ENVIRONMENTAL CHANGE AND HUMAN CULTURE
IN THE NILE BASIN AND NORTHERN AFRICA
UNTIL THE SECOND MILLENNIUM B.C.
Poznań 1993
PL ISSN 0866-9244 ISBN 83-900434-1-6

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# Problems of assessing environmental impact on the Predynastic settlements of Hierakonpolis

## Introduction

This paper presents taphonomic and environmental observations derived from our work in the Predynastic and Early Dynastic settlements of Hierakonpolis. Hierakonpolis possesses the largest and best preserved Predynastic settlement complex known in Egypt as well as extensive cemeteries and rock art localities. The area played a pivotal role in the evolution of the Egyptian state during the fourth millennium B.C. In discussing the Predynastic settlements of Hierakonpolis it is always necessary to consider that they are found in two radically different environments – desert and floodplain – each with its own, often contrasting, erosional and depositional regime.

Recent exploration of both desert and floodplain sites has thrown light on the nature of Predynastic settlement remains, helped document the impact of natural and cultural processes on those settlements and pinpointed a wide variety of sources for detecting and evaluating environmental change. A number of interesting issues have been raised, including the interpretation of radiocarbon dates from Predynastic settlement sites.

## The nature of Predynastic settlement remains

A wide variety of materials, construction techniques and building froms were employed in Predynastic times. Material typically used included: reed, light timbers, mud plaster, mud clods, mudbricks, stone cobbles and even potsherds.

Superstructures were generally of mudplastered reed supported by light (*Tamarix*) wooden poles. The walls were anchored in shallow, linear trenches and the posts were grounded in circular holes of varying sizes and depths. Mudbrick was known throughout the Predynastic, but used sparingly in the earliest periods. In the floodplain, massive mudbrick structures date from Nagada II/III (Gerzean-Protodynastic) times (*ca.* 3,200 B.C.). These were generally built on an existing surface. By the First Dynasty (*ca.* 3,100 - 2,900 B.C.) builders' trenches and sand builders' levels were employed. In the desert Predynastic mudbrick buildings utilized foundations of cobblestones, brick bats and potsherds all cemented together with mud and often mixed with midden.

Predynastic house plans ranged from rectangular to circular, with the former being more characteristic of "permanent" dwellings. A number of *ad hoc*, irregular structures served as outbuildings much as they do in contemporary Egyptian villages. Houses might be semi-subterranean or built on the surface.

Dwellings were sometimes spaced far apart and surrounded by large, fenced-in areas or squeezed one against the other, sharing common walls. An intermediate spacing strategy included arranging rectangular houses and their appended courtyards next to one another. At least by the Gerzean (Nagada II) period (*ca.* 3,500 - 3,200 B.C.) there were large temple and place-like complexes within settlements, reflecting increasing social, economic and political differentiation.

## The impact of natural and cultural processes on Predynastic settlement remains

### Cultural processes

Included under cultural processes are the day-to-day activities which occurred at a site after its initial Predynastic occupation as well as blatantly destructive activities of *sebakhin*, looters and previous archaeologists. The tendency of Predynastic peoples to treat their yards and abandoned homes as barrow pits and trash heaps (both modern customs as well) increases difficulties of interpretation. On top of such human activities are imposed a wide range of natural erosional and depositional processes.

Usually, in archaeology we discount or minimize the effect of ancient peoples in alternating their landscape in major ways. Nevertheless, in a country like Egypt, which has had a central government and a tradition on monumental public works for over 5,000 years, it is necessary to consider the effect of such activities.

Our geoarchaeological investigations in the floodplain, have recovered evidence through reverse stratigraphy that apparently "natural" strata of mid-Holocene silts were mixed with midden and redeposited on an old desert surface to extend the cultivable land in early Roman times (Hoffman *et al.* 1986: 186; 1987: 10). Interestingly, a wide range of archaeological material ranging in age from Predynastic to Ptolemaic was transported 200 - 300 meters. Unlike riverine redeposition, no sherd erosion was evident.

**Wind**

In most cases, un-fired mudbrick has eroded away on desert sites and all that remains are "ghost walls" marked by lines of stones and sherds. Where cobblestone foundations were large and terraced (as in two famous Gerzean and Protodynastic "stone mounds" at Hierakonpolis) their collapse has added to the general disarray and made detection of room patterns difficult. In other instances, the nature of underlying architectural features, such as wall stubs and wall trenches, can encourage dune formation which hides and protects structural remains. In the desert settlements of Hierakonpolis, cobblestones and especially sherds have played a major role in armoring the old surface, once fine clay, silt and midden mortar has been removed by aeolian erosion. In floodplain sites, the effects of wind erosion, naturally, are less pronounced, except along old desert margins.

Water

Water has played a major role in altering both desert and floodplain settlements. In the desert, architectural remains such as walls, wall trenches, postholes, pits and piles of debris create convenient paths for runoff and alluvial transport. At site HK-29A, a Gerzean temple complex in the midst of large town, waterborne deposits of approximate Protodynastic date (*ca.* 3,200 - 3,100 B.C.) overlie and stabilize aeolian deposits of the terminal Gerzean (*ca.* 3,200 B.C.; Fig. 1), providing a rare instance of vertical stratigraphy in a desert site and a date for the beginning of the last wet phase of the Holocene Subpluvial.

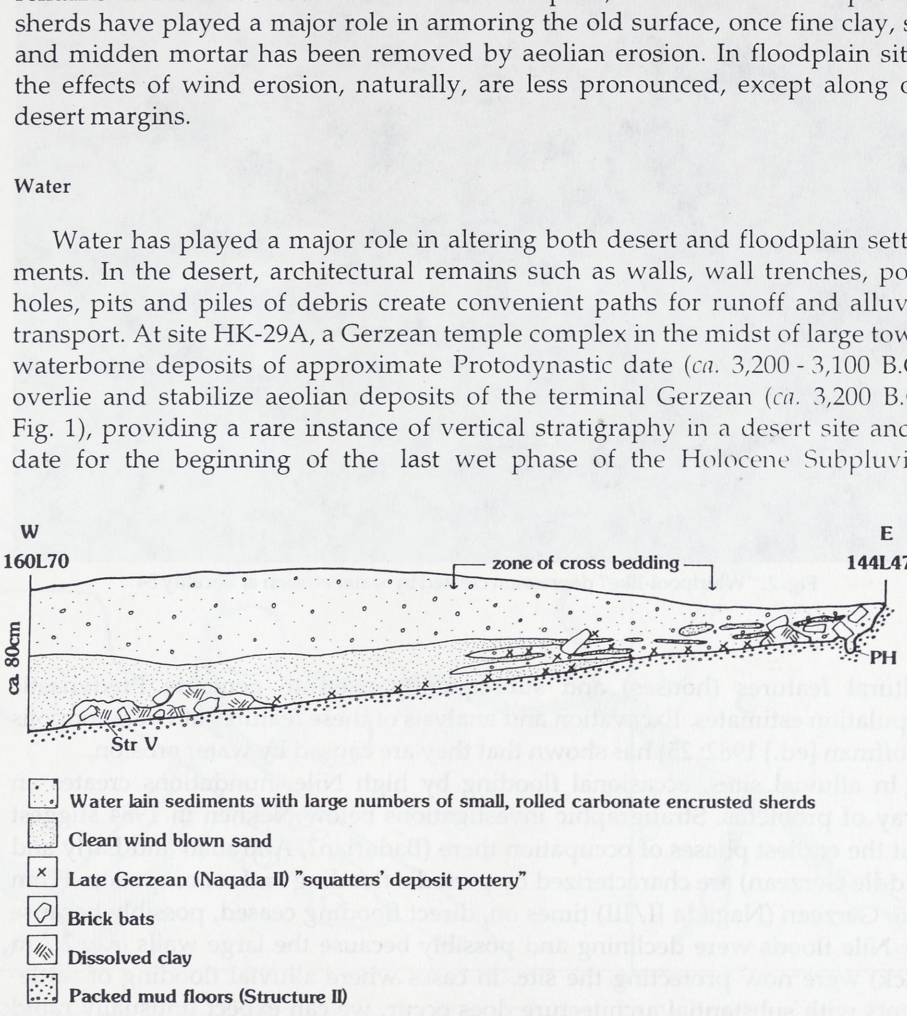


Fig. 1. Interpretative summary of microstratigraphy over HK-29A. Structure II, mud plastered floor (not to scale).

Because water erosion and deposition are much more important factors in desert site taphonomy than generally realized by archaeologists, it is necessary to pay close attention to artifact provenience to avoid inaccurate dating and contamination.

Another major problem of water erosion on desert sites is "whirlpool-like" depressions (Fig. 2). These have previously (Butzer 1959) been misinterpreted as

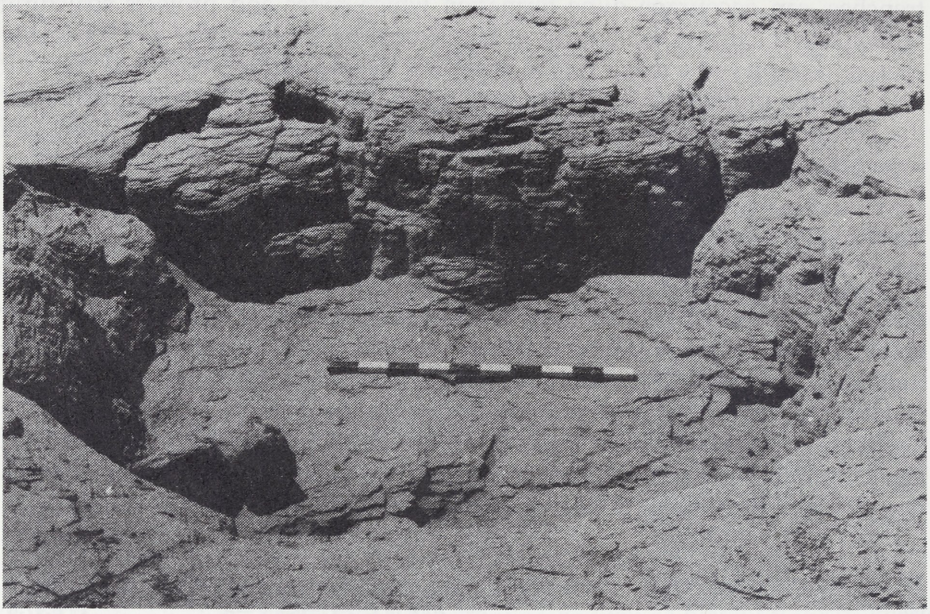

Fig. 2. "Whirlpool-like" depression created by water erosion at Locality 54.

cultural features (houses) and subsequently used to generate Predynastic population estimates. Excavation and analysis of these features at Hierakonpolis (Hoffman [ed.] 1982: 25) has shown that they are caused by water erosion.

In alluvial sites, occasional flooding by high Nile inundations creates an array of problems. Stratigraphic investigations below Nekhen in 1984 suggest that the earliest phases of occupation there (Badarian?, Amratian and Early and Middle Gerzean) are characterized by periodic flooding and reoccupation. From Late Gerzean (Nagada II/III) times on, direct flooding ceased, possibly because the Nile floods were declining and possibly because the large walls (*e.g.* 2.7 m thick) were now protecting the site. In cases where alluvial flooding of settlements with substantial architecture does occur, we can expect unusually rapid buildup of sediments due to the flood shadow effect. Given sufficient time, eroded and reworked clay and mudbrick structures can be reduced to a seemingly "natural" appearance.

**Soil cracks**

When Brunton visited Hierakonpolis in 1928, he noted that, "The ground is seamed with little trenches running in all directions. These vary in size, but probably none is wider or deeper than 2 feet. They do not seem to be made in any definite order or plan" (Brunton 1932: 272 - 273).

In recent seasons we have encountered similar features which we have identified as soil crack resulting from desiccation. Furthermore, we have established criteria by which man-made trenches and their natural equivalents, soil cracks (Fig. 3), can be differentiated: Man-made trenches are typically characterized by: 1. Being relatively wide (up to *ca.* 70 cm) and shallow (5 - 65 cm); 2. Showing occasional digging tool scars; 3. The inclusions of postholes and, less frequently, actual post remains; 4. "U"-shaped cross-sections; 5. Being orientated in relatively straight lines and at right angles.

Natural soil cracks are, by contrast: 1. Relatively narrow (10 cm or less) and deep (often over 50 cm); 2. Very long (of six continuous 10 × 10 meter squares excavated we never found both ends of a natural trench); 3. "V"-shaped in cross-section; 4. Meandering in plan, and generally do not turn or intersect at right angles; but typically diverge at oblique angles, forming a "Y" intersection.

The patterning and extent of natural soil cracks is best explained by the structural characteristics of the local Pleistocene Sahaba-like silts and their

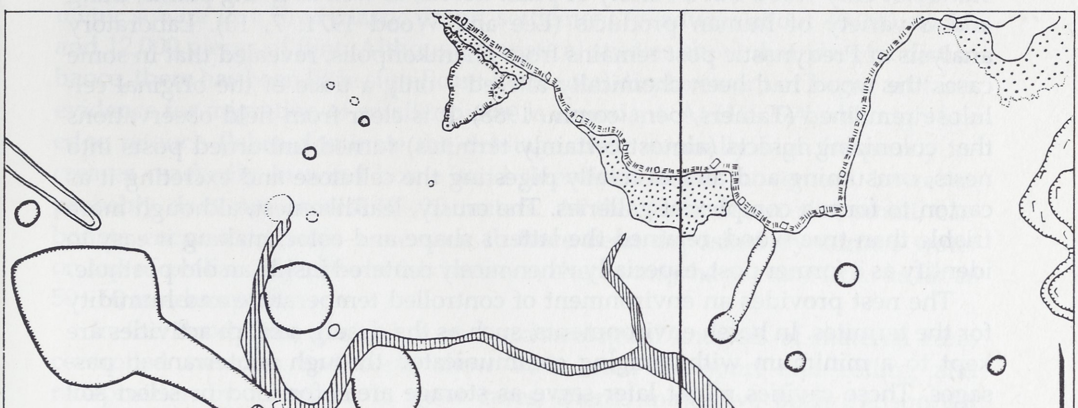


Fig. 3. Relation of soil cracks to cultural features in 160L160 and 160L70, HK-29A.

mechanical response to desiccation in an arid environment. Specifically, these silts are vertisols, which in drying contract and crack vertically. The patterning of soil cracks at Locality 29A was further influenced by pre-existing cultural features, such as postholes, wall trenches, and pits, which as voids lack the tensile strength of a relatively homogeneous silt bed. During desiccation, cracking sought a path of least resistance and was drawn towards and often through cultural features (Fig. 3). Additionally, contraction and splitting of the soil was found to shift architectural alignments.

#### Insect activity

Insects, specifically termites, may be responsible for considerable site disturbance. In arid regions of the world, termites are generally scarce, but some are apparently confined to such regions (Lee and Wood 1971: 21). In the Sahara, *Anacanthotermes ochraceus* inhabits areas with clayey soil, and in sandy regions is replaced by *Psammotermes hybostoma* (Lee and Wood 1971: 89, after Harris 1970). Both construct entirely subterranean nests (Lee and Wood 1971: 91, after Bernard 1954), often within their food source, such as a stump or dung heap, or beneath artifacts which reinforce nest architecture.

Both *Psammotermes hybostoma* and various species of *Anacanthotermes* consume not only wood but a variety of plant debris, as well as living plants, dung and a variety of human products (Lee and Wood 1971: 7, 10). Laboratory analysis of Predynastic post remains from Hierakonpolis, revealed that in some cases the wood had been chemically altered – only a trace of the original cellulose remained (Tamers, pers. comm. 1988). It is clear from field observations that colonizing insects (almost certainly termites) turned unburned posts into nests, consuming and almost totally digesting the cellulose and excreting it as carton to form a complex of galleries. The crusty, leaf-like nest, although more friable than true wood, retained the latter's shape and color, making it easy to identify as a former post, especially when nicely centered inside an old posthole.

The nest provides an environment of controlled temperature and humidity for the termites. In harsh environments, such as the desert, surface activities are kept to a minimum with foraging communicated through subterranean passages. These cavities might later serve as storage areas for food or select soil fines used in construction with organic matter (either excreted or regurgitated) and/or saliva as the cementing agent (Lee and Wood 1971).

At Hierakonpolis, we occasionally find fine materials from underlying silts stored in between layers of bark rings and within the original posts. The sorting and collection of soil fines, their redeposit, and the eventual in-filling of abandoned nests and galleries produces patches of soil discoloration and diffuses distinct soil horizons.

Further study of termite ecology and behavior may shed light on the environmental and taphonomic history of archaeological sites. Each termite species is biologically and behaviorally adapted to limited ecological parameters and its capability to respond to environmental pressures with variant nest design, is limited.

In terms of termite influence in Predynastic times, it should be noted that they may have totally denuded large areas of grassland only to enrich the soil with the nitrogen rich remains of their nests, thus enhancing later plant growth (Lee and Wood 1971). Termite nests may also have served as an alternate source of slow-burning fuel for hearths or kiln fires.

#### Weathering of culturally altered silt surfaces

In desert settlements it is often difficult to distinguish between natural surfaces within the late Pleistocene silts and those which have undergone cultural alteration. Slick or gently smoothed surfaces are found throughout Predynastic desert settlements and often indicate intentional or unintentional molding of living floors by water. In cases of clear cultural alteration, patterns may be detected by cleaning surfaces and viewing them in oblique light or by repeated brushing and natural drying. We have detected the application of mud "plaster" applied directly onto natural silts in which the raw material for both the natural and cultural units was Sahaba-like silt.

#### Artifact migration

Our most prevalent artifacts are sherds and chipped flint. An average 10 meter square in a Predynastic desert settlement, produces about 40,000 sherds and 12,000 pieces of flint. Although statistical studies show that, despite disturbance, there has been little significant horizontal displacement of larger artifacts, evidence for migration of smaller pieces is abundant. At HK-29A, although fine edge retouch flakes dominate the debitage, their normally high frequency increases markedly in wind borne sand deposits. Lateral movement, however, probably does not exceed 10 - 20 meters. At the same desert site, small, carbonate encrusted sherds were seen to have been deposited by surface water on top of aeolian deposits. In this instance, sherds may have come from as far as 50 - 60 meters uphill.

In the floodplain, geological and archaeological analysis of material from controlled trenches and cores show both wadi transport and rolling and redeposition by the river. In these cases, sherds may have been transported several hundred meters.

#### Halfa grass

In the alluvium on sites like Nekhen, halfa grass has become an increasingly serious problem since completion of the Aswan High Dam and the subsequent raising of the mean annual groundwater level. Halfa roots penetrate well over a meter below the surface, splitting walls, features and large, *in situ* artifacts like storage pots and make neat digging difficult. They also introduce the possibility of greater contamination, especially by small "diagnostic" artifacts filtering down through root cavities.

### Salt

The negative results of ground salts may be seen most clearly in the modern alluvium where, since completion of the Aswan High Dam, the mean annual water table has risen slowly but steadily under the pressures of constant cultivation. To give an idea of the degree of change, the same salt crust which took six weeks to form on an open profile twenty years ago, now takes about six hours. This situation not only adversely affects preservation of materials, but often obscures subtle soil differences useful in "reading the dirt".

In the desert the problem of salinization is mainly the result of ancient historical pluvials and provides useful environmental and chronological information. This is balanced by the negative effect salt has on pottery.

## Sources of environmental information in Predynastic settlement sites

### Carbonate horizons

Carbonate horizons are widespread throughout the desert at Hierakonpolis. One horizon in particular is consistently found on top of Amratian (Nagada I) and Gerzean (Nagada II) occupations. It is about 1 - 2 cm thick and seems to represent the onset of the latest rainy episode of the Holocene Subpluvial. By combining this information with other stratigraphic and ceramic data, it is possible to date the beginning of the last wet phase of the Holocene Subpluvial to Protodynastic (Nagada III) times (*ca.* 3,200 - 3,100 B.C.). The moist interval lasts until *ca.* 2,500 B.C.

### Potsherd taphonomy

As a part of our detailed, multivariate pottery analysis program, we have, to date, studied approximately three quarters of a million sherds, mostly from Predynastic settlements. Based on the ceramicists' observations, we have set up two coding categories (which complement longer notebook entries about particular pottery deposits) – encrustations and abrasion. These allow us to note, in the first instance, whether a sherd is encrusted with a foreign material, such as carbonates, sand, *etc.*, after breakage and, in the second case, whether or not it has been abraded by wind, water or both agencies. The taphonomy of sherds can be quite useful. For example, in geological trenches in the alluvium it was noted that Hard Orange Ware sherds of Protodynastic date were water worn, reflecting the local pluvial conditions previously alluded to. In a desert site, small carbonate encrusted sherds indicated a water deposited stratum (also of Protodynastic date). The size and condition of sherds and the type of wear on their edges may also give an indication of post-depositional processes. In contrast to natural processes, a number of cultural activities can effect pottery distribution, including their reuse in buildings and features, like ovens, both common Predynastic practices.

#### Root casts

Carbonate root casts are often found in Late Pleistocene silts. Usually they are believed to date to the time of deposition when the Nile ran high and the climate was hyper-arid. Given the correlation of Predynastic settlements, low desert Sahaba-like silts and root casts Fairservis (pers. comm. 1988), has recently suggested the possibility that the root casts represent plants which thrived during the Predynastic. According to this view, the herding-oriented Amratian peoples (see McArdle 1982 and current research) would have sought out areas favorable to their flocks. Given the rainy conditions reconstructed for the Amratian and the needs of the economy, it is possible that our root casts are the product of Holocene and not Pleistocene conditions. Dating of carbonates is the only way to test this hypothesis.

#### Changing settlement distribution

Settlement patterns at Hierakonpolis show a marked shift from Amratian through Early Dynastic times (Hoffman, Hamroush and Allen 1986: 175 - 187; 1987: 1 - 13; Hoffman 1970). The shifting of population away from the low desert toward and into the alluvium in early Gerzean times (*ca.* 3,500-3,400 B.C.) reflects a drying trend. Earlier Amratian sites were widely distributed throughout a variety of low desert microenvironments and display maximum functional variability and abundant wild and domesticated macrofaunal remains (see below).

#### Floral remains

Twenty different species, ranging from domesticated wheat and barley to weeds such as Halfa grass and xerophytic trees like tamarisk and acacia have been documented in low desert Amratian settlements (Hadidi 1982). They reflect environmental diversity and relatively high desert biomass. These provide strong evidence of moist desert conditions between approximately 3,900 and 3,500/3,400 B.C. The possibility that this wet interval extended earlier is good but, so far, we lack direct evidence.

#### Faunal remains

One of the most surprising facts about Predynastic faunal assemblages (approximately 5,000 identifiable bones have now been analyzed by McArdle from Amratian and Gerzean settlements) is the almost total lack of wild forms. Contrary to earlier speculations (*i.e.* Butzer 1959) and the impression gained from the rock art, wild animals were apparently quite rare (less than 1%). Judging by the high percentages of grazing animals (cattle, sheep and goats), whatever plant cover did exist in the low desert must have been under severe pressure during the earlier part of the Predynastic.

In light of the recent statement that a domesticated donkey from Maadi is the earliest published specimen (Caneva *et al.* 1987: 107), the senior author notes that in our 1982 monograph, *The Predynastic of Hierakonpolis*, McArdle published a domesticated donkey (*Equus asinus*) from an Amratian settlement at Hierakonpolis. Since this time, additional specimens have been identified.

**Radiocarbon estimates**

The interpretation of C-14 estimates is usually regarded as a strictly chronological problem. Our work in the Predynastic settlements of Hierakonpolis suggests some alternate interpretations. Initially, our dating of local Amratian settlements (Hoffman [ed.] 1982: 139) produced a fairly tight and consistent clustering of radiocarbon estimates which was more or less in line with what we expected. The corrected dates ranged from *ca.* 3,800 to 3,500 ± 100 years B.C. Our one date for Late Protodynastic (on a tomb) likewise was close to traditional estimates at 3,025 ± 80 B.C. More recently, however, problems have arisen. A suite of dates on a clearly Gerzean settlement complex (see Table 1, and note that one new date is also too old), produced another fairly tight and internally consistent clustering of estimates. Unfortunately, the Gerzean dates fall squarely within the range of Amratian dates from nearby sites. Moreover, a single date on an apparent C-Group campsite (not shown in Table 1) came out to *ca.* 3,200 B.C., *i.e.* to the Early Protodynastic. Obviously, most of our dates cannot be contaminated, since they are all consistent. We suggest that these dates may or may not date the associated cultural materials, but that they certainly date local moist intervals of the Holocene Subpluvial. This interpretation is also supported by settlement pattern distribution, geology, pedology, and the ancient flora and fauna. We suggest that, in the Hierakonpolis region of southern Upper Egypt at least,

Table 1

**Radiocarbon estimates from HK29A.**

| Date No. | Provenience (site/square/find) | Archaeological context/remarks | Uncalibrated date B.P. | Calibrated date B.C.* |
|---|---|---|---|---|
| Beta 16150 | HK-29A/140L40/8 - 2 | Loose sand filling WT#1, Level 3. 0.1 g. carbon, extended counting time. | 4820 ± 330 | 4350 (3636) 2071 |
| Beta 16151 | HK-29A/140L60/20 - 3 Feature 7 | Large posthole (Fea. 7) of Struct. III, from burned ash and wood within silty level below sand (unit 8). | 4580 ± 70 | 3510 (3351) 3044 |
| Beta 16152 | HK-29A/140L60/23 | Level 4, fine sandy silt fill within Wall Trench 3A, Structure III. | 4890 ± 90 | 3944 (3695) 3385 |
| Beta 16154 | HK-29A/150L50/26 - 6 | Wall Trench #1, charcoal Level 3, organically stained silt. | 4770 ± 70 | 3771 (3619, 3576, 3531) 3370 |

* Intercepts and maximum range at two sigma. Value with highest probability in parenthesis and underlined. Calibrations provided by courtesy of Beta Analytic, Inc.

xerophytic trees like tamarisk and acacia stopped taking in C-14 during periods of extreme stress (*i.e.* drought) but either survived in dormancy for a long time or eventually died but remained standing in the desert. They were subsequently harvested by local peoples and used as construction elements in light wattle and daub type superstructures or as fuel. This presupposes a fairly high production of biomass before drought conditions developed about 3,500/3,400 B.C. in the early Gerzean times. Nevertheless, it helps explain the failure, to date, of radiocarbon dating to differentiate Amratian and Gerzean periods at settlements which are clearly (stratigraphically and seriationally) distinct as well as the anomalous date on the C-Group site at HK-64. In light of recent comments from the International Radiocarbon Congress in Yugoslavia (Tamers, pers. comm. 1988) which suggest that trees like tamarisk cease accumulating C-14 in periods of drought, and in light of the importance often given by pre- and protohistorians to radiocarbon dating over more conservative stratigraphic and seriational techniques, we feel that we need to determine to what degree many of our apparently consistent suites of C-14 estimates are dating cultural processes and to what degree they may be dating natural events. At present, we suggest that two wet intervals are in evidence at Hierakonpolis, one dating *ca.* 3,900 - 3,500/3,400 B.C. and one dating *ca.* 3,200 - 2,500 B.C.

## Summary and conclusion

In this paper we have suggested that a rich diversity of architectural forms and materials may be recovered from Predynastic settlements, given favorable conditions of preservation and sufficiently sensitive survey and excavation techniques. We have discussed a number of natural and cultural processes which effect the taphonomy of Predynastic settlement sites and suggested identified sources of environmental information available from those sites. Finally, we have noted problems of interpretation raised by some of the environmental information, especially radiocarbon dates.

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