Acta Palaeobot. 35 (1): 157–162, 1995

# PARENCHYMATOUS TISSUES FROM THE EARLY NEOLITHIC SITE E-75-6 AT NABTA PLAYA, WESTERN DESERT, SOUTH EGYPT
## PRELIMINARY REPORT

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ABSTRACT. Parenchymatous tissues derived from roots and tubers were examined from an early Neolithic site at Nabta Playa, ca. 8000 yrs bp. Tubers of *Cyperus rotundus* and an undetermined grass species as well as rhizomes of *Typha* and *Nymphaea* formed a significant element of the diet of the inhabitants of this site. Paleoenvironmental implications are briefly discussed.

KEY WORDS: early Neolithic, Egypt, Sahara, tubers, rhizomes, paleoeconomy, paleoecology

## INTRODUCTION

From three seasons excavations at Nabta Playa, site E-75-6 (Wasylikowa et al. 1995), 129 samples contained what were thought to be parenchymatous tissues, derived from the soft vegetative parts of root and tuber organs. Of these samples a proportion contained degraded dicotyledonous wood and a few monocotyledonous "wood" most probably derived from a member of the Palm family. Only samples that contained parenchymatous tissue will be dealt with here.

### METHODOLOGY

All fragments from each sample were viewed under low power microscopy using an incident light binocular microscope. Those fragments thought to be parenchyma were mounted on to "cambridge" type aluminium scanning electron microscope stubs and coated with gold. All fragments were then viewed under SEM and the results recorded by photography. Characters observed in the archaeological material were compared with both experimentally charred modern material, stained thin sections of comparable tissues and standard anatomical texts (see Hather 1991 for a detailed description of the methodology).

For each of the categories of tissues identified photographs illustrating the nature of the diagnostic characters were taken and are presented here along with a description of each of these categories.

## RESULTS

Seven categories of parenchymatous material were determined in the analysis each of which are dealt with separately below.

I) *Cyperus* cf. *rotundus* (Fig. 1)

This is one of two categories of remains that are represented, at least partially, by whole, morphologically recognisable organs (the other being the Gramineae tubers described below). The elliptical tubers, between 7 and 11 mm long and 3 to 6 mm across at their widest point. Many of the tubers were broken and represented by recognisable fragments. Both rhizome detachment scars, scale leaf scars and scale leaves were observed. Of the many fragments assigned to this category few were morphologically distinct and were identified by characters of the internal anatomy. In all fragments identified as *Cyperus* vascular bundles were observed. These were rather small, often not more than 4.5–5.5 mm across. These were amphivasal concentric in organization, that is to say that the vessels of the xylem surrounded the phloem. The ring of xylem vessels was only occasionally observed to be complete and often fibres were present either completing the ring or as a partial sheath. Phloem was never seen to be preserved, marked only by a central cavity. Breakdown of the phloem was occasionally accompanied by partial or more

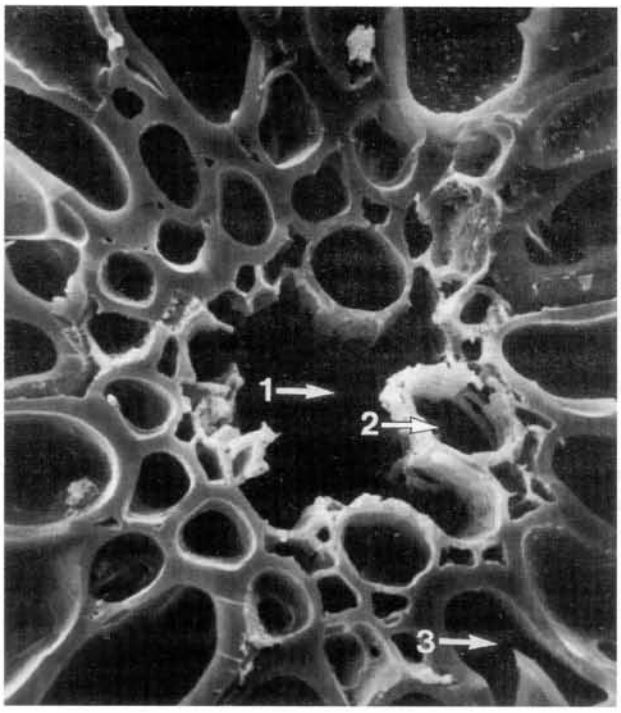


**Fig. 1.** *Cyperus rotundus* from Nabta Playa. An amphivasal concentric vascular bundle: 1 – position of deteriorated phloem, 2 – xylem, 3 – parenchyma. Scale: figure width = 100 μm

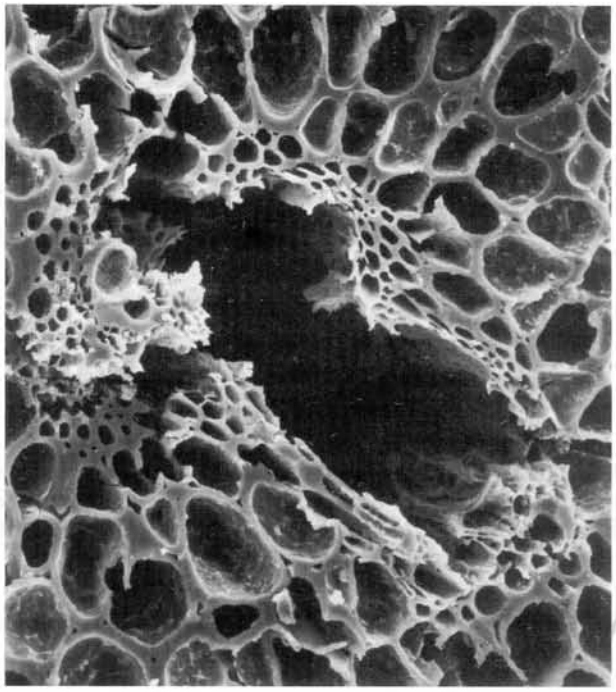

**Fig. 2.** *Typha* sp. from Nabta Playa. A collateral vascular bundle where most of the tissues have deteriorated leaving an elongated cavity partially surrounded by a fibre sheath. Scale: figure width = 200 μm

complete breakdown of the xylem, leaving a channel containing only a few elements of sclerenchyma. This form of vascular bundle, in terms of both its anatomy and preservation is entirely consistent with that observed in modern material of *Cyperus*, both thin sectioned and experimentally charred, and with other examples of this identification from the archaeological record (Hillman et al. 1989).

*Cyperus* parenchyma was found in a total of 48 samples and was the most abundant identified remain of this type in this analysis.

In whole tubers, where both proximal and distal extremities were well preserved, rhizome detachment scars were present in both positions. This indicates that at least those tubers where this character was observed are *Cyperus rotundus* and not *Cyperus esculentus*, in which each tuber is terminated by a bud, surrounded by scale leaves.

II) *Typha* sp. (Fig. 2)

Fragments identified as *Typha* were represented only by broken pieces of tissue with no epidermal surfaces. All identifications were based upon anatomical characters of the vascular tissue. The rhizomes of *Typha* species have a broad aerenchymatous cortex internal to which is a solid aerenchymatous stele. Vascular tissue occurs in both regions but is most heavily developed in the stele where the vascular bundles are large and collaterally organised. This is to say that the xylem lies adjacent to the phloem. In *Typha* there is a fibre sheath, sometimes existing only at the poles but usually extending around the bundle. Viewed in transverse section the stele is a typical monocotyledonous atactostele, with vascular bundles apparently placed randomly, although they are less dense away from the perimeter of the stele so that a parenchymatous pith occurs at the centre.

The vascular bundles tend to be elongated with a slight constriction at the junction between the xylem and phloem, approximately two thirds along the long axis of the bundle. In the fragments of this taxon recovered here the majority of vascular bundles observed had little vascular tissue remaining, most likely having deteriorated during the process of charring. However, in a significant number vessel elements of the xylem tissue survived and in many cases the fibre sheath was present. It was possible to observe the constriction at the xylem/phloem junction and the nature of the sheath and, though deteriorated, some characters of the xylem. These matched closely characters of *Typha* and are significantly different

from the vascular bundles of other organs of this type. *Typha* was recovered from six samples, with parenchyma that closely matched that of the *Typha* remains being found in one other sample (see category VII below)

III) *Nymphaea* sp. (Fig. 3)


**Fig. 3.** *Nymphaea* sp. from Nabta Playa. A vascular tract made up of several bundles in which the xylem has survived intact (1) and the phloem has deteriorated to a solid strand of tissue (2). Scale: figure width = 250 μm

Fragments in this category were found in only one sample and were represented by three fragments of tissue that were in all probability a single fragment, at least at the point of preservation. Subsequent conditions of the depositional environment no doubt caused the fragment to break. This exemplifies the problem of the quantification of this type of plant remain well; this topic will be returned to below.

Many Nymphaeaceae species are polystelic with each stele comprising a number of rather disorganised vascular bundles. Lacking true vessels the bundles of *Nymphaea* have a tend to have a lobed appearance with strands of phloem leading away from a mass of xylem tissue adjacent to a central pith. In Fig. 3 a single bundle can be seen with three areas of solid tissue on the right representing deteriorated phloem and a mass of xylem on the left. The areas of phloem are associated with the larger metaxylem vessels suggesting the pith would be to the left of the bundle. Vascular characters are not well preserved enough for an identification below that of the genus *Nymphaea*.

IV) Gramineae (unidentified) (Fig. 4)

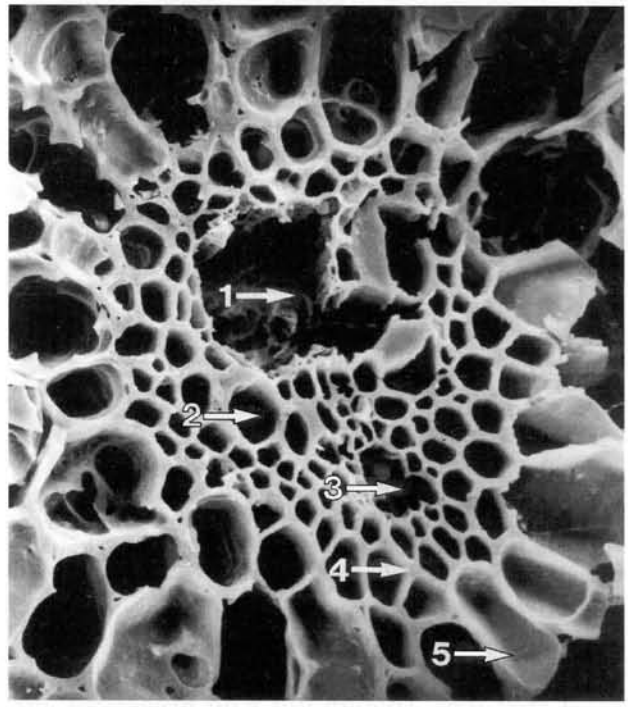


**Fig. 4.** Gramineae indet. from Nabta Playa. A closed vascular bundle in which the phloem has deteriorated to leave a cavity (1), both metaxylem (2) and the protoxylem canal (3) have survived. The vascular bundle is surrounded by a fibre sheath (4) and parenchyma (5). Scale: figure width = 100 μm

Recovered from three samples were whole and fragmented basal tubers of a member of the Gramineae. These were both morphologically recognisable and anatomically well preserved. The tubers of *Arrhenatherum elatius* var. *bulbosus* are common in European archaeological plant assemblages and have variously been interpreted as food or the result of turf burning (Parrington 1978, Heslop 1987) . Though well preserved anatomically – vascular tissue easily recognisable with the positions of both protoxylem, metaxylem and phloem easily discernable – identification beyond the level of Family is not possible. It most closely resembles *Arrhenatherum elatius* var. *bulbosus* but ecologically this is unlikely. Further work on these remains may allow an identification to be suggested.

V) Pteridophyte (unidentified) (Fig. 5)

A single fragment of charcoal from one

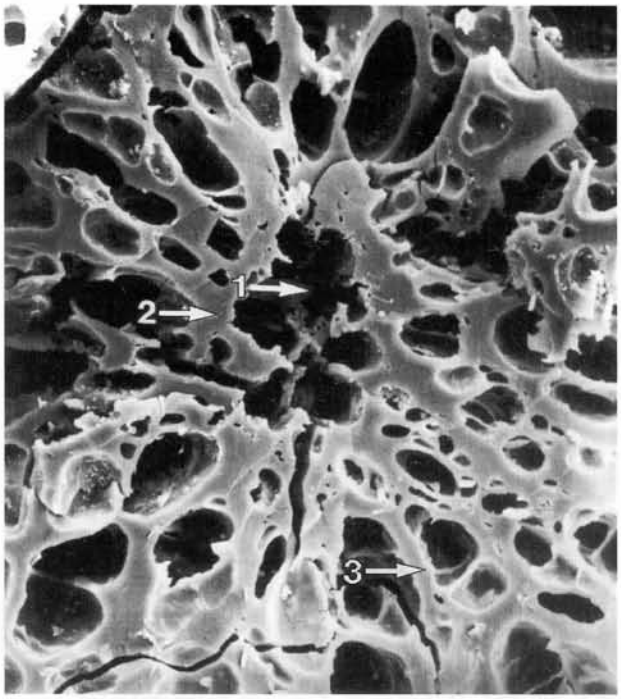


**Fig. 5.** Pteridophyte vascular bundle (meristele) from Nabta Playa. The meristele is poorly preserved but a central strand of xylem is clearly visible (1) and surrounded by a cylinder of solid phloem (2) and parenchyma (3). Scale: figure width = 100 μm

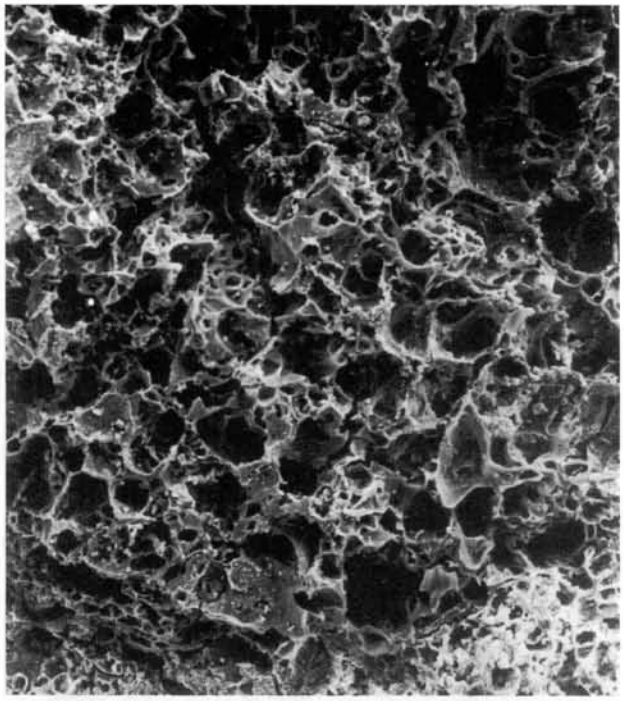

**Fig. 6.** Isolated aerenchyma from Nabta Playa. Scale: figure width = 600 μm

sample had running through it a vascular tract that was, though not well preserved, different from others identified in this assemblage. It was concentric in arrangement, similar to that of *Cyperus*, but the vascular tissues were of amphicribal organization, that is to say the phloem surrounded the xylem. Such vascular bundles are rare in angiosperms and it is suggested here that this may be a fragment of pteridophyte tissue as bundles of this type are common in this group of plants. As an isolated fragment of poorly preserved tissue it is difficult to refine any identification beyond this point. Similarly any interpretation based upon this remain will be problematical.

VI) Isolated aerenchyma (Fig. 6)

A single fragment tissue was identified as being aerenchymous tissue. Aerenchyma in plants may be divided into tissues made up of cells specifically shaped to create large intercellular spaces, and that comprised of more or less isodiametric cells that form chains and plates which themselves form the walls of large intercellular spaces. In the former airspaces are much smaller than in the latter and such tissue often fills the cortex of many aquatic plants. Tissues with larger air spaces formed by chains and plates of rounded cells are more common in the stele surrounding vascular tissues. Neither tissue type survives well on preservation by charring and the resulting charcoal is fragile and is likely to fragment easily in most post-depositional conditions. However the type with isodiametric cells and larger intercellular spaces is sometimes recovered and is represented in the Nabta Playa assemblage by this fragment. All cells become compressed by the expansion of the air in the intercellular spaces, the resulting form being one of large cavities formed by a vesicular matrix. No vascular tissues were observed and as vascular tissues in aerenchyma tend to be rather minimal this is not surprising. Further identification is not possible although it is likely that these tissues derive from plants such as *Alisma* or *Sagittaria*.

VII) Isolated parenchyma (Fig. 7)

In terms of fragment number, the most abundant remain was that of isolated parenchyma, that is to say fragments of parenchymatous tissue that were without vascular tissues. By their very nature such fragments were small but resilient. Only one type was observed with thick walled more or less isodiametric cells and small triangular air spaces. Though not identifiable this parenchyma type is very similar to the parenchyma of *Cyperus rotundus* and dissimilar to that of the

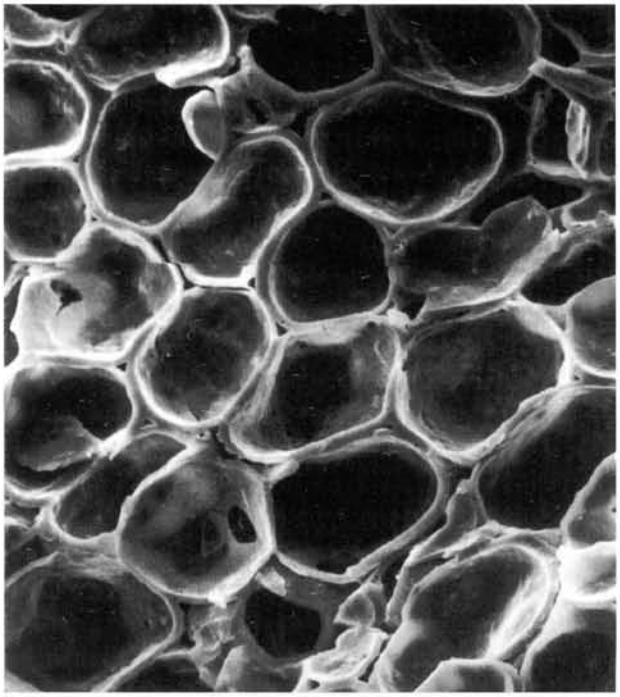

**Fig. 7.** Isolated aerenchyma from Nabta Playa. Scale: figure width = 100 μm

other taxa identified in this assemblage. It is also a frequent remain and though not always associated with the large number of *Cyperus* remains is likely to have been derived from this taxon.

## QUANTIFICATION

It is well known that the quantification of any plant remain that is represented by a fragment of a whole of unknown size is problematical. Relating the quantity (and therefore its palaeo-economical or -environmental importance) of one taxon to the same taxon in another assemblage or to another taxon in the same assemblage may be done by weight, fragment number or volume. Each has its problem. In order to demonstrate the nature of this problem three statements of quantitative potential are presented:

I) In this assemblage, if we assume that all the isolated parenchyma is derived from *Cyperus*, then this taxon dominates in terms of all three of these methods of assessing quantity: weight, fragment count and volume. Both *Typha* and *Nymphaea* are represented by a small number of fragments, nine and three respectively. *Cyperus* also dominates in terms of ubiquity, though without secure data concerning context related sampling ubiquity counts may not be meaningful.

II) However, if we assume that the *Typha* and *Nymphaea* remains were derived from at least a moderate proportion of their rhizomes then it is possible that, purely in terms of biomas, these taxa each at least equaled that of the *Cyperus*.

III) On the other hand, if we assume that the quantity preserved for each taxon is, as a proportion the quantity originally present on the site, roughly equal, then however much biomas there was for each taxon, a fixed percentage becomes preserved, i.e. however much more *Cyperus* has been preserved that either *Typha* or *Nymphaea*, this equates with the quantity originally present on the site prior to preservation.

The quantification of these types of remains will, no doubt, rely on a combination of statistical methods and an understanding of the taphonomy of each taxon involved. As such this is beyond the scope of this report however any quantitative method that simply tells us how much more of one category there is than another, in any terms, will only be useful if adds in any meaningful way to interpretation.

## COMMENTS ON THE NABTA PLAYA PALAEOECONOMY

It is without question that the taxa identified could have formed a significant element of the diet of the inhabitants of this site. There are numerous ethnographic examples for the use, as a carbohydrate producing staple, of *Cyperus* (Guest 1933, Medsger 1939, Morton 1963, Uphof 1968), *Typha* (Morton 1963, Rogers 1980) and *Nyphaea* (Morton 1963, Uphof 1968). However, without more information concerning context interpretation and other specialist information concerning other remains this is difficult to assess.

## COMMENTS ON THE NABTA PLAYA PALAEOENVIROMENT

*Cyperus, Typha* and *Nymphaea* are all aquatic taxa and therefore of considerable significance in interpreting the environment of the Nabta Playa site. Undoubtedly there was a water source but both *Typha* and more so *Cyperus* will tolerate periods of drying. However, *Nymphaea* will not, and as such is evidence of a permanent water source.

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