18 September 1970, Volume 169, Number 3951 SCIENCE

Egyptian Prehistory: Some New Concepts

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Until recently, most archeologists assumed that there were few Paleolithic remains along the Nile in Egypt. The general belief was that most of the places where Paleolithic man was likely to have lived would have been deeply covered by later deposits of Nile silts or, if near the surface, the evidence would have been destroyed by the intensive cultivation of these silts during the past several thousand years.

On the basis of occasional scattered and rolled artifacts, prehistorians had also come to believe that the Nile Valley and Egypt, particularly during the Late Paleolithic, had been a culturally conservative cul-de-sac, where the technological and typological attributes of the Middle Paleolithic survived relatively unchanged until near the end of the Pleistocene (*1*).

From the limited evidence available, archeologists had concluded that the stone industries of Late Paleolithic age along the Nile Valley contained a few simple tool types, usually made on flakes and with a high frequency of Levallois technology, features that elsewhere were characteristic of the Middle Paleolithic. The diagnostic elements of the Late Paleolithic—the blade technology and the associated complex of tools emphasizing endscrapers, burins, and backed pieces—were believed to be absent. It was also inferred that these simple flake industries of Middle Paleolithic type persisted in Egypt long after compound tools, indicated by the presence of geometric microliths, had appeared in Europe and southwestern Asia.

At a still later date, the role of the Nile Valley in the origin and development of food production was also discounted by scholars as it became fashionable to regard the upland areas around the Tigris and Euphrates rivers as the probable center for the origins of agriculture (*2*). This conclusion was based on the assumption that the beginnings of cultivation most likely occurred where the wild relatives of wheat and barley, probably the first domesticated plants, still grow today. This hypothesis failed, however, to take into account the possibility that there were climatic changes of sufficient magnitude to cause these wild plants to have had significantly different distributions in the past.

These concepts of Nilotic Paleolithic scarcity and conservatism had a profound effect on the prehistoric studies that were undertaken in the Near East after World War II. They effectively served to inhibit interest in the prehistory of the Nile Valley for an entire generation, and, as a result, from 1946 to 1961—otherwise one of the most productive periods for prehistoric studies throughout the world—there was almost no scientific work undertaken on prehistoric materials in Egypt and the lower Nile Valley.

It is now known that these assumptions of Nilotic conservatism and scarcity were grossly in error. The recently completed work done in Nubia in connection with the salvage program in the Aswan Reservoir area disclosed that the Nile Valley contains numerous rich Paleolithic sites ranging in age from Early Paleolithic to the beginning of written records. Furthermore, there is convincing evidence that these sites were occupied by groups whose lithic technology and typology were fully as complex and as progressive as those known from other parts of the world (*3, 4*).

Even more surprising, many of the Late Paleolithic sites along the Nile contained evidence suggesting that these groups used ground grain as a source for food as early as 13,000 B.C.—some 4,000 years earlier than suggested by present evidence for the use of this food source in the Levant or elsewhere in the Near East. The Nilotic evidence for the use of ground grain consists of numerous, heavily worn grinding stones and small flaked pieces with lustrous edges, possibly "sickle blades." There is also botanical evidence for the presence of wheat rust and cells from an unidentified large grass. These indications are highly suggestive but not conclusive evidence that along the Nile man may have taken the crucial first steps that led to the utilization of ground grain as a significant source of food [see (*3*), pp. 940–946; and (*5*)]. Such tentative steps—either along the Nile or elsewhere—led to the development of food production in the Near East.

Recent Work along the Nile

The field work in Nubia was discontinued when the Aswan Reservoir began to fill. Because of the possible significance of the new discoveries in the reservoir area, however, interest in the prehistory of the Nile Valley remained high. Some researchers who had been working in Nubia continued their studies in areas both upstream and downstream from the new reservoir. Among them were the prehistorians who had been working with the Combined Prehistoric Expedition, sponsored

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by Southern Methodist University with the joint participation of the Egyptian Geological Survey and the Polish Academy of Sciences. This group planned an ambitious program to study the entire Nile Valley from its headwaters in the highlands of East Africa to the Mediterranean. To achieve this goal, the personnel of the Combined Prehistoric Expedition were divided into two groups. One party, under the direction of Joel Shiner of Southern Methodist University, worked first near Dongola, Sudan, just south of the reservoir, and then moved farther upstream to the upper Atbara near the Sudanese-Ethiopian frontier. Another party (directed by F.W.) began just north of Aswan and worked downstream toward the Mediterranean (Fig. 1). At this writing, three seasons have been spent in the field since the close of the Nubian campaign, and only one or two more short field periods are needed to complete the reconnaissance phase of the planned long-range study of the Nile Valley. In this article we give a brief description of the results to date from the Egyptian portion of the project.

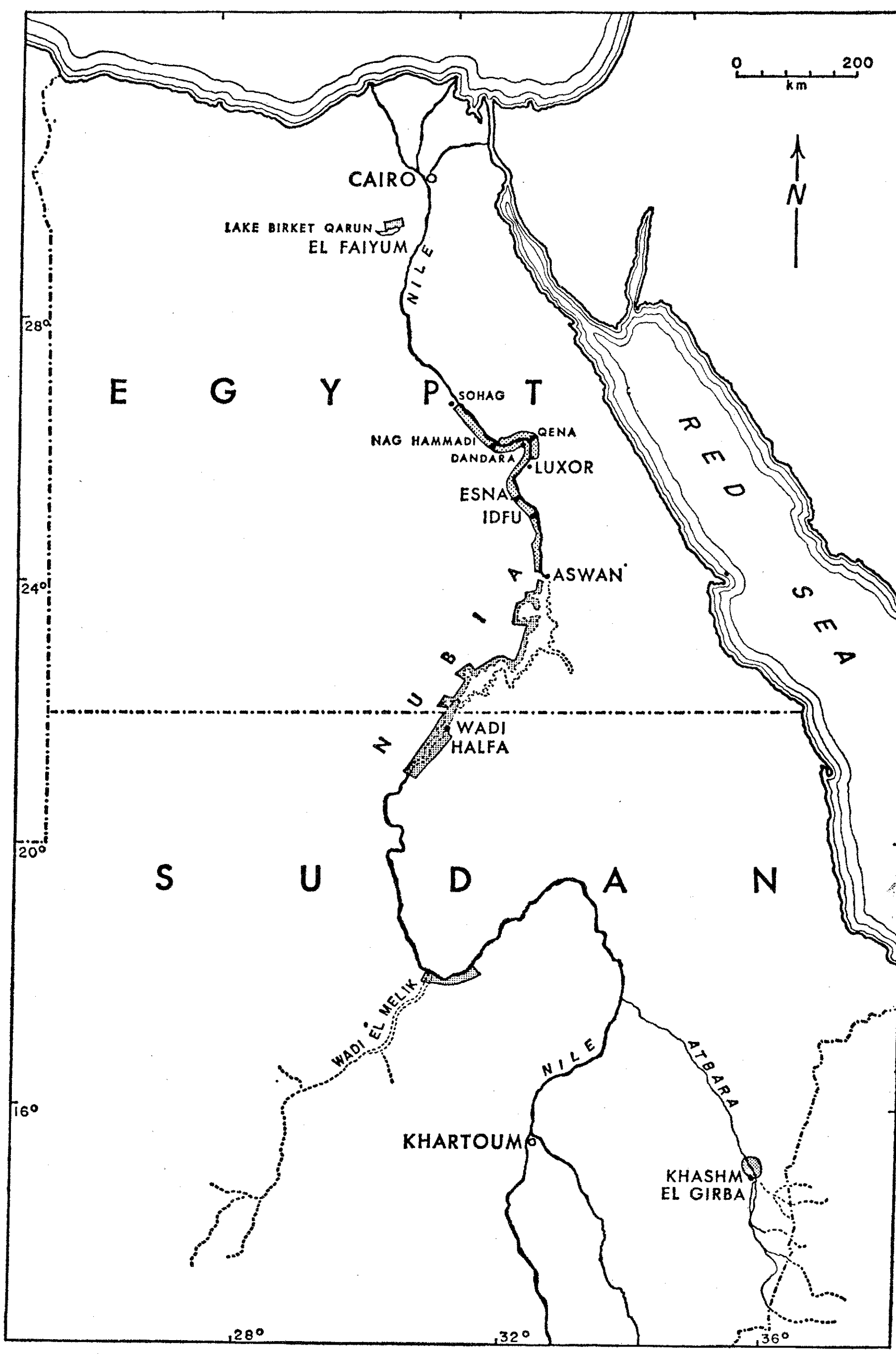


Fig. 1. Map of northeast Africa showing location of area studied from 1961 to 1969.

Geographic Setting

Two main areas in Egypt have been surveyed thus far. The first begins on the west bank of the Nile, just below Aswan, and extends northwest to Sohag; on the east bank, it extends from Luxor to a point opposite Nag Hammadi. The second area borders the northern and western edge of the Fayum depression, just 50 kilometers south of Cairo. These areas are separated by a distance of approximately 400 kilometers.

Throughout most of the stretch between Aswan and Sohag, the Nile cuts its course through a plateau capped by the Thebes formation (Lower Eocene), which covers the greater part of southern Egypt. On the west bank, from Aswan northward almost to Luxor, the escarpment that marks the edge of the plateau is more than 5 kilometers from the river. Near Luxor and northward from there almost to Qena, however, the footslopes of the rock formation almost reach the floodplain. Beyond Qena the cliffs again recede to a distance of from 10 to 14 kilometers from the river, and they are separated from it by a wide plain strewn with cobbles and rubble. Paleolithic sites occur here in a narrow fringe of silt, which stands slightly higher than the cultivated lands and separates the farming areas from the cobble-strewn plain.

On the east bank the bordering escarpments abut the cultivated land. The otherwise continuous line of the escarpment is broken, however, by the numerous wadis that join the valley along this stretch, draining the Eastern Desert. Near the mouth of each wadi the cliffs recede sharply, exposing a broad plain. These plains are ideal areas in which to look for prehistoric sites. Cultivation is rarely practiced in these reentrants near the wadi mouths because they are covered by a veneer of sand and gravel; moreover, exposures of silt and sand are found in the more eroded sections. Living sites of Paleolithic man occur commonly in these silt remnants.

The second area studied, the Fayum, is a circular basin located immediately west of the Beni Suef province of the Nile Valley and some 50 kilometers south of Cairo. It is separated from the valley by a divide that is 8 to 14 kilometers wide and from 30 to 100 meters above sea level. The Fayum depression reaches a maximum depth of 46 meters below sea level. A modern lake (Lake Birket Qarun), some 214 square kilometers in area, occupies the deepest portion of the depression. A canal, the Bahr Youssef, connects the Nile with the depression and provides water for the large area along the eastern side of the depression, which is now cultivated.

The origin of the Fayum depression and its Quaternary history have attracted the attention of scientists for a long time. Perhaps the earliest was Herodotus, who mentioned the presence of a more extensive lake (Lake Moeris) during his visit to Egypt in 450 B.C. (*6*). This has led numerous authors to believe that the present-day lake represents a final stage of a shrinking and older lake that was fed by the Nile. The extensive remnants of lake deposits that occur around the northern and western edges of the depression at a much higher elevation than the present lake also testify to the former presence of a more extensive body of water in the depression. The surfaces of these remnants of lake deposits are littered with fire-cracked rocks and other artifacts, which indicate that man made extensive use of this area in the past.

Older Deposits and Associated Assemblages

Although the emphasis of the work in Egypt has been on the Late and Terminal Paleolithic, some observations were made on earlier deposits and the artifacts found with them. The oldest exposed unit of fluviatile sediments in the areas examined was found in several cuts on both the east and west banks from Dandara to south of Qena (Fig. 2). This unit, the Dandara formation (*7*), forms low ledges 8 to 15 meters above the modern floodplain, between the cultivated land and the footslopes of the hills (*gebels*). It consists of a compact and massive, gray-colored, silty sand with occasional bands of gravel and lenses of coarse sand. At one locality, Late Acheulian artifacts occur within and on the surface of this unit and under a thick bed of rubble which unconformably overlaid it. At another locality, carbonaceous marl from near the top of the deposit yielded a radiocarbon date of more than 39,900 years ago (sample I-3423).

Unconformably overlying the Dandara formation is an extensive deposit of coarse sand and gravel reaching a thickness of over 20 meters. This deposit, the Qena formation, was recognized by Sandford (*8*) and estimated to be of Plio-Pleistocene age. Although our work did not establish the age of the Qena formation, we can say with certainty that it is not Plio-Pleistocene. It overlies the Dandara formation, which contains Late Acheulian artifacts; in addition, two rolled flakes were recovered from one exposure of the Qena formation. At another locality, on the eroded surface of this unit in a thin veneer of sheetwash is a large and rich assemblage showing certain characteristics of the Sangoan-Lupemban tradition of sub-Saharan Africa.

The Qena formation also contains shells of *Unio abyssinicus* (Martens) and *Aspatharia caillaudi* (von Martens). Heavy mineral analysis of both this unit and the underlying Dandara formation indicate that the modern Nile regimen, with streamflow at least in part derived from the East African highlands, had been established by the time these two units were deposited. This information requires a revision in our previously held view that the modern regimen of the Nile dates from the Late Pleistocene (*9*). A considerably earlier age for this event must now be assumed.

Over the Qena formation, a thick gravel cover was deposited, mostly on the east bank. The present-day hilly topography of this reach developed at this time. On this rolled topography a sheetwash was formed, which contains, in the lower part, rolled Middle Paleolithic artifacts, and, in the upper part at one locality, a living site of early Late Paleolithic aspect.

The assemblage from this site, which we have elsewhere referred to as industry C (*10*), contains a moderate Levallois index, accompanied by true blades from opposed platform cores of Late Paleolithic technology. The tools are typologically limited, mostly side-scrapers, denticulates, and notches (*11*). No dates are available for this assemblage, but, on typological grounds, it should be older than the industries associated with the Dibeira-Jer formation, here informally referred to as the

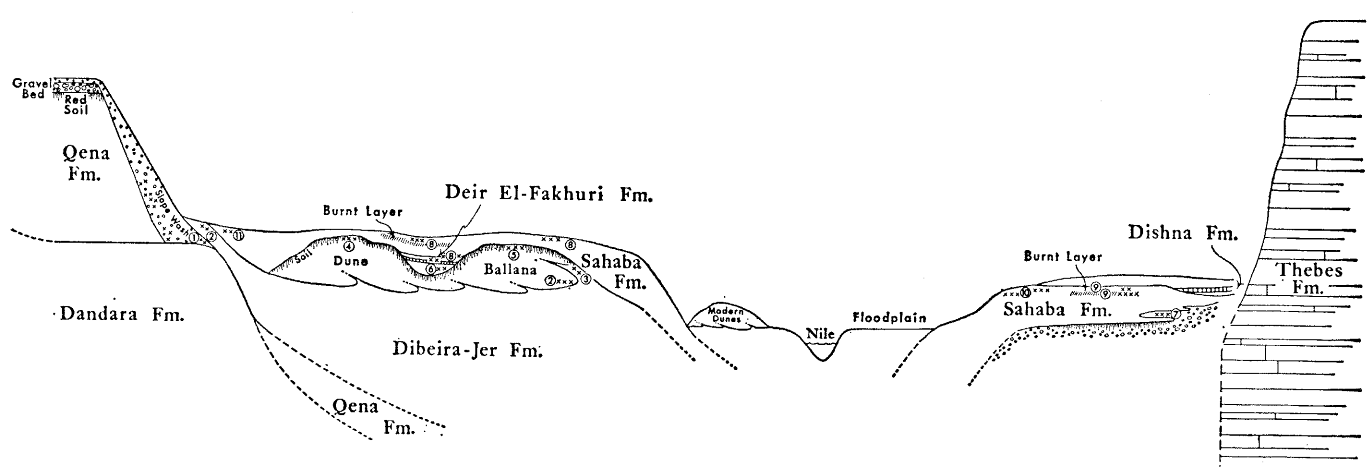


Fig. 2. Schematic profile of Nile Valley showing relationships of various geologic units and archeological industries discussed in text. (1) In situ living floor with early Late Paleolithic assemblage (C); age unknown. (2) Indicated positions for several sites assigned to complex A with associated radiocarbon dates ranging from 15,000 to 16,000 B.C. (3) Complex B, with radiocarbon dates indicating an age between 15,500 and 16,000 B.C. (4 and 5) Position of complex D and assemblage E, both estimated to date around 15,000 B.C. (6) Several sites of complex F occur here and are estimated to date around 13,000 B.C. (7) Position of one poorly defined assemblage in wadi deposits at the base of the Sahaba formation. (8) The location of the variety of stratigraphic positions for the several sites of complex G, with associated radiocarbon dates indicating an age between 10,000 and 12,000 B.C. (9) The position of the Dishna sites, possibly related to quarry activities. (10) The indicated position of the two Sebilian sites known in Upper Egypt.

"lower silts." Other evidence, which will be mentioned later, indicates that sheetwash is most prevalent in this area during the periods when the Nile is at a comparatively low level. Thus, in the absence of evidence to the contrary, this assemblage is regarded as being of an earlier date than the lower silts.

Assemblages with the Lower Silts

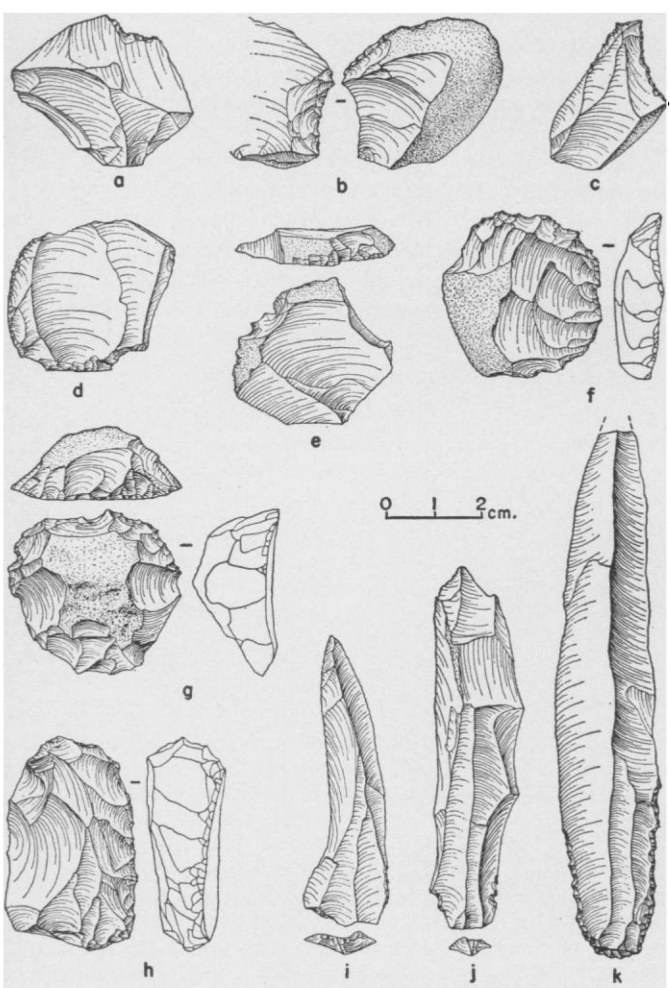
Except for the one example noted above, Late Paleolithic sites in Egypt occur buried within a complex series of Nile fluviatile and eolian sediments, which record three main episodes of aggradation—each separated by intervals when ponding, erosion, soil development, and wadi action were prevalent. This stratigraphic sequence of geologic events provides the basis for chronologically ordering the associated archeological material. Relatively precise dates for these events and the associated industries have also been determined on the basis of the almost 60 radiocarbon dates now available from this area (*12*).

The earliest of the known Nile sediments of Late Paleolithic age has been named the Dibeira-Jer formation (*13*) (Fig. 2). In Nubia, between the First and Second cataracts, the Dibeira-Jer silts reach a maximum elevation of slightly more than 34 meters above the modern floodplain. Downstream from the First Cataract, the silts believed to be equivalent (here called the "lower silts") are only 6 meters above the modern floodplain. At one time it was believed that the Dibeira-Jer was the oldest unit reflecting the modern Nile regime; however, as we have seen, this is now known to be incorrect.

In Upper Egypt there are at least two distinct Late Paleolithic assemblage groups associated with living floors in the upper part of the lower silts. Materials from these two groups have not been studied in detail, and thus only brief descriptions will be attempted and no industry names will be proposed. Both groups are of about the same age, and both are quite distinct from the contemporary Halfan and Khormusan industries in Nubia (*14*).

One of the assemblage groups, referred to as complex A, is represented at five sites located in two areas on the west bank of the Nile, between Luxor and Aswan. This group may have to be divided when the detailed studies are completed because, as presently defined, it includes several sites that have a strong element of Levallois technology and other sites that have almost no Levallois technology. For the moment, however, they will be treated as a single complex because the tools in both groups appear to be closely similar and because both facies sometimes occur in different parts of the same site.

The tools include a wide variety of burins, endscrapers (mostly on flakes), backed bladelets with regular and Ouchtata retouch, notched and denticulated flakes and blades, scaled pieces, and



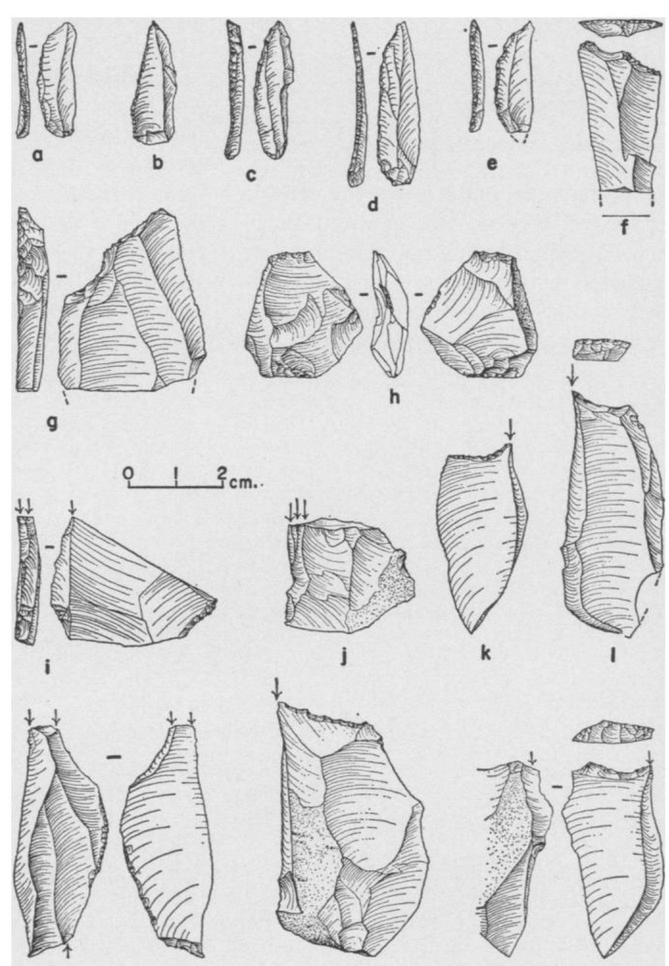


Fig. 3 (left). Tools from site E71P1, assigned to complex A, about 16,000 B.C.: (a–d) retouched flakes; (e) denticulate; (f–h) scrapers; (i–k) elongated blades with basal blunting. Fig. 4 (right). Tools from site E71P1, assigned to complex A, about 16,000 B.C.: (a–e) Ouchtata backed bladelets; (f–g) truncated pieces; (h) scaled piece; (i–o) burins.

elongated points with lateral basal blunting (Figs. 3 and 4). In many respects—particularly in the burins and backed blades—there are specific resemblances to the Upper Paleolithic III and IV in the Levant. From the associated faunal remains, it is clear that both fishing and large mammal hunting were practiced, with perhaps more emphasis on hunting. The five radiocarbon dates associated with this complex (with sample numbers given in parentheses) are:

15,000 B.C. ± 300 years (I-3248)
15,300 B.C. ± 300 years (I-3249)
15,500 B.C. ± 300 years (I-3418)
15,650 B.C. ± 300 years (I-3419)
15,850 B.C. ± 300 years (I-3417)

Complex B, which is about the same age as complex A, has a much higher frequency of both microlithic tools and tools flakes. It occurs at three sites near Esna, between Luxor and Aswan. The typology is dominated by denticulates, retouched pieces, endscrapers on flakes, doublebacked perforators, and bladelets with Ouchtata retouch. Fishing was apparently the most important economic activity, although there was some hunting of large mammals. Information on the physical appearance of these people is provided by a single burial, but unfortunately the skeleton is poorly preserved. On the basis of this single example, however, these people may have been significantly less heavily muscled with less gonial eversion and generally not as primitive as the slightly later population found in Nubia (*15*). The two radiocarbon dates associated with this industry (with sample numbers given in parentheses) are:

15,640 B.C. ± 300 years (I-3415)
16,070 B.C. ± 330 years (I-3416)

Assemblages of the Deir El-Fakhuri Episode

After about 15,000 B.C., the level of the Nile fell considerably from the maximum attained during the aggradational interval represented by the lower silts. The decline was around 24 meters in Nubia; in Upper Egypt it was probably less, but the magnitude of recession is not known. Permanent ponds developed in the peripheral swales abandoned by the river and in the topographic lows between the dunes that accumulated during the latter part of the preceding episode. The higher slopes of these dunes were stabilized by vegetation. There is also evidence that the wadis that drain the adjacent deserts were eroding and were carrying gravel into the channels cut by this erosion. These pond sediments and other recessional features have been named the Deir El-Fakhuri formation (*7*). The duration of this episode of sedimentation is not precisely known. Several radiocarbon dates that probably refer to this period are available; however, in each instance there are valid questions as to the precise stratigraphic position of the sample (*12*). For this reason, the best estimate of the age of this event is the bracket between the most recent dates from the Dibeira-Jer and the oldest dates from the succeeding aggradational phase, the Sahaba. On this basis, a time range from about 15,000 to 12,000 B.C. is indicated.

All the evidence seems to suggest that this period was one of rapid cultural change along the Nile. In Upper Egypt there were at least four distinct assemblage groups present during this time, and none of them is closely similar to any contemporary Nubian industries that have been described. Two of the most interesting of the Upper Egyptian groups of this interval are known at present from only one site each. The first is here referred to as complex D. The collection from this site contains several thousand tools and displays a very high frequency of straight-backed, pointed bladelets (almost all of which have retouch at one or both extremities), notched or denticulated pieces, and retouched pieces. There are a few double-backed perforators on bladelets or microblades, burins, and endscrapers. The assemblage is closely similar to that from the Ibero-Maurusian sites of La Mouillah and El Hamel in the Maghreb (*16*).

Nearby, and in the same stratigraphic unit, is another rich site with yet another distinct assemblage (assemblage E). Here over 80 percent of the tools are Ouchtata-retouched bladelets, and the remaining tools are mostly truncated pieces, backed bladelets, notched and denticulated pieces, retouched pieces, and a few endscrapers and burins (Figs. 5 and 6). This assemblage also has a resemblance to a facies of the Ibero-Maurusian—particularly the site of Lalla de Gafsa (*17*). Since both of these sites yielded only large mammal remains, fishing was probably not an important economic activity.

The third lithic complex is represented in a series of sites on the west bank of the Nile, approximately 10 kilometers north of Luxor. Most of these localties were disturbed by wind erosion, but a few patches were still in situ at the top of an eolian sand; they were correlated with the final phase of the Dibeira-Jer aggradation and were covered by a thin veneer of Sahaba silt. Burnt shell from a hearth yielded a date of 14,880 B.C. ± 300 years (sample I-3427). The most numerous tools were retouched flakes, but the industry is also characterized by many endscrapers (mostly on flakes), notches on both flakes and blades, and truncated flakes, and by few groovers, burins, and sidescrapers.

The fourth lithic complex (complex F) recorded during this period in Upper Egypt is represented at six living sites near Esna, all associated with ponds that developed during an early phase of the Deir El-Fakhuri. None of these sites can be dated precisely, but an age around 13,000 B.C. is indicated by the geological evidence. This complex is characterized by numerous truncated microblades, lunates, trapezoids, and triangles, together with a fully developed microburin technology. Other tools include arch-backed and pointed bladelets, distally truncated bladelets, and endscrapers on both flakes and blades (Figs. 7 and 8). The major economic emphasis, as indicated by the faunal remains, was on fishing.

None of the four distinct industrial groups recorded thus far from Upper Egypt during the Deir El-Fakhuri interval yielded grinding stones or other evidence that ground grain was being utilized as an important source of food. This is not necessarily an indication that this technology was unknown during the period, however, but only that the sites investigated were confined to the earlier rather than to the later part of the Deir El-Fakhuri interval. There is evidence from Nubia that the technology for grinding grain was known in that area before the end of the Deir El-Fakhuri period, by 12,500 B.C. or slightly earlier (*3*, *5*), and, as will be noted later, a ground grain technology was fully developed in the earliest sites associated with the Sahaba aggradation in Upper Egypt. These occurrences suggest that the exploitation of the new economic resource of ground grain first appeared along the Nile during the latter part of the Deir El-Fakhuri interval and was widespread during the subsequent period of the Sahaba aggradation.

Assemblages of the Sahaba Aggradation

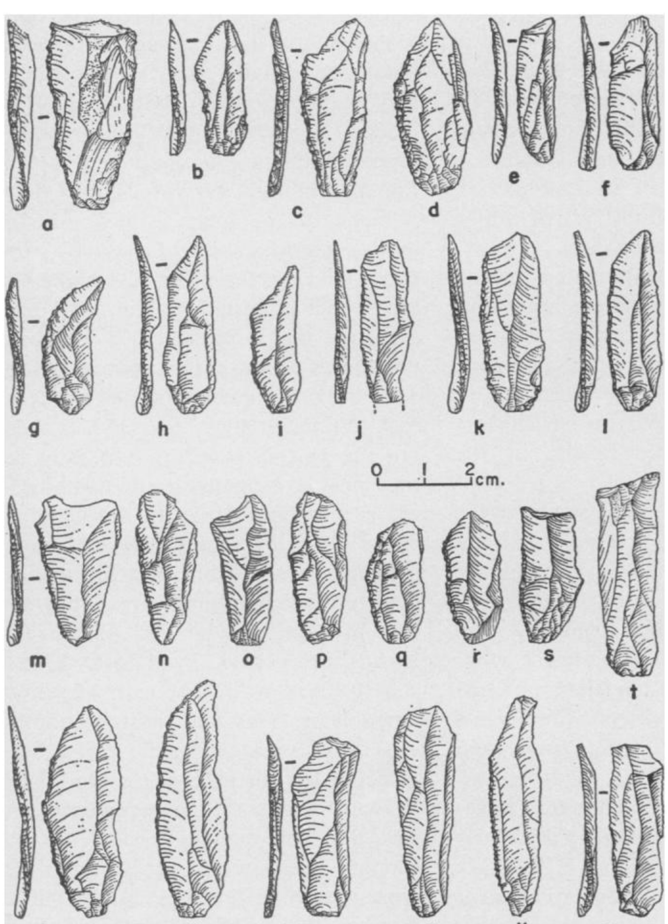
Extensive remnants of silt, accumulating to a maximum elevation of 10 meters above the modern floodplain, occur commonly along both the east and west banks of the Nile in Upper Egypt. The stratigraphic position, associated archeological materials, and related radiocarbon dates all strongly indicate that these silt remnants are the equivalent of the Sahaba formation described by de Heinzelin from Nubia (*13*).

There are two, and possibly three, distinct archeological lithic complexes associated with the Sahaba aggradation. Two localities (one near Qena, the other near El Kilh) have yielded typical Sebilian assemblages characterized by high Levallois indices, typical flat, discoidal cores, together with a group of tools that is typologically very limited and comprised mostly of basally and distally truncated flakes. One of these sites was on the surface, the other was in situ within the Sahaba silts.

The second lithic complex (complex G) of this period is represented at six sites near Esna. There are two chronological phases of this industry. The earliest occurs below the Sahaba silt in the very top of the sediments attributed to the end of the Deir El-Fakhuri interval and may actually date with that period. The younger phase occurs in the uppermost part of the Sahaba silt, just above a burnt layer believed to be an important regional chrono-stratigraphic marker. This marker appears to have been caused by a widespread brush fire which seemingly swept over the vegetation along the valley for a distance of almost 200 kilometers on both banks of the river. Evidence of this fire was observed at several localities near the top of the Sahaba silt from Esna northward to beyond Qena. It was not seen outside the valley, possibly indicating that the vegetation at this time was confined to the floodplain of the river, as it is today. Carbonaceous silt from this brush fire yielded a date of 10,550 B.C. ± 230 years (sample I-3424). This date is in close agreement with several others from Nubia, which indicate that the maximum of the Sahaba aggradation occurred shortly before 10,000 B.C. (*12*).

All the known sites of complex G are extremely large. Whether this size indicates a large social group or merely more frequent reutilization of the same locality by small groups could not be determined. This complex is primarily a flake industry, with the dominant type of tool being endscrapers, which represent some 35 percent of all tools. Other common tools include several varieties of burins, notched and denticulated flakes, retouched flakes, and arch-backed bladelets.

Of considerable interest in these sites are the occasional grinding stones present and the surprising number (15 percent) of the in situ tools that display a lustrous sheen on the edges. These pieces also have the minute, irregular, lustrous "wear ridges" that occur on much later flint sickles in Europe and



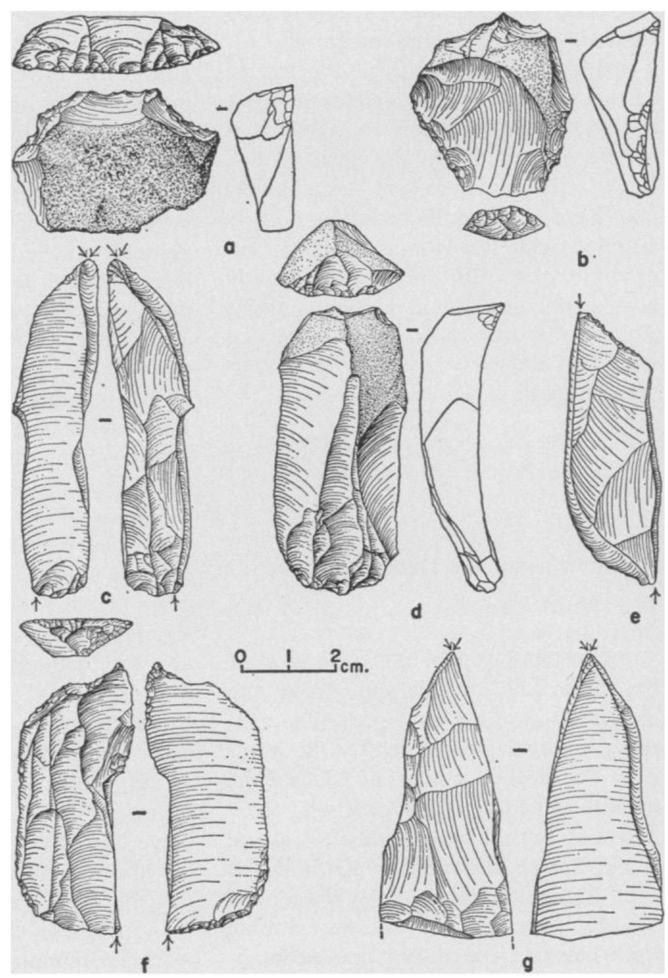


Fig. 5 (left). Tools from site E71K13, assigned to assemblage E, about 15,000 B.C.: all bladelets with Ouchtata retouch. Fig. 6 (right). Tools from site E71K13, assigned to assemblage E, about 15,000 B.C.: (a, b, and d) endscrapers (c and e–g) burins.

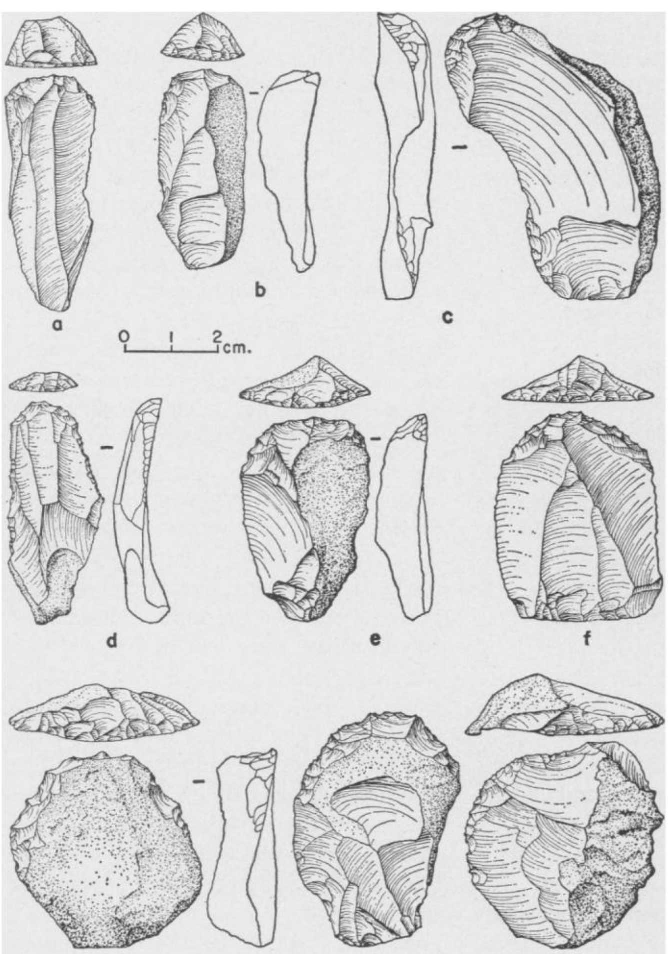
the Near East. The simultaneous appearance of grinding stones and pieces with lustrous edges is regarded as indicative of some form of grain being cut and the seeds being ground for food. It also seems significant that the sites are bigger at this time, although, as noted, the presence of larger social groups cannot be demonstrated from the evidence now available.

A third group of sites occupied during this period was located near Dishna, north of Qena. These sites, all near an extensively utilized exposure of Eocene flint, may contain tool assemblages that reflect the specialized activities conducted at the quarries. The assemblages from all of the sites have numerous notched and denticulated flakes, somewhat fewer endscrapers, burins, elongated basally blunted points, and, rarely, backed blades. The ratio between tools and flaking debris is unusually low, a characteristic of sites near quarries. In the endscrapers and in the notched and denticulated flakes there are resemblances to complex G discussed above, but there are also significant differences, possibly reflecting the specialized activities represented at the Dishna sites.

None of these sites from the Dishna area yielded any grinding stones or pieces with lustrous edges, although they must be contemporary with the sites at Esna where such tools are numerous. The Dishna sites occur in the upper part of the Sahaba silts, both above and below traces of the same widespread brush fire discussed above.

Industries with the Dishna Recessional Internal

There is clear evidence in both Nubia and Upper Egypt that around 10,000 B.C. or slightly later the level of the Nile fell significantly from the maximum attained during the aggradation of the Sahaba silts. In Nubia a recession of at least 17 meters is indicated (*13*). No precise figure can be given for Upper Egypt, but recessional features physiologically similar to those noted during the Deir El-Fakhuri interval are recorded at several localities along this reach of the Nile. One of these localities is at El Kilh, near Idfu, where a pronounced recessional beach from the Sahaba maximum may be seen along the west bank. A small occupation site associated with this beach yielded an assemblage strongly reminiscent of complex G discussed above. The predominant tools are endscrapers on both blades and flakes, followed by retouched pieces; backed and truncated blades and flakes; arch-backed bladelets; elongated retouched points, some of which have flat retouch near the point or at the base to form a pediculate stem; and a few microlithic geometrics. Grinding stones and a few pieces with lustrous edges also occur. *Unio* shells associated with this site yielded a date of 9610 B.C. ± 180 years (sample I-3760).



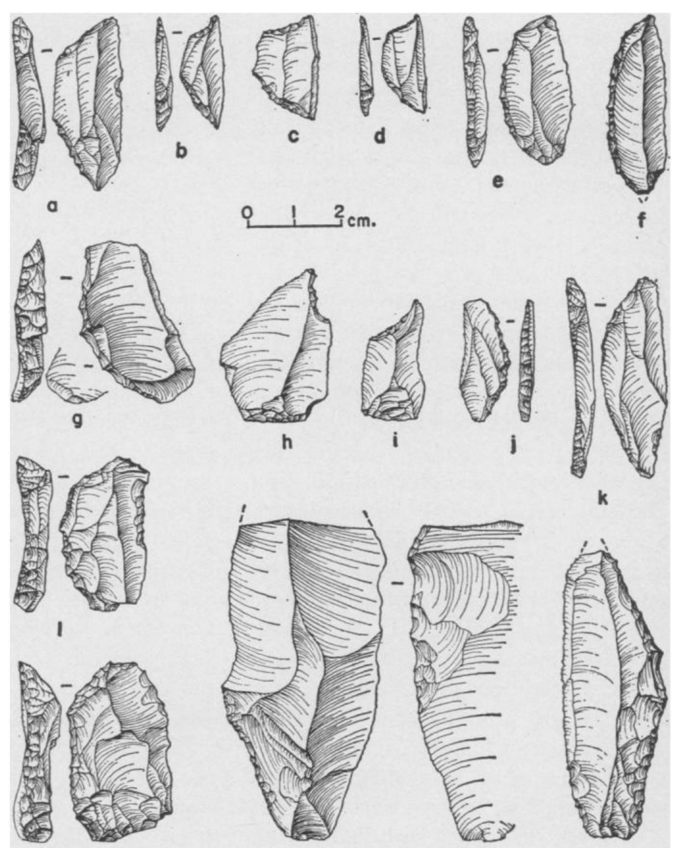


Fig. 7 (left). Tools from site E71K18, assigned to complex F, about 13,000 B.C.: all endscrapers. Fig. 8 (right). Tools from site E71K18, assigned to complex F, about 13,000 B.C.: (a–d) trapezoids; (e–g, and j) arch-backed bladelets; (h–e) notched pieces; (k) partial arch-backed bladelet; (l) backed and retouched piece; (m) backed and distal truncated piece; (n and o) fragments of elongated blades with basal blunting and retouch.

Recessional features of this period also occur at Dishna, north of Qena. Here, along the east bank, are two playa deposits, separated by a thin lens of silt, which accumulated behind natural levees in swales and abandoned channels of the Sahaba aggradation after that event was receding from its maximum. These playa deposits appear to be equivalent to the perennial ponds that existed during the Deir El-Fakhuri interval. It should be noted that in neither instance can it be determined if these ponds and playas owe their existence primarily to seepage or to increased rainfall, but the fact that they were perennial indicates considerably lower temperatures and less evaporation than exist today. No archeological materials were found associated with the playa deposits.

The Dishna recession appears to have been brief. In Nubia, silts of the Arkin formation began aggrading around 9200 B.C. and reached a maximum shortly after 7500 B.C. (*13*). Neither deposits nor industries of this age were noted in Upper Egypt, presumably because the sites are now under cultivation. The recession from the Arkin maximum, recorded at several localities in Nubia, is equally poorly known in Upper Egypt. One locality, probably of this time range, has been reported near El Kab (*18*). The assemblage contains numerous microburins, backed bladelets, shouldered bladelets, notches, truncated pieces, and a few geometrics. Associated charcoal yielded a date of 6400 B.C. ± 160 years (sample LV-393).

The most detailed information on this period comes from the Fayum. This depression, which once contained a much larger lake than today, apparently received significant amounts of water from the Nile during and after the final Paleolithic period. Despite statements to the contrary (*19*, *20*), there is considerable doubt that an extensive lake existed in the depression during the Late Pleistocene. Some of the features reported to be of that age (for instance, the "Levalloisian gravels") may be fluvial rather than lacustrine in origin. Other supposed Late Pleistocene features, including the extensive remnants of lacustrine sediments along the northwestern edge of the depression (the so-called "sand rock butts") contain Terminal Paleolithic sites near the base, Neolithic "Fayum A" sites in the middle sections, and Old Kingdom materials in the upper one or more meters (*21*).

The lacustrine deposits in the depression have been named the Fayum formation and have been divided into three units or members (*21*). The oldest of these, the Paleomoeris member, is a series of diatomites, silts, and sands, which yielded no archeological materials. Unconformably above the Paleomoeris deposits were similar silts, sands, and diatomites (the Premoeris member), in which occurred several in situ living floors of Terminal Paleolithic age. These sites occur at various levels throughout the deposits of this period and contain a lithic industry with numerous pointed backed blades, bladelets, and microblades, and with fewer retouched blades and flakes, notches and denticulates. Grinding stones and bone "harpoons" also occur. The site concentrations are small, and fishing was a major economic activity. This industry was a component of the "Fayum B" described by Caton-Thompson and Gardner (*19*); however, "Fayum B," as described, was based on surface materials only, and the collections contained a mixture of materials from the Terminal Paleolithic industry (described above) and later items. Pottery, bifacial tools, and arrowheads do not occur in the Terminal Paleolithic industry recovered in situ. The four radiocarbon dates from these Terminal Paleolithic sites in the Premoeris member (with sample numbers given in parentheses) are:

5190 B.C.± 120 years (I-4129)
5550 B.C. ± 125 years (I-4130)
6120 B.C. ± 115 years (I-4126)
6150 B.C. ± 130 years (I-4128)

The third unit of lacustrine sediments in the Fayum (Moeris member) also contains living sites of the Terminal Paleolithic in the base and, at higher levels, several sites of Fayum A. Predynastic and Old Kingdom materials occur near the top, and they are the highest remnants of *confirmed* lacustrine sediments in the depression. The reduction from this lake level to the present level may well have begun with the efforts at hydrological control that are recorded near the end of the Old Kingdom (*22*).

The lithic complex associated with the Fayum A settlements is very different from the complex recovered from the Terminal Paleolithic sites. Most of the tools are large, thick flakes, with notches and denticulates, produced by the stone hammer technique. Other common tools are bifacially flaked, stemmed, and concave-based arrowheads, large bifacially flaked leaf-shaped pieces, chipped and polished celts, and grinding stones. The associated pottery is thick and frequently tempered with fiber, and it has simple direct rims. The four radiocarbon dates on materials associated with Fayum A (with sample numbers given in parentheses) are:

3860 B.C. ± 115 years (I-4127)
3910 B.C. ± 115 years (I-4131)
4145 B.C. ± 250 years (C-457)
4441 B.C. ± 180 years (C-550 and C-551)

These dates indicate that only a thousand years or less separate the Terminal Paleolithic and Fayum A. The technological and typological differences between these two groups are of such a magnitude, however, that it is unlikely for Fayum A to have developed from the Terminal Paleolithic in this area. An outside source, not yet identified, seems probable.

Discussion

An evaluation of the remarkably diverse lithic assemblages found along the Nile in central Egypt and the Fayum must await the more complete analysis now under way on the materials. Until the completion of this analysis, it would be fruitless to speculate on whether these industries from Upper Egypt and the Fayum represent essentially a continuum of a local development within some generalized Near Eastern or North African sphere of influence (or a combination of both), or whether each industry represents a distinct new group which moved to or along the Nile, adjusted to the local environment, only to be displaced by more recent arrivals. It is evident in the preliminary analysis of the data, however, that there are few parallels between the lithic industries of Egypt proper and those of Nubia. With the exception of the Sebilian, which occurs in both areas, the Egyptian materials are significantly different from the contemporary industries of Nubia at all time levels of the Late Paleolithic. Evidently the cultural distinctions of these two areas, which persist even today, were a factor during prehistoric times as well.

Several points in the preliminary data should be considered further because of their implications beyond this immediate region. The first is the indicated relationship between the local climate and the level of the Nile. Evidence on this point, noted at several localities, consists of the following:

1) Sand dunes were migrating coeval with the maximum of the Dibeira-Jer silt accumulation.

2) During the recession from the Dibeira-Jer aggradation, these dunes were stabilized by vegetation, and perennial ponds formed in the topographic lows between the dunes.

3) A second episode with perennial ponds occurred after the Sahaba maximum and before the following Arkin aggradation.

4) Erosion and deposition in the wadis were most active during the recessions that followed the maximum aggradations of both the Dibeira-Jer and Sahaba silts.

5) The widespread brush fire which occurred near the maximum of the Sahaba possibly indicates that vegetation at this time, as today, was limited to the floodplain.

6) Erosion and deposition in the wadis were negligible during the maximum of the three Nile episodes of silt aggradation.

These observations, although simplified and preliminary, strongly suggest that the periods of maximum silt aggradation on the Nile were relatively dry, with little vegetation beyond the floodplain and considerable dune accumulation along the valley margins. Conversely, periods of Nile recession seem to have been relatively moist, with permanent ponds, increased wadi action, and vegetation stabilizing the dunes. Whether this additional moisture was achieved by a significant increase in precipitation, by reduced temperatures and lower evaporation, or by both, cannot be determined. The correlation of aggradation with relative aridity is, however, in agreement with modern observations that the Nile is presently in the process of aggradation (*23*).

The aggradation of the Nile is independent of the water discharge of Egypt; rather, it is dependent on the larger supply of water and sediment from the East African highlands. The evidence suggests that it was during periods of aridity in Egypt that greater sediment was available from the East African highlands for the accumulation of silts in the downstream sections of the river. Fairbridge (*24*) has argued that this period was also an arid one in the East African highlands and that silt accumulation was due "to minimal fluvial discharge." De Heinzelin (*13*), on the other hand, has suggested that aggradational episodes were contemporaneous with fluvial conditions in Nubia which coincided, in turn, with a bigger rainfall in Ethiopia which brought bigger volumes of water and sediments.

The Egyptian data do not as yet enable us to make a clear choice between these alternatives; however, elsewhere (*7*) we have proposed that this relationship between episodes of silt accumulation and local climate in Egypt might best be explained by a parallel with the present-day situation. Most of the rainfall in Ethiopia today is derived from a current of air that comes from the South Atlantic and is strongly influenced by air pressure over India and the Himalayas (*25*). Glaciation in East Africa and the Himalayas would modify the distribution of this pressure. This would in turn weaken the effects of the Indian monsoon in Ethiopia and would reduce streamflow in the Nile. If this hypothesis is correct, then the intervals of monsoons in East Africa would coincide with interstadials, when the system of air circulation resembled the present system. Periods of glacial maxima would have a different system of air circulation, reduced monsoons, less streamflow, a consequent lowering of the level of the Nile, and cool pluvial conditions in Egypt.

This interpretation is further strengthened by the general reconstruction of sea level fluctuations during the Pleistocene. Phases of Nile aggradation would then be contemporaneous with the higher sea levels, whereas interstadials and recessional features on the Nile would be correlated with the lower sea levels of glacial maxima.

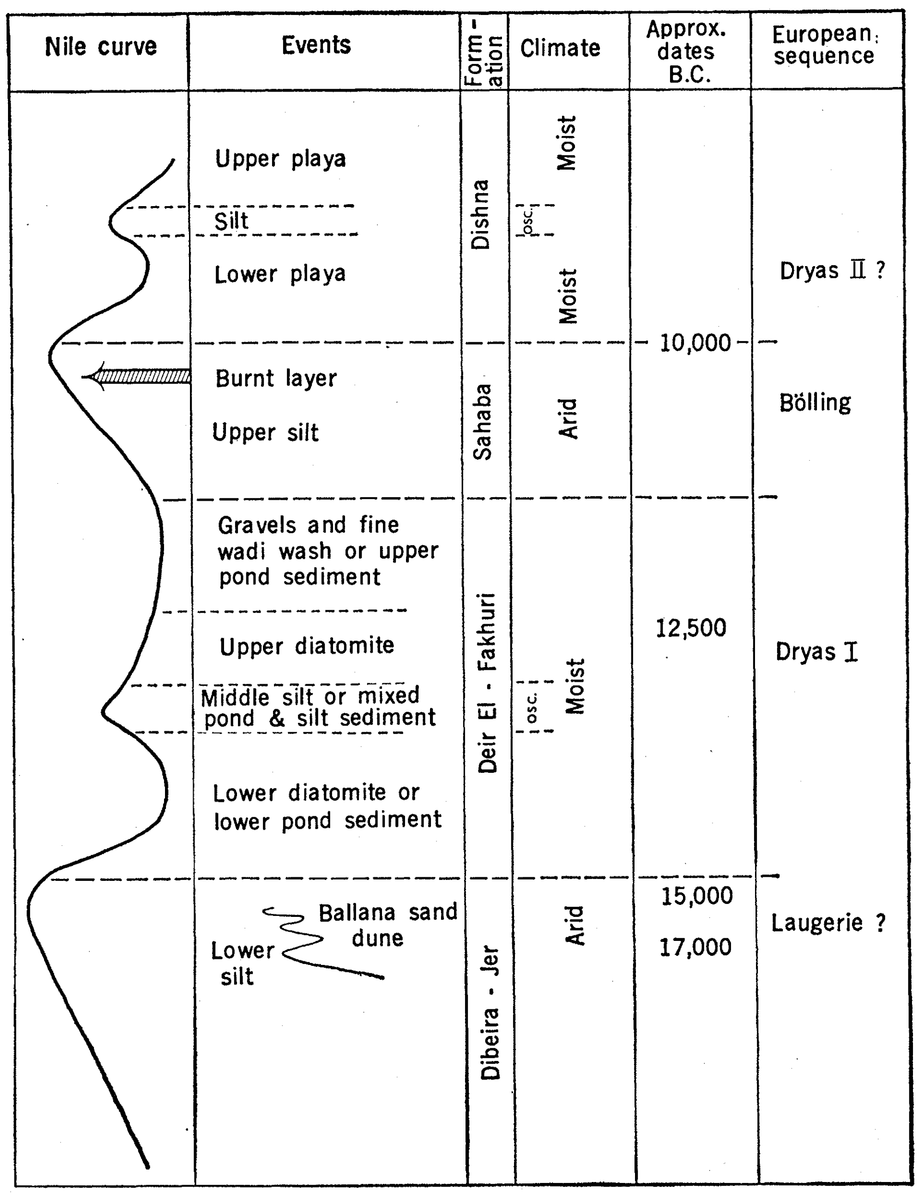


Fig. 9. Summary chart showing indicated correlation between Nilotic events and European sequence.

The Egyptian sequence is not yet dated with the precision necessary for an adequate evaluation of this suggested correlation with the glacial phenomena; however, in gross outline there is obvious agreement with the European sequence (Fig. 9). The two episodes of maximum silt accumulation, the Dibeira-Jer and Sahaba, have radiocarbon dates of 17,000 to 15,000 B.C. and 11,000 to 10,300 B.C., respectively. The Dibeira-Jer maxima would seem to be contemporaneous with the Laugerie interstadial (the Wurm III/IV interstadial of some authors, 17,000 to 15,000 B.C.), and the Sahaba maxima with the Bolling oscillation (11,300 to 10,400 B.C.). The Deir El-Fakhuri recession, which seemingly dates between 15,000 and 12,000 B.C., might have been partially contemporaneous with the beginning of the Oldest Dryas (11,600 to 10,400 B.C.), and the Dishna episode, dating between 10,000 and 9,000 B.C., may be roughly correlated with the Older Dryas (10,000 to 9,800 B.C.) and the Allerod (9,800 to 8,900 B.C.) [see (*26*) and Figs. 2 and 9].

Another point of general interest concerns the implications of the Egyptian data on the problem of the origin of food production in the Near East. The discovery of grinding stones and pieces with lustrous edges in relatively early contexts in Nubia indicated that utilization of ground grain as a significant source of food may have first occurred along the Nile; it raised the possibility that this early utilization could have led to a domestication of grain in this area. This now seems most unlikely.

There is clear evidence in Upper Egypt, as in Nubia, for the importance of the collecting and grinding of grain as an economic activity along the Nile well before 10,000 B.C. Although the evidence that the grinding stones found in these sites were used for the preparation of some sort of grain is presumptive, it is by far the most logical explanation. Some of the stones show traces of pigments; on occasion, they were probably used for grinding pigments—just as similar grinding stones are sometimes used for this purpose by the Pueblo Indians in the American Southwest (*27*). To assume that this was their primary function, however, would be to ignore the heavy wear evident on the stones recovered and the amount of effort required to produce this wear. In modern ethnographic analogy, stones used only for paint grinding are smaller and display much less wear. The grinding stones are also numerous. Some sites have yielded literally scores of them, while the lustrous-edged pieces may also be numerous and occasionally represent from 10 to 15 percent of all tools. One can reasonably argue that only an activity of economic significance could justify such investment of time and effort by a hunting and gathering society. The fact that the grinding stones and the pieces with lustrous edges appear at the same time and in the same sites suggests that techniques for efficient gathering appeared simultaneously with the methods for the preparation of grain for food.

The social or cultural effects of ground grain as a new food resource are not clearly evident. There are some indications, which are not conclusive, that communities became noticeably larger and either occupied longer or reoccupied more frequently in the period shortly after these new techniques appeared. If so, the new social structure was short-lived. The only known site that dates in the subsequent Dishna recessional interval was occupied briefly by a small group, and in the Fayum the in situ Terminal Paleolithic concentrations are all small and clearly ephemeral.

At that time, there existed large, permanent, and obviously complex communities in Palestine, the northern Levant, and possibly even southern Europe, many of which were apparently supported by intensive collection of wild foods and incipient domesticates (*28*). Thus it seems obvious that the Terminal Paleolithic fishers, hunters, and gatherers of the Nile Valley and the Fayum would be poor candidates as potential innovators of food production. We must conclude that, although the Nile may have been the place where grain was first utilized as an important source of food, either the wild grasses for this new resource were not sufficient to support significant changes in the traditional pattern of exploitation of the Nilotic environment, or the inhabitants of this area failed, for some reason, to take maximum advantage of it.

True permanent communities with clear evidence of food production occur along the Nile suddenly, and they almost surely record the appearance of a new population. These are the Fayum A and early "Predynastic" communities of Middle and Lower Egypt. In addition to domestic wheat and barley, sheep and goats, these new Nilotic communities contain well-made pottery, permanent adobe-walled houses, storage structures, and a lithic tradition radically different from that of the immediately preceding Terminal Paleolithic people in this area. More work will be required to determine if the local Terminal Paleolithic people of Middle and Lower Egypt provided a sizeable increment in the Neolithic communities that emerged at this time, but at present their role seems insignificant. It seems highly likely that these new Neolithic peoples, and not the descendants of the Paleolithic hunters and gatherers of the Nile during the Late Pleistocene and Early Holocene, formed the cultural base from which Egyptian civilization was to emerge.

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Ribosome Structure and Function Emergent

Unexpected aspects of ribosome structure and function are revealed by studies of the ribosomal proteins.

C. G. Kurland

The discovery of the genetic code is one of the principal triumphs of molecular biology. Nevertheless, it can be argued that the genetic code will remain just a set of rules until the reasons for that particular kind of solution to the coding problem are forthcoming. This in turn will require a deep understanding of the translation mechanism and of its evolution.

The translation of the coded information from messenger ribonucleic acid (mRNA) into the amino acid sequences of proteins involves the orderly interactions of more than 100 different macromolecules. We have barely identified the contributions that some of these macromolecules make in the translation process, and the physical events that take place in the course of protein synthesis are still quite obscure. To a lesser extent similar remarks could be made about the replication of the genetic material and the transcription of genetic information from deoxyribonucleic acid (DNA) to mRNA molecules. From this point of view, the peroration that Stent (*1*) has recently intoned for molecular biology may seem somewhat premature.

Stent's premise is that at an earlier time the fascination of molecular biology lay in the possibility that new physical laws might be discovered in the domain of molecular genetics. Since such new laws have not been discovered, and since the flow diagram for the transmission of information from DNA to the structure of protein is in hand, there is little to do, Stent thinks, except to fill in the details. Stent's conclusion is based on the assumption that we know enough about the physics of macromolecular replication to decide whether or not anything new and exciting is happening in this domain. I doubt that this assumption is correct, especially since most attempts to describe macromolecular biosynthesis involve a deep faith in the overworked hydrogen bond and a considerable amount of hand waving. Indeed, our knowledge of fundamental aspects of protein synthesis is so bare that we cannot demonstrate at present that this process obeys the first and second laws of thermodynamics (or their statistical analogs). Therefore, it would seem appropriate to postpone any decision concerning the uniqueness of the physical laws governing the domain of molecular genetics until these laws have been discovered.

The analysis of the translation mechanism has been severely limited by the absence of structural information concerning the ribosome, which is the ribonucleoprotein particle that mediates protein synthesis in all organisms of our biosphere. Here I describe current work on the ribosomal proteins, work which may eventually provide the key to the mechanism of protein synthesis. Before doing this, it will be useful to review what is known about protein synthesis.

A View of Protein Synthesis

The process of protein synthesis has been reviewed quite recently by Lipmann (*2*), who focused attention on the role of the protein factors which, together with the ribosome, are responsible for translating the coded information of the mRNA into the amino acid sequences of proteins. In this process each amino acid is brought to its position in the nascent protein by a specific adapter molecule, transfer RNA (tRNA). Each different tRNA molecule can carry one kind of amino acid, and the different aminoacyl-tRNA molecules are selected by specific trinucleotide sequences (codons) in the mRNA. A given aminoacyl-tRNA is transiently bound to the ribosome-mRNA complex until the amino acid is inserted into the nascent protein, and then that tRNA is displaced by the next aminoacyl-tRNA to be inserted into the nascent protein. The nascent protein is at all times coupled to the tRNA that has just carried an amino acid into the assembly line. The stepwise growth of the polypeptide chain is paralleled by a concomitant move-

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