9 *Examination of botanical remains from early neolithic houses at Nabta Playa, Western Desert, Egypt, with special reference to sorghum grains*

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Introduction

During the field seasons of 1990 and 1991 a rich collection of charred fruits and seeds was found at the early neolithic site E-75-6 at Nabta Playa (Fig. 9.1). Samples from 1990 were collected, sorted and tentatively identified by the first author; those from 1991 were collected and briefly examined by Lucyna Kubiak of the A. Mickiewicz University, Poznan. Plant materials from both seasons were generally similar in taxonomic composition.

It must be emphasized that the results presented below are still preliminary.

Archaeological setting

Site E-75-6 was discovered in 1974. It is on a fossil dune and is partially covered by the silts of one of the largest playas in the Western Desert of Egypt. The site was initially studied in 1974, 1975 and 1977 (Banks 1984, pp. 61–129). Almost 1000 m² were excavated, revealing cultural deposits of two different types of early Neolithic but without reaching the southern and southeastern boundaries of the site. The lower layer was assigned to the early Neolithic of el-Kortein type, dating to about 8800–8500 BP. The upper horizon, which was orginally thought to represent a single phase of occupation, is early Neolithic of el-Nabta type, dating to about 8100 BP, and showed a patterned arrangement of two rows of features, including the basin-floors of huts, hearths, storage-pits and walk-in wells. This laid-out village was seen as one of the first indications of developing social control within these societies (Wendorf & Schild 1980, p. 269; Wendorf, Close, Gautier & Schild 1990, p. 445).

Excavation of Site E-75-6 was continued in 1990 and 1991 (under the archaeological direction of Wendorf, Schild, Close and Królik) (Fig. 9.1). An area of 165 m² was opened; it was sealed beneath early holocene playa clays and lay southeast of the earlier areas (in the direction of the two lines of features) (Fig. 9.2). Removal of the seal of playa clays disclosed a very intricate microstratigraphy, involving several consecutive occupations. Four houses (two oval and two round, all dug to a depth of about 30 cm into the top of the dune), twelve pits and a well were exposed and partially excavated.

The two oval houses are large (8.3 × 4.5 m and 7 × 2.5 m), shallow basins. Hearths in each of them have radiocarbon dates on charcoal of 8550 ± 130 bp (Feature 1/90; Gd-6254) and 8600 ± 140 bp (Feature 3/90; Gd-4587), but these dates are problematically older than AMS radiocarbon dates on *Sorghum* seeds from the same hearths (OxA-3217 and OxA-3219, respectively; see below). In addition, a small hearth cut into the southwestern quadrant of Feature 1/90 gave a date of 7770 ± 110 bp (Gd-6257). The floor of one of them had traces of six hearths (<1 m^2 in area) and, separate from them, at least 74 small hemispherical depressions, or 'pot-holes', usually 10–20 cm in diam-

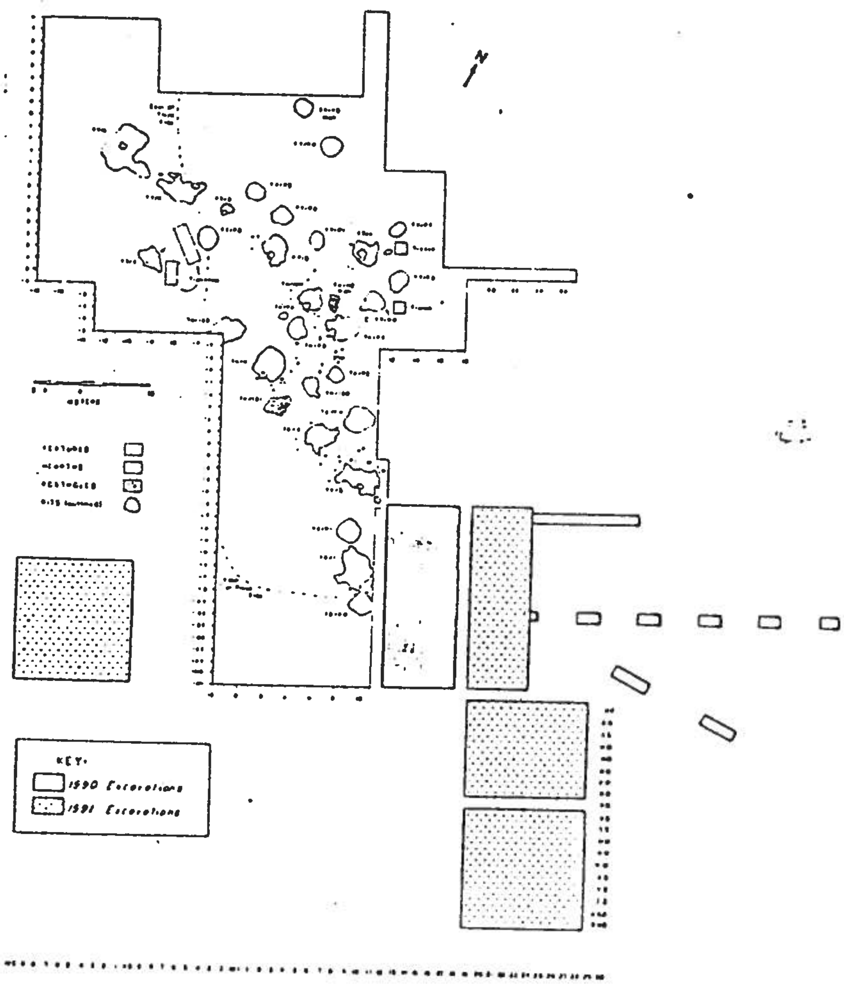

Figure 9.1 Nabta Playa, site E-75-6: site-map showing the relative positions of the 1977 (unshaded), 1990 and 1991 areas of excavation.

eter. The excavated portion of the other oval house had four hearths and 18 hemispherical depressions.

The shallow, circular houses are about 4 m in diameter, and one (Feature 2/90) is dated 7920 ± 100 bp (Gd-6258). One of them had three hearths and seven 'pot-holes' plus an irregular bell-shaped storage pit, while the other had a single hearth and 28 'pot-holes'.

In all the houses, a burned, ashy sediment had been piled up around some of the 'pot-holes' while they held containers, and this sediment was particularly rich in plant remains. This suggests that containers of food were placed in the 'pot-holes' and that hot ash (the brown sediment) was piled up around them to cook the contents, which sometimes boiled over or fell into the ash, leading to their carbonization and preservation. Many of the 'pot-holes' intersect each other at various levels within the houses, indicating repeated occupations. The house basins as a whole are filled with a grey sand, which is rich in organic remains.

Eleven samples of identified plant remains have direct AMS radiocarbon dates, which cluster tightly around 8000 bp and are in accord with the earlier suite of dates for the site (Haas & Haynes 1980):

8080 ± 110 bp (OxA-3214), Cruciferae? seeds from Feature 1/90
8095 ± 120 bp (OxA-3215), Leguminosae? seeds from Feature 1/90
8020 ± 160 bp (OxA-3217), *Sorghum* seeds from Feature 1/90
8050 ± 130 bp (OxA-3218), *Zizyphus* seeds from Feature 1/90

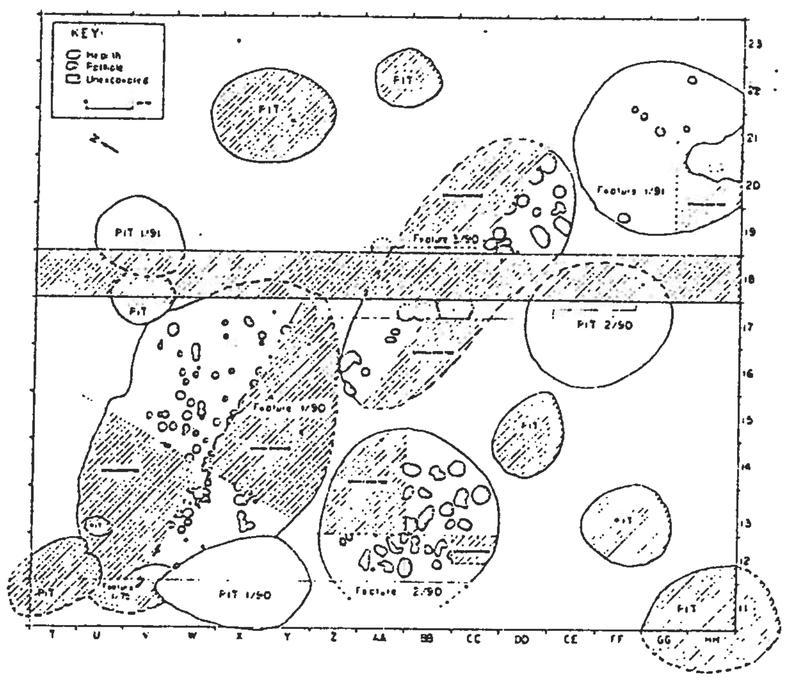

Figure 9.2 Nabta Playa, site E-75-6: detailed plan of 1990 and 1991 excavations.

7980 ± 110 bp (OxA-3221), *Sorghum* seeds from Feature 1/90
8060 ± 120 bp (OxA-3222), *Sorghum* seeds from Feature 2/90
7950 ± 160 bp (OxA-3219), *Sorghum* seeds from Feature 3/90
7960 ± 100 bp (OxA-3216), *Sorghum* seeds from Feature 1/91
8025 ± 120 bp (OxA-3220), *Zizyphus* seeds from Pit 1/90
7950 ± 90 bp (OxA-3484), *Panicum*-type from 90/90
7980 ± 95 bp (OxA-3485), *Zizyphus* seeds from Feature 2/90

2/90

Two other radiocarbon age estimates came from the pits: Pit 1/90 gave a date of 8260 ± 100 bp (Gd-6260); Pit 5/75 (in the profile) gave a date of 7450 ± 120 bp (Gd-4586). The microstratigraphy and the radiocarbon dates suggest that the upper occupations, which took place after the dune had stabilized, may cover a period of >1100 years. The presence of wells and the location of occupation near the very centre of a playa suggest dry season occupations.

Pottery was present in some of the features, but was very rare: only nine potsherds were recovered in the 1990 excavation and only three in 1991, including some with herringbone design (from Pit 1/90 and Feature 2/90). Pottery vessels were thus not the usual mode of cooking. In addition, there was almost no burned rock at the site, so pot-boilers were little used, if at all, and food was not commonly roasted on heated rocks. It seems that any containers used in cooking (and the size of most of the plant foods would have necessitated containers) must have been perishable.

All of the houses contained remains of sorghum, as well as other plant materials. Grains of sorghum type were also present in Pits 1/90 and 2/90.

Description of sorghum sp. remains from Nabta Playa

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The genus is represented by numerous charred caryopses and a few charred spikelets. Grains are dorso-ventrally flattened, usually with broad oval or obovate outline; a few are elongated, narrow oval. The large embryo on the dorsal side is as long as 1/3 or more often 1/2 to 2/3 of grain length; the small hilum at the base of the ventral side is oval or obovate. The shape and size of grains show considerable variation (Fig. 9.3). Their dimensions, based on fifteen measurements, are: length 1.65–2.90 mm, average 2.29 mm, breadth 1.25–1.90 mm, average 1.59 mm, thickness 0.85–1.55 mm, average 1.22 mm. Index of the length/breadth ratio is 132–78, average 156; index of thickness/breadth ratio is 61–88, average 76.

All grains are charred, most of them are badly damaged and show deformations characteristic of charred grasses, such as perforations and extrusions of endosperm outside the grain coat in the form of a charred foam. Several grains have glume fragments attached, while some show longitudinal impressions of glume margins along the lateral sides, both features which may suggest that they were charred while still within the glumes.

The ancient charred grains are much smaller and relatively narrower than grains of *Sorghum* varieties cultivated at present and resemble the caryopses of extant wild taxa of this genus. All the ancient charred grains may belong to one taxon but it is also possible that the most elongated specimens represent another form within the same taxon of higher rank.

Spikelet remains (Fig. 9.4) are composed of the second (ventral) glume which at the base is enclosed by the remnants of the first (dorsal) glume. Glumes are thick, with no traces of nervation, which indicates that these are sessile (i.e. fertile) spikelets. In a few specimens, remnants of immature caryopsis are visible inside the glume. Remains of the membranaceous lemmas were not seen, but one specimen has a fragment of geniculate awn inside the glume. The disarticulation scar is rather broad in relation to

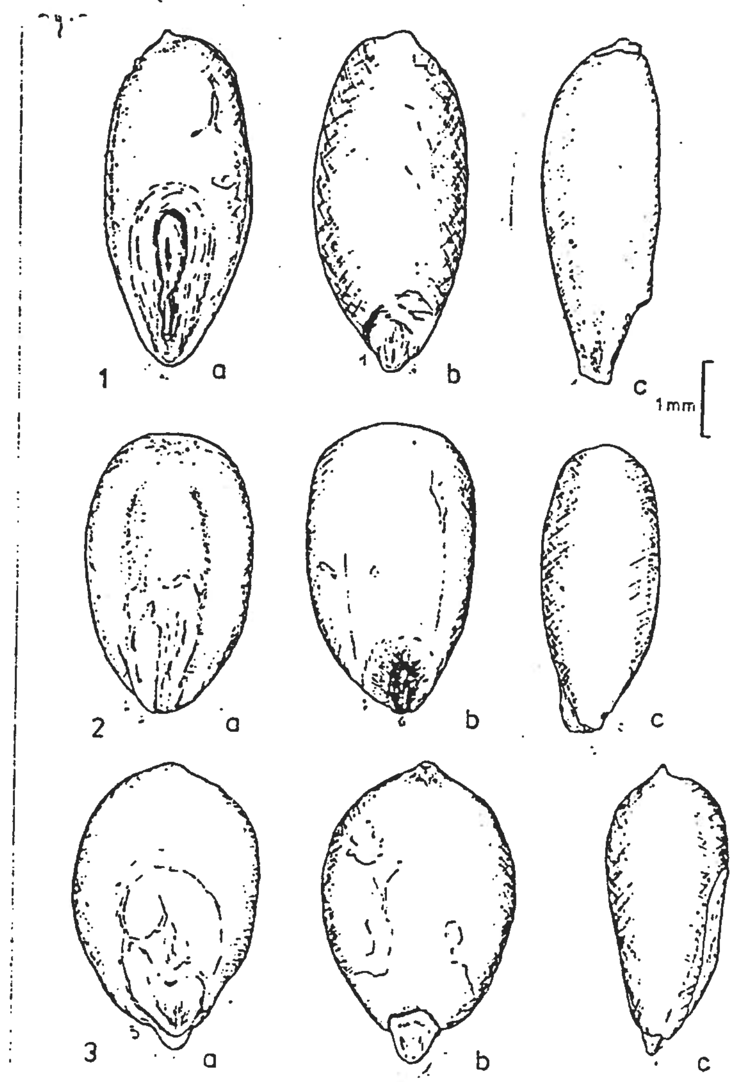

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Figure 9.3 Grains of *Sorghum* sp. from Nabta Playa, site E-75-6: a, b, c – one specimen from each of the dorsal, ventral and lateral sides. 1 – Pit 1/90; 2, 3 – Feature 1/90, Southwest quarter.

the spikelet breadth, broader than in mature spikelets of *Sorghum* but comparable to immature ones.

Infra-red spectroscopy[1]

The identification of plant remains from archaeological sites, and the establishment of the phylogenetic relationship of ancient species to modern ones, relies primarily on gross morphological attributes of the plant remains themselves and on appropriate histological criteria. Such identifications are particularly difficult when the samples have

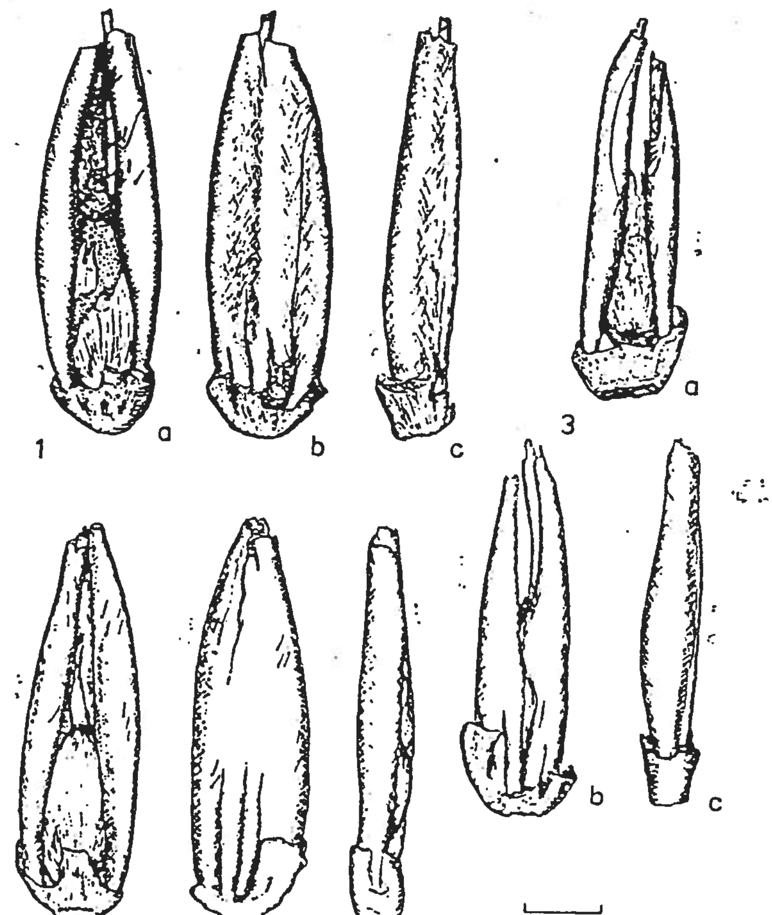

Figure 9.4 Spikelets of *Sorghum* sp. from Nabta Playa, site E-75-6, Pit 1/90: a, b, c – one specimen from each of the dorsal, ventral and lateral sides. Dorsal glumes broken, immature grains visible inside ventral glume; specimen no. 1 shows a basal portion of twisted awn.

been charred as, in the majority of cases, their characteristic criteria become distorted, making identification even at species level uncertain. However, it is usually possible to assign seeds to a limited number of alternatives.

A relatively simple, inexpensive and non-destructive method of identifying plant remains involving the use of infra-red spectroscopy (IR) has recently been developed (McLaren, Evans & Hillman 1990). The theoretical background to the concept is that the seed is the product of a series of biochemical processes that take place during its development and which are encoded in the genotype. The morphological changes involved in the process of domestication or other crop development result from a divergence of the gene pools, due both to selection by early cultivators and to natural processes. Thus, each seed variety is unique, as will be its biochemistry, although it will share much of its identity with closely related forms.

Unfortunately, standard methods of chemical taxonomy such as serology or allozyme-electrophoresis are all relatively expensive and require a high degree of skill to carry out successfully. Additionally, the major biochemical components studied are usually proteins or nucleic acids, both of which degrade readily after deposition, or on exposure to heat. Equally, they are easily contaminated by other biological agencies such as bacteria or by exchange with their depositional environment. Consequently, when such studies are undertaken on archaeological materials, the work is difficult, complex and expensive, and thus beyond the reach of most archaeobotanists.

The present method involves the lipid fraction of the seed. Lipids are on the whole stable molecules, well understood chemically, and are easily extracted from seeds without damaging their morphology. They are usually mixtures of fatty acids, glycerides, long-chain hydrocarbons and long-chain mono-esters. The actual proportions tend to depend on the species of seed and to some extent the time in the growth cycle. Experience has shown that lipids are archaeologically stable. For instance, beeswax has been detected in sherds from the British neolithic period (Needham & Evans 1987). Also, lipids (unlike proteins etc.) survive the act of charring. It would appear that the actual charring process causes the lipids to migrate into the body of the seed, thus escaping from the heat source and hence avoiding thermal degradation. Additionally, the actual charring process has two beneficial side effects. First, it tends to sterilize the seed and, second, it coats the seed with an inert wall of carbon. This inert wall protects the sterilized core of the seed from further degradation (biological and chemical) and minimizes contamination from the depositional and post-excavational environments.

Fortunately, the daunting task of unravelling the exact biochemical nature of the lipid residues surviving in the charred seed is not necessary for the archaeobotanist to make an identification. It is equally unimportant for the archaeobotanist to have a detailed knowledge of infra-red spectroscopy. All that is required for identification purposes is to match the overall pattern of the actual infra-red spectrum to a standard spectrum produced under identical conditions. This in itself would be a somewhat lengthy task if the seed was totally unknown but it must be stressed that the technique is employed in conjunction with standard morphological criteria, hence the archaeobotanist will already have assigned the seed to a small number of possibilities.

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Heading follows.

Procedure

Only one seed was examined at a time. Throughout the extraction process the seed was contained in a lipid-free cellulose thimble. It was thus protected from accidental contamination or physical damage. All solvents used were double distilled in all-glass apparatus in order to have a high purity. All glassware was thoroughly cleaned with detergent followed by 24-hour immersion in chromic acid. One set of glassware was dedicated to each seed to eliminate the possibility of cross-contamination.

The seed was weighed, placed in its thimble and the thimble placed in a soxhlet apparatus. The seed was extracted for three hours sequentially with hexane and chloroform. The extracts were carefully reduced in volume to less than 1 cc. Samples of this solution were spotted onto a previously prepared IR grade potassium bromide disc, the excess solvent being evaporated off by the use of an overhead infra-red heating lamp. A reference disc of identical weight and thickness was similarly prepared using a corresponding amount of pure solvent.

The two discs were inserted into a Perkin-Elmer 781 Infra-red Spectrophotometer and the spectrum was obtained using the multi-scan mode. (Clearly the quantity of lipid present was exceedingly small and consequently the spectrum obtained for a single scan would be very weak – hence the necessity for the multi-scan procedure.) The actual number of scans varied between five and fifteen depending on the amount of extract.

Results

Five archaeological specimens representing different morphological types (2 grains – samples 78/90 (Fig. 9.5) & 16/90 – from Pit 1/90; 2 grains – sample 125/91 – from Pit 2/90 and 1 grain – sample 119/91 – from Feature 1/91), six cultivated races of *Sorghum*

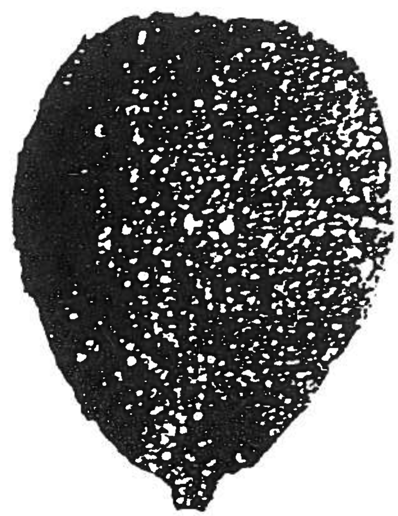

Figure 9.5 *Sorghum* grain no. 78/90 from Pit 1/90.

bicolor (race *bicolor*, race *guinea*, small-seeded; race *guinea*, large-seeded; race *caudatum*; race *kafir*, race *durra*) and four wild species (*Sorghum arundinaceum*; *Sorghum aethiopicum*; *Sorghum verticilliflorum*; *Sorghum virgatum*) were investigated by the above procedure.

Results obtained for the archaeological specimens were all very similar and the spectra strongly suggest that they all belong to the same species. Unfortunately, three of the cultivated specimens from Kew gave very poor results owing to some form of contamination (probably caused by adhesive, fungicide or something similar). Although other modern, related genera need to be investigated, there is a marked similarity in the general appearance of all the uncontaminated spectra which strongly supports a sorghum designation for the archaeological specimens. A comparison of the various spectra (Figs. 9.6, 9.7) showed no exact match but the archaeological specimens showed a nearer kinship to the cultivated specimens than to the wild ones, especially in the hexane extracts.

Conclusion

Clearly, any conclusions drawn must be considered to be highly speculative as a much more detailed study of modern species must be undertaken. With this proviso, the preliminary data support a sorghum designation for the archaeological specimens and suggest the *possibility* that the archaeological materials could reflect some cultivation. Further work is being undertaken, including more detailed analytical studies involving sophisticated chromatographic techniques of the various extracts.

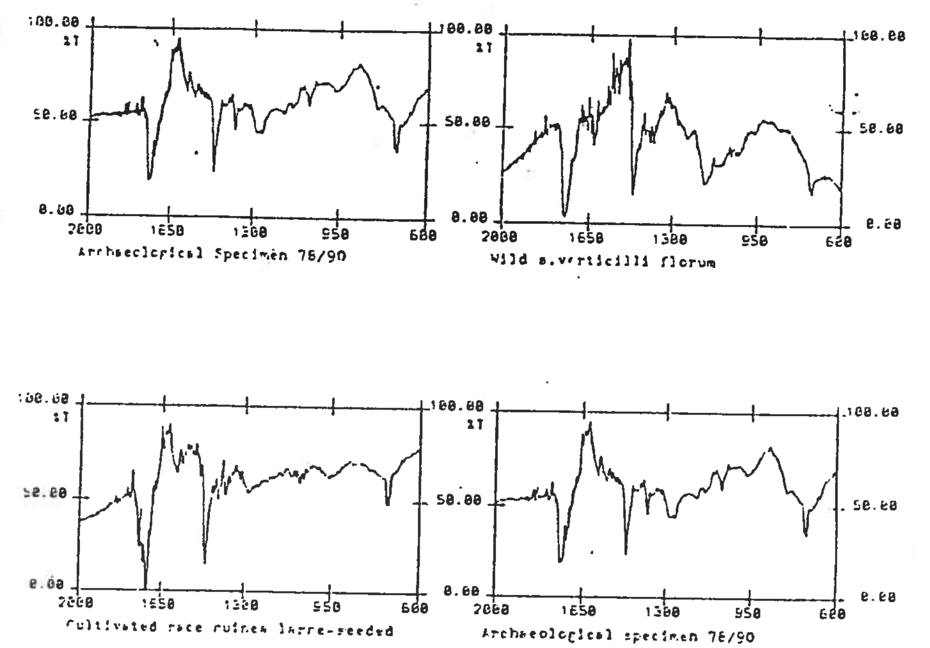

Figure 9.6 Infra-red spectra: typical of hexane extracts.

The identification of *Sorghum* sp. grains from Nabta, based on their morphology, is supported by infra-red spectroscopy. However, the question whether they represent a wild or cultivated form remains unresolved. The lipid analysis does not rule out the possibility that they were cultivated, while grain size and shape, as well as contextual evidence, suggests rather that they were wild.

Sorghum sp. grains were frequent at Nabta, occurring in *c.* 30 per cent of all samples which contained seeds and fruits, but usually in small numbers (1–6 specimens per sample). Thus far, the largest number present in one sample is about 40 specimens. *Sorghum* was found in a botanically rich context which included several other grass genera, other herbaceous plants and at least one tree species. The frequent grasses belong to *Panicum*-type, *Echinochloa*-type and *Setaria*-type, while *Digitaria*-type and *Urochloa/Brachiaria*-type occur only in a few samples. Today, several grass species from these genera are collected for food by nomads living in the Sahara (Harlan 1989). *Sorghum* was the most frequent grass type at Nabta and, since its grains are larger than those of other grasses, we may suppose that it was an important food plant. More detailed estimation of the role it played in the diet of the early neolithic people at Nabta is not possible until quantitative analyses are finished, but Site E-75-6 already gives the first evidence of the use of sorghum grains, whether gathered from the wild or already under cultivation.

Other wild food plants included *Zizyphus* sp. Fruit-stones and seeds of this tree were

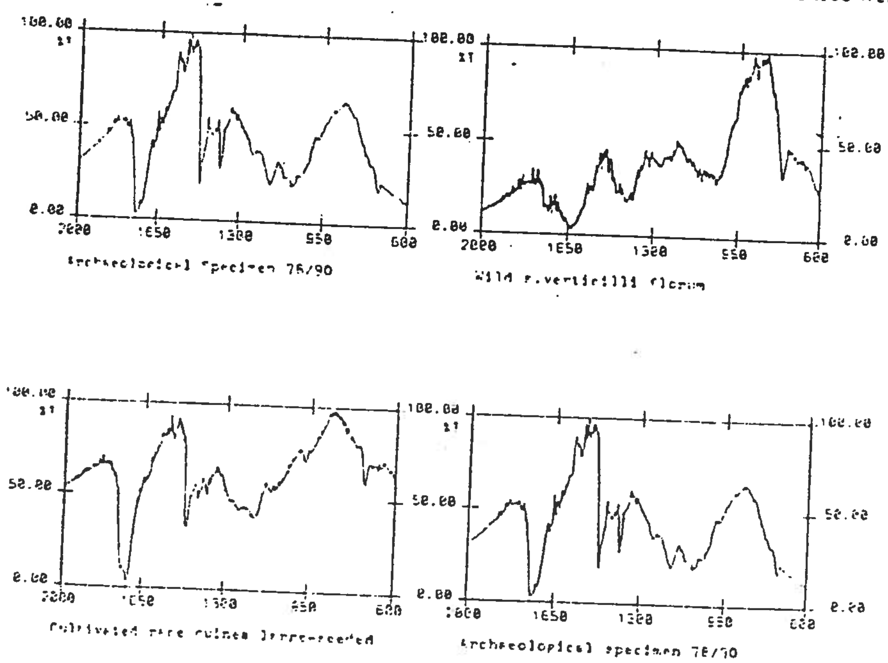

Figure 9.7 Infra-red spectra: typical of chloroform extracts.

frequent at Nabta. Tubers (undetermined) were also relatively common but were probably of less importance in the diet than they were at the late palaeolithic sites of Wadi Kubbaniya (Hillman, Madeyska & Hather 1989; Hillman 1989; Wetterstrom 1992).

Fruits of other plants are so incompletely identified that their usefulness for people is difficult to assess. If we assume that the abundance of remains may be an indication of gathering, then Leguminosae indet., Cruciferae indet. (tribe Brassicae), Cucurbitaceae indet. and Capparidaceae indet. (*Capparis*-type) could represent collected plants. The frequently occurring *Arnebia*-type fruits are inedible and are unlikely to have been gathered for food. Less frequent seeds or fruits at Nabta belong to *Cyperus/Fuirena*-type, *Scirpus/Schoenoplectus*-type, *Rumex*-type, Chenopodiaceae indet. (?) and Malvaceae indet. (?). A considerable portion of the material remains unidentified.

All plant remains were charred with the exception of *Arnebia*-type nutlets. Fruits of most members of the family Boraginaceae do not turn black on burning because of the high content of silica in the pericarp, although they sometimes turn a distinctive pale grey colour (van Zeist & Waterbolk-van Rooijen 1985). Siliceous nutlets of these plants are very resistant to decay and tend to be over-represented relative to remains of species dependent on charring for their preservation. In Nabta, the presence of two charred seeds inside uncharred pericarps indicates that they have been subjected to high temperatures and may be of the same age as the other plant remnants preserved entirely by charring.

The present study did not confirm the occurrence of cultivated barley at Nabta (el Hadidi 1980; Stemler & Falk 1980) and, with the possible exception of sorghum – on which further work is required – the whole plant assemblage points to a food economy based on wild plants, as far as the vegetal component of the diet is concerned.

Note

[1] Infra-red spectroscopy was applied by J. Evans to archaeological and present-day grains of *Sorghum* races selected by J. R. Harlan.

Acknowledgements

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