocarbon date of 8070 B.P. ± 100 years (Mori 1965:239); at sites along the Wadis Tihedine and Sughd, surveyed in 1983; and further north in the Ti-n-Torha area, which was systematically explored during the 1970s (Barich 1974).

The hunting-gathering-fishing level of exploitation dates from the tenth to the eighth or seventh millennia B.P. in the Wadi Ti-n-Torha, and is well documented at three sites: Ti-n-Torha Two Caves, Ti-n-Torha East and Ti-n-Torha North, which have related stratigraphies. After abandonment during a period of extreme aridity, Ti-n-Torha

Figure 10.3 Panoramic view of the Wadi Ti-n-Torha (Tadrart Acacus).

North was reinhabited by pastoral groups. Two Caves dominates the former river valley, while the sites of Ti-n-Torha East and Ti-n-Torha North overlook a small valley, protected on all sides by cliffs and watered by a stream that was an attraction to both men and animals (Figure 10.3). The whole area is directly linked to the Tahala drainage basin, which is still active on the opposite slope of the Acacus and can be easily reached through the 'Tulla Pass.

The thickness of the anthropogenic deposit, particularly at Ti-n-Torha East, is indicative of the length of the occupation. Occupation is likely to have been seasonal at first, most probably during the dry winter months when the valley became more accessible as the floodwaters fell (Gautier and Van Neer 1982). The transformation of the site begun in Level II, when stone blocks were used to partition it into separate areas, indicates increasing sedentism. These separated spaces were probably intended for nuclear families (Figure 10.4). The radiocarbon date of 8460 B.P. ± 50 years (R.1161 from Level RSup) coincides with the rather lengthy dry period that Maley has identified by comparing the sedimentary sequences from the Tibesti and from Nabta, in the Egyptian Sahara (Maley 1981:229–230). It is not coincidental that the later levels (Levels II–I) show an increased frequency of *Ammotragus*, the wild sheep that thrives in dry climates.

The high frequency of *Ammotragus* could be an indication in itself of some form of control over groups of animals, similar to what has been suggested at Tamar Hat (Saxon *et al*. 1974). This would imply a pre-adaptation for or, at least, a propensity towards the domestication of animals by hunter-gatherer-fishers. We will see below that this propensity might have been even more important during periods of stress or depletion in the purely natural resources.

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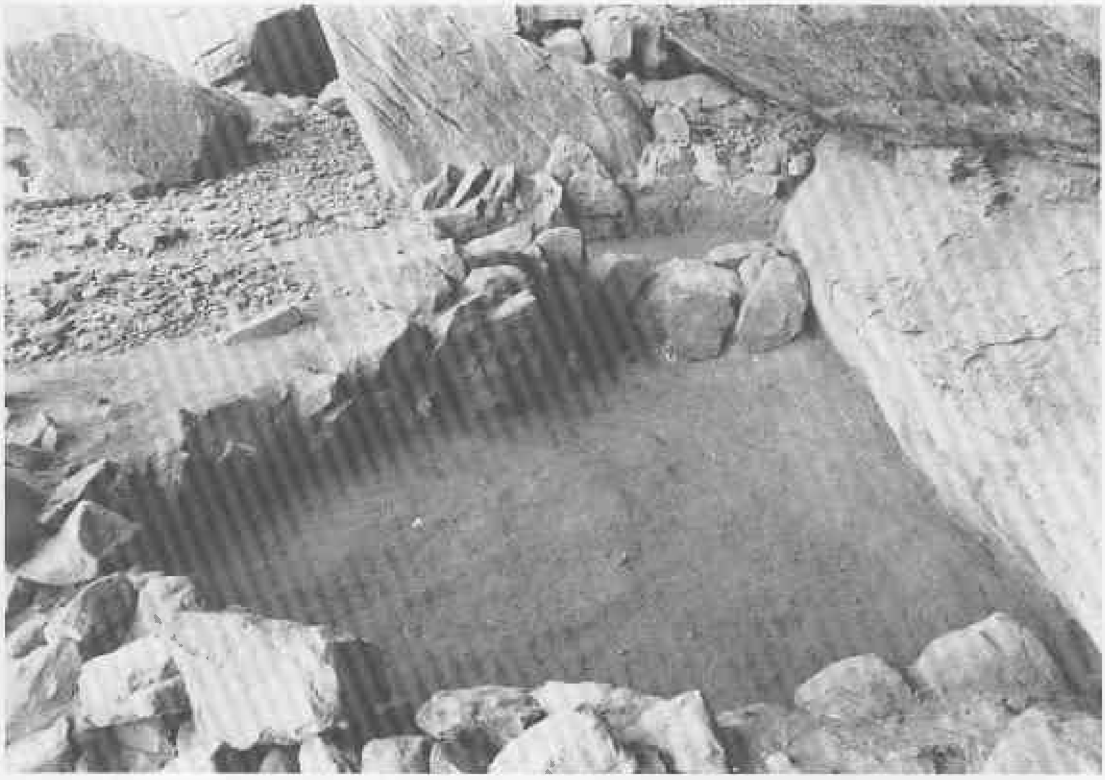


Figure 10.4 "Huts" in the Ti-n-Torha East settlement.

Technology

Special varieties of stone tools were developed to meet the needs of hunting and fishing activities. Thus, one finds a high incidence of blades, particularly backed blades and bladelets with a tendency to be microlithic. Geometric microliths, especially crescents, were frequent and bifacially retouched arrowheads were also developed. Larger stone tools, such as endscrapers, sidescrapers and denticulates, became more important as sedentism increased (indicated by the structures). The Two Caves lithic assemblage is somewhat more archaic and lacks arrowheads.

The high frequency of the blade group as a whole, which has indices of 90.7% and 82.6% at Torha East and Two Caves respectively, is very significant. Within this group, the class of pointed backed bladelets (12.0% and 15.1%, respectively) is one of the most important for the placement of these industries within their proper context. Equally high values for blades are reported for Late Paleolithic and Epipaleolithic (Columnatian, Keremian and so forth) tool-assemblages of the Iberomaurusian tradition, as well as for Nilotic (*sensu lato*) industries such as the Qarunian and Shamarkian.

From the very beginning (in Level RInf, with a date of 8640 B.P. ± 70 years [R.1035α]), the Epipaleolithic industry of Ti-n-Torha East is also associated with ceramics that show a high standard of manufacture in both paste and decorative motifs. The latter are made by impression, mostly multiple comb-impressions to obtain woven-mat motifs that often include the characteristic dotted wavy-line pattern (Figure 10.5). Throughout the Ti-n-Torha East sequence, the ceramics tend to become more standardized, the blade index falls and arrowheads become more complex. This suggests that the lower levels (V–IV) of Ti-n-Torha North should be ascribed to a later phase of the same horizon of occupation. These lower levels include dotted-patterned

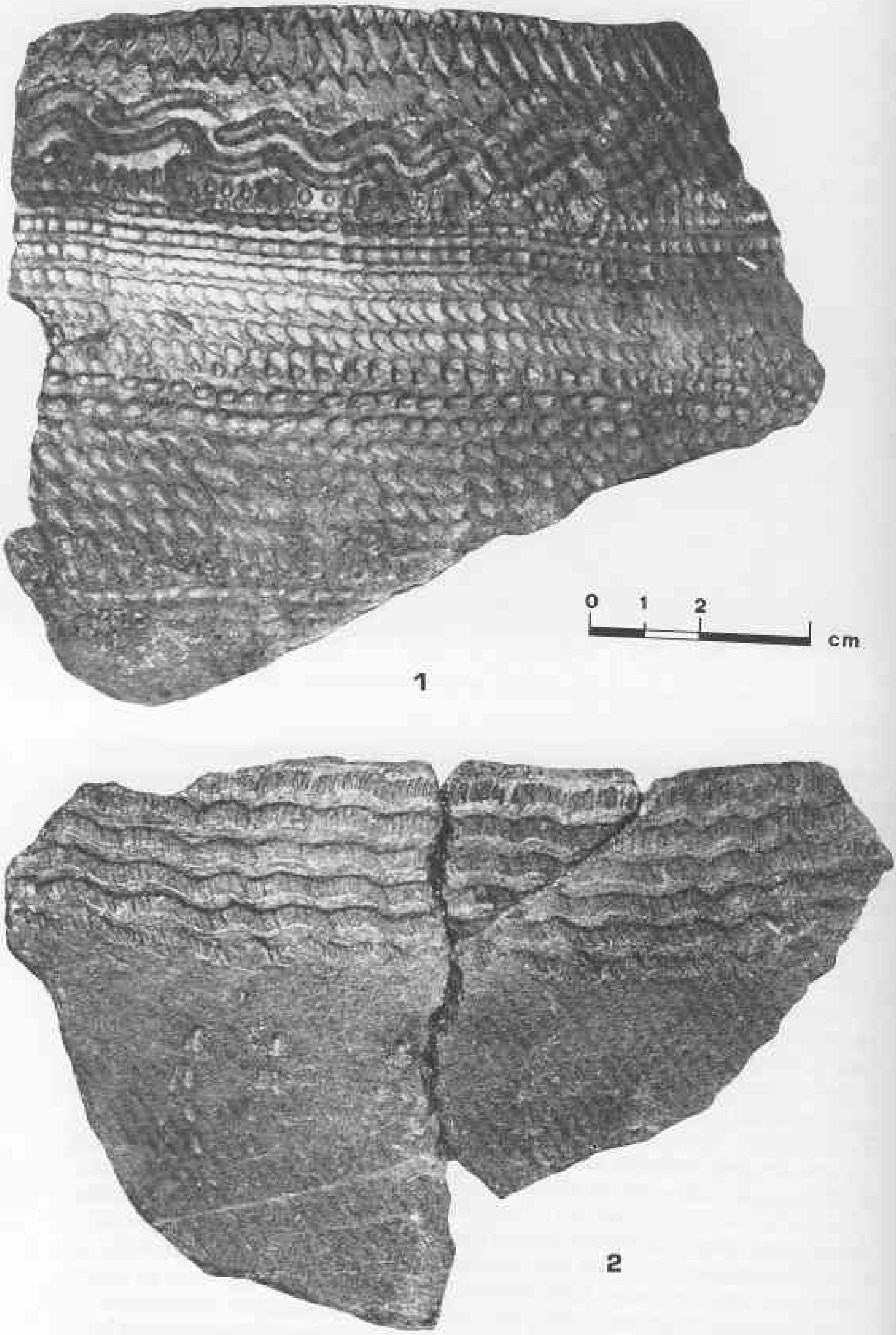
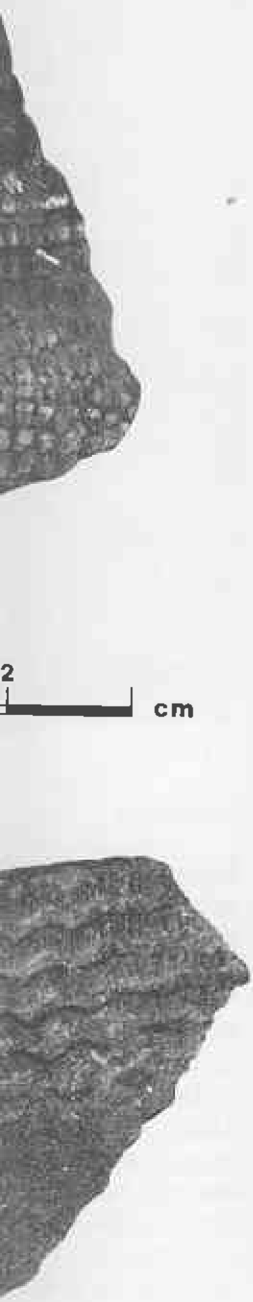


Figure 10.5 Comb-impressed ceramics from Ti-n-Torha East.



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ceramics, associated with a lithic industry in which the same bifacial technique prevails as in the final level of Ti-n-Torha East (CI).

If this interpretation is correct, it means that the hunter-fishers who began the earliest experiments in domestication may have remained in the Ti-n-Torha area until the middle of the seventh millennium B.P. After that time, the wadi became increasingly inhospitable, as evidenced by the vault collapses related to extreme aridity, and people abandoned the site, moving either towards the interior, where some water was still available, or to territories beyond the massif.

TRANSITION FROM AN EXTRACTIVE ECONOMY

The archaeological record provides an indication of the adaptive strategies practiced by groups who inhabited the massif. The interpretations of the subsystems are determined by the governing model, which was formulated on the basis of observations of present-day systems. Specific data are thus applied to a general explanatory model of the mechanisms involved in the transition from a purely extractive (Ingold 1983:553) or subsistence economy (Earle 1980:1) to incipient forms of food-production. As noted above, the value of the model lies in its ability to reach a "universal" level of explanation.

The data obtained from the archaeological record of the Tadrart Acacus may be interpreted as showing a trend towards domestication in response to selective pressures exerted by the environment on human behavior. The explanatory mechanism used here is the resource-stress model discussed above. It is one of the environmental models used in the analysis of hunter-gatherer societies (Bettinger 1980:271–272) and is founded on the principle, borrowed from cultural ecology, that cultural and biological systems tend to maximize the reliability of their resource base (Hayden 1981:523).

Under typical conditions of resource stress, environmental reliability was maximized during the Pleistocene by increasing the diversity of the resources exploited. In the post-Pleistocene period, the opposite strategy was adopted: the number of exploited species was reduced in order to concentrate on the most productive ones. Specialization is the major change in exploitative strategy that may be seen associated with the passage from Pleistocene to Holocene environments, posing the question of what might have caused this reversal of the earlier trend towards diversification.

Our specific focus is on the final phases of the Pleistocene, when many groups were compelled to consider the nutritional value of small-sized species (*r*-selected species). The procurement of these was not easy and effective use of them depended on the local development of specialized technologies. However, once the technology exists, small-sized species are high-yielding and practically inexhaustible resources. This could lead to the development of wealth hierarchies, based on competition, in areas where such resources were plentiful and where there were semi-sedentary communities.

The resource-maximization strategy therefore resulted in such adaptive changes as the invention of specialized tools for the exploitation of the new resources, an increase of the resource-base due to the extension of the exploitable spectrum, and the first stages of sedentism, resulting from the general exploitation of the immediately accessible habitat. Even the first forms of domestication may be viewed as an adaptive change resulting from attempts to increase diversification and thus the availability of resources in times of stress. The acquisition of the first domestic animals constituted a reversal of strategy, with a reduction in the number of exploited species and a focus on the highest-yielding species. (This is also similar to the "focal-diffuse model" of Cleland [1976] that involves a progressive shrinking of the subsistence pattern.) Seen in this light, the gradually increasing control over domesticable species appears as another technological innovation. This argument holds good even in view of the cost model proposed by Earle (1980:23), whereby the adoption of agriculture in the prehistoric American Midwest was determined by its cost-advantages compared with hunting-gathering strategies. According to Earle, a producer evaluates both the costs and yields of the available procurement strategies and selects the combination of strategies that minimizes cost and gives the maximum yields in terms of subsistence requirements. In fact, cost-minimization appears to be a significant factor in the behavior of ethnological groups, who try to obtain adequate nutrition at the lowest possible cost in labor (Reidhead 1980).

These types of study may provide other instruments for the explanatory process. This framework includes the concept of the "cost-effective option" proposed by Lightfoot (1983), whereby adaptive strategies are selected on the basis of their cost-effectiveness. Studies of prehistoric and present-day groups in the American Southwest, the Great Basin, the Kalahari and Australia have identified two main strategies for minimizing the effects of local resource variability. The selection of one or the other of these depends on their cost-effectiveness with respect to the organization and size of the group. If a seasonal-round strategy is profitable for groups characterized by considerable mobility, a low population density and no real managerial organization, then more sedentary groups will probably select a different strategy. In the latter case, the alternative of moving the actual resources appears more cost-effective, since the sedentism of the group and its intensive exploitation of resources allow storage. In addition, the higher population density reduces the cost of exchange of goods by reducing the distance between groups. Groups which fall halfway between these two types of organization may have recourse to a mixture of the two strategies. Groups characterized by semi-sedentary settlements, a moderate population density and a simple managerial hierarchy may select either a modified seasonal-round strategy or some form of a storage and food-exchange strategy (Lightfoot 1983:198).

All of this indicates a need to re-evaluate the probability that some form of storage was practiced by groups with a rather simple organization, and the related possibility of some form of resource exchange. This would provide a specific framework for contacts between different groups and for the exchange of goods, including domestic animals.

REACTIONS DURING CLIMATIC CRISIS: THE ANCIENT PASTORAL FACIES IN THE LIBYAN SAHARA

A fresh light has been cast on the archaeological record of the Tadrart Acacus by the general arguments discussed thus far. Groups of hunter-fisher-gatherers seem to have reached an optimal system of resource exploitation, and to have become pre-adapted to productive (as opposed to extractive) developments. By the end of the Ti-n-Torha cycle, the original system had been changed and domestication should be viewed as a simple technological innovation within this. This section will focus on this context in order to discover any discordances with the governing explanatory model.

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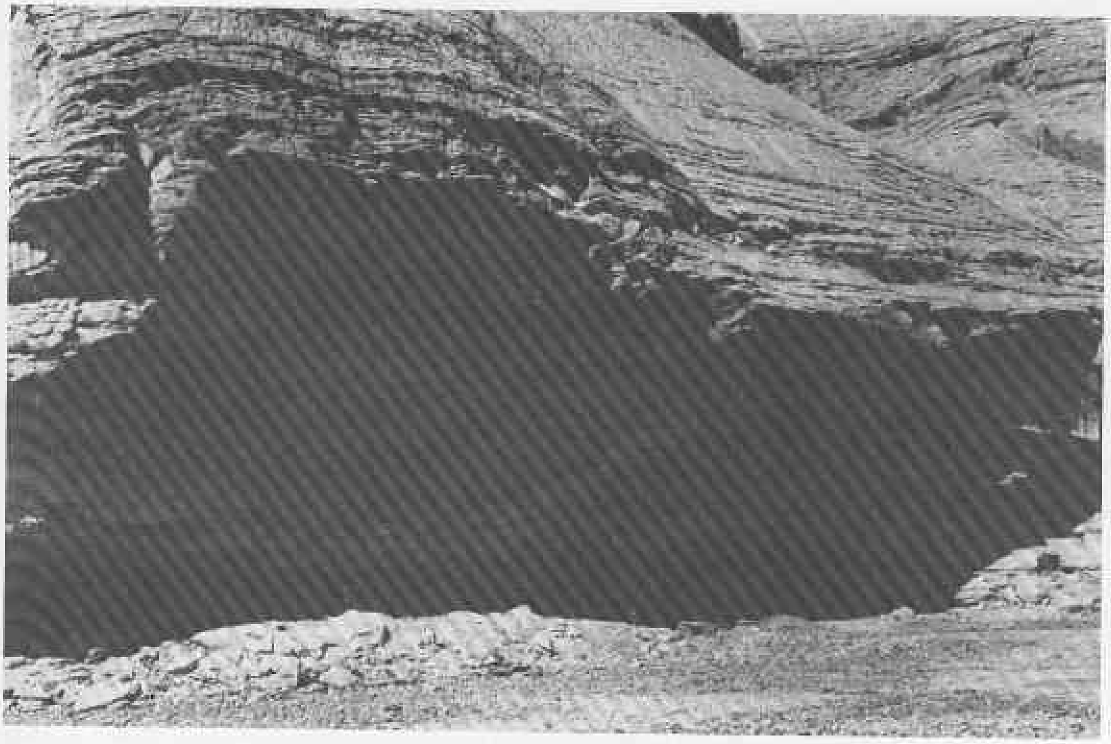

Figure 10.6 Uan Muhuggiag shelter in the Wadi Teshuinat (Tadrart Acacus).

of the massif, where the greater supply of water permitted the maintenance of a particular economic system. It is in this area that we find strongest support for our model of the transition from a hunting-gathering strategy, since it is here that its most advanced stage can be seen to have been fully established domestication.

The interior of the massif reaches a height of 900 m asl, so the elements of the ecosystem are rather different. It is characterized by generally narrower wadis, the presence of *gueltas* (depressions in the rock), where rainwater might be retained, and the presence of herbaceous vegetation, so that pasture was available. Archaeological sites are more numerous than in the outer part of the massif. They are usually rockshelters that have both a cultural deposit and figures painted on the walls. The major center of rock-art in the Tadrart is this inner section; there are fewer painted rockshelters on the eastern slope. This might also be related to the location of the rockshelters there, which are more exposed to the agents of erosion.

The settlements, nevertheless, have similar characteristics and chronologies. The anthropogenic deposit is always quite thick and extensive in area, although there are never any structures. The nature of the sediment, consisting of small lenses 10–15 cm thick and rich in hearths, ash, bones and fibers, is indicative of many reoccupations at short intervals, as is customary for pastoral peoples. The sequence is invariably closed by a concretionary crust of cattle dung mixed with vegetal fibers and dust.

Uan Muhuggiag is the most interesting and representative site (Figure 10.6). The large quantity of rock-art on the walls of the shelter bears witness to the shelter's significance as a reference and a stop-over point. Excavation of the site was carried out in the 1960s by Pasa and was then resumed in 1982 by the author to verify the results of the original explorations, especially the recovery of the skull of an unquestionably domestic *Bos*, dated to 5950 B.P. ± 120 years (Mori 1965:234) and associated with caprovine remains.

The stratigraphic sequence includes two very different series. The beginning of the formation of the deposit can be assigned to an extremely humid period, perhaps before the seventh millennium B.P.; a radiocarbon date of 7440 B.P. ± 220 years (Mori 1965:234) was obtained by Pasa from the basal levels and may be confirmed by the 1982 samples now being processed. The plant-cover included *Acacia-Panicum*, a few types of shrubs and *Typha*, indicating the presence of stagnant water nearby (Schulz in press). This series developed essentially without interruption until the shelter was adandoned during a dry phase, which is documented by a series of cave-ins shown very clearly in one sector of the excavation. After about 3770 B.P. ± 200 years (Ud.224), there is evidence of a second phase of occupation (the upper horizon), which was completely different in character from the occupations known in the Acacus sites and which should probably be related to the phenomenon of the Horse peoples (the *Caballin* or "Equidian" phase), the last period of occupation in the Acacus (Figure 10.7).

Artifacts are, on the whole, much rarer in the basal level of the deposit than in the subsequent levels. A few elements typical of the Ti-n-Torha facies were found, such as straight backed and pointed bladelets, a few potsherds with dotted wavy-line decoration and microlithic arrowheads with bifacial retouch. The archaeozoological study by Gautier (in press) stresses the higher incidence of cattle in this basal section than in the upper part of the deposit. While cattle and small livestock are of approximately equal frequency in the two basal levels, there is a marked prevalence of small livestock from the middle section of the sequence onwards. Both faunal and palynological data therefore support the existence of a first and distinctive phase of occupation.

This interpretation of the Uan Muhuggiag site is consistent with the finds from Ti-n-Torha. Uan Muhuggiag is equivalent to the occupation in the Ti-n-Torha area of Torha North Levels V–IV, where there was an impoverishment of the lithic industry about the eighth or seventh millennium B.P., shown by the general contraction of the assemblage and the abandonment of blades in favor of flakes. The entire lower horizon of Uan Muhuggiag belongs to this same period at Ti-n-Torha, when the latter was becoming inhospitable. After the short uninhabitable phase at Ti-n-Torha North, which is interpreted as a severely arid oscillation, developments at the two sites were parallel throughout the sixth millennium B.P.

In the technological subsystem, there is a shift not seen in the Ti-n-Torha facies. The spatulae or combs with multiple serrations on the distal edge or sides, used for making rocker-type impressions on the ceramics, are progressively replaced by simpler, two-toothed implements (Figure 10.8) and the techniques of ceramic decoration become more standardized. (This method of manufacture for the *ceramica puntinata in serie* was suggested by the author [Barich 1974]; a detailed study of manufacturing methods has since been carried out by Caneva [in press].) This is not unusual for a society of herders, who move considerable distances and for whom clay vessels may have little traditional importance, often being replaced by organic containers. Similarly, the lithic industry witnesses a gradual disappearance of the backed blades associated with hunting and fishing activities. Pointed backed bladelets, geometric microliths and the microburin technique are eventually replaced by tools of much lower technological sophistication: after an initial florescence of microlithic bifacial arrowheads, the range of stone tools is eventually reduced to only amorphous flakes. This indicates that stone tools were no longer used for specialized activities. Bone implements intended for ceramic decoration continue to be produced, but grinding-stones disappear completely.

There is also a fundamental change in the subsistence pattern, with 92.4% of the fauna being domestic species—cattle and small livestock. It is, in fact, the composition of the fauna from Uan Muhuggiag, which is indicative of a specialized, pastoral pattern

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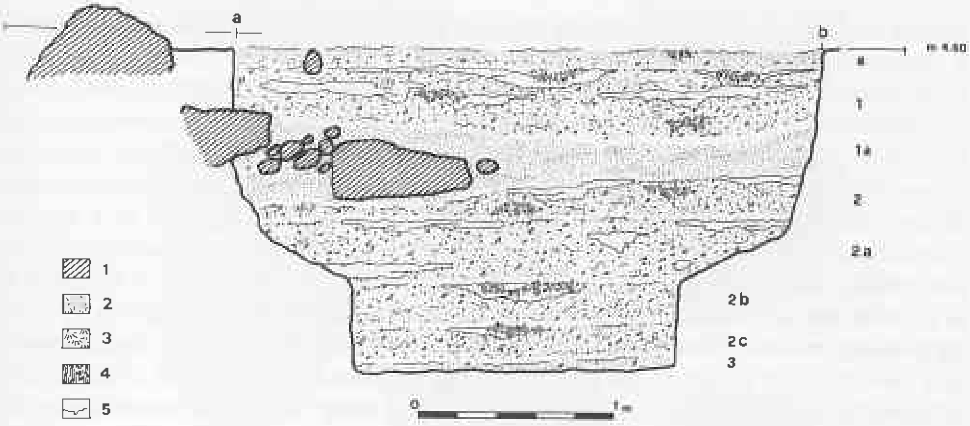

Figure 10.7 Stratigraphy in Sector A of Uan Muhuggiag.
Key: 1, sandstone; 2, sand; 3, fibers; 4, charcoal; 5, clay.

of exploitation, that is the main obstacle to the suggested continuity with the Ti-n-Torha facies. On the other hand, Gautier's recognition of an archaic type of cattle ("large bovid") in the Ti-n-Torha East fauna made such continuity more plausible: it provided direct, rather than circumstantial, evidence that the Ti-n-Torha groups were adapted to domestication by the time of Level CII at Torha East. It is superfluous to stress the difficulties inherent in an exact reconstruction of the intermediate stages between one state and the other. However, economic development almost everywhere in the Central Sahara seems to have passed through the same evolution as that observed in the Tadrart Acacus, which gives yet further verisimilitude to the proposed model.

The closest convergences seem to be those with the region of Niger, where, at Adrar n'Kiffi (Ténéré), Temet and Tagalagal (Aïr), local pastoralists of the Ténéréan facies were preceded by early ceramic-using groups that have been dated to the same chronological span as those of the Acacus (tenth to eighth millennia B.P.) (Roset 1978, 1983; Smith 1976). Even in the Tibesti, the development of pastoralism associated with the climatic optimum of the sixth millennium B.P. is later than the local occurrence of dotted wavy-line pottery and of an identified "large bovid" (Gabriel 1981:210). Bailloud's work (1969) at the sites of Délébo and Soro Kézénanga, in the Ennedi (Chad), provides further evidence of the process recognized in the other massifs. The change evident in the ceramic decoration corresponds precisely to that observed in the passage from the Ti-n-Torha facies to a pastoral context.

Throughout the area of the Central Sahara, then, the fully cattle-based economies are separated by intervals of about two millennia from the purely extractive hunting and gathering economies. This led to our original hypothesis, that pastoralism might have been an imported phenomenon. However, the hypothesis now put forward, of a fluid and undifferentiated socio-economic level serving as a pre-condition to the later experiments in domestication, is further supported by investigations conducted in the Egyptian Sahara. In the Bir Kiseiba area, evidence for cattle dates back to approximately 9000 B.P. and cultivated plants (barley and wheat) have been found rather later, at about 8100–7100 B.P. (Wendorf and Schild 1980; Wendorf *et al.* 1984). Gautier (1984:71) hypothesizes that the cattle might have come from the Nile Valley as a result of contacts made between the Nilotic groups and the Saharan hunters. This hypothesis is in accord with the observational data and with some of the explanatory models mentioned above, particularly the modified seasonal-round strategies, attributed to semi-sedentary groups with a moderate population density, thus allowing some form of resource-storage and distribution among neighboring groups (Lightfoot 1983:198).

Pastoralism is a special and more advanced level in terms of storage-techniques and modalities of group-organization. Storage among pastoralists is different from the elementary forms adopted by hunters, who do no more than set aside a limited amount of their catch for consumption soon afterwards. The birth:death ratio of a herd is extremely dependent on environmental variability; since the herd is the guarantee of the pastoralists' future subsistence (the *minimum* herd—Ingold 1983:564), it is essential to provide for an increase in the size of the herd by limiting consumption to non-reproducing animals. This basic requirement means that herders manage their property very carefully and access to the herds is strictly regulated by individual or household distribution. Within the pastoral context, therefore, "store" refers that part of the whole group's animal-property to which a right of ownership exists. This type of storage has been called "social storage" by Ingold (1983:563).

In terms of community organization, the existence of a managerial hierarchy responsible for assimilating information from several disparate sources may have facilitated the rapid mobilization of groups for purposes of transhumance. It may also have helped to maintain the cohesion of the group in times of severe shortage of resources, as happens in agricultural communities. Gabriel (1981) and Smith (1984) have suggested the possibility of the development of alternate, open-plain and mountain systems of internal and external group structures. Smith (1984:105) outlines two different forms of transhumance practiced by all of these groups, supporting his hypothesis with data from the Tuareg and Zaghawa, and he firmly supports the thesis that Saharan pastoral society was made up of rather independent groups: perhaps subtribal entities similar to the present Tuareg confederation, extending across northern Niger, Mali, southern Algeria and southwestern Libya. Detailed knowledge of the routes over the open prairies and a suitable use of marginal areas would have necessitated a constant flow of information, however, and this may have been maintained through a somewhat centralized organization.

The movement of the groups as they followed their herds accounts for the extensive dispersal of important cultural traits and, therefore, the affinities that may be observed even between very distant localities. Additional domesticates, such as sheep or goat and more evolved and, thus, more productive forms of *Bos*, could have been acquired through secondary contacts. In this respect, we may recall the hypothesis of Puglisi (1976, 1981) that the secondary development of pastoralism in this area may have owed something to conflicts between Saharan groups and Nilotic groups, such as those known at Badari or Fayum A by the middle of the seventh millennium B.P., and a consequent retreat towards the massifs.

CHANGE IN THE SAHARAN ENVIRONMENT

I have tried to show in this chapter how the theme of adaptation may be approached in the field of archaeology, using principles derived from the working of ecosystems that allow us to reach a more general level of explanation. Thus, the specific archaeological record, that of the hunter-gatherers of the Libyan Sahara, has been fitted to an environmental model that emphasizes resource-stress as a factor in the increasing diversification of the exploited base and in the increasing complexity of the social

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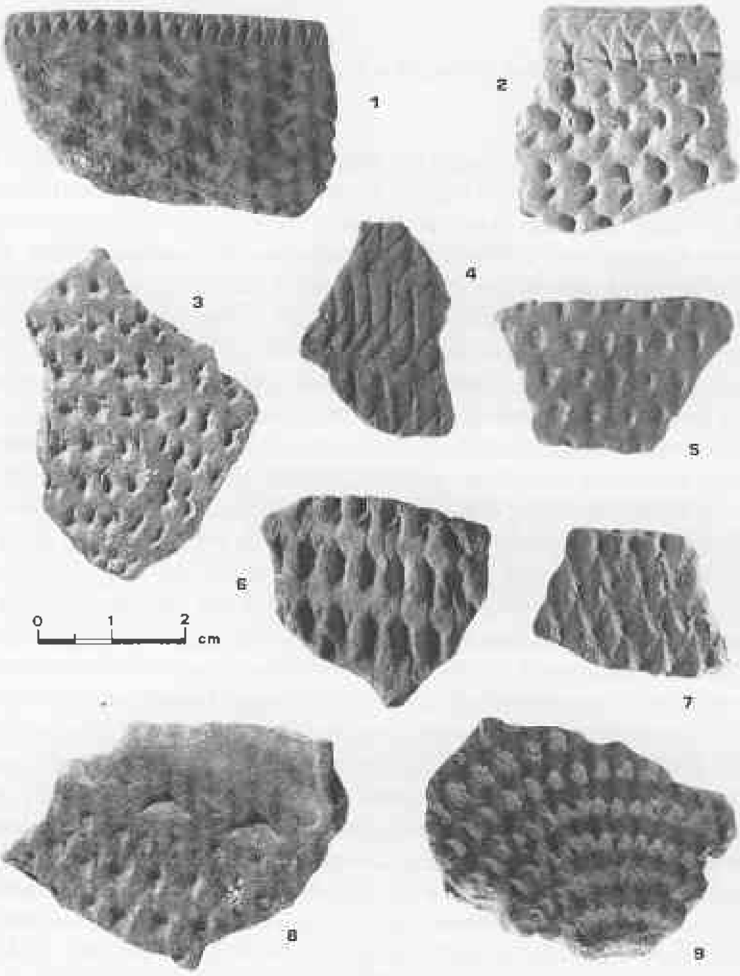

Figure 10.8 Ceramics from Uan Muhuggiag.

structure. The period under consideration is the transitional phase between the Pleistocene and the Holocene environments, when human groups were forced to reconsider the nutritional value of *r*-selected resources: small-sized species that were extensively available in their habitat. This selection may be seen as an adaptive strategy that led to a series of modifications and innovations, determined by the criterion of cost-effectiveness.

Under these conditions, systems intermediate between those of simple mobile societies and those of complex sedentary societies seem to have been most successful as adaptive strategies to reduce the effects of recurrent shortages of resources. These systems, characterized by semi-sedentism, a controlled population density and a simple hierarchical structure, were evidently the best suited for the development of simple storage of goods and for the circulation of those goods by means of exchange with neighboring communities located at such a distance from the sources as to make the transfer profitable. It is quite likely that it was in this way that the first domestic species, whether plants or animals, became spread among the communities in which a pre-adaptation to food-production already existed. It is also likely that they acquired the technical knowledge requisite for food-production by the same means.

As for the direction of this movement, we may reject the hypothesis of a single point of origin and unidirectional movement from there. Comparisons between, for example, the Ti-n-Torha facies and the area of the Egyptian Sahara suggest, rather, long-term relations throughout the Early and Middle Neolithic phases of that area (Wendorf *et al.* 1984:7–8). Furthermore, only a comprehensive view of this entire phenomenon, with its numerous returns and shifts, can explain the appearance in the Acacus of technological changes and of species domesticated elsewhere, simultaneous with the last manifestations of a purely extractive economy. (Sheep/goat were domesticated very early in the Near East, occurring at Zawi Chemi, in Iraq, at about 11,000 B.P. and at Tell Asiab, in Iran, at about 10,000 B.P. [Gautier 1980:336], so that we may suppose a very early and wide diffusion of these domesticates from that region.)

The model emphasizing resource-stress as a factor in change suggests a hypothetical sequence into which the conditions present between the Sahara and the Nile can be quite properly fitted. Working comparatively, we may then be able to identify more remote analogies and progressively fill in our reference grid. Thus, the areas of Niger, the Egyptian Sahara and the Sudan seem to provide the best opportunities for comparison; however, we should be aware that we are not literally trying to find links between them, or between them and the Acacus, but rather are regarding them as possible sources of additional confirmation for or illustrations of the same transitional model. For example, the superpositioning of Middle and Late Neolithic at Site E-75-8 at Nabta Playa may reflect the same process as can be seen in the Acacus in the Torha East-Lower Torha North-Uan Muhuggiag sequence. Any attempt to make direct comparisons would meet with the greatest difficulties (especially in the case of the Sudan), even though the archaeological record as a whole indicates a cultural process broadly similar to the Saharan model (Caneva 1983; Krzyzaniak 1977).

Nevertheless, we do not expect that the first experiments in control over the species eventually domesticated would proceed everywhere at the same pace and or in the same way, nor that they would be a fixed step in an evolutionary process. It seems most sensible to assume separate origins and independent experiments, although under similar environmental constraints. In this perspective, the affinities between the societies associated with ceramics in the Sahara appear primarily as affinities of environmental selection and of adaptative strategies to counterbalance environmental changes. Subsequent and additional convergences, which did result from direct contacts between the groups, may then be viewed as additions built upon this substratum of basic affinity.

ACKNOWLEDGMENTS

The Tadrart Acacus is the area of operation of the Libyan-Italian Joint Mission for Saharan Research, set up in accordance with an agreement between the University of Rome "La Sapienza" and the General Direction of Antiquities of Libya. The Mission is divided into two sections, rock-art and stratigraphic excavations, directed by F. Mori and the author, respectively. A monograph concerning the most recent research activities in the Tadrart Acacus is now in press in the International Series of the British Archaeological Reports: *Archaeology and Environment in the Libyan Sahara. Excavations in the Tadrart Acacus 1978–1983* (edited by B. E. Barich).

The new samples for radiocarbon dating from the 1982 season at Uan Muhuggiag are being analysed by G. Belluomini of the Department of Earth Sciences, University of Rome "La Sapienza."

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Paleoclimatic and Cultural Conditions of Neolithic Development in the Early Holocene of Northern Niger (Aïr and Ténéré)

JEAN-PIERRE ROSET

INTRODUCTION

The possibility that there might have been significant climatic changes in the Sahara within the relatively recent past has been the subject of heated debate ever since it was first proposed, by archaeologists among others. Over the last 15 years, it has been the subject of painstaking research which has allowed us to make considerable progress towards an understanding of the problem.

The early prehistorians were able to show that the Sahara had previously been humid by the presence, and often extraordinary abundance, of evidence for permanent settlement by what were probably large groups of people in regions which are, today, completely desertic. It is difficult to imagine any other explanation for the florescence of the Neolithic in northern Niger, for example, in the vast, empty plains of the Ténéré, which even the Tuareg call a desert within the desert. Here, there are huge villages littered with stone tools and flakes, arrowheads, grinding-stones for the grinding of seeds and ceramic vessels for their storage, all laid out on the sand in patterns which echo the organization of the settlement. The change which has occurred in the environment is further indicated by the remains of large fish, which have been found in comparable archaeological contexts in various parts of the Hoggar and of Mauritania, sometimes associated with fishing-gear as they are in northern Chad, and by the rock-art. There are innumerable representations of megafauna, including elephants, giraffes, rhinos and lions, painted or engraved on the rock-surfaces of all the mountainous massifs, and large herds of domestic cattle are depicted in the rockshelters of the Tassili.

In contrast, the actual reconstruction of this paleoenvironment by earth-scientists has been difficult and very time-consuming. It was not until quite recently, in the mid-

1970s, that they could demonstrate that there was a sequence of different paleoclimates and could define their principal characteristics. This has been accomplished by a combination of different approaches, derived from geomorphology, stratigraphy, sedimentology, palynology, the analysis of fossil diatoms, and, above all, by the numerous radiocarbon dates, which have meant that it is now possible for scientists to compare results obtained from throughout the vast reaches of the African continent. Thus, with the establishment of a chronological scale has come the reconstruction of climatic development in tropical latitudes over the last 40,000 years. One of the major points of interest which has emerged from this overall picture is the parallelism and, frequently, the synchroneity of the climatic sequences during this period from the Atlantic to the Red Sea.

The early research in central Africa was often carried out by individual scientists, such as Faure (1962), Schneider (1967) and Pias (1970), and served to demonstrate the importance of the desert and Sahelian regions of Niger and Chad for Quaternary studies. O.R.S.T.O.M. (Office of Overseas Scientific and Technical Research) subsequently organized an interdisciplinary research program, focused on the Chad basin, involving stratigraphy and sedimentology (by Servant), diatom micropaleontology (by Servant-Vildary) and palynology (by Maley). This resulted in the publication, between 1973 and 1980, of a series of regional monographs which, for the first time, defined the main characteristics of the local climatic evolution at the end of the Pleistocene and during the Holocene (Maley 1981; Servant 1973; Servant-Vildary 1978). Several expeditions, which were not directly involved in this program but working parallel to it, provided complementary information about the neighboring regions of northeastern Aïr (Clark *et al.* 1973) and Tibesti (Jäkel 1977, 1979). The research currently being carried out on the western bank of Lake Chad will undoubtedly refine parts of the chronology (Durand 1982; Durand and Mathieu 1979–80, 1980). Similarly, the recent PALHYDAF (paleohydrology in Africa) program of the C.N.R.S. (National Center for Scientific Research, Paris), carried out in 1985 by Fontes and Gasse on a north-south transect from Tunisia to Niger, will enrich our understanding of the mechanics of paleoclimates and of their impact on the environment. Nevertheless, it is the synthesis of the O.R.S.T.O.M. team of geologists which defines the environmental framework within which prehistoric populations developed along the southern border of the Sahara during the period under consideration.

A second O.R.S.T.O.M. team, this time composed of prehistorians and including the writer, undertook the study of the development of these prehistoric groups in eastern Niger during the sequence of climatic variations revealed by the earth-scientists. This will undoubtedly be a longer-term project, since datable archaeological sites, in a sufficiently good state of preservation to yield useful information, occur much more rarely than do the outcrops and profiles which provide our colleagues with food for thought!

Nevertheless, after the surveys and excavations of the last decade, we are now able to compare the findings of geology and archaeology and, more especially, to examine in detail those conditions which characterized the last millennia of the Pleistocene and which heralded the climatic revolution which took place after 10,000 B.P. In the last few years, we have been able to show unequivocally that there was human occupation in several parts of northeastern Niger during this period. Further, the archaeological evidence which we have recovered strongly suggests that this was, in fact, a critical period in the history of human occupation of the southern Sahara and, to a very large degree, in the establishment of the Neolithic.

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CLIMATIC RECONSTRUCTION: PURPOSE, METHOD AND TYPE

We will first discuss in general outline how and on what bases the O.R.S.T.O.M. geologists have tried to make their reconstructions of the paleoclimates. This will also make it apparent what types of climates can be reconstructed.

The reconstruction is essentially based on the fact that during the course of the Quaternary there have been significant lacustrine transgressions in the basin of Lake Chad, followed and separated by temporary periods of greater aridity. It had been known since the time of Garde's work (1911) that there had been major oscillations in the level of the lake, and that at some period the lake had invaded the interdunal depressions of Manga to the northwest. In 1925, Tilho was able to trace the highest shoreline of the lake around the basin; at the time of its maximal extension, the lake had been similar in size to the Caspian Sea (Tilho 1925). Subsequently, fossil beachlines, interpreted as those of a very large fossil lake, were observed at an altitude of 320 m asl (Pias and Guichard 1957) and were dated to about 6000 B.P. (Schneider 1967). At about the same time, Faure (1962) discovered lacustrine deposits in Niger similar to those of the Lake Chad region and dating from more than 21,000 B.P. to 3000 B.P.

On the bases of a re-examination of the earlier data and, more importantly, new systematic surveys of the fossil lake-deposits of the Chad basin, Servant (1973) worked out a detailed paleoclimatic chronology for the last twelve millennia. This chronology is based upon the hypothesis that the recorded amplitude of the lake's fluctuations is a direct reflection of climatic variations in the Upper Pleistocene and the Holocene. Methodologically, the chronology is based on the study of the variability through time in the ratio of rainfall to evaporation; according to Servant, the variation in this ratio is sufficient to define local climatic conditions. There is considerable variation from one area to another in the sources of water and Servant distinguished three types: run-off into the piedmont lakes; groundwater for the interdunal lakes; and the drainage of huge, internally drained basins into the hydrographic lakes. In spite of this, comparative analysis of the deposits through time shows that the levels of water throughout the Chad basin varied synchronously. This means that the overall effects of run-off from local topographic features are negligible. In addition, it is possible to detect changes in the type of rainfall from study of the lithological sequences.

The various transgressive and regressive lacustrine episodes, for which the chronological limits have been established by radiocarbon, thus correspond to an equal number of well-defined climatic phases. Servant groups all of those within the last 12,000 years into the "Nigero-Chadian." This alternation of positive and negative oscillations, of which eight have thus far been defined, makes clear how unstable the climate of the southern Sahara has been throughout the Late Quaternary.

For each of these phases, paleoecological data have confirmed and refined the climatic milieu thus reconstructed. The changes and development of the lacustrine environments were functions of the depth of the water. Diatoms were deposited on lake-beds during periods of transgression, and the study of the diatom assemblages is complementary to the sedimentological studies. According to Servant-Vildary (1978), diatoms are good paleolimnological indicators of a variety of parameters, including the depth, salinity, trophic characteristics and, occasionally, the temperature of Quaternary lakes.

The stratigraphic sequences in the central part of the Chad basin and in eastern Niger, which have been the subject of research into diatoms, have seen parallel analyses by Maley (1977a, 1977b, 1980) into their palynology. Study of the fossil pollen has provided interesting additional information about the sources of water in the lakes during the Holocene. By comparing the variation in the lake-levels as determined by the diatoms with variation in the pollen diagrams, Maley was able to determine the relative importance in the overall supply of water of local rainfall as opposed to rivers flowing in from some distance. Significant changes in the terrestrial vegetation correlated with equivalent changes in the lacustrine flora. We refer the reader to these detailed studies, of which the principal results for the period under consideration will be given below.

It is important to bear in mind that the climatic chronology for Chad and Niger established by Servant is based on a paleohydrological interpretation. The Quaternary paleoenvironments defined by the work of Servant-Vildary and Maley on the sedimentary environments are important and original contributions to stratigraphic methodology. However, if we are careful to refer to the climates they have reconstructed as "hydrological," this will provide a useful reminder of exactly what types of phenomena they are studying and what are the limits of their fields of research.

CLIMATIC SETTING OF THE LOWER NIGERO-CHADIAN (12,000–8000 B.P.)

Servant's work has demonstrated that about 12,000 years ago there was a climatic revolution which led to the rapid and simultaneous appearance of numerous lakes in the Chad basin. This paleogeographic change is the local reflection of a more general phenomenon which affected the whole southern edge of the Sahara at that time. Various scholars (notably Butzer *et al.* 1972; Gasse 1975; Hébrard 1972; Michel 1969) have made comparable observations which indicate a reversal of climatic trends from the Atlantic to the Red Sea during the last millennia of the Pleistocene, when humid conditions became generally and rather suddenly established after a long period of extreme aridity. This arid period, which is called the Kanemian in central Africa (Servant 1973) and the Ogolian in West Africa (Michel 1977) began about 20,000 years ago and resulted in a significant desertification of all the Sahelian region south of the Sahara. The return of humidity, which Servant has named Nigero-Chadian I, is the beginning of the series of oscillations which have characterized the Holocene up to the present day.

However spectacular it might seem, the appearance of lakes in the arid lands was not completely unheralded. In the Chad basin, Servant noted that run-off began at about 13,000 B.P. and was sufficient to bring about the cutting of the Bahr el Ghazal valley, which is a natural outlet of Lake Chad toward the northeast. Maley (1980) noted the occurrence of brackish surface-water of a similar age, associated with a shallow water-table, in an arid environment north of the thirteenth parallel. In a more detailed investigation of this subject, Durand and Mathieu (1980) have estimated that the period of maximal aridity was between about 20,000 and 17,000 B.P., but that surface run-off never, in fact, really stopped during the Kanemian, even during the driest phase. Evidence for this lies in the fluvio-deltaic formation which was built up in the Chad basin before 17,000 B.P. and which indicates the local existence of more humid conditions, even though aridity persisted farther north in the Kanem and the Nigero-Chadian Manga. The contemporaneity of the humid event on the southern side of the lake with the rainfall of Mediterranean origin observed by 16,500 B.P. in the Tibesti (Jäkel 1977) and other central Saharan massifs (Faure 1969; Rognon 1967) led Durand and Mathieu to suggest that the desertic zone was already retreating after about

17,000 B.P. "under the combined effects of tropical rainfall in the south and Mediterranean rainfall in the north" (1979–1980:198). Numbers of observations made in neighboring regions support this suggestion. The analysis of a series of cores taken from the delta of the Niger confirms that there was a significant increase in global rainfall after 14,500 B.P. (Pastouret *et al.* 1978). To the north in the Tibesti, Maley (1981) notes the existence of a high lake-level in the natural rain-gauge of the Trou au Natron at about 14,000 B.P. To the south in northern Cameroon, Hervieu (1970, 1975) has described an episode of sedimentation with soil-development after about 15,000 B.P. To the east in the Jebel Marra, a high lake-level has been observed at about 14,000 B.P. (Williams *et al.* 1980). It therefore seems, according to Durand (pers. comm.), that the end of the Kanemian was very gradual and that the period of transition into the Nigero-Chadian lasted more than 4000 years. This model may be of great importance for the available archaeological evidence, as will be seen below.

In any case, at about 12,000–11,000 B.P., lakes came into existence throughout the region under study, independent of local topography and thus of orographic rainfall and run-off; this indicates a significant improvement in climate after the Kanemian period. The critical fact according to Servant, as we have indicated above, is that the inflow of water which led to this, whether it was from rainfall, run-off, rivers or groundwater, was greater in volume than the loss to evaporation. Servant's Nigero-Chadian I is thus the first period of lake-expansion in the paleo-hydrogeographic chronology which he has proposed for the Chad basin; it is dated between about 12,000 and 10,620 B.P. In the Kanem, there was a rapid and synchronous expansion of the interdunal lakes at about 11,000 B.P. Farther west, in the Kadzell of Niger, the chronology of this transgression is confirmed by a lacustrine shoreline at 280–281 m, with radiocarbon dates of 11,435 B.P. ± 200 years at the base and 10,625 B.P. ± 300 years at the top (Durand 1982).

According to Servant, this was followed by a short period of regression in Chad and eastern Niger, Nigero-Chadian II, with radiocarbon dates ranging from a little before to a little after 10,000 B.P., according to area. This period is well characterized by marsh sediments in the Kanem, by aeolian sands at Termit and, perhaps most importantly, by an erosional surface in the Bahr el Ghazal, separating two lacustrine series with dates of 10,900 B.P. ± 300 years and 10,300 B.P. ± 300 years.

After this brief interruption, conditions changed again and soon became wetter than they had been before. Nigero-Chadian III was a new phase of lake-expansion, greater than the previous one, which Servant has been able to recognize in almost every depression in the Chad basin and for which he has a consistent series of radiocarbon dates ranging from 10,160 B.P. ± 160 years at the base of the Angamma delta to 7450 B.P. ± 140 years at the top of the Bilma sequence. We have been able to date the Nigero-Chadian III transgression at several localities in eastern Niger, and have obtained radiocarbon ages falling well within the limits proposed by Servant:

9080 B.P. ± 230 years at Tin-Ouaffadene (20°10′40″N, 9°11′30″E)
9460 B.P. ± 120 years at Temet (19°58′0″N, 8°40′25″E)
8565 B.P. ± 100 years at Temet
8060 B.P. ± 250 years near Rocher Toubeau (21°18′40″N, 9°8′0″E).

In addition, Servant has recorded the highest values for the rainfall: evaporation ratio at about 9000–8000 B.P. and so would date the highest levels and maximal expansion of the lakes to that period.

The wetter conditions which began at the end of the Pleistocene and prevailed during the Early Holocene along the entire southern border of the Sahara also affected the interior massifs, such as the Tibesti (Hagedorn and Jäkel 1969) or the Hoggar (Rognon 1967), as well as regions like the Saoura, the Erg Chech and Tanezrouft (Conrad 1969). These all have particular paleohydrological and paleoecological features which permit a better understanding of the climatic conditions they represent.

A general outline of the hydrological regime can be deduced from observations of the types of river alluvia deposited during this period. In the valleys of the small massif of Takolokouzet in the eastern Aïr, Servant (1973) observed fine, well-sorted deposits, which were generally well stratified and often loamy, spread extensively over the valley bottoms, in spite of their steep longitudinal profile. Fine and well-bedded sediments have also been observed in the Hoggar (Rognon 1967), where they have been dated to 11,580 B.P. ± 350 years and 8380 B.P. ± 300 years (Delibrias and Dutil 1966). In the Tibesti, they form the "middle terrace" of the German scientists, which has been dated by radiocarbon to between 15,000–14,000 and 7000 B.P. (Hagedorn and Jäkel 1969; Jäkel and Schulz 1972). This was, therefore, probably a widespread phenomenon. These concordant observations suggest to Servant that, at the end of the Pleistocene and in the Early Holocene, streams flowed sufficiently slowly to allow the deposition of fine alluvia. He believes that the slowness of the stream-flow must mean that there was a continuous and regular influx of water without any pronounced floods; this, in turn, would strongly suggest that precipitation was quite even and gentle throughout the year, and rarely torrential. He further believes that the absence of coarse detrital deposits along the shores of the piedmont lakes of Nigero-Chadian III supports the hypothesis of gentle rainfall, rather than implying the existence of a thick vegetational cover, which would have prevented any significant erosion of the hills.

As part of the O.R.S.T.O.M. group's parallel research into Quaternary paleoenvironments, Servant-Vildary created a classification of the diatom assemblages found in the lacustrine deposits of the Chad basin. Although the temperatures of these ancient lakes cannot be determined precisely, estimates can be made on the basis of the diatom populations which developed there, since they include species which are very characteristic in terms of biogeography, and thus can serve as local climatic indicators. According to Servant-Vildary, those species which live preferentially in colder waters predominated between about 12,000 and 7,000 B.P.; today, these psychrophilic diatoms are characteristic of the flora of temperate zones. They are equally dominant in the lacustrine deposits overlying archaeological layers which we have observed and dated in northeastern Aïr. At Temet, Tin-Ouaffadene and Rocher Toubeau Site 14, they date between about 9500 and 8000 B.P. (see above; the samples are currently being studied by F. Gasse).

As far as the vegetational cover is concerned, it has long been recognized that a Mediterranean or Sudanese type of vegetation developed in the massifs of the central and southern Sahara (Hoggar, Aïr, Tibesti and Ennedi) during the Late Quaternary, since some relict patches of it still survive today (Gillet 1967; Quézel and Martinez 1958). In February 1982 in the Bagzanes (Aïr), very close to the archaeological site of Tagalagal (discussed below) and at an altitude of more than 1850 m asl, we ourselves collected samples of southern Sahelian and northern Sudanese plants, which optimally grow in zones with about 500 mm of rainfall; these included *Boscia salicifolia* Oliv. and *Grewia flavescens* Juss. (identifications by H. Gillet of the Natural History Museum, Paris). Unfortunately, the rainfall in the Aïr mountains is still essentially unmeasured. For the Bagzanes, there are only five years' records available, which were made by

O.R.S.T.O.M. (1976–1980), as part of a detailed hydrological study, at four stations in the southern part of the Bagzanes at altitudes of about 1500 m asl. The mean for three of these stations from 1977 to 1980 is to 106.3 mm per annum (R. Gallaire, pers. comm.). It seems evident that these plants became established in the Aïr at a time when the climate was more humid than it is today, and that they still survive in areas where men and animals have little impact because the effect of aridity is mitigated by the altitude. The nights are cooler and dews more frequent, especially at the end of the rainy season, than they are at the same latitude on the plains.

The problem of when this vegetation became established is very difficult and seems still to remain unresolved. As far as the relict plant species of Mediterranean type in the Tibesti are concerned, pollen analyses of sediments from the area (Maley 1981) have showed that there was no real difference between the vegetation of the massif at the end of the Pleistocene or in the Early Holocene and the modern vegetation. According to Maley and in contrast to the hypothesis previously put forward by Schulz (1974), there is therefore no reason to suppose that there was a zonation of Mediterranean type in the Tibesti at the time when the middle terrace was formed. In the Sahelian zone farther south, Maley has carried out an intensive palynological study of the lacustrine series of Tjéri (13°44′N, 16°30′E), which showed that there were only very low percentages of pollen originating in the Mediterranean or temperate zones. Maley therefore considers that a vegetation of northern type could not have grown at these latitudes during the period in question.

On the contrary, the evolution of the assemblages of tropical pollens observable at Tjéri (Maley 1977a, 1977b, 1981) correlates well with the fluctuations of the lake between 13,000 and 7000 B.P. as shown by analysis of the diatoms (Servant-Vildary 1978). The first sequence, L_1, from about 13,000 to 9200 B.P., is marked by three minor transgressions and is characterized by the predominance of Sahelian pollen of local origin. There were three more transgressions at the beginning of the L_2 sequence, between about 9200 and 7300 B.P., which were caused primarily by inflow of river-water from the south, so that they are characterized by increasing amounts of Sudanese and Sudano-Guinean pollen (Maley 1977a, 1977b, 1981). Working on the basis of the ecological characteristics of the various taxa included in the Sahelian and Sudano-Guinean pollen, Maley finds that the pollen diagrams of Tjéri provide a good reflection of the fluctuations in climate, which are also witnessed in the sedimentological studies.

In short, these several complementary approaches, of which we have briefly discussed the aims, methods and principal results, combine together to provide a reconstruction of the main outlines of the paleoclimate prevailing in the period from 12,000 to 8000 B.P. It has been shown that the marked oscillations, which characterized the final millennia of the Pleistocene, led up to the establishment of very humid conditions in the northern regions of Niger and Chad, with a maximum humidity at about 9000–8000 B.P. This resulted from the rate of precipitation being higher than that of evaporation, as well as its being rather evenly distributed throughout the year. Local temperatures were therefore lower than those of today (Servant 1973).

HUMAN OCCUPATION OF NORTHEASTERN NIGER IN THE EARLY HOLOCENE

One of the most significant results of the systematic surveys and excavations we have carried out in northeastern Niger over the last ten years has been to date the human occupation of these now-desertic regions to the Early Holocene. We investigated four *in situ*, archaeological sites, at which it was possible both to maintain good stratigraphic control and to obtain radiocarbon dates. As our research progressed, we learned from these how much of the material culture remained of the people who had lived there during the tenth millennium B.P. under the climate we have just described. The site of Tagalagal was the first to be discovered, in 1978, and its archaeological significance is such that we will describe its principal characteristics.

Tagalagal is the name given by the Tuareg to an inselberg which lies in the northern part of the Bagzanes massif at 17°50′50″N, 8°46′15″E. The Bagzanes massif itself is a vast and high granite formation, rising out of the ancient substratum of the Aïr as a high plateau, more or less oval in shape, with escarpments all around its edge and rising from the south toward the north to an altitude of more than 1800 m asl. As far as the eye can see, its surface consists of a succession of granitic domes and ridges, as well as evidence of more recent volcanic activity. It is cut by deep valleys, which are frequently blocked by basaltic flows and sometimes expand out into flat-bottomed basins where sand has accumulated. It is in these basins that one finds both concentrations of vegetation and several villages occupied by the Kel Owey Tuareg (Morel 1973).

It takes several days of camel-riding, walking and, finally, climbing to reach the inselberg. The site lies on a shoulder at the foot of it, at an altitude of about 1850 m asl. There, enormous granite balls surround a small empty area, which is about 40 m long from north to south and about 20 m wide; it is a sheltered glade in the middle of the rocks, where people came and settled (Figure 11.1). The soil is littered with potsherds, stone tools and flakes, and upper and lower grinding-stones, all mixed with fossilized bones. In the southern part, several of the large blocks form a shallow rockshelter, which has protected the archaeological deposit from erosion over an area of about 5 m^2.

The excavation of this deposit did not yield any real, organized features, by which we might have characterized it, but it did yield an abundance of the same materials as occurred on the surface, buried in a blackish sediment down to a maximum depth of 0.7 m (Figure 11.2). We thus have a good stratigraphic basis for associating the pottery, grinding-stone fragments and stone tools with each other. In addition, two radiocarbon dates run on the charcoal fragments studded throughout the sediment gave very similar ages of 9330 B.P. ± 130 years, for a sample taken from the top of the sediment, and 9370 B.P. ± 130 years, at a depth of about 0.3 m (results kindly communicated by J.-C. Fontes, Laboratoire d'Hydrologie et de Géochimie Isotopique, Université de Paris-Sud, Orsay, 1980).

Simply in terms of radiocarbon measurements, these dates are among the oldest ever obtained in the Sahara for a site with ceramics. However, even at this early date, ceramic technology seems to have been fully mastered at Tagalagal. Both open and closed vessel-forms exist, the former being more common among the sherds found *in situ*; all the reconstructions that we have made show that they are types of bowls, either simple hemispheres or with a slightly recurving lip. The closed forms have a very short and slightly out-turned neck (Figure 11.3). However, the most striking aspect is the diversity of techniques used to decorate these vessels, usually over their entire surface. One of the most common is that which is used to create the famous "dotted wavy-line" motif, a flexible comb (Camps-Fabrer 1966), usually deeply impressed into the paste. These lines of deep impressions may be either only slightly wavy and parallel to the opening, or very sinuous—even so much as to cross back on themselves—or else be arranged in contrasting bands (Figure 11.4).

Rocker-stamping (Camps 1958) was also frequently used and thus seems to be as old a decorative technique in the southern Sahara as that which produced the dotted wavy-

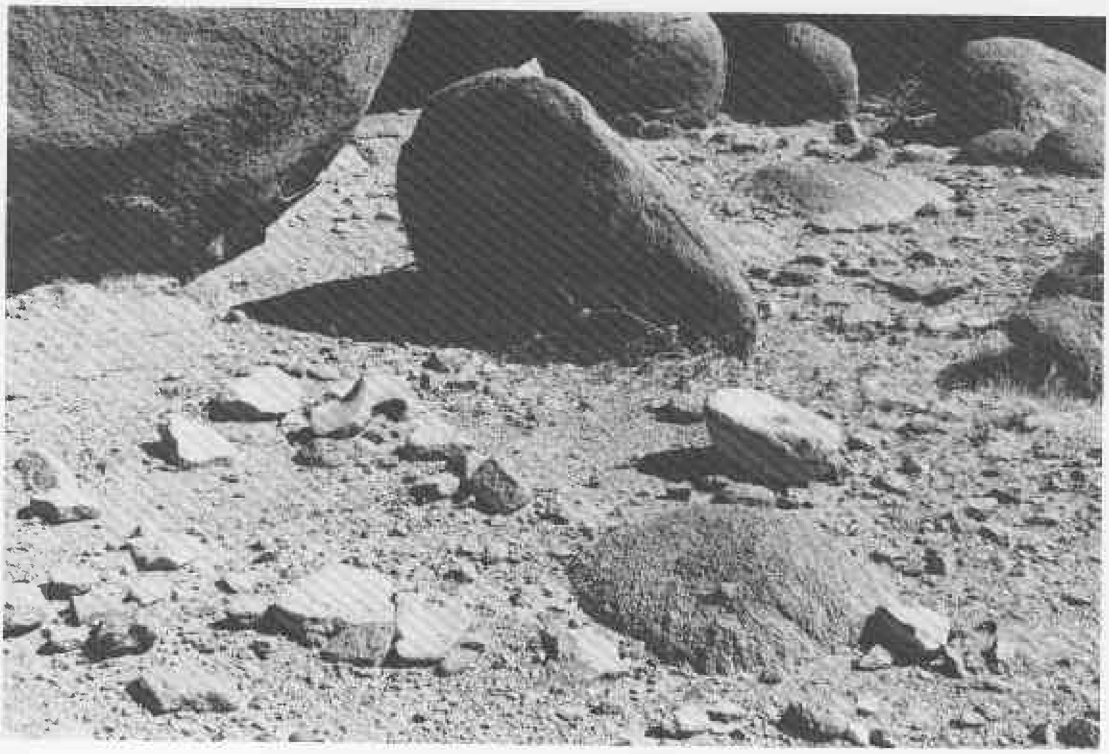


Figure 11.1 The open-air site of Tagalagal.

line motif; rocker-stamping was done with the straight or curved end of a spatula, producing the characteristic flame-shaped decoration, or, again, with a comb (Figure 11.4). Semi-rocker-stamping was also used to decorate some of the exterior thickened rims. Various other types of impressions were contemporaneous (Figure 11.5): lines of dots, angle-impressions, incised parallel lines, and even a very peculiar motif, which we already knew from having found it in the more recent sites of Adrar Chiriet, and which is composed of small and very acute chevrons arranged point-up and point-down in alternate horizontal rows, and made by direct impression of a spatula with a straight, narrow end (Roset 1978).

The associated lithic assemblage (Figure 11.6) is much less rich and even rather crude, which seems to result from the poor flaking qualities of the rock most commonly used, a rhyolite with phenocrystals. It is composed mainly of rather short, thick flakes, struck from discoidal or polyhedric cores and rarely retouched. However, the excavation yielded flakes retouched to form endscrapers, sidescrapers (often transverse), a few pointed blades, and single and double angle-burins (which sometimes show resharpening). A distinctive element in the assemblage are the burin-like flakes, which have a burin-like facet on the platform that shows the same use-wear as a true burin (Figure 11.6: 12–15); they are quite common and seem to have been a desired type. All of these tools are rather rudimentary, but this should not lead us to underestimate the technical competence of the Tagalagal craftsmen, which is revealed in the manufacture of arrowheads. The arrowheads, which are always made on rocks of finer texture, are so delicately worked on both faces that one might think they came from a site of the Ténéréan Neolithic. However, their contemporaneity here cannot be doubted, since all of them were found within the cultural layer.

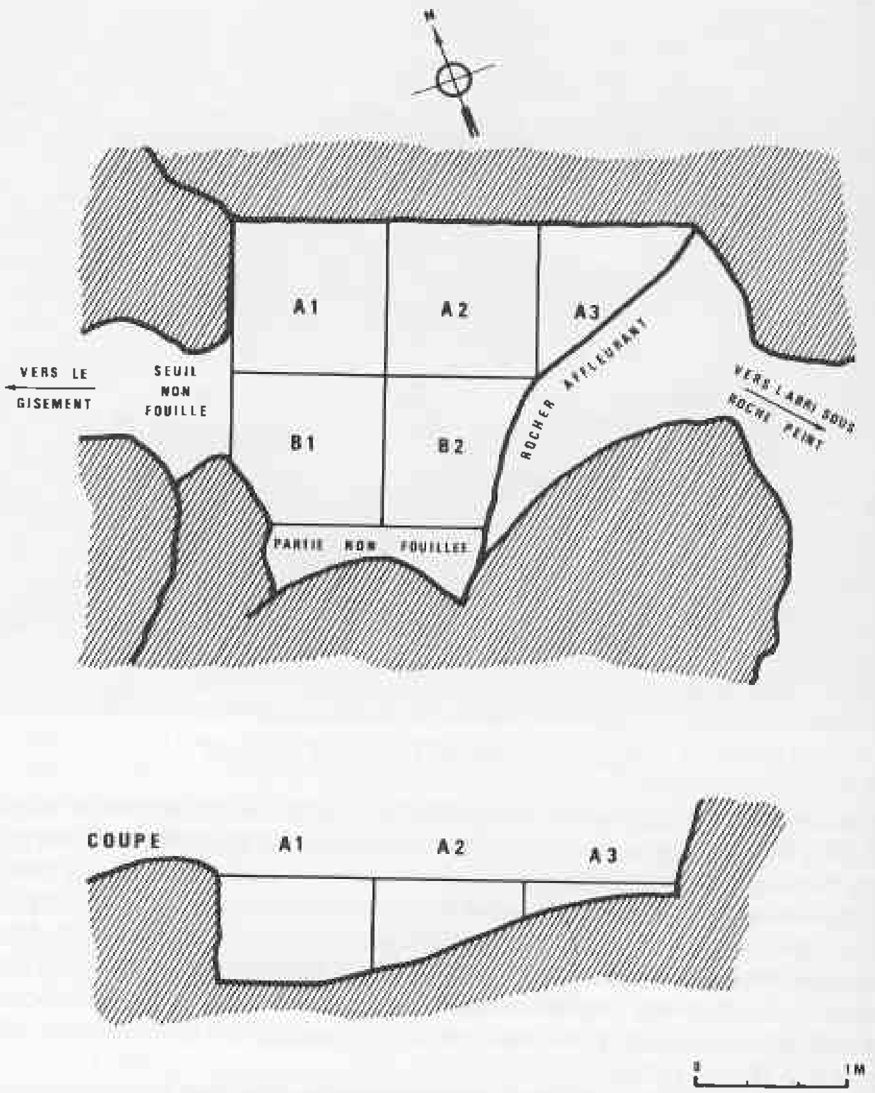
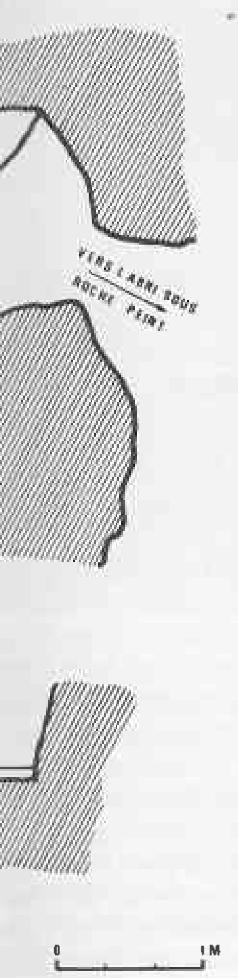


Figure 11.2 Tagalagal. Plan and cross-section of the excavation of the rockshelter.

As well as the potsherds and flaked stone, there is also a considerable quantity of grinding equipment. Various rocks were used for the manufacture of upper and lower grinding-stones, which occur, both whole and broken, over the entire surface of the site; fragments of them also occur throughout the cultural deposit.

We will now leave the interior of the Aïr and turn to the Ténéréan edge of the massif, more than 200 km toward the northeast, where there are three other sites earlier than 9000 B.P. and contemporaneous with Tagalagal. These are the sites of Temet (19°58′0″N, 8°40′25″E), Adrar Bous 10 (20°19′50″N, 9°2′0″E) and Tin-Ouaffadene (20°10′40″N, 9°11′30″E) which were discovered between 1978 and 1980 and have been investigated since then. All three of them are archaeological sites *in situ* beneath lacustrine sediments.

At Temet, at the southeastern foot of Mount Gréboun, the cultural layer lies on the surface of colluvial sands, covered by diatomite deposits which are more than 6 m thick



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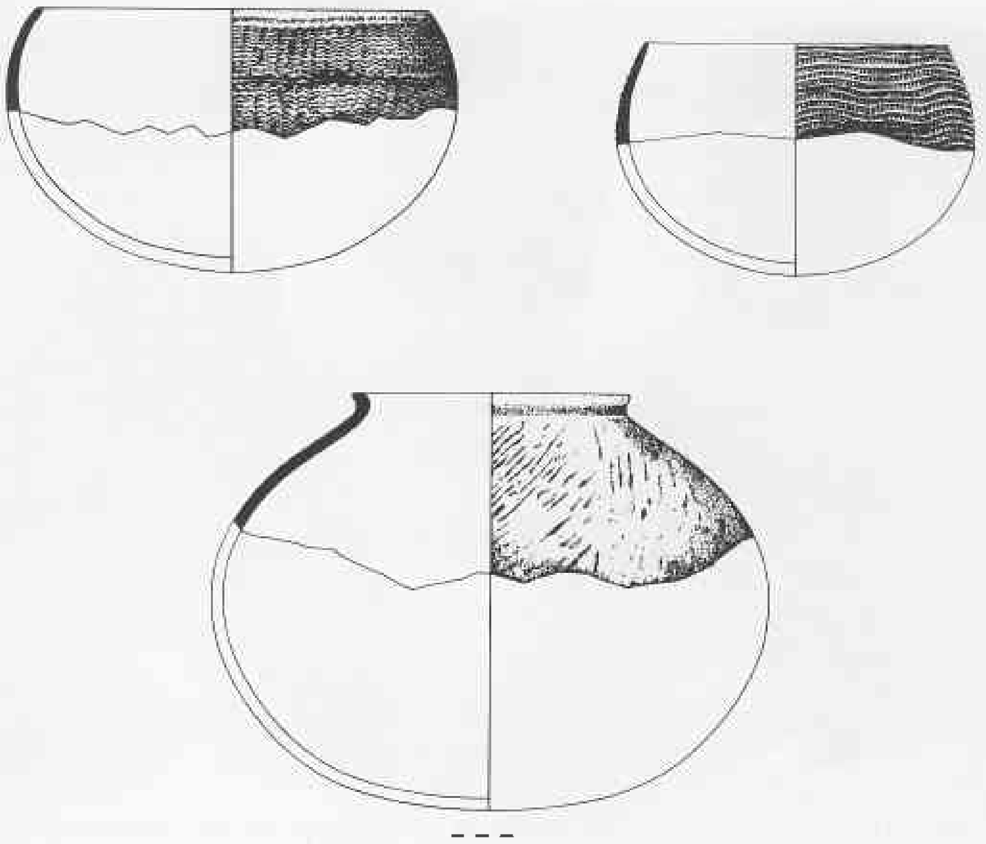

Figure 11.3 Tagalagal. Different types of ceramic vessels reconstructed from sherds recovered during excavation of the rockshelter.

just back from the area of excavation (Figure 11.7). We have obtained two dates for the transgression: the first, 8565 B.P. ± 100 years, is on the diatomite overlying the archaeological layer (by J.-C. Fontes in 1980) and the second, 9460 B.P. ± 120 years, is also from the base of the diatomites but some 500 m west of the site itself (by J.-F. Saliège, Laboratoire de Géologie Dynamique, Université de Paris VI, in 1985). During the excavations carried out from 1979 to 1983, the diatomites were removed from an area of about 20 m² and the underlying material has been dated to 9550 B.P. ± 100 years on the associated charcoal (by J.-C. Fontes in 1980). The sequence is, therefore, perfectly consistent in terms of both stratigraphy and radiometry. It may be observed that the Nigero-Chadian III transgression followed very soon after the human occupation of the site.

On the other hand, the archaeological material recovered from the site is very different from that of Tagalagal, and, in this respect, it is the lithic industry which is worthy of note. Most importantly, in this horizon we can see the coexistence of an industry made on blades and bladelets, which yielded a varied tool-kit that has been described elsewhere (Roset 1983), and of a microlithic component which includes a significant number of geometric pieces (Figures 11.8 and 11.9). This means that in this area there are no grounds for distinguishing between an Epipaleolithic, as defined by Clark (1976), and a more recent microlithic industry (Smith 1976). This distinction

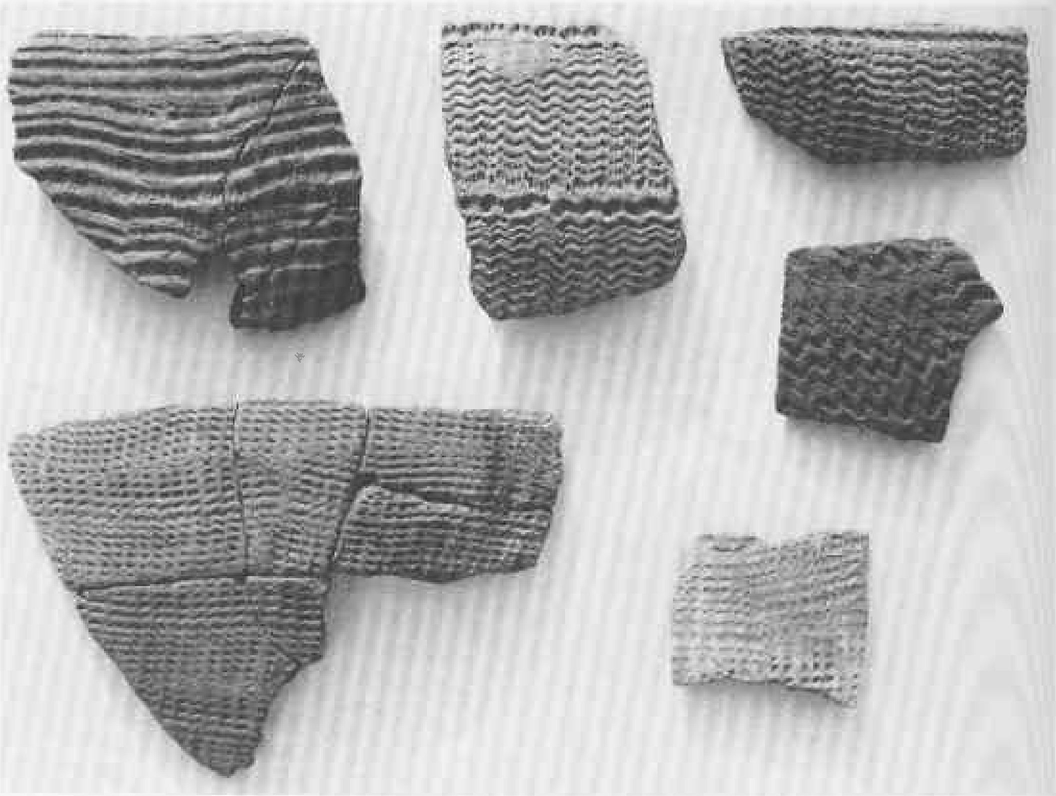

Figure 11.4 Tagalagal. Various types of dotted wavy-line decoration and comb-impressed motifs.

was based on an incomplete study and on material collected only from the surface; the two are in fact one and the same culture.

The flaked stone tools are associated with several vessels carved out of blocks of fibrolite and polished (Figure 11.10). On the other hand, the excavation did not yield a single potsherd. However, a knowledge of ceramics is unequivocally demonstrated by the occurrence, *in situ*, of a potter's comb carved out of a thin plate of fibrolite (Figure 11.11). As at Tagalagal, all of this material is associated with fragments of upper and lower grinding-stones.

The main site of Adrar Bous 10 is in a similar position. The exposed part of this site covers an area of about a hectare on the surface of a fossil dune. The lower parts of the dune were covered by the deposits of a later episode of lacustrine transgression (Figure 11.12). Between 1982 and 1985, the diatomites downslope were removed from an area of 144 m², which revealed that the archaeological layer continued for some depth beneath the lacustrine deposits. The industry recovered from this layer is very similar to that of Temet. In addition, it is associated with numerous potsherds, on which we have found multiple examples of almost all the decorative motifs known in the Tagalagal repertoire, as well as with the usual large numbers of fragments of upper and lower grinding-stones. The site has three radiocarbon dates, on fragments of charcoal found *in situ*. The ages obtained are 9030 B.P. ± 190 years (which was measured on a very small charcoal sample by A. W. Fairhall, Department of Chemistry, University of Washington, in 1982), 9130 B.P. ± 65 years (by the same laboratory on a larger sample in 1983) and 9100 B.P. ± 150 years (by J.-F. Saliège in 1985).

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Figure 11.5 Tagalagal. Top row: rocker-stamped motifs made with curved and straight spatulae. Middle row: opposed rows of chevrons (compare the sherd on the left, from a Ténéréan Neolithic site at Adrar Chiriet [4500–4000 B.P.], with that on the right, *in situ* in the Tagalagal rockshelter); lines of dots; straight comb-impressions. Bottom row: impressed motifs; incised parallel lines; roulette-impressions.

The site of Tin-Ouaffadene, about 25 km southeast of Adrar Bous in the middle of the Ténéré, is in an identical geomorphological position: a living-site on a fossil dune which was drowned by a later transgression, here dated on carbonaceous sediments to 9080 B.P. ± 230 years and on shells to 9060 B.P. ± 240 years (by J.-F. Saliège in 1985). Access to the underlying archaeological layer is extremely difficult and it has been reached only over an area of some twenty square meters from which the diatomites have been removed. The layer has yielded limited quantities of an industry identical to those of Temet and Adrar Bous 10, plus several fragments of lower grinding-stones and, most importantly, a significant faunal assemblage. The fauna was concentrated around a hearth from which charcoal has been dated to 9220 B.P. ± 140 years (by J.-C. Fontes in 1983). The excavated fauna is still being studied, but it already seems that among the hunted animals, which were primarily various antelopes, there are the remains of a large bovid. This has not yet been identified precisely, but it was also found at the sites of Tagalagal and Adrar Bous 10 (F. Poplin [Natural History Museum, Paris] pers. comm.). In contrast, not one sherd had been recovered by the time the excavations ended in 1985.

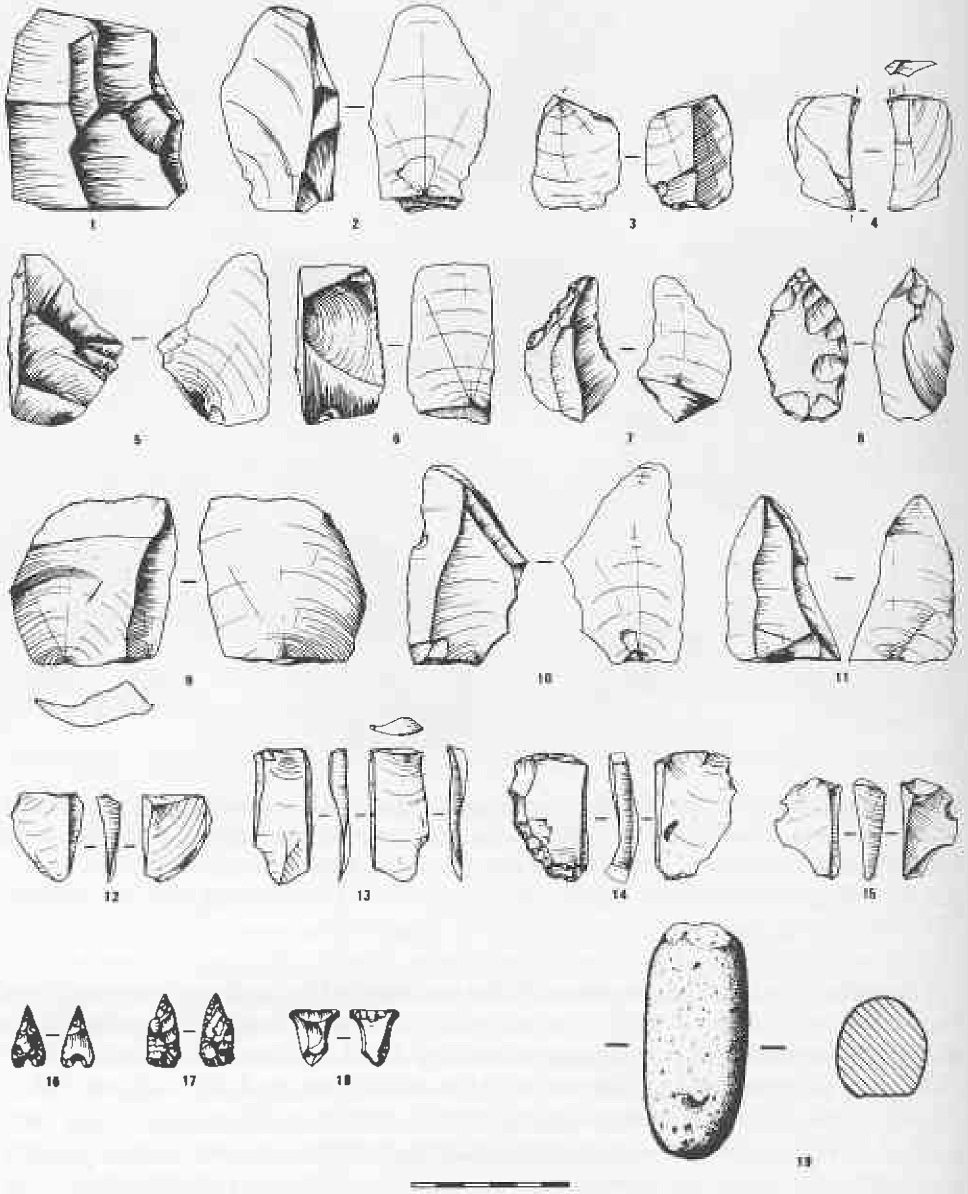
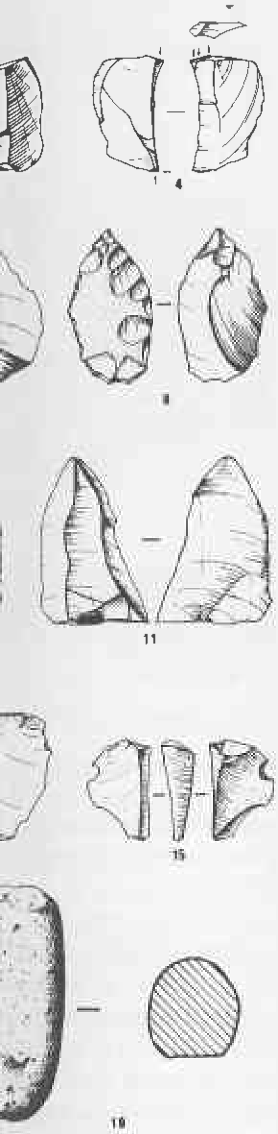


Figure 11.6 Tagalagal. Lithic artifacts. 1, tabular opposed-platform core; 2, preparation flake; 3, 4, burins; 5, sidescraper; 6, atypical backed piece; 7, shouldered scraper; 8, retouched point; 9–11, unretouched flakes; 12–15, burin-like flakes (14, with side- and endscraper, 15, notched); 16–18, arrowheads (17, unfinished, 18, transverse); 19, pestle.



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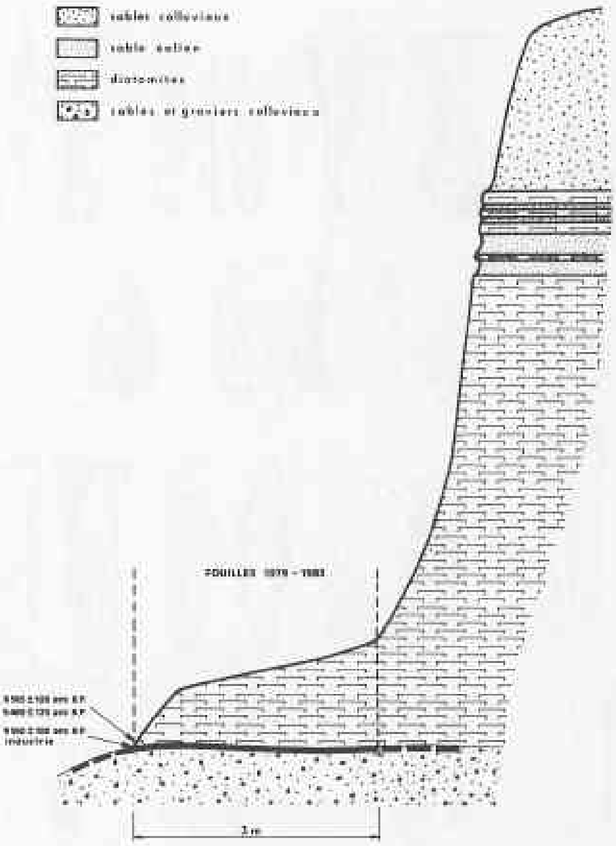


Figure 11.7 Temet. Cross-section.

LOCAL DEVELOPMENT OF THE NEOLITHIC

This is, therefore, a previously unknown archaeological industry, for which we now have good radiometric and stratigraphic controls. Its principal characteristic is the association of a blade and bladelet industry with pottery and with equipment for grinding seeds, an association which also occurs in many of the open-air sites inventoried during our surveys of the region. In addition to the four sites described above, more than twenty other surface occurrences have been discovered. They are distributed in a band over 100 km long north of the Adrar Bous, mainly toward the northwest, and they frequently occur on fossil dunes of white sand analogous to the dune of Tin-Ouaffadene. They can be of impressive size: they may be masked in parts by a thin veil of recent sand, but it is still often possible to trace a site for several hundred meters in every direction, or sometimes even more. For the most part, the density of material on the surface is very similar to that of Final Neolithic sites in this region; that is to say, the number of stone tools, flakes, potsherds and other objects brought in or modified by man amounts to dozens per square meter. One must obviously keep carefully in mind the risks inherent in open-air sites and the very real possibility of admixture from more recent periods of prehistory. In the end, however, after one has

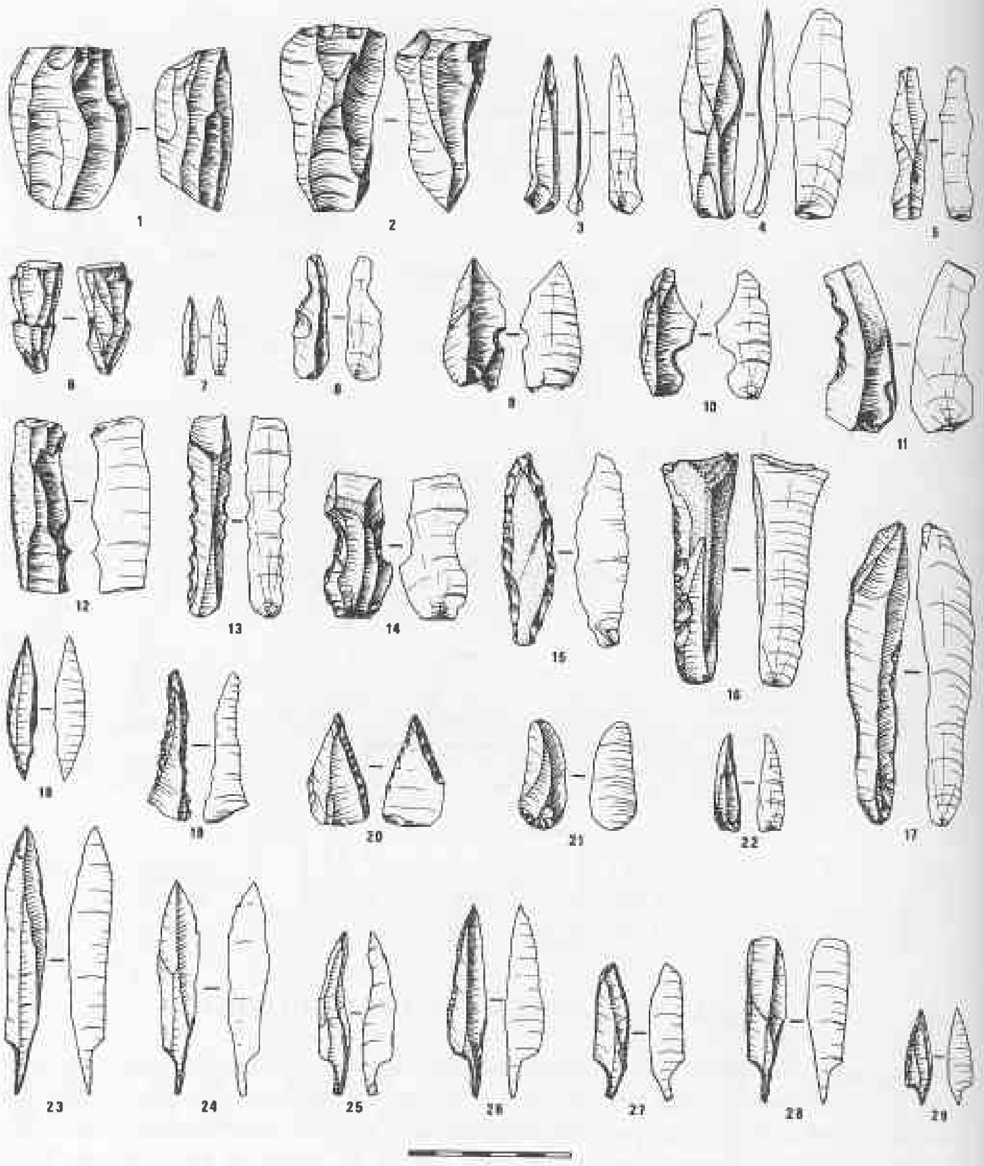
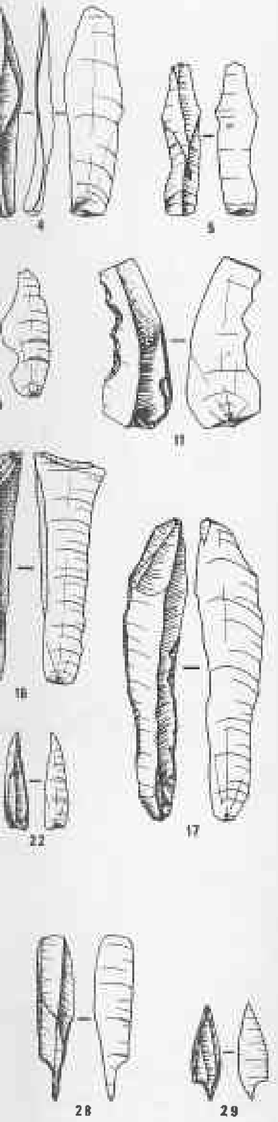


Figure 11.8 Temet. Lithic artifacts. 1, 2, 6, prismatic cores; 3–5, 7, unretouched blades and bladelets; 8–10, notched blades and bladelets; 11–13, denticulated blades; 14, strangled blade; 15–17, 22, backed blades and bladelets; 18, 19, perforators; 20, retouched point with modified base; 21, endscraper on a blade; 23–29, Ounan points.

surveyed these sites at length and has examined them very carefully and systematically, excavation not always being possible, one gradually develops the impression of a very well-established human occupation of this region during the Early Holocene. On the other hand, it remains very difficult to determine the nature of this occupation and the level of economic development reached by these populations; we are still dealing primarily only with working-hypotheses.



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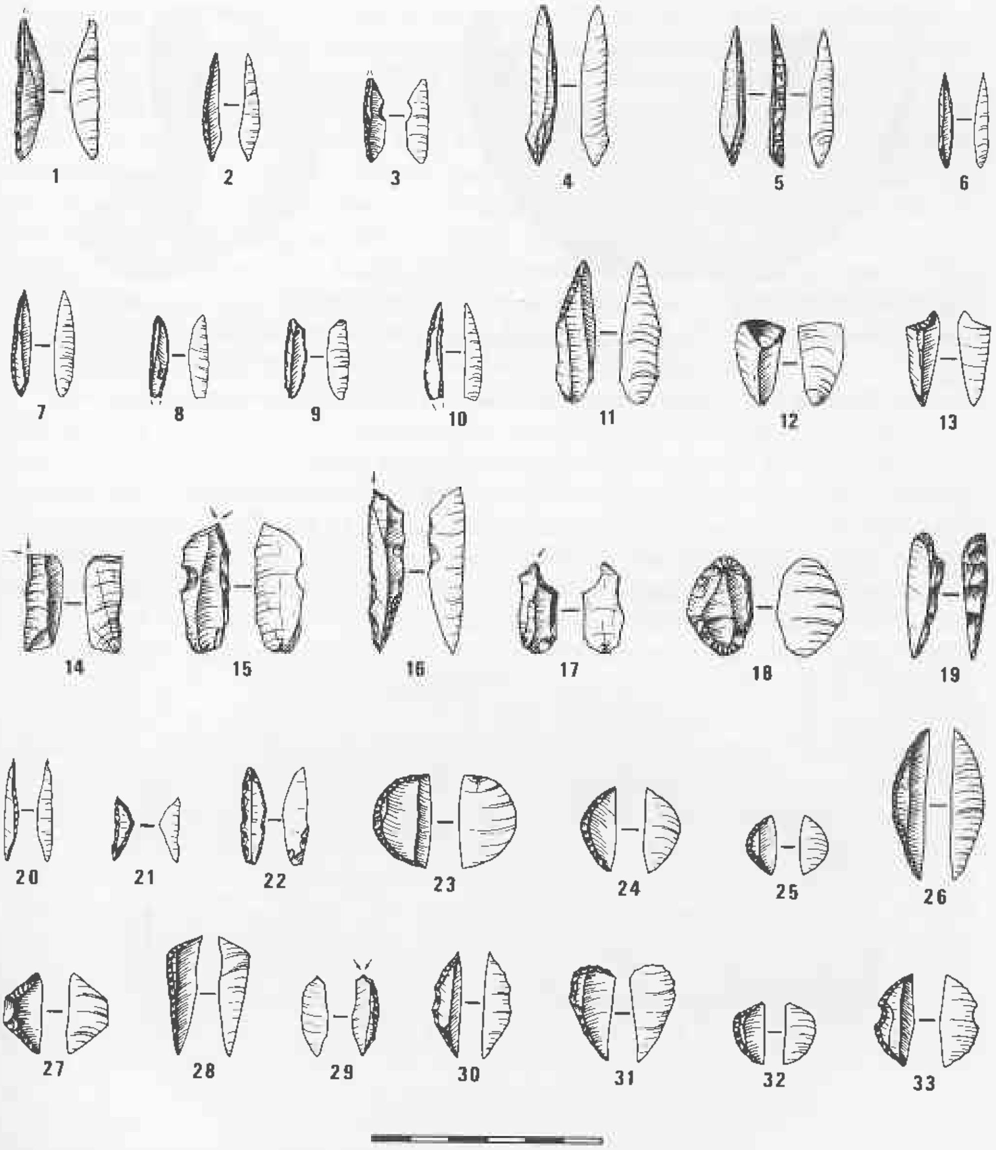


Figure 11.9 Temet. Lithic artifacts. 1–10, pointed, backed bladelets with plain or modified bases; 11–13, truncated bladelets; 14–16, burins; 17, microburin; 18, 19, scrapers; 20–22, perforators; 23–26, 29–33, segments (29, with burin, 30, with perforator, 31, with scraper, 32, truncated, 33, notched); 27, trapeze; 28, scalene triangle.

Our research has, however, established one fundamental point beyond any doubt: that pottery was known in Africa in very ancient times. We noted above that the radiometric ages we cited are among the highest ever obtained for Saharan sites with pottery. Furthermore, they fully support other comparable, or slightly more recent, radiocarbon dates obtained from sites with pottery elsewhere in the Sahara. In the Hoggar, as long ago as 1967, our late colleague J.-P. Maître obtained a date of 9210 B.P. ± 115 years for the base of the fill of the Launey site; this was an isolated reading

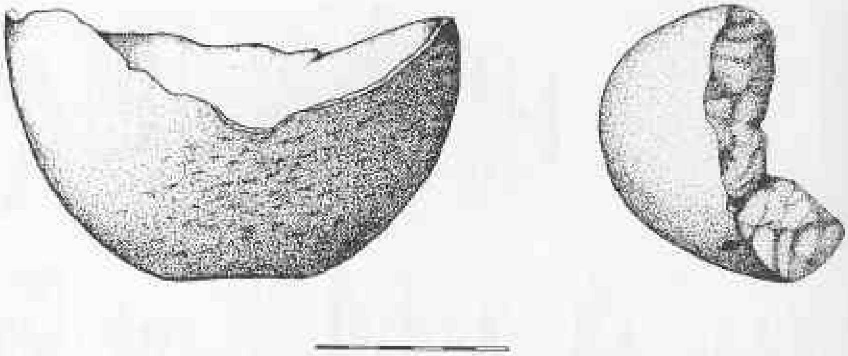


Figure 11.10 Temet. Polished fibrolite bowl and fragment of a handstone.

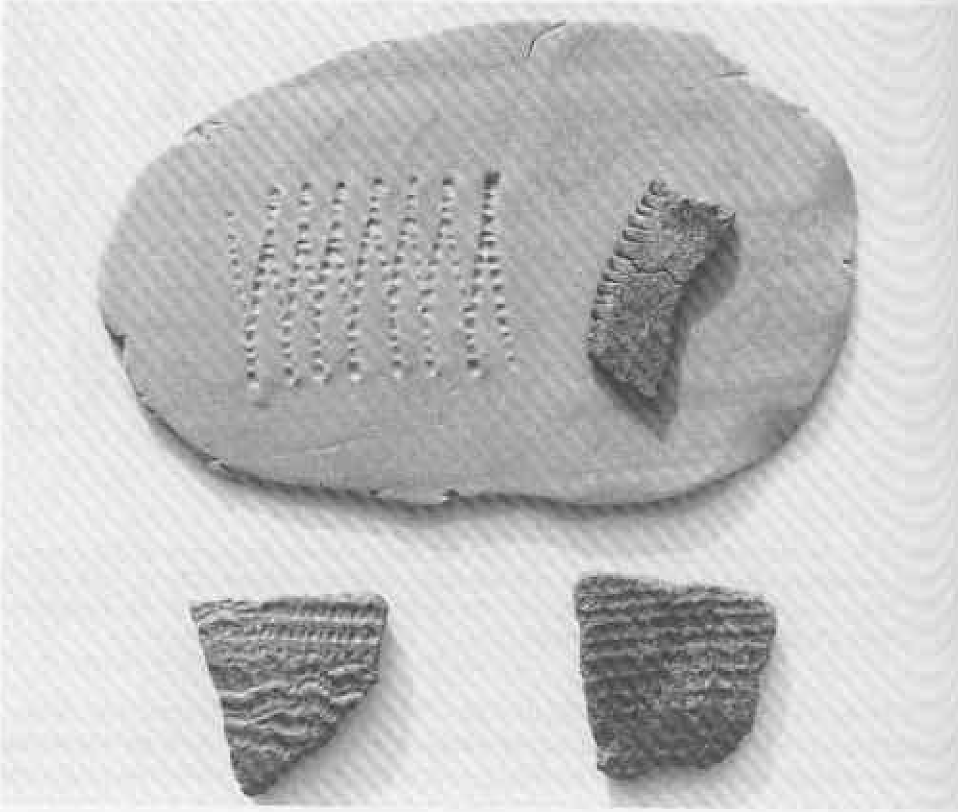
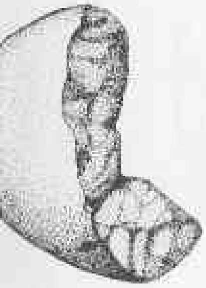


Figure 11.11 Temet. Top: fibrolite potter's comb and rocker-stamping made by it. Bottom: left, dotted wavy-line sherd; right, comb-impressed sherd (both sherds probably eroded out of cultural layer).



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and at that time was considered to be too old (Camps *et al.* 1968). In the Tadrart Acacus, the oldest date for the remarkably long and consistent sequence of Ti-n-Torha is 9080 B.P. ± 70 years (Barich 1974). In the Bir Kiseiba region of the Eastern Sahara, Site E-79-8 has a series of seven radiocarbon dates, from 8920 B.P. ± 130 years to 9820 B.P. ± 380 years (Wendorf *et al.* 1984). It seems, therefore, to be firmly established that populations who knew how to make pottery lived in some parts of the central and southern Sahara as early as the second half of the tenth millennium B.P. This, in turn, indicates that these regions were probably one of the centers for the invention of pottery, independent of the Middle East. In the latter area, it should be observed that none of the dates thus far obtained from ceramic sites is earlier than 9000 B.P., except for the lower level of the Syrian site of Tell Mureybet which, after Cauvin's work, is now attributed to the first three centuries of the tenth millennium B.P.

The variety of vessel-forms and of motifs, which we have seen at both Tagalagal and Adrar Bous 10, is somewhat surprising for a period when one might reasonably think that the manufacture of pottery had only recently been mastered. It seems difficult to imagine that a new technique could appear with so many of its eventual developments already discovered. This is a very important point: these sites already have most of the elements which we will find, over the course of the millennia, in the pottery-manufacture of the various later Neolithic facies of this region (Delibrias and Hugot 1962). This could suggest two very different explanations. First, one cannot exclude the possibility that the real beginnings of pottery-making may have been much older. In this respect, geological research, as was noted above, has shown that the last millennia of the Pleistocene were not so markedly arid as completely to preclude the possibility of human occupation in these latitudes. The first attempts to master ceramic technology could, therefore, have been much earlier than 9500 B.P. and we might, some day, find some evidence of this.

It might also be suggested, and this is, perhaps, more likely, that once the underlying principle had been mastered, ceramic technology evolved very rapidly. In fact, there is nothing within this domain of human activity which is comparable to the gradual development of flaking-techniques, where advances were slowly added, little by little

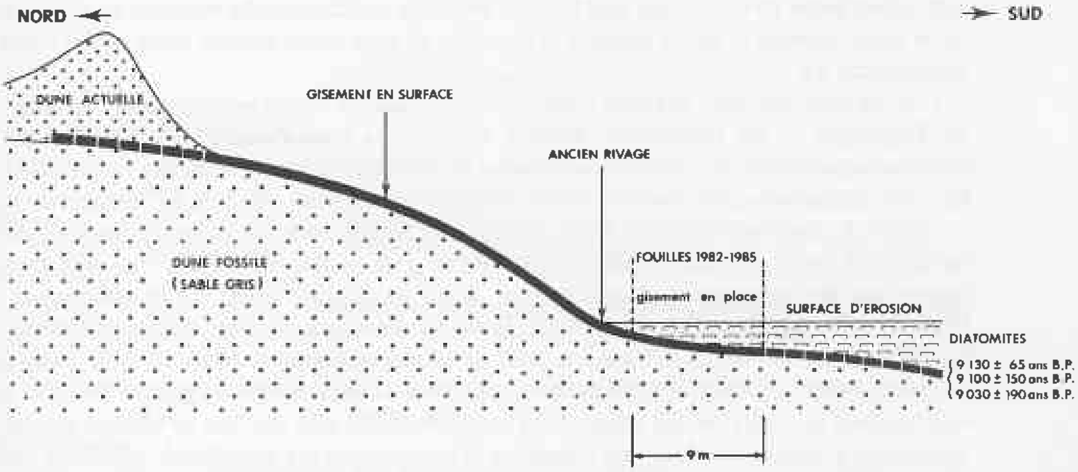

Figure 11.12 Adrar Bous Site 10. Cross-section.

and one by one through the course of time, until finally the hand of a craftsman could create well-made and designed tools from a block of stone. On the contrary, one might hypothesize that people probably advanced relatively quickly from the stage of complete ignorance to that of knowing full well how to make pottery. Instead, it was the actual need for water-tight and easily made vessels that was a long time in coming. This need marks a critical stage in the economic evolution of society and it probably results from multiple causes, both internal and external to the societies in which it arises. We do not find it surprising that, once the need has been felt, the technological response to it—that is, pottery-making—should follow very soon, and that the full range of the technique's potential should immediately become available. We would therefore prefer to explain the diversity of vessel-forms and motifs observed at Tagalagal and Adrar Bous 10 as representing the immediately available, technological minimum. As far as decoration is concerned, it may be observed that there is no indication that there was such a thing as a primordial motif predating all the others at about 9400–9300 B.P. However, the most important point is that the appearance of pottery, as it is seen in the sites of eastern Niger, is fundamentally linked to an indisputable change in the economy.

Whatever might be the interest and future of research into the antiquity of Saharan pottery, one cannot discuss its occurrence after 9500 B.P. without mention of its consistent association with seed-grinding equipment. This association is a crucial piece of evidence: it clearly indicates that the harvesting, preparation and storage of edible grasses were integrated into the subsistence practices of the prehistoric populations of the southern Sahara at a very early date. However, it would probably be rather premature to draw conclusions about the ways of life and economic systems of these groups on the basis only of this evidence. The practice of hunting or fishing is obvious as soon as one finds projectile-points or other specialized equipment, especially in a lacustrine environment, but pottery and grinding-stones are somewhat ambiguous. They attest equally well to the casual consumption of wild plants, obtained by gathering or foraging, as to a type of subsistence based upon true agriculture and thus, paradoxically, they are indicators of two completely different economies, one of food-extraction and the other of food-production.

Nonetheless, recent petrographic analysis of a series of sherds collected at Tagalagal and Adrar Bous 10 (Echallier and Roset 1986) has yielded results which may allow us to be more precise in some aspects of our idea of how these groups lived in the tenth millennium B.P.

For the moment, this analysis refers to two situations which are not quite the same. At Tagalagal, in the mountains, pottery was always manufactured elsewhere, from weathering soils which occur within a radius of less than 75 km and usually less than 25 km; the archaeological site does not, therefore, seem to have been permanently occupied. In contrast, at Adrar Bous 10, a rather high proportion of the ceramics (one third) were most probably made at the site or else in the immediate vicinity, thus suggesting an occupation which was at least long-term, even if not permanent. However, there is also evidence at Adrar Bous 10 of some movement within a relatively limited radius, about 15–20 km, as well as of some contacts over a much greater distance. What we have in both cases is a picture of semi-nomadic groups living in a well-defined territory on the edge of the rocky massifs, and not one of human groups wandering at random across vast expanses. These results are significant insofar as the extent of a territory used by a group is directly linked to its subsistence economy.

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Data of the type outlined above are not yet, in themselves, sufficient to indicate the existence of a Neolithic, agricultural economy, and all the less so since the persistence of a certain degree of mobility, as shown by the analyses of the ceramics, would be inconsistent with a type of economy for which sedentism is a necessary condition. However, it should be observed that further petrographic analyses of the pottery are essential. The conclusions which can be drawn from the initial results are not at all consistent with what one would have supposed on the basis of the large size of the sites; it is difficult to imagine that they represent nothing more than the remains of temporary camps. Of course, the same localities could have seen periodic reoccupations by small groups, who juxtaposed their successive settlements of the dunes so as to give a final impression of large, established villages, but, in practice, such a system would be very difficult to control.

As far as an academic definition of the Neolithic is concerned, we should not use this term to characterize the possible way of life of these groups without giving some tangible proof of it, such as conclusive pollen analyses, or the discovery of the seeds of cultivated plants, or the existence of specialized agricultural tools. In the current state of our research, we have no such irrefutable evidence.

The archaeological data which we have outlined must now be placed within the environment in which they developed and to which they are indissolubly linked. This environment, as we have seen, was propitious; the humidity which still prevailed in the southern Sahara would undoubtedly have been favorable to an incipient agriculture. The auspicious climatic conditions reconstructed by the soil scientists give significance to the various elements revealed by archaeology, and these elements show that a radical change in economy was either taking place or had already been achieved. By way of conclusion, therefore, and as a minimal hypothesis, we believe that the observations we have made argue in favor of a local and normal evolution from the simple collection of seeds (and it is to this stage that we will, for the moment, assign the occupations of all these sites) to the organized production of cereals. In other words, the way seems to have been open for a completely African development of the Neolithic.

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12

Neolithic of the Basin of the Great Eastern Erg

G. AUMASSIP

INTRODUCTION

The basin of the Great Eastern Erg, or the *Bas-Sahara* (so named by Rolland in 1880 because of the altitude of the basin, which is below sea-level in the Chott Melrhir), lies to the north of the Hoggar massif, between latitudes 35°N and 27°N and longitudes 1°W and 12°E (Figure 12.1). Its landscape has no trace of geomorphological features postdating the Soltanian (Aumassip *et al.* 1972). Most of its surface is covered by massive dunes, which may be arranged in long parallel series, separated by wide streets or *gassi*. A reduced hydrographic system, with only limited activity, drains the edges of the basin towards the peripheries of the erg. Since the direction of the Wadi Igharghar has been changed toward the eastern periphery of the central Saharan massif, only the Wadi Mya in the south and, more importantly, the Wadi Djedi in the north still have floods worthy of note. The low level of precipitation is to some extent compensated for by underground, artesian water; springs, now inactive, can still be seen in the north, the area of lowest altitude, where they feed the Wadi Rhir.

The first identifications of Neolithic assemblages were made in the last century by Féraud (1872), and were among the earliest discoveries of any prehistoric occupations in the Sahara. In 1939, when Vaufrey defined the Neolithic of Capsian Tradition, he included the Neolithic of this region within it. Later scholars have tried to limit the coverage of the Neolithic of Capsian Tradition (Camps-Fabrer 1966; Hugot 1957), but Roubet (1979) is the only one to exclude this local variant.

Because of the very poor conditions of preservation, almost all of the archaeological materials to be found in this area are mineral. Pollen-grains are not only very poorly preserved but also have been much reworked. It follows from this that the most important part of the study of these prehistoric sites is concerned with lithic artifacts (Table 12.1).

Figure 12.1 Neolithic sites of the Bas-Sahara. Key: ■, Hadjarien; ○, Faciès El Bayed; Δ, Faciès Hassi Mouillah; ⊖, Nomade; ●, Faciè indéterminé; ⅄, Gravure rupestre.

EPIPALEOLITHIC AND NEOLITHIC

The prehistoric record shows that the Aterian was followed by industries with bladelet debitage, which are called Epipaleolithic and Neolithic. The oldest radiocarbon dates which can be assigned to these industries are no more than 8600 B.P. ± 150 years (Mc.150). The Aterian itself has not been dated directly, but it is frequently found on top of the most recent *glacis*, which is associated with the last pluvial period (the Soltanian of the Moroccan writers).

Not all bladelet industries have the same characteristics. Those which have a very high frequency of abrupt retouch also have highly standardized tool-forms and a tool-kit in which backed bladelets are overwhelmingly predominant. Other bladelet industries have a much lower frequency of abrupt retouch and higher frequences of flat and semi-abrupt retouch. Their tool-forms may result from the same pattern of motor-habits, but

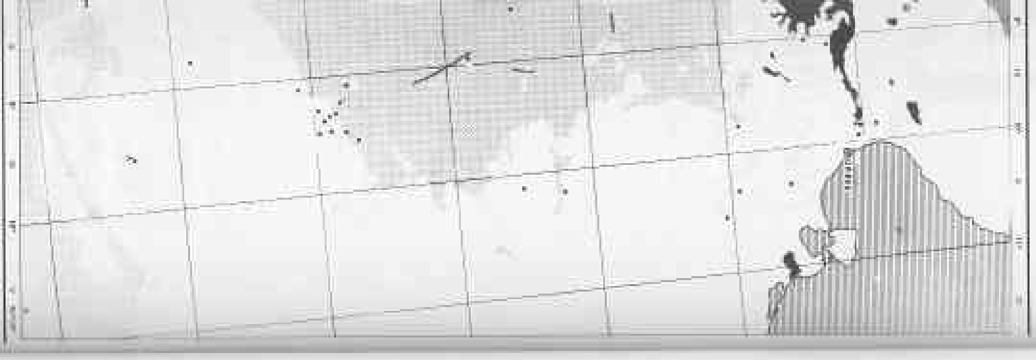

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TABLE 12.1
Percentage Frequencies of Classes of Retouched Tools

	Aïn Guettara	Hassi Mouillah lower	Hassi Mouillah upper	Izimane	Khellal II	El Bayed	Site 6509	Hadjarian Site 6701	Site 6910	Bordj Mellala
Endscrapers	5.5	0.6	1.8	2.8	15.8	2.2	7.2	7.4	1.6	1.2
Perforators	1.2	2.7	5.3	25.0	4.3	10.0	11.3	6.7	4.9	6.4
Burins	1.1	-	0.4	0.1	8.8	2.3	2.7	3.1	3.7	0.4
Backed blades and flakes	0.4	0.3	2.0	3.6	3.0	2.7	4.1	1.8	2.1	0.8
Backed bladelets	14.1	3.3	0.2	5.2	21.9	34.6	49.0	33.9	23.5	13.1
Notches and denticulates	18.0	13.6	13.0	12.9	14.3	15.0	13.5	14.3	10.6	11.5
Sidescrapers	4.6	0.3	2.1	13.9	5.2	8.9	1.9	3.1	4.1	3.3
Truncations	4.2	8.9	4.3	0.3	1.2	0.9	0.8	2.7	2.9	4.2
Geometrics	10.1	15.1	14.1	2.7	1.5	3.2	3.4	11.6	21.3	17.5
Microburins	25.7	45.0	26.9	0.4	5.4	3.9	1.8	13.1	17.9	37.7
Arrowheads	2.6	4.7	25.1	30.4	1.2	7.8	1.2	1.8	5.1	1.4
Foliates	0.7	-	1.1	10.5	-	3.0	-	0.5	0.3	0.2
Varia	11.6	5.6	5.3	2.4	16.8	5.6	1.2	1.5	2.8	2.1

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Backed blades and flakes	0.4	0.3	2.0	3.6	3.0	2.7	4.1	1.8	2.1	0.8
Backed bladelets	14.1	3.3	0.2	5.2	21.9	34.6	49.0	33.9	23.5	13.1
Notches and denticulates	18.0	13.6	13.0	12.9	14.3	15.0	13.5	14.3	10.6	11.5
Sidescrapers	4.6	0.3	2.1	13.9	5.2	8.9	1.9	3.1	4.1	3.3
Truncations	4.2	8.9	4.3	0.3	1.2	0.9	0.8	2.7	2.9	4.2
Geometrics	10.1	15.1	14.1	2.7	1.5	3.2	3.4	11.6	21.3	17.5
Microburins	25.7	45.0	26.9	0.4	5.4	3.9	1.8	13.1	17.9	37.7
Arrowheads	2.6	4.7	25.1	30.4	1.2	7.8	1.2	1.8	5.1	1.4
Foliates	0.7	-	1.1	10.5	-	3.0	-	0.5	0.3	0.2
Varia	11.6	5.6	5.3	2.4	16.8	5.6	1.2	1.5	2.8	2.1

are no longer perfectly alike and there are many minor variations around the theme which the archaeologist defines as a "type." Backed bladelets are usually quite common and are sometimes dominant, but never overwhelmingly so. The distribution of tool-types is another point of differentiation. In the first group, there are generally few types or, if there are many, then most of them are represented by very few examples. In the second group, there is not only a higher number of types, but each type is well represented. It is also worthy of note that it is only in this latter group of industries that one finds polished stone (in the form of axes and adzes) and pottery.

The terms "Neolithic" and "Epipaleolithic" can be applied, respectively, to the less standardized industries with polished stone and pottery, and to the more standardized industries where abrupt retouch predominates. Such differences between the lithic assemblages indicate an important cultural change, which, there is every reason to believe, involved a new way of life. It is extremely unlikely that we should find direct evidence of agriculture or of animal husbandry, but these changes in the lithics provide a reflection of the new economy.

The earliest industries which can be assigned to the Neolithic, as the term is here defined, have a radiocarbon date of 8050 B.P. ± 110 years (Mc.400) at El Hadjar-*démantelé*. The Epipaleolithic of Hassi Mouillah is not very much older (8600 B.P.), and Epipaleolithic has been identified as late as 6240 B.P. ± 270 years (Alg.20) at El Mermouta. The two are, therefore, in large part contemporaneous. After about 7000 B.P., however, the one declined while the other flourished.

EARLIEST NEOLITHIC

From its very first appearance, the Neolithic of the Bas-Sahara was not homogeneous. Several facies have been identified which, on the basis of present evidence, were contemporaneous but existed in different regions.

Hadjarian

The Hadjarian is confined to the western edge of the basin and is known from 8050 B.P. at Site 6709 (El Hadjar-*démantelé*—see above) down to 5125 B.P. ± 140 years (Alg.55) at Ashech G2; its florescence seems to have been in the sixth and seventh millennia B.P. The sites each cover an area of about 10,000 m² and represent very long-term occupations without noticeable interruption. Their surfaces are veritable carpets of flint, overlying cultural layers of variable thickness.

Archaeological Material. The facies is defined by the co-occurrence of trapezes with one convex side, scalene-perforators with rounded angle and escutcheon-shaped arrowheads. Polished stone is known but pottery is lacking.

Backed bladelets and geometric microliths were the preferred tool-classes, although the latter might be replaced by notched pieces. The backed class includes many types, but with a predominance of straight-backed and pointed bladelets and partially backed bladelets. The straight-backed pieces are usually narrow and made by *sur enclume* backing, rounded or truncated bases are frequent, and there may be fine retouch on the end or on the cutting-edge.

Two of the characteristic types of this facies are geometric microliths: the scalene-perforator (Figure 12.2: 5) and the trapeze with one convex side (Figure 12.2: 4). The

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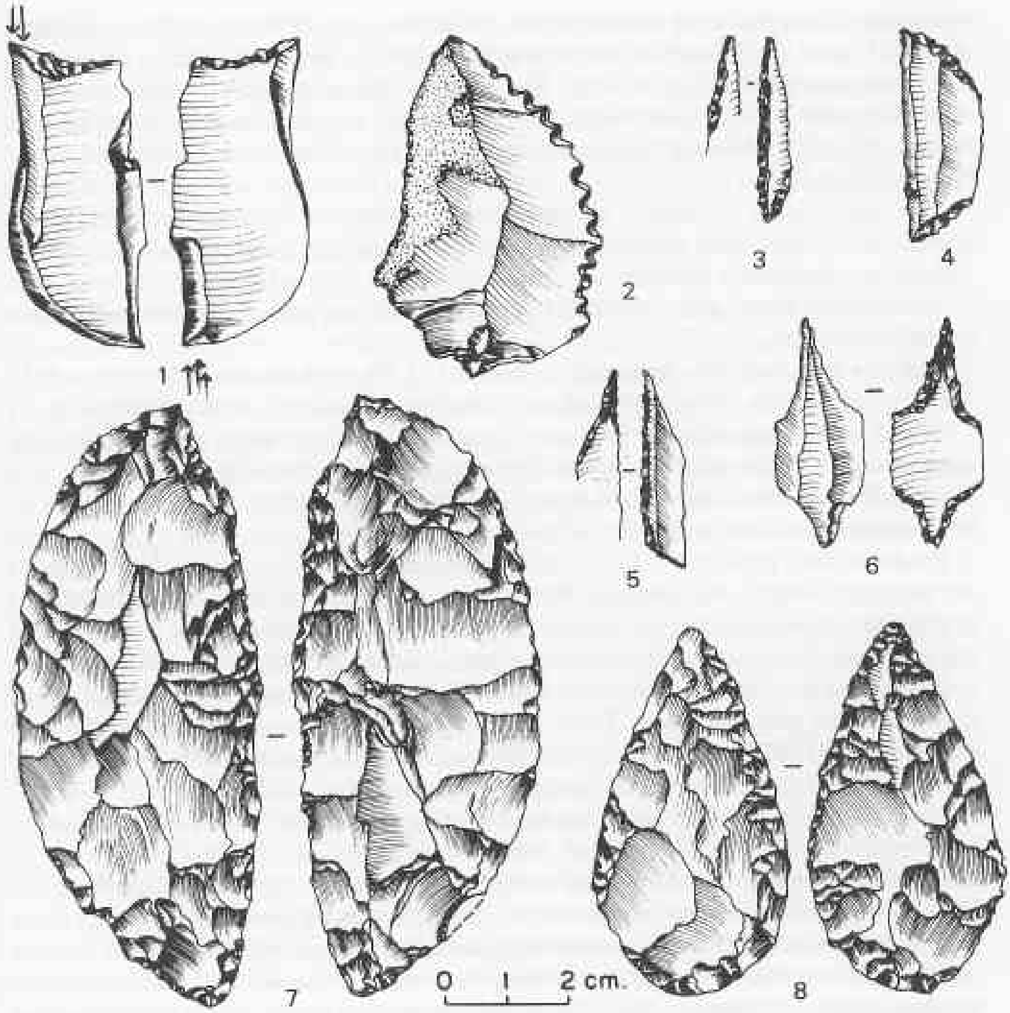


Figure 12.2 Hadjarian stone tools of the Bas-Sahara. 1, burin; 2, scalloped saw; 3, straight-backed and basally truncated bladelet; 4, trapeze with convex sides; 5, scalene-perforator with rounded angle; 6, escutcheon-shaped arrowhead; 7, 8, foliate pieces. (*Provenance*: 1–3, 8, Site 6910; 4, Site 6710; 5, 6, Site 6601; 7, Site 6909) (Drawn by A. Amrouche)

latter, which are most frequent, are often quite large specimens and may grade into double truncations.

Notched pieces are numerous, most of them being saws. One typical form, called "scalloped" (*en feston*), has a convex front formed by Clactonian notches (Figure 12.2: 2), although the saws are more usually made with retouched notches.

In some sites, perforators are an important group, due primarily to the presence of *mèches de foret*, which are most commonly double. Perforators on backed bladelets, which are inevitably reminiscent of scalene-perforators, are also a common type.

It is more difficult to assess the true importance of armatures, whether arrowheads or foliate specimens. On the one hand, they are clearly more frequent in the most remote sites, which would suggest that there has been looting of the other sites; on the other hand, they are very rare in some of the excavated levels. Many of them are no more than simply modified bladelets among which the most complex form is the escutcheon-shaped (Figure 12.2: 6), which is characteristic of this facies. Tanged forms are the next most common, followed by foliates. The shape of the foliate points varies with their size: the small ones are symmetrical with one end rounded and the other pointed (Figure 12.2: 8), while the large specimens are asymmetrical with both ends pointed (Figure 12.2: 7).

The sidescrapers are usually single and either straight or convex. The endscrapers always have a very clear and carefully shaped scraping-edge, and they often also have notches or continuous retouch.

Some of the sites have yielded flaked axes, which are trapezoidal in shape with a slightly curved edge.

One site had a notable frequency of burins (31.7%), which markedly lowered the relative frequencies of backed bladelets (10.6%) and of geometric microliths (only 1.9%). A wide range of burin-types are represented and forms made on truncations are common. One noteworthy variety, which occurs in most of the Hadjarian sites, is a mixed burin, in which the second burin is struck from the distal end of the scar of an overpassed burin on a truncation (Figure 12.2: 1).

Bladelets were preferred as blanks for the manufacture of stone tools, although flakes are more numerous in the debitage. When cultural deposits are sufficiently thick that it is possible to detect changes within the debitage, bladelets become less frequent through time. There are very few large artifacts. Fluted cores are common and it is easy to follow their development out of mitre-shaped cores; in the final stages of exploitation, they grade into globular pieces. There are also cores with two opposed platforms at an angle of about 120° to each other; this form is typical of the Mellalian, an Epipaleolithic industry common in the area of Ouargla (Aumassip *et al.* 1972; Camps 1974).

Hammerstones are quite typical and occur in the form of thick discs with percussion scars and wide scalings around their edges.

Grinding-stones are common and pottery is absent (the few sherds found on the surface of some of the sites are intrusive). Ostrich eggshell is abundant and is often decorated. Although there is considerable variation between sites, there is a marked preference for rectilinear motifs, sometimes formed by series of dots. Their aesthetic sense also led to the manufacture of large ostrich eggshell beads, which were shaped in series, and of perforated shells, as well as to the use of coloring materials.

El Bayed Facies

In the south of the basin are industries which have been long known for the fineness of their workmanship and for the iridescent colors of the flints and jaspers on which they are made. They are concentrated along the edge of the eastern erg, at a short distance from the dunes. At some of them, artifacts can be found densely, although not continuously, scattered over an area of as much as a square kilometer. The oldest site known, El Bayed, has a date of 7300 B.P. ± 200 years (Mc.152). The facies lasted for a very long time, changing throughout. A date of 3600 B.P. ± 100 years (Gif.1655) from Izimane may refer to its final phase.

Archaeological Material. The facies is defined by the co-occurrence of the following types: a perforator—the Labied point (Aumassip 1967); a backed bladelet—the Temassinine point (Aumassip 1986); a geometric microlith—the Izimane point

(Roubet and Mateu 1970); a sidescraper—the limace; a saw made on a blade and notched by pressure; and an arrowhead (Type a25 of Hugot 1957).

Backed bladelets were a preferred tool-class during the archaic phase. They are primarily straight-backed types, usually with modified bases. A flat retouch is often found at the end or on the blade; it is applied to one or both faces and frequently results in denticulation of the edge (the Temassinine point: Figure 12.3: 10). Partially backed pieces are also common.

The classes of notches and perforators together make up a quarter of the tool-kit. Saws are numerous and many of the denticulated pieces grade towards that type. The majority of perforators are robust *mèches de foret*, formed either by alternating abrupt retouch or by complete or partial invasive retouch (the Labied point: Figure 12.3: 9).

The other characteristic elements of these industries are arrowheads and foliate pieces, of which the latter are most commonly small specimens with scaled retouch. The abundance of arrowheads of Type a25 (Figure 12.3: 7) means that Hugot's Index 1 (the index of triangular and lozenge-shaped types [Hugot 1957:160]) is always very high (Figure 12.4). Tanged types with pointed barbs are as common as Type a25 arrowheads, while the scarcity of simple shaped bladelets is in marked contrast to the Hadjarian.

Sidescrapers are an important group, most of which are convex. The endscrapers are often denticulated. In accord with the low number of microburins, geometric microliths never make up more than 5% of the tool-kit and are mostly triangles. Frequently, one side is rounded by abrupt retouch, while the base is scaled and resembles an endscraper (the Izimane point: Figure 12.3: 11).

As in the Hadjarian, the debitage consists mostly of flakes which become increasingly predominant over bladelets through time, although bladelets were preferred as blanks for the manufacture of retouched tools. In this case, however, the fluted cores coexisted with Levallois cores.

Potsherds occur, although not in abundance, and their decoration is not standardized. It includes comb-impressed motifs, bee-hive motifs and sometimes dotted wavy-line motifs. There is considerable ostrich eggshell, on which the decoration is predominantly of rectilinear patterns, sometimes of dots. Eggshell beads also occur. Other aesthetic objects include engraved stone (at El Bayed, the cortex of a primary flake had an incised pattern of squares) and perforated fossil sea-urchins.

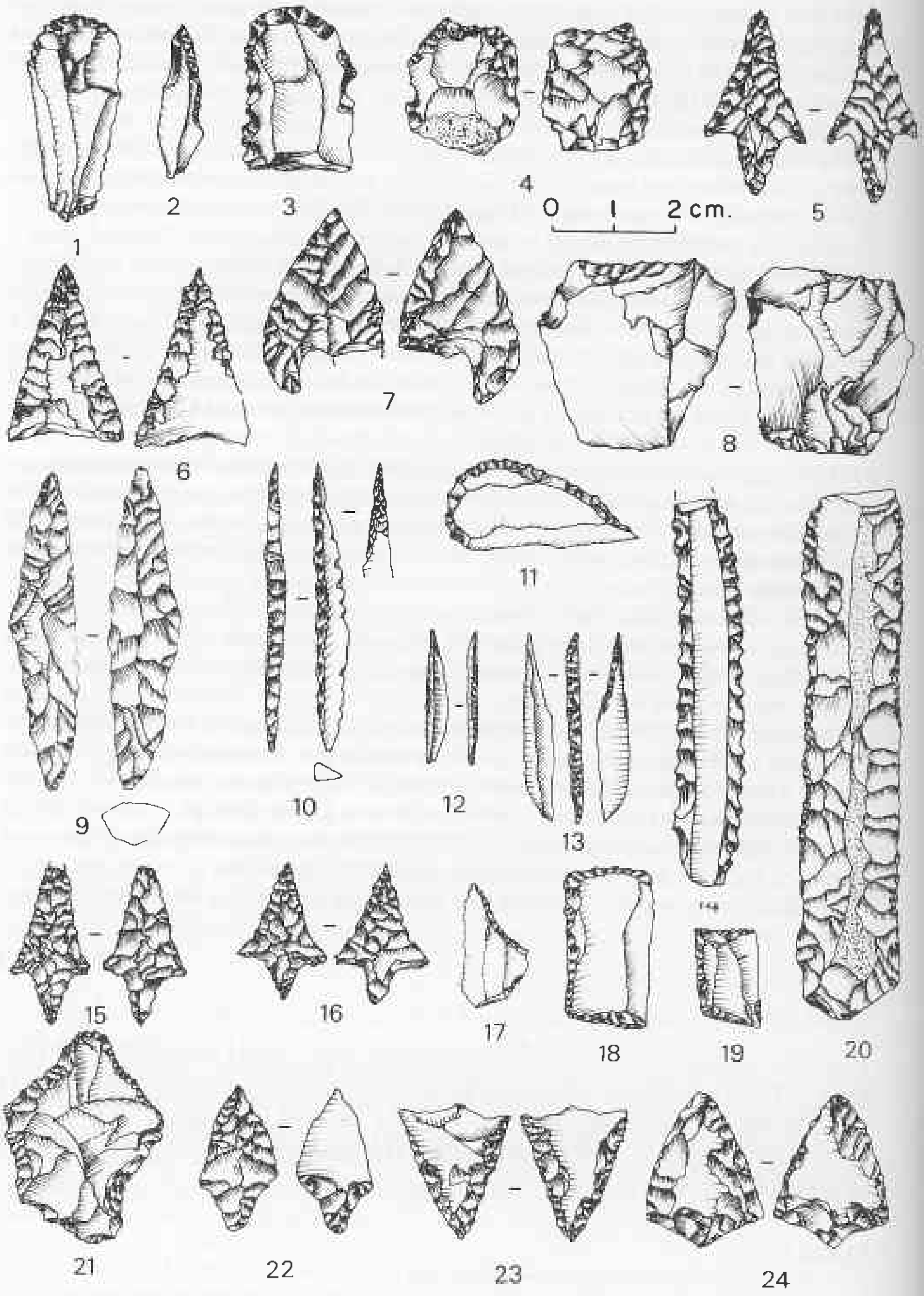
Grinding-stones are very common and most of the handstones have more than one working-face.

OTHER SITES

These two industries do not complete the roster of the earlier Neolithic of the Bas-Sahara. There are various sites, apparently of the same age, which do not belong to either facies, although, unfortunately, they are isolated occurrences of which the significance is not clear. They include Khellal II (Aumassip 1986) and Bordj Mellala I (Tixier *et al.* 1976).

Khellal II

This site in the southeastern part of the basin has limits that are difficult to define, but it covers an area of about 40 × 20 m. It has numerous remains of hearths, associated with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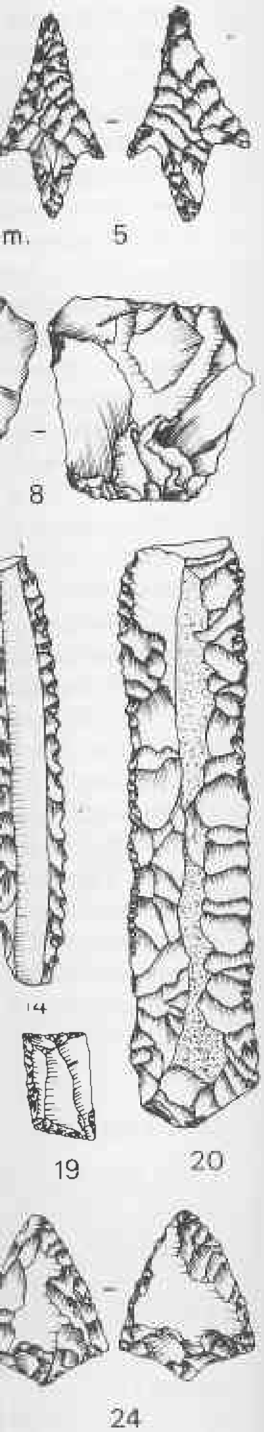


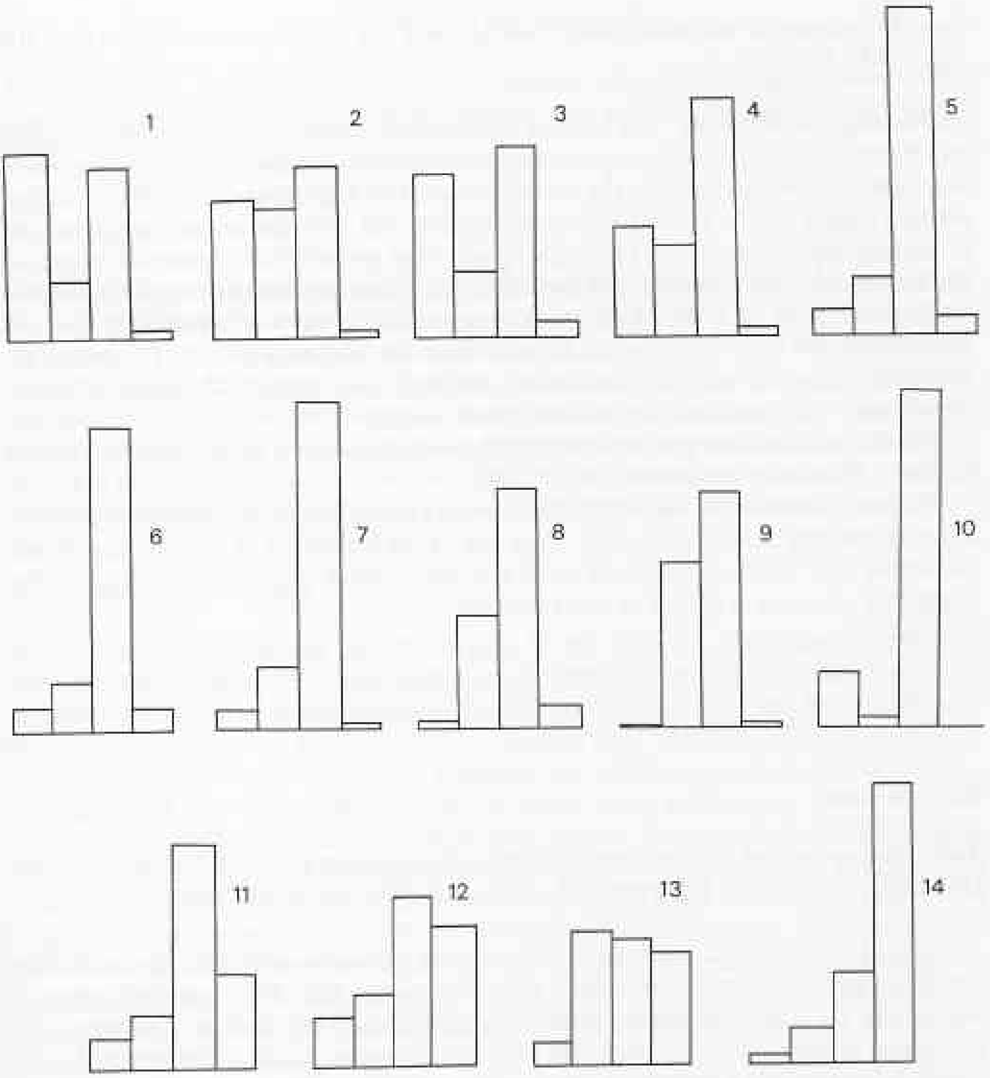


Figure 12.4 Relative frequencies of classes of arrowheads in the Bas-Sahara. From left to right, columns represent Hugot's (1957:160) Indices 1 (triangular and lozenge-shaped), 2 (foliate or amygdaloidal), 3 (tanged) and 4 (transverse, rounded or on bladelets). 1, El Bayed; 2, Oued Labied; 3, Temassinine (= Fort Flatters); 4, Izimane; 5, Site No. 707; 6, Fort Thiriet; 7, Hassi Mouillah (upper); 8, Les Deux Oeufs; 9, Bamendil-Gara Driss; 10, El Fredj AQ; 11, El Fredj AR; 12, Site 6908; 13, Site 6601; 14, Site 6710.

Figure 12.3 Neolithic stone tools of the Bas-Sahara. 1, denticulated endscraper; 2, perforator; 3, scalloped saw; 4, 8, scaled pieces; 5, 15, 16, 22, tanged arrowheads; 6, straight-based arrowhead; 7, concave-based arrowhead with rounded barbs; 9, Labied point; 10, Temassinine point; 11, Izimane point; 12, bladelet with Ouchtata retouch; 13, scalene-perforator with rounded angle; 14, saw; 17, trapeze with concave side; 18, 19, rectangles; 20, sidescraper-*limace*; 21, notched piece; 23, transverse arrowhead; 24, convex-based arrowhead. (*Provenance*: Lower Neolithic—1–5, 8, Khellal II; 7, 14, 21, El Bayed; 9–11; Oued Labied; 12, 13, 20, Bordj Mellala I; Middle Neolithic—15–17, Hassi Mouillah; 18, 19, 22, Sebkha el Melah; Upper Neolithic—23, 24, Les Perles) (Drawn by A. Amrouche) irregular scatters of archaeological material, and has been dated to 7750 B.P. ± 100 years (Mc.401).

Archaeological Material. The backed bladelets are a heterogeneous group, although mostly arch-backed, and are only marginally predominant in the tool-kit. The classes of secondary importance include the *varia*, because of a high frequency (15%) of scaled pieces (Figure 12.3: 4), and then endscrapers and notched pieces, which are of essentially equal frequency. The endscrapers were preferentially made on elongated blanks (blades), while the notches include a significant number of saws, some of them scalloped (Figure 12.3: 3), which was a common variety in the Hadjarian. Burins and sidescrapers are only slightly more frequent than the remaining classes. The burins are almost all on breaks, and the sidescrapers, although short, are usually made on blades. Arrowheads are rare and there are no foliate pieces.

The debitage consists predominantly of flakes, but bladelets were selected as blanks for tools. There are no fluted cores.

Grinding-stones exist, but only in fragmentary form. Pottery is common and is very strongly colored but not decorated. Very few of the fragments of ostrich eggshell are decorated and only one eggshell bead has been found, which might suggest that aesthetics were not a matter of great concern.

Bordj Mellala I

This site covered an area of two hectares and has dates of 7125 B.P. ± 120 years (Mc.810), 6950 B.P. ± 120 years (Mc.809) and 6950 B.P. ± 120 years (Mc.811).

Archaeological Material. The high frequency of geometric microliths is matched by the frequency of microburins, which (if one excludes the rare segments) occur in essentially the same frequency as the triangles (almost all scalene), trapezes and rectangles (Figure 12.3: 19). Notched pieces, which were made on the largest blanks found in the site, are a secondary class among which saws are not common; they are followed in importance by backed bladelets. There are few sidescrapers, perforators or arrowheads, but the scarcity of the last, at least, may be an artifact of the presence nearby of a military fort (*bordj*) and the consequent likelihood that the arrowheads have been collected.

The debitage is mostly of flakes although, here again, tools tend to be made on bladelets. There are some fluted cores.

Some fragments of grinding-stones were found. Pottery was rare, mostly undecorated, and the vessels probably had conical bases. Ostrich eggshell was abundant and several complete eggshell bottles were found: seven were found grouped in a circle and others were found in isolation. Tixier observed that the latter have engraved decoration of either concentric circles or crosses around the orifice, while those grouped in the circle were not engraved, but had traces of red ocher around the orifice.

Unlike Khellal II, there was considerable evidence for an aesthetic sense at Bordj Mellala. Besides the ceramic decoration, it takes the form of numerous ostrich eggshell beads, perforated and sometimes ocher-stained shells and coloring materials.

ORIGINS OF THE NEOLITHIC

Because of the multiplicity of facies associated with the first appearance of the Neolithic, the problem of its origins involves two aspects: the substratum and the vector.

SUBSTRATUM

The high index of bladelet tools which is common to all these sites and the decrease in that index during the course of the Neolithic argue in favor of an Epipaleolithic substratum. The amount of difference evident between one Neolithic site and another is matched by the diversity of Epipaleolithic industries in the Bas-Sahara. Some sites resemble the Capsian in their emphasis upon geometric microliths, while others have a clear predominance of backed bladelets, although never approaching the frequencies known in the Iberomaurusian. The use of the Levallois technique in the southern region is worthy of note, and might even suggest a survival of the Aterian tradition.

DIRECTION OF MOVEMENT

It has long been supposed that the origins of the Saharan Neolithic lie in Egypt, although the evidence for this is rather poor. There are only a few resemblances in certain forms of arrowheads, axes and ceramic vessels. Some of the Saharan pottery which resembles that of Gebel Uweinat occurs in sites which are clearly much more recent, while the more convincing analogies in artistic expression are difficult to interpret until the relative chronologies are more firmly established.

Several radiocarbon dates give a tantalizing glimpse of a possible center of Neolithic development in the Saharan central massif (Camps 1969; Roset 1982a, 1982b). They extend back to the ninth or tenth millennium B.P., but the available data are too few and fragmentary to permit us to follow the development of the process. Nonetheless, the earliest dates which can be attributed to the Neolithic in the Bas-Sahara are significantly later than those from the Hoggar and the Aïr, which might indicate influence from the south. This is supported by similarities in the ceramics in that they are completely decorated, in the use of combs for decoration and in the method of making vessels by moulding.

However, a northern source of influence still remains possible. Grébénart (1970) has found Neolithic sites in the Saharan Atlas which date back to 7500 B.P. ± 220 years (Gif.1221) and 7220 B.P. ± 100 years (Mc.820). The pottery from them shows remarkable similarities to that from Oran, but not to the Saharan pottery. At Aïn Naga, there are very close correspondences between the lithic assemblages from the lower, Capsian layer and from the Neolithic layer which overlies it (Grébénart 1976).

The distribution of early Neolithic sites thus supports the hypothesis of a heterogeneous Epipaleolithic substratum, and also suggests that the process (or processes) of Neolithic development occurred in several areas.

DEVELOPMENT OF THE INDUSTRIES

The development of these industries involved an increase in the frequency of arrowheads (Figure 12.4) and, to a lesser extent, of perforators and of sidescrapers; there may also have been an increase in the number of flaked axes. These changes took place at the expense of the backed bladelets and had almost no effect on the frequencies of other classes. At the same time, there were changes within the preferred classes; thus, hollow-based arrowheads were replaced by tanged and, to some degree, foliate forms. There was also a marked concern with decorative objects.

On the basis of the sites studied so far, three stages can be recognized—Lower (see above), Middle and Upper Neolithic—and it is possible to trace their lines of development through certain industries, such as those of the Aïn Guettara facies. The transition to the Middle Neolithic is reflected in an increase in the class of arrowheads (or of foliates, or both), which come to account for more than a quarter, and sometimes a half, of the tool-kit (Figure 12.4). This increase takes place at the expense of all other classes. At Hassi Mouillah, microburins, which had been numerous, were particularly affected by this, although there is no parallel decrease in the types made by this technique.

The density of sites which can be assigned to this period and which share similar features indicates that occupation of the area was much greater than it had been previously; this is in accord with Alexander's (1984) model.

MIDDLE NEOLITHIC

Aïn Guettara Facies

This facies, which was first recognized at Aïn Guettara and is well known from the lower level of Hassi Mouillah (Marmier and Trécolle 1971, 1972), has several characteristics which are reminiscent of the Hadjarian. However, at the type-site it is dated to 5950 B.P. ± 100 years (Mc.279) and 5930 B.P. ± 140 years (Gif.1223) and is therefore more recent.

The industry is dominated by notched pieces, which are a heterogeneous group although the actual notches tend to be very consistent. Saws were lacking in the lower part of the layer at Aïn Guettara, but made up 2.5% of the tools in the upper part. This increase is matched by the geometric microliths, particularly the isosceles trapezes. Backed bladelets form a rich secondary class at the site, including a wide variety of types, although many of them are represented only by single examples. Straight-backed types are predominant and many pieces are partially backed. Bases were rarely modified, but there is frequently a fine retouch along the edge. Ouchtata retouch was also very common (15%) at Aïn Guettara, which is most unusual in the Neolithic of the Bas-Sahara. Backed bladelets are much less important at Hassi Mouillah and geometric microliths more so.

There are, again, pieces with continuous retouch, denticulated working-edges on many of the endscrapers, and single sidescrapers made by flat or oblique, marginal retouch. Microburins are frequent and occur consistently; many of those at Aïn Guettara are double. The group of arrowheads shows a preference for hollow-based or tanged forms (Figure 12.3: 5).

Ostrich eggshell is abundant, but pottery is rare. Aïn Guettara yielded a few sherds, which are noteworthy for their thin edges and for the occurrence of decoration on both faces—extremely unusual features in the Bas-Sahara. Decorative motifs consist predominantly of angle-impressions and grooves. At Hassi Mouillah, there is both a dark-colored pottery, which becomes common in the upper layer, as well as undecorated, thin-walled, narrow-necked vessels with calcareous temper, which are reminiscent of the pottery of Gebel Uweinat. The same forms occur in the Neolithic of the eastern Maghreb, although they are more crudely made there and of a later date. The ostrich eggshell is often decorated with straight lines which, at Aïn Guettara, form lozenges.

There are also large eggshell beads, stone beads, ocher and fragments of bone and of stone with geometric designs.

Flakes are highly predominant in the debitage, but bladelets continued to be preferred as blanks for tools. Fluted cores are rare; most of the cores are globular and rather small. Aïn Guettara yielded one specimen which resembles a tortoise-core.

Hassi Mouillah Facies

The development of the industry at Hassi Mouillah can be traced without difficulty. The lower layer is followed without a break by a layer with features which are found at numbers of sites in the Ouargla region. This industry is dated between 5190 B.P. ± 70 years (UW.388) at Bamendil-Gara Driss and 6100 B.P. ± 160 years (Brézillon *et al.* 1972) at Hassi Mouillah X5.

Arrowheads make up a quarter of the tools in the upper layer of Hassi Mouillah, and a half at Bamendil-Gara Driss; their lower frequencies at the surface sites are probably related to the looting of those sites (Figure 12.4). Half of the arrowheads are tanged, with rather short tangs (Figure 12.3: 16), and many of them are small in size. Foliate pieces are not numerous and are very often broken.

Geometric microliths are a class of secondary importance and are represented by trapezes; they show a clear preference for pieces with one concave side (Figure 12.3: 17). The class of notches and denticulates is of similar frequency and includes numbers of saws and denticulates. *Mèches de foret* occur with noteworthy frequency, but sidescrapers and, more particularly, backed bladelets are almost nonexistent.

In contrast to what was observed in earlier occupations, tools made on bladelets are less common than those made on flakes. Nevertheless, fluted cores are frequent: at Deux Oeufs, a quarter of the cores are fluted.

Grinding-stones are numerous. Most of them are flat handstones with two opposed grinding-surfaces, which are flat or somewhat convex and converge slightly towards each other (Marmier and Trécolle 1972).

There is a considerable quantity of the dark-colored pottery, which was found in the lower layer of Hassi Mouillah. The vessels are of simple, ovoid forms, 15–22 cm high (Figure 12.5). The base is conical, the vertical walls are 7–8 mm thick and the diameter of the orifice is about 15 cm. The entire external surface of each vessel is decorated with a monotonous, pseudo-cord-impressed motif arranged in bands parallel to the orifice, from which it is separated by a row of chevrons or cross-hatching (Figure 12.6). The paste includes vegetable temper and was fired under strongly reducing conditions.

Ostrich eggshell was frequently used and a pile of 11 undecorated eggshell bottles was found at Hassi Mouillah (Marmier and Trécolle 1971). Nonetheless, many of the orifices of bottles were decorated with concentric arcs or with lines converging towards the pole. Many of the fragments are also decorated, usually with rectilinear motifs (Figure 12.7). As well as the numerous eggshell beads, there are also beads of amazonite and some of quartz, and many traces of coloring materials.

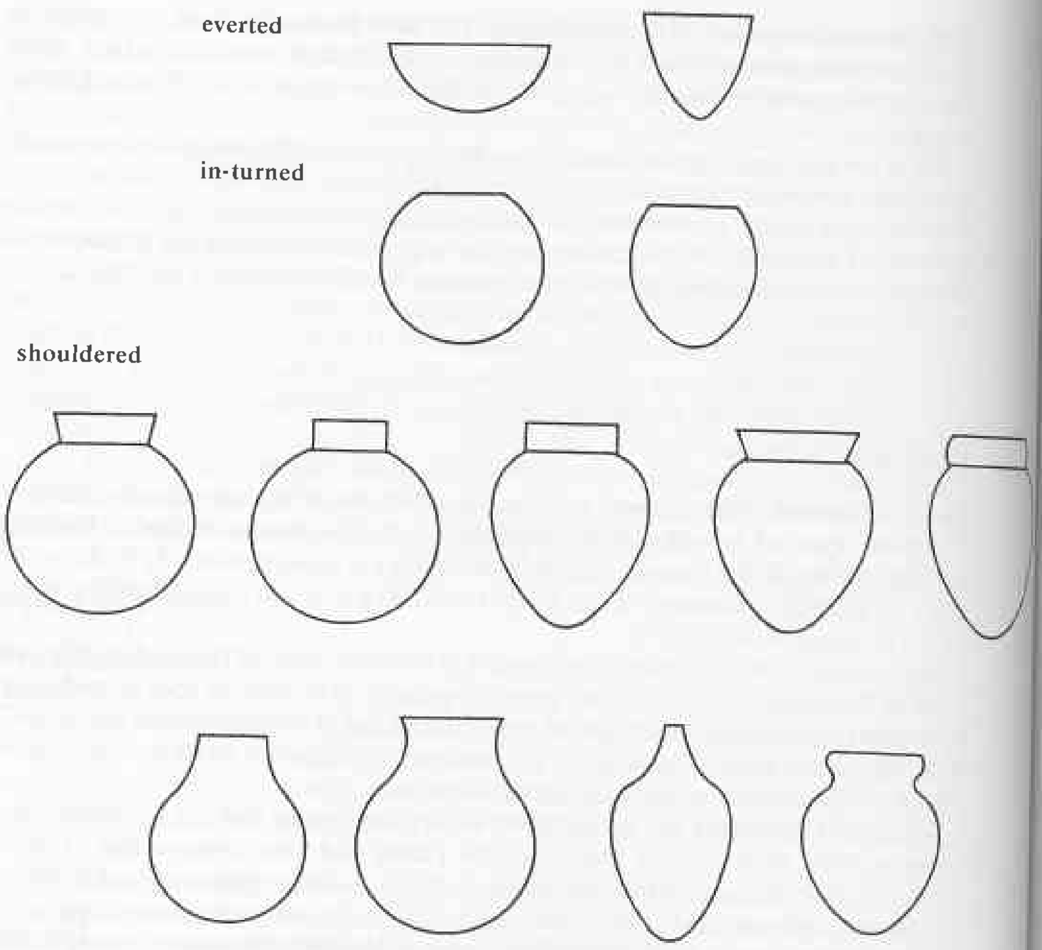


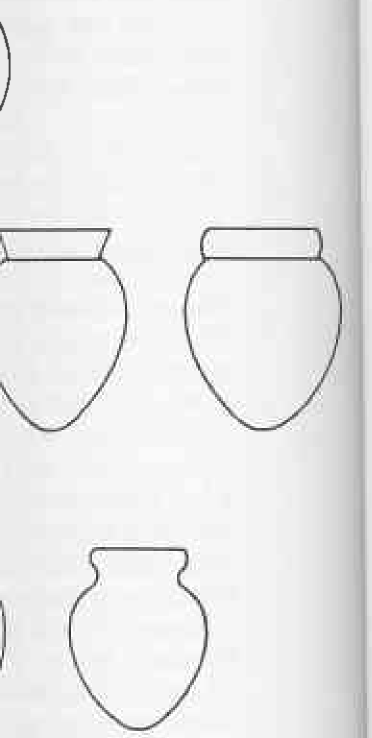
Figure 12.5 Pottery-shapes of the Bas-Sahara.

Capsian Neolithic

This industry is well documented in the region of Gabès, where it is dated to 5920 B.P. ± 120 years (Perthuisot 1975). It may be a successor to the presumed "Neolithicized Capsian" in the area of Ouled Djellal, some six to eight hundred years earlier, and at Bordj Mellala I before that.

Notched pieces are predominant (Figure 12.3: 21), while sidescrapers and end-scrapers are important. Conversely, geometric microliths, which consist mostly of rectangles (Figure 12.3: 18, 19), are not numerous and microburins are rare. The frequencies of arrowheads (Figure 12.3: 22) and of foliate pieces may not be reliable because the sites are surface occurrences. Abrupt retouch was rarely used; it occurs on perforators and a few backed blades and bladelets.

Ostrich eggshell is always frequent. It cannot be determined whether or not pottery was used: the sites examined are mixtures of several periods, so that those who studied them neglected the pottery.



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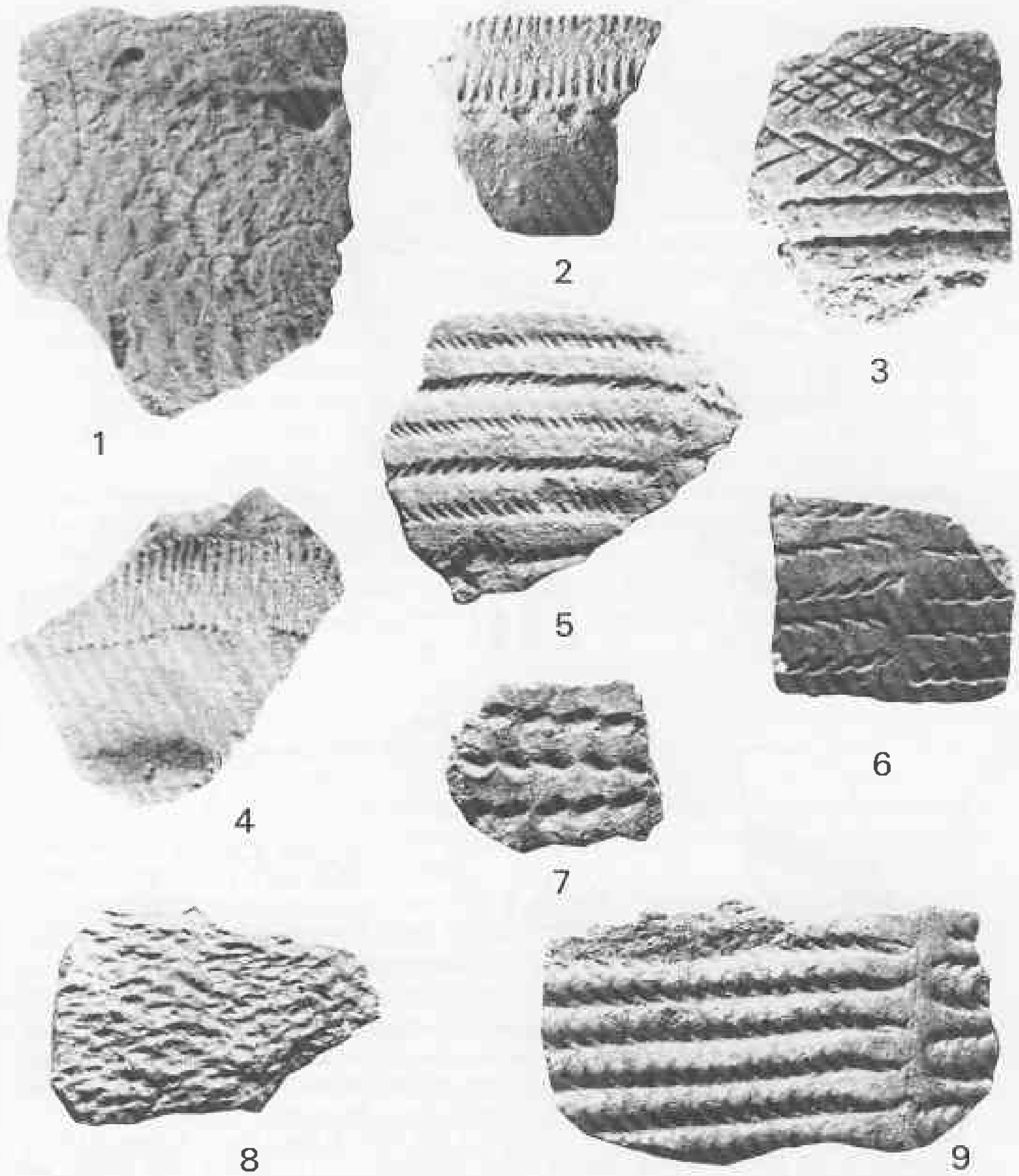


Figure 12.6 Principal decorative motifs on pottery of the Bas-Sahara. 1, 5, teeth; 2, teeth underlined by angle-impressions; 3, 4, 6, 7, 9, varieties of pseudo-cord impressions (No. 3 has two bands of cross-hatching on one edge, followed by pseudo-grooves); 8, rouletted. (*Provenance*: 1, 2, 5, 8, Site No. 707; 3, 4, 6, 7, Première Sebkha; 9, Les Perles) (Photos by M. Arib)

Other Facies

Because of the small number of artifacts recovered from each site, it is not always possible to identify the industries or to recognize continuity. ONM 17, in the area of Hassi Messaoud and dated to 5490 B.P. ± 150 years (Brézillon *et al.* 1972), has features reminiscent of Khellal II, with the same dominance of backed bladelets and high

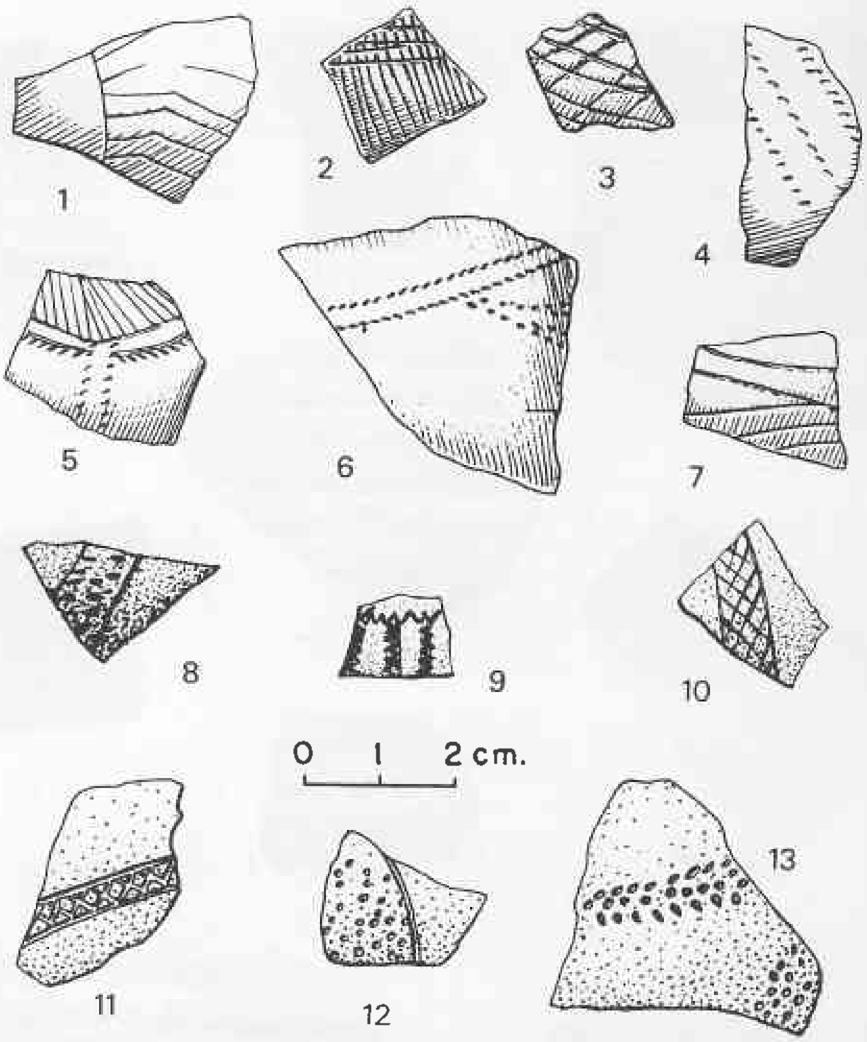
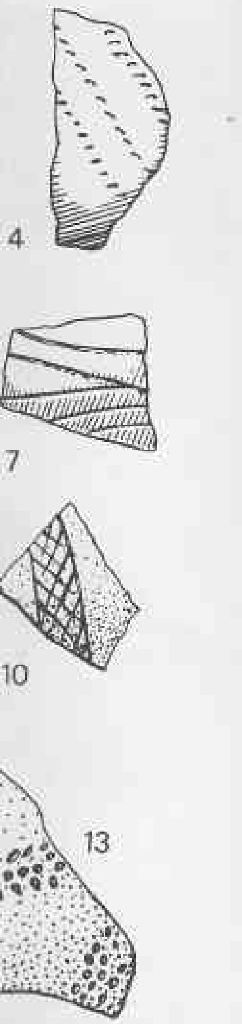


Figure 12.7 Decorative motifs on ostrich eggshell in the Bas-Sahara. 1, 7, diverging lines; 2, cross-hatching; 3, lozenges; 4, dotted lines; 5, complex motif with cross-hatching underlined by feathered lines and dotted lines; 6, 13, pseudo-branches; 8, bands of dots; 9, broken divergent lines; 10, 11, bands of lozenges; 12, random dots enclosed by a curved line. (*Provenance*: Lower Neolithic—1–3, Site 6710; 4, Site 6601; 5, Site 6709; 6, Site 7015; 7, Site 6908; 8, Hassi Mouillah [lower]; Middle Neolithic—9, 10, Hassi Mouillah [upper]; Upper Neolithic—11–13, Izimane [after Roubet and Mateu 1970])

frequencies of endscrapers and notched pieces. There are numerous arrowheads but no geometric microliths.

Several sites, which fall between 6435 B.P. ± 100 years (Mc.908) and 4910 B.P. ± 140 years (Gif.3414), share a predominance of notched pieces, accompanied by sidescrapers. Backed bladelets and perforators are often common, while geometric microliths vary in frequency.

Ostrich eggshell is never common. Pottery is either undecorated, or only slightly so, and the bases were probably rounded, which suggests a very different technique from that of the ceramics of the Hassi Mouillah facies. The firing of the pottery in an oxidizing atmosphere is a further point of difference between them.



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UPPER NEOLITHIC

An Upper Neolithic stage can be recognized, but is not well known and, because of the poor preservation of metal, may even have been Eneolithic. The stage is dated to 3750 B.P. ± 90 years (Mc.523) and 2400 B.P. ± 120 years (Mc.723) at Les Perles, and to 3600 B.P. at Izimane (see above).

The Upper Neolithic continues the Middle Neolithic tradition in the importance of arrowheads (Figure 12.4), but the variety of stone tools is more limited and sidescrapers are more important. There is also a relatively higher number of decorative objects.

At Izimane, south of the basin, arrowheads dominate and are followed by approximately equal numbers of perforators (especially *mèches de foret*), sidescrapers and notched pieces (especially saws). Backed bladelets and, in particular, geometric microliths were rare. Quite a lot of flaked axes were found, which vary in form but all have straight or slightly convex blades and are less than 10 cm long. As well as the usual decorative pieces, there were also amazonite and agate beads and an agate lip-plug.

Les Perles, in the Ouargla region, has the same predominance of arrowheads, most of which are transverse (Figure 12.3: 23), and numerous sidescrapers, but notched pieces and, especially, perforators are less common. Pottery of the Hassi Mouillah tradition occurs, as does ostrich eggshell; there are many eggshell beads and some stone beads.

ENVIRONMENTAL SETTING

The various data concerning the setting in which the Neolithic developed are limited but basically in agreement, and show that environmental constraints were severe even from the very beginning of the Neolithic.

Geomorphology is very important in this respect. The sites at El Hadjar lie in a deflational basin at the mouth of Wadi Touiel (Aumassip *et al*. 1972). At the edge of the basin, the Epipaleolithic passes beneath a horizon of fine, soft sand, which underlies a thin and slightly cemented layer of rounded fragments of Tertiary sandstone. The Hadjarian occurs in the lowest part of the basin. Analysis of this stratigraphy, which shows a rapid succession of excavation and refilling, indicates an arid environment in which aeolian action was the predominant agent.

At the same sites, sedimentological analysis indicates extensive wind-sorting, which is confirmed by the occurrence of dull and pitted grains. The grain-size curves for the samples from the Hadjarian sites (El H3) appear to be coarser and less well sorted because of the presence of gypsum. Calcium carbonate is always present: its percentage is low (6.4%) in sediments from the Epipaleolithic layer (El H4), but it reaches 40% in the Hadjarian sediments (El H3), which is identical to its percentage in the continental Tertiary samples (El H5) (Figure 12.8).

This sequence is confirmed by paleontology and paleobotany. At El Hadjar, the flora contemporaneous with the level dated to 7225 B.P. ± 130 years (Mc.527) and 7300 B.P. ± 170 years (Gif.880) is dominated by Gramineae, while chenopods are rare. In the Mellala sebkha, near Ouargla, a level with a fauna of *Cardium* and *Melania* has a date of 7900 B.P. ± 110 years (Gif.1854). An abiotic layer separates this from another bed dated to 9550 B.P. ± 130 years (Gif.1853), but the later part of the sequence is not known.

The Hadjarian industries at the same sites, which are dated to 6160 B.P. ± 150 years (Alg.42), are associated with predominantly chenopods of Atriplex type. Beucher (pers. comm.) has identified large quantities (98%) of *Cornulaca monacantha*, a plant characteristic of the 150-mm isohyet. There is a similar vegetation in contemporaneous layers (6450 B.P. ± 260 years [Alg.18]; 6240 B.P. ± 270 years [Alg.20]) at El Mermouta in the north of the basin.

The vegetation dated to 5500 B.P. ± 125 years (Alg.34) at Deux Oeufs, not far from Ouargla, is comparable although it includes some arboreal pollens (*Cedrus, Pinus* and *Pistacia*), which were more common in the eighth millennium samples. *Acacia raddiana* has been identified among the charcoal. A deterioration of the landscape may well be indicated by the disappearance of the arboreal pollens after the eighth millennium levels. Although they result primarily from long-distance transport, their absence would suggest a reduction of the trees followed by a slight increase in the sixth millennium.

These data may be interpreted as indicating a landscape with an Upper Saharan type of vegetation, with trees restricted to the *dayas*, or small internally drained basins, and wadi beds. The habitations of the Neolithic populations were determined by two factors: the catchment-areas for surface water and the locations of springs. The deterioration of the landscape is well demonstrated by the fact that sites of the much earlier Aterian industries showed no such overriding concern.

The geographical distribution of the sites shows that they were preferentially located near low points, presumably where run-off would be concentrated. This is true to the south of the erg near the *maaders* (internal drainage basins, some of which are still active), and along the higher ground of the Saharan Dorsale, between the eastern and western ergs, where sites occur on its eastern edge either along or in the sebkhas. The latter were inactive and had been deflated by the wind because of the lowering of the water-table, but served as catchments for run-off from the Saharan Dorsale. All of this implies that, in the seventh millennium B.P., there was running water in an area where today there is almost none.

There are many sites in the erg and they are often concentrated near calcareous concretions or travertines. Even if, as at El Hassi (Tabni *et al.* 1977), these are not true travertines, they nevertheless indicate points of greater moisure related to springs. These springs were artesian, as they are throughout the Bas-Sahara, and the aquifer is recharged from the north.

The Bas-Sahara is thus made up of a mosaic of individual microenvironments.

WAYS OF LIFE

LIVING-SITES

Two types of sites can be defined which, even at this date, foreshadow modern habitation-sites. Some occupations cover modest areas, as indicated by the mantles of flaked stone which may or may not overlie archaeological levels. They may even form small mounds like those of Hassi Mouillah and El Hadjar sebkha. The excavations carried out at Site 6910 revealed circular structures, about 3 m in diameter and outlined by a ridge of pieces of sandstone with a gap 0.6–0.8 m long (Aumassip 1972:27). The sediment outside the structures was fawn-colored, while that inside was blackened by ash and charcoal. Stone artifacts were very common inside, but rare outside. A stone-

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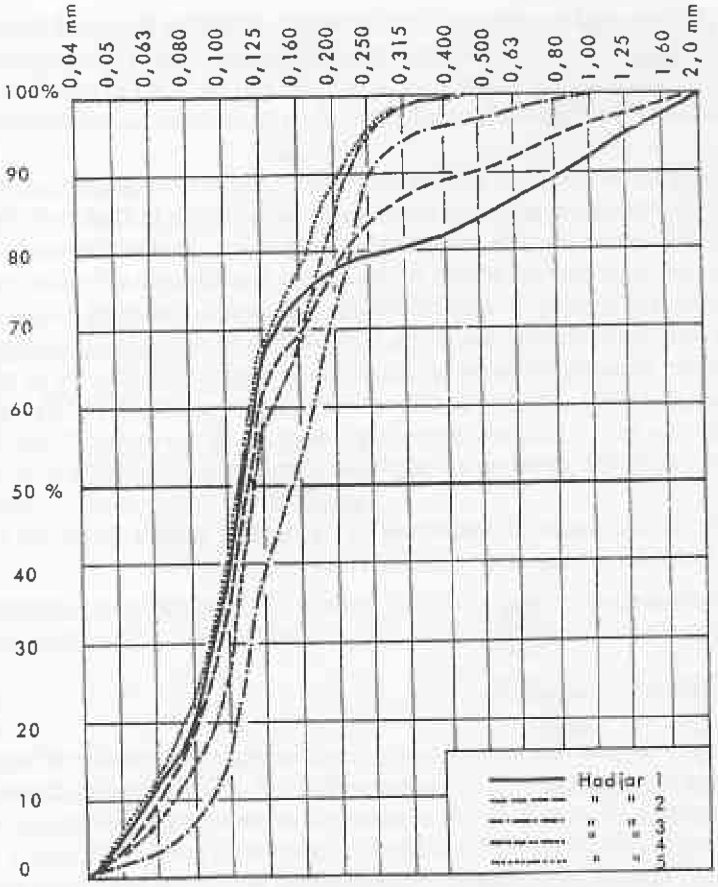

Figure 12.8 Sedimentological curves for the sands of El Hadjar. 1, superficial sands from Site 6710; 2, superficial sands; 3, consolidated sands from Site 6710; 4, sands from the Epipaleolithic site; 5, sands and nodules of Tertiary sandstone.

lined hearth occurred in the center of one structure, with upper and lower grinding-stones nearby; two other hearths were found near the entrance. We feel justified in regarding these as enclosed spaces where prehistoric people lived and carried out their activities for long periods without interruption; that is, as sedentary living-sites.

The other sites never have an archaeological layer, the flaked stones may be more or less densely scattered but never form a mantle, and they are usually mixed with burned rocks. Such sites may cover vast areas. The distribution of the artifacts at Bordj Mellala I was such that it was possible to try to reconstruct the occupation-area (Tixier *et al.* 1976). Two areas, about 40 m apart, were called living-areas and contained varied tool-kits and stone-lined hearths. Three smaller areas, of about 50 m² each, included almost exclusively geometric microliths (one of them with nothing but rectangles). It was possible to refit some of them to the microburins found nearby and so these areas have been interpreted as workshops for the manufacture of geometrics.

Several sites have yielded well-defined stone hearths, lying within and overlapping each other; the evidence suggests that these are more or less frequent reoccupations of the same spot. In other cases, no structures could be identified, so that it would be rash to speak of continuity or discontinuity; it is, however, tempting to regard them as favored spots for occupation since the cultural material extends over such large areas. Other scatters cover no more than a few square meters, and the limited numbers of artifacts they yield indicate only brief occupation. Such aspects of archaeological sites suggest nomadism.

The radiocarbon chronology demonstrates the contemporaneity of these two ways of life, sedentism and nomadism, and thus raises the question of their relationship. The answer to this question may be provided by the pottery. In the temporary sites, there occur bright red, undecorated sherds derived from vessels with spherical bases. In the sedentary sites, the pottery is conical-based, and usually covered with a decoration which quite often extends over the entire surface; it is always of a much more subdued color. Together, these differences of detail would suggest differences of tradition. In Tunisia, Gobert (1940) observed that the modern hand-made pottery is painted among sedentary groups but is not so among the nomads. We wonder if this nomadism, involving returns to the same spot, might be related to herding, as it is at the present day.

Very little of the material recovered is of such a nature as to be completely intelligible, but a few things are informative of everyday life.

A PEACEFUL LIFE

In the absence of defensive sites, the arrowheads indicate the practice of hunting rather than of fighting between people. The upper and lower grinding-stones do not constitute proof of the growing of cereals, but do suggest that cereals (or similar plants) were eaten. They are always associated with numbers of geometric microliths and of saws, and occur in the permanent settlements. Nevertheless, all of these elements are no more than suggestive and do not demonstrate the practice of agriculture.

It is above all through the medium of art, whatever might have been its purpose, and of ritual that we can observe the spiritual development of prehistoric populations. In this respect, the Bas-Sahara is an inhospitable land with few localities suitable for rock-art; only a very few rock-art sites are known, some in the extreme north and some in the extreme south of the basin. The Wadi Timissit, in the south, has primarily spirals (David and Huard 1979) of unknown age but which could be very old. Elsewhere, near the more recent engravings of camels and ostriches, are polished-line engravings, of monumental size, of buffalo, elephants, giraffes, antelopes, cattle, as well as masked men. Engravings of the same subjects, but much smaller in size, are also found near Temassinine. In the north, all of the engravings seem to be more recent; they are made by pecking and have a light patina. Depictions of people and cattle occur at Chabet Naïma, while the buffalo is known only from Guerrara, where there is one small drawing of it (Lefèbvre and Lefèbvre 1967).

Mobiliary art is found in many sites but the specimens are always broken; it may have become more important in the Middle Neolithic, when stone beads became numerous. The use of paints is frequently suggested by the presence of coloring materials (ochers, in particular). The variety of decoration which can be seen on the ostrich eggshell is the only real indication of a richness of artistry (Figure 12.9). Beads are not usually common, most of the pottery is undecorated and the motifs on the decorated vessels are monotonous.

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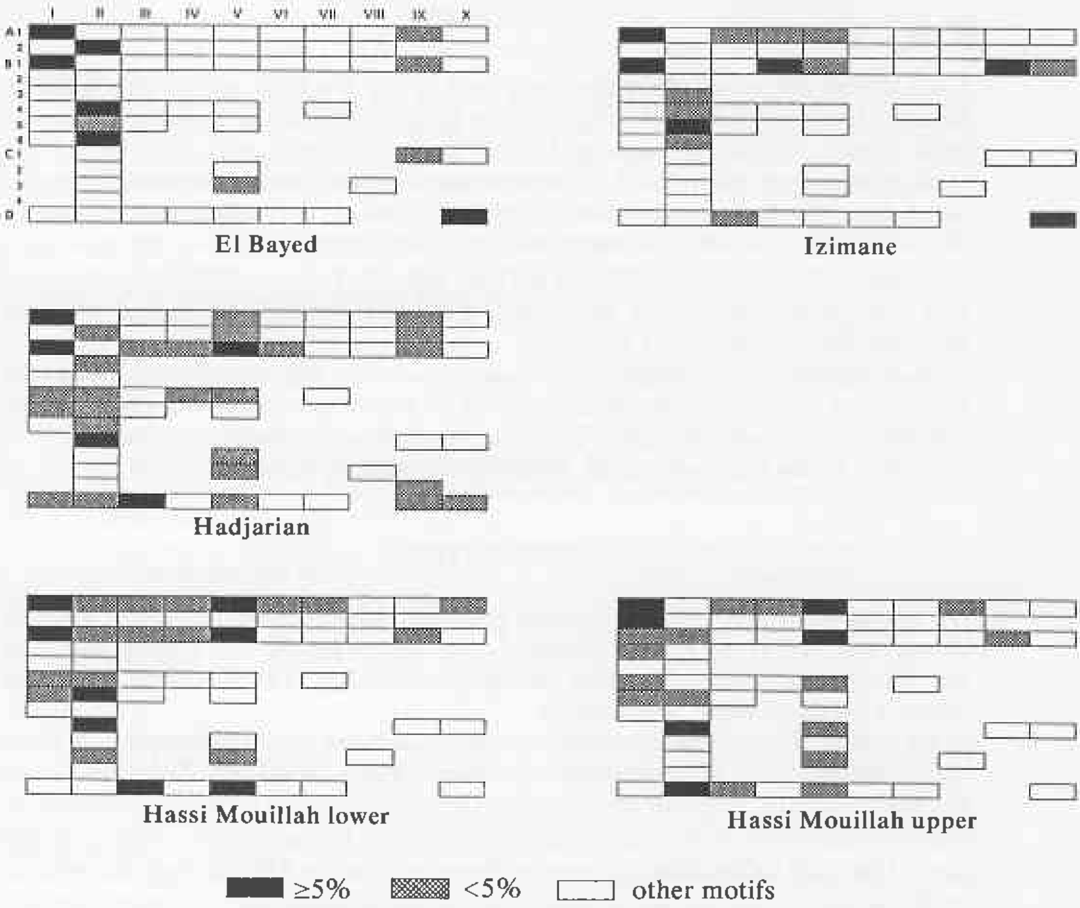

Figure 12.9 Relative frequencies of decorative motifs on ostrich eggshell according to the classification of Camps-Fabrer (1966). I, straight; II, oblique; III, chevrons; IV, broken lines; V, curves; VI, scallops; VII, waves; VIII, circles; IX, dotted straight lines; X, dotted curved lines; A1, simple; A2, combed or feathered; B1, parallel; B2, hatched; B3, staggered hatchings; B4, scaled; B5, quadrilaterals or lozenges; B6, staggered scaling; C1, divergent; C2, divergent feathered; C3, divergent quadrilateral; C4, divergent hatching; D, opposed.

SPECIALIZATION

The existence of specialized activity-areas at several sites implies task-specialization. At Bordj Mellala I, the hypothesis that there were areas where certain tools were left is disproved by the amount of debitage, by the number of microburins associated with the geometric microliths and, above all, by the numerous refittings that could be made.

A similar problem is posed by the pottery. The potsherds are frequently dark in color, with pseudo-cord-impressed decoration, and derived from vessels of the same shape and more or less the same size, so that one can almost imagine an assembly-line production. However, the idea that there might have been one place which specialized in the manufacture of these is not supported by chemical analyses of the pastes, which have given extremely varied results (Aumassip *et al.* 1974). There could, nevertheless, have been a band of people who specialized in pottery-making.

Trade

Even though almost all of the materials used by the Neolithic populations could be found in the vicinity of their sites, from the sixth millennium B.P. onwards, there do occur exotic materials and objects. In the Tassili, in addition to obsidian, which has been reported from Hassi Inifel, Ghadamès and southern Tunisia but which cannot be dated, there are also amazonite beads (a mineral known in the Hoggar and the Tibesti), chrysolite (which is often mistaken for jade) and marine shells. Among the last, a specimen of *Spatha caillandi* found at Hassi Djemel (Pallary 1906) comes from the Red Sea. Other objects, such as cylindrical stones (*rondins*) and waisted axes, are characteristic of neighboring cultures.

Such allochthonous objects or raw materials are very rare, which would support a low level of mobility for the human groups. If this is considered together with the distribution of the archaeological facies, it strongly suggests that groups had their own territories, in the same way as do groups of the modern Sahara.

CONCLUSION

Our present knowledge of the Bas-Sahara suggests that the Neolithic process began in the eighth millennium B.P. Environmental constraints were still very marked and there are numerous paleoenvironmental indicators of aridity. The Neolithic developed during a period of slight amelioration.

As seen in terms of material culture, various facets of the Neolithic process make their appearances in different places and upon different substrata. From the Lower Neolithic onwards, different facies can be identified, and they retain their richness in backed bladelets or in geometric microliths from the Epipaleolithic which underlies them. The sixth millennium B.P. saw the florescence of the Middle Neolithic with its proliferation of arrowheads, and it is at this time that there appears evidence of contact with other regions, some of them very distant. The permanent habitations, which earlier had appeared parallel to evidence for nomadism, become more common. This evolution took place at the time of an improvement in the climate, although much less so than that of the eighth millennium, so that the expansion suggests a better adaptation to the environment than had gone before. Evidence pertaining to the Upper Neolithic is much more limited. The tool-kit is extremely monotonous, but now includes aesthetic or prophylactic objects.

Within this heterogeneous cluster, a link is suggested by the rarity of pottery and of polished stone; this would suggest some unity of cultural tradition.

Various elements of this way of life are already very similar to those of the modern Bas-Sahara. Some of the populations live sedentary lives at more favorable spots, while others are nomadic, although probably within fixed territories, and carry out trade with groups nearby, or even at some distance. This latter practice, for which there is no evidence before the sixth millennium B.P., may well have marked a new level of development in prehistoric times.

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13

Holocene Populations of the Western and Southern Sahara: Mechtoids and Paleoclimates

N. PETIT-MAIRE
O. DUTOUR

INTRODUCTION

The paleoanthropological history of the Sahara is still poorly known because of the paucity of material which has been recovered thus far from this vast area. The age of *Tchadanthropus* remains unknown (Coppens and Chamla 1979; Servant *et al.* 1969), *Homo erectus* has never been found in the Sahara, despite the large number of Acheulean sites there, and the few remains of Aterian hominids which are available to us are all from coastal Morocco (Debénath 1975; Ferembach 1976; Roche and Texier 1976). The Late Paleolithic finds from Wadi Halfa, in the Sudan (Anderson 1968; Wendorf 1968), have been the only indication that Mechta-Afalou traits might have been spread throughout the Sahara. However, neither Chamla (1968) nor Petit-Maire (1979b) was able to establish any connection between these and the robust, sometimes archaic-looking, skulls from the Western Sahara (except for the Izriten burial, near Cap Juby, which is dated to the early Holocene [Charon *et al.* 1973; Petit-Maire 1979c]), or between the Wadi Halfa specimens and those from the Hoggar (Camps 1969; Charon *et al.* 1973, 1974a, 1974b) or from the Tilemsi valley (Boule and Vallois 1932).

Considerable new light has been cast upon the possible genetic relationships between the makers of the Aterian, the so-called Mechtoids and the Holocene Saharan populations by recent discoveries in northern Mali. There, a large number of well-preserved Holocene burials have been recovered (Dutour and Petit-Maire 1983; Petit-Maire 1986; Petit-Maire *et al.* 1983), which can be placed in an environmental context that has been studied in great detail (Petit-Maire 1986; Petit-Maire and Riser 1983). Detailed anthropological descriptions of these burials have been published elsewhere and will not be repeated here. Instead, this chapter will provide a summary of the principal characteristics of the skeletal remains and will propose new interpretations of them and of their relationships.

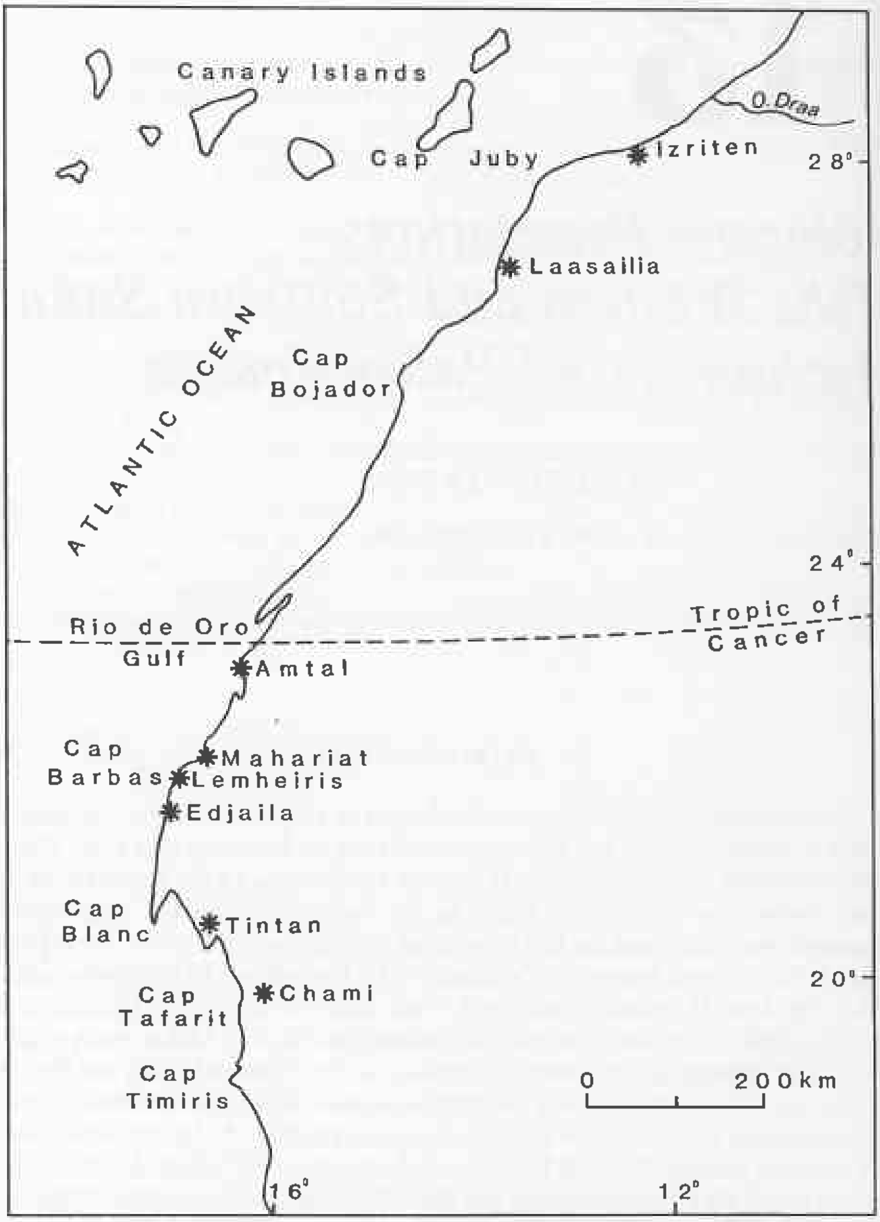
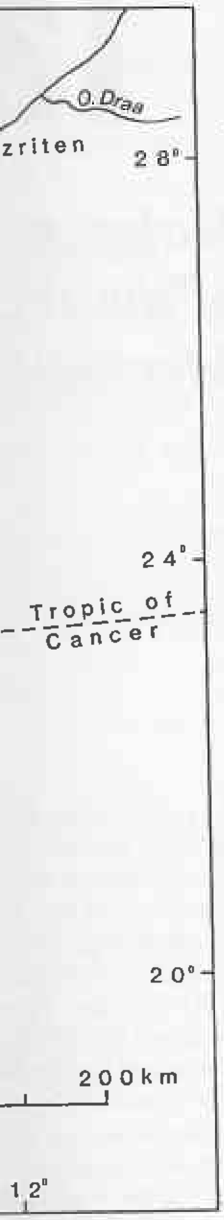


Figure 13.1 Anthropological sites along the Atlantic coast of the Sahara.

THE ATLANTIC COAST

Today, the Atlantic coast of the Sahara between Cap Juby and Cap Timiris (Figure 13.1) is a barren desert, with annual rainfall ranging between 43 mm at Tarfaya and 28.7 mm at Nouadhibou (Dubief 1963). North of Cap Blanc, the aridity of the shore is aggravated by the cold stream of the Canary Islands. Numerous Epipaleolithic and Neolithic sites have been observed along this 2000-km stretch of coastline, and 214 associated burials have been excavated (Delibrias *et al*. 1976; Petit-Maire 1973, 1979a, 1980).



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In the area of Cap Juby, most of the coastline consists of cliffs, but there are a few beaches, backed by consolidated dunes which rest upon the Moghrebian sandstone formation. At Izriten (28°1'N), the remains of three individuals were found in one of these dunes, buried about 1.5 m beneath low structures built of stone. The bones had been heavily burned and wood charcoal was recovered from among them. Radiocarbon dates of 10,430 B.P. ± 180 years and 9450 B.P. ± 160 years have been obtained on the charcoal, and of 6100 B.P. ± 120 years on the bones themselves (Delibrias *et al.* 1976). The shell-midden which covers the site has dates of 8100 B.P. ± 110 years and 7860 B.P. ± 170 years (Grébénart 1975). The skeleton of a young woman, 20–25 years old, was well preserved. It is, on the whole, small and gracile but with some surprisingly developed, and apparently inappropriate, robust features. The cranial vault is gabled, with a relatively protruding glabella, considering the small size of the skull, low rectangular orbits and heavy cheek bones. The piriform aperture is delimited by a prominent crest. The occipital area is elongated with a slight angle at the lambda. Seen from the back, the skull is pentagonal. The mandible is remarkable for the verticality of the ramus, the gonial eversion and the rugged muscle insertions; cingula and shovel-shaped incisors were observed on the teeth. The femur also has a self-contradictory morphology, in that it is gracile but with a very marked pilaster. The robust traits of the Izriten skull thus seem to contrast the gracility to be expected in a young and female skeleton with genetically determined robust characters, which are reminiscent of the Columnata-Taforalt series (Figure 13.2).

Fifteen kilometers south of El Aiun is the Laasailia depression, which is separated from the shore by a narrow bar. Fifteen burials lined the edge of the depression, of which 12 have been excavated; two of the skeletons have been dated to 2740 B.P. ± 110 years and 3100 B.P. ± 110 years (Gif.3249 and Gif.3465). The remains are very fragmentary and not very informative. However, the only skull still preserved has a slight occipital mound, a pentagonal shape when viewed from the rear, and shovel-shaped incisors.

Between Laasailia and the Rio de Oro peninsula, the steep coastal cliff is 40–100 m high and the beach is completely inaccessible. This barren, rocky, inhospitable length of coast also suffers from strong cold winds and heavy fogs. Human life was as impossible here in prehistoric times as it is today. In contrast, from Dakhla south down to Cap Tafarit (Figure 13.1), the Moghrebian plateau gradually lowers and disappears, and the coast becomes more heterogeneous, with bays, small promontories, longitudinal dunes and dry lagoons. The coastal sebkhas, at 0.5–2 m above the present sea-level, are evidence of fossil embayments associated with the Holocene transgression. Their surfaces are generally covered with evaporitic deposits, and radiocarbon dates measured on shells found *in situ* range from about 6000 to about 3000 B.P. (Delibrias *et al.* 1976). Shell-middens and burials have been found all along this coastline (Petit-Maire 1972, 1973, 1978, 1979a); they date from either the Nouakchottian transgression (Elouard 1968) or the lagoonal Tafolian regression (Hébrard 1978) which followed between about 4000 and 2000 B.P. During the latest stage, the slight fall in sea-level, combined with sedimentary processes such as the building of spits and sandbars, led to the gradual filling of the sebkhas. Littoral dunes separated the lagoons from the open sea and were ideal habitation-sites for human groups who subsisted primarily on marine resources. None of the dated middens is older than 6200 B.P., so that it is tempting to suggest that people came to live along the coast when the hinterland began to dry up after the climatic optimum. The Sahara became increasingly arid after about 7000 B.P. (Petit-Maire 1986), and at that time, the large game also probably migrated towards wetter refuges, such as the mountains, rivers or the coast.

Figure 13.2 Izriten II. The clavicle is compared with a modern robust example (above).

st example (above).

The human skeletal remains collected in this area include 199 individuals, 18 of them from between Dakhla and Cap Blanc, and the remainder from two large cemeteries between Cap Blanc and Cap Timiris (Petit-Maire 1979a). The adult skull, Amtal III, is very robust with a frontal bone which is narrow relative to the parietal width, giving it a bursiform shape. The mandible has everted gonions and very marked muscular insertions (Figure 13.3), which contrast with the relative gracility of the bone. The incisors were lost before death and the healing is complete; it is not possible to determine if this was an accidental loss or a ritual mutilation. The juvenile skull, Amtal I, is gracile but already shows some robust features: a thick glabella, a very thick mandibular horizontal ramus with a strong mylo-hyoidian line, gonial eversion and pronounced masseter insertions. In addition, both of the well-preserved mandibles decrease in height from the symphysis to the level of M_3; this is a trait which is frequently observed from this site southward to Mauritania. The occurrence of archaic robust features on a juvenile skull indicates that they were genetically determined, as in the case of the young female from Izriten, described above.

Sebkha Mahariat, at 22°16′N, covers an area of about 100 km². The high (5–15 m), littoral dunes are covered by shell-middens, which have been dated between 6180 and 5220 B.P. (Delibrias *et al.* 1976). Four burials were excavated, yielding three well-preserved skeletons. All of them have archaic features and are extremely robust. The skulls are pentagonal when seen from the back, and the vault is gabled with vertical sides in the occipital view; the occiputs are slightly mound-shaped. The temporal is low and arched, and a very strong supramastoid crest, delimited by a deep groove on its rear side, rises vertically on the temporal bone. The frontal bone is low and narrow with a postorbital constriction and a 2-mm depression, which almost forms a torus. The temporal lines are massive and rugged; they can be traced to within 1 cm of the coronal suture. The superciliary arches project into a thick, V-shaped glabella and the interorbital region is extremely wide (29 mm). All the vault bones are very thick, even on a female skull. The face is very wide and low, which is disharmonic with the elongated cranium. The nasal aperture is wide with a nasal spine, the orbits are low and rectangular; Mahariat II has a marked palatine torus. The horizontal rami of the mandibles are high and robust; one of them has three mental protuberances, the lateral ones being well developed. The vertical rami are massive and short, with everted gonial angles. All the muscular insertions (masseters, mylo-hyoidians, genioglossa and digastric) are remarkably enlarged; one of the mandibles has a retro-M_3 space, which is a rather archaic feature. The long bones are strikingly robust: the lateral flattening of the tibia and its muscular insertions are enormous. These characteristics will be observed again at other sites farther to the south, most notably at Tintan (see below). The index of robustness of the Mahariat I tibia (27.2) approaches that of the Neandertals (Figures 13.3–13.5).

The single skeleton recovered from Sebkha Lemheiris, 15 km south of Cap Barbas (22°6′N), has a more recent date of 3740 B.P. ± 130 years. Nonetheless, the mandible, the only bone that could be studied, is very robust, with a square and everted gonial angle, a short vertical ramus, and a horizontal ramus which decreases in height from the symphysis to the level of M_3 (like many of the specimens from Tintan and Chami, at 20°-21°N). The long bones are characterized by a very marked, transverse expansion (as was also observed at Mahariat and Tintan [see below]) and very strong muscular markings, in spite of the probable female sex of the skeleton, which is indicated by the wide sciatic notches.

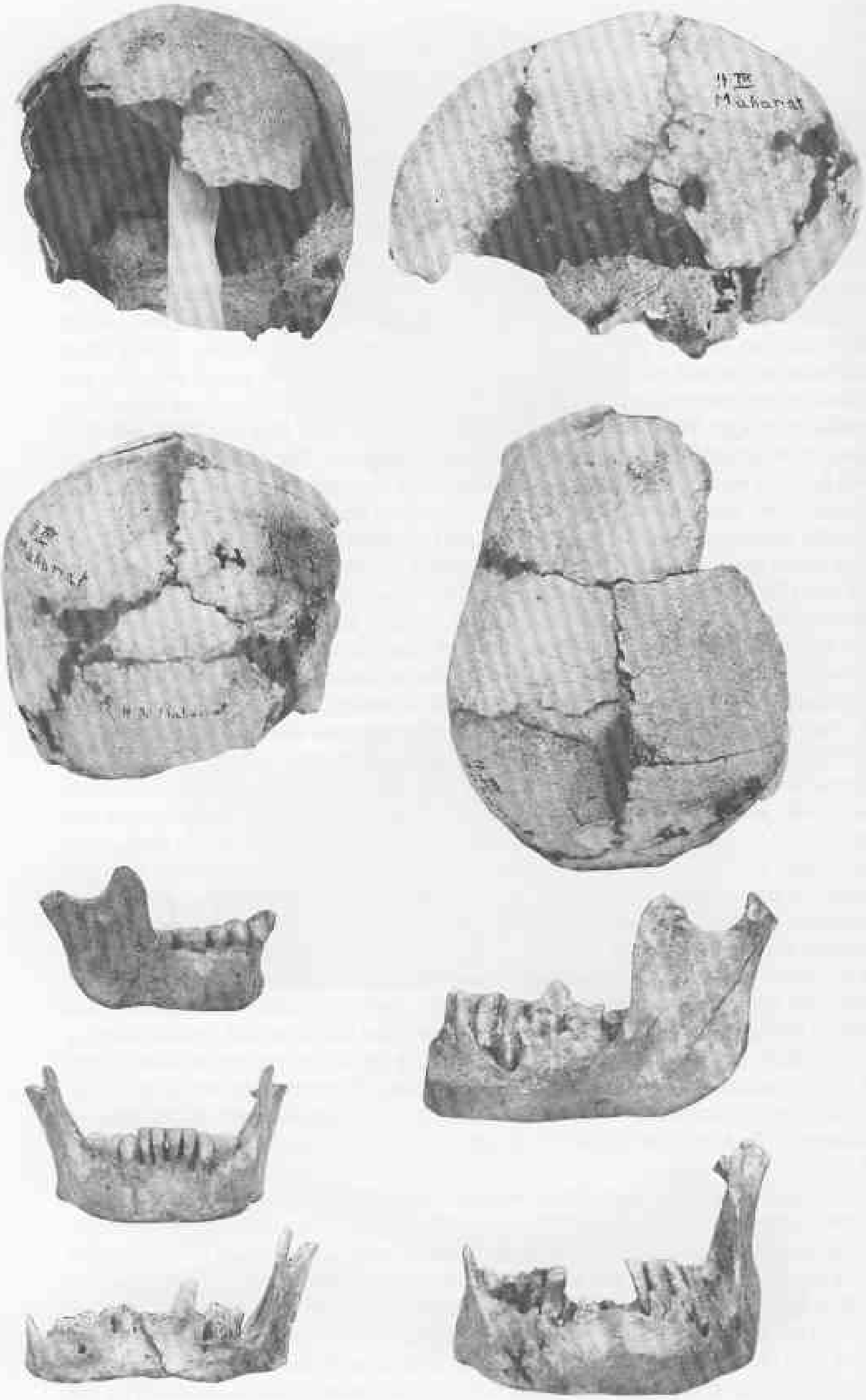

Figure 13.3 Mahariat III skull. Left: three Amtal mandibles. Right: Edjaila mandible.

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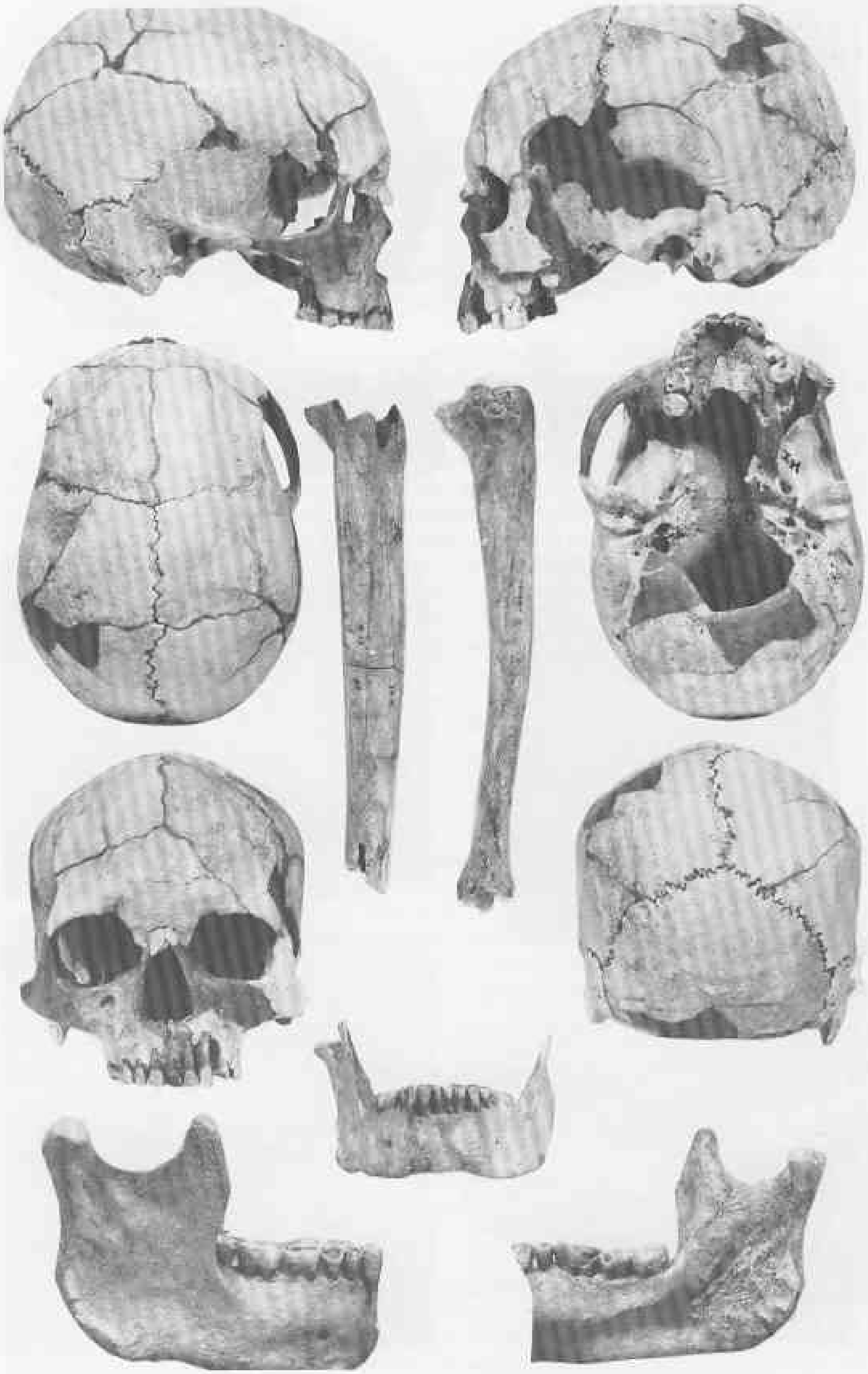

Figure 13.4 Mahariat I. The femur is compared with a modern robust example (right).

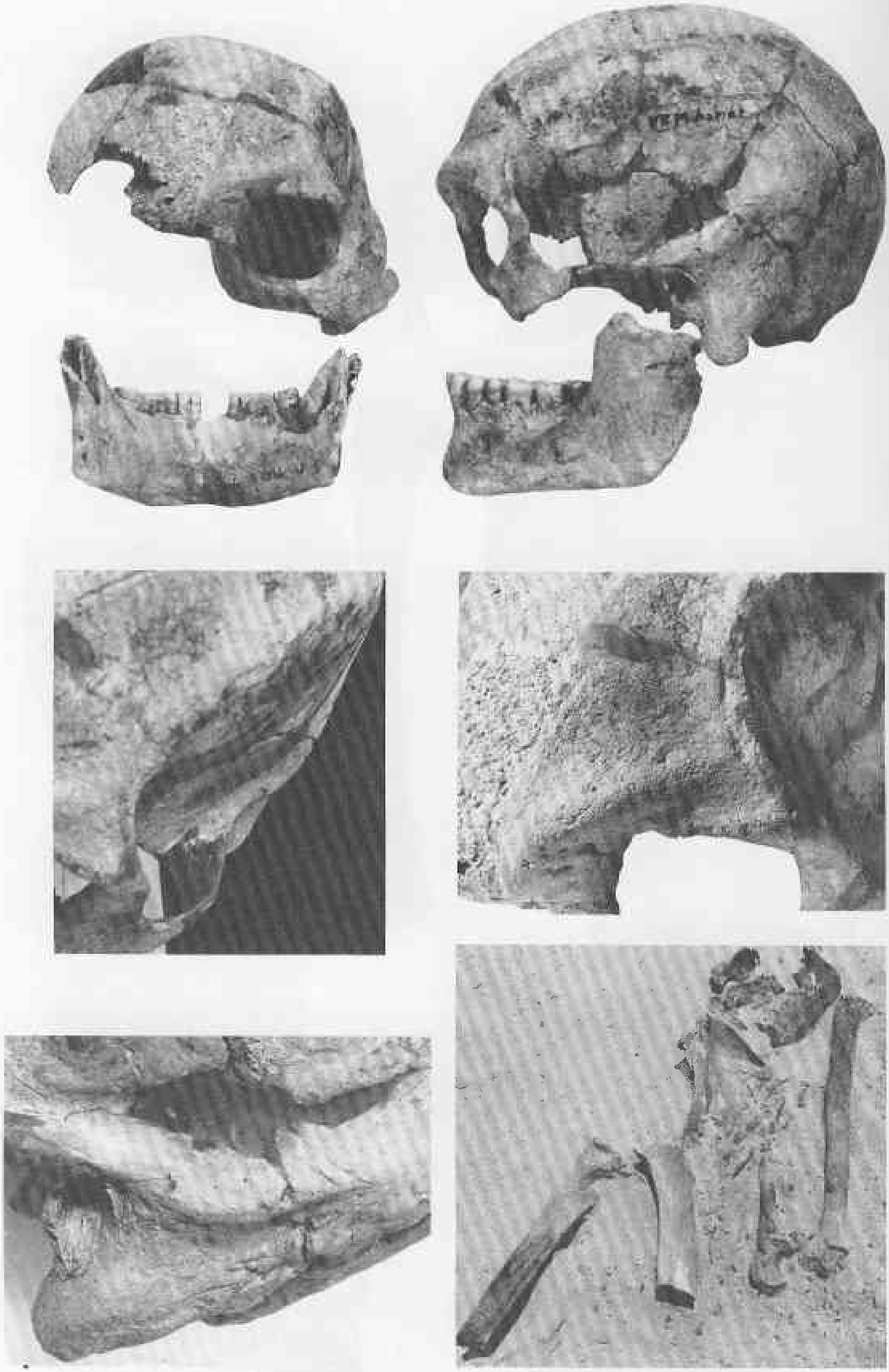

Figure 13.5 Mahariat II, showing details of the frontal and temporal bones; the skeleton was *in situ* in a consolidated dune.

; the skeleton was *in situ* in

The coastal dunes along Sebkha Edjaila contain a large number of burials but the skeletal remains have been heavily burned and are poorly preserved. As a consequence, it was possible to study only fragments but all of them indicated a high degree of robustness. The occiputs are markedly mound-shaped and the glabellae are short, very thick and V-shaped. The mandibles share the same characteristics as those described above from more northerly sites: everted and square gonial angles, and location of the maximal height at the symphysis. They also have large teeth and very thick mylohyoidian lines (Figure 13.3).

The sites of Tintan and Chami in northern Mauritania yielded the remains of 50 and 60 individuals, respectively, which were sufficiently well preserved to permit anthropological analysis.

At Tintan, the archaic features of the skull which were observed at the northern sites are repeated: great robustness; very thick cranial vaults; superciliary arches forming short, protruding V-shaped glabellae; everted gonions; inio-mastoidian ridges; projecting thick oblique lines of the mandibles; and short and massive, vertical, mandibular rami. Again, we have evidence that these characteristics are genetic, since they are present on juvenile and even infant skulls. More specifically, the parietal thickness is 10 mm for three children aged 10–13 years and 5 mm for an infant. The teeth include a high frequency of shovel-shaped incisors and of archaic traits such as a squat, globular shape and very thick enamel; the occlusal type and the eruptive chronology are different from those of modern groups. The long bones are very robust; the development of the femoral pilaster is striking (the mean pilasteric index is 122) and the two components of the *linea aspera* are often not fused in the middle of the diaphysis, a phenomenon which is rarely observed in present-day populations but which is a classic Neandertal characteristic. The fibula is often hypertrophic with an extraordinary tranverse development (like the Mahariat I tibia) while none of the other bones has any flattening at all (Figure 13.6).

At Chami, the skeletal and dental morphologies are more heterogeneous, including both the Tintan type as well as more gracile forms. The standard deviations of biometrical features are much higher here than in the northern series. Some individuals still have an archaic-looking, V-shaped, thick, protruding glabella and low orbits with a wide interorbital region but these features are far from being as frequent as they were in the north. About half the population still have shovel-shaped incisors, and the mean femoral pilasteric index remains at 120 (the Neandertal range) but its distribution curve is now bimodal; the tibiae often have an archaic morphology with a mean index of platycnemia of 78.3. The heterogeneity of the Chami series could suggest either marked sexual dimorphism or genetic heterogeneity. The latter is the more probable explanation, since marked sexual dimorphism was not apparent among populations farther to the north, where the female skeletons showed the same characteristics as the males. At Chami, therefore, we are dealing with a contact area between two populations, the southern one being most probably from sub-Saharan Africa.

THE TAOUDENNI BASIN

The southeastern part of the Taoudenni basin in Mali (Figure 13.7), some 1500 km inland from the Atlantic, is now hyperarid with annual precipitation varying between 5 mm and 50 mm, depending on latitude. It has recently been the subject of a detailed, multidisciplinary investigation (Petit-Maire 1986; Petit-Maire and Riser 1981, 1983;

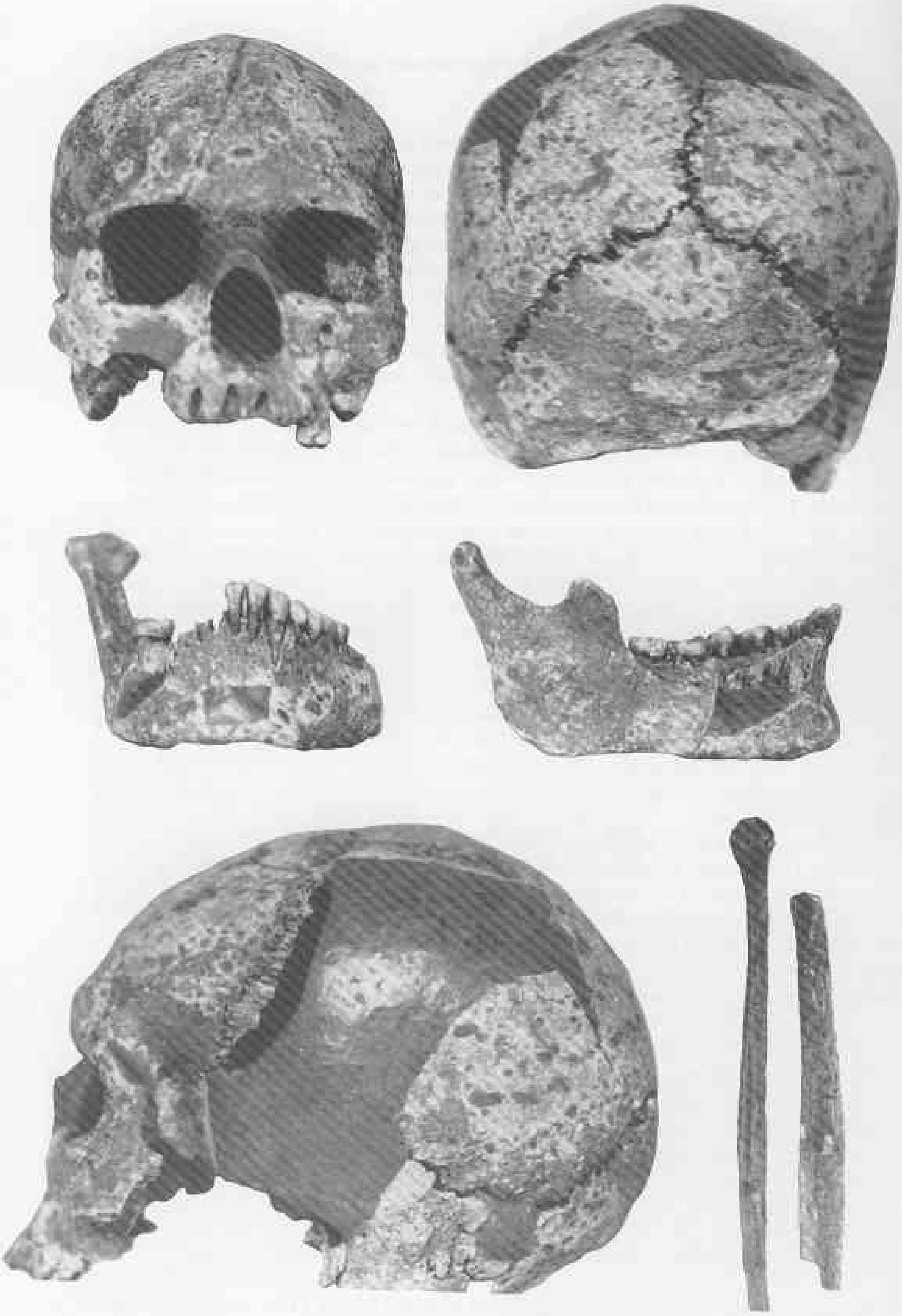

Figure 13.6 Chami VII. Tintan 337K fibula compared with a modern robust example (left).

robust example (left).

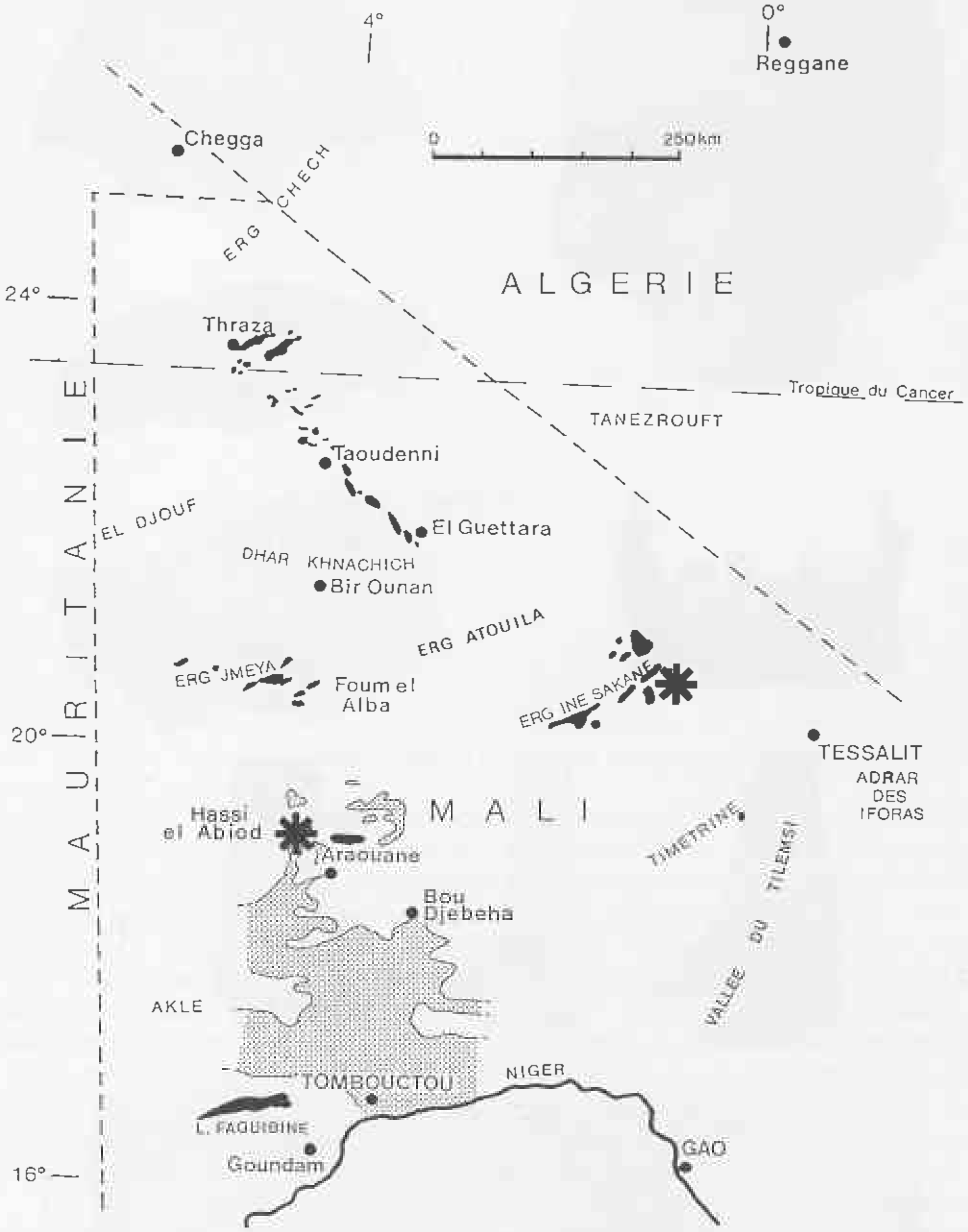

Figure 13.7 Anthropological sites in the Malian Sahara.

Petit-Maire *et al.* 1983). Several Holocene burials were excavated and a preliminary anthropological study of 20 of the skeletons (Dutour and Petit-Maire 1983) led to the conclusion that some individuals from the area of Hassi el Abiod (19°8′N, 3°57′W) showed attenuated Cromagnoid traits: a slight occipital torus, low and rectangular orbits, gonial eversion and cranio-facial disharmony. Some specimens had an archaic look, resulting from their supramastoid crests, heavy pilasteric lines and generally high degree of robustness (Figure 13.8). However, the series was heterogeneous and the archaic features not usually prominent.

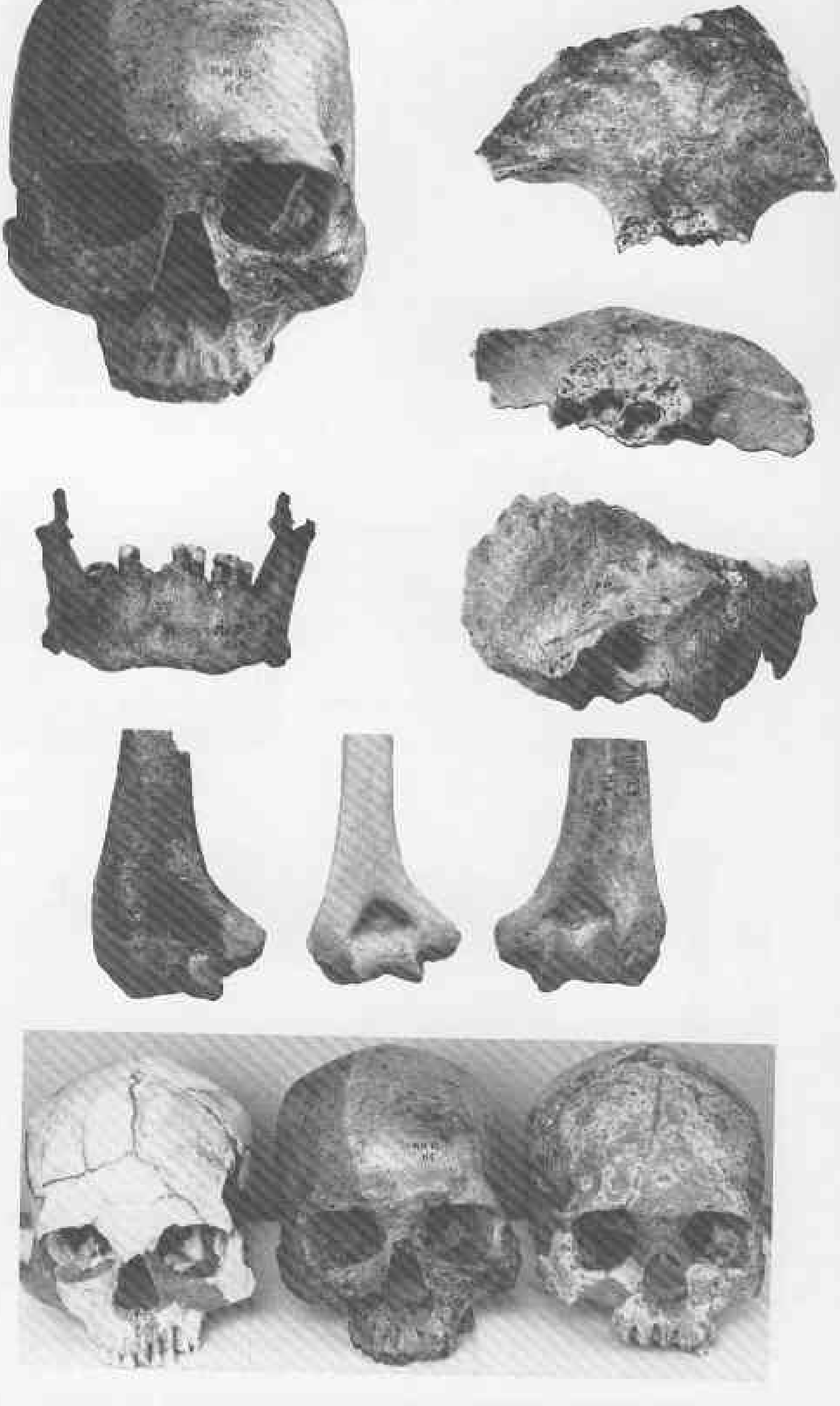

Figure 13.8 MN10: skull and mandible. AR7: frontal and temporal bones. MN27 (right) and MK37 (left) humeral lower epiphysis compared with a modern robust example (center).

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ample (center).

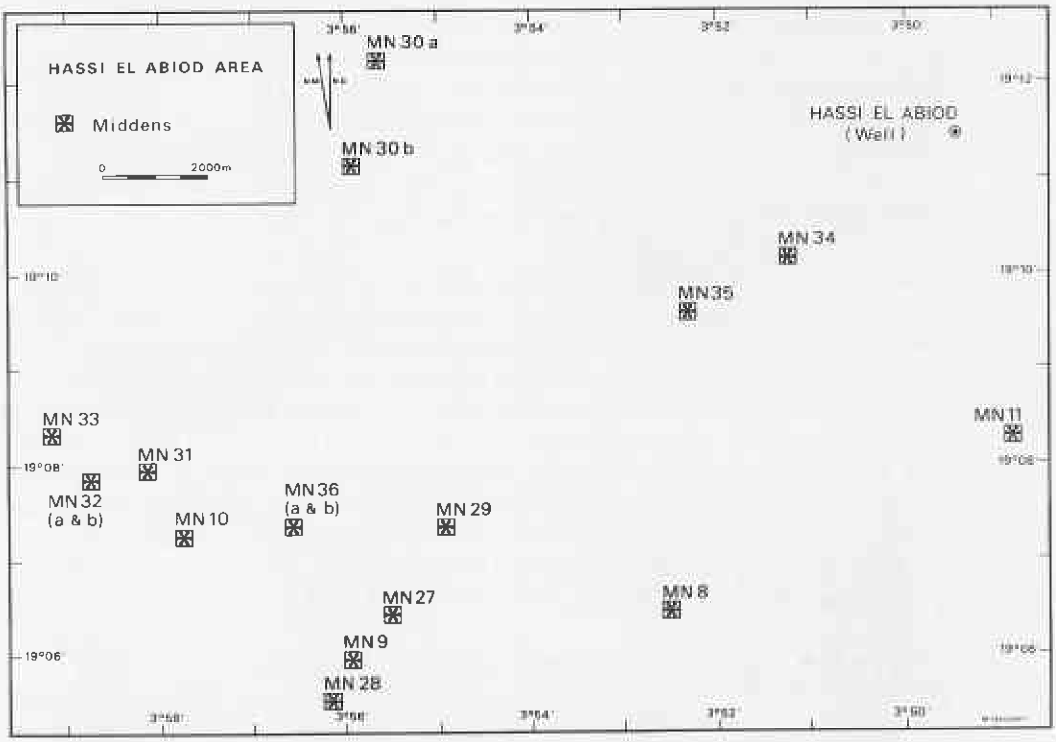

Figure 13.9 Anthropological sites in the Hassi el Abiod area of northern Mali.

In 1983, another field-season was carried out at sites in the same region, and numerous additional burials were found and excavated. These provide an important and well-preserved sample, complementing the earlier finds. They were found in middens associated with abundant faunal material, consisting mostly of fish, crocodiles, turtles and mammals (de Broin 1983; Buffetaut 1983; Gayet 1983; Guérin and Faure 1983), as well as with stone artifacts and ceramics (Commelin 1983, 1984; Raimbault 1983). The middens were located on the shores of fossil lakes; sediments and bones from them have been radiocarbon dated to the early Holocene (Petit-Maire 1986; Petit-Maire and Riser 1981, 1983). A preliminary study of the skeletons, and particularly of some of the complete specimens, confirmed beyond any doubt that the Mechta-Afalou type was present as far south as 20°N during the early Holocene (Dutour 1984).

The material consists of 89 skeletons, including both adults and juveniles, distributed among 16 sites (Figure 13.9). The skeletons had been buried in shallow graves in the middens, very tightly flexed and lying on their left or right sides. They have been studied by Dutour. Cranial and postcranial measurements were made following the osteometric technique of Martin (1956). Sex was determined according to the morphology of the pelvis. Only 20% of the skeletons were well preserved; they are derived from a homogeneous population.

The skulls are characterized by their robustness. The vault is noticeably thick, especially in the obelion region. It was not possible to measure the cranial capacity directly, but it was calculated using Olivier's formula (Olivier and Tissier 1975) and found to be high: 1400–1600 cc for the male skulls. The general dimensions are large, particularly the maximal length for which the mean value among the males is greater than in modern populations (Howells 1973). The neurocranium is long relative to its breadth and the mean cranial index indicates dolichocrany. The values of the height indices fall within the metrio- and orthocranic classes (Table 13.1).

In *norma verticalis* (Figure 13.10), the overall shape of the cranium is roughly either pentagonal, oval or ovo-rhomboidal. The zygomatic arches are always noticeably prominent (phenozygy). The craniofacial breadth index is high, with a bizygomatic breadth about 4% greater than the biparietal breadth. The frontal bone is broad (eurymetopic) and slightly divergent.

In *norma lateralis* (Figure 13.11), the glabella is rather prominent in the males (types 3 and 4, according to the Broca-Martin classification) but less so in the females (type 2). The Schwalbe bregmatic angle indicates slight frontal obliqueness (60°) and the fronto-sagittal index indicates average curvature for this bone. On four skulls, the parietal segment begins with a depression behind the bregma and, in four others, ends with a semi-flat region in front of the lambda. The occipital curvature is slight according to the occipito-sagittal index (Tobias 1959). Pronounced occipital mounds were observed on two male skulls and incipient mounds on six others. The inion prominence is poorly defined, being no greater than Broca type 3 in the male skulls. The supramastoid crest is always present, and is pronounced or very pronounced in both sexes. Upper facial prognathism is slight in contrast to the marked alveolar prognathism.

The cranium is pentagonal in *norma occipitalis* (Figure 13.12).

In *norma facialis* (Figure 13.13), the supraorbital eminences are massive in both sexes and most frequently correspond to Cunningham's type II (1908). The facial skeleton is low, broad and dysharmonic with the neurocranium. The orbits are low, rectangular and elongated. The interorbital breadth is large, with a mean value higher than the highest values observed in modern Melano-Africans (Howells 1973). The mean value of the nasal index falls within the platyrhine range. The inferior margin of the nasal aperture is variable and a prenasal groove (*sulcus praenasalis*) can be observed on most specimens.

The mandibles are robust, massive and large in size. The mean mandibular index indicates dolichognathism. The mandibular body is very high. The ramus is broad and short with a mean index which is higher than even the highest values observed for modern populations. The muscular insertions are rugged and sometimes very pronounced. Almost all individuals, even infants, show gonial eversion.

TABLE 13.1
Cranial Indices for the Hassi el Abiod Skulls (both sexes)

	No.	Mean	Range	St. Dev.
Cranial index	12	71.8	63.4– 77.4	3.36
Length-height index	12	60.6	54.0– 67.2	3.98
Breadth-height index	11	84.8	77.0– 93.3	5.38
Craniofacial breadth index	8	103.2	99.2–106.4	2.87
Frontosagittal index	14	88.4	84.8– 90.6	3.40
Occipitaosagittal index	17	86.9	83.0– 93.8	3.87
Upper facial index	8	48.5	45.0– 53.6	3.47
Orbital index	10	71.2	68.1– 73.9	2.12
Nasal index	8	51.4	43.3– 64.4	6.98
Mandibular index	15	92.6	75.0–112.0	8.80
Ramus index	16	67.2	58.2– 80.0	5.41

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77.4	3.36
67.2	3.98
93.3	5.38
106.4	2.87
90.6	3.40
93.8	3.87
53.6	3.47
73.9	2.12
64.4	6.98
112.0	8.80
80.0	5.41

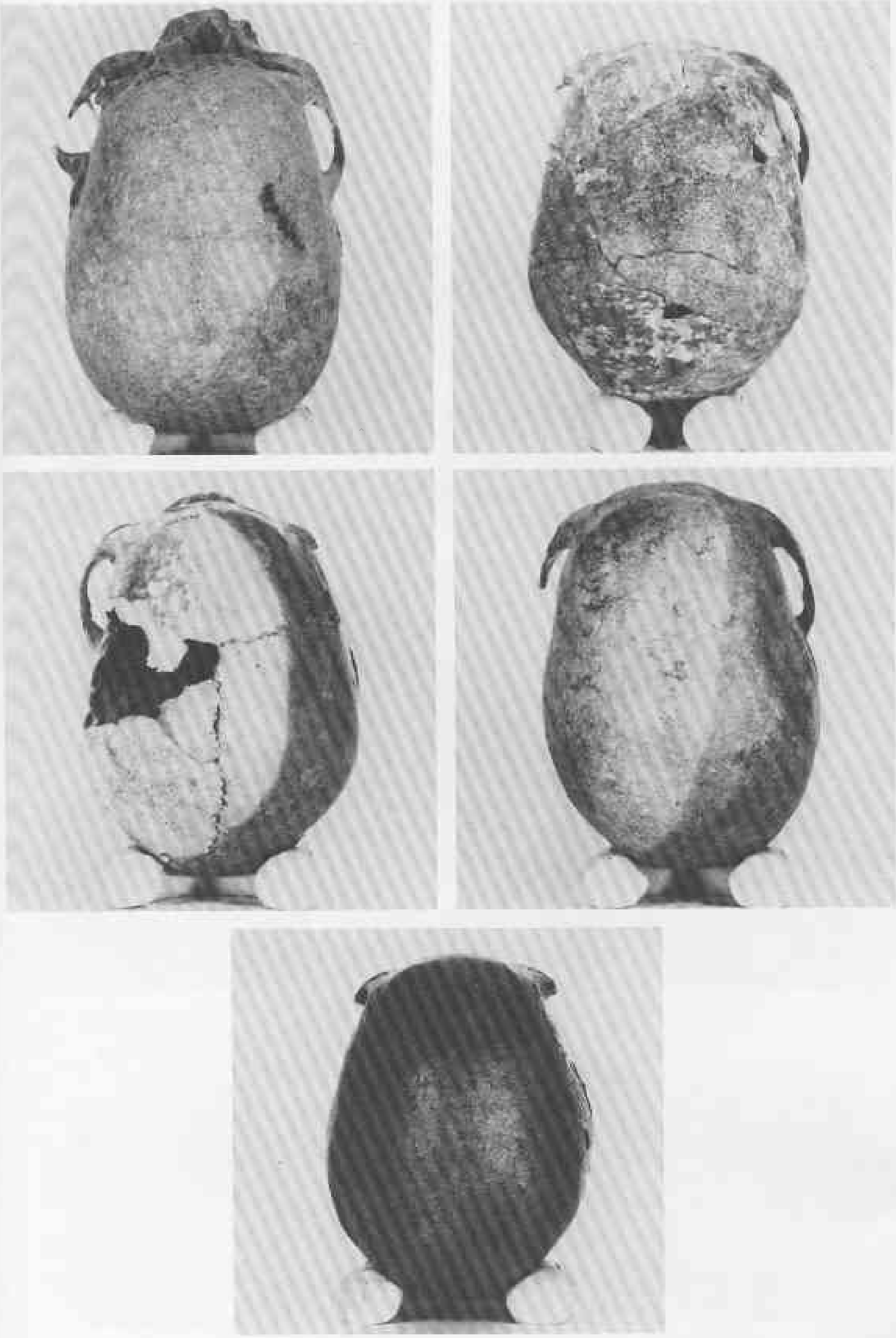

Figure 13.10 Hassi el Abiod skulls in *norma verticalis.*

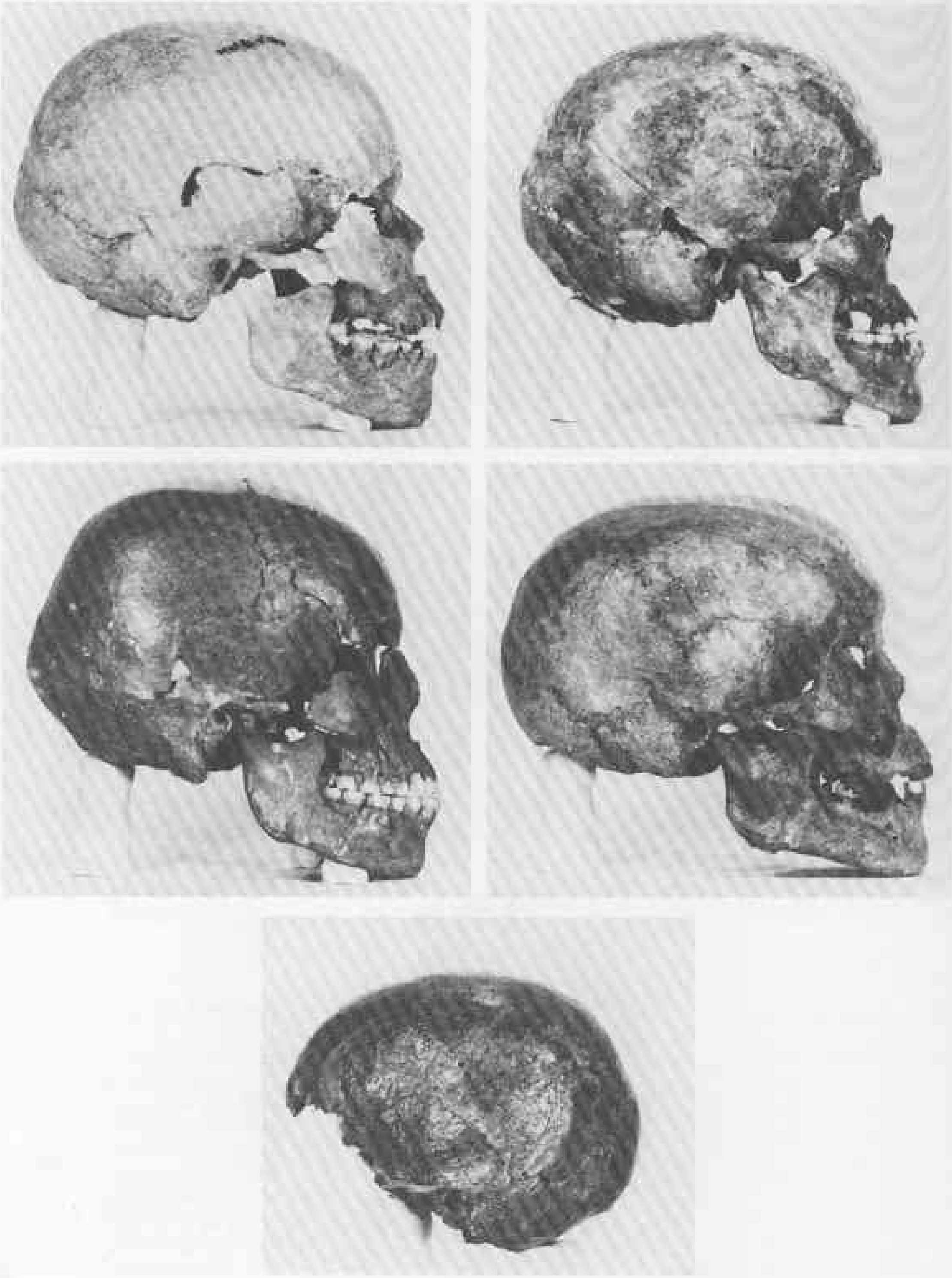

Figure 13.11 Hassi el Abiod skulls in *norma lateralis.*

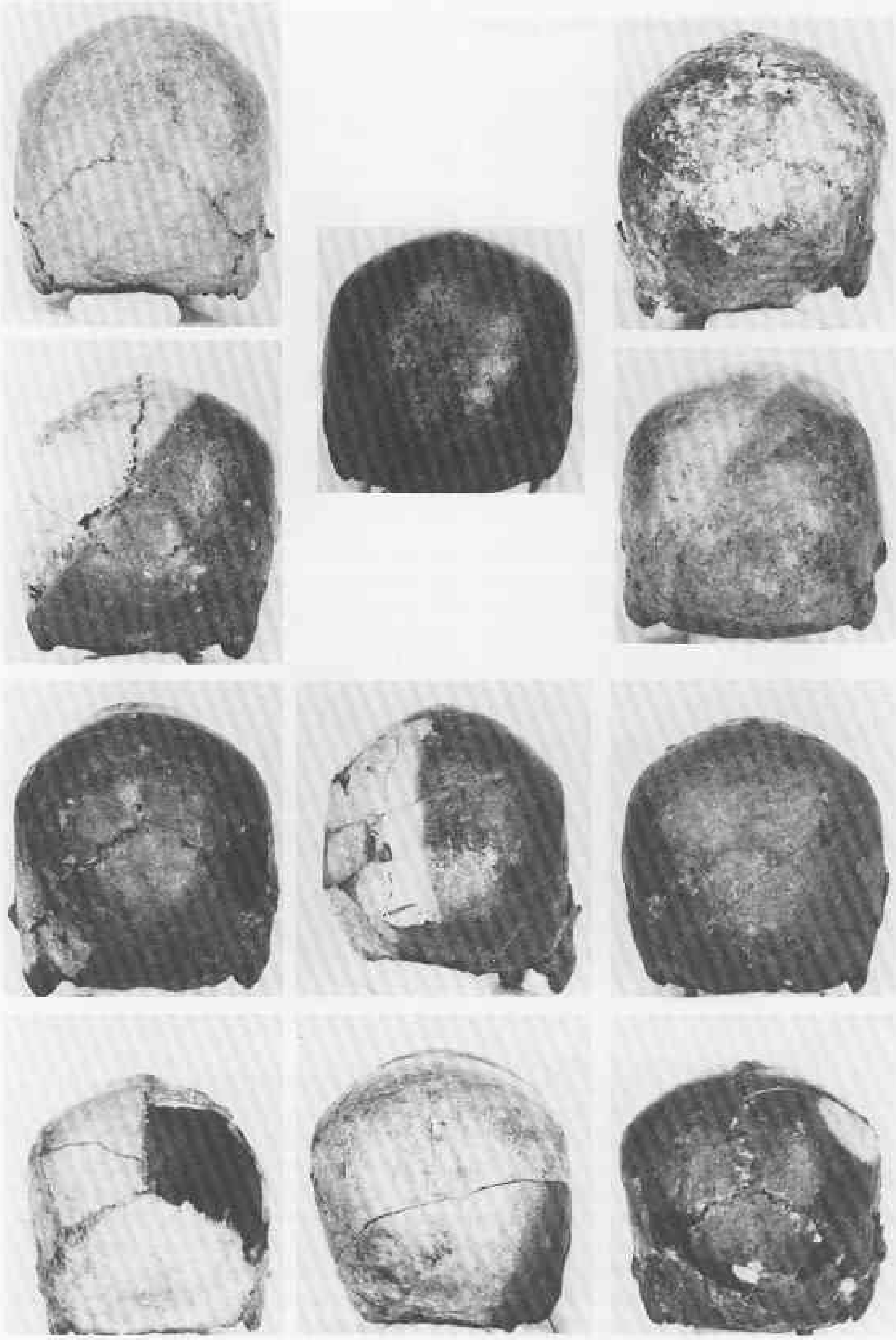

Figure 13.12 Hassi el Abiod skulls in *norma occipitalis*.

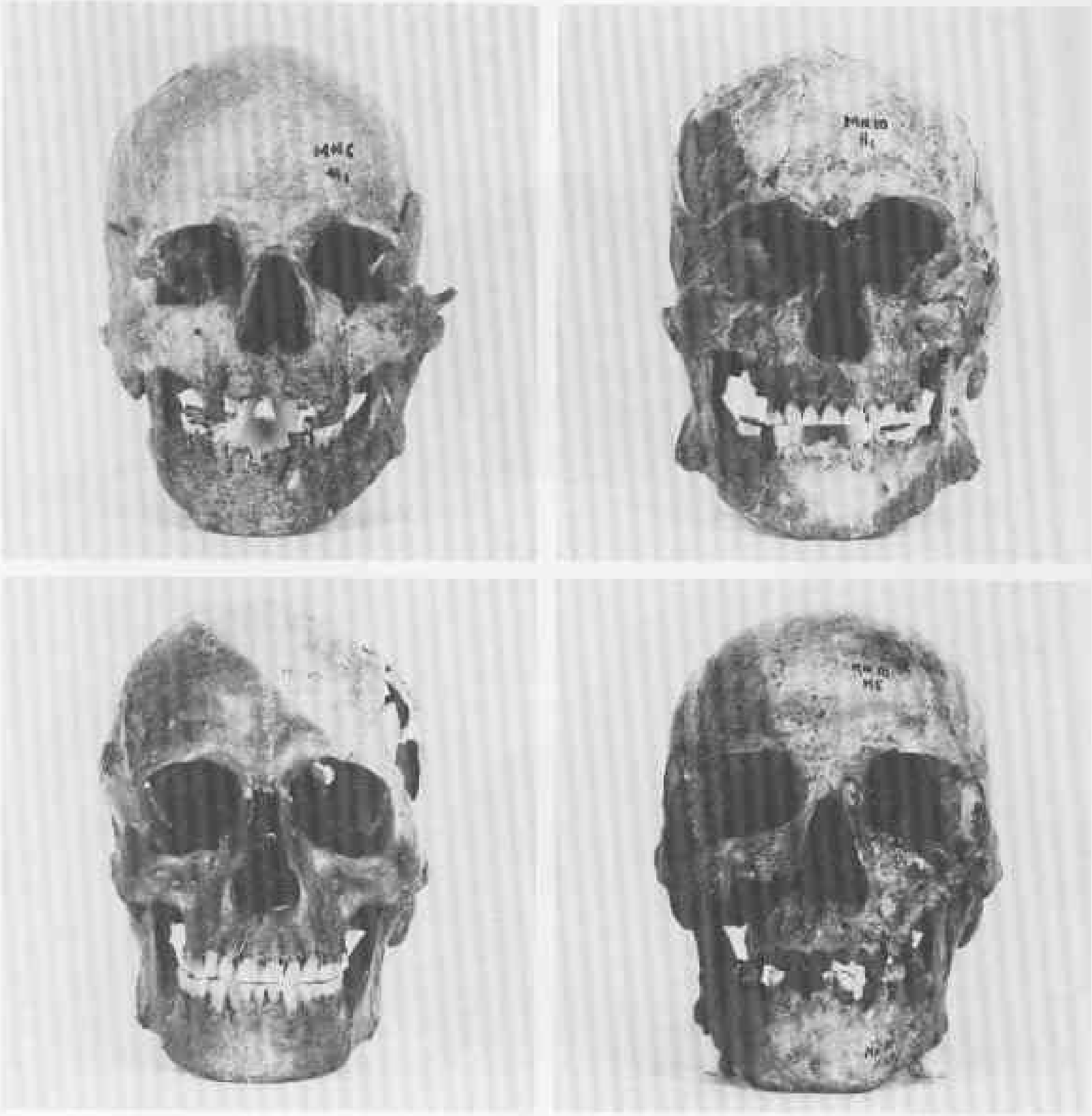

Figure 13.13 Hassi el Abiod skulls in *norma facialis*.

The humerus shows very strong muscular insertions in both sexes; the mean value of the platybrachic index falls within the eurybrachic category (Table 13.2); a septal aperture is present in 12 out of 31 specimens (39%). The radius is characteristically long, as is the ulna which also usually has a very prominent *pronatus quadratus* crest.

The femur is elongated, with a high mean value for the pilasteric index. The two components of the *linea aspera* do not join at the middle of the diaphysis, which is an archaic trait also observed on Neandertal femora. The degree of subtrochanteric flattening of the shaft is variable, as is shown by the wide range of the platymeric index.

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TABLE 13.2
Postcranial Indices for the Hassi el Abiod Population (both sexes)

	No.	Mean	Range	St. Dev.
Platybrachic index	25	78.2	68.0–86.9	5.10
Pilasteric index	29	117.9	103–134	6.87
Platymeric index	16	86.5	70.2–103	8.11
Platycnemic index	17	69.4	55.4–80	6.18

The tibia is relatively long with moderate flattening of the shaft, as indicated by the mean value of the platycnemic index. Stature was estimated using Olivier's formula (Olivier and Tissier 1975) and values of 167–185 cm were obtained for the males, which are rather high.

COMPARISONS

The material described above, which has been found within the last ten years, has certain, sometimes numerous, morphological similarities to populations and individuals known from earlier work in the Maghreb, the Sahara and the Nile Valley. These populations include the human remains from Mechta el Arbi (Balout and Briggs 1951); Afalou bou Rhummel (Arambourg *et al.* 1934; Vallois 1952); Jebel Sahaba (Figure 13.14; Anderson 1968); Wadi Halfa (Greene and Armelagos 1972); Taforalt (Ferembach 1962); Columnata (Chamla 1970); Tagdaït (Charon *et al.* 1974a); Meniet V (Charon *et al.* 1974b); Mbak-Dhoual, Tin-Lalou, Zaki, Ait el Khaoua, El Guettara and Karkarichinkat (Chamla 1968) and Asselar (Boule and Vallois 1932). The most striking characteristics, which may be more or less pronounced, are a long and robust neurocranium with mound-shaped occiput; heavy mastoids; very marked temporal lines; thick V-shaped glabellar ridges; a very wide, massive interorbital region; a short, broad face with low, rectangular orbits; a massive mandible with a short, broad, vertical ramus and gonial eversion; and a very high general robustness of the long bones with an occasional huge (but not pathological) transverse enlargement. These characteristics have been described as "Cromagnoid" by most authors, and can be observed on female, juvenile and even infant skeletons, which suggests that they are inherited traits.

The population from the Malian Sahara has been compared with the other Epipaleolithic and Early Neolithic groups by means of a sigmatic scale (Figure 13.15) and of multivariate analysis (Figure 13.16). The specimens from Hassi el Abiod are very similar to those from Afalou bou Rhummel and, still more so, to those from Taforalt. However, they differ from both groups in a few details, such as the smaller biparietal and frontal breadths, the higher frequency of occipital mounds, shorter rami and the absence of the cultural practice of avulsion of the incisors. The most recent series from Columnata show more attenuated Mechtoid traits. The Egyptian and Sudanese specimens have the same range of similarities to and differences from the Northwest African Mechtoids. Asselar Man clearly belongs to the Hassi el Abiod subgroup, although it was found some 600 km to the east of the latter. Chamla's "neolithics" are very diverse in chronological and geographical provenance and do not correspond to a single group. It is, therefore, not unexpected that the multivariate analysis shows an intermediate position for these populations.

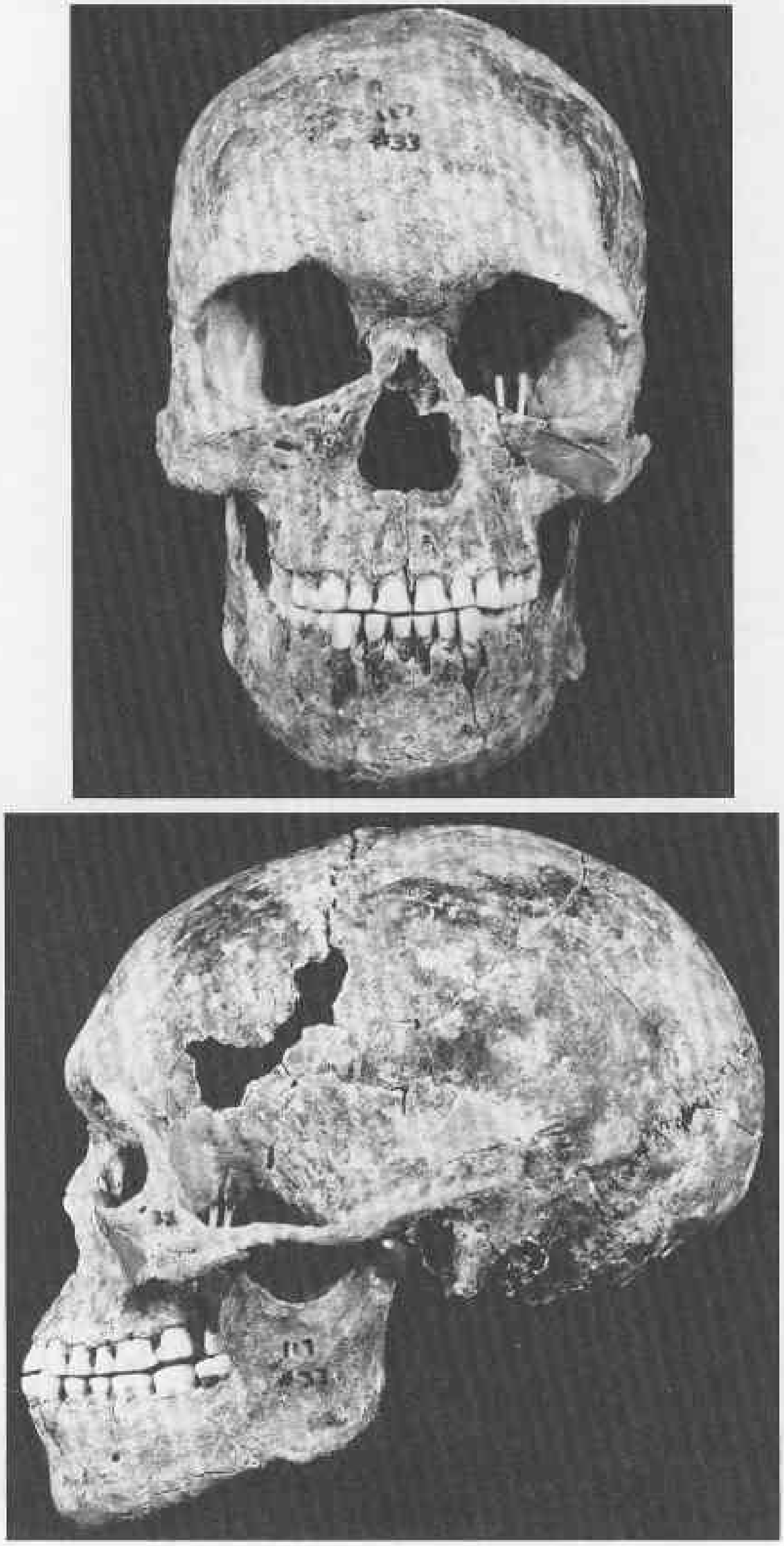

Figure 13.14 Skull of burial 117-102 from Jebel Sahaba, Nubia.

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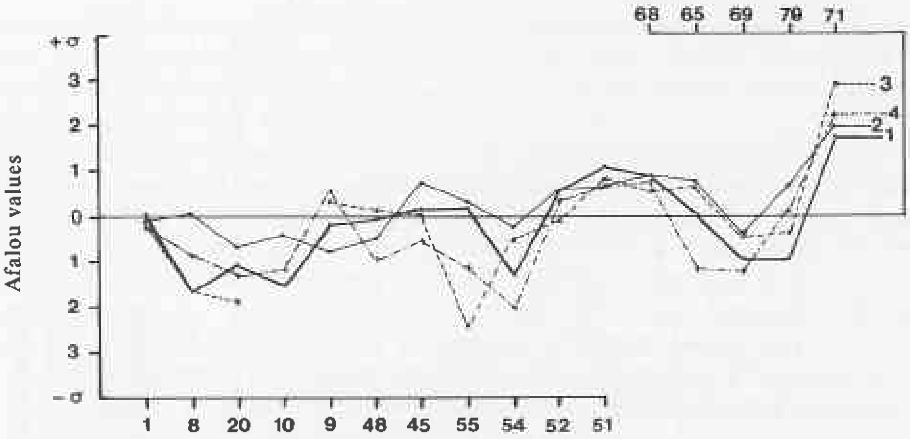

Craniometric values (Martin 1956)

Figure 13.15 Sigmatic scale. Comparison of some mean male craniometric values for five Mechtoid populations. Populations: 0, Afalou; 1, Hassi el Abiod; 2, Taforalt; 3, Jebel Sahaba; 4, Wadi Halfa. Craniometry: 1, cranial length; 8, cranial breadth; 20, auricular height; 10–9, maximum and minimum frontal breadth; 48, upper facial height; 45, bizygomatic diameter; 55, nasal height; 54, nasal breadth; 52, orbital height; 51, orbital breadth; 68, mandibular length; 65, bicondylar diameter; 69, symphysis height; 70, ramus height; 71, ramus breadth.

Some of the Neolithic skeletons from the Malian Sahara (Dutour 1984; Dutour and Petit-Maire 1983) were found not in the middens but in constructed graves lying well to the north of the other sites. They are more recent than those described above, dating from about 4000 B.P. (Petit-Maire 1986; Petit-Maire and Riser 1983), and statistical analysis shows that they are not Mechtoids.

In the light of these new findings, it is now evident that the Malian Sahara, down to 19°N, was inhabited by a typical Mechtoid population during the early Holocene. It is well established that an attenuated Mechtoid type occupied Northwest Africa during the same period. Thus, the Mechtoids of Northwest Africa did not become morphologically more gracile throughout the continent, but, in some areas, the descendants of the original Mechta-Afalou populations retained the same robust characteristics for about 5000 years.

ORIGIN OF THE MECHTOIDS

The geographical extension of populations of the Mechtoid physical type throughout the Maghreb and the Sahara is now known to have been wide, but the problem of their origin and development has not yet been solved. The possibility of a "Negroid" origin cannot even be considered, since there are no skeletal attributes which are diagnostic of such an origin; vague references to prognathism and to limb proportions are of little value (Anderson 1968:1028, 1035; Charon *et al.* 1974a:154; Petit-Maire 1979a:212). On the other hand, the hypothesis of an Aterian ancestry appears much more promising (Ferembach 1976, 1985; Petit-Maire in press a, in press b; Thoma 1978). The two Aterian skulls which are now known, from Témara and Dar es Soltane (Debénath 1975, 1980), have many of the same features as those described above, although they

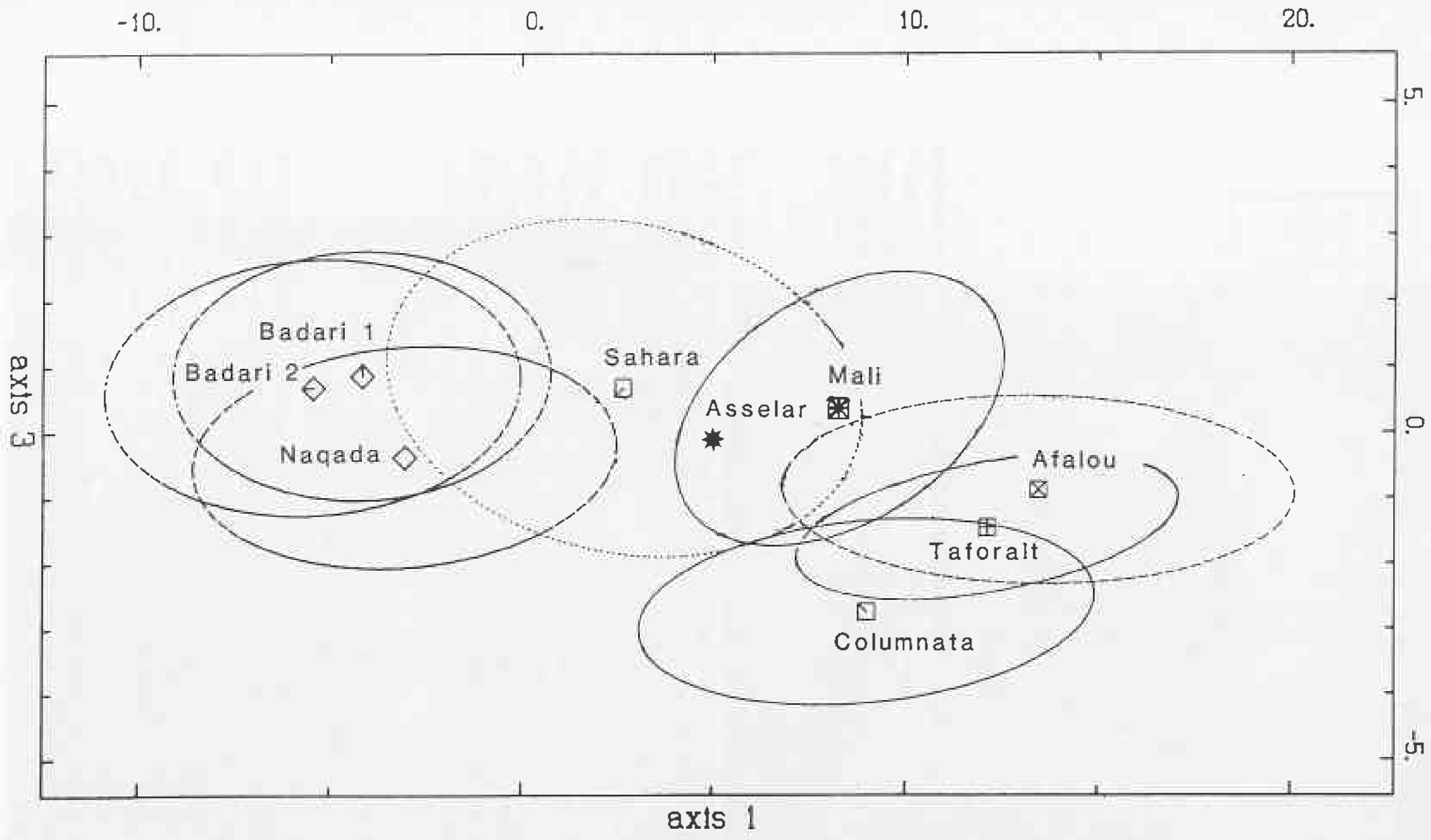

Figure 13.16 Multivariate analysis (after Menk's [1981] method). Comparison of Mechtoid populations (Afalou, Taforalt and Columnata) with the authors' series (Asselar is located within the latter). Analysis shows clear differences between Mechtoid and non-Mechtoids—Egyptian and Nubian series from Naqada (Fawcett 1902 [quoted in Menk 1981]), Badari 1 (Morant 1935 [quoted in Menk 1981]), Badari 2 (Stoessiger 1927 [quoted in Menk 1981])—and assigns intermediate position to mixed Neolithic series described by Chamla (1968).

Figure 13.16 Multivariate analysis (after Menk's [1981] method). Comparison of Mechtoid populations (Afalou, Taforalt and Columnata) with the authors' series (Asselar is located within the latter). Analysis shows clear differences between Mechtoid and non-Mechtoids—Egyptian and Nubian series from Naqada (Fawcett 1902 [quoted in Menk 1981]), Badari 1 (Morant 1935 [quoted in Menk 1981]), Badari 2 (Stoessiger 1927 [quoted in Menk 1981])—and assigns intermediate position to mixed Neolithic series described by Chamla (1968).

are much more pronounced. Ferembach (1976) has even proposed a filiation among the Mousterian populations of Morocco (as at Djebel Irhoud), the makers of the Aterian and the makers of the Iberomaurusian industries, in spite of the cultural chasm which separates their lithic cultures (Debénath 1986).

Recent research into the paleoclimatology of the Sahara now permits us to make a more informed and useful consideration of these hypothetical origins and descents. This responds to Wendorf's early lament, "it is unfortunate that we are unable to provide more specific data on the environment of the Sahara during this period" (1968:1057), so that the role of the Sahara in the development of prehistoric cultures might be assessed. The following climatic sequence has now been established for the basins of the Western Sahara by a large number of radiocarbon dates.

1. *Ca.* 30,000 to *ca.* 20,000 B.P.: a wet phase marked by widespread lacustrine transgressions, associated in the west with Aterian artifacts (Durand and Lang 1983; Durand *et al.* 1983; Petit-Maire 1986; Tillet 1985).

2. *Ca.* 20,000 to *ca.* 10,000 B.P.: an arid phase when much of the Saharan belt encroached towards the south (Rognon 1980). The low-lying areas became totally desertic, deflation and accumulation processes took place and no surface water was available anywhere, since even in the southern Sahel precipitation was reduced to 20–50% of the present-day amount (Talbot 1984). In the Taoudenni area of northern Mali, the pedunculate Aterian, which is known throughout the region (Chavaillon and Fabre 1960; Raimbault 1983), has recently been found *in situ* beneath thick (*ca.* 2 m) sand deposits which underlie paleolacustrine, fossiliferous silts dated to about 9000 B.P. (Petit-Maire 1986). This Aterian site is stratigraphically equivalent to those which are commonly found in the same basin along the highest shores of the fossil lakes; one of these lakes, about 130 km to the southeast, has a date of 21,000 B.P. ± 300 years (Petit-Maire 1986). Thus, for the first time, we have direct evidence for the chronostratigraphic position of the typical Aterian industry and also evidence for the association of a pronounced change in climate with the abandonment of a site. Throughout the entire Sahara at this time, the makers of the Aterian were compelled to migrate towards wetter areas, such as the coast, the valleys of large rivers (the Nile and the Niger) or mountainous areas.

3. *Ca.* 12,000/9000 B.P. to *ca.* 4000 B.P.: a wet phase marked by the return of extensive lakes or areas of swamp. In the early and mid-Holocene, numerous Epipaleolithic and Neolithic sites were occupied in the Western Sahara, in association with the widespread expansion of Sahelian vegetation and fauna into that area (Petit-Maire 1979a, 1980, 1986; Petit-Maire and Riser 1983). The human populations in the Nile and Tilemsi valleys, along the Atlantic coast and in the Hoggar had Mechtoid-like features developed to a greater or lesser extent, while a typical Mechtoid population lived at Hassi el Abiod along the northern shores of a vast interior delta that was fed by floods from the Niger, occurring as much as 200–300 km north of its present bend (Gayet 1983; Petit-Maire and Gayet 1984; Petit-Maire and Riser in press).

In the late Pleistocene and early Holocene, therefore, Saharan populations, who still retained the archaic physical features that had been characteristic of the Aterian populations (and perhaps even of the Neandertals?), inhabited precisely those areas to which the makers of the Aterian had most probably retreated during the late Pleistocene arid phase—the Atlantic coast, the Nile and Tilemsi valleys and the Niger basin. It is difficult to regard this as purely coincidental. At the present time, the lithic artifacts do not support a hypothesis of filiation between the Aterian and the Epipaleolithic and Neolithic groups. However, it is not impossible that there should have been very intensive cultural change during the ten millennia of exile from the Sahara enforced by hyperaridity, especially since it may have been only small groups who came into contact with alien cultures. Genetic traits, on the other hand, would have been more likely to survive even if there was cross-breeding and could probably be traced even down to the present day on the peripheries of the Sahara.

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14

Characteristics of the Final Neolithic and Metal Ages in the Region of Agadez (Niger)

DANILO GRÉBÉNART

INTRODUCTION

The Eghazer basin lies at about 17°N, at the contact between the Sahara and the Sahel. It is a wide plain bounded on the northeast by the footslopes of the Aïr and on the south by the Tigidit scarp, forming a curved *cuesta* about 200 km long. The first evidence of protohistoric copper-working, tied to the presence of copper-ores, was discovered in 1962 (Mauny 1962). However, the exceptional archaeological interest of the area has become apparent only since a program of research which was begun in 1976 (Grébénart 1985). Both copper and iron were locally worked, and using technological and chronological criteria, it has been possible to distinguish several different phases of these activities within the archaeological record. In addition, metallurgy was developed within an apparently Neolithic context: the copper-workers are related to Neolithic industries of Saharan type, while the first iron-workers may have been derived from a Sahelian Neolithic established to the south of the Tigidit scarp.

NEOLITHIC

There are many Neolithic sites on the plains of the Eghazer basin below the Aïr, and about 150 have been inventoried. On the basis of the first radiocarbon dates and the affinities in ceramics which exist between them and the earliest metal-using sites, all of the sites appear to belong to a Late, or even Final, Neolithic. Preliminary test-trenches and limited excavations have been carried out at only a few sites, while at others there has been no more than the collection of diagnostic artifacts from the surface scatters.

SAHARAN NEOLITHIC

The term *Saharan Neolithic* is used because of the resemblances in pottery between this industry and those of the Sahara; the same vessel-forms and decorations are found to the north within the desert proper.

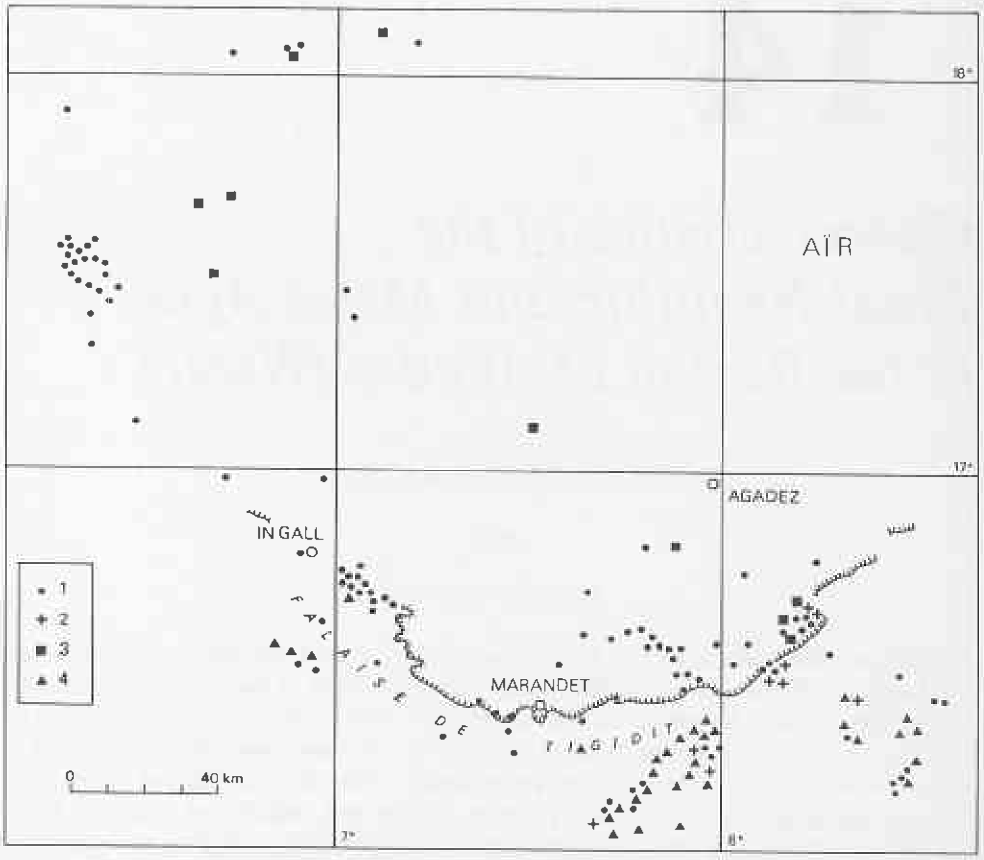
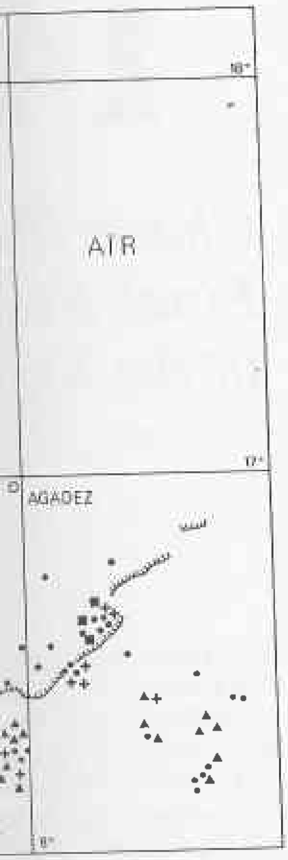


Figure 14.1 Map showing the locations of the principal archaeological sites in the Eghazer basin. Key: 1, Saharan Neolithic; 2, Sahelian Neolithic; 3, Copper Age (Copper I and Copper II); 4, Early Iron Age (Iron I).

The Saharan Neolithic is represented by the largest number of sites. There are about 120 scattered throughout the Eghazer basin as well as to the south of the Tigidit scarp (Figure 14.1). All of them are open-air sites, often covering more than a hectare. The principal characteristics of the Saharan Neolithic are an extreme abundance of pottery, a scarcity of stone tools, the presence of terra-cotta figurines and terra-cotta structures, and the offering of sacrificial animals with some of the human burials.

Ceramics

The homogeneity in shape and decoration of the ceramics from the various sites studied and their affinities with vessels from more northerly regions undoubtedly mask some facial differences, which may be clarified by future excavation. For the moment, however, the pottery of the Saharan Neolithic is characterized by a predominance of rounded or spherical shapes, wide openings so that vessels resemble salad-bowls or cooking-vessels (narrow necks exist but are rare), openings with concave profiles on some vessels (Figure 14.2), and bobbin-shaped handles sometimes accompanied by purely decorative *appliqué* lozenges (Figure 14.2). These last traits, which are quite



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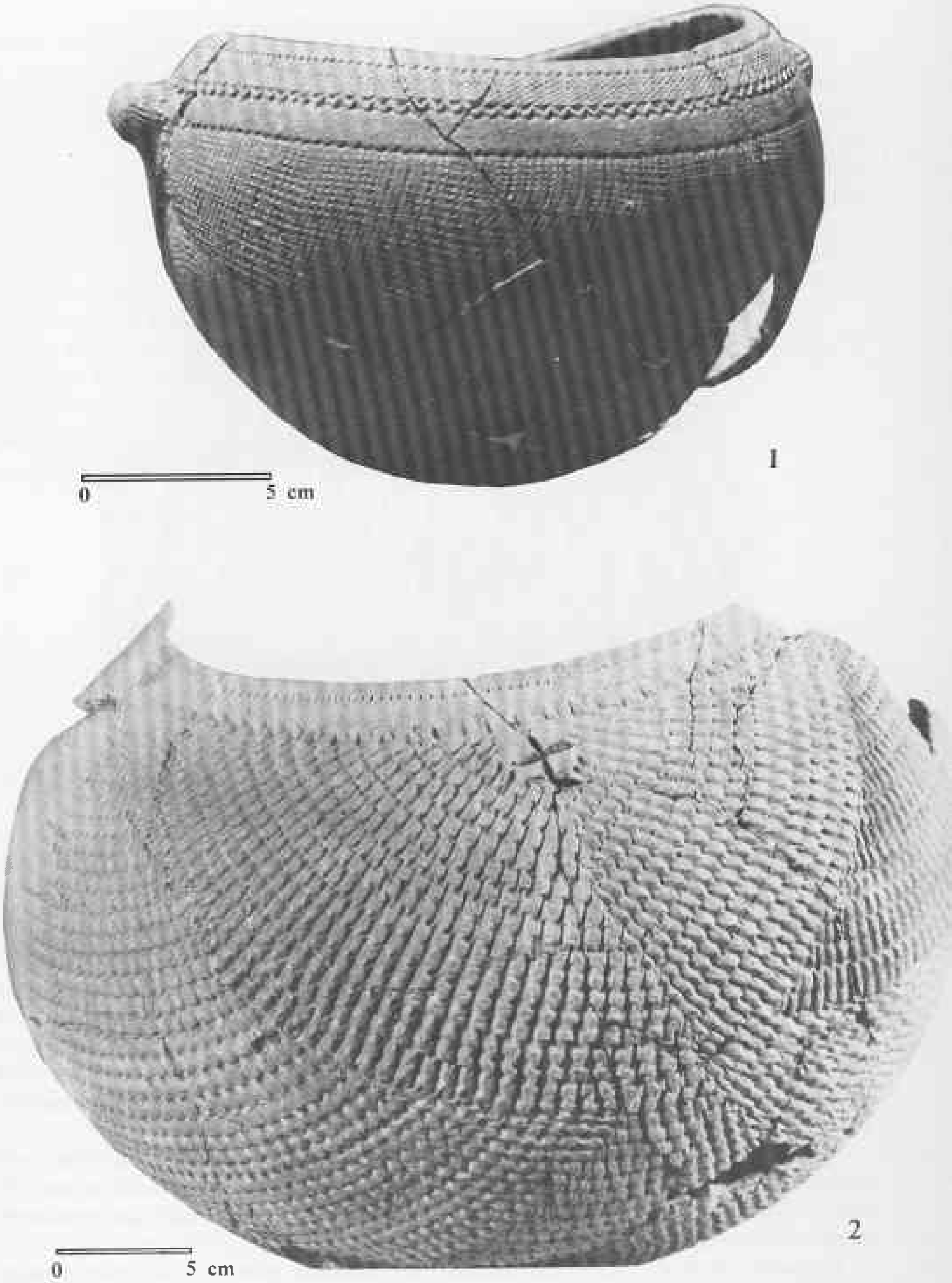

Figure 14.2 Ceramics of the Saharan Neolithic. 1, vessel with concave-profiled orifice, two perforated handles and decoration including a band of chevrons in relief near the orifice (from Chin Tafidet); 2, a large, sub-spherical vessel with a band of chevrons in relief and a crossed, *appliqué* lozenge near the orifice, and offset, overlapping fans of inverted angle-impressions covering the walls (from Orub).

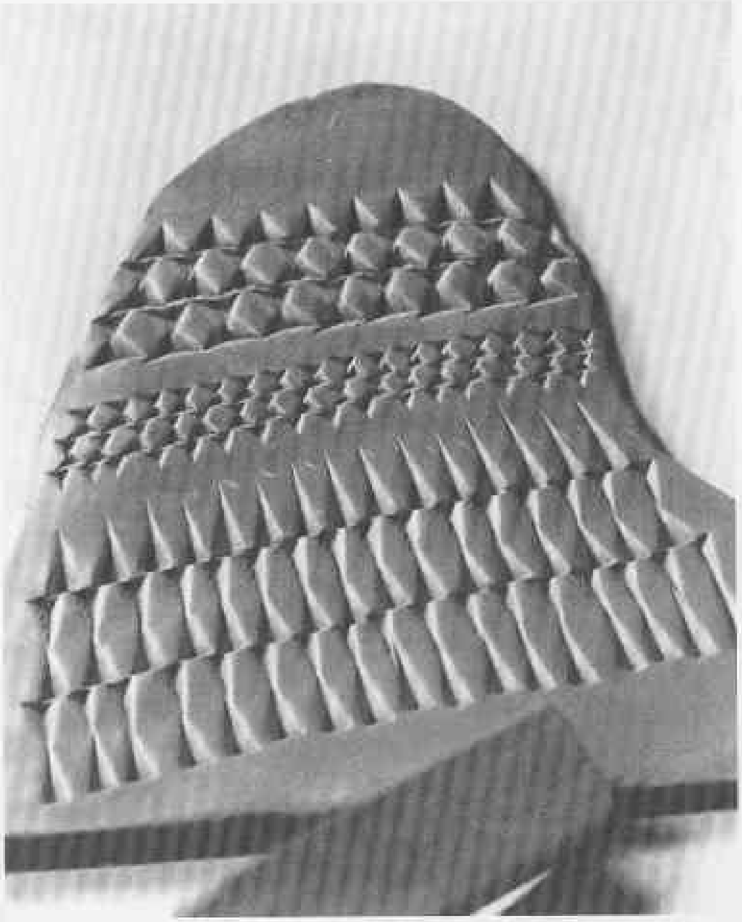

Figure 14.3 Saharan Neolithic. Experimental replication of the decorative motif called "inverted angle-impressions" and the tool with which it was made.

common in the Agadez region, appear to be extremely rare elsewhere. Some vessels with concave-profiled openings have been reported from the Atlantic coast of Mauritania (Hugot 1974:118), and they may also have been known in the Tassili, if we are correct in our interpretation of some of the objects represented in the rock-paintings (Lajoux 1977:110). Bobbin-shaped handles, however, seem to have been completely unknown in the Sahara.

Most of the vessels are extensively decorated. Chevrons are the most common motif and are found in bands of raised relief (Figure 14.2), or as contiguous impressions in lines or squares, or in wide bands or ribbons. All of these variants were made by direct or pivoting impressions; incised decoration is very rare.

Two sites, Orub and Anyokan Site 201, are characterized by a rather unusual motif in the shape of bee-hives, which we have called "inverted angle-impressions" and have replicated experimentally (Grébénart 1978). This motif covers the whole of the vessel-surface and is often placed as concentric arcs forming enclosed fans, which are aesthetically very pleasing (Figure 14.3). The motif is formed by impressing the the dihedral angle of the corner of a plain wand.

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Lithic Industry

Stone artifacts are more numerous in the north than in the south near the Tigidit scarp. In the latter area, the site of In Taylalen I provides a numerical indication of their importance. Here, a systematic collection taken from an area of 120 m², or about an eighth of the total area of the site, yielded only 2400 pieces of debitage and 170 retouched tools. The frequencies of the tool-classes are given in Table 14.1, where the Epipaleolithic types (the first nine types listed in the table) follow the definitions of Tixier (1963). The predominance of endscrapers is particularly noteworthy; this is a characteristic of all of the sites in the region and recurs farther to the east, in the Ténéré (Quéchon and Roset 1974).

The higher standard of manufacture of stone artifacts to the north of the Eghazer basin, at Tuluk Site 211 for example, may be attributed to the presence of a better quality raw material that permitted the production of consistent blade debitage, unlike the rocks available around the Tigidit scarp.

TABLE 14.1
Frequencies of Retouched Tools from In Taylalen I

	No.	%
Endscrapers	83	48.82
Perforators	2	1.17
Burins	1	0.58
Retouched bladelets	3	1.76
Notched and denticulated pieces	25	14.70
Scaled pieces	12	7.05
Scraper-like pieces	6	3.52
Worked pebbles	5	2.94
Pieces with continuous retouch	6	3.52
Flaked or polished axes	18	10.58
Arrow heads	5	2.94
Bifacial foliates	4	2.35

Terra-Cotta Figurines and Structures

There are many anthropomorphic and, above all, zoomorphic, terra-cotta figurines (Figure 14.4), only a few centimeters high. There are also small objects which may have been gaming-pieces (Gouletquer and Grébénart 1979).

Several sites have yielded blocks of terra-cotta and even structures of terra-cotta. The latter occur north of the eighteenth parallel and have been reduced by deflation to a truncated foundation covering an area of up to 4 m². Gutter-like conduits, without any particular orientation, may be distinguished, but little else. The structures have no traces of metal-working, such as slag or vitrification of the walls, or of combustion (there is no ash or charcoal). They are always situated in Neolithic sites and surrounded by the normal Neolithic detritus, notably potsherds. No study has yet been made of these enigmatic structures. They cannot, however, be confused with pottery-kilns, which are unknown elsewhere in the southern Sahara.

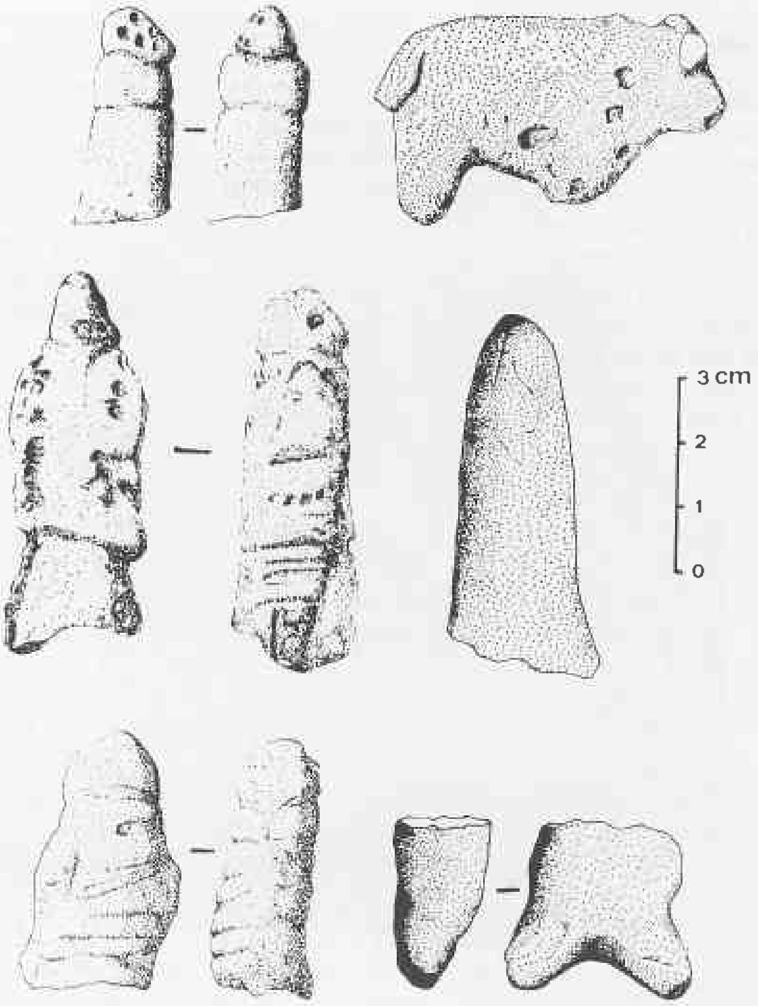

Figure 14.4 Saharan Neolithic, Sekiret valley. Terra-cotta figurines (from Gouletquer and Grébénart 1979).

Human and Animal Burials

The deliberate burial of a bovid in a Neolithic cultural deposit is known from Adrar Bous, northeast of the Aïr (Carter and Clark 1976). The burial has been radiocarbon dated to 5760 B.P. ± 400 years, which, when calibrated, would give an age between 5260 and 3940 B.C. (Klein *et al.* 1982). Complete bovid skeletons occur quite frequently at sites in the Eghazer basin, and at Chin Tafidet there is evidence that these animals were offerings to accompany the human burials (Paris 1984). A neck vertebra of one bovid was even marked from the cutting of its throat.

Radiometric Dating

There are two radiocarbon dates which relate directly to the Saharan Neolithic. The site of Orub is dated to 3390 B.P. ± 100 years (Gif.4173) and Chin Tafidet to 3385 B.P.

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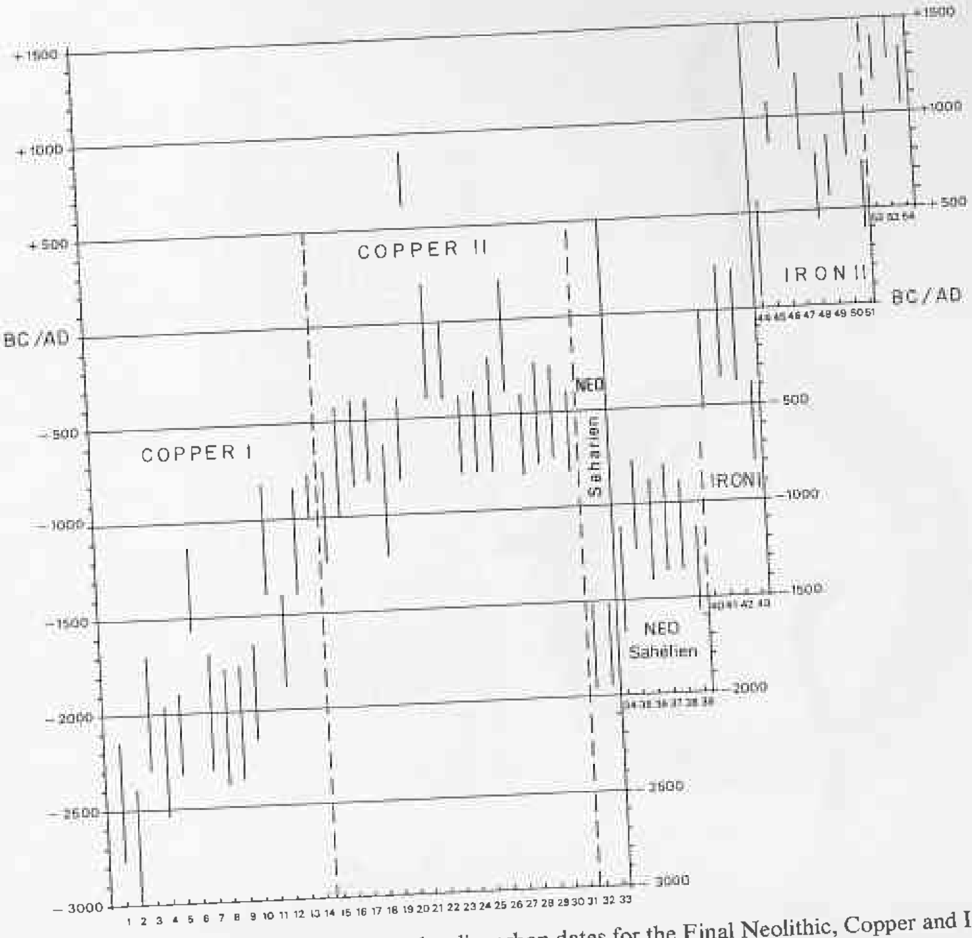

Figure 14.5 Distribution of calibrated radiocarbon dates for the Final Neolithic, Copper and Iron Ages near Agadez (Niger). Key: 1–10, Afunfun Site 175; 11, Aghtauzu Site 178; 12–14, 31, Sekiret Valley; 15–20, Afunfun Site 162; 21–23, Ikawaten Site 193; 24–28, Azelik Site 210; 29, Tyeral Site 207; 30, Tuluk Site 211; 32, Orub; 33, Chin Tafidet; 34–36, Chin Wasararan Site 117; 37, Effey Waschran Site 149; 38, Afunfun Site 179; 39, Mio Site 169; 40–41, In Taylalen II; 42, Tegef n'Agar Site 74; 43, Ekne Wan Ataran Site 119; 44–50, Marandet I; 51, Afenouk; 52–54, Azelik Wan Birni.

± 65 years (unnumbered date from the Laboratory of Hydrology and Isotopic Geochemistry, Paris). When calibrated (Klein *et al.* 1982), these would give ages between 1960 and 1535 B.C. and between 1885 and 1565 B.C., respectively (Figure 14.5).

SAHELIAN NEOLITHIC

The Sahelian Neolithic occurs within the expansion zone of the Saharan Neolithic, but occupies a distinct location south of the eastern part of the Tigidit scarp (Figure 14.1). It is known from only nine sites of which the most important, Chin Wasararan Site 117, covers an area of several hectares. Apart from the specific location of the sites, the Sahelian Neolithic is best characterized by its ceramics (including both pottery and terra-cotta) and radiocarbon dates. Flaked or polished stone artifacts are rare but are always present, particularly the small endscrapers.

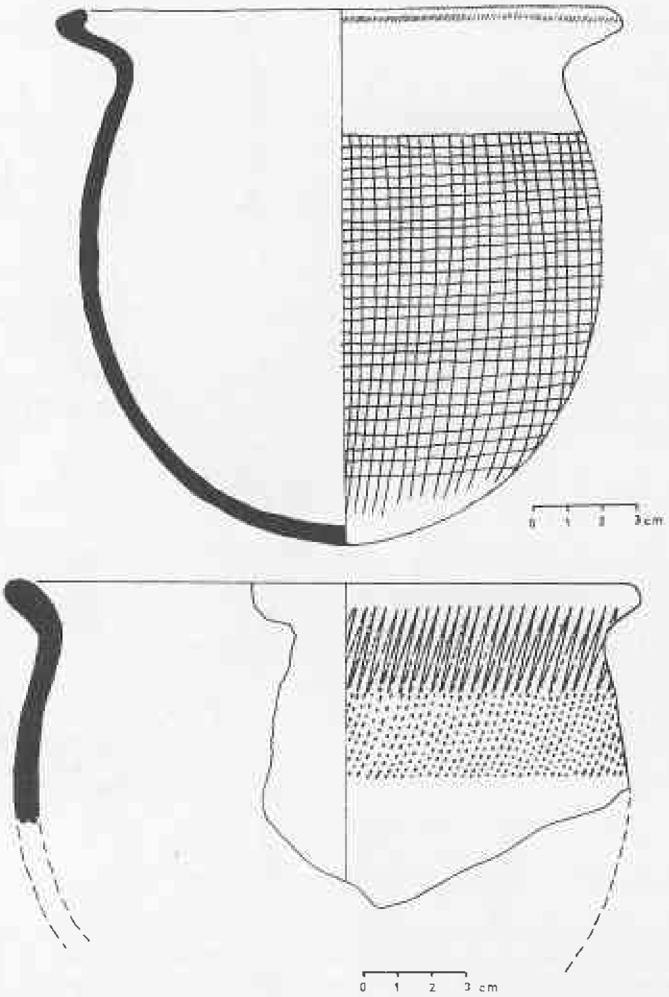

Figure 14.6 Sahelian Neolithic, Chin Wasararan Site 117. Ovoid vessels with flared rims.

Ceramics

The pottery of the Sahelian Neolithic is so individual that, in order to distinguish it from that of the Saharan Neolithic, we have named it "Wasa type" (after Chin Wasararan Site 117), both for ease of reference and to indicate its originality. Pottery of Wasa type is very different from that of the Saharan Neolithic and the two cannot be confused.

Pottery is extremely common on all sites. Almost all of the vessels have thick, irregular walls scarred with numerous imprints of vegetation. The vessel-forms show little variation and are essentially spherical with wide openings. Many of them resemble basins or salad-bowls, some of the latter having flat bases. One common form is an ovoid bowl with a short, flared neck (Figure 14.6).

Decoration is rare. The most common varieties, which are arranged in horizontal or vertical bands, are parallel rows of dots made by rocker-stamping and large, incised cross-hatchings on the ovoid bowls (Figure 14.6). Some vessels are covered with a

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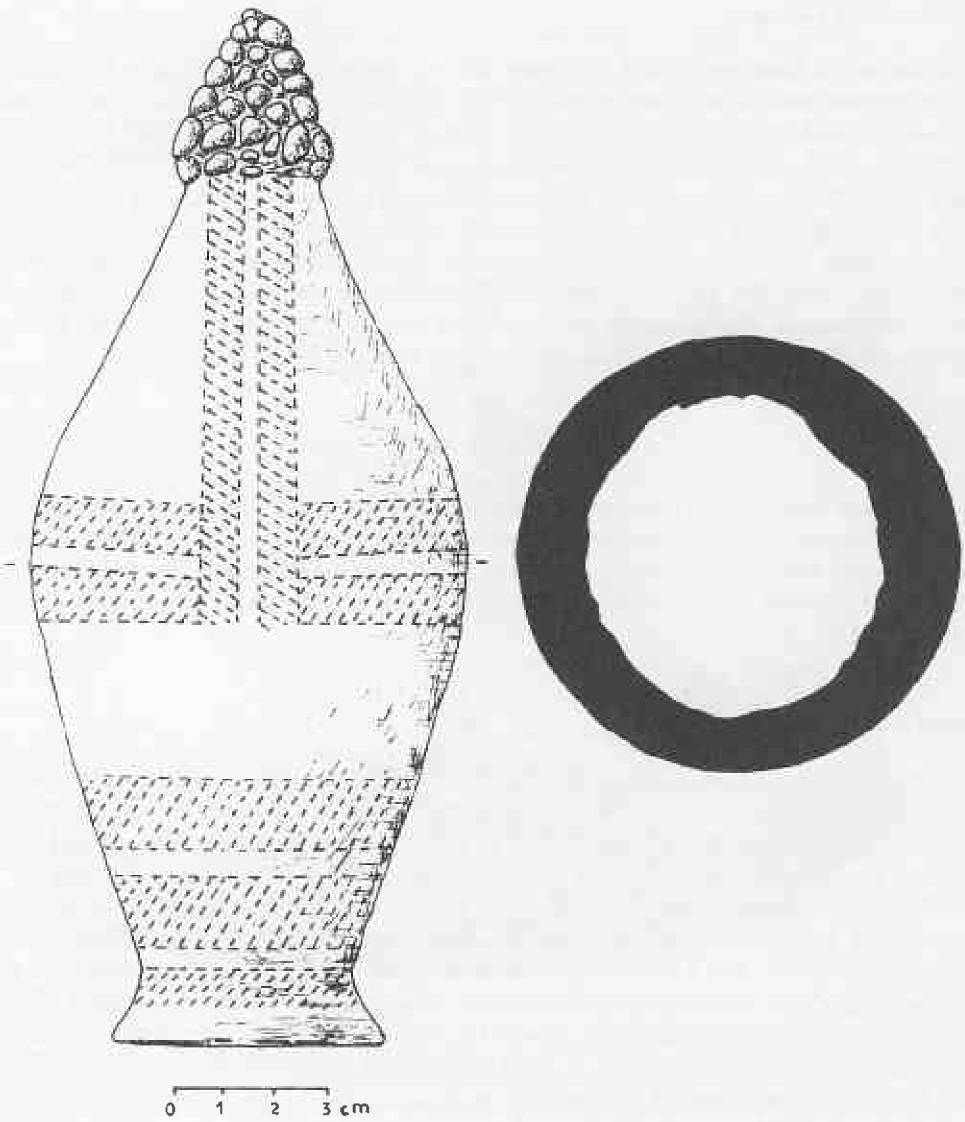

Figure 14.7 Sahelian Neolithic, Chin Wasararan Site 117. Enigmatic object of terra-cotta.

plain, brick-red slip, sometimes associated with painted cross-hatching in bistre and black.

In addition to pottery, the Sahelian Neolithic is also characterized by the presence of enigmatic, terra-cotta objects which are found on the surface of almost all sites and in the test-excavations dug into them. Some of them could be completely reconstructed and have the form of a flask with a round cross-section. They are hollow but are completely sealed and could not, therefore, have been used as bottles. They often have one end in the shape of the stopper of a decanter, covered with small, relief lozenges, and can be stood upright on the other, flattened end (Figure 14.7).

Radiometric Dating

The age of the Sahelian Neolithic is better defined than is that of the Saharan Neolithic. There are six radiocarbon dates available from four sites. Chin Wasararan Site 117 has three dates of 3160 B.P. ± 95 years (MC.1700), 2795 B.P. ± 105 years (MC.1701) and 2870 B.P. ± 95 years (MC.1702), which give ages of 1685–1130 B.C., 1250–790 B.C. and 1425–890 B.C., respectively, after calibration (Klein *et al.* 1982). Efey Washaran Site 149 is dated to 2875 B.P. ± 105 years (MC.1703; 1360–815 B.C. after calibration). Afunfun Site 179 is dated to 3030 B.P. ± 100 years (Gif.5178; 1550–915 B.C. after calibration). Mio Site 169 is dated to 3170 B.P. ± 90 years (MC.2395; 1690–1140 B.C. after calibration). The Sahelian Neolithic thus extended from the seventeenth to the ninth centuries B.C. and was contemporaneous with the Saharan Neolithic.

COPPER AGE

The Copper Age remains from the region of Agadez are, at this time, the oldest known from the southern Sahara. We can distinguish two phases in the development of this industry: the Early Copper Age, or *Copper I*, and the Late Copper Age, or *Copper II*. All of the remains from both of these periods occur to the north of the Tigidit scarp (Figure 14.1).

EARLY COPPER AGE OR COPPER I

For this period, we are dealing essentially with the remains of furnaces, usually occurring in groups but sometimes isolated. There are several hundred of them at the foot of the Tigidit scarp at Afunfun Site 175, where most of the study of them has been carried out, and also farther north in the Sekiret valley and the area of Tawadji.

These furnaces are never associated with living-sites. Their archaeological context consists of a few, rare artifacts: potsherds, which may certainly be attributed to the Saharan Neolithic, and a few objects of metal. The latter are small hammered bars of copper and of iron. Since these artifacts occur scattered on the surface and since there are no "type-fossils," the age of the assemblages must be that of the youngest elements in them. The iron which occurs is, as we will see below, considerably more recent than are the furnaces of Copper I, so that, for the moment, the furnaces themselves are the only evidence for the practice of metallurgy at this period.

Furnaces of Copper I

Most of the study of the furnaces has taken place at Afunfun Site 175. There are more than a hundred of them, scattered over an area of about 20 ha. The variety and complexity of the different types of furnaces in use during Copper I mean that only a broad overview of them can be given within the scope of this chapter (Grébénart 1985).

On the basis of the quantity of slag by-products, two groups of furnaces can be distinguished: those which contain a lot and those which contain very little. There seems to be no intermediate stage. (The slag results from the conversion of ore or the smelting of native copper which was to some extent oxidized and encased in non-mineral gangue.) The first group is represented by only one furnace, while the second includes

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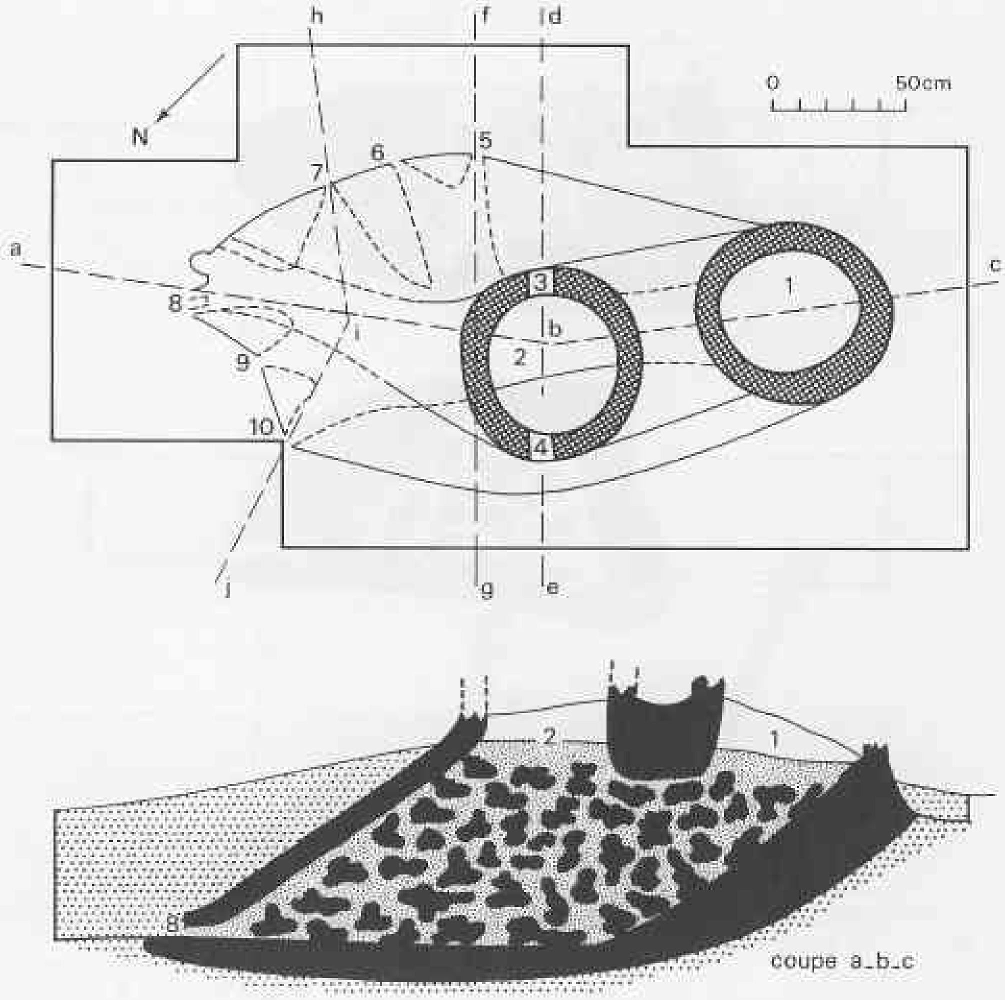


Figure 14.8 Early Copper Age, Afunfun Site 175, Furnace No. 1. Plan and longitudinal section along axis a-b-c. Key: 1–2, principal openings; 3–4, traces of openings; 5–10, ends of internal funnels. Unbroken line around plan is limit of excavation. Erosional cross-sections of openings 1 and 2 are indicated by cross-hatching; hypothetical and artificial sections of furnace-walls and of slag are indicated in black. (These conventions are also followed in Figures 14.9–14.11, below.)

some structures which contain no slag, although slag may occur in nearby and identical furnaces. On the other hand, almost all of the furnaces have yielded wood-charcoal at the bottom of the basal conduit dug into the soil, or even included within the actual walls of the structure (the walls always show signs of some degree of calcination).

Furnace with Abundant Waste-Products. The only furnace to contain abundant slag waste-products was Furnace 1 (Figures 14.8 and 14.9). On the outside, it has two circular openings slightly above ground-level, and the otherwise horizontal base slopes upward to the level of the first opening (Figure 14.8: 1). The second opening (Figures 14.8: 2 and 14.9: 2) gives directly into the body of the furnace, which

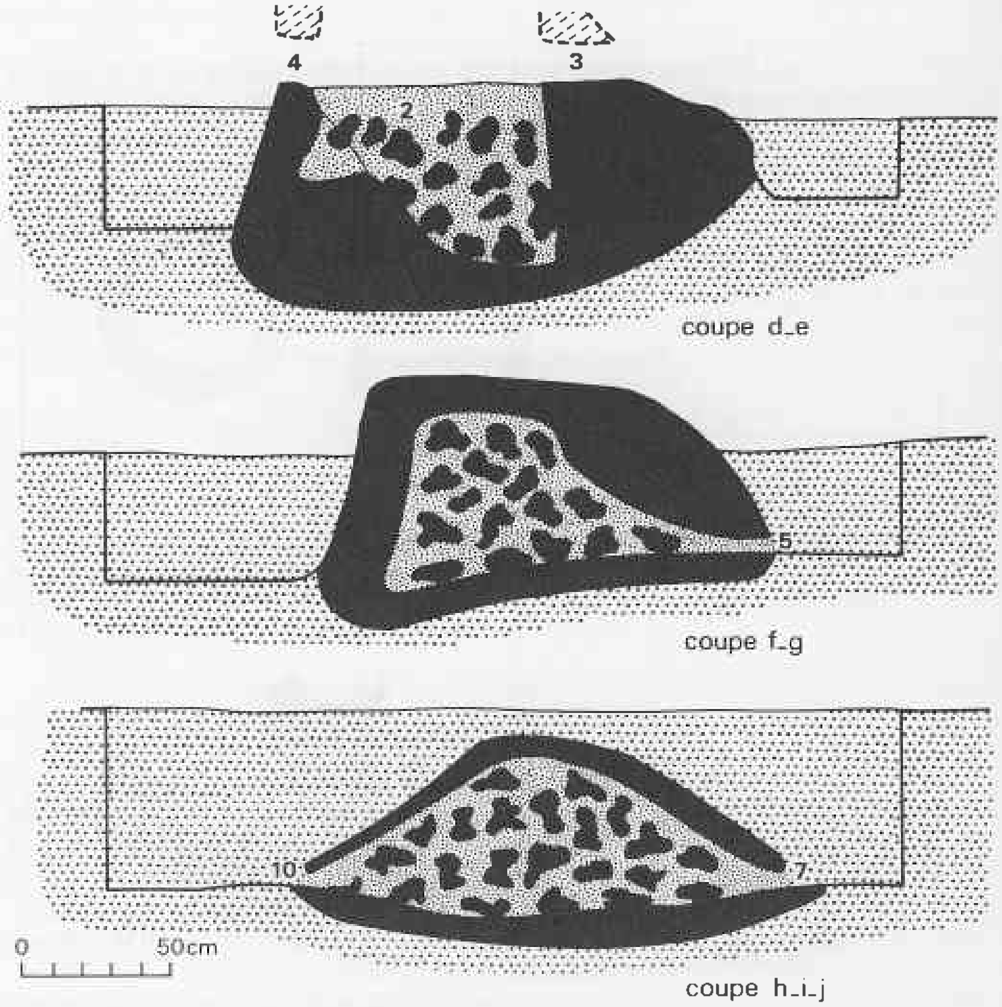
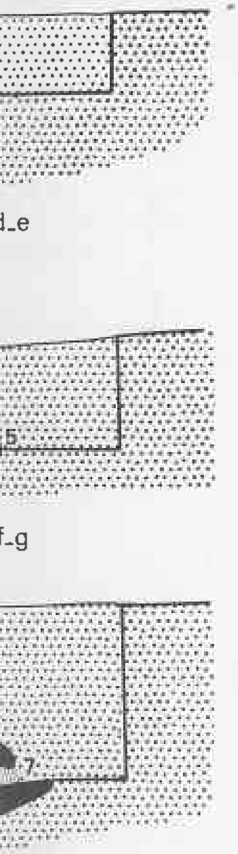


Figure 14.9 Early Copper Age, Afunfun Site 175, Furnace No. 1. Sections along axes d-e, f-g and h-i-j. Key: as for Figure 14.8.

expands laterally in the form of funnels that are connected to the outside by small conduits, often blocked with charcoal (Figures 14.8: 5–10 and 14.9: 5–10). Opening No. 2 is a destroyed chimney. It cannot have been much more than a meter high and its base has two holes, Nos. 3 and 4, which are 12 cm in diameter.

The interior of the furnace was filled with quantities of porous slag, sometimes found sticking to the walls which were highly calcined and in places encrusted with dross. The craftsmen who built the furnace built the walls around a framework of branches, which were left in place and were thus converted by combustion into charcoal within the walls.

When in working order, the sides of the furnace were clear. Bellows must have been fixed to the ends of the funnels to obtain a sufficiently high temperature. The two holes (Nos. 3 and 4) at the base of the chimney (No. 2) may have served the same purpose, since, if they had been used as overflows for the removal of dross, there would still be deposits of dross on the outside walls. The stoking with charcoal and ore could have been done through the chimney, and the metal may have been removed by the inclined



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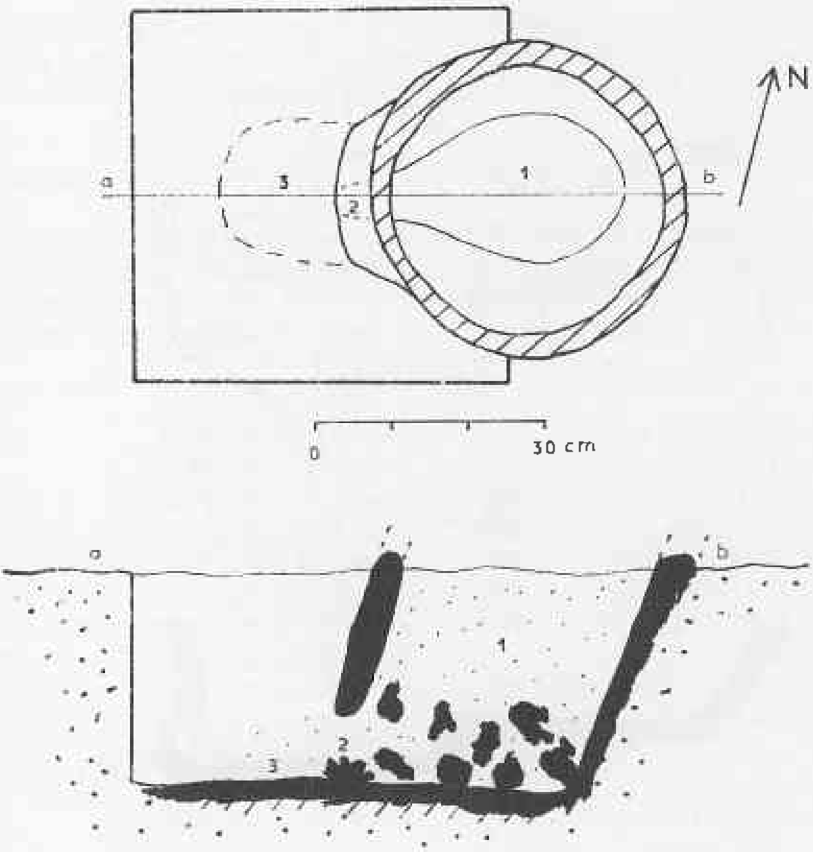

Figure 14.10 Early Copper Age, Afunfun Site 175, Furnace No. 8. Plan and section along axis a-b. Key: 1, buried base of furnace chimney; 2, orifice permitting combustion; 3, external, fire-hardened extension of base of furnace.

slope of the other opening (No. 1), which would have been no higher than it is today. Since the furnace would not thus be destroyed, it could have been used several times.

On the basis of the radiocarbon dates given below, this furnace is not only the oldest at Afunfun Site 175, but also of the Agadez region and of Copper I.

Furnaces with Few or No Waste-Products. Most of the furnaces are of this group and two, of very different types, will be described as examples.

Furnace No. 8: This is an essentially cylindrical furnace with its base buried (Figure 14.10). From the thickness of the walls, the slightly leaning superstructure cannot have reached much more than 80 cm above ground-level; it is 42 cm in diameter. When working, at least parts of the sides of the furnace were clear, and combustion was achieved by means of a bellows attached to an opening at the bottom of one side (Figure 14.10: 2). Mixed with the fill of aeolian sand in the basin at the bottom were several porous lumps of slag and numerous pieces of wood-charcoal, from which a radiocarbon date was obtained (see below).

Furnace No. 7: All traces of this furnace were buried. It was an elongated structure, measuring 1.9 m and 1.0 m along the longest axes, with two lobes in plan (Figure

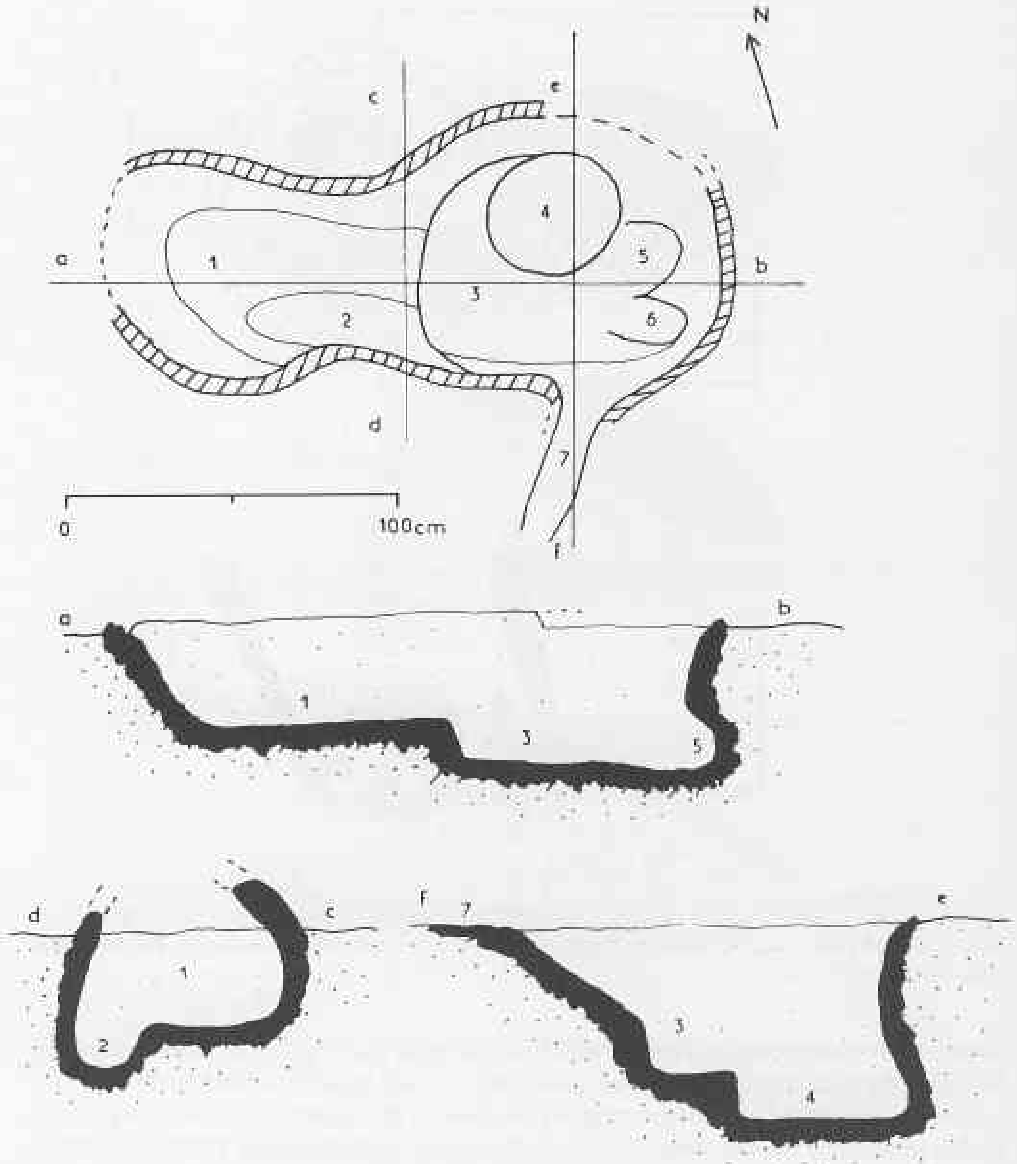

Figure 14.11 Early Copper Age, Afunfun Site 175, Furnace No. 7. Plan and sections along axes a-b, d-c and f-e. Key: 1–4, basins in floor; 5–6, niches in eastern wall.

14.11). It has a maximal depth of 55 cm below the modern ground-level. The walls have traces of calcination and have partly crumbled away on the east and west sides. On the north and south, they are clearly visible above the ground and the cross-section (Figure 14.11: c–d) shows the very beginnings of an arched shape, indicating an open-air, vaulted superstructure which is now destroyed. At the south, erosion has turned a cylindrical conduit into a ground-level gutter (Figure 14.11: 7). The base of the furnace is irregular and consists of a succession of basins (Figure 14.11: 1–4), with two niches (Figure 14.11: 5–6) in the eastern part. The surface of the bottoms of the walls is carpeted with a white powder, resulting from the calcination of calcareous rock. Pieces

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of charcoal (used for radiocarbon dating) were found at the bottom of the fill of aeolian sand but there were no by-products of metal-working. Such by-products did, however, occur at other furnaces very similar to this one (notably Furnaces 9 and 10).

Radiometric Dating

Fourteen radiocarbon dates have been obtained from charcoal included within the walls of the furnaces or within the soil in the basins at their bottoms. Most of the dates are from Afunfun Site 175, but there are some from two other sites in the area, Aghtauzu Site 178 and the Sekiret valley. The dates are as follows:

Afunfun Site 175		
Furnace No. 1	3920 B.P. ± 90 years	(MC.2398) (or 2775–2160 B.C.)
	4140 B.P. ± 90 years	(MC.2399) (or 3015–2415 B.C.)
Furnace No. 2	3600 B.P. ± 90 years	(MC.2400) (or 2300–1710 B.C.)
	3800 B.P. ± 90 years	(MC.2401) (or 2545–1965 B.C.)
Furnace No. 3	3680 B.P. ± 50 years	(Gif.5172) (or 2310–1890 B.C.)
Furnace No. 4	3100 B.P. ± 70 years	(Gif.5173) (or 1560–1135 B.C.)
Furnace No. 5	3580 B.P. ± 100 years	(Gif.5174) (or 2290–1695 B.C.)
Furnace No. 7	3680 B.P. ± 100 years	(Gif.5175) (or 2395–1785 B.C.)
Furnace No. 8	3660 B.P. ± 110 years	(Gif.5176) (or 2385–1770 B.C.)
Furnace No.12	3510 B.P. ± 100 years	(Gif.5177) (or 2150–1665 B.C.)
Aghtauzu Site 178		
	2900 B.P. ± 100 years	(Gif.5179) (or 1380–830 B.C.)
Sekiret		
	3310 B.P. ± 100 years	(Gif.3862) (or 1875–1400 B.C.)
	2900 B.P. ± 100 years	(Gif.4177) (or 1380–830 B.C.)
	2700 B.P. ± 70 years	(Gif.5543) (or 1035–780 B.C.)

The calibrated radiocarbon dates (Klein *et al*. 1982) are shown graphically in Figure 14.5, from which it is obvious that Furnace No. 1 of Afunfun Site 175 is older than the others and that the dates otherwise cluster over the rather long period of 2500–1000 B.C.

Analyses of Metallurgical By-Products

The first analyses of by-products from the furnaces of Copper I have been carried out by Bourhis (in Grébénart 1985) and Tylecote (1982). Because of the importance and originality of the Copper I furnaces, details of most of these analyses are given in Tables 14.2–14.4. The samples were all from Afunfun Site 175; Samples 1–3 are from Furnace 1, Samples 4 and 5 from Furnace 3, Samples 6–8 from Furnace 6, Samples 9 and 10 from Furnace 8, Samples 11 and 12 from Furnace 9 and Samples 13 and 14 from Furnace 10. All were of slag, except that Sample 4 was a sample of the wall, Sample 7 was a globule of bronze encased within Sample 6 (a second sample of slag from the same furnace was used for the chemical analysis of Sample 7), Sample 12 was white powder and Sample 14 was poorly baked slag. The same samples were used for both spectrographic and chemical analyses except as noted above for Sample 7. The

TABLE 14.2

Spectrographic Analyses of Metallurgical By-Products from Copper I Furnaces at Afunfun Site 175

Sample	Cu	Sn	Pb	As	Sb	Ag	Ni	Bi	Fe	Zn	Mn	SiO_2
1	0.30	0.001	-	0.001	0.001	tr	0.005	0.001	XX	0.001	0.10	XXX
2	0.20	-	-	0.003	-	0.002	0.001	-	X	-	0.05	
3	0.01	-	-	0.003	-	0.001	0.005	-	X	0.001	0.05	
4	0.005	-	-	0.005	-	-	0.005	-	X	-	0.03	
5	0.001	-	-	0.003	-	-	0.005	-	X	-	0.03	
6	3.5	0.001	0.02	0.003	0.001	0.003	0.007	0.002	XX	0.002	0.15	XXX
7	(82)	15	1	0.50	0.02	0.008	0.005	0.004	0.15	-	0.05	1
8	0.005	-	-	0.005	-	-	0.003	-	X	-	0.05	
9	1	0.001	0.005	0.002	0.001	tr	0.005	0.001	XX	0.001	0.15	XXX
10	0.001	-	0.2	0.002	-	-	0.002	-	X	-	0.02	
11	-	-	-	0.002	-	-	0.005	-	X	0.001	0.02	
12	0.001	-	0.003	0.002	-	-	0.003	-	X	-	0.07	
13	-	-	0.001	0.002	-	-	0.002	-	X	-	0.02	
14	-	-	0.001	0.003	-	-	0.003	-	X	-	0.01	

Key for Tables 14.2 and 14.3: ( ), proportion calculated by difference; XXX, >50%; XX, 50%–20%; X, 5%–20%; tr, >0 and <0.001%.

proportions of impurities were established by arc spectrography, and the proportions of copper and the high proportions of lead were established by electrolysis. In the chemical analyses, all the samples, except the first from Furnace 1, the first two from Furnace 6 and the first from Furnace 8, were analyzed with the help of reference samples of slag, which allowed the calculation of semi-quantitative frequencies for the major elements. A sample from Furnace 1 at Afunfun Site 175 was analyzed separately by Tylecote and the results of that analysis are given in Table 14.4.

The presence of traces of copper in the slags shows that the traces did not result from the reduction of an oxide or of a carbonate (otherwise the proportion of iron would have been higher), but from the smelting of native copper, which was encased in a siliceous gangue. A calcareous marl was added as a flux to facilitate the separation of the metal, and this is now found as the white powder which carpets the floors of some of the furnaces (Sample 12 in Tables 14.2 and 14.3). Samples 6 and 7 (Table 14.2) are a slag enclosing a small nodule of bronze with a 15% inclusion of tin. The occurrence of such a nodule is not particularly exceptional, since a piece of cassiterite could easily have been mixed with the native copper in the furnace, but it is likely to have been accidental as this is the only occurrence of this alloy in Copper I.

In the area of Agadez, therefore, Copper I may be regarded as essentially pre-metallurgical since it dealt only with native copper. (See also Killick and others [in press] for details of a complementary study of the by-products of smelting collected from Copper I furnaces.)

LATE COPPER AGE OR COPPER II

Copper II followed Copper I within the same area, north of the Tigidit scarp (Figure 14.1). In terms of technology, from now on we find a true metallurgy, with copper ores being processed in the same type of furnace as was known before. There are many and varied finds from this period, including remains of furnaces, slag-heaps, objects worked

TABLE 14.3

Chemical Analyses of Metallurgical By-Products from Copper I Furnaces at Afunfun Site 175[a]

Sample	Cu	SiO_2	CaO	MgO	Al_2O_3	FeO	Na_2O	Lost by calcination at 1000°C
1	0.3	69	2.5	-	-	27.8	-	-
2	-	60	2	1	25	10	2	-
3	-	60	1	2	25	10	2	-
4	-	60	1	2	25	10	2	-
5	-	60	1	2	20	15	2	-
6	3.5	65.5	2.8	-	-	28	-	-
7	0.5	62.7	3.7	-	-	33.1	-	-
8	-	60	1	2	25	10	1	-
9	1	63.5	4.2	-	-	31.2	-	-
10	-	60	2	2	25	9	2	-
11	-	60	1	2	25	10	2	-
12	-	50	4	4	10	15	5	12
13	-	60	1	2	25	10	2	-
14	-	60	1	2	25	10	2	-

[a] Expressed as percentages.

in metal and ceramics. The age of Copper II is well established by a large number of radiocarbon dates, and archaeological research in the area provides a firm basis for the study of copper-working during this period.

Furnaces of Copper II

All the furnaces of Copper II are of the same type, which is reconstructed in Figure 14.12. The chamber of the furnace was cylindrical, or slightly conical and truncated. It stood about a meter above the ground and the base, which was 60–80 cm in diameter, was more or less buried. Combustion was effected by blast-pipes, sloping towards the bottom of the furnace and presumably attached to some (unknown) type of bellows. After smelting, the superstructure had to be broken in order to recover the metal, so that the furnace could be used only once. The abandoned furnace now consists only of the base buried in the ground and forming a basin containing slag, fragments of the walls and the blast-pipes and residual wood-charcoal.

Artifacts and Ceramics of Copper II

Stone tools were still used during Copper II. The dwellings of the copper-workers (discussed below) have yielded artifacts of Neolithic type made on various types of stone, both bifacially flaked and polished, as well as small endscrapers, which are usually made on flint flakes. Objects made of worked copper are always small (Figure 14.13) and consist mainly of very flat, spatulate arrowheads, awls, pins, shafts, metal strips and perforated plaques; all were made by hot-hammering. The lost-wax method of casting was not known but some moulded ingots have been found, of which the largest weighs only 160 g (Figure 14.13). The craftsmen of Copper II also made both bronze and brass, but these alloys seem to have been used exclusively for the manufacture of jewelry, again always by hot-hammering (Figures 14.13 and 14.14).

TABLE 14.4
Analysis of Sample from Furnace 1 at Afunfun Site 175

	% of matrix	% of inclusion
SiO_2	59	4.12
CaO	1.4	0.15
MgO	1	4.10
Al_2O_3	22.5	7.24
FeO	6.7	19.44
Na_2O	1.3	-
K_2O	3.1	0.32
MnO	0.2	-
TiO_2	1.4	62.53
Cu	-	-

The stone and metal artifacts are associated with potsherds which can sometimes be reassembled into complete vessels. They are generally very similar to those of the Saharan Neolithic but there are also forms peculiar to Copper II. These are small, open bowls with rounded bases and sometimes a keeled profile; the mouth is always decorated with grooves (Figure 14.14). Their assignment to Copper II is beyond doubt, since they are sometimes found in the bottoms of the furnaces, which were used as refuse-pits after being abandoned.

Radiometric Dating

Seventeen radiocarbon dates have been run on charcoal samples taken from the bottoms of the furnaces.

Afunfun Site 162

2800 B.P. ± 90 years	(MC. 2404) (or 1250–790 B.C.)
2740 B.P. ± 90 years	(MC. 2406) (or 1225–645 B.C.)
2590 B.P. ± 90 years	(Gif.5541) (or 1010–425 B.C.)
2540 B.P. ± 90 years	(MC. 2405) (or 850–410 B.C.)
2520 B.P. ± 90 years	(MC. 2402) (or 830–405 B.C.)
2520 B.P. ± 90 years	(MC. 2403) (or 830–405 B.C.)

Ikawaten Site 193

2160 B.P. ± 90 years	(Gif.5186) (or 410 B.C.–A.D. 15)
2090 B.P. ± 90 years	(Gif.5185) (or 395 B.C.–A.D. 195)
1280 B.P. ± 70 years	(Gif.5184) (or A.D. 610–880)

Azelik Site 210

2510 B.P. ± 70 years	(Gif.5546) (or 825–405 B.C.)
2490 B.P. ± 90 years	(Gif.4175) (or 815–400 B.C.)
2480 B.P. ± 90 years	(Gif.4330) (or 810–395 B.C.)
2400 B.P. ± 90 years	(Gif. ?) (or 785–215 B.C.)
2040 B.P. ± 90 years	(Gif.3863) (or 380 B.C.–A.D. 210)

Tyeral Site 207

2410 B.P. ± 90 years	(Gif.5542) (or 790–260 B.C.)

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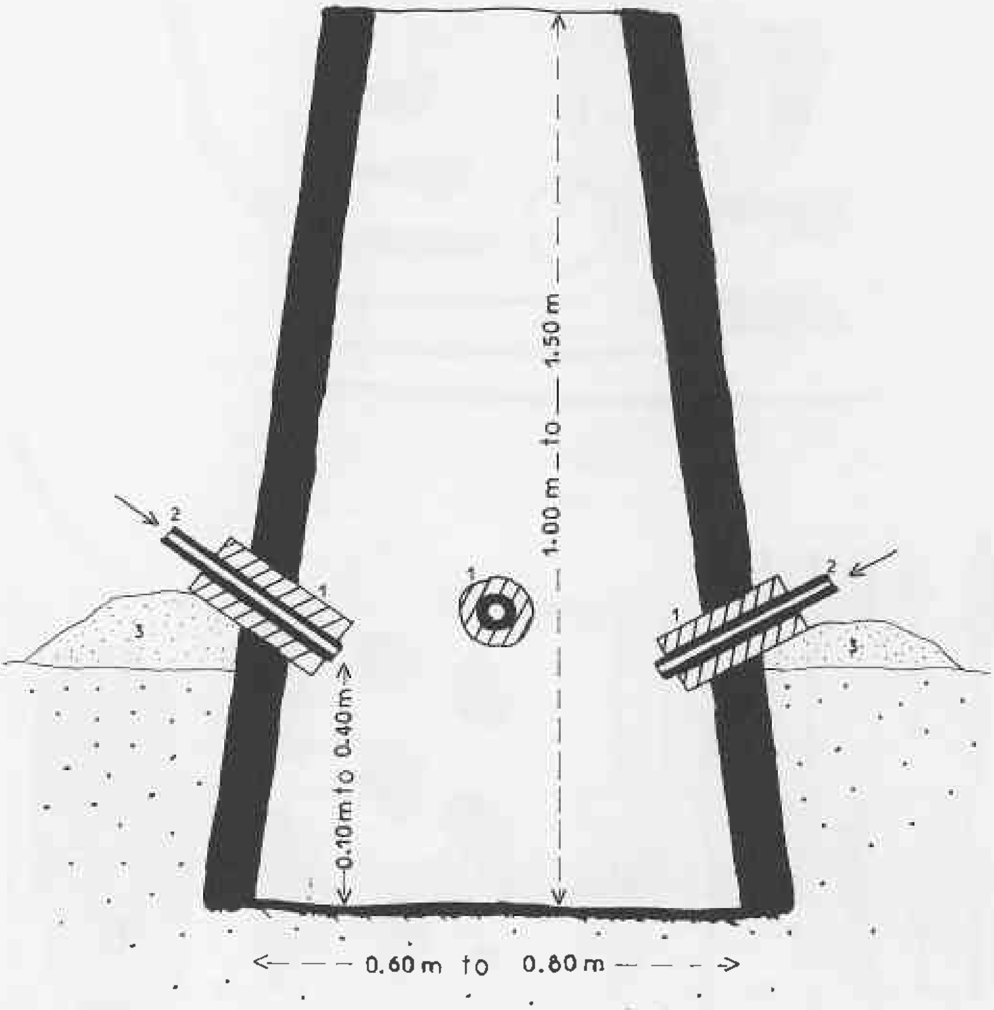

Figure 14.12 Late Copper Age. Reconstruction of furnace used in Eghazer basin for processing copper-ore.

Tuluk Site 211

2360 B.P. ± 70 years (Gif.5545) (or 755–275 B.C.)

Sekiret valley

2470 B.P. ± 100 years (Gif.5544) (or 810–395 B.C.)

The distribution of the calibrated radiocarbon dates (Klein *et al.* 1982) shows a remarkably tight clustering (Figure 14.5). If the single outlier is eliminated (which might result from accidental contamination of the charcoal sample), then the great majority of them fall between 800 and 200 B.C. In any case, Copper II extended throughout the last millennium B.C. and, in particular, the furnaces of Copper I essentially ceased to be used after the appearance of those of Copper II. The chronological succession of these two seems certain.

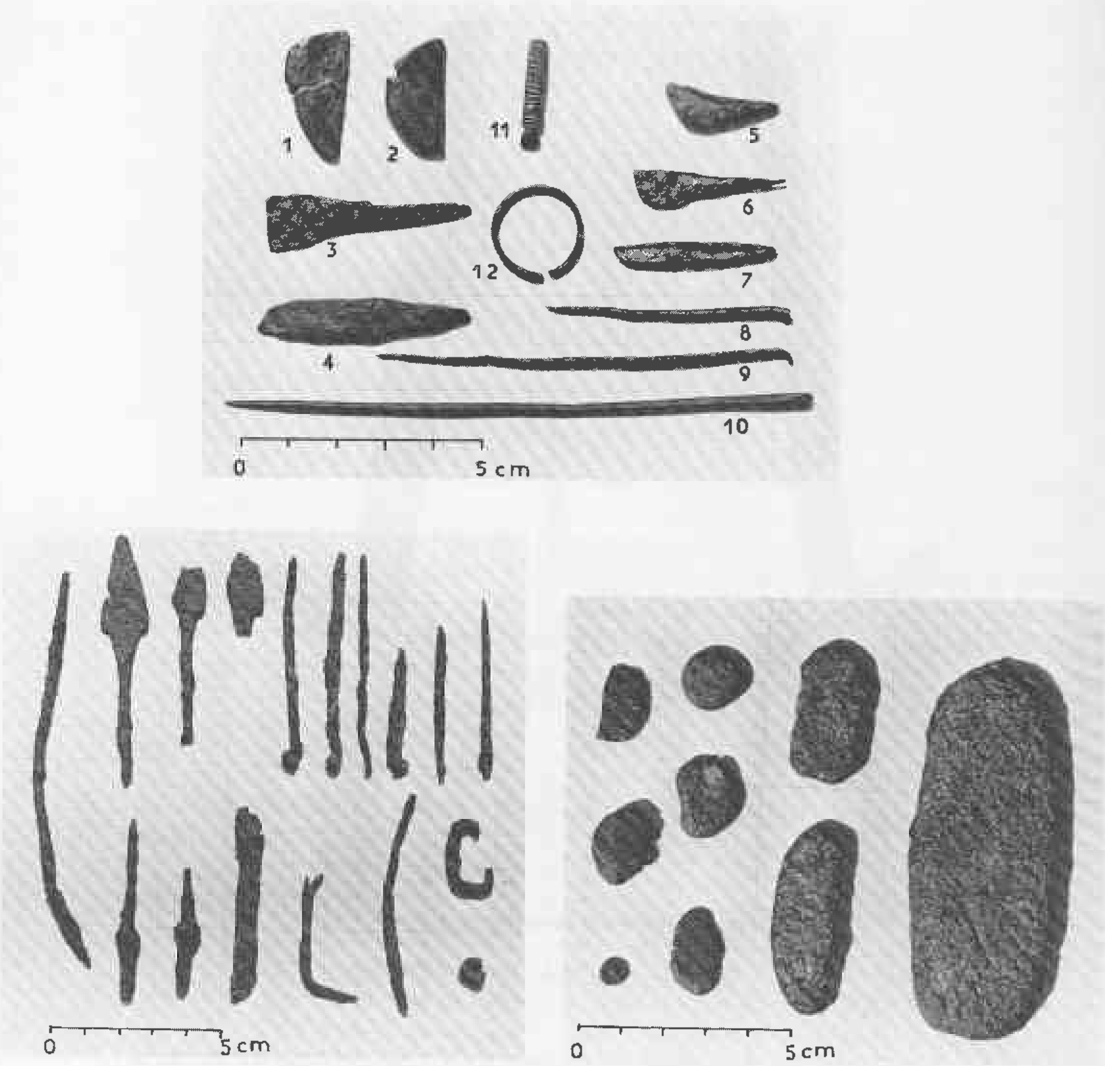

Figure 14.13 Objects of worked metal. Top: Late Copper Age, Afunfun Site 162. 1–10, artifacts of hammered copper; 11, brass bracelet; 12, bronze ring. Middle: iron artifacts of Early Iron Age, Mio Site 169. Bottom: small copper ingots (the largest weighs 160 g) of Late Copper Age.

Metal-Workers' Dwellings and Estimates of Production

At Ikawaten Site 193, Azelik Site 210 and Afunfun Site 162, it could be shown that the movable cultural materials (stone and metal artifacts and pottery) were horizontally concentrated near the furnaces. The artifacts occur either on the surface of the ground or buried only a few centimeters deep. The low densities of artifacts and the relatively long period during which each locality was used for working metal indicate that these scatters represent temporary occupations by the metal-workers during the periods that the furnaces were actually operating.

The volume of slag could be measured at some sites and has been estimated at others, giving a total of about 85 m^3. If the volume of slag from one furnace is estimated as 20 l,

Site 162. 1–10, artifacts of
rtifacts of Early Iron Age,
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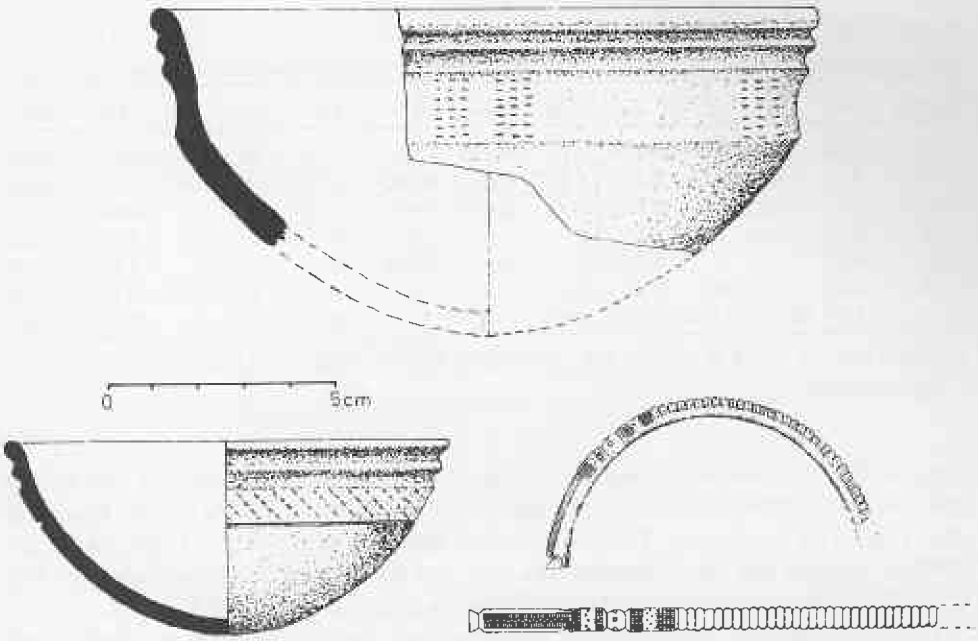

Figure 14.14 Late Copper Age. Above, characteristic pottery with grooved decoration used by the metal-workers (Afunfun Site 162); below, bronze bracelet or anneau de cheville (Shin Ajeyen Site 112).

then the number of individual ore-smelting operations was about 4250. If each of these operations yielded between 2 and 4 kg of metal (Grébénart 1985), then the mean annual production of copper over a period of about one thousand years varied between 8.5 and 17 kg. In light of the small size of the metal artifacts, a weight closer to the lower of these figures seems more likely. These figures are, of course, only approximations and not all of the manufacturing-points have been found. However, the surveys of the Eghazer basin have been such that any slag-heaps not yet recorded are very unlikely to reach volumes of hundreds of cubic meters; they are even less likely to attain the volumes of several thousand cubic meters, such as are known from the major copper-producing regions of Morocco and Sinai. The sites not yet discovered are probably similar to those already known. In addition, the limits of the period being used are not immovable and any modification to them will only extend the duration of Copper II, which would lessen the mean annual metal production yet further. The smelters of Copper II were, therefore, itinerant craftsmen and the manufacture of metal was only an occasional activity. It may have been seasonal, but was not necessarily annual.

Analyses of Metallurgical By-Products

Three series of by-products have been studied by Bourhis (in Grébénart 1985), Tylecote (1982) and de Paepe. For the spectrographic analyses (Table 14.5), the first two samples are slag with an included copper nodule, from Afunfun Site 162 and Azelik Site 210, respectively; the third, fourth and fifth samples are from Furnace 2 at Azelik Site 210 and are, respectively, slag, slag adhering to the wall, and the wall itself; the sixth and seventh samples, both slags, are from Ikawaten Site 193.The proportion of trace

TABLE 14.5

Spectrographic Analyses of Metallurgical By-Products from Copper II Furnaces

Sample	Cu	Sn	Pb	As	Sb	Ag	Ni	Bi	Fe	Zn	Mn	SiO_2
1	0.70	-	0.50	0.003	tr	0.001	-	-	0.50	0.002	0.15	52.5
2	5.2	0.005	0.03	0.08	-	0.001	0.001	-	0.50	0.002	0.05	40.8
3	19.5	0.001	-	0.02	-	0.005	tr	-	~2	-	0.001	70.2
4	0.15	-	-	0.003	-	-	tr	-	X	-	0.005	XXX
5	0.05	-	-	0.001	-	-	0.001	-	X	-	0.02	XXX
6	1.5	-	0.02	0.01	-	tr	tr	-	~1	0.001	0.10	74.6
7	~1.5	0.01	0.003	0.005	tr	tr	-	tr	XX	tr	0.20	XX

Key for Table 14.5: XXX, >50%; XX, 50%–20%; X, 5%–20%; tr, >0 and <0.001%; ~, approximately.

elements (<1%) were determined by arc-spectrography, the proportion of copper and lead were established by electrolysis and those of tin, iron (Fe_2O_3 for the slag) and silica (SiO_2) by gravimetry. For the chemical analyses of the slags (Table 14.6), the first five samples are from Afunfun Site 162 and the second five from Ikawaten Site 193. (The first nine were analyzed by Tylecote and the last by de Paepe.)

The spectrographic analyses of Bourhis indicate that the slags from Afunfun and Azelik certainly result from the metallurgical processing of an ore, but only two of the slag samples from Ikawaten seem to have been produced by the same process. De Paepe's chemical analysis of the sample from Ikawaten confirms this conclusion, while Tylecote has more reservations because of the low quantities of FeO in the samples which he analyzed.

IRON AGE

As for the Copper Age, there are two phases of the Iron Age. They are based solely upon chronological criteria and are called the Early Iron Age, or Iron I, and the Late Iron Age, or Iron II.

EARLY IRON AGE OR IRON I

The remains of Iron I are in the form of open-air habitation sites located essentially to the south of the Tigidit scarp (Figure 14.1). There are 31 of them, which vary in size from 20–30 m in diameter to more than a hectare in area; many of them could have been real villages. The surficial scatters consist of small iron objects, iron slag, stone tools and, above all, potsherds. The irregularities of the surface distributions almost certainly reflect the locations of domestic structures and huts. All of the structures must have been built of branches since there are no traces of stone walls, and the villages completely lack any enclosures of earthen banks, ditches or palisades. The dead were buried either within the villages or at the very edges of them, since one often finds simple graves dug into the earth that have now been exposed by erosion.

The slag, which is always present on the surface of the habitation sites, undoubtedly reflects on-site manufacturing of metal, but there are very few remaining traces of furnaces. Since they were built directly on the surface of the ground, after the body of a

TABLE 14.6

Chemical Analyses[a] of Metallurgical By-Products from Copper II Furnaces

	1	2[b]	3	4	5[b]	6	7[b]	8	9	10
SiO_2	44.4	42.4	43	49	1.6	42.5	0.45	38.7	39.5	42.91
CaO	29.6	28.5	27	22.7	1	37.3	0.71	10.5	37.8	24.59
MgO	10.8	10.2	10	8.9	3.3	10.6	5.9	13.2	9.8	12.49
Al_2O_3	7.1	7	7.9	7.7	-	5.5	-	15.1	6.4	9.02
FeO	1.5	1.5	2.1	1.2	0.4	0.2	0.25	1.9	0.4	1.47
Na_2O	2.99	1.2	2.6	1.1	-	2.4	-	5.5	2.4	3.6
K_2O	1.1	1	0.9	1.2	-	-	-	1.5	0.1	0.7
MnO	0.38	0.4	-	0.3	-	-	-	0.63	-	0.20
TiO_2	0.53	0.6	-	0.6	-	-	-	1.5	-	0.63
Cu	0.34	5.9	1.2	5.7	93.9	-	93.5	0.26	-	6437[c]
Co										6[c]
Cr										73[c]
Li										15[c]
Ni										30[c]
Rb										25[c]
Sr										2803[c]
Zn										28[c]

[a] Expressed as % except as noted.

[b] Inclusion.

[c] Expressed as ppm.

furnace had been broken to recover the metal, there remained nothing but a fire-hardened patch of ground, 40–60 cm in diameter, and fragments of slag and of the furnace-walls. The latter, being unprotected, would soon disintegrate. The furnaces can not be dated directly; the radiocarbon dates have been run on charcoal found in small refuse-pits containing slag and iron artifacts mixed with other rubbish, especially potsherds.

Iron artifacts are quite common but very small. They consist mainly of pins with rolled heads and sometimes with twisted shafts, shafts with circular or triangular cross-sections, arrowheads and harpoons with or without barbs, perforated plaques, rings and fragments of blades; all of these objects are strongly oxidized. The smiths also made iron jewelry, especially thin bracelets, sometimes with sinuous edges and decorated with punctations (Figure 14.13).

Stone tools continued to be used alongside those of iron. They seem to be quite rare, but in the absence of extensive excavations, it is difficult to assess their importance. Neolithic types, such as axes and arrowheads, still occur, as well as small endscrapers.

Pottery is ubiquitous and very characteristic; it has therefore been named the Tegef type, after the type-site of Tegef n'Agar Site 74. The vessels are thick-walled and have impressions of the numerous plant-materials included in the temper. They are almost always completely decorated with contiguous cord-impressions; they may also have large, incised strokes forming chevrons or circles. The most common vessel-form is an ovoid bowl, 15–50 cm high, with a constricted neck and a flared rim. The next most common type are very open, salad bowl-like vessels, with their edges either straight or with a rolled lip. There are also a small number of vessels with a slight constriction on the upper portion of the vessel, giving an S-shaped profile, which have more complex and carefully executed decoration (Figure 14.15).

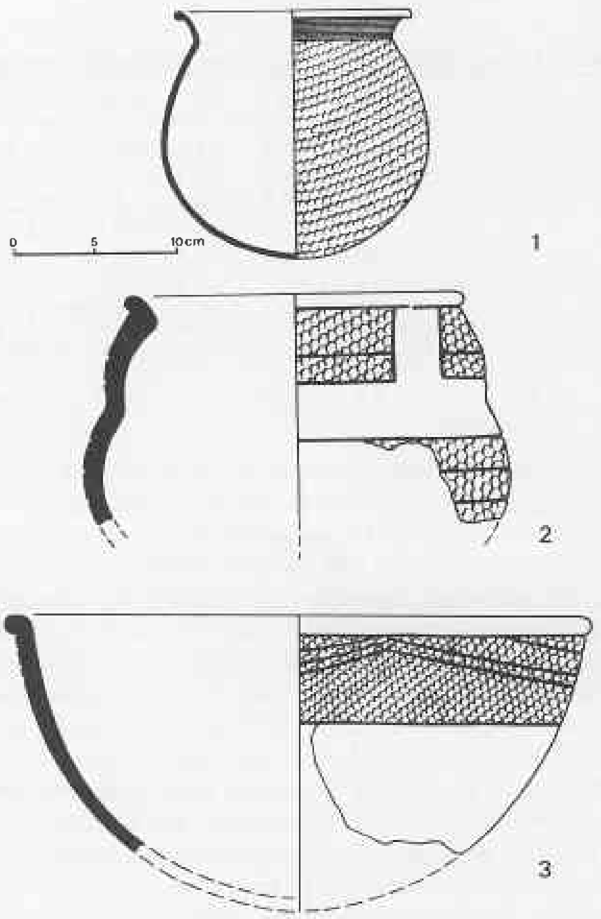

Figure 14.15 Early Iron Age. Typical vessel-forms. Decoration consists of continuous cord-impressions and is represented schematically (Tegef n'Agar Site 74).

The age of this first iron-working is known from four radiocarbon dates ranging between 2440 B.P. ± 90 years and 2010 B.P. ± 90 years or, after calibration (Klein *et al.* 1982), from 800 B.C. to A.D. 220. The dates have been obtained from the following sites (Figure 14.5).

Tegef n'Agar Site 74

2090 B.P. ± 90 years	(Gif. 4172) (or 395 B.C.–A.D. 195)

In Taylalen II

2210 B.P. ± 90 years	(Gif. 4170) (or 525–15 B.C.)
2010 B.P. ± 90 years	(Gif. 4171) (or 370 B.C.–A.D. 220)

Ekne Wan Ataran Site 119

2440 B.P. ± 90 years	(MC. 2397) (or 800–390 B.C.)

LATE IRON AGE OR IRON II

This phase will be only mentioned since it falls beyond the chronological limits of this chapter (Grébénart 1985).

During the first centuries of the modern era, the Early Iron Age villages to the south of the Tigidit scarp were abandoned, probably because of the pressure of increasing aridity. There are no definite signs of human occupation of the area during the first millennium A.D., and the only permanent habitation-site known from the Eghazer basin is Marandet, at the very foot of the Tigidit scarp in a place where there is still abundant spring-water even today.

There are several archaeological sites at Marandet, of which the most important is Marandet I. This site is an accumulation of occupational debris covering more than a hectare in area and with a depth of at least 2 m. Unfortunately, the archaeological deposits have been extensively destroyed by fluviatile erosion. Marandet I was built on the edge of a stream-channel, of which the bed has been raised and displaced laterally, thus partly levelling the anthropogenic deposits which are now found beneath the sands of the wadi. On the left bank, there still remains a small area, in the process of being destroyed, which was probably the craftsmens' area of the town. There are several pits, some of them partially cut by the steep banks of the stream-channel, filled with the debris of metal-working, notably small, conical, earthen crucibles and traces of the manufacture and working of iron. Therefore, although the earlier craftsmen of Copper II and Iron I had practiced smelting separately from the working of the actual metal, these two activities were carried out together at Marandet. Nevertheless, most of the finds relate to the making of metal artifacts rather than to smelting.

RELATIONS BETWEEN NEOLITHIC AND METAL-WORKING GROUPS

The high Eghazer basin and the region around the modern town of Agadez lie at the border between two climatic zones and close to a large, mountainous massif. This specific geographical setting has made the area a privileged one in terms of human settlement and explains the presence there of several different cultures. It appears, in fact, that populations of different origins co-existed, which means that there must have been relations between them, especially within an area lacking in natural barriers, and archaeology may reveal traces of these relations.

SAHARAN NEOLITHIC AND COPPER AGE

Relations existed between Neolithic and metal-working groups during both phases of the Copper Age but they are most apparent during the second phase and are of three kinds. First, the copper-workers and the Neolithic groups used almost identical ceramics. Second, the two groups have similar radiocarbon dates, although such dates are rare for the Saharan Neolithic. Chin Tafidet and Orub were contemporaneous with Copper I, while Tuluk Site 21 I continued to be occupied during Copper II, into the first half of the third millennium B.P. Third, some of the Saharan Neolithic sites have structures of terra-cotta. These structures have not yet been studied but could have preceded the furnaces of Copper I; they indicate a certain mastery of fire which may have been a prerequisite for the use of native copper.

SAHELIAN NEOLITHIC AND IRON AGE

In contrast to the above, the Sahelian Neolithic and Iron Age were not contemporaneous, but successive; the Sahelian Neolithic is clearly earlier than the Iron Age of the Tigidit scarp. The ceramics of the two groups are not identical, but there are significant analogies between the ceramics of Wasa and of Tegef types, which imply either that Iron I is directly descended from the Sahelian Neolithic, or that they share a common origin. This origin must have been southern, or sahelian, because the Tigidit scarp is the northern limit of the distribution of habitation-sites. The two groups occupied the same spot at Mio Site 169, but they were separated chronologically. Although the process of erosion has mixed together the remains of both cultures on the surface, they are separated in the refuse-pits which have been excavated and dated.

On the other hand, the Saharan and Sahelian Neolithic were contemporaneous, the latter, near the Tigidit scarp, having a shorter period of development than the former.

EARLY IRON AGE AND LATE COPPER AGE

From the very beginning, the Iron I populations must have been in contact with the metal-workers of Copper II living to the north of Tigidit. Exchange took place between them and can be traced in the archaeological record. The jewelry made of copper alloys (bronze and brass), which is relatively common in Early Iron Age sites, was worn by the people buried in the actual cultural layers or very close by. Similarly, tools of worked iron—pins, blades and points—are always found around the Copper I furnaces, since they were used by the workers in copper. On the other hand, the ceramics were very characteristic within each group and were not produced for exchange, nor were the small artifacts of hammered copper, which have never been found in Early Iron Age sites. It appears that each group manufactured only one metal; these two activities were combined only later, during the Late Iron Age, notably at Marandet.

CHARACTERISTICS OF THE FIRST METAL-WORKERS NEAR AGADEZ

It might seem rather surprising to refer to the Saharan and Sahelian groups adjacent to the copper-workers as "Neolithic." The term "Chalcolithic" might seem preferable but has not been used here because there is no firm evidence that the groups in question ever used metal. The evidence indicates that the metal-workers of Copper II were itinerant craftsmen, practicing their craft only occasionally, and they must have had some relations with their immediate, Saharan Neolithic neighbors. However, in spite of the similarities in ceramic decoration, metal artifacts have been found only in the ore-processing locations and never in the "Neolithic" habitations.

The metals do not seem to have affected the ways of life of their users during the Late Copper Age or, more particularly, during the Early Iron Age. There is no difference in arrangement between the habitation-sites of Iron I and those of the Neolithic; no defensive constructions such as ditches or earthen banks existed; and the economy continued to be based upon pastoralism and hunting. It seems as if the use of metal was simply added to that of stone, bone and wood to round out the small tools and weapons of everyday life: pins, arrowheads, knives and so forth. There are no large objects, such as helmets, cauldrons or cooking-pots, perhaps because such were beyond the technical abilities of the smiths.

The terms *Copper Age* and *Iron Age* and their subdivisions are used for convenience, to note a fact of technology rather than to imply socio-economic changes. This is why we have not used the term *Bronze Age*, which refers to a very specific social level found in Europe, the Nile Valley and the Near East before the spread of iron-working and which would have no meaning here.

The dating of the Saharan Neolithic as continuing into the first half of the second millennium B.C. is not unusual. The Neolithic way of life seems to have lasted quite late at this latitude. Neolithic sites have been found near the Tichitt scarp in Mauritania (Munson 1980) and in the Koro-Toro region of Chad (Treinen-Claustre 1982) which are at least as young as those of Agadez and differ only in that metal was not fabricated nearby.

The objects of bronze and brass from Agadez are the oldest occurrences of these alloys in sub-Saharan Africa and therefore raise the question of their origins. They were undoubtedly manufactured *in situ*. Ores of zinc and tin are known in the Aïr, the former in only small quantities although the latter is very abundant. Cassiterite, which is very easy to exploit, occurs in the form of nodules included in the granitic sands and could be obtained simply by collecting it. The abundance and accessibility of this mineral are such that one can imagine it having been exported in antiquity, specifically during the Late Copper Age, although there is no mention of it in the texts (Desanges 1978 is the most important source on this subject). It should, however, be borne in mind that the Sahara could be crossed without difficulty with horses, that the Mediterranean coast was quite close and that Carthage was, at this time, a very important commercial center.

The cassiterite of the Aïr was rediscovered by geologists about forty years ago; the use and very existence of the mineral were unknown to the Kel Ewey Tuareg who now live in the area. Since then, it has been exploited in a very traditional manner: the local people collect the nodules and carry them to the village of El Mekki, where each collection of a few hundred grams or several kilograms is bought by the representative of a mining company. Everything is then stored in a shed until there is a sufficiently large quantity to justify being carried out by lorry. Exploitation could have been carried out in a very similar fashion in antiquity.

THE WEST AFRICAN CONTEXT OF THE FIRST METAL-WORKERS OF AGADEZ

The Early Copper Age poses very special problems with regard to its age, its origin and the type of furnaces used. This is the first time that evidence for metal-working of this age has been found in Africa outside the Nile Valley. The furnaces of Copper I can be dated from the middle of the second millennium B.C. (using calibrated radiocarbon dates), so that Nilotic, and specifically Nubian, influence is possible since metallurgy had begun there by that time. However, if one takes into account the distances involved (it is 2500 km from Agadez to the Nile) and the peculiarity of the furnaces, then it seems possible that the Eghazer basin may have been an autonomous center for the working of native copper, and for which we have not yet found any of the end-products. The

TABLE 14.7

Comparison of Ceramics and their Decoration in the Saharan Neolithic, the Copper Age, the Sahelian Neolithic and the Early Iron Age

	Saharan Neolithic	Copper I & II	Sahelian Neolithic	Iron I
Plant-impressions in the paste	X	X	XXX	XXX
Ovoid vessels with flared rims			XXX	XXX
Vessels with double-curved profile				X
Bobbin-shaped handles	X	X		
Appliqué lozenges	X	X		X
Vessel-apertures with concave profile	X	X		
Chevrons in raised relief	XXX	XXX		
Contiguous chevrons in lines or squares	XXX	XXX	X	X
Wide bands of chevrons	XXX	XXX		
Concentric circles	XX	XX		
Offset overlapping fans	X	X		
Rocker-stamped impressions	XXX	XXX	X	
Various direct impressions	XX	XX	XX	
Continuous cord-impressions				XXX
Thumb-nail impressions	X	X		
Incisions			X	XXX
Inverted angle-impressions	X			
Grooved decoration		XX		
Slipped before firing			XX	X
Painted			XX	X

X – present; XX – common; XXX – very common.

question still remains of why furnaces of such complexity were built for such a simple operation as the smelting of native copper.

The true metallurgy, which appears with Copper II, is very early for sub-Saharan Africa but late compared with the Mediterranean basin. Copper II, however, was not an isolated phenomenon: there was a very similar development at about the same latitude farther to the west near Akjoujt in Mauritania (Crova 1912; Lambert 1970, 1971, 1972, 1974, 1981, 1983). This took place at the same time and does not appear to have developed out of Copper I. Since Copper II replaced Copper I very rapidly near Agadez and since the same types of furnaces were used in both Mauritania and Niger, it is possible that the metal-working in these two areas may be derived from the same source. This source was probably to the north, towards the Mediterranean, and, more specifically, in Morocco which has much evidence of mining activities. Finally, it should be noted that the metallurgy occurs in the Saharan region but not in the Sahel, where no artifacts of hammered copper have been found.

The problems raised by iron-working are very different from those posed by the working of copper. There are several centers of iron-working known in the Sahel, from which the evidence consists mainly of the remains of furnaces. These occur near the Termit massif, which is east of the Tigidit scarp but still in Niger (Quéchon and Roset 1974), and on the Jos plateau in northern Nigeria (Shaw 1981). (In the latter instance, the early iron-working is related to the Nok culture, which is known for its terra-cotta statuettes. Numerous remains of furnaces have been found at Taruga, but there has still been no definitive publication of this site.) Elsewhere, the only evidence of early iron-working consists of slag at the base of the cultural deposits at Mdaga in Chad (Lebeuf *et* *al.* 1980) and at Jenné Jeno in Mali (McIntosh and McIntosh 1980); these indicate that iron was manufactured locally. It is, however, along the Tigidit scarp that the data are most numerous and, above all, most varied. Although the iron-working of Niger is dated to the first half of the third millennium B.P. in the Termit massif, it is younger than that of the Mediterranean basin, and it is therefore in the latter direction that we must look for the origins of this new industry. Nevertheless, it is possible that the populations who introduced iron technology may have originated farther to the south, because of the locations of the Early Iron Age sites near Agadez (see above) and because of the the puzzling relations which seem to have existed between this Early Iron Age and the Sahelian Neolithic (Grébénart 1986).

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Overview

ANGELA E. CLOSE

PALEOENVIRONMENT

Most of the research synthesized in the preceding chapters has been carried out in the high desert of the great Sahara or in the lush ribbon of the Nile Valley. There is no environmental gradation between these two, and the contrast is abrupt and startling. It has long been apparent that this was not always so and that during certain periods of prehistory the Desert has been wetter and the Nile Valley has been drier (although not necessarily at the same time). A considerable part of all prehistoric research in North Africa is therefore devoted to the resolution of paleoenvironmental problems *sensu lato*.

Considerable changes have occurred in the last few years in our views of the recent evolution of the Nile. In the major interpretations of the 1960s (Butzer and Hansen 1968; de Heinzelin 1968), the Nile was imagined as a major river very much like that of today, which underwent a series of aggradations and down-cuttings during the Late Pleistocene. The episodes of aggradation, in particular, were difficult to reconcile with the lowered Mediterranean base-level at that time. The model of Nile behavior proposed here (Schild, this volume), which assigns important roles to both the amount of water and the amount of sediment in the river, seems to be more consistent and more satisfying.

It now appears that with the coincidence of reduced water and increased sediment, the Nile became so choked that it simply had not the power to down-cut, even with the low base-level of the last glacial maximum. Instead, down-cutting occurred when the river was competent to do so, with more water and less sediment, even if the base-level was not at its lowest. The level of the Nile below the Second Cataract is still, therefore, seen as having varied considerably during the Late Pleistocene and the Holocene, but the pattern of the variations has changed somewhat. After a major episode of alluviation during the Middle Paleolithic, which ended perhaps by 40,000 B.P. and certainly by 30,000 B.P., there was an episode of down-cutting until shortly before 20,000 B.P., when the Late Paleolithic alluviation began. The latter subsumes the former complex of Sahaba, Darau, Ballana and Masmas aggradations (Paulissen and Vermeersch, this volume; Schild, this volume) and lasted until the beginning of the early Holocene down-cutting at about 12,400 B.P.

The correlation of the behavior of the Nile with variations in rainfall in Ethiopia and Equatoria and, by extension, within the Sahara itself is a crucial aspect of this general model of the North African paleoclimate. Insofar as comparative data exist, the fit is generally good. In fact, although the model has been constructed for Nile behavior in the later Pleistocene, it would also seem to be applicable to a much earlier period if the reduced water and increased silt of the "Dandara Crisis" can be correlated with the cold and arid conditions of the mid-Brunhes climatic change (Paulissen and Vermeersch, this volume). The significant exception in goodness of fit is for the Nile down-cutting between the Middle and Late Paleolithic alluviations, when some indication of higher rainfall might be expected in the Sahara. While there is evidence of wetter periods within the Pleistocene from throughout the Desert, their dating is not consistent. Indeed, the Sahara itself is so vast and varied that it might be simplistic to expect that paleoclimatic changes should have been synchronous and identical throughout.

There are some indications from the Central and Western Sahara of a wetter phase between about 30,000 and 20,000 B.P. (Petit-Maire and Dutour, this volume; Roset, this volume), which accords well with the Nile, but the Eastern Sahara seems to have been hyperarid during this period (Wendorf and Schild 1980). (The problem of the conflicting Eastern Saharan dates is discussed at some length by Haynes [this volume].) The suggestion of a brief, wetter interval in the lower Nile Valley at about 23–21,000 B.P. (Paulissen and Vermeersch, this volume) may be unduly influenced by run-off from the Red Sea Hills, which, even during the modern hyperaridity, still receive considerably more (orographic) rain than does the Eastern Sahara. There are two possible explanations of this discrepancy. It may be that the increase in rainfall to the south was not so marked as to have had any effect on the Sahara and that the 30–20,000 year dates are incorrect. The samples from which they were obtained were carbonates, which are notoriously unpredictable for radiocarbon dating, while more reliable materials (charcoal and shell) have generally been used in the Eastern Sahara and the Nile Valley. Alternatively, increased rainfall to the south may have affected the Western and Central Sahara, but may not have been detectable in the east. This would not so much echo as greatly amplify the east-to-west gradient of increasing aridity known from the Holocene (Pachur and Röper 1984), when the onset of a less-pronounced wet phase can be seen throughout the Desert. It would also imply that some of the archaeological occurrences associated with lacustrine deposits in the Western and Central Sahara may have persisted as late as 20,000 B.P. These occurrences are usually described as Aterian, a Middle Paleolithic variant that was established at least by the Last Interglacial (Wendorf *et al.* in press a) and for which there is no evidence in northeastern Africa within the last 30,000 years and probably not within the last 40,000 years. In light of the precocity of the Middle Stone Age industries of southern and eastern Africa (Volman 1984; Wendorf *et al.* in press a), it is difficult to accept that their North African equivalent might have lingered on until 20,000 years ago.

The correlation is much better for the terminal Pleistocene and early Holocene, when the Nile began to down-cut shortly before we find evidence for a wetter phase throughout the Sahara. The correspondence between dates for the Holocene wet phase(s) is good for all regions of the Desert, although not perfect (Hassan and Gross, this volume; Petit-Maire and Dutour, this volume; Roset, this volume; Schild, this volume). Perfect synchronism would not be expected in light of Haynes' ability (this volume) to detect movement of the wetting front even across so short a distance as northern Sudan and southern Egypt. It is generally agreed that the last, and therefore most visible, moist

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period in the Desert was very complex, and that earlier periods are likely to prove similar, if equally good documentation should be recovered. In this context, it may be noted that new research into the Middle Paleolithic sites of Bir Sahara and Bir Tarfawi has already revealed a sequence of at least four Middle Paleolithic lacustrine episodes, and possibly more (Wendorf *et al.* in press b).

LOWER AND MIDDLE PALEOLITHIC

It is now well over a decade since much significant research was done into the Lower Paleolithic of North Africa, and the archaeology of that period is not a real focus of attention in this volume, although the concept of the Dandara Crisis seems to represent major progress in the study of the behavior of the Nile at that time (Paulissen and Vermeersch, this volume). Lower Paleolithic material is now known from most of the lower Nile Valley, where it was associated with wetter intervals of unknown number, duration and intensity. However, the artifacts are at best only geologically *in situ* and, archaeologically, are not very informative. The earliest good evidence for human occupation of the lower Nile Valley is Middle or Late Acheulean, as it is also in the Eastern Sahara (Paulissen and Vermeersch, this volume).

Rather more work has recently been done on the Middle Paleolithic, that discussed here, again being concentrated in the Nile Valley. Respectable Middle Paleolithic sites are now known from north of the First Cataract (Paulissen and Vermeersch, this volume); most are of generalized character, and two of the major Nilotic variants of the Middle Paleolithic, Aterian and Khormusan, have been recognized north of Aswan only in Wadi Kubbaniya (Wendorf *et al.* 1980, 1986). The sites occur in the lower desert and seem to be related to the initial processing of raw material rather than to more general domestic activities. (The occurrence of hunting stations is less secure, being founded upon the assessment of "good observation points.") If the same pattern of locations of site-types was followed in the Nile Valley as has been found at Bir Tarfawi, then the living-sites would have been much closer to water and, as suggested by Paulissen and Vermeersch, would now be buried or destroyed.

UPPER AND LATE PALEOLITHIC

There is no evidence for Middle Paleolithic in the Nile Valley after 40,000 B.P. and it had disappeared also from Cyrenaican Libya by that time (McBurney 1967). There seems to have been little Middle Paleolithic occupation of any age in Sinai (Phillips, this volume). The data from the Maghreb are somewhat confused, but most of the reliable radiocarbon dates are infinite (Close 1980, 1984) and we may, with some confidence, place the upper limit of the local Middle Paleolithic no later than 30,000 B.P. In the Eastern Sahara, the end of the Middle Paleolithic lies beyond the range of radiocarbon dating, while its duration in the Central and Western Sahara is linked to the existence or not of a wetter phase between 30,000 and 20,000 B.P. In any case and with even the most liberal interpretation of the data, there is a distinct thinning of the North African archaeological record as a whole between 40,000 B.P. and the beginning of the bladelet industries shortly before 20,000 B.P.

Continuity of occupation throughout this period has long been known for Cyrenaica and is now known for Sinai (Phillips, this volume), but only in very recent years have sites of the period been located and studied in the Egyptian Nile Valley. It is highly likely that most sites of the period are buried beneath the deposits of the Late Paleolithic alluviation, but with Nazlet Khater-4 and Shuwikhat-1 (if the single thermoluminescence date should be confirmed), we are at least no longer faced by a complete hiatus. Nazlet Khater-4 is particularly important both for the evidence there of an actual flint mine and for the discovery of an associated burial (Paulissen and Vermeersch, this volume). The mine is complete with simple shafts and galleries and, at 33,000 years old, seems to be the earliest such occurrence known; most early mines are of the "open-cast" variety, consisting of small holes in the ground. The associated burial is that of a Mechtoid (Thoma 1984), which accords well with the suggestion that the Late Paleolithic Mechtoids found across North Africa might be a local development out of the earlier Aterian stock (Petit-Maire and Dutour, this volume). Such continuity in physical type would also indicate that the archaeological record of 40–20,000 B.P. does indeed show a thinning rather than a hiatus.

The apparent contrast in technology between the known Nilotic, Upper Paleolithic sites without Levallois and the florescence of Late Paleolithic bladelet industries often with Levallois has led to a provocative reinterpretation of much of the Nilotic Late Paleolithic (Paulissen and Vermeersch, this volume). Although stimulating, this reinterpretation seems to us to be somewhat overstated. The fundamental problem is that Nazlet Khater-4 and Shuwikhat-1 are the only two sites known from the entire Egyptian Nile Valley during a time-span of at least 20,000 years; they simply are not sufficient to demonstrate that the Levallois technique had disappeared from the area. The concept of the persistence of Levallois technology as an essentially southern phenomenon is a useful one and fits the data quite well; thus, the Levallois-rich site of 6B32 in Nubia (Irwin *et al.* 1968) is radiocarbon dated to contemporaneity with Levallois-free Shuwikhat-1 in Egypt. However, Levallois does exist in the Late Paleolithic north of the First Cataract. It occurs in small quantities, in irreproachable stratigraphic contexts, in the Kubbaniyan (the Egyptian equivalent of the Nubian Halfan) of Wadi Kubbaniya between *ca.* 18,000 and 17,000 B.P. (Wendorf *et al.* 1980, in press c). It is undoubtedly associated with bladelets in the Idfuan, where single cores combine both the Levallois technique and typical, Late Paleolithic bladelet production (P. Van Peer, pers. comm.). It also occurs in the Late Paleolithic as far north as Isna, where it was found (although not initially recognized) in the Kubbaniyan site of E71K13 (Phillips 1973; see, for example, Figures 25 and 26). The Sebilian, we must confess, is not well dated and is anomalous within the Nilotic, Late Paleolithic context; we prefer, however, the suggestion that it was a "non-Mediterranean" intrusive, presumably from the south, rather than that it was Middle Paleolithic.

The idea that the Sebilian, the Levallois Idfuan and Halfan Stage II were Middle Paleolithic seems to us improbable. The only thing which they share with the true Middle Paleolithic is the use of the Levallois technique; in other respects, they are relatively well-preserved Nilotic sites, rather than poorly preserved lower desert sites; they are rich in tools, while the Middle Paleolithic sites are poor, and most importantly, they are bladelet industries (except for the Sebilian). It is also difficult to justify the separation of the Levallois Idfuan from the non-Levallois Idfuan, and of "Stage II" of the Halfan from the rest of the Halfan and from the Kubbaniyan. To us, the weight of the evidence suggests that Levallois technology was not forever abandoned in the Egyptian Nile Valley after the Middle Paleolithic, although it may have been used more rarely. It may also have been reintroduced from the south (as may the entire Sebilian). Nor would so late a survival of the technology be unique: Aumassip (this volume) reports that it is found even in the Early Neolithic of the southern Bas-Sahara.

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Unfortunately, the hypothesis of a southern reintroduction of the Levallois technique into the lower Nile Valley is difficult to test in the absence of any known sites of this period above the Second Cataract and along the Atbara (Marks *et al.*, this volume). The lack of sites arises principally from the lack of exposures of sediments of the period. If, as Williams and Adamson have suggested (1980:302), the Late Pleistocene Nile aggraded from north to south, then the relevant deposits above the Second Cataract may be at low elevations and now buried. Alternatively, not a great deal of archaeological surveying has been done along the margins of the Sudanese Nile Valley (F. Wendorf, pers. comm.). It is also possible that the earlier sites along the Atbara (Marks *et al.*, this volume) might be somewhat older than the radiocarbon date for KG15 would suggest. If the Early Holocene wetting front had reached northwestern Sudan by about 9300 B.P. (Haynes, this volume), then the Khashm el Girba area is not likely to have been still relatively arid only a thousand years before. However, for the moment the problem of the Sudanese Late Paleolithic must remain without solution.

NEOLITHIC AND LATER

Most of the Holocene archaeology discussed in this volume is from the Sahara, and reveals some noteworthy correspondences in cultural development across the entire sweep of the Desert, even when only the mineral portion of the archaeological record is preserved. The first Holocene colonists tend to appear late in the tenth or early in the ninth millennium B.P., usually equipped with a tool-kit based upon fine bladelets, so that they have frequently been called "Epipaleolithic" or "Terminal Paleolithic" in the literature. However, these same groups were in possession of well-made pottery and grinding-stones before 9000 B.P. in western Egypt (Wendorf *et al.* 1984), by 8600 B.P. in western Libya (Barich, this volume) and by 9300 B.P. in northern Niger (Roset, this volume). In southwestern Egypt, they also had domestic cattle by the same date (it is unfortunate that there were no bones preserved in the Siwa sites to the north [Hassan and Gross, this volume]), and in light of the generally early and widespread appearance of domestic cattle throughout the Desert (Gautier, this volume), we are tempted to speculate on the status of the 9000-year-old cattle remains from Tin-Ouaffadene in Niger (Roset, this volume). As the Holocene progressed, we see development into a more conventional form of "Neolithic" (by about 8000 B.P.) throughout the Sahara (Aumassip, this volume; Barich, this volume; Roset, this volume), progressively greater reliance upon food-production (where direct economic evidence is available), the widespread occurrence of dotted wavy-line pottery, and a decline in the lithic industries from bladelets to flakes and from standardized microliths to larger and less-formal tools.

A broadly similar sequence is apparent in the Khartoum Mesolithic-Neolithic development of the central Sudan (Mohammed-Ali, this volume). The Khartoum Mesolithic is comparable in age to the Early Neolithic of the Sahara and is equally rich in plant-processing equipment and pottery. The little direct evidence available to us, however, seems to suggest that food-production began much later along the central Nile Valley than in the Desert. This might reflect a less stressful and more predictable riverine environment, but merits further investigation.

Within this overall framework, closely defined industries or sequences in the Sahara tend to be very localized, as would be expected in view of the widespread evidence for at least semi-sedentism. However, there is an additional stratum of very broad and general trends, which may reflect contact and exchange of goods and ideas between partially nomadic groups, or task-groups (Barich, this volume; Roset, this volume). Thus, arrowheads appear very early in the Central and Western Sahara and are a numerically important, formally diverse and very characteristic class of tools in the Neolithic of those regions. They do not appear in the Eastern Sahara, however, until comparatively late in the sequence and are never so important or so varied as they are to the west. Again, the Holocene artifact-sequence from Ti-n-Torha echoes the broad outlines of that of the Eastern Sahara (Close in press) (although the latter, being a more arid region, has a more patchy record), the points of difference usually being the points of similarity between Ti-n-Torha and more westerly regions. Or again, to the south, the peculiar segments, micro-scrapers and rectangles of the Atbara sites are also widespread in the Desert of northwestern Sudan (making their absence from the Sudanese Nile Valley rather curious!)

On the other hand, it is apparent from the archaeological and the paleoenvironmental studies discussed here that the Great Sahara is not environmentally uniform or monotonous and was even less so during the wetter phases of the Holocene. Human groups cope with, or adapt to, their own, very local, environment and, even in the modern world, rarely regard the stresses and changes occurring a few hundred kilometers away as something with which they need concern themselves. This also is reflected in the archaeological record. At the local level, it may be seen in the location of the Siwan sites at the border between two environmental zones and not far from water (Hassan and Gross, this volume), or in the locations of the Neolithic sites both in the Bas-Sahara (Aumassip, this volume) and in the Eastern Sahara (Wendorf *et al*. 1984) near the lowest points of internal drainage basins. At the broader level, rainfall (and with it the ease of making a living) generally increased towards the west and around the massifs, so that in the Early Holocene of the Central Sahara there is evidence of semi-sedentism in the Tadrart Acacus (Barich, this volume) and probably in the Bas-Sahara (Aumassip, this volume), and of relatively large and rich sites in the Aïr and Ténéré (Roset, this volume). In the Eastern Sahara, on the other hand, conditions were much drier, semi-sedentism was not possible before about 8100 B.P. and the Desert initially may not even have been habitable throughout the year. It was in the east, therefore, that the Early Holocene adaptations to aridity were most developed, and it seems to have been here that the very specific, and highly successful, adaptation of cattle-domestication and -herding came into being, and from here that it spread across the Desert (Gautier, this volume).

Most of the archaeological record, however, is determined by the continuity of local tradition; external contact was much less influential. This is particularly noticeable when we find stratified sites within a small area, such as in the Tadrart Acacus where the rockshelters provided natural foci for human occupation and reoccupation. There, the evidence for continuity of population is overwhelming and quite independent of changes in material technology (the appearance of pottery) or subsistence economy (domestic cattle). A similar continuity across economic change is also apparent in the Khartoum Mesolithic-Neolithic sequence of Shaqadud (Mohammed-Ali, this volume).

This is not surprising—it is some years since all technical or economic changes were the result of waves of invaders—but underlines the error behind an unreasoning emphasis upon the "invention" or "first appearance" of pottery, food-production, or what-have-you. In the prehistoric world, there were no global impacts. Every invention was made on a local scale even if the concept came from outside, and every innovation was made anew by each local group adopting it, through the very process of adapting the innovation to the local society.

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We would also observe that new concepts were assimilated in such a way as to cause the least disruption to the existing fabric of society, to minimize the effects of the innovation and most certainly to avoid anything approaching a revolution. This was true of the spread of pottery and of domestic cattle among the Early Holocene populations of the Sahara, so that both, when initially present, were very rare and were probably viewed as dispensible. It was equally true of the later appearance of metallurgy in the Sahel, which was practiced by task-groups within an essentially Neolithic society and with no apparent effect on the overall way of life (Grébénart, this volume). However, this conservatism is not in any way equivalent to a "development" spanning several millennia. The Sahara was not populated by village idiots; the members of a local group were fully capable of mastering new concepts in their entirety and of then applying them, even if sparingly, within their own peculiar, social context. The earliest ceramics in the Desert were technically very good (Barich, this volume; Roset, this volume; Wendorf *et al.* 1984), and the earliest cattle were fully domestic (Gautier, this volume). Once the basic concept has been mastered, there is no need for a lengthy period of development (Gautier, this volume; Roset, this volume). This means that we should not expect to be able to trace the "spread" of a new concept, or innovation, as if it were a Holocene wetting front. The front may advance at a steady pace of half-a-kilometer a year; humanity, fortunately, is much more complex and much more capricious.

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APPENDIX

The Combined Prehistoric Expedition: The First Twenty-Five Years

MICHAŁ KOBUSIEWICZ

INTRODUCTION

The history of the Combined Prehistoric Expedition deserves a special chapter. In the study of prehistory, there has been no comparable scientific enterprise which has lasted so long and covered such vast areas of space and such comprehensive scientific problems, and which has consistently published a comparable number of papers presenting the scientific results to all those interested.

The Expedition (as we will refer to it) has conducted its activities without interruption for 25 years. The initial period was chiefly concerned with the recovery of archaeological information before the flooding of the reservoir behind the New High Dam at Aswan. Later groups of seasons were devoted to the solving of particular problems, such as the Upper Paleolithic in the Nile Valley, or the Early Neolithic of the Eastern Sahara. The range of studies has covered the prehistory of three large, northeastern African countries—Egypt, Sudan and Ethiopia—from the Acheulean up to the beginnings of Egyptian civilization (Figure A.1). If we take a period of ten weeks as an average field-season, then the fieldwork alone has lasted for five years. The time for study, analysis and writing is difficult to calculate, but the best indication of it is the number of scientific publications: thus far, 16 books have appeared based on the Expedition's work, as well as numerous smaller papers and articles.

The name "Combined Prehistoric Expedition" is itself significant. The core of the Expedition has always been composed of American, Polish and Egyptian groups, working together under long-term contracts of scientific co-operation. However, people of other nationalities also take part in the Expedition, sometimes only for a short period and sometimes as a co-operative effort stretching over many years. The name, therefore, is neutral; it does not emphasize the contribution of any one national group and leaves room for everybody.

The purpose of this rather condensed account is to present a short chronicle of the research field-seasons, an account of the scientific problems tackled and the results achieved, and a characterization of the way of life of the Expedition.

HISTORY

The beginnings of the Combined Prehistoric Expedition are linked to the campaign to salvage the Nubian relics threatened by the flooding of the reservoir behind the New High Dam. In 1960, U.N.E.S.C.O. made an appeal, on behalf of Egypt and Sudan, for assistance in rescuing the cultural monuments. Fred Wendorf was already experienced in conducting large-scale, archaeological salvage programs in the U.S.A., and it was he who undertook the long-term program for the salvaging of the prehistoric material in Nubia. He began by organizing a program of studies in Egyptian Nubia. At the same time, in the winter of 1961–62, Ralph Solecki and Rhodes Fairbridge, of Columbia University, were conducting an initial reconnaissance in Sudanese Nubia. Having, however, other primary interests, at the end of 1962 they suggested to Wendorf that he should take over management of the salvage program in the whole of Nubia. Since then, Wendorf has been Project Director for every season and for all activities of the Combined Prehistoric Expedition. The research seasons, in chronological order, have been as follows.

1962–1963 Season

Egypt. A preliminary survey was made of the oases of Kurkur and Dungul (in the Eastern Sahara) and on the western bank of the Nile, near Ineiba, Ballana and Abu Simbel; numerous Paleolithic sites were found.

Sudan. A survey was made of both banks of the Nile in Sudanese Nubia and excavations were begun at several localities.

1963–1964 Season

Egypt. Excavations were carried out at Dungul oasis and a survey was made along the western bank from Ineiba to the Sudanese border.

Sudan. Work along both sides of the Nile. This season was the most important in Sudanese Nubia.

1964–1965 Season

Egypt. Kurkur oasis was studied briefly and excavations were carried out at Ballana and Tushka on the western bank of the Nile in Egyptian Nubia.

Sudan. Research continued on both banks of the Nile in Sudanese Nubia.

1965–1966 Season

Egypt. Additional work was done in the area of Tushka. The study of Late Paleolithic sites led to the discovery of grinding-stones, flaked stone artifacts with sickle sheen and wheat-rust spores.

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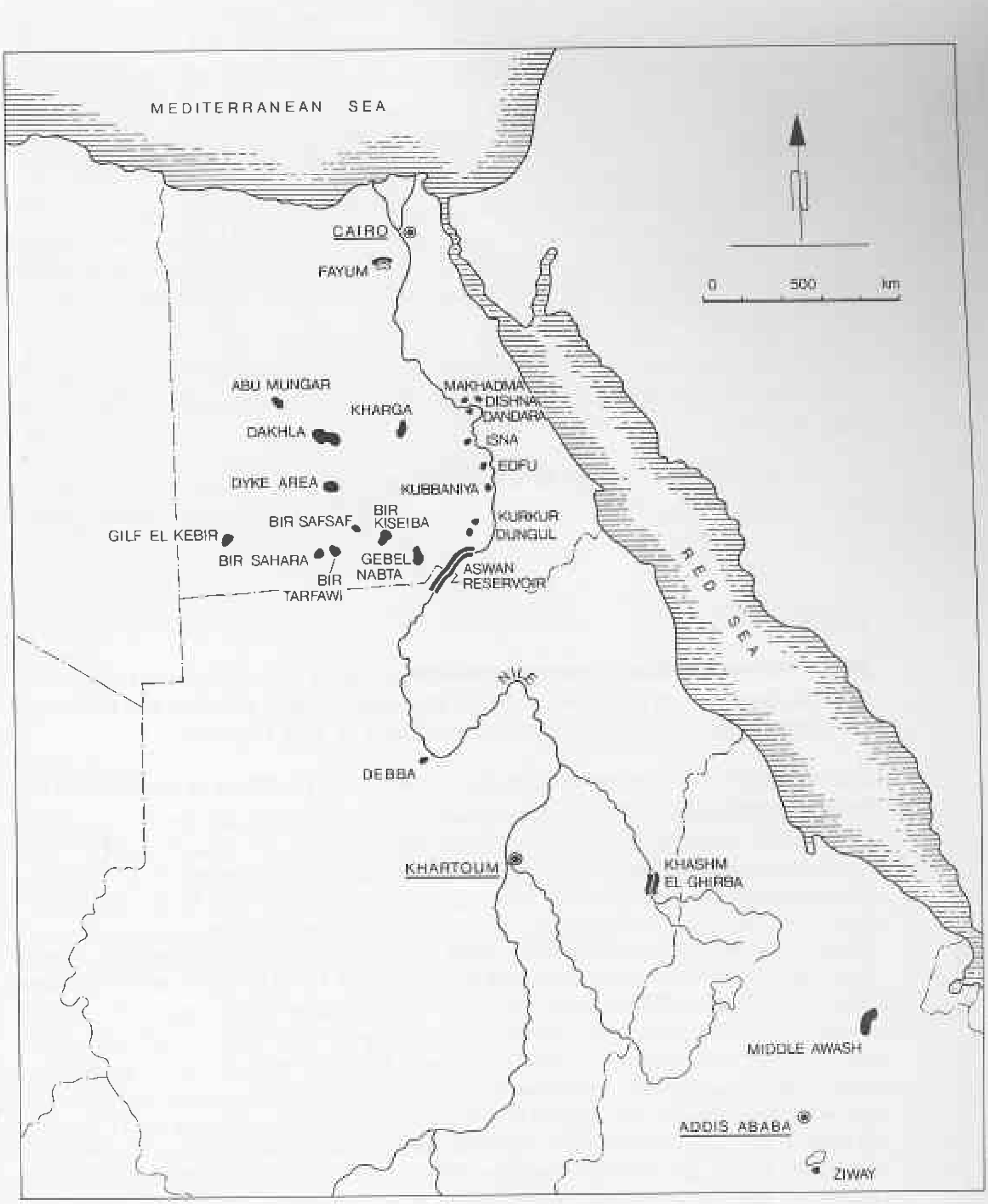

Figure A.1 Areas studied by the Combined Prehistoric Expedition 1962–1986.

Sudan. Excavation of the Jebel Sahaba cemetery was concluded.

This completed the archaeological salvage in the Aswan reservoir, and the last sites were inundated.

1967 SEASON

This marks the beginning of a new phase in the work of the Expedition, when it was decided that study of the little-known prehistory of the Nile Valley should be extended beyond the inundated areas of Nubia to the entire valley. The Expedition was now divided into two groups, one working northwards into Egypt and the other southwards into Sudan.

Egypt. Upper and Late Paleolithic sites were studied in the region of Idfu and Isna. A pollen profile taken near Isna showed the existence of cereal-like grasses. The western bank was surveyed from Wadi Kubbaniya to Armant.

Sudan. Work in the environs of Debba on the Nile and Khashm el Ghirba on the Atbara resulted in the discovery of rich Lower Paleolithic and Neolithic sites in eastern Sudan.

1968 SEASON

Egypt. Research was on the Middle Paleolithic sites on the western bank of the Nile near Dandara, and on the Upper and Late Paleolithic near Makhadma and Dishna on the eastern bank. A survey was made from Luxor to Nag Hammadi.

Sudan. The work in Sudan was interrupted because of the illness of the leader of the Sudanese group (Shiner).

1969 SEASON

Egypt. Epipaleolithic and Neolithic sites were investigated in the northern Fayum depression. Both banks of the Nile were surveyed from Tahta to Asyut, and the western bank from Tahta to Mallawi.

1970–1971 SEASON

Studies in both Egypt and Sudan were now interrupted: in Sudan, because of Shiner's continued illness, and in Egypt, because of the Arab-Israeli conflict and the imposition of martial law. Research now began in Ethiopia.

Ethiopia. Interest in this country resulted from the survey on the Atbara (Khashm el Ghirba) in 1967, indicating the existence of rich prehistoric sites near the Ethiopian border. In December 1970, the planned survey along the River Takkaze, the right tributary of the Atbara, had to be cancelled because of the unrest in Eritrea. A few Middle Stone Age sites were found near Lake Tana, and many more were found near Lake Ziway in the Central Rift Valley.

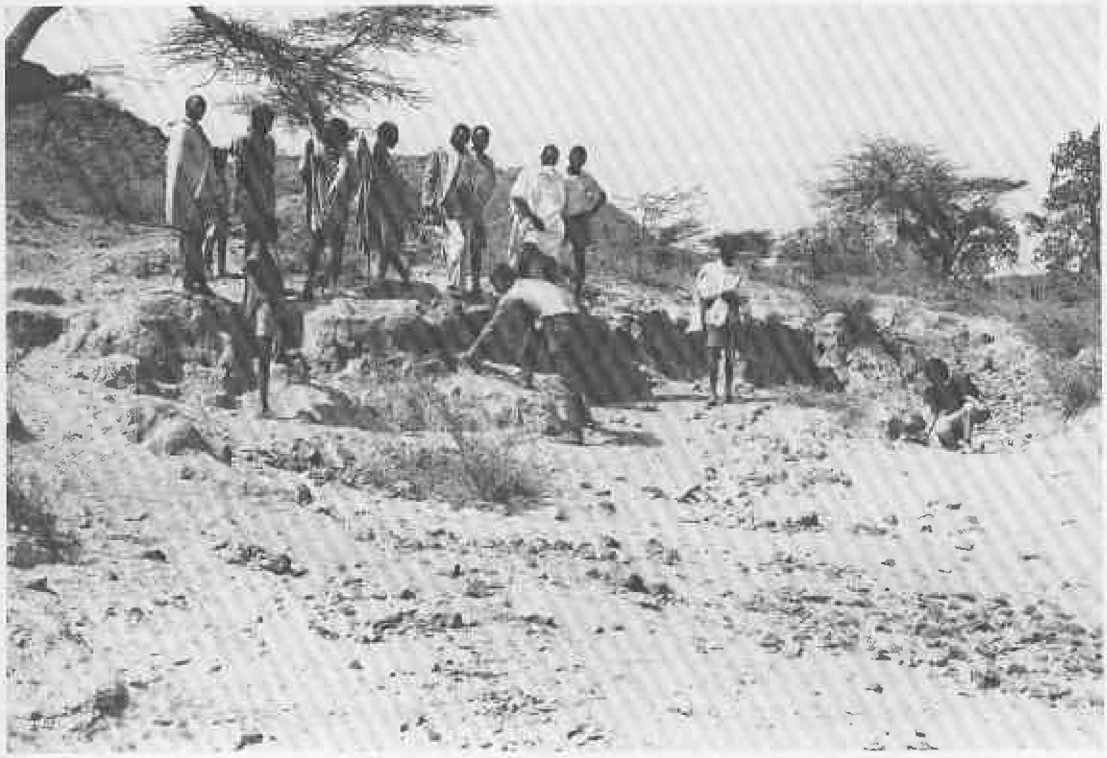

Figure A.2 Excavation in Ethiopia, a much more lush environment than is normal for the Expedition.

1972 Season

Ethiopia. Work was carried out in the area between Lakes Ziway and Langano in the Rift Valley. Studies of Middle Stone Age sites in the Gademotta Hills, in the Gademotta-Kulkuletti sequence and near Lake Ziway provided important new data for the Middle Stone Age in East Africa (Figure A.2). A number of Late Stone Age sites were also discovered south of Lake Ziway, and an ethnoarchaeological study was made of modern obsidian-knappers.

Egypt. The opportunity arose to return to Egypt, although farther from the theater of war. The Nile Valley was temporarily abandoned, and research began into the prehistory of the Eastern Sahara. Lower and Middle Paleolithic and Neolithic sites were studied in the areas of Dakhla Oasis and Abu Mungar and south of Dakhla (Dyke Area). There were also surveys in the direction of Kharga, Bir Sahara and Bir Tarfawi.

1973 Season

Ethiopia. Work was on Late Stone Age sites at Lake Ziway, with a survey from Ziway to Moyele at Lake Stephanie on the Kenyan border. Several Middle Stone Age sites were found in the region of Lake Galla.

Egypt. Lower and Middle Paleolithic sites were studied at Bir Sahara and the adjacent oasis of Bir Tarfawi was surveyed.

1974 SEASON

Egypt. Middle Paleolithic sites were studied at Bir Tarfawi, and Early Neolithic in the vicinity of Gebel Nabta.

1975 SEASON

Ethiopia. Studies were made of the rich Acheulean butchery sites in the middle Awash basin.

Egypt. Early Neolithic sites in the region of Gebel Nabta were excavated and a survey was carried out in the Gilf el Kebir and Bir Tarfawi.

1976 SEASON

Ethiopia. Studies of the Acheulean butchery sites in the middle Awash basin were continued briefly, but political events in Ethiopia prevented extensive studies.

Egypt. Middle Paleolithic and Early Neolithic sites were studied at Kharga Oasis, and a survey was made near Bir Kiseiba.

Sudan. A geological survey was carried out in the Sudanese oases of Laqiya, Selima and Merga.

1977 SEASON

Egypt. Early Neolithic sites were excavated in the vicinity of Gebel Nabta. Surveys were made of oases in the southern part of the Egyptian Western Desert (Bir Nakhlai, Bir Abu el Hussein, Bir Aïd, Bir Kiseiba, Bir Safsaf, Bir Sahara and Abu Ballas) and in the Qattara depression in northern Egypt and along the coast of the Mediterranean to Marsa Matruh. There was also a brief survey in Wadi Kubbaniya, north of Aswan.

1978 SEASON

Egypt. The Expedition returned to the Nile Valley to study Late Paleolithic sites in Wadi Kubbaniya. Surveys were made along the Red Sea coast from Marsa Alam to Safaga, and in Wadi Qena.

1979 SEASON

Egypt. The Expedition returned to the Eastern Sahara and worked at Early and Middle Neolithic sites in the vicinity of Bir Kiseiba.

Sudan. A survey was made of the oases of Laqiya and Selima, including isotopic studies of groundwater using geochemical modelling.

1980 Season

Egypt. Study of the Neolithic sites in the region of Bir Kiseiba and Bir Aïd was continued, with an additional detailed survey of Neolithic sites on the plateau above the Kiseiba scarp. A few days were spent at Wadi Kubbaniya.

Sudan. A survey was carried out from Jebel Marra and El Fasher to north of Jebel Maydub in northern Darfur.

1981 Season

Egypt. Work was begun again on the Late Paleolithic sites in Wadi Kubbaniya, including studies of micro- and macro-settlement patterns and an intensive search for archaeobotanical remains.

1982 Season

Egypt. Work continued on the Late Paleolithic sites at Wadi Kubbaniya, and a detailed study was begun of the Middle Paleolithic sites and the Late Paleolithic skeleton found near the mouth of the wadi.

Sudan. Rich Holocene sites were found during a survey carried out in the region of Merga Oasis.

1983 Season

Egypt. Work continued at the Middle and Late Paleolithic sites at Wadi Kubbaniya, and there was a survey of the western bank of the Nile near Isna and El Kilh.

1984 Season

Egypt. Work at Wadi Kubbaniya was completed. A systematic survey was made over part of the "radar channels" (see below) near Bir Safsaf in the Eastern Sahara.

1985 Season

Egypt. Systematic surveys and some excavations were made in the southern part of the Eastern Sahara to test the hypothesis that ground-penetrating radar from the space-shuttle (SIR-A) had revealed ancient, buried river-systems. There were also studies of Late Pleistocene deposits and Middle Paleolithic sites at Bir Sahara and Bir Tarfawi.

1986 Season

Egypt. Investigation was begun of the numerous, small, Middle Paleolithic sites associated with the shores of a series of fluctuating lakes at Bir Tarfawi. Excavation was also begun of a deeply-stratified, Aterian "butchery site," as part of a study of Middle Paleolithic meat-procurement.

BASIC RESEARCH PROBLEMS

REGIONAL STUDIES

Nubia

The Expedition carried out four season of work (1962–1966) in Nubia, studying the Stone Age sites threatened by inundation. Intensive surveys revealed numerous settlements, many of which were carefully studied. The oldest can be assigned to the Middle Acheulean, and there were numerous Middle and Late Paleolithic sites and traces of Early Neolithic. An important result of the first cycle of research was disproving the erroneous, but then generally accepted, concept that the Nile Valley was poor in Stone Age remains and that those few remains present indicated cultural stagnation. It became apparent that many rich and varied prehistoric cultures had flourished along the Nile in those times.

The rich cemeteries of Jebel Sahaba and Tushka were discovered during this period. These finds showed that most of the Late Paleolithic inhabitants of Nubia were affiliated to the Mechta el Arbi physical type, previously known from the Maghreb.

The concept of a "Nilotic adaptation" was developed on the basis of the work in Nubia and has proved to be very important for our understanding of the prehistory of northeastern Africa. It emphasizes the integrative role of the specific milieu of the Nile Valley, which profoundly influenced the culture of all hunter-gatherer societies functioning within it. It provides an explanatory tool for the regularities and mechanisms of adaptation and development of primitive Nilotic societies.

Apart from numerous shorter papers and articles, the culminating work of the Expedition's first stage of research was the two-volume *Prehistory of Nubia*, published in 1968.

The Nile Valley

Other expeditions dealing with prehistoric remains in the Aswan reservoir dissolved soon after completion of the salvage work, but the Combined Prehistoric Expedition continued its activities. The spectacular results of the Nubian campaign directed the interest of the Expedition toward the remaining sections of the Nile Valley, where the prehistory was still essentially unknown. This second cycle of research comprised eight seasons: 1967–1969, 1978 and 1981–1984 (see above).

The scientific results of the Nile seasons were abundant. Rich concentrations of Late Paleolithic settlements were discovered in the regions of Wadi Kubbaniya, El Kilh, Isna, Dandara, Makhadma and Dishna in the Nile Valley; of Epipaleolithic and Early Neolithic in the Fayum depression; and of Lower Paleolithic and Neolithic in Sudan in the vicinity of Khashm el Girba.

The discovery of grinding-stones in numerous Late Paleolithic sites, of artifacts with sickle sheen, of cereal-like pollen and wheat-rust spores in pollen diagrams from the Isna region led to concentration of the Expedition's research efforts on the problem of intensive food-gathering and its role in the subsistence of the Late Paleolithic inhabitants of the Nile Valley. Particularly rich data pertaining to these problems were obtained from the work at Wadi Kubbaniya in Upper Egypt. Here, by passing all of the

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cultural sediments through graded screens and with the aid of a large group of botanists, extensive collections of archaeobotanical material were recovered, which have considerably expanded our knowledge of the prehistoric use of plants in the Nile Valley.

Research along the Nile also provided a great deal of information about the geomorphological sequence, which has been important not only in the reconstruction of the history of the river, but also in the study of the climatic changes which took place in northeastern Africa in the Late Pleistocene and Early Holocene.

The main publications resulting from the second stage of research are listed in the References below, as follows: Close *et al.* 1979; Hassan 1974; Lubell 974; Phillips 1973; Wendorf and Schild 1976; Wendorf *et al.* 1980, 1986.

Ethiopia

Five seasons were spent in Ethiopia: 1970–1973 and 1975–1976 (see above). The cultural and adaptational transformations of the Middle Stone Age were studied at a stratified sequence of occupations in the lake district of the Central Rift Valley. By means of the potassium-argon method, these were dated back to 140–180,000 years ago, an almost unheard-of age for Middle Stone Age at that time. In addition, a series of beautifully preserved, Acheulean butchery sites were found in the middle Awash basin. Detailed study of them was prevented by political unrest, but they did yield the important Bodo skull, with the well-preserved face of an archaic *Homo sapiens*.

The report on the Middle Stone Age sites around Lake Ziway was published in *A Middle Stone Age Sequence from the Central Rift Valley, Ethiopia* (1974).

Eastern Sahara

Thus far, ten seasons have been devoted to the prehistory of this vast, but fascinating, area: 1972–1977, 1979–1980 and 1985–1986 (see above). In the course of these ten seasons, detailed studies have been carried out of Late Acheulean, Middle Paleolithic and Neolithic societies. The detailed stratigraphic work and mapping involved in the study of the Mousterian and Aterian sites at Bir Sahara and Bir Tarfawi have provided important new data concerning the adaptation of Middle Paleolithic societies to the semi-desertic and desertic conditions of northeastern Africa, and the rich faunas associated with the sites have permitted accurate reconstructions of the contemporaneous natural environment.

The greatest research effort thus far has been that devoted to the study of the Neolithic inhabitants of the Eastern Sahara, who left a surprisingly rich archaeological record. Numerous sites were found around the Early Holocene playas near Gebel Nabta, Bir Kiseiba, Bir Aïd and in the Kharga Oasis. They yielded abundant cultural remains, as well as remains of the flora and fauna, from which it has been possible to reconstruct the previously unknown world of human groups who lived in an area which is today one of the driest in the world. A particularly important achievement of this stage of the Expedition's work was the discovery of a very old system of Neolithic pastoralist groups, reaching as far back as the tenth millennium B.P. (Figure A.3). Through paleogeographic and climatic data, it was also possible to trace the slow process of desertification in this region, with increasingly impoverished plant-

Figure A.3 An Early Neolithic (ninth millennium B.P.) walk-in well near Bir Kiseiba; scale is provided by Aïd Maariif.

communities, local extinction of the fauna, and a slow decline of human settlement, in spite of dramatic efforts by the prehistoric groups to adapt their ways of life to the ever-more-desertic natural environment.

In addition to the regular program of excavation in the Eastern Sahara, other survey expeditions were undertaken during this period, sometimes on a large scale, such as that to the plateau of the Gilf el Kebir, but usually relatively limited in scope, such as those to the oases of northern Sudan. Sites of various periods of prehistory have been discovered during these surveys, and some preliminary geological and archaeological studies have been made.

The published monographs reporting the scientific results of the Expedition's work in the Eastern Sahara, listed below in the References, are Banks 1984; Schild and Wendorf 1977, 1981; Wendorf and Schild 1980; Wendorf *et al.* 1984.

THEMATIC STUDIES

The Combined Prehistoric Expedition has deliberately and almost invariably worked in areas that were archaeologically otherwise unknown. This has meant that the prehistory done by the Expedition is almost always "new," rather than a reworking of older findings, and also, since the areas of study are archaeologically virgin, that a part of the Expedition's effort must be devoted to recreating the basic framework within

Figure A.4 Drawing of a stratigraphic profile (Schild records while Wendorf measures).

which local prehistory may be viewed. A traditional cultural-historical approach is, therefore, rather more prominent in publications by the Expedition than is necessary in areas where the basic archaeological sequence has already been established.

Nevertheless, in addition to the regional studies outlined above and to the reconstruction of the local framework for prehistory, the Expedition has devoted considerable time to the study of more general archaeological problems, not linked to any specific area. Among these are the paleogeography of northeastern Africa, the economic basis and settlement-systems of Stone Age populations and studies of stylistic variation in stone artifacts.

Paleogeography

Systematic geomorphological studies have been carried out both of individual archaeological sites and of larger areas of settlement (Figure A.4). The history of the Nile during the last 80,000 years has been established in some detail. A sequence of alluviations and down-cuttings was first developed during the salvage excavations in Nubia. These were responses to global changes of climate and profoundly influenced prehistoric settlement in the region. This sequence has since been modified and refined as new information has been acquired.

The climate and natural environment of the vast territories of the Eastern Sahara have been reconstructed from the Middle Pleistocene up to the present day. This area is now extremely arid, but it has been possible to recognize and to date considerable variations in the climate. In the Upper Pleistocene and in the Early Holocene, the Eastern Sahara was sufficiently humid to support rich human settlement. When the area began to dry up rapidly later in the Holocene, the social and political consequences were marked, not only for the desert but also for the adjacent Nile Valley to which the desert groups migrated.

Prehistoric Economies and Settlement-Systems

The Expedition has attached considerable importance to the problem of the economic basis of prehistoric populations in all the areas it has studied. Sites likely to yield organic remains have been deliberately sought out and selected for study, so that rich archaeozoological and archaeobotanical collections are now known from several regions of northeastern Africa. These have been studied by co-operating specialists in the biological, physical and chemical sciences.

Detailed archaeozoological analyses have permitted the reconstruction of the ecological spheres in which particular human groups lived, and have often allowed the identification of the seasons at which particular activities were performed. Floral and faunal remains have also provided information both confirming and supplementing the environmental reconstructions based upon local and regional geomorphology.

The Expedition's interest became focused on prehistoric economies very early in its history, with the discovery of grinding-stones and sickle sheen in Late Paleolithic sites in Nubia. This suggested that the Nile Valley might have been a very early center of plant-domestication, and possibly earlier than the known centers of the Near East. Even when sites of other periods were known, therefore, much of the Expedition's subsequent work in the Valley was concentrated on sites of the Late Paleolithic, which might be expected to yield data relevant to this problem. This quest culminated in the five seasons of work at Wadi Kubbaniya, where, after heroic efforts, sufficient archaeobotanical remains were recovered to demonstrate that plant-gathering was a very important activity during the Late Paleolithic of the Nile Valley, and that the plants gathered were native wild species, which were still of economic importance to the Pharaonic and later inhabitants of the Valley. This was not, of course, the finding originally hoped for, but represents in itself a significant contribution to Late Paleolithic studies and a useful modification to the more usual picture of mighty Paleolithic hunters.

The suspicion that plant-gathering, whether of domesticates or not, was an important aspect of Paleolithic economies in the Nile Valley suggested the existence, at the very least, of pre-conditions favoring domestication. This seems to be reflected in the economic strategies of Neolithic groups moving into the Eastern Sahara early in the Holocene. Domestic plants became known to them not long after their first appearance in the Near East, but cattle do seem to have been a local domesticate, tamed in response to the specific requirements of life in the post-Pleistocene Sahara. Cattle-pastoralism was an inventive and effective adaptation to the precariousness of life in the semi-desert.

An important facet of prehistoric economy is the settlement-system in which it functions, and the Expedition's research has involved extensive studies of such systems. At the "micro" level, single-level sites have been preferentially excavated or collected, since these are most likely to retain intact cultural patterns, and all of the artifacts and other cultural materials are individually mapped (Figure A.5). Many of these "scatter-patterns" have been published, and those from several areas, including Wadi Kubbaniya and Bir Tarfawi, have been studied statistically. At the "macro"

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Figure A.5 Scatter-patterning during excavation at Wadi Kubbaniya.

level, the areas around excavated sites are usually surveyed for additional occurrences, and the regional geomorphological studies, which always accompany the archaeology, provide a landscape within which located sites can be realistically placed (Figure A.6). With the aid of any floral and faunal data, it may then be possible to determine actual seasons at which sites are likely to have been occupied, or not, and to reconstruct functioning systems out of apparently miscellaneous archaeological sites.

Stylistic Studies

A third general research problem has been study of the stylistic differentiation of assemblages of flaked stone artifacts. The purpose of the study has been to develop a method of identifying cultural differentiation in the archaeological record, independent of all technological or functional sources of variability. Since the method is essentially statistical in nature, it requires large samples of artifacts, studied by the same methods and classified according to a uniform system, preferably by the same group of researchers. This program is promising, but far from completion; much of its success is due to the duration and consistency of work within the Expedition. Stylistic studies have thus far concentrated chiefly on the Late Paleolithic and Neolithic societies of northeastern Africa.

ORGANIZATION OF THE EXPEDITION

The work of the Combined Prehistoric Expedition cannot be fully appreciated without some mention being made of the logistical problems of the fieldwork, in both sedentary

Figure A.6 Regional mapping at Wadi Kubbaniya.

periods of excavation and mobile survey expeditions, and of their solutions. It should be remembered that many of the field-seasons are conducted in extremely arid and remote areas, which are very difficult of access and are sometimes several hundred kilometers away from the nearest human settlement or trace of modern civilization. This has presented enormous logistical challenges, and overcoming them is the sine qua non of the Expedition's work. The experience of many seasons has led to the development of efficient and effective ways of coping.

Fieldwork is usually carried out in winter or, at the latest, in early spring, to avoid the heat of summer. The organization of the Expedition's camp has usually been in the hands of representatives of the Geological Survey of Egypt, who are well acquainted with desert conditions. A camp, sometimes consisting of scores of tents, is pitched near the area selected for investigation (Figure A.7). Some tents are occupied by the scientific staff of the Expedition and some by the technical and support staff, such as mechanics, drivers, cooks and laborers. The temperatures in the desert fluctuate markedly, sometimes falling below 0°C at night, with sharp, penetrating North winds, so the entire Expedition is provided with blankets and sleeping bags. Separate, larger tents serve as the mess-tent and the field-laboratory, which is indispensable since most of the artifact-analyses are carried out in the field (Figure A.8). Camps like this have been pitched both deep in the Desert and on the edge of the Nile Valley, beyond the limits of cultivation. When an excavation site lies far from the main camp, a flying-camp is pitched there, for only as many people as are necessary. This saves both time and, even more precious in the desert, fuel.

Water is transported from the Nile Valley or, more usually (and if conditions are right), new wells are dug in the oases to reach the shallow groundwater. When work is carried out in extremely remote areas, a sufficient stock of food has to be taken along.

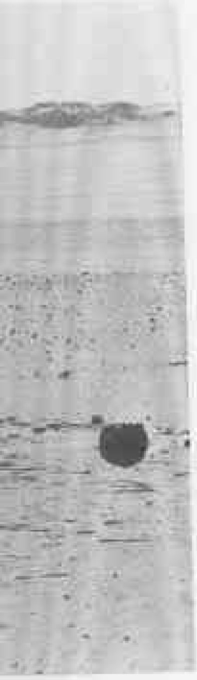

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Figure A.7 Camp of the Combined Prehistoric Expedition at Nabta.

Figure A.8 Artifact-analysis being done in camp.

Figure A.9 Wendorf taking Polaroid portraits of the workers at the end of the season—an essential form of *baksheesh*.

This consists largely of dried (or canned) foods with as much fresh food as can be consumed before spoilage. Experience has shown that the best source of fresh meat under these circumstances is a flock of ducks, which may number as many as 150 at the beginning of a season and none by the end of it.

From the very beginning, the Expedition has been assisted by Bedouin from the Maariif family of the Awazin tribe. A group of 12–18 men are engaged each year for the field-season, and Aïd Maariif, the headman of the family, is their leader and the Expedition's desert-guide (Figure A.3). His perfect knowledge of the desert and extraordinary sense of direction in this vast and often featureless terrain have several times saved the members of the Expedition from serious danger. Since the same Bedouin have been participating in the fieldwork for many seasons, they have a great deal of experience, and, because of their quick intelligence and natural sense of responsibility, they are skilled assistants to the scientists. Their anonymous contribution to the Expedition's research achievements is enormous (Figure A.9).

Transportation in the desert is by various types of vehicles which are built for rough terrain, such as Land-Rovers, Russian "jeeps" and Volkswagen 181s, and by heavier lorries. There are usually three or four cars with the Expedition, although when a large field-expedition was mounted to the then-remote Bir Tarfawi area, 16 different vehicles were necessary, including water- and fuel-tankers (Figure A.10; the Expedition has become considerably more streamlined of late!) The presence of four-wheel-drive cars in the camp means that excavation can be conducted, if necessary, many kilometers away from the camp itself, the workers and archaeologists being transported there each day. The most reliable vehicles are used in far-reaching surveys, which may last more than a week. This kind of survey plays an important role in the Expedition, its purpose

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Figure A.10 The Combined Prehistoric Expedition at Bir Tarfawi (Eastern Sahara) in 1974.

being the discovery of new areas of archaeological importance so that further seasons can be planned. Several scientists with driver-mechanics and a guide will take two or three cars, equipped with light tents, sleeping bags, a stove and a supply of food and water. Such a small group can cover long distances very easily, frequently using pre-arranged fuel-dumps, and will then remain for several days reconnoitring the area of interest.

Every day, including Friday and Sunday, is a workday, since the cost of maintaining the camp is high. The good organization and experience of the entire group, which may consist of as many as 40 people, mean that work begins immediately after arrival in camp and proceeds without interruption throughout the season. The only tolerated disruption of the everyday routine is a major sandstorm.

CONCLUDING REMARKS

Of necessity, this has been a very brief sketch of the history of the international group of scientists which is called the Combined Prehistoric Expedition. I have tried to outline the achievements of the Expedition during the last 25 years and to give some indication of the efforts which were necessary to attain these goals. Above all, the work of the Expedition is a prime example of successful, international co-operation in the field of science and of the possibilities created by such co-operation. The main factor in this great and continuing enterprise is Fred Wendorf, who has directed the Expedition from its very beginning. It is he who is ultimately responsible for planning the research program and choosing appropriate co-workers. Through his perseverance, strong will and optimism, he has surmounted the numerous hindrances which have threatened the very existence of the project over the years. His tact and innate ability to handle people have led to 25 years of efficient work in an atmosphere of friendship and camaraderie. Without his peculiar talents, there would be no twenty-fifth anniversary of the Combined Prehistoric Expedition.

Table A.1

Members of the Combined Prehistoric Expedition

Fred Wendorf – Project Director
Romuald Schild – Associate Project Director

Kamal Abu Zeid, geologist, 77
Claude C. Albritton, geologist, 65*, 69, 72–73Et
J. Anne Attebury, archaeologist, 76–77
Kimball Morgan Banks, archaeologist, 77–79, 82
A. Christy Bednar, archaeologist, 83
James Bennett, archaeologist, 81
Hala Barakat, botanist, 83
Maria Chmielewska, archaeologist, 63
Waldemar Chmielewski, archaeologist, 62–64, 67
Kathryn Clisby, botanist, 62–63
Angela E. Close, archaeologist, 77–86
Douglas R. Connor, archaeologist, 79–80
Richard B. Daugherty, archaeologist, 62
Robert DuBois, geophysicist, 68
Frank Eddy, archaeologist, 63
Philip Evans, archaeologist, 63
Richard H. Falk, botanist, 83
James Gallagher, archaeologist, 71Et
Achilles Gautier, paleontologist, 68, 74, 76, 79, 82, 84
Gèneviève Guichard, archaeologist, 62–63
Jean Guichard, archaeologist, 62–63
Herbert Haas, physicist, 77
M. Nabil el Hadidi, botanist, 77, 81
Fekri A. Hassan, archaeologist, 68, 71Et
C. Vance Haynes, geologist, 68, 73, 73Et, 75–77
Thomas R. Hays, archaeologist, 67–69, 73
Jean de Heinzelin, geologist, 62–64
Owen Henderson, 73, 75Et
James J. Hester, archaeologist, 63
Harold J. Hietala, statistician, 83
Christopher L. Hill, archaeologist, 84, 86
Gordon Hillman, botanist, 83
Mohamed el Hinnawi, geologist, 76–79
Audrey Hoebler, laboratory supervisor, 63
Philip Hoebler, archaeologist, 63
William Hootkins, archaeologist, 65
Gerald K. Humphreys, archaeologist, 72–73Et
Bahay Issawi, geologist, 62–65, 67–69, 72–73, 78
Peter Jeschofnig, archaeologist, 73Et, 74
Roland Jones, analytical chemist, 83
Michal Kobusiewicz, archaeologist, 67, 69, 73–75, 77–80, 82–83
Halina Królik, archaeologist, 81, 83, 86
Robert L. Laury, geologist, 72–73Et
Paul Larson, archaeologist, 76Et
Jacek Lech, archaeologist, 72
David Lubell, archaeologist, 67
Ewa Madeyska, botanist, 82–83
Anthony E. Marks, archaeologist, 63–64, 67

Francine Martin, biologist, 63
Ali A. Mazhar, geologist, 80–86
William McHugh, archaeologist, 63, 85
Louis W. MacNaughton, archaeologist, 71–72Et
Peter Mehringer, botanist, 73
William Merrill, draftsman, 63
Abbas S. A. Mohammed-Ali, archaeologist, 81, 85
Russ Morrison, 73, 75Et
Herbert Mosca, archaeologist, 74–76, 75–76Et
Nadia Mostafa, laboratory assistant, 63
Jane Nettle, laboratory assistant, 63
Catherine J. Newman, secretary, 63
Reefat A. Osman, geologist, 74–77
Roland Paepe, geologist, 62–63
Dexter Perkins, paleontologist, 62–63
James L. Phillips, archaeologist, 67–69
Harvey S. Rice, archaeologist, 62
Colette Roubet, archaeologist, 81–82
Jay Ruby, archaeologist, 62
Thomas M. Ryan, archaeologist, 72Et, 72–74
Mohamed Said, geologist, 74–75
Rushdi Said, geologist, 62–65, 67–69, 72
Joe Saunders, archaeologist, 86
Romuald Schild, archaeologist, 63–64, 67–69, 72–73Et, 75Et, 72–86
Brenda K. Scoggins, archaeologist, 82–83
Mushref Selim, geologist, 77
Frank A. Servello, archaeologist, 72Et, 72
Abdelkader el Shafie, geologist, 80
Joel L. Shiner, archaeologist, 63–64, 67
Maxine Shiner, bookkeeper and house manager, 63
Nancy Singleton, archaeologist, 72Et
William L. Singleton, archaeologist, 76Et, 78
Bob H. Slaughter, paleontologist, 65
Irina Springuel, botanist, 81–84
Mary Beth Stokes, laboratory supervisor, 63
Kazimierz Szczepanek, botanist, 80
Mustafa Tawakol, geologist, 74
Phillip Volkman, archaeologist, 80–81
John Waechter, archaeologist, 62
Fred Wendorf, archaeologist, 62–69, 71–73Et, 75Et, 72–86
Michael Wendorf, archaeologist, 74
Ronald K. Wetherington, archaeologist, 65
Hanna Więckowska, archaeologist, 67, 72–73Et, 77–84
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Antiquity Inspectors—Egypt	
Gamal el Din, 64	Gallal Noaman, 78
Fathi Afifi, 65–66	Aadel Farid Tobia, 79
Ahmed Said Hindi, 63, 67–69, 72–73, 77	Attiya Radwan, 80–84
Abdelaziz el Shennawi, 74–75	Aadel es-Saadani, 85
Mahmoud Hamza, 76	Wagdi Naim Labib, 86
Abdelfatah el Sabahi, 76	
Antiquity Inspectors—Ethiopia	
Abaté Bété Mariam, 72Et	Gatachew Ayéké, 72Et, 73Et

*The 1962/1963 season is referred to as 62, and so on.

TABLE A.2
Major Sources of Support for the Combined Prehistoric Expedition

- U.S. State Department (U.S.A.)
- National Science Foundation (U.S.A.)
- Fort Burgwin Research Center (U.S.A.)
- Smithsonian Institution (U.S.A.)
- Southern Methodist University (U.S.A.)
- Institute of the History of Material Culture, Polish Academy of Sciences (Poland)
- Egyptian Geological Survey (Egypt)
- Fonds National de la Recherche Scientifique (Belgium)
- Centre National de la Recherche Scientifique (France)

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