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FLORA OF THE 8000 YEARS OLD ARCHAEOLOGICAL SITE E-75-6 AT NABTA PLAYA, WESTERN DESERT, SOUTHERN EGYPT

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ABSTRACT. Early Neolithic site E-75-6 at Nabta Playa is located in the centre of a large basin east of Gebel Nabta, in the driest part of the Western Desert. The site was inhabited by hunter-gatherers about 8000 years ago. Several huts and pits discovered on the top of a fossil dune contained charred fruits, seeds, tubers, rhizomes and wood charcoal which belonged to some 127 taxa. The paper presents descriptions, photographs and drawings of taxa determined on the basis of seeds and fruits. Many species belong to plants gathered for food today in the Sahara and the Sahel and were probably collected by people living in the settlement in prehistoric times. The presence of the oldest known *Sorghum* remains is of special interest. The grains and spikelets have morphological characters of a wild race but further evidence is needed to answer the question if they represent a wild grass collected for food, or a cereal at an early stage of cultivation or domestication.

KEY WORDS: archaeobotany, charred seeds/fruits, plant gathering, sorghum, Early Neolithic, Sahara, Egypt

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INTRODUCTION

The Holocene history of the Saharan climate and vegetation has been much discussed in the literature with the emphasis put on the southward extension of Mediterranean elements, changes in the position of the southern limits of the Sahara and the living conditions of human populations within the area of the present-day desert. These discussions refer to arguments promoted in various sciences, including geology, archaeology, zoology and botany. The botanical contribution has been based mostly on information derived from the phytogeography of the modern flora and pollen analysis of sediments covering the last 10000 years (e.g. Quézel 1965, Schulz 1994a, b). Studies of plant macrofossils played a subordinate role because of the latter's fragmentary character resulting from limited preservation and difficulties of recovery. The main source of macroscopic plant remains are archaeological sites, where they are preserved in charred, desicated or mineralized condition, or as impressions in pottery or daub. The identified taxa provide direct evidence of the past flora, and allow to hypothesize about various aspects of the former natural environment, the history of cultivated and wild species and the economic significance of plants.

From the time of the early and middle Holocene, between ca. 9000 and 5000 BP, only a few detailed studies on macroscopic plant remains were done in northeast Africa. Extensive research on wood charcoals from sites in Egypt and Sudan (Barakat 1995a, b, Neumann 1989a, b) contributed to the reconstruction of paleoenvironmental conditions. Identifications of plant impressions in pottery from several locations in central Sudan revealed some evidence for the use of plants (Magid 1989, 1995, Stemler 1990). Charred remains from Nabta Playa enrich our knowledge of the flora and vegetation of some 8000 years ago in an area which today belongs to the driest part of the Sahara.

In the present paper, the main emphasis is on the identification of seeds and fruits and documentation of their morphological characters, with only a brief summary of the paleoecological and paleoeconomic implications. These last questions, as well the significance of the plant material in the whole archaeological context, are discussed at length elsewhere (Wasylikowa et al. 1997).

NATURAL ENVIRONMENT OF THE STUDY AREA

Nabta Playa lies in the Western Desert of Egypt, some 100 km west of the Nile Valley near Abu Simbel (Fig. 1). A flat area, at an elevation below 200 m a.s.l., which extends south of the escarpment of the Eocene Libyan Plateau is interrupted here and there by dunes and small mountains (gebels). One of them is Gebel Nabta, rising to 346 m a.s.l., which has given its name to a playa situated about 7 km east of it (Haynes 1980, Wendorf & Schild 1980).

At present, the area lies between the belts of winter rains to the north and summer rains to the south, and is the driest part of the Sahara, having a mean annual precipitation below 1 mm, with rare and very irregular rains and no true rainy season. Water is available only in a few springs and wells scattered in the desert (Wendorf & Schild 1980).

The vegetation of the Western Desert has been poorly investigated. The area discussed here was placed by Bornkamm and Kehl (1990) in their zone V-3, described as an extreme desert. Vegetation is limited to the immediate surroundings of wells or springs and places where run off water accumulates due to a favourable geological structure. Bornkamm (1986), who studied the modern vegetation in several small uninhabited oases west of Nabta Playa found 14 plant species in an area of ca. 20000 km^2. Trees and shrubs were represented by *Hyphaene thebaica, Acacia ehrenbergiana, Tamarix mannifera, Capparis decidua* and *Phoenix dactylifera*, grass stands by *Stipagrostis vulnerans, Phragmites australis, Sporobo-*

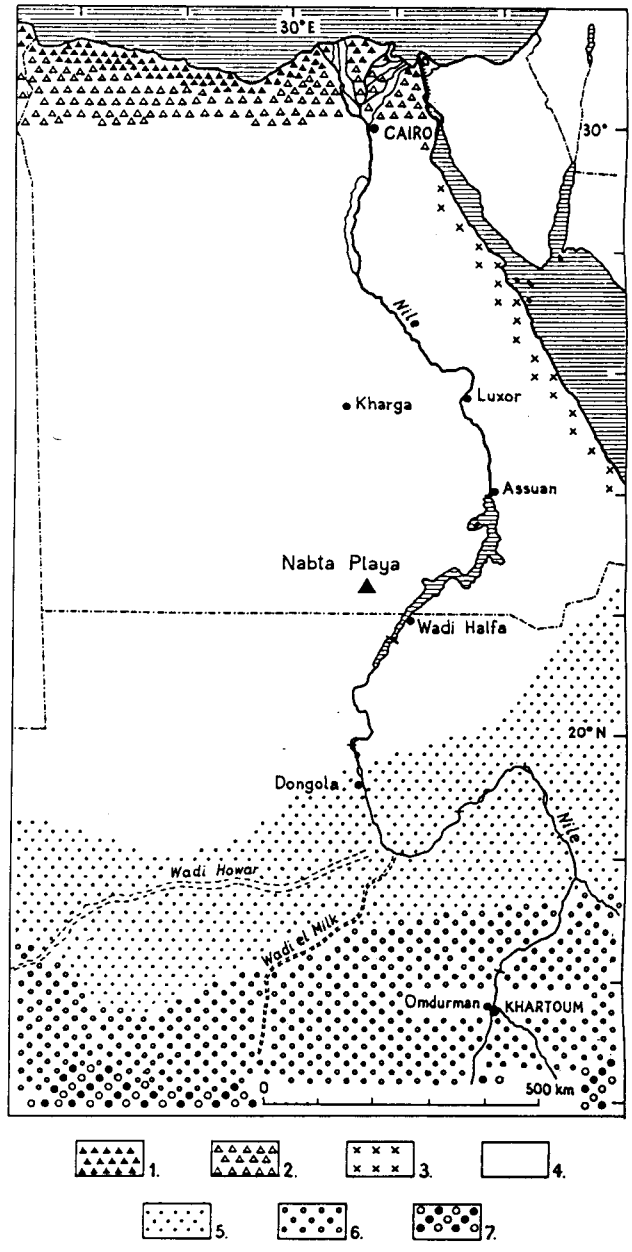

Fig. 1. Map of Egypt showing the location of Nabta Playa. **1** – sub-mediterranean vegetation changed by man; **2** – contracted desert vegetation of northern type; **3** – desert vegetation of Red Sea coast; **4** – extreme desert; **5** – contracted desert vegetation of southern type; **6** – semi-desert with *Acacia-Commiphora* scrub; **7** – thorn savanna with *Acacia mellifera* and *A. senegal* (from Neumann 1989a, simplified)

lus spicatus, Cynodon dactylon and *Imperata cylindrica* and other herbs by *Allhagi mannifera, Typha domingensis, Juncus rigidus* and *Cornulaca monacantha.* In a previous survey of this same area El Hadidi (1980) recorded also, in addition to the taxa enumerated above, *Panicum turgidum, Stipagrostis ciliata, Astragalus vogelii, Fagonia arabica, F. indica, Tribulus pentandrus, Euphorbia granulata, Citrullus colocynthis, Aerva persica, Crotalaria thebaica, Salsola baryosma* and *Francoeuria crispa. Sorghum sudanense*, collected at Bir Kiseiba in 1978 by Mehringer, had, in his opinion, been introduced along the camel route. A dead specimen of *Salsola baryosma*, recorded by El Hadidi on the pan of Nabta Playa, had probably started to grow around 1960–61 (estimation based on C-14 content). In 1990, a living specimen of *Zygophyllum coccineum* L., with green leaves and flowers, was seen by the present author in the playa half way between the sites E-75-6 and E-75-8 (in 1993 the shrub had already withered). Not far from site E-75-6, a stand of withered plants of *Astragalus vogelii* (Webb) Bornm. existed in 1990–91–92, other dried out plants recorded in 1992 were *Fagonia indica* Burm. and *Tribulus longipetalus* Viv. ssp. *macropterus* (Boiss.) Maire.

Geological evidence from the region around Gebel Nabta shows that more favourable environmental conditions existed in this area in the early and middle Holocene (ca. 10000-5000 BP). This evidence includes, i.a. lacustrine sediments present in several places (sand and clay), casts of plant roots suggesting deposition of eolian sand in depressions or marshes overgrown by plants, terraces and beaches indicating former lake levels, and fossil wadis (Haynes 1980). The most complete evidence of environmental fluctuations comes from the deposits of several enclosed drainage basins (playas) in this area. It shows three stages of increased rainfall ca. ?11000–8200 BP (playa I), 8100–7900 BP (playa II) and 7700–4600 BP (playa III), separated by two short hyperarid intervals ca. 8200–8100 BP and 7900–7700 BP. (Wendorf & Schild 1980, Wendorf et al. 1991). The majority of plants described in this paper come from the playa II episode, a small portion is connected with the playa III.

THE SITE E-75-6

SITE LOCATION AND ARCHAEOLOGICAL SETTING

The Nabta Playa basin is about 10 km long and 7 km broad. The size of the basin cannot be determined accurately because its shores are covered with slope wash and eolian sand. It is filled with clay, silt and sand deposits. Evidence of the inundation of fossil sand dunes is provided by remnants of lacustrine playa sediments found on top of one fossil dune, ca. 3 m above the present playa floor. Test borings have shown a clay thickness of up to 2 m (Haynes 1980, p. 362). During 20 years of study several archaeological sites have been discovered within the playa. All of them contained abundant charred wood but charred seeds and fruits were rarely found and only at site E-75-6 occurred in large numbers.

The site E-75-6 is situated in the southwest sector of the basin, near its centre (Fig. 2). It lies on top of a fossil dune and is partly covered with lacustrine silts (Wendorf & Schild 1980). Three Neolithic levels were found there. The Lower Level of El-Kortein type has been dated by one ^{14}C measurement to 8270±80 BP (SMU-257). The age of the Middle Level of El-Nabta is ca. 8000 BP on the basis of 11 accelerator dates on individual seeds. The Lower and Middle Levels are stratigraphically separated by a thin bed of sand and silt, which contains freshwater molluscs and land snails and represents the shallow water sediment of an expanding lake. The Upper Level, which cuts through the Middle Level, is associated with ^{14}C dates between 7600 (Gd-6503) and 7330 (Gd-6510) BP and relates to the early Middle Neolithic of the Western Desert.

The list of AMS radiocarbon dates, presented below, contains name of plant remain dated, feature number, context type, number of botanical sample and its position within the excavation grid (Wasylikowa et al. 1993, Wendorf et al. 1992, R. A. Housley pers. comm.).

8080±110 BP OxA-3214, *Schouwia purpurea* seeds, hut F 1/90, hearth, 37/90, W/14

8095±120 BP OxA-3215, Trifolieae seeds, hut F 1/90, hearth, 51/90, W/14

8020±160 BP OxA-3217, *Sorghum* grains, hut F 1/90, hearth, 53/90, Y/16–17

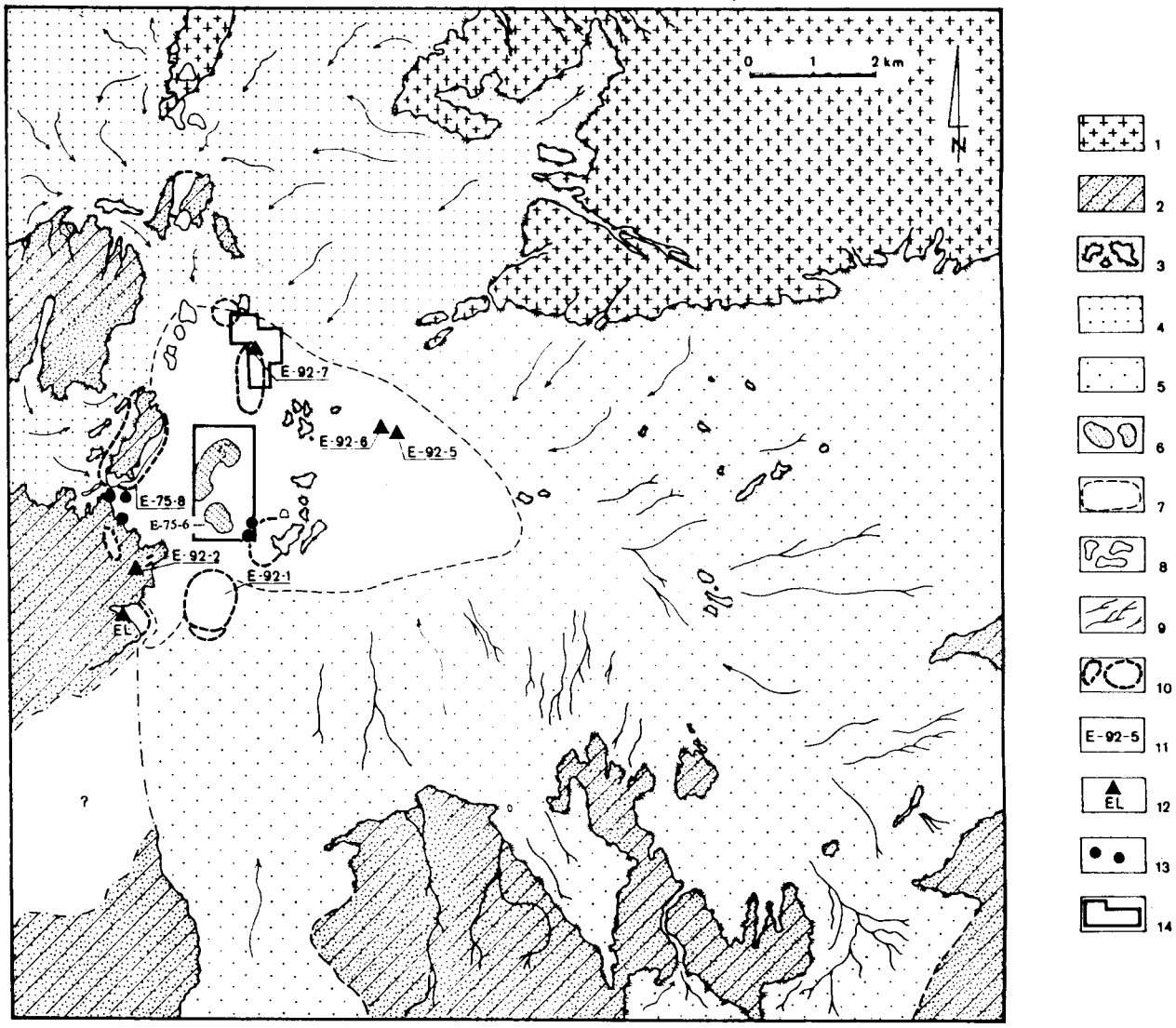

Fig. 2. Geomorphological map of Nabta Basin based on air photographs. **1** – basement rocks; **2** – sandstones and shales; **3** – sandstone hills; **4** – gravelly alluvia grading into fine-grained alluvia; **5** – fine-grained alluvia; **6** – fossil phytogenic dunes; **7** – silts and clays; **8** – recent dunes; **9** – shallow wadi channels; **10** – Neolithic archaeology on surface; **11** – archaeological sites; **12** – elephant site; **13** – megalithic tumuli; **14** – location of detailed maps (map by Schild from Wasylikowa et al. 1995)

8050±130 BP OxA-3218, *Ziziphus* sp. fruit-stones, hut F 1/90, hearth, 58/90, W/13

7960±100 BP OxA-3216, *Sorghum* grains, hut F 1/91, house fill, 119/91, GG/20–21

7980±110 BP OxA-3221, *Sorghum* grains, hut F 1/91, hearth, 110/91, HH/20

7950±160 BP OxA-3219, *Sorghum* grains, hut F 3/90, hearth, 40/90, BB/17

8060±120 BP OxA-3222, *Sorghum* grains, hut F 2/90, hearth, 82/90, BB/12

7950±90 BP OxA-3484, *Panicum turgidum* grains, hut F 2/90, hearth, 90/90, BB/12

8025±120 BP OxA-3220, *Ziziphus* sp. fruit-stones, pit P 1/90, 79/90, X-Y/12

7980±95 BP OxA-3485, *Ziziphus* sp. fruit-stones, pit P 75/5, 2/90, BB/10

For the same features, as well as for some others which contained plant diaspores, several dates based on wood charcoal are available (SMU dates from Haas & Haynes 1980, Gd dates acc. to Schild et al. 1996).

8550±130 BP Gd-6254, hut F 1/90, hearth, Y/16

7830±110 BP Gd-6498, hut F 1/90, hearth, X/15

7770±110 BP Gd-6257, hut F 1/90, hearth, W/13

7920±100 BP Gd-6258, hut F 2/90, hearth, BB/12

7910±110 BP Gd-6500, hut F 2/90, branch

8600±140 BP Gd-4587, hut F 3/90, hearth, BB/17

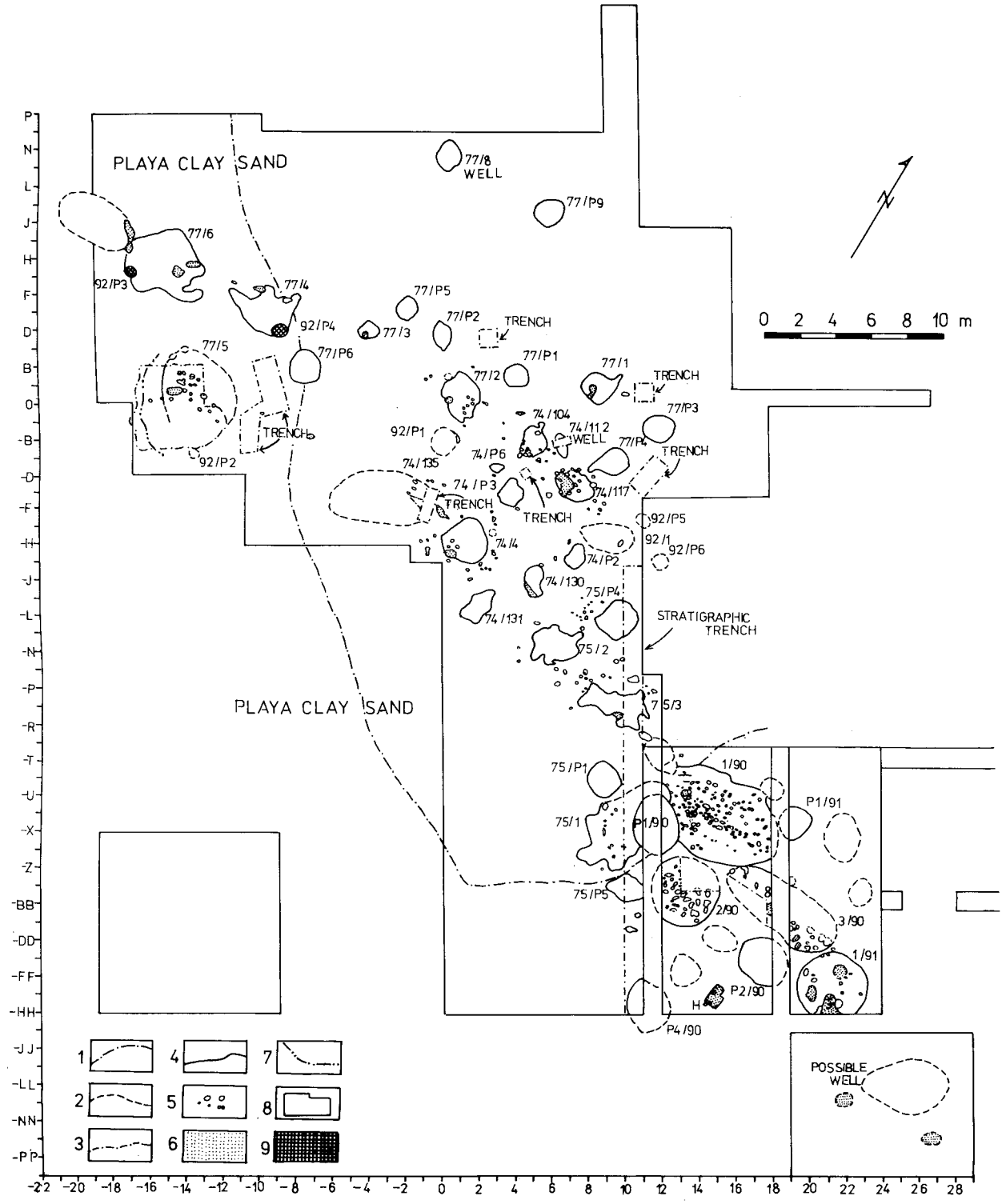

Fig. 3. Map of major cuts and trenches at site E-75-6. **1** – contact of playa silt and dune sand; **2** – unexcavated edges of huts and pits; **3** – additionally excavated areas within cuts; **4** – excavated edges of huts and pits; **5** – pot-hole/posthole; **6** – hearth/burned areas; **7** – edge of upper hut at Feature 77/5; **8** – cuts and trenches; **9** – excavated bell-shaped pit (map by Schild from Wasylikowa et al. 1995)

7590±110 BP Gd-6503, hut F3/90, hearth, DD/19

8280±70 BP Gd-5971, hut F 1/91, around cooking depressions, HH/20–21

7850±70 BP Gd-6506, hut F 1/91, younger hearth, GG-HH/22

7610±120 BP Gd-6507, hut F 1/91, layer with charcoal 3–5 cm above floor, NWQ

7710±70 BP SMU-191, hut F 74/117
8120±100 BP SMU-199, hut F 74/117
8260±100 BP Gd-6260, pit P 1/90, X/12
7450±120 BP Gd-4586, pit P 75/5, BB/10
7480±110 BP Gd-6509, pit P 2/90
7330±100 BP Gd-6510, pit P 1/91

In a few cases the datings of wood charcoal and seeds from the same features gave different ages. AMS dates probably give better age estimates but there are a few exceptions. According to Schild (pers. com.) pit P 75/5 is stratigraphically younger than the other features, thus the date 7450 (Gd-4586) based on wood probably indicates correct age, while the AMS date 7980 (OxA-3485) shows the intrusion of older *Ziziphus* stones to a younger feature. On the other hand, the two older dates from huts F 1/90 (8550 Gd-6254) and F 3/90 (8600 Gd-4587) may suggest the burning of old wood.

The majority of seeds and fruits were associated with features of the Middle Level, except for pits P 2/90, P 1/91 and P 75/5, which belonged to the Upper Level.

The Middle Level at site E-75-6 contained several basin-floors of huts, hearths, storage pits and walk-in wells. They were arranged in two or three rows (Fig. 3) suggesting the existence of "a relatively large and disciplined community" and prolonged habitation with houses and storage pits located above groundwater level throughout the period of their use (Wendorf & Schild 1980, p. 269). The site was probably inhabited in the autumn and winter, and abandoned before the advent of summer rains which flooded the basin each year (Wendorf & Schild 1995–1996, Wendorf et al. in print).

SAMPLING

The first botanical samples were collected during the field seasons 1974, 1975 and 1977. Wood charcoals were the only plant remnants associated with the archaeological assemblages, and information about the presence of other plants appeared to be incorrect (see below).

Excavations undertaken on the same site in 1990–92 in order to find more plant material met with full success. Four huts and several pits in the eastern part of the site (Fig. 3) were excavated with great accuracy and fairly rich vegetal material was recovered. Samples for archaeobotanical studies were precisely located within the excavation grid and their lithology and affiliation with the type of archaeological context were recorded. The following types of context were distinguished: hearths, pot-holes, post-holes, the fill of huts divided into a lower level (hereafter called house fill) and an upper level (hereafter called house fill top), and the fill of pits. Pot-holes are small basins, 7–30 cm in diameter, in which containers with food were placed for cooking in hot ashes (for profiles of pot-holes see Wendorf & Schild 1980 p. 134). A few huts and pits, studied in the 70s, were re-excavated in 1992 and samples were collected from the remaining deposit (for more details on sampling see Wasylikowa et al. 1995).

In 1990, two types of samples were collected, bulk soil samples untreated in the field and samples sieved at the excavation in coarse mesh sieves (4.5 mm and 2–3 mm mesh) used in routine archaeological exploration. Both categories were examined in the field laboratory organized in a tent. Only dry sieving was possible because charred diaspores disintegrated in water. After the volumes of the bulk soil samples had been measured, they were sieved through 1.0 or 0.5 mm mesh sieves and the fraction retained in the sieves was searched for plant remains with the aid of a lens (× 4). Occasionally, the fraction which went through the sieve was checked and was found to contain a few small seeds of the same types as those which were retained in the sieve.

The samples sieved at the excavation contained mostly charcoal with a very small number of large specimens like tubers and *Ziziphus* fruit-stones. During subsequent field seasons these samples were not examined for plant remains. In a few instances, individual large fruits recognized by the excavators in the field were sampled separately. Samples sieved at the excavation, fruits picked up in the field and a few other samples for which position or volume were not recorded, were called additional samples, and were not included in quantitative analyses.

In total, ca. 460 samples were collected for botanical examination; 439 were analyzed, including 371 bulk soil samples and 48 additional samples. The total volume of deposit searched for diaspores was ca. 355.90 l, the volume of individual samples ranging from 0.05 to 4.30 l.

TAPHONOMY

All plant remains were charred and came from definite archaeological contexts. Most plants must have been brought to the settlement by man as purposeful harvests containing some accidental admixtures. Their transportation to the features by natural agents seems unlikely, and if indeed it did occur, must have been, quantitatively, insignificant. People were collecting plants in abundance mainly for food and fuel; other uses (medicinal, magic) required much smaller quantities. Animal dung could be a source of seeds or fruits but there are no indications of dung being used for fuel.

The charring of plant material probably occurred near hearths (not in open fires) and pot-holes, because there are no indications of conflagrations which would have destroyed houses and pits. Seeds and fruits show damage caused by high temperatures but they do not stick to each other. This could suggest that they had been spilled around the hearths and pot-holes during the preparation of food but were not remnants of actual dishes ready for consumption. Plant fragments, charred near fires, were then scattered over the whole house floor both while the house was still inhabited and later, when it had been abandoned. The state of preservation of diaspores, estimated by the visual inspection, seems to be similar in all samples. Chemical analyses of *Sorghum* grains, recently performed by Biel (in print), have revealed, however, higher degree of carbonization of specimens from hut F 1/90 than in hut F 77/5. Such a difference could be caused by different charring conditions, for instance prolonged exposure to higher temperatures in hut F 1/90 compared to F 77/5, but also by a considerable difference of age of both huts. Because no radiocarbon dates are available from hut F 77/5 the elucidation of this question must be postponed until seeds from this hut are dated by the AMS method.

PREVIOUS ARCHAEOBOTANICAL STUDIES AT SITE E-75-6

Archaeobotanical studies at site E-75-6 were initiated by El Hadidi (1980). In the Lower Level, then described as the Terminal Palaeolithic and dated to about 9360–8580 BP, the following plants were found: pieces of *Salsola baryosma* (Schult.)Dandy, empty glumes of *Phragmites australis* (Cav.)Trin. ex Steud. (El Hadidi 1980, Fig. A5.1d), and numerous fibrous grass roots. The Neolithic horizon, which is re-examined now, contained: "numerous fragments of *Tamarix* branchlets; fibrous roots of grass; reticulated vascular strands of a palm; numerous wood fragments of *Acacia ehrenbergiana*; bark and wood fragments of *Salsola baryosma* (Schult.) Dandy; a fragment of the pericarp of *Hyphaene thebaica* (L.) Mart. (dom palm); a fragment of a fruit of a *Medicago* sp. (an annual weed); and two wèll preserved grains of barley (Figure A5.2c, d)" (El Hadidi 1980, pp. 346–7).

From site E-75-8 at Nabta Playa, about 3 km west of site E-75-6, El Hadidi (1980, pp. 347–8) has also described "few spikelets of a small-sized variety of barley" (El Hadidi 1980, Fig. A5.2a, b) in the Lower Level and larger and broader barley spikelets in the Upper Level (the specimen illustrated on Fig. A5. 2a does not belong to barley but to wheat). Other plants reported by him from the same site were: "extensive fibrous roots of a grass" (l.c., fig. A5.1b), *Calendula* sp. fruit (l.c., fig. A5.1e), *Tribulus pentandrus* Forssk. mericarps (l.c., fig. A5.1a) and seed of a *Phoenix dactylifera* prototype (l.c., fig. A5.3). Tentative identification of one piece of *Sorghum* rachis, cited by Wendorf and Hassan (1980 p. 417) from El Hadidi's manuscript and Clark (1980 p. 566), was later verified and the specimen was described as rachis of a grass "closely allied to *Phragmites*" (El Hadidi 1980, p. 347).

Both sites E-75-6 and E-75-8 were extensively sampled in 1990–92 with special attention being paid to all plant remains other than charred wood and particularly to those resembling barley and wheat. In 31 samples from E-75-8 only charcoals were found and one charred fruit of *Heliotropium* sp.; at E-75-6 various seeds and fruits were very abundant, but barley and wheat were not found. The present author is convinced that these cereals did not belong to the seed assemblage contemporaneous with the Middle Level Neolithic site at Nabta Playa (Wendorf et al. 1991, Wasylikowa et al. 1995).

Some other plant determinations also seem doubtful. The evidently uncharred specimen described as "empty glume of *Phragmites australis*" (El Hadidi 1980, p. 346, Fig. A5.1d) must be recent fruit of *Astragalus* and does not belong to the archaeological context. Dead *Astragalus* plants occur on the playa not far

from the site and their fruits, very numerous in the sand below every shrublet, can easily contaminate archaeological layers. No opinion can be expressed about other specimens for which no information is given by El Hadidi on the state of their preservation.

IDENTIFICATION PROCEDURES

Identification of taxa is based on comparison with fruits and seeds of extant plants, supplemented by descriptions given in publications dealing with modern African flora. Determination accuracy varies from that of a species, genus or family, to the separation of only a distinctive morphological type, without indicating its taxonomic status. Even when botanical names are ascribed to remains, the determinations may differ in their reliability and these differences are indicated as follows.

Species name with no additional comments indicates the most precise identification, based on morphological resemblance combined with modern geographical distribution. The indication of a genus or family name only (or a tribe within a family) means that a fossil may belong to several species of that genus or several genera of that family (or of another taxonomic unit). The abbreviation "cf." placed before the specific or generic name indicates that species or genus identification is not certain, but the fossil is very close to either of the two. In such a case usually the other related species or genera were seen. The qualification "type" following plant name means that the remains are similar to a taxonomic unit indicated but the other possibilities were not checked. The qualification "cf." indicates more reliable identification than "type". It is unavoidable that the estimation of identification accuracy, in several cases, is biased the author's personal experience.

Undetermined seeds or fruits having distinct morphological characters were described under the nickname NP (for Nabta Playa) followed by numerals. They were consistently recognized in all samples and counted. Besides, some unknown seeds or fruits are illustrated, which either occurred only once or had no distinct characteristics, so that their consistent recognition in all samples was not possible. They were not taken into consideration in quantitative interpretation.

The estimation of identification reliability is important for the interpretation of plant material particularly in terms of paleoecological reconstructions because usually only the species (sometimes also genera, seldom higher taxonomic units) provide the most useful evidence of the past environments. In view of difficulties to precisely identify several diaspores it seemed justified to separate and quantify morphological seed types in order to get an idea about the diversity of the ancient flora. The separation of various plant types, particularly of grasses, sedges and legumes, may be of some significance for the understanding of plant use by people, even if botanical names remain unknown.

Each taxon is described according to the following scheme. Three paragraphs deal with the subfossil material. Number of specimens gives the number of seeds or fruits and a general indication of their frequency. Number of specimens refers only to those recovered from bulk soil samples, unless otherwise stated. Description of fossils presents morphological characteristics of charred specimens and their dimensions. Average, maximum and minimum size is given if 10 or more specimens were measured, in other cases size of individual specimens is recorded. Discussion gives criteria used for the identification of a given taxon. The two consecutive paragraphs contain information based on modern flora, namely the distribution and ecology as well as present-day use of identified species or allied taxa. Taxa are grouped by families, which are arranged in alphabetical order.

Drawings and photographs were performed by the author, unless otherwise stated. Plant names follow "Flora of Egypt Checklist" (Boulos 1995), except for *Sorghum*.

Reference material of fruits and seeds included the following collections:

- Carpological collection of the Department of Palaeobotany, W. Szafer Institute of Botany, Polish Academy of Sciences, Kraków
- Kew Gardens Herbarium, particularly the grass section and Snowden's collection of *Sorghum*, Kew
- British Museum Herbarium, London
- African Herbarium of J. & A. Kornaś (grasses and sedges), Institute of Botany, Jagiellonian University, Kraków
- African Herbarium of S. Lisowski (*Sorghum*), Institute of Geobotany, A. Mickiewicz University, Poznań

– Collection of seeds and fruits from west Africa offered by K. Neumann, Johann Wolfgang Goethe-Universität, Frankfurt am Main

– Sorghum Collection from Tropical Agriculture Research Station in Mayagüez, United States Department of Agriculture, provided by J. Dahlberg, Mayagüez

– Herbarium of the W. Szafer Institute of Botany, Polish Academy of Sciences, Kraków

– Herbarium of the Institute of Botany, Jagiellonian University, Kraków

SYSTEMATIC DESCRIPTION OF THE FLORA

BORAGINACEAE

cf. ***Arnebia hispidissima*** (Lehm.) DC.
(Previousely described as Boraginaceae or *Arnebia* type)
Pl. 1 figs 1–7

Number of specimens. Fairly common type, 630 fruits and 35 seeds in most of the excavated units. The majority of fruits are crushed, total number of fruits in each sample includes complete specimens and fragments preserved with undamaged upper or lower end.

Description. Nutlet shape typical for the family, large attachement scar, pointed opposite end, longitudinal edge along the concave side. The attachement scar narrower than the maximum nutlet breadth. Surface tuberculate, in several specimens outer layer damaged. The nutlets are uncharred, usually light yellow, seldom grey or dark grey, all colours may be found in the same sample. The seeds are black, charred, with a smooth surface. In a few cases seeds were still placed inside fruits (Plate I fig. 7). Size of 10 fruits: length 2.15 (1.9–2.25) mm, breadth 1.6 (1.4–1.7) mm; size of 10 seeds: length 1.21 (0.9–1.6) mm, breadth 0.88 (0.65–1.1) mm.

Discussion. Fruits of Boraginaceae family are often found in uncharred condition because their pericarps contain silica and on burning turn whitish to yellowish-grey (Zeist van & Waterbolk-van Rooijen 1985). This fact makes difficult the recognition of younger intrusions. At Nabta Playa, the presence of fruits containing charred seeds indicates that the fruits were in contact with high temperature and are of the same age as other fossils (for discussion see Zeist van & Bakker-Heeres 1982/1985, 1984/1986). Being resistant to decay, Boraginaceae fruits may be over-represented in fossil material. Four *Arnebia* species occur in Egypt today (Täckholm 1974, Boulos 1995): *Arnebia hispidissima* (Lehm.) DC, *A. tinctoria* Forssk., *A. decumbens* (Vent.) Coss. & Kralik and *A. linearifolia* A. DC. In Sudan the genus is represented only by *A. hispidissima*, common in the central and northern parts of the country (Andrews 1956). On the basis of the fruit length given in literature (Qaiser 1979) *A. linearifolia* (3.5–5 mm) and *A. tinctoria* (ca. 1 mm) were exluded. *A. decumbens* having fruitlets of similar size to the ancient specimens (2–2.5 mm) was not seen but its attachement scar is broader compared to the fruitlet breadth (Qaiser 1979 p. 69, Zeist van & Bakker-Heeres 1982/1985 p. 211). Subfossil specimens strongly resemble extant *A. hispidissima* but the identification is not quite certain because of a too small modern material available for reference.

Distribution and ecology. *Arnebia hispidissima,* herbaceous desert annual, does not occur in the Western Desert at present and is not included in the flora of the Sahara by Ozenda (1983). According to Boulos (pers. com.) it is rather wide-spread in the southern part of the Eastern Desert, Gebel Elba and Sinai, where it grows in sandy plains and wadis.

Present-day use. The only information about useful properties of that species concerns the extraction of red or purple dye from the roots (Dalziel 1955).

cf. ***Heliotropium*** sp.
Pl. 3 figs 1–3

Number of specimens. 6 nutlets in four samples from huts F 1/90 and F 2/90.

Description. Nutlet outline obovate, dorsal side convex, ventral one ± flat, with an attachement point on a protruding stalk. Surface of both sides covered with a very characteristic sculpture in the form of short, irregular, elongated wrinkles. A narrow but distinct wing runs around the dorsal side (Fig. 4: 1–2). One specimen differs slightly from the rest by having a roof-like convex ventral side and a less pronounced sculpture. Size: 1.8 × 1.2, 1.85 × 1.3, 1.75 × 1.3, 2.1 × 1.5 and 2.05 × 1.5 mm.

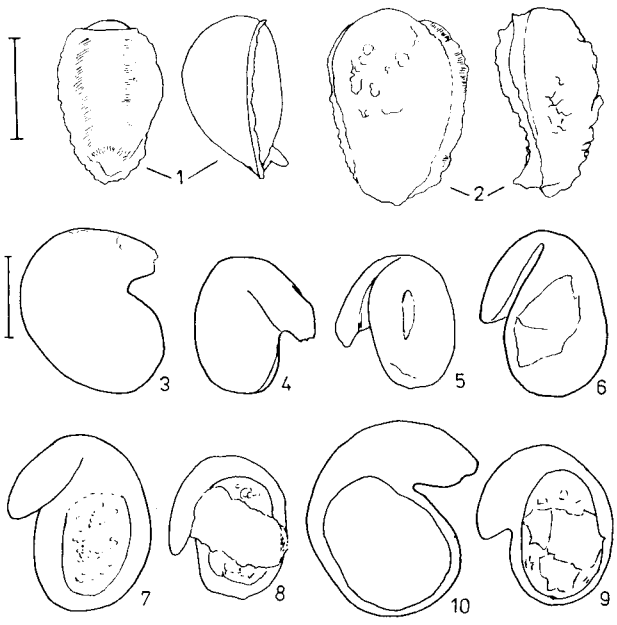

Fig. 4. 1–2 – two fruits of cf. *Heliotropium* sp. from one sample in hut F 1/90, 1 – from the ventral and lateral side, 2 – from the dorsal and lateral side; note the attachement point on a protruding stalk. **3–9** – seeds of *Capparis* sp. from hut F 1/90, 4–5 – one cotyledon from the outer (4) and inner (5) side, 7–9 – "central fields" with spongy tissue. **10** – extant seed of *Capparis spinosa* L.; all *Capparis* seeds without testa. Scale bars equal 1 mm

Discussion. The present-day flora of Egypt includes 17 species (Boulos 1995), only two of them, *Heliotropium lasiocarpum* Fisch. & C. A. Mey (*H. europaeum* L. var. *tenuiflorum* (Guss.) Boiss.) and *H. supinum* L. were available for examination. The specimens from Nabta Playa resemble the fruitlets of the first mentioned species but, except for one specimen, are a little more flat. Fruits of *H. supinum are* much bigger. Generic identification seems reliable, the presence of two species is possible.

Distribution and ecology. Several *Heliotropium* species, frutescent, perennial and annual, are common in the deserts of Egypt (Täckholm 1974).

Present-day use. *Heliotropium baccíferum* has medicinal properties (Boulos 1983).

CAPPARACEAE

Capparis sp.
Pl. 2

Number of specimens. A fairly abundant type represented by 295 seeds recovered from most of huts and pits. Because of identification difficulties, caused by fragmentation of seeds, the specimen number may be underestimated.

Description. Seeds reniform, laterally flattened, radicle curved. Seedcoat damaged to various degree, sometimes completely absent (Fig. 4). The most complete specimens have convex lateral sides (cross section broad oval) and ± smooth surface. When the outer testa layer is removed the lateral sides become flat and show the oval "central field" covered with a spongy tissue (Fig. 4: 7–9). At low magnification (× 60) the surface below this tissue appears smooth. Subfossil seeds tend to split into two cotyledons, the feature that has not been observed in modern seeds. No detailed anatomical studies were done. The size of 10 subfossil seeds without testa: length 2.27 (2.0–2.5) mm, breadth 1.92 (1.65–2.10) mm; the original size of complete seeds must have been slightly bigger.

Discussion. The available reference material consisted of two samples of *C. spinosa* L. very different in seed size. Sample labeled *Capparis spinosa* L., from the Botanical Garden in Tashkent, had much bigger seeds, size of 10 uncharred specimens with testa was 3.37 (3.10–3.90) mm × 2.75 (2.4–3.3) mm. Sample of unknown origin, labeled *C. aegyptia* Lam., had much smaller seeds, the size of 5 specimens was 2.46 (2.3–2.6) × 2.08 (2.0–2.3) mm. Scanty information about seed size in literature gives the range of 6–12 × 5–7 mm for the genus (Corner 1976) and 2–5 mm in diameter for *Capparis decidua* (Forssk.) Edgew. (Jafri 1977a). Genus identification is reliable (the suggestion of G. Hillman is acknowledged), species determination not possible.

Distribution and ecology. Modern flora of Egypt includes 3 species of *Capparis* (Boulos 1995) with several varieties treated as separate species by Täckholm (1974). *C. decidua* (Forsk.) Edgew., shrub or a small tree, grows in different scrub communities of the Western and Eastern Deserts, in the Nile valley, in oases and the Red Sea coast (Täckholm 1974, Zahran & Willis 1992). It is widely distributed in Sudan with the exception of the most southern parts (Andrews 1950). Its general distribution includes north and tropical Africa, Arabia, east to India (Jafri 1977a). *C. spinosa* L. var. *aegyptia* (Lam.) Boiss. is a shrub common in all deserts of Egypt, on rocky ground, steep cliffs and sands. General dis-

tribution includes Mediterranean Europe and north and central Africa (Ozenda 1983). The third species, a shrub *C. sinaica* Veill. (*C. cartilaginea* Decne), grows on rocky ground in the Eastern Desert, Red Sea coast and Sinai Peninsula (Täckholm 1974, Boulos 1995). It occurs in northern Sudan (Andrews 1950, I:39).

C. decidua is the most probable species to have occurred in the samples from Nabta Playa (L. Boulos pers. comm.). Charcoal of this species was identified from the site by Barakat (1995a, b).

Present-day use. Fruits of various *Capparis* species are gathered in Africa for food (Knapp 1973) and are eaten with no preparations or only after the slightly bitter skin is removed (Täckholm 1974). In Sudan fruits of *C. decidua* are collected from the shrubs or from the soil for immediate consumption, but not for storage; gathering period lasts from November to March/April (Magid 1989). Young fruits and flower buds of *C. decidua* and *C. spinosa* L. subsp. *orientalis* (Duh.) Jafri are used as condiment (capers) (Jafri 1977a). Schulz and Adamou (1992) report the extraction of salt from twigs and leaves of *C. decidua* in Northern Niger. Several medicinal properties of *C. decidua* and *C. spinosa* are listed by Boulos (1983).

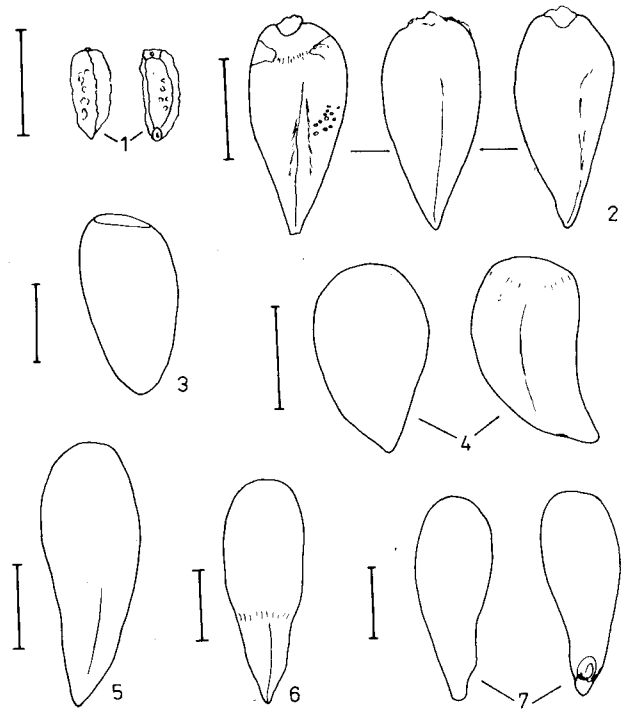

Fig. 5. Different types of Compositae fruits. **1** – one fruit of A type; **2–4** – three fruits of B type, 2 – one fruit from the concave, convex and lateral side; **5–7** – three fruits of C type; 7 – one fruit from two sides. 1–4 and 6–7 hut F 1/90; 5 hut F 2/90. Scale bars equal 1 mm

Compositae A type

Pl. 1 figs 8–9

Number of specimens. One fruit in hut F 1/90.

Description. Small fruit, pericarp has distinct four longitudinal ribs, a small attachement point at the base and style base at the apex surrounded by a low rim (Fig. 5: 1). The surface is covered with small shallow pits. Size: 0.9 × 0.3 mm.

Compositae B type

Pl. 1 fig. 10

Number of specimens. 18 fruits in 6 huts and 2 pits.

Description. Fruits narrow oval, almost circular or indistinctly triangular in the cross section, truncated at the apex, narrowed at the other end. A few are bent, with the edge on the incurved side (Fig. 5: 2–4). Pericarp of one specimen has delicate papillae, the surface of the others is damaged or smooth, probably the outer pericarp layer is missing. Fruits may belong to more than one species. Size of 17 fruits: length 2.26 (1.50–2.90) mm, breadth 1.06 (0.75–1.30) mm.

Compositae C type

Pl. 1 fig. 11

Number of specimens. 9 fruits in 4 huts.

Description. Fruits oblong, gradually narrowed toward the lower end with a small incision at its tip (attachment point), rounded at the apex (Fig. 5: 5–7). They differ from the B type by a bigger size and a greater length/breadth ratio. Size: 3.2 × 1.1, 2.9 × 1.1, 3.2 × 1.2, 3.3 × 1.4, 3.1 × 1.3, 2.4 × 0.95, 3.1 × 1.3, 2.9 × 1.1 and 3.1 × 1.25 mm.

Present-day use of Compositae. Leaves, flower receptacles and rhizomes of several species of this family are gathered and eaten as vegetables in different parts of the world, several species are used as medicines (Boulos 1983). Gathering of mature fruits for food is also reported in literature (Hillman et al. 1989b). The possibility of fruit consumption was suggested for the Late Palaeolithic site at Wadi Kubbaniya where achenes, resembling a species of the tribe Anthemideae, were found embedded in human feces (Hillman et al.

1989b). The fruits from Nabta Playa are different from those from Wadi Kubbaniya. Their use by people remains a possibility but they may also represent an accidental admixture.

CRUCIFERAE

Schouwia purpurea (Forssk.) Schweinf.
(Previousely described as Cruciferae indet.)
Pl. 3 figs 4–10

Number of specimens. The most abundant and one of the most frequent species; over 7588 seeds were found in almost all huts and pits.

Description. Seeds spherical with a conduplicate arrangement of cotyledons. Most specimens have no testa; if preserved, testa is covered with cracks caused by charring. Testa surface smooth, no cell pattern can be seen under the low power microscope. Few specimens preserved with a hilum. Seed shape and size, testa surface and thickness are very similar to modern seeds of *Schouwia*. Diameter of 10 seeds: 1.4 (1.3–1.6) mm.

Discussion. Seeds with a conduplicate embryo appear in species from the tribe Brassiceae. Seeds resembling specimens from Nabta Playa are found also in the genus *Brassica,* but testa in *Brassica* has a distinctly reticulate cell pattern on the surface. Identification reliable.

Distribution and ecology. *Schouwia purpurea* is an annual herb, up to 1 m tall (Jafri 1977b). Boulos (pers. com.) states that "*Schouwia purpurea* is a very common and widespread species in the southern deserts of Egypt, especially east of the Nile. As an annual it would grow in desert depressions or water catchements, or around a water basin. During good rainy seasons the growth of this species is remarkable and it occupies a substantial part of the vegetation". According to Ozenda (1983) the plant is common in the central Sahara as one of the dominant species of the acheb flora. In northern Niger, in winter, it makes extensive stands on submerged clayey-sandy substrate (Schulz & Adamou 1992).

Present-day use. *Schouwia purpurea* has palatable leaves used in human nutrition (Ozenda 1983). They are collected before the flowering (Gast 1968). In Libya (Jafri 1977b) and in northern Niger it makes a good fodder for camels and cattle (Schulz & Adamou 1992). The plant probably is consumed as a pot herb by man (Boulos pers. com.). Tar used by the Zaghawa to cure animals and men is possibly made from seeds of this plant (Tubiana & Tubiana 1977, footnote 15). Gast (1968) describes from the Hoggar the gatherings of people with their camels to use rich pastures covered with high growing *Schouwia* stands after heavy rain. It is said that *Schouwia* enhances milk production by female camels, and drinking this milk by people may substitute for drinking water (Bernus 1992–93).

CUCURBITACEAE

Cucurbitaceae indet.
Pl. 3 figs 11–14, Pl. 4 figs 1–4

Number of specimens. 21 complete seeds, 6 seeds with no testa and abundant small testa fragments in 6 huts and 2 pits. Many samples contained only small testa pieces which were counted as one or two seeds.

Description. The flattened seeds are narrow to broad oval or ovate in outline, slightly pointed at the micropylar end and truncated

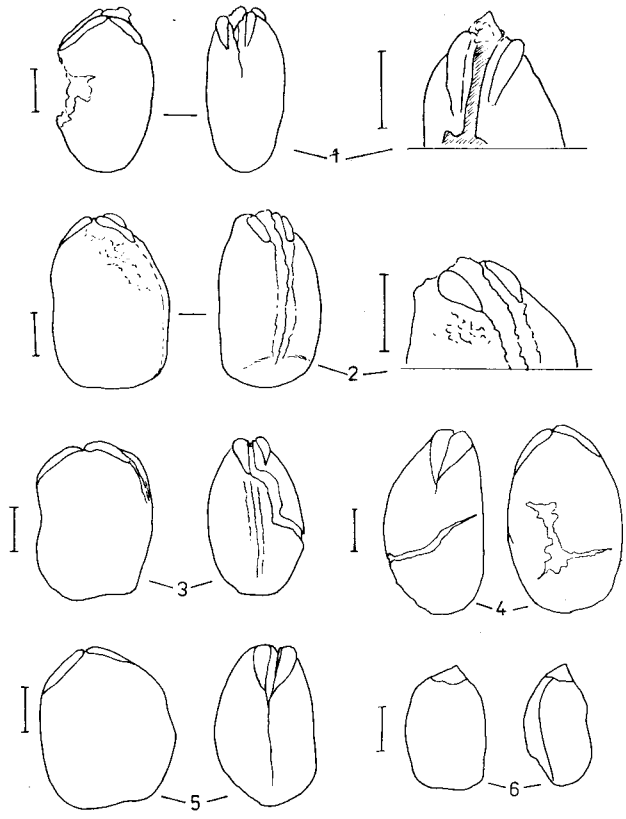

Fig. 6. Six seeds of Cucurbitaceae indet. shown from broader and narrower side. The details of the micropylar end are shown for (1) and (2); 6 – one seed without testa, radicle visible at the top. 1 pit 75/5; 3 and 6 hut F 1/90; 2 and 4–5 additional sample. Scale bars equal 1 mm

at the opposite one. On each side of the micropylar end there are two thickenings along the seed margin (Fig. 6, Pl. 3 fig. 14). The seed surface is smooth or rough, in the latter case covered with indistinct rugose/wrinkled sculpture (Pl. 4 fig. 4). The specimens with the sculpture have a low, thin rim running along the circumference, often with the two delicate "lines" parallel to it. Seeds tend to split along this rim. The seeds preserved without testa show two cotyledons and a radicle at the pointed end (Fig. 6: 6). Size of 21 seeds: length 3.95 (3.5–4.4) mm, breadth 2.88 (2.4–3.7) mm.

Discussion. All seeds are of the same type and belong probably to one species. They show several characters of the family Cucurbitaceae which is represented in the Egyptian flora by 14 species (Boulos 1995). The most common and most likely species to be found in a desert situation is *Citrullus colocynthis* (L.) Schrad. but the seeds from Nabta do not belong to this plant. The thickenings sticking out of the seed surface differ the ancient seeds from the modern seeds of *Citrullus colocynthis* which have narrow grooves in the same position. The presence of a rim is another difference compared to *C. colocynthis* seeds. This rim and the way of seed splitting resemble seeds of some *Bryonia* species but thickenings at the micropylar seed end look different. The other species that have been seen and found to have a different seed structure include *Bryonia cretica, Coccinia grandis, Corallocarpus schimperi, Cucumis prophetarum* and *Kedrostis foetidissima.*

Present-day use. Fruits of several wild species from this family are gathered in Africa for food and medicinal purposes, e.g. *Citrullus colocynthis, Cucumis prophetarum, Coccinia grandis, Bryonia dioica* (Boulos 1983, Nicolaisen 1963, Schulz & Adamou 1992). The frequent occurrence of an unknown cucurbitaceous plant at Nabta Playa suggests its use.

CYPERACEAE

Fuirena type
(Previousely described as *Cyperus/Fuirena* type and *Cyperus/Fuirena/Scirpus holoschoenus*)
Pl. 5 figs 2–3

Number of specimens. 69 fruits in three huts and two pits.

Description. Small, trigonous fruits, 3 walls have almost equal size, edges distinct, sharp throughout or, more often, only toward the base (Fig. 7). Fruit outline obovate, base narrowly elongated, apex more or less truncate. Surface smooth. Size of 19 specimens: length 1.01 (0.65–1.2) mm, breadth 0.69 (0.45–1.05) mm.

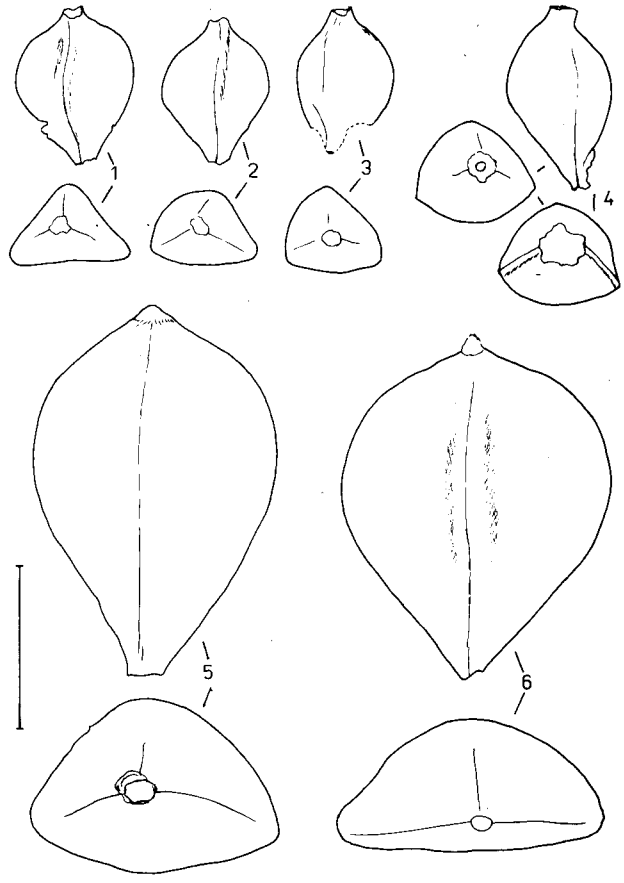

Fig. 7. 1–4 – four *Fuirena* type fruits from hut F 1/90, 1–3 – from the lateral side and from the apex, 4 – from the lateral side, from the apex (left) and the base (right). **5–6** – two fruits of *Scirpus maritimus* from hut F 2/90 from the lateral side and from the apex. Scale bar equals 1 mm

Discussion. The reference material available included 18 *Cyperus* species from Nigeria and a few species of other genera occuring in Africa, namely *Eleocharis, Fimbristylis, Kyllinga, Lipocarpha, Bulbostylis, Pycreus, Scirpus, Schoenoplectus, Rhynchospora.* Several species of *Cyperus* have small trigonous fruits with a smooth surface, slightly similar in shape to *Fuirena* but much smaller. The fruits of *Cyperus rotundus*, represented in the material by numerous tubers (Hather 1995), are larger and differ by having a narrow oval outline with almost paralell margins. Some *Bulbostylis* species (e.g. *B. barbata* Kunth. not

present in the modern flora of Egypt) have trigonous fruits of the size similar to the fossil specimens but with a less elongated basal part. The fruits from Nabta Playa mostly resemble those of the genus *Fuirena*. Extant fruits of *F. pubescens*, occurring in Egypt, and those of *F. umbellata* Roth., growing in Sudan (Andrews 1956) were seen. Identification of the genus is very likely, but not certain, because many African species of the sedge family were not seen.

Distribution and ecology. In the flora of Egypt the genus is represented by two species *Fuirena pubescens* (Poir.) Kunth and *F. ciliaris* (L.) Roxb. (Täckholm 1974, Boulos 1995). Both are perennial plants growing in swampy places (Zahran & Willis 1992). *F. ciliaris* is limited to the Nile valley, *F. pubescens* occurs in the Western Desert oases, in the Eastern Desert and on the Mediterranean coast (Boulos 1995).

Scirpus maritimus L.

(Previousely described as *Scirpus/Schoenoplectus* type or *Schoenoplectus* type)

Pl. 4 figs 5–9

Number of specimens. 46 fruits in 15 samples from five huts.

Description. Nuts indistinctly trigonous, one wall broader than the two others (Fig. 7), longitudinal outline obovate, fruit base narrowed. One specimen has a collar-like thickening at the base, formed by the bases of broken bristles (Plate 4 fig. 8). Nut surface smooth. A few fruits preserved with seeds inside. Size of 30 fruits: length 2.11 (1.7–2.5) mm, breadth 1.46 (1.3–1.6) mm.

Discussion. Nine species of *Scirpus* occur in the modern flora of Egypt (Täckholm 1974, Boulos 1995). The reference material seen included seven of them, namely *S. supinus* L., *S. praelongatus* Poir., *S. mucronatus* L., *S. holoschoenus* L., *S. triqueter* L. and *S. maritimus* L., as well as *S. lacustris* L. (including subsp. *tabernaemontani* (C.C. Gmelin) Syme, not reported from Egypt. *S. maritimus* L. var. *tuberosus* Desf. was not seen.

The fossil fruits are most similar to the fruits of the extant *S. maritimus* and resemble also modern fruits illustrated by Hillman, under the name *S. tuberosus,* in his publication about the plants from Wadi Kubbaniya (see fig. 7.18 in Hillman et al. 1989b). The fruits from Nabta Playa are small compared to the available reference material, and below the average 3.1 × 2.2 × 1.2 mm given by Berggren (1969) for *S. maritimus* L., but within its length range 0.9–3 mm cited in the "Flora europaea" (DeFilipps 1980). They may belong to the same species as the fruits identified as *Scirpus* sp. of the *S. maritimus/tuberosus* type from Wadi Kubbaniya (Hillman et al. 1989b) and Tell Abu Hureyra (Hillman et al. 1989a).

The occurrence of *Scirpus maritimus* seems most likely but *S. litoralis* Schrad. could be another possibility. It grows in Egypt as a very common plant (Täckholm 1974), has obovoid, plano- or biconvex (rarely trigonous) smooth nuts, 1–2-(3) mm long (Täckholm & Drar 1973, DeFilipps 1980). The reference material of *S. litoralis* was not available and thus the identification of *S. maritimus* is not quite certain.

Distribution and ecology. *Scirpus maritimus* and *S. tuberosus*, are closely related taxa, sometimes treated as separate species of different general distribution, sometimes as synonyms and sometimes the second taxon is included to the first one as subspecies.

In the "Flora of Egypt" Täckholm and Drar (1973) list *S. tuberosus* Desf. and include "*S. maritimus*, Egyptian record, not of L. 1753" among its synonyms. They state clearly that "The true *S. maritimus* L. is another species, not occurring around the Mediterranean Sea, but confined to Eurasia from Central Europe and northwards". However, in the recently published "Flora of Egypt checklist" Boulos (1995) treats *S. tuberosus* Desf. and *S. maritimus* L. var. *tuberosus* (Desf.) Roem. & Schult. as synonyms of *Scirpus maritimus* L. This is in agreement with the view of many European authors (Schultze-Motel 1966) who considered *S. tuberosus* Desf. to be a form (f. *compactum*) of *S. maritimus* L. The range of so broadly treated *S. maritimus L.* includes the whole world excluding Arctic regions. "Flora europaea" (DeFilipps 1980), on the other hand, does not mention *S. tuberosus* at all and defines the range of *S. maritimus* L. as covering only central and northern Eurasia. Several non-European "Floras" list the occurrence of *Scirpus maritimus* in the sense of Linné in Africa (e.g. Andrews 1956, Erteeb & Sherif, 1985).

For the ecological interpretation of the material from Nabta Playa taxonomic problems

have little meaning because both taxa are perennials, have similar habitat requirements, grow on wet grounds, swamps, on river sides, in ditches. The problem may be of some interest from the point of view of plant use because *Scirpus maritimus* L. is known to produce underground tubers while for *S. tuberosus* Desf. such information is not given in the literature. The question was discussed in detail by Hillman (Hillman et al. 1989b) in connection with the identification of *Scirpus* tubers by J. Hather from Wadi Kubbaniya. Tubers slightly resembling those of *Scirpus* were also found by J. Hather (pers. com.) in two huts from Nabta Playa (Pl. 26 figs 1–2).

Present-day use. Various *Scirpus* species have edible tubers, rhizomes and seeds, and several ethnografic records evidence their gathering for human consumption in modern time. Nicolaisen (1963 p. 176) cites the observation of Foucauld, 1922, concerning *S. maritimus* "An annual plant having edible fruit in its roots", which might indicate the use of tubers by Tuaregs, but the statement that it is an annual plant makes species identification uncertain. Fruits have been eaten raw or pounded to mush (for discussion see Hillman et al. 1989b). Fruit consumption in prehistory is confirmed by a few archaeological finds. Hillman has identified *S. maritimus/tuberosus* type nutlets from human feces at Wadi Kubbaniya. He also cites the finding of *Scirpus* sp. fruits in human coprolites from Lovelock Cave in Nevada, in layers dated from before 3500 b.p. up to 1200 b.p., and states that fruits of that genus were abundant at some other hunter-gatherers' sites. At Nabta Playa *Scirpus* fruits and tubers could have contributed to the plant foods but small number of remains is no direct evidence of their use.

Cyperaceae A type

Pl. 5 figs 12–13

Number of specimens. 5 fruits in 3 samples from huts F1/90 and F2/90.

Description. Fruits plano-convex, one side slightly concave, the other one convex with an indistinct third edge at the base (Fig. 8: 1–3). Marginal edges fairly sharp. Fruit outline obovate, traces of an inflated style base at the apex. Size: 1.0 × 0.7, 1.05 × 0.7, 1.2 × 0.8, 1.1 × 0.75 mm.

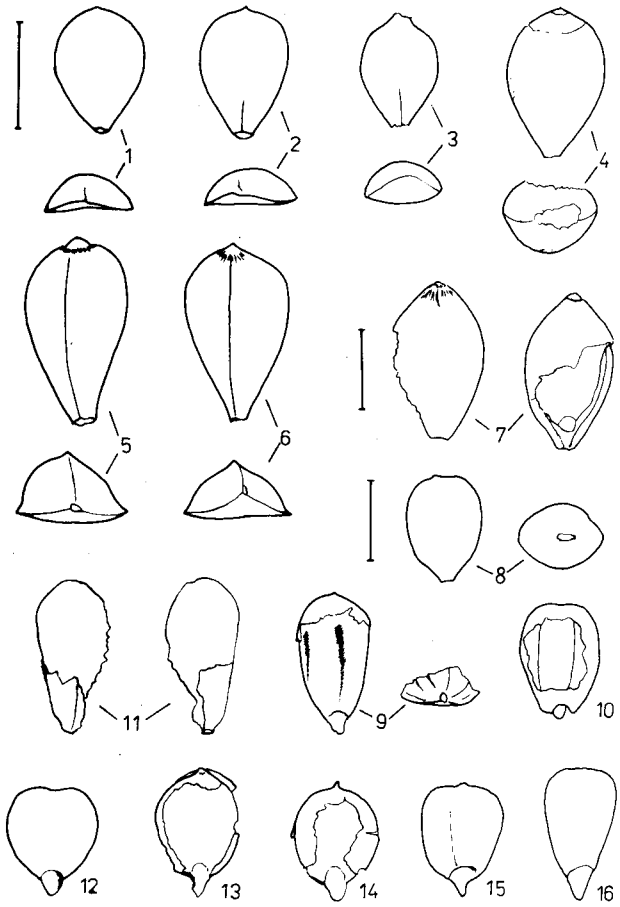

Fig. 8. Different types of Cyperaceae fruits shown from the lateral side and the apex. **1–3** – A type, three fruits from hut F 1/90; **4** – B type, fruit from hut F 2/90; **5–6** – C type, two fruits from hut F 74/104; **7** – D type, one fruit from the two lateral sides, note the thickness of fruit wall and the seed inside, hut F 1/90; **8** – F type, one fruit from the isolated hearth; **9–10** – E type, two seeds with pericarp fragments, 9 from hut F 74/104, 10 from hut F 1/90; **11–16** – Cyperaceae NP-21 type, six seeds, a few with pericarp remnants, one fruit from two sides (11). 11 and 14–16 hut F 1/90; 12–13 hut F 74/104. Scale bars equal 1 mm, bar at upper left for all drawings except Nos 7 and 8

Discussion. Shape similar to *Blysmus compressus* but ancient fruits are much smaller. *Blysmus* does not occur in Egypt today.

Cyperaceae B type

Pl. 5 fig. 5

Number of specimens. One fruit in hut F 2/90.

Description. Fruit narrow obovate, broad oval in cross section, both sides convex. Surface damaged, possibly remnant of a stylopodium at the apex (Fig. 8: 4). Size: 1.35 × 0.85 mm.

Discussion. Similar in shape to *Eleocharis* but much smaller than any species available in the reference collection.

Cyperaceae C type
Pl. 5 figs 6–8

Number of specimens. Five fruits in 2 samples from huts F 74/104 and F 1/90.

Description. Two complete fruits are trigonous, with one wall distinctly broader than the others, narrow obovate in outline. Two marginal ribs sharp, the third one distinct on the convex side (Fig. 8: 5–6). Surface covered with longitudinal rows of small papillae. Three seeds, preserved with only fragments of the pericarp, are oval in the cross section, with a distinct tip of an embryo. They are of the same type as seeds described below under the name Cyperaceae NP-21 type, but larger. Fruit wall thin. Size of 2 complete fruits: 1.75 × 0.95 and 1.55 × 0.9 mm.

Discussion. Slightly resembles *Eriophorum* fruits in shape but is much smaller.

Cyperaceae D type
Pl. 5 figs 9–10

Number of specimens. One fruit and one fruit fragment in hut F 1/90.

Description. Fruit indistinctly trigonous, almost plano-convex, one side broader and more flattened than the the two others (Fig. 8: 7). Pericarp thick, seed similar to the Cyperaceae NP-21 type is visible inside. Fruit outline oval. Size: 2.0 × 1.2 mm, pericarp thickness at the base ca. 0.1 mm.

Discussion. Slightly similar to *Scirpus* fruits, differs from them by a distinctly oval and not obovate outline.

Cyperaceae E type
Pl. 5 fig. 11

Number of specimens. Two seeds in huts F 1/90 and F 74/104.

Description. Seeds similar to the Cyperaceae NP-21 type with remnants of pericarp, one side flat and broad as with the Cyperaceae C type but the pericarp with more than one rib on the convex side (Fig. 8: 9–10). Size: 1.25 × 0.65 and 1.2 × 0.75 mm.

Discussion. No modern fruits of similar shape were seen.

Cyperaceae F type
Pl. 5 fig. 4

Number of specimens. Four fruits in hut F 1/90 and in the isolated hearth.

Description. Fruits broad obovate in outline, broad oval in the cross section (Fig. 8: 8), with a badly damaged pericarp. Size of one fruit: 1.5 × 1.0 mm.

Discussion. No modern fruits of similar shape were seen.

Cyperaceae NP-21 type
Pl. 6 figs 1–10

Number of specimens. One of the five most abundant fossils at Nabta Playa, represented by 1963 seeds found in almost all samples.

Description. Seeds dorsally flattened, one side flat or slightly concave, the opposite side convex; outline variable, usually narrow or broad obovate, with a truncate apex and a pointed base (tip of embryo), sometimes oval or almost circular (Fig. 8). Several specimens preserved with pericarp fragments show sharp marginal ribs and a distinct third rib on the convex side (Pl. 6 figs 4, 5, 7); the third rib may be missing (Pl. 6 figs 1, 3). These specimens resemble fruits described as Cyperaceae C type, but are smaller. The NP-21 type differs from *Scirpus maritimus* fruits by a much smaller size (Pl. 6 figs 10– 11), sharp marginal ribs, a thinner fruit wall and the presence of small papillae on the pericarp surface (Plate 6 figs 8–9). Size of 10 seeds: length 1.15 (1.0–1.3) mm, breadth 0.72 (0.6–0.8) mm.

Discussion. The shape of seeds and the position of embryo is typical of the family Cyperaceae. They are too small to belong to *Scirpus* and too big for several *Cyperus* species, including *C. rotundus* represented by tubers in several samples from Nabta Playa (Hather 1995). They may represent one species of considerable seed shape variation or a few different species.

Distribution and ecology. Due to inadequate identification no direct conclusions are possible as far as the ecology of the NP-21 type plant is concerned. Many species of the sedge family grow in moist places, along rivers or around water reservoirs and, probably, this was also the case with that unknown plant (or

plants) which could have occurred on the playa itself.

Present-day use of Cyperaceae fruits. Little ethnographic information was found about the use of fruits of plants from Cyperaceae family. Different *Scirpus* species are collected (see also under the description of *Scirpus*). Maurizio (1926) mentions the gathering of fruits of some *Carex* species (i.a. *C. arenaria*). The occurence of a large number of charred seeds at Nabta Playa may indicate their use but it is difficult to suggest for what purpose. Seeds are preserved in fairly good condition, with unbroken delicate tip of embryo. In extant species of this family, it is difficult to get the seeds out of the fruits without damaging them. This is particularly true with the genera having thick fruit walls as is the case, for instance, with the genus *Scirpus*, but may be easier with thin-walled fruits of other genera, e.g. *Eriophorum*. The experimental roasting of modern fruits of *Scirpus maritimus* and *S. lacustris* did not help much; their pericarps became fragile but at the same time most of the seeds were popped and lost their original shape. Few complete seeds of *Scirpus lacustris*, that were successfully freed from their pericarps, were larger and relatively broader than subfossil seeds of the NP-21 type (Pl. 6 fig. 11).

The only suggestion which can be made is that we are dealing with seeds of a sedge family plant or plants, having medium size fruits with thin fruit wall. If, as it is assumed, they were really used for food, prehistoric people must have had the skill of their extraction from fruits without getting them crushed or they have eaten the whole fruits.

GRAMINEAE

Brachiaria sp.

Pl. 7 figs 1–5

Number of specimens. Rare type, 20 grains in 4 huts.

Description. Caryopses dorsally flattened, dorsal outline broad oval, distinctly broadest at the middle; embryo more than half grain length. Hilum not visible. Kernel margins rounded, embryo long, longer than with *Panicum turgidum*, grains gradually narrowed towards both ends and less flattened than with *Urochloa* (Fig. 9: 1–6). Remnants of lemma or palea with transversal wrinkles preserved in a few specimens (Pl. 7 figs 1–3). Size: 1.35 × 1.05 × 0.6, 1.45 × 1.05 × 0.8, 1.45 × 0.95 × 0.5, 1.75 × 1.25 × 0.85, 1.45 × .1.1 × 0.75, 1.65 × 1.3 × 0.85, 1.4 × 1.2 × 0.7, 1.8 ×. 1.35 × 0.8 mm.

Discussion. About a 100 species of the genus *Brachiaria* occur in the tropics of the Old World in various habitats from semi-deserts to swamps (Clayton & Renvoize 1986). Six species grow in Egypt, only grains of *B. deflexa* (Schumach.) Robyns were seen (Cope & Hosni 1991, Boulos 1995). Generic determination seems fairly reliable, though kernels of this genus enclosed in lemma and palea may be mistaken for certain *Setaria* species.

Distribution and ecology. Most Egyptian species are annuals growing in wadis, in the oases and the Nile valley, often in grasslands dominated by *Panicum turgidum*. *Brachiaria deflexa*, also an annual grass, occurs in sandy wadis and on the sea shores in the Eastern Desert, the Red Sea coast and Gebel Elba, but is not recorded from the Western Desert (Boulos 1995).

Present-day use. Many species of *Brachiaria*, collected for food in different parts of

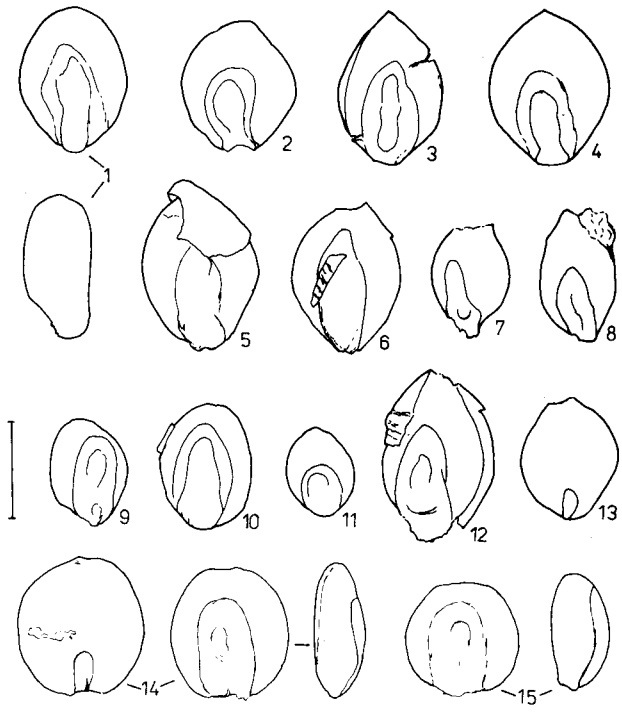

Fig. 9. 1–6 – *Brachiaria* sp., grains in dorsal view, 1 – also in lateral view, 5–6 – with remnants of lemma. 1–4 hut F 1/90, 5–6 hut F 77/5. **7–13** – *Setaria* type, grains in dorsal (7–12) and ventral (13) view. 7–10 hut F 1/90; 11 hut F 1/91; 12 additional sample; 13 hut F 3/90. **14–15** – *Urochloa* sp., two grains from hut F 1/90, note a very big embryo, oval hilum and lateral compression of grains. Scale bar equals 1 mm

the southern Sahara and Sahel, are listed by Portères (1976). To this list Schulz and Adamou (1992) add *B. lata* (Schumach.) Hubb., growing on seasonally moist soils at the foothills of the Aïr Mountains and regularly collected as wild cereal. Perhaps the most interesting species is *B. deflexa*, widely exploited as wild cereal, which has a domesticated race cultivated in a very restricted area in Guinea (Harlan 1989b). The small material from Nabta Playa does not allow species determination.

The exploitation of *Brachiaria* at the time corresponding approximately to Nabta Playa settlement is evidenced by the recovery of abundant spikelets belonging to this genus in the Early Neolithic layers at the site Ti-n-Torha/Two Caves in Libya (Barich 1992, Wasylikowa 1992a, b, 1993), north of its modern range. At Nabta Playa *Brachiaria* was probably of limited significance because it made only a small portion of grass grains.

Digitaria type

Pl. 7 figs 6–7

Number of specimens. The total of 62 grains were present in several samples from 6 huts and one pit; never in large numbers in one sample.

Description. Grains narrow oval, ventral side flattened, embryo shorter than half of grain length (Fig. 10). Only one specimen was found with a lemma and palea showing narrow longitudinal cell rows (Pl. 7 fig. 7). Size of 21 grains: length 1.56 (1.14–1.98) mm, breadth 1.03 (0.66–1.56) mm, index of length/breadth ratio 160 (100–206).

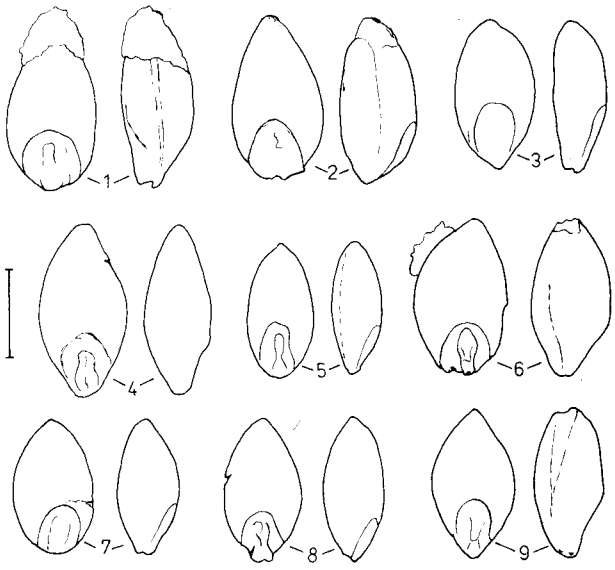

Fig. 10. Grains of *Digitaria* type from hut F 1/90 in dorsal and lateral view. Scale bar equals 1 mm

Discussion. Over 200 species are known from the tropical and warm temperate regions (Clayton & Renvoize 1986). Six species grow in Egypt at present, three of them are native, namely perennial *Digitaria nodosa* Parl. and annuals *D. velutina* (Forssk.) P. Beauv. and *D. ciliaris* (Retz.) Koel. (Cope & Hosni 1991). In all wild species caryopsis shape is fairly uniform and species identification was not attempted. Five species were available in the modern reference material, European *Digitaria sanguinalis* (L.) Scop. and *D. ischaemum* (Schreb.) Muehlenb., African wild species *D. guayana* (Kunth.) Stapf., *D. leptorhachis* (Pilger) Stapf., and *D. ciliaris* (Retz.) Koeler, and cultivated *D. iburua* Stapf. Size differences may point to the presence of more than one species.

Distribution and ecology. *Digitaria* species may occur on a wide variety of habitats, from dry sandy soils to damp places and cultivated grounds (Clayton & Renvoize 1982).

Present-day use. Different *Digitaria* species are collected for food in the savanna zone, as the component of a mixture of different grass species called "kreb" or "kasha" (Harlan 1989a, b). A small number of grains at Nabta Playa may indicate that, if collected at all, they constituted only a minor admixture to other grasses.

Echinochloa colona (L.) Link.

Pl. 7 figs 8–12

Number of specimens. Most abundant and frequent grass species at the site, 2806 caryopses present in almost all huts and pits.

Description. Ventral side of naked grains very flat, dorsal side convex, dorsal outline broad oval to oval, apex almost truncate, rounded or gradually narrowed (Fig. 11). Embryo long, half of grain length or more, hilum (when present) broad obovate (Fig. 12: 1). Only a few specimens were preserved with small remnants of lemma or palea, showing broad, parallel cell rows on the smooth surface (Plate 7 fig. 12). Caryopses are slightly smaller than modern grains of *Echinochloa colona* but in all other characters resemble very much this species. Size of 158 grains: length 0.94 (0.66–1.26) mm,

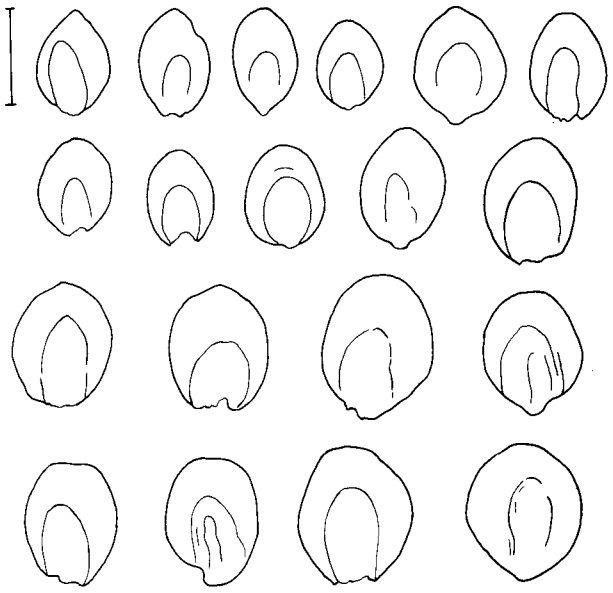

Fig. 11. Grains of *Echinochloa colona* in dorsal view showing shape variation in one sample from hut F 1/90. Scale bar equals 1 mm

breadth 0.72 (0.54–0.9) mm, index of length/breadth ratio 132 (100–173).

Discussion. Three species of *Echinochloa* occur today in Egipt, *E. colona (L.) Link.*, *E. crus-galli* (L.) P. Beauv. and *E. stagnina* (Retz.) P. Beauv. (Cope & Hosni 1991, Boulos 1995). The occurrence of *E. pyramdalis* (Lam.) Hitchc., widespread in central and southern Sudan, is not confirmed for Egypt (Cope & Hosni 1991). *E. crus-galli* and *E. stagnina* have bigger grains. Caryopses of *E. pyramidalis* are similar in size to *E. colona* but on the basis of modern distribution the occurrence of the latter species is much more likely. Other genera having kernels with a flat ventral side are *Paspalidium* and *Paspalum*, but they have a shorter embryo and a narrow oval hilum; *Paspalum* grains besides, are bigger than those from Nabta Playa (Fig. 12: 3–4). Identification reliable, though a few less typical dehusked grains may be confused with *Brachiaria* and *Setaria*.

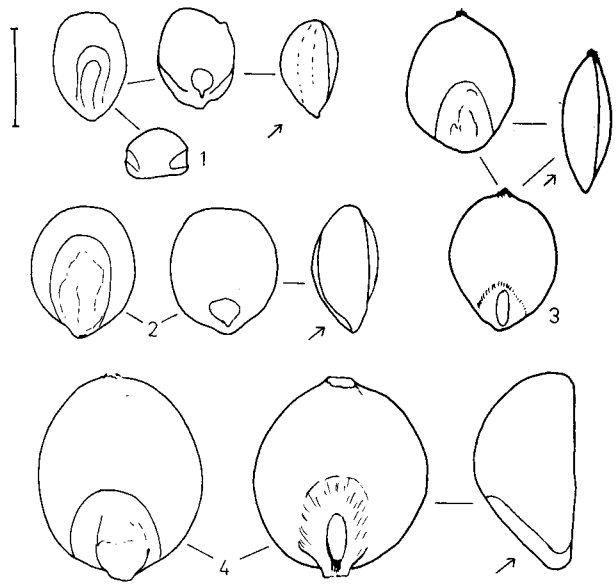

Fig. 12. One grain of *Echinochloa colona* seen from the dorsal, ventral, lateral and bottom side, hut F 1/90 (**1**), compared with grains of extant *Echinochloa colona* (**2**), *Paspalidium geminatum* (**3**) and *Paspalum polystachium* (**4**); arrow points to embryo. Note the difference in the shape of hilum and embryo between *Echinochloa* and the two other species. Scale bar equals 1 mm

Distribution and ecology. Habitats of *E. colona* in Egypt include canal banks, gardens, cultivated fields and other moist places, where the species may grow in extensive stands (Täckholm 1974, Cope & Hosni 1991). It is an annual plant which grows throughout the tropics and subtropics as a weedy species of muddy or swampy places (Clayton & Renvoize 1982). It may occur on slightly wet, saline soils in the Western Desert (Zahran & Willis 1992). In the "Flora of Libya" it is described as nitrophilous, aquatic or semiaquatic grass (Sherif & Siddiqi 1988).

Present-day use. *Echinochloa colona* makes a good pasture for cattle (e.g. in North Niger, Schulz & Adamou 1992) and is gathered for human consumption. As an admixture of so called "bougrou" grasses, dominated by *E. stagnina,* it is collected in damp places in the Sahel of Mali and Nigeria (Harlan 1989a). Tubiana and Tubiana (1977) identify with *E. colona* grasses gathered by the Zaghawa people of the Sudan and Chad. They are designated with two different local names and are harvested twice at a month interval. The harvest is done either by beating the growing plant so that the grain falls to the basket or by cutting with a reaping-hook. Magid (1989), describing the gathering of *E. colona* in Sudan, mentions also the sweeping of the grain from the soil. It is a valued wild cereal collected in the Aïr Mountains (Schulz & Adamou 1992).

Abundant and frequent occurrence at Nabta Playa indicates that this grass belonged to plants collected for food. Täckholm (Täckholm & Drar 1973) suggested that *E. colona* could have been cultivated in Ancient Egypt because a large number of pure grain was found in the intestines of a prehistoric mummy (the site Naga ed Deir, ca. 4000–3500 B.C.). However,

extensive use of a wild plant in modern times makes the origin of that accumulation from gathering more probable (Germer 1985).

Panicum turgidum Forssk.

Pl. 8 figs 1–4)

Number of specimens. Fairly abundant and frequent species, 576 grains in 8 huts and 3 pits.

Description. Grains dorsally flattened, dorsal side more convex than the ventral one, but the ventral side never distinctly flat (Fig. 13). Outline of grains oval, broadest in the middle or slightly below. Embryo short, less than half grain length and relatively broad. Hilum oval or narrow obovate, usually not preserved. The assemblage contains almost exclusively naked grains, only one fragment of a loose lemma is present (Pl. 8 figs 3–4) and small lemma or palea pieces are attached to a few grains; the surface of lemma and palea is smooth, covered with narrow longitudinal cell rows. However, a large portion of grains got probably charred while being still in glumes because they have pointed apex and distinct shallow grooves along lateral sides which may be the impressions of lemma and palea tightly clasping the grain. Grains charred without glumes are rounded at the top (Fig. 13, left). Size of 90 grains: length 1.52 (1.26–1.92) mm, breadth 1.04 (0.84–1.32) mm, length/breadth ratio 147 (122–181) mm.

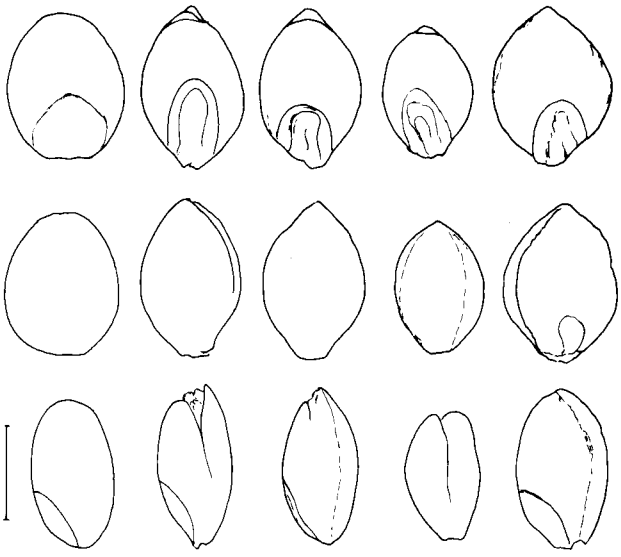

Fig. 13. Five grains of *Panicum turgidum* from hut F 1/90 in the dorsal (top row), ventral (middle row) and lateral (bottom row) view. Rounded kernel (on the extreme left) was probably charred without glumes, one grain shows obovate hilum (on the extreme right). Scale bar equals 1 mm

Slightly similar grains of *Brachiaria* have a longer embryo and a narrower hilum, those of *Digitaria* are more flattened on the ventral side and relatively narrower (higher length/breadth ratio).

Discussion. Six *Panicum* species occur in Egypt today; cultivated *Panicum maximum* Jacq. and *P. miliaceum* L. and introduced *P. antidotale* Retz. (Boulos 1995) are not taken into consideration. Three wild native species, all perennials, *P. turgidum* Forssk., *P. repens* L. and *P. coloratum* L., could have occurred at Nabta Playa. The reference material of these three species has allowed to exclude *P. repens* and *P. coloratum* having kernels smaller than the subfossil material.

The fossil specimens are identical with the modern material of *Panicum turgidum*, and the present-day distribution, habitats and exploitation by people make it the most likely species to have occurred at Nabta.

Distribution and ecology. *Panicum turgidum*, a perennial desert grass with a woody culm (frutescent), grows in large stands, up to 1 m high, as a very common plant in sandy and gravelly deserts. The species is very drought resistant and may survive several years in dry condition without loosing its ability to grow immediately after the rainfall (Täckholm & Drar 1973). In good conditions it flowers the whole year, but less commonly in winter. It is a common species in the whole central and western Sahara and makes typical communities of contracted vegetation along the wadi beds (Ozenda 1983).

Present-day use. According to ethnographic evidence, until recent time, *Panicum turgidum* was an important grass gathered for food across the Sahara. The use of grain, straw and young green parts by nomads of the Hoggar is described by Gast (1968). Harvest is done either by beating the ears with a stick over a leather bucket or by rubbing them between the hands. Grains are used to prepare porridge or may be eaten raw after being pounded in a mortar. A kind of cakes may be baked by shepherds in the ashes for immediate consumption. Straw is used for making wattles used for fencing tents. Ash is added to tobaco for chewing. Pulverized old culms are used to cure wounds. Young green plants, with or without ears, are consumed in the periods of famine. Stems are collected for fuel. It is also a

good fodder plant, grazed by different animals, including cattle (Schulz & Adamou 1992, Sherif & Siddiqi 1988). In Sudan it is gathered and used in similar way as *Echinochloa colona* (Magid 1989). The importance of this grass for the nomads is reflected in strict rules, protecting areas covered with *Panicum* stands against exploitation at certain times to enable seed maturing (Gast 1968, Harlan 1989a, b).

Setaria type

Pl. 8 figs 5–9

Number of specimens. Rare type of grass, 33 grains in 4 huts and 1 pit.

Description. Caryopses dorsally flattened, narrow to broad oval in outline, narrower than those of *Brachiaria* (Fig. 9: 7–13). Embryo longer than half of grain length, hilum (if present) narrow oval. These characters differ *Setaria* type from *Panicum turgidum*. Few grains have fragments of lemma or palea attached, with transversal wrinkles made of rows of small papillae. Two specimens of almost complete palea (Pl. 8 figs 8–9) show a narrow oval papillose central field, narrower at the apex than with *Urochloa* and *Brachiaria*. Size: 1.35 × 0.95, 1.4 × 0.8, 1.6 × 1.05 and 1.3 × 0,95 mm.

Discussion. Over a 100 species of *Setaria* are known from the tropics and subtropics (Clayton & Renvoize 1986). Four weedy and two cultivated species occur in Egypt today (Cope & Hosni 1991, Boulos 1995), several species are present in the Sudan (Andrews 1956). Identification uncertain, may be confused with *Brachiaria* type.

Present-day use. A few wild *Setaria* species were used for food in prehistoric and modern times in Europe but no information was found about gathering of grasses from this genus in Africa.

Sorghum bicolor (L.) Moench. subsp. ***arundinaceum*** (Desv.) de Wet & Harlan

Pls 9–14

Number of specimens. *Sorghum* is represented by 816 kernels, 6 spikelets (only one mature specimen), 8 spikelet bases (2 mature specimens) and 23 fragments of detached glumes. *Sorghum* was found in 187 samples from almost all huts and pits but spikelet remains were present only in 14 samples.

Description. Previously published descriptions were based on partly examined material, coming from the successive field seasons of the years 1990 (Wasylikowa et al. 1993, Wendorf et al. 1992), 1990–91 (Wasylikowa & Kubiak-Martens 1995) and 1990–91–92 (Kubiak-Martens & Wasylikowa 1994). The details of grain and spikelet morphology presented in this paper are based on the whole material recovered from Nabta Playa. *Sorghum* nomenclature follows Harlan and de Wet (Wet de 1978).

Dorsally flattened grains have a long and broad embryo and a small obovate hilum. Shape and size of the grains and length of the embryos show a considerable variation (Pls 9–11, Fig. 14). The embryo is longer than or, less frequently, equal half of grain length; a few grains have a still shorter embryo. The dorsal outline varies from obovate (most common), through broad oval to narrow oval; the lateral outline is narrow obovate or narrow oval. Most of the grains are symmetrical in lateral view, few have more convex ventral or dorsal side. The range of grain shape variation does not exceed that of modern grains in any one wild race, indicating that all ancient grains may represent one taxon. Similar suggestion was expressed by Evans (Wasylikowa et al. 1993) on the basis of the analysis of lipid fraction in five sorghum grains from Nabta Playa.

All kernels are charred. It seems that their shapes have not been much changed by carbonization because no typical "popped" grains were found. A few grains showed only foam-like extrusions of the endosperm at the apex (Pl. 13 fig. 5) indicating that grains still enclosed in glumes were subject to charring. Tight clasping of caryopses by glumes prevented shape distortion, leaving space for bubbling of the endosperm only at the upper grain end. A few grains have narrow grooves along the lateral sides, formed probably by the pressure of the glume margins during carbonization of hulled grains (Pl. 10 fig. 3). The relatively insignificant shape deformation of grains from Nabta Playa is particularly evident compared to the distortion of some grains from Jebel et Tomat (Pl. 14 figs 5, 7–8), seen in the material kindly provided for reference by Dr. J. Desmond Clark (Clark & Stemler 1975).

In spite of little changes in the shape, most grains from Nabta Playa have a badly damaged surface. The pericarp is missing over

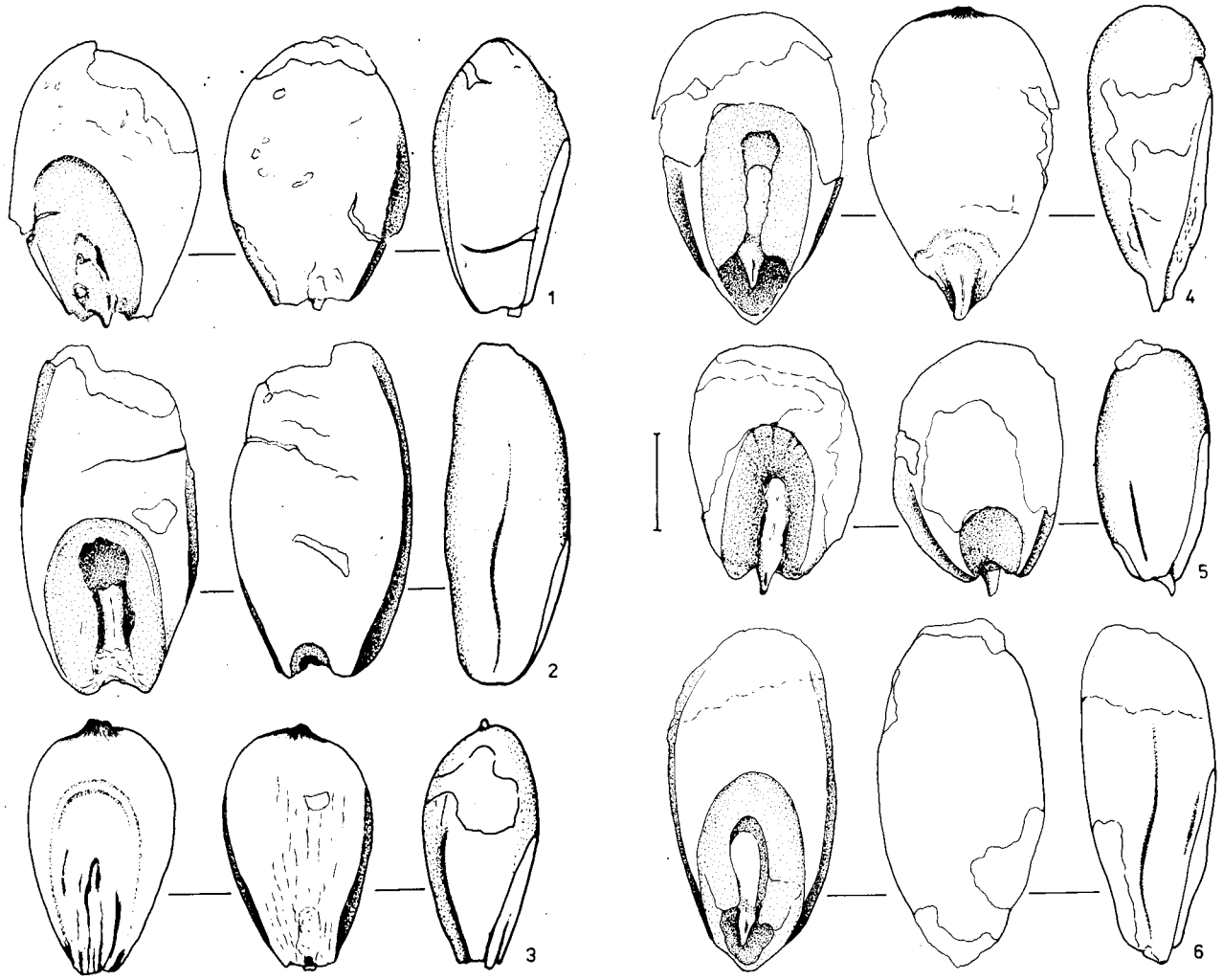

Fig. 14. Six grains of *Sorghum bicolor* subsp. *arundinaceum* in the dorsal, ventral and lateral view, hut 77/5. **2**, **6** – elongated type with a groove along the margin, **3–4** – obovate type, **1**, **5** – broad oval type. Drawn by Z. Tomczyńska. Scale bar equals 1 mm

much of the surface which is covered with small pits of various size and shape, well seen on the photographs. This type of damage is very striking compared, for instance, to the grains from Jebel et Tomat, having a well preserved, smooth and shiny outer grain coat. Different aspects of these two sorghum grain assemblages may result from different charring and/or preservation conditions. Sorghum from the storage pit at Jebel et Tomat was carbonized presumably rather quickly, at higher temperatures (hence many popped grains), and once charred underwent no subsequent deterioration. Charring of sorghum grains at Nabta Playa proceeded either more gradually or at lower temperature, causing less changes in the grain shapes, but either charring itself or unknown post-depositional processes, e.g. changes in deposit humidity, have damaged the grain surface. This kind of damage was not observed in kernels of other grasses and perhaps sorghum grains were more subject to destruction due to their larger size. Unequal charring conditions in various parts of the site were indicated by chemical analysis performed on *Sorghum* grain from Nabta Playa by Biel (in print) who has found out that grains recovered from hut F 77/5 were less charred that those from F 1/90.

Routine measurements of 262 grains gave the following results: length 2.53 (2.0–3.9) mm, breadth 1.61 (1.1–2.1) mm, thickness 1.21 (0.7–2.0) mm, index of length/breadth ratio 157 (111–279), index of thickness/breadth ratio 75 (42–114) (Fig. 15).

Most of the spikelet fragments represent immature specimens (Pl. 12, Fig. 16). They are narrow oval in outline, one or two coriaceous glumes are preserved. The glume surface is smooth, with no signs of nerves, which indi-

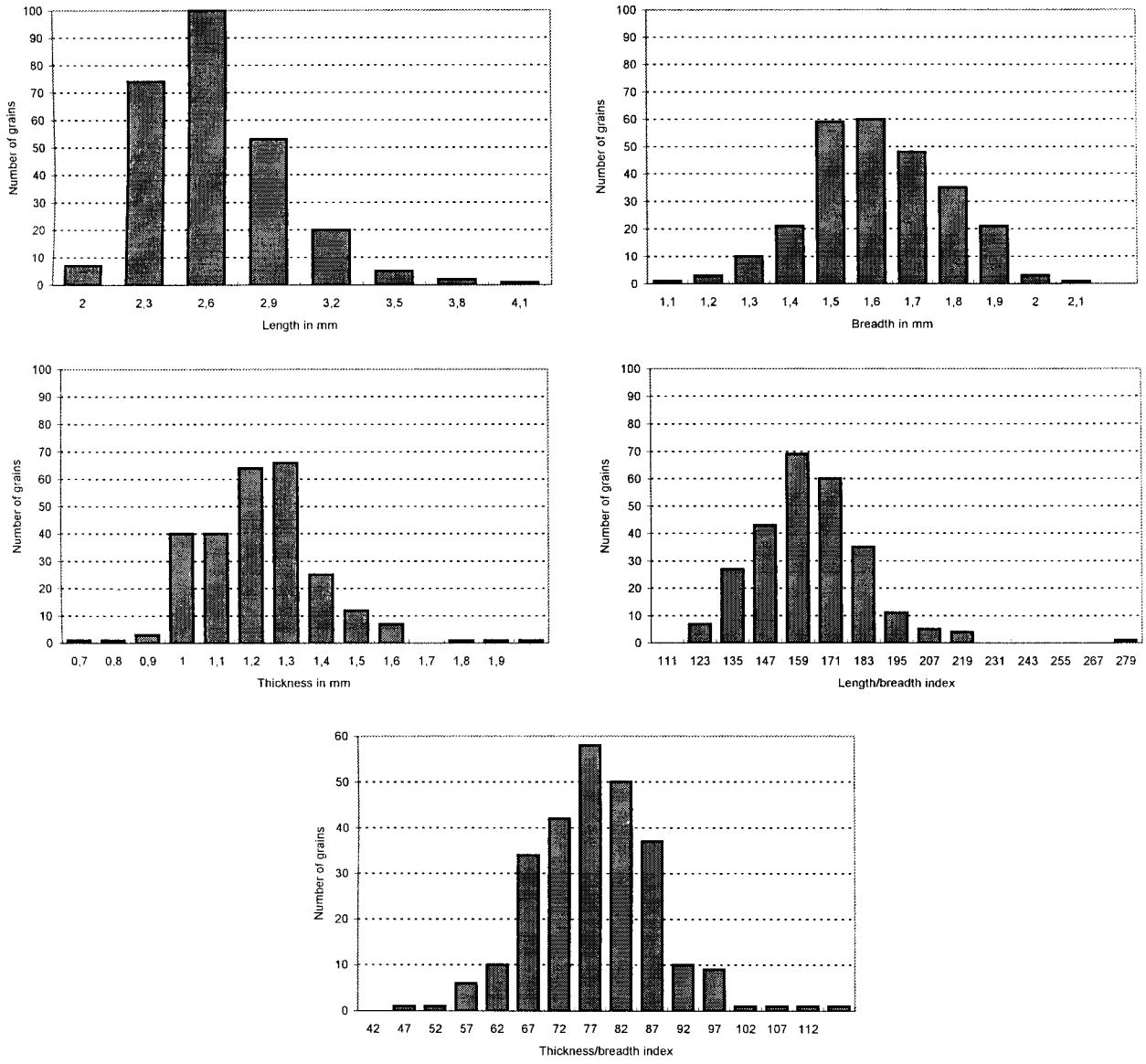

Fig. 15. Dimensions of *Sorghum* grains from site E-75-6 at Nabta Playa. N = 262

cates that they belong to fertile (sessile) spikelets. The pedicellate (sterile) spikelets in extant specimens have more delicate glumes with a very distinct nervation. One spikelet has hair remnants at the glume margin. One specimen is preserved with a twisted awn placed inside the glumes, thus evidently attached to the invisible, delicate lemma, a feature characteristic of the tribe Andropogoneae within the grass subfamily Panicoideae. Immature grain is visible in this spikelet (Pl. 12 fig. 1, Fig. 16: 1). Articulation scar is smooth in all spikelet fragments (Pls 12, 13). Few specimens have remnants of two stalks above the base, one is the pedicel of a sterile spikelet and the other is a raceme branchlet. Three more or less mature spikelets are preserved. They are obovate and narrow obovate in the dorsal outline, have no traces of pedicel at the base, the articulation scar is smooth, the glumes enclose the whole grain and are broken at the apex (Pl. 13).

In a few cases, the endosperm extrusions at the top of grains form a kind of "inner cast" of the glume apex showing that glumes were longer than the grain and tightly clasped the grain. Upper glume had the keel above the middle (Plate 13 fig. 5). In other cases apical extrusions are irregular either due to the damage of glume tips during charring or because the glumes were slightly gaping prior to charring.

In a few specimens spikelet length and breadth and articulation scar breadth could

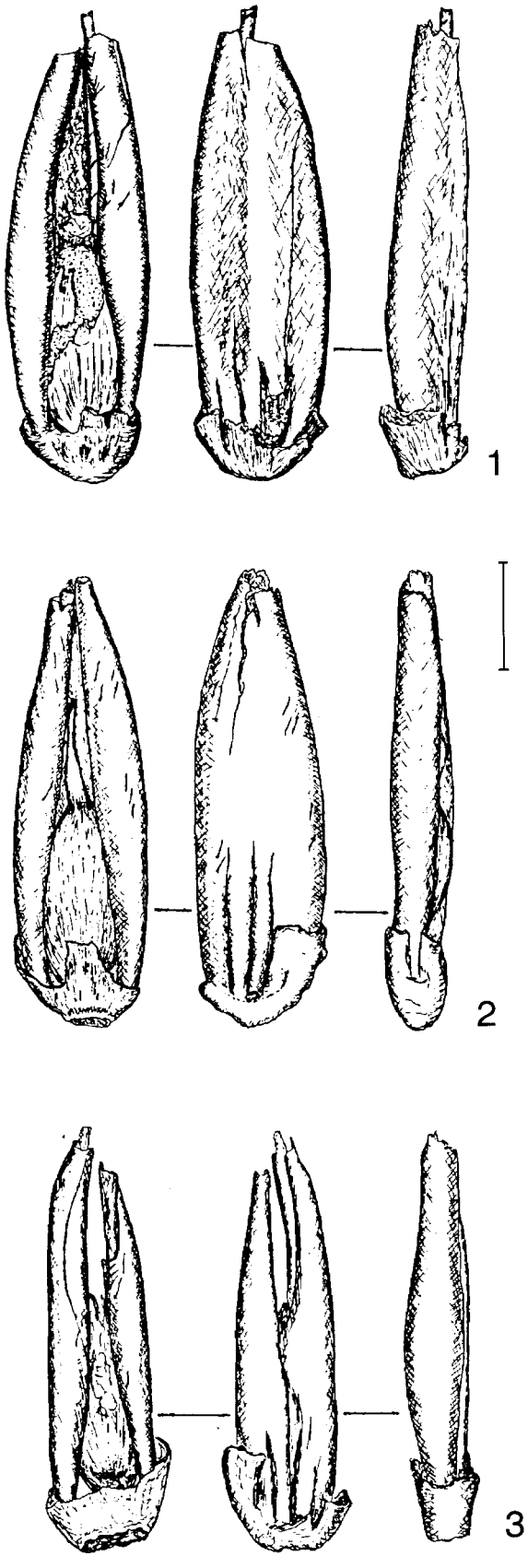

Fig. 16. Three immature spikelets of *Sorghum bicolor* subsp. *arundinaceum* from the side of lower (broken) and upper glume and from the lateral side; note broad articulation scar and twisted awn, hut F 1/90. Drawn by Z. Tomczyńska. Scale bar equals 1 mm

have been measured (Table 1). The measured spikelet length is a minimum value, because the upper ends of all glumes are broken.

A few preserved spikelets and certain deformations of grains caused by charring help to reconstruct the original shape of spikelets. The sessile spikelets were dorsally flattened, obovate or elliptic in the dorsal outline. Glumes were thick, coriaceous, perhaps less so at the top, usually without a visible nervation, with or without hairs. The glumes were longer than the grain, at maturity they could have been slightly gaping at the top. The spikelets were deciduous.

Discussion. It has been assumed that modern counterparts of the sorghum from Nabta Playa should be looked for among the African taxa of the genus *Sorghum* which are exploited by man, either in cultivation or from the wild state. According to modern taxonomy (Harlan & de Wet 1972, Wet de 1978) they are all classified as one species *Sorghum bicolor* (L.) Moench. with three subspecies: subsp. *bicolor* which includes all cultivated races, subsp. *drummondii* (Steud.) de Wet which includes stabilized weedy taxa and subsp. *arundinaceum* (Desv.) de Wet et Harlan which includes true wild races verticilliflorum, arundinaceum, virgatum and aethiopicum. The taxa given the rank of races by Harlan and de Wet were often treated by other taxonomists as separate species (e.g. Snowden 1936, 1955, Wickens 1976, Boulos 1995).

The identification of *Sorghum* from Nabta Playa to a race appeared impossible. The material consists almost exclusively of naked caryopses and grain characters alone have limited taxonomic value. The shape of the grains alone (narrow obovate or oblong, symmetrical dorso-ventrally, shorter than the glumes), does not allow to eliminate the cultivated race bicolor. Spikelets, which give better diagnostic criteria, are very rare. The combination of grain and spikelet characters, compared with the seven basic spikelet types recognized within *S. bicolor* by Harlan and de Wet (1972), suggests that the subfossil material represents a wild type and can be classified as *Sorghum bicolor* ssp. *arundinaceum* in the sense of de Wet and Harlan (Wet de 1978). However, smooth articulation scar at the glume base, a feature characteristic of wild taxa, shattering their spikelets spontaneously,

Table 1. Size of sorghum spikelets from site E-75-6 at Nabta Playa. L spikelet length, B spikelet breadth, Art breadth of articulation scar in mm

Hut/Pit	Sample	Kind of remain	L	B	Art
F 1/90	73/91	immature spikelet	3.5	1.3	0.4
	91/91	immature spikelet	3.7	1.05	0.4
	133/92	mature spikelet	3.7	1.6	0.3
F 3/90	136/91	mature spikelet base		1.7	0.4
F 74/4	1/92	immature spikelet base		1	0.3
F 75/1	16/90	immature spikelet	4	1.3	0.3
		immature spikelet	3.6	1.1	0.55
		immature spikelet	4	1.2	0.35
P 75/P1	3/90	mature spikelet base		1.9	0.6

may not be conclusive in the case of the specimens from Nabta. Rare spikelet fragments may represent exceptional and not typical disarticulation mode, such as can be found also in immature spikelets of a domesticated sorghum.

In order to examine grain morphology in a more objective way statistical measurements with the aid of image analysis were applied by Dahlberg (Dahlberg & Wasylikowa 1996). In addition to grains from Nabta Playa also grains of cultivated race bicolor from Jebel et Tomat, dated to AD 240 (Clark & Stemler 1975), and modern grains of 13 wild and cultivated races were examined by measuring six size and shape characters. The final conclusion of this study was that ancient sorghum was morphologically wild.

A slight suggestion that a cultivated form might be present at Nabta Playa was expressed by Evans. Five grains from Nabta Playa were compared with those of the cultivated race guinea (*Sorghum bicolor* ssp. *bicolor*) and wild race verticilliflorum (*Sorghum bicolor* ssp. *arundinaceum*). No exact match was found but the graphs for subfossil grains were slightly more similar to those for cultivated than wild races (Wasylikowa et al. 1993). These preliminary studies were based, however, on a very limited modern material and need to be verified in more extensive investigations, before any reliable conclusions can be drawn.

New biochemical investigations of *Sorghum* grains from Nabta Playa were started by Biel (in print) with more extensive reference material of modern races. The first results have shown the best resemblance of the ancient specimens to *Sorghum sudanense* (Piper) Stapf, species described by Snowden (1936) among the wild sorghums. De Wet, however, considers it a stabilized weedy taxon, derived from introgression between domesticated and wild species, and includes it to *S. bicolor* subsp. *drummondii* (Wet de 1978). It seems thus that, as yet, biochemical analyses, have opened new interesting perspectives for the study of prehistoric sorghum grains but did not solve the problem of their relationship to the modern taxa. The suggestion that *Sorghum* from Nabta Playa was allied to *S. sudanense* would require firm evidence because it would necessitate the revision of taxonomic status of the extant species. Spikelets from Nabta do not confirm this suggestion because the racemes of *S. sudanense* are usually tough and the pedicells remain attached to the sessile spikelets, as with cultivated races.

To sum up, sorghum from Nabta Playa represents the oldest finding of this cereal in the world. Its morphological characters suggest that it was a wild grass and for this reason it has been included to the subsp. *arundinaceum*. The taxonomic status of this very interesting finding is, however, not certain. It is also not known if this sorghum was collected from the wild stands or already cultivated, perhaps only occasionally. The recent finding by Fahmy (in print) of sorghum grains from the Neolithic site in the Farafra Oasis, similar in shape to those from Nabta but about a thousand years younger, suggests the this grass was widely used by people living in the Western Desert.

Distribution and ecology. All modern wild sorghum races are annual or short-lived perennials. They are so close to each other morphologically that, according to de Wet "they are more or less well defined ecotypes" (Wet de 1978). At present probably only one

wild sorghum occurs in Egypt, namely *S. bicolor* ssp. *arundinaceum* race virgatum (*S. virgatum* (Hack.) Stapf). It is an annual, or sometimes perennial, plant growing on damp sandy soils, as a weed in fields, along streambanks and irrigation ditches, in the Nile Valley, in oases of the Western Desert, in the Eastern Desert, Sinai and Mediterranean coast (Boulos 1995, Cope & Hosni 1991, Täckholm & Drar 1973). To be sure, according to Snowden (1955) also *S. sudanense* has natural stands in Egypt and Sudan, and Täckholm (1974) describes it as "A casual, sometimes cultivated" in Egypt but Boulos (1995) does not include it in his checklist. The species is widely cultivated for fodder in America and elsewhere (Snowden 1955). The range of all the other wild races extends from southern fringes of the Sahara to south Africa and the nearest stands occur several hundreds kilometers south of Nabta Playa. The most widely distributed across the African savanna is the race verticilliflorum (*S. verticilliflorum* (Steud.) Stapf) considered by Harlan the most likely progenitor of cultivated sorghum. According to this author, it is often a dominant species of the tall grass savanna, especially in Sudan (Harlan 1976). For the history of sorghum it would be important to know if the form present at Nabta Playa is related to southern or northern races. On phytogeographic grounds the presence of the race virgatum seems the most likely. If it is allied to one of the southern races a considerable shift of their ranges to the north must have occurred in the early Holocene.

Present-day use. Harlan (1989b) states that only few ethnographic records are published about the gathering of wild sorghum, but he himself has observed harvesting of wild sorghum grain in the savanna. According to him also weed sorghums are collected in Sudan and Ethiopia mostly for making beer. The race verticilliflorum, according to Snowden (1955 p. 233) is sometimes consumed as famine food by native African peoples who consider it "... a wild state of their cultivated grain sorghums...". Nicolaisen (1963) mentions the gathering of virgatum race in the Aïr and its use for porridge but in this case the identification may not be quite certain because this race should not grow there (Snowden 1955). In northern Niger, Schulz and Adamou (1992) observed, in 1988, collecting grain of the race aethiopicum (*Sorghum aethiopicum* (Hack.) Rupr.) for human nutrition. The yield could be as high as 250 kg/ha. According to these authors, the race aethiopicum is a very good fodder for camels and cattle but only in mature stage.

Urochloa sp.

Pl. 11 figs 5–8

Number of specimens. Very rare grass type, 7 grains in six samples from hut F 1/90.

Description. Grains dorsally flattened, very flat in the cross section, much more so than *Brachiaria* grains, almost circular in outline; embryo broad and very long, ca. 2/3 of grain length (Fig. 9: 14–15). Similar in size and shape extant grains of *Paspalidium* differ by having a much shorter embryo. Size: 1.4 × 1.2, 1.1 × 1.1, 1.25 × 1.0, 1.4 × 1.25 × 0.5, 1.45 × 1.2 × 0.55, 1.5 × 1.3 × 0.6 and 1.45 × 1.35 × 0.5 mm.

Discussion. Distribution and ecology. About 12 species of *Urochloa* occur in Africa, mainly in the savanna zone (Clayton & Renvoize 1986), but none in Egypt (Cope & Hosni 1991). Three species grow in the Sudan, *U. trichopus* (Hochst.) Stapf being widespread in the savanna and fallow land, particularly in moist places (Wickens 1976). Generic identification is fairly reliable, species identification was not attempted.

Present-day use. *Urochloa trichopus*, a species growing throughout the tropical Africa, is collected as a wild cereal for human nutrition (Schulz & Adamou 1992). The use of a grass from this genus in prehistoric times is indicated by the finding of grains and straw with spikelets attached in the Neolithic levels at the sites Uan Muhuggiag and Ti-n-Torha/Two Caves in Libya (Wasylikowa 1992a, b, 1993).

Paniceae A type

Pl. 11 figs 3–4

Number of specimens. Rare type, 12 grains in 2 huts.

Description. Grains dorsally flattened, ventral side flat, outline broad oval with a more or less pointed apex; embryo short (Fig. 17: 1–7), shorter than with *Brachiaria*. Size of 10 grains: length 1.39 (1.1–1.6) mm, breadth 1.10 (0.9–1.3) mm, length/breadth ratio 127 (108–140).

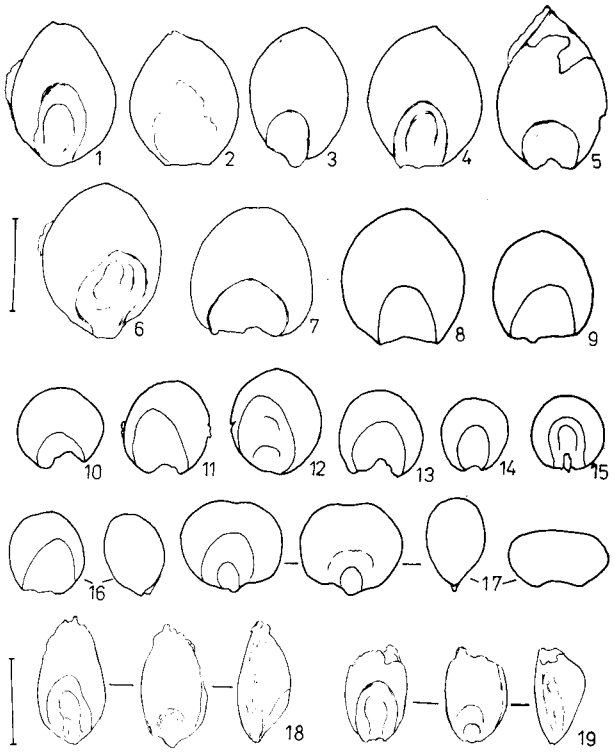

Fig. 17. 1–7 – Paniceae A type grains from hut F 1/90 in the dorsal view; **8–17** – Paniceae B type, 8–15 – grains from the dorsal side, 16 – one grain in the dorsal and lateral view, 17 – one grain in the dorsal, ventral and lateral view and from the apex, concavity indicates the position of embryo. 9–8 and 12–17 from hut F 1/90; 10 from the isolated hearth; 11 from hut F 3/90; **18–19** – Paniceae indet., two grains in the dorsal, ventral and lateral view, hut F 74/104. Scale bars equal 1 mm, lower bar only for nos 18 and 19

Discussion. The grains are smaller and relatively broader that those included to *Panicum turgidum*. They differ from kernels of Paniceae B type by being pointed at the upper end. They slightly resemble the kernels seen in one collection of *Digitaria iburua* Stapf from Nigeria but the occurrence of this species is highly improbable on the basis of its modern distribution.

Paniceae B type

Pl. 10 figs 7–10

Number of specimens. Fairly frequent type, 34 grains in 6 huts and one pit.

Description. Grains slightly flattened at the ventral side, dorsal outline broad oval or circular, transversal section broad oval. Lateral margins and grain apex rounded, embryo short and broad; hilum broad oval visible in one specimen (Fig. 17: 8–17). Size of 15 grains: length 1.01 (0.8–1.5) mm, breadth 0.96 (0.7–1.4) mm, length/breadth ratio 106 (90–125).

Discussion. Very distinctive type of kernels but in spite of that the identification was not possible.

Paniceae indet.

Number of specimens. 48 grains in 6 huts and one pit.

Description. Dorsally flattened grains of different shapes, usually naked, a few with small fragments of smooth lemma or palea. They probably belong to one of the types described above but could not have been included in any of them due to having mixed characters (e.g. of *Setaria* and *Digitaria*) or being badly damaged (Fig. 17: 18–19)

Gramineae indet.

Pl. 15, Pl. 16 figs 1–3

Number of specimens. The total of 36 grass grains, representing morphological types different from caryopses of Paniceae, were found in samples from 5 huts and one pit. Each individual type is represented by one or a few grains.

Description. The grains have various

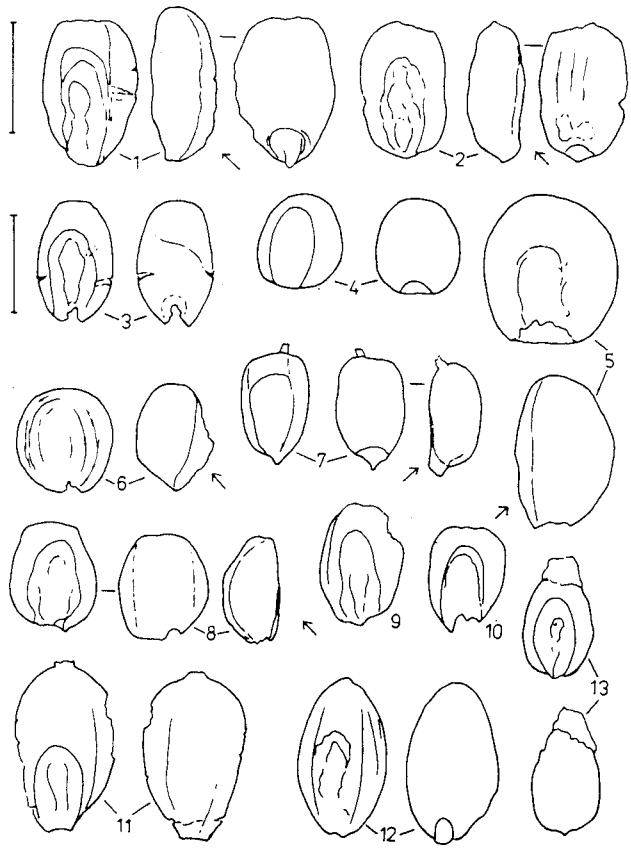

Fig. 18. Gramineae indet., different types of dorsally flattened kernels, all in the dorsal, some also in the ventral and lateral view, arrows point to embryo. 1–8 hut F 1/90; 9 hut F 2/90; 10–11 hut F 77/5; 12–13 F 74/104. Scale bar equal 1 mm, upper bar only for Nos 1 and 2

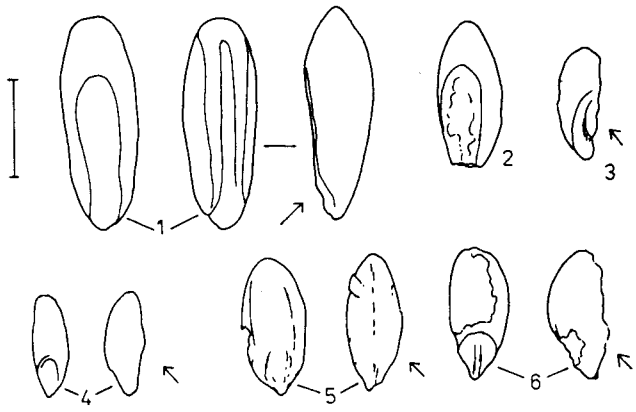

Fig. 19. Gramineae indet., different types of elongated grains, oval in cross section. 1 and 4–6 – dorsal, ventral and lateral view, 2 – dorsal view, 3 – lateral view. 1–2 hut F 1/90; 3 hut F 74/104; 4–5 hut F 2/90; 6 pit P 2/90; arrows point to embryo. Scale bar equals 1 mm

shapes and sizes and represent at least 14 species belonging to different genera. Identification was not possible. It was only checked that kernels of common desert grasses from the genus *Stipagrostis* (= *Aristida*) were not present (Figs 18, 19).

LABIATAE

Salvia/Stachys type

Number of specimens. 8 fruitlets in two huts and one pit.

Description. Fruitlets approximately oval in outline, tapering toward the attachement point, almost circular in the cross section. Dorsal side rounded, ventral side indistinctly roof-shaped (Fig. 20: 1). Surface damaged. Size: 1.75 × 1.25, 1.9 × 1.2, 1.5 × 1.2, 1.75 × 1.25, 1.75 × 1.1, 1.35 × 1.0, 1.8 × 1.3, 1.8 × 1.35 mm.

Discussion. Generic identification uncertain. All specimens may belong to one species.

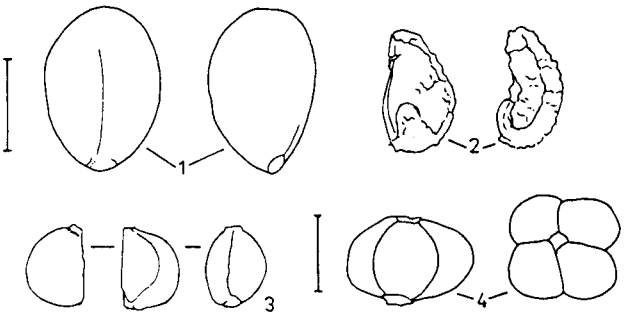

Fig. 20. **1** – *Salvia/Stachys* type, one fruitlet from hut F 1/90; **2–4** – Labiatae/Boraginaceae, two fruitlets from hut F 2/90 (2–3) and one schizocarp from hut F 1/91 (4). Scale bars equal 1 mm, lower bar only for No. 4

Labiatae/Boraginaceae type

Pl. 16 figs 4–9

Number of specimens. 3 nutlets and one complete schizocarp in two huts.

Description. The schizocarp composed of 4 nutlets is oblate-spherical, rounded-angular when viewed from the apex. Outer surface damaged, preserved fragments of exocarp covered with small papillae. The largest diameter is 1.6 mm, hight 1.25 mm, size of individual nutlet 1.1 × 0.7 mm (Pl. 16 figs 4–5, Fig. 20: 4).

Two nutlets are more or less flat, incurved, oblong. Surface of both sides covered with thick wrinkles. Size: 1.25 × 0.6 and 1.2 × 0.65 mm (Pl. 16 figs 6–7, Fig. 20: 2).

One nutlet is relatively broad and thick, its ventral side is roof-shaped with a sharp edge in the middle, the two lateral surfaces are smooth. Dorsal side convex and irregularly pitted. Size: 0.85 × 0.55 mm (Pl. 16 figs 8–9, Fig. 20: 3).

Discussion. The fruits represent three different species from one or both families.

LEGUMINOSAE

cf. ***Astragalus vogelii*** (Webb.) Bornm.

Pl. 16 figs 10–12

Number of specimens. 7 seeds in 6 samples from 3 huts.

Description. Seeds laterally compressed, seed outline broad oval, flattened along the radicle (Fig. 21: 1–4). The seed surface usually damaged, preserved testa fragments have distinct coarse pits. Size of better preserved specimens: 1.3 × 1.1, 1.8 × 1.3, 1.7 × 1.3, 1.6 × 1.2, 1.7 × 1.4 and 1.9 × 1.6 mm.

Discussion. The size, shape and sculpture much resemble modern seeds of this species but identification, although very likely, is not certain because the seeds of other *Astragalus* species were not seen.

Distribution and ecology. *Astragalus vogelii* is an annual herb, common in Egypt in the oases and in the Nile valley (Täckholm 1974). It may cover large areas in the acheb vegetation (Schulz & Adamou 1992). During the field seasons 1990–92 a few withered specimens were observed on the playa surface, not far from the site E-75-6. The sand below each plant was filled with its dessicated seeds

Fig. 21. 1–4 – cf. *Astragalus vogelii* seeds; 5–9 – *Astragalus* type seeds. 1–2 and 6–7 hut F 1/90; 3 additional sample; 4 hut F 74/104; 5 pit P 75/5; 8–9 hut F 74/117. Scale equals 1 mm

and fruits where from they could have been blown into the site. In the present study only charred seeds were found and are considered as belonging to archaeological context.

Present-day use. In the Hoggar area leaves are eaten raw, seeds are collected from ants' nests (Gast 1968).

Astragalus type

Pl. 16 figs 13–14

Number of specimens. 7 seeds in 4 samples from two huts and one pit.

Description. Seeds laterally compressed, when viewed from broader side truncated at both ends; radicle distinctly separated from cotyledons (Fig. 21: 5–9). Seed surface damaged; testa, if present, shows no sculpture. The type may include 2 different species. The size of more or less complete specimens is: 1.35 × 1.0, 1.6 × 1.1, 1.75 × 1.2, 1.9 × 1.6 and 2.4 × 2.0 mm.

Discussion. The genus *Astragalus* is represented by several species in the flora of Egypt. Identification of the genus is fairly reliable, species determination was not attempted.

Coronilla scorpioides (L.) Koch type

Number of specimens. Two fragments of seeds in one sample from the hut F 1/90.

Description. The specimens were identified by A. Butler (in prep.) on the basis of seed size and shape, testa texture and features of hilum recognized in SEM.

Discussion. At present two species occur in Egypt, both are rare annuals; *Coronilla scorpioides* (L.) Koch grows in the Eastern Mediterranean and on the desert east of the Nile, *C. repanda* (Poir.) Guss. only in Sinai and the Eastern Mediterranean area (Täckholm 1974, Boulos 1995). In the flora of Libya (Jafri 1980) the first species is described as "a desert species often found near cultivated fields", the latter as "a species of sandy sea shores". It is not listed in the flora of Sahara by Ozenda (1983) and in the flora of Sudan by Andrews (1952). For further discussion see Butler (in prep.).

Indigofera type

Pl. 16 figs 15–17

Number of specimens. 20 seeds in 14 samples from 3 huts and one pit.

Description. Seeds cylindrical (breadth equals thickness), truncated at both ends, radicle not separated from cotyledons, hilum oval. Two distinct types are present. One includes 9 smaller seeds, less than 1.25 mm long (0.95 × 0.95, 0.95 × 0.7, 0.9 × 0.75, 1.1 × 0.9, 1.05 × 0.9, 1.2 × 0.9, 1.1 × 0.85, 0.95 × 0.8 mm), with smooth or distinctly pitted testa surface (Fig. 22: 1–3, Plate 16 figs 15–17). The other type is represented by 11 larger seeds, preserved fragments of testa are smooth (Fig. 22: 4–6). Their size is 1.75 × 1.1, 1.55 × 1.2, 1.5 × 1.25, 1.75 × 1.2, 1.8 × 1.1, 1.85 × 1.1 mm.

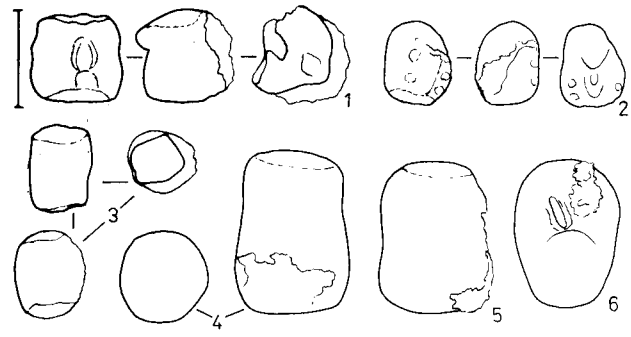

Fig. 22. Seeds of *Indigofera* type, 1–3 – three seeds of the smaller type, 1 and 2 with pitted surface, 4–6 – three seeds of the bigger type with smooth surface, note large oval hilum. 1 hut F 74/104, 2–6 hut F 1/90. Scale equals 1 mm

Discussion. Several *Indigofera* species occur in Egypt today, none were available for reference. The identification points only at the morphological type, the other genera are possible. Subfossil seeds represent two species.

Trifolieae tribe
(Previously described as Leguminosae small-seeded)
Pl. 17 figs 1–3

Number of specimens. One of the five most abundant types of fossils, over 1560 seeds found in almost all huts and pits.

Description. Seeds small, slightly flattened laterally, their outline usually broad oval with a small knob formed by the tip of curved radicle. Testa broken or totally missing, when preserved has smooth surface. Seeds distorted to various degree due to charring but the original shape variation can be discerned (Fig. 23: 1–8). Size of 20 seeds from one sample: length 1.25 (1.05–1.45) mm, breadth 1.02 (0.8–1.2) mm, L/B index 123 (109–140).

Discussion. A portion of seeds of this shape and size was examined by incident-light microscopy in Cracow by Dr. Ann Butler. She selected 17 specimens for detailed studies with the aid of SEM that she has completed in the Institute of Archaeology, London. Her general conclusion was that ancient seeds belonged to at least two members of the Trifolieae tribe. One resembled the genus *Medicago*, the other one *Coronilla scorpioides* (L.) Koch (Butler 1995, in prep.).

Distribution and ecology. The genus *Medicago* is represented in the flora of Egypt by 16 species, several of them growing in the oases and in the deserts (Boulos 1995, see also Butler, in prep.).

Present day use. Small legume seeds are often found in archaeological sites from southwest Asia, north Africa and south Europe but their role in prehistoric economy is not clear. Recently Butler (1995) has summarized the information on their possible uses scattered in archaeobotanical literature and ancient documentary sources. She is of the opinion that these tiny seeds, so frequently and abundantly recovered, are not casual admixtures but represent deliberate gathering of plants (one or more species). Most authors suggest that small legume seeds were collected for human nutrition, other possible uses could include medicines, dye, flavouring and animal forage. In some sitations the high seed production would make gathering an easy job. In arid lands, for instance, heavy grazing would cause the increased seed production by clovers and medics (Butler 1995).

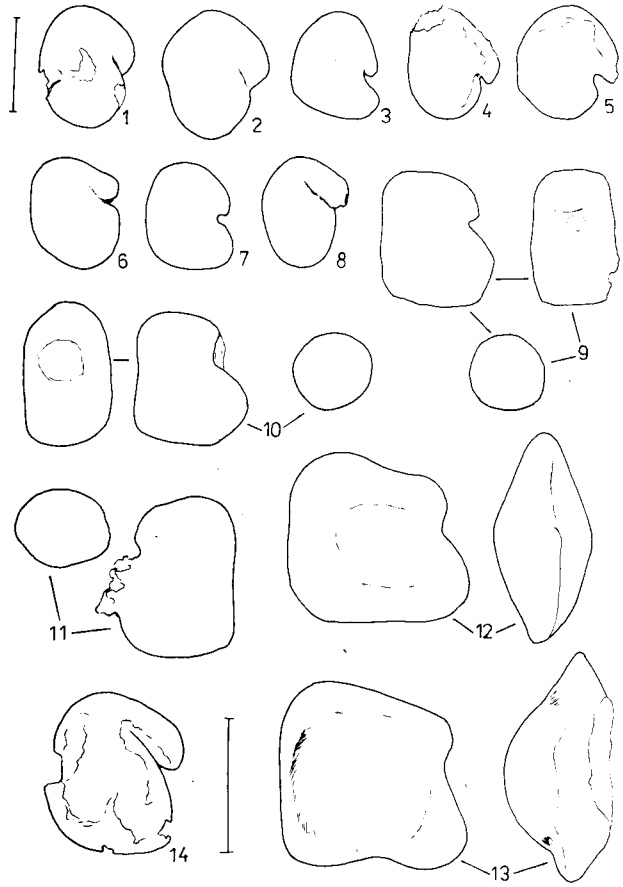

Fig. 23. 1–8 – Trifolieae tribe seeds from one sample; **9–11** – Leguminosae NP-13 type, three seeds in lateral and apical view; **12–14** – Leguminosae NP-9 type seeds with (12–13) and without testa showing radicle (14). 1–8, 10–11 and 14 hut F 1/90; 9 pit 75/5; 12–13 hut F 3/90. Scale equals 1 mm

Leguminosae NP-9 type
Pl. 17 fig. 4

Number of specimens. The fairly abundant type, 393 seeds in 5 huts and 3 pits.

Description. Seeds flattened, with distinct edge; when viewed from the broader face they have roundish-rectangular outline with a small hilar notch in the middle of one side. Central part of seeds is inflated, probably due to charring. Most seeds are preserved with testa which is smooth, specimens with no seedcoat show the position of radicle (Fig. 23: 12–14). Size of 10 seeds: length 1.23 (1.1–1.35) mm, breadth 1.15 (0.95–1.3) mm.

Discussion. No modern counterparts could be found. The family identification is uncertain.

Leguminosae NP-13 type
Pl. 17 figs 5–7

Number of specimens. 62 seeds in 5 huts and 2 pits.

Description. The seeds are more or less cy-

lindrical, tapering at both ends, like with the *Indigofera* type, but the hilum is placed in a distinct depression and the radicle is separated from the cotyledons (Fig. 23: 9–11). Surface smooth. Size varies from 1.9 × 1.3 to 1.5 × 1.0 mm. The group includes more than one taxon. The family identification is fairly reliable.

Leguminosae NP-19 type

Pl. 18 figs 1–6

Number of specimens. The fairly common seed type, 130 specimens in 8 huts and 3 pits, never abundant in one sample.

Description. Seeds kidney-shaped to broad oval, broad (seldom narrow) oval in cross section (Fig. 24). Hilum circular (Pl. 18 figs 1–3). Seedcoat usually absent, a few preserved fragments show its considerable thickness (Pl. 18 fig. 1). Two cotyledons usually stick together, radicle tip is broken. On the inner side of the isolated cotyledons a trace of a plumule in the form of a small depression (Fig. 24: 3, Pl. 18 fig. 6). Cotyledon surface usually smooth, in a few cases delicately wrinkled (Pl. 18 fig. 4). Two specimens are more flattened laterally and have a distinct, though very fine, sculpture. Seed size shows great variation from 3.2 × 2.4 mm for the largest to 1.7 × 1.2 mm for the smallest specimen. The size based on 30 measurements is: length 2.52 (1.7–3.2) mm, breadth 1.85 (1.2–2.4) mm.

Discussion. The subfossil seeds are similar in shape to the seeds of *Bituminaria bituminosa* (L.) C. H. Stirt., occurring on Sinai, but much smaller. The extant seeds of this species in the available reference collection are about 5.2–5.6 mm long. Similar seed shape may be found also in some other genera, e.g. *Onobrychis caput-galli*, which has much bigger seeds or *Desmodium* species with smaller seeds; both not growing in Egypt at present. The seed shape seems fairly characteristic but the identification requires more studies on modern seeds of African Leguminosae. The presence of more than one species cannot be excluded.

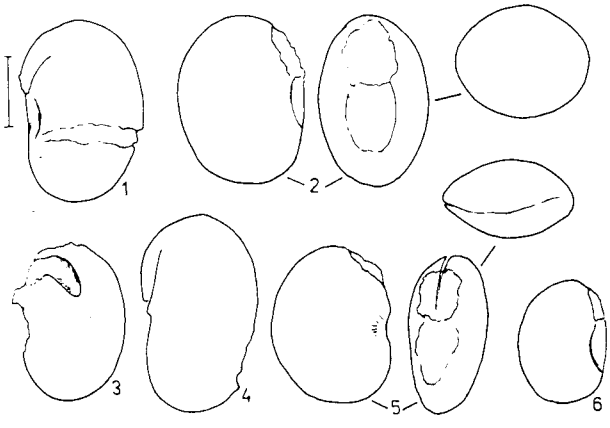

Fig. 24. Six seeds of Leguminosae NP-19 type without testa, radicle tip broken except for (4), 3 – cotyledon from the inner side showing depression left by broken plumule, 4 – a rare type of narrow seed, 6 – the smallest seed type; 2 and 5 two seeds from the lateral and hilum side and in apical view. 1–2 and 5–6 hut F 1/90; 3 hut F 2/90; 4 hut F 3/90. Scale equals 1 mm, lower bar for 12–14

Leguminosae NP-24 type

Pl. 18 fig. 7, Pl. 19 figs 1–2

Number of specimens. The fairly abundant type, 430 seeds in 8 huts and 2 pits.

Description. Seeds elongated, narrow (seldom broad) oval in outline, laterally flattened, their thickness variable. Radicle curved, adhering to cotyledons (Fig. 25). Most specimens have no seedcoat, a few preserved fragments show its considerable thickness. Surface of cotyledons smooth, often covered with remnants of a spongy tissue. A few seeds have small round hilum below the radicle tip (Fig. 25: 3, Pl. 19 fig. 2). Seeds poorly preserved, broken. Size of 20 seeds from one sample: length 2.77 (2.10–3.70) mm, breadth 1.36 (1.0–1.7) mm, index of length/breadth ratio 206 (153–264). The dimensions of extremely broad and extremely narrow specimens are 3.1 × 1.7 × 1.4 mm and 3.0 × 1.1 × 0.9 mm respectively.

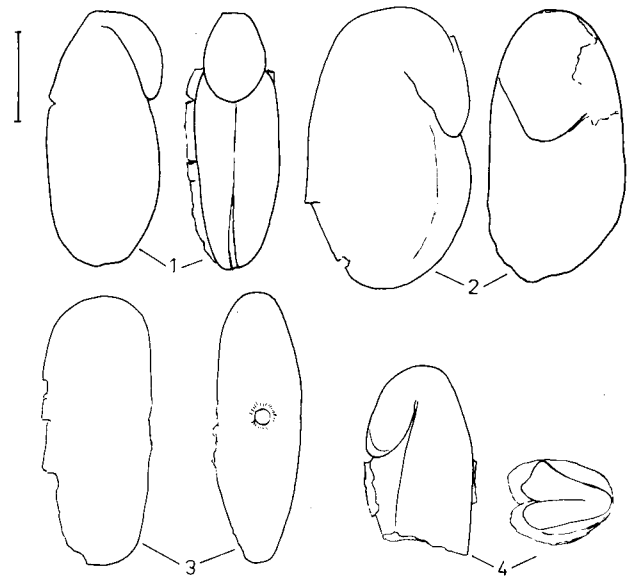

Fig. 25. Four seeds of Leguminosae NP-24 type, 1–3 – seeds from the lateral and hilum side, showing thickness of testa remnants in (1), radicle covered by testa and hilum preserved in (3), 4 – seed fragment from lateral side and in cross section. 1 and 3–4 hut F 1/90; 2 hut F 3/90. Scale equals 1 mm

Discussion. No modern counterparts were found. Similar seed shape was found in some non-African *Coronilla* and *Tephrosia* species (e.g. *Coronilla coronata* L., *Tephrosia biflora* DC) but the African ones are different. Also the specimens described as *Coronilla* sp. by van Zeist from Selenkahiye (Zeist van & Bakker-Heeres 1982/1985) differ by being much narrower (length/breadth ratio is 244–370). The size and shape variation does not exclude the possibility that the type NP-24 represents more than one species. Family identification reliable.

Leguminosae NP-30 type

Pl. 19 figs 4–6

Number of specimens. 32 seeds in 20 samples from one hut and 2 pits.

Description. Seeds cylindrical with both ends rounded or one end slightly flattened, radicle tightly adherent to the cotyledons. Testa surface usually damaged, when outer layer is preserved it is smooth (Fig. 26: 1–3) or shows very minute or coarse pits or transversal ribs (Fig. 26: 4–5, Pl. 19 figs 5–6). Size varies from 2.5 × 1.6 to 2.0 × 1.3 mm.

Discussion. The seeds of e.g. *Sesbania sesban* (L.) Merr. have similar shape but are much larger. The group may include 2–3 different species. Family identification reliable.

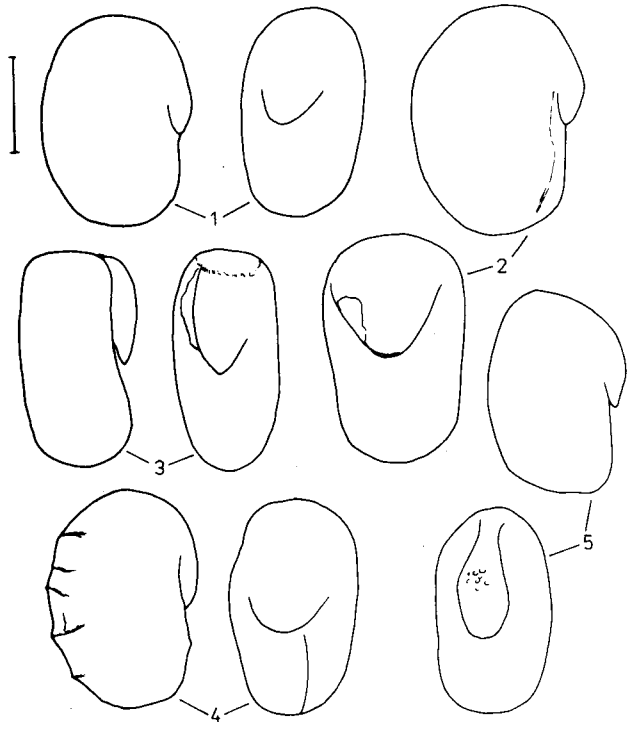

Fig. 26. Five seeds of Leguminosae NP-30 type from the lateral and hilum side, 1–3 – testa surface smooth, 4 – testa with transversal ribs, 5 – finely pitted testa; hut F 1/90. Scale equals 1 mm

Leguminosae indet.

Pl. 20 figs 1–2

Number of specimens. The group includes 104 seeds occurring in 38 samples from 8 huts and 3 pits.

Description. Seeds of different shapes and sizes (Fig. 27), often badly damaged and distorted by charring. Their size varies between 1.5 × 1.1 and 2.9 × 2.1 mm. Seeds represent a few species, some of them may belong to the other legume types distinguished here (e.g. to *Astragalus* type). Family determination fairly reliable.

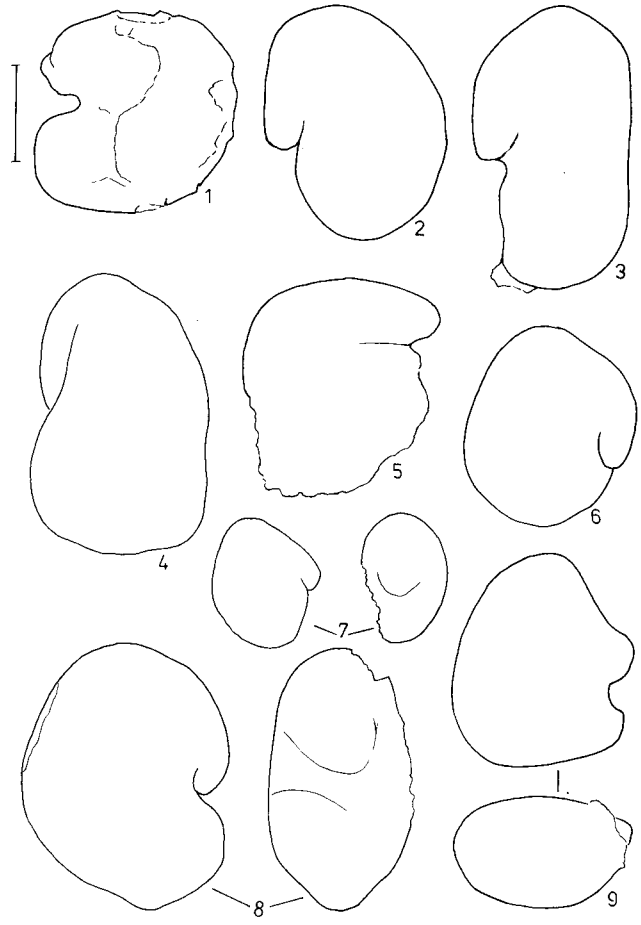

Fig. 27. Seeds of Leguminosae indet. in lateral view, hilum side shown for (7–8), apical view for (9). 1 hut F 75/1; 2–3, 5–6 and 8–9 hut F 1/90; 4 hut F 74/104; 7 pit 75/5. Scale equals 1 mm

MALVACEAE

Abutilon type

Pl. 19 fig. 3

Number of specimens. One seed in pit 75/P1.

Description. The seed reniform with protruding radicle, large hilum in indentation below radicle (Fig. 28: 1); surface smooth, outer layer of testa probably not preserved. Size 1.7 × 1.8 × 1.4 mm.

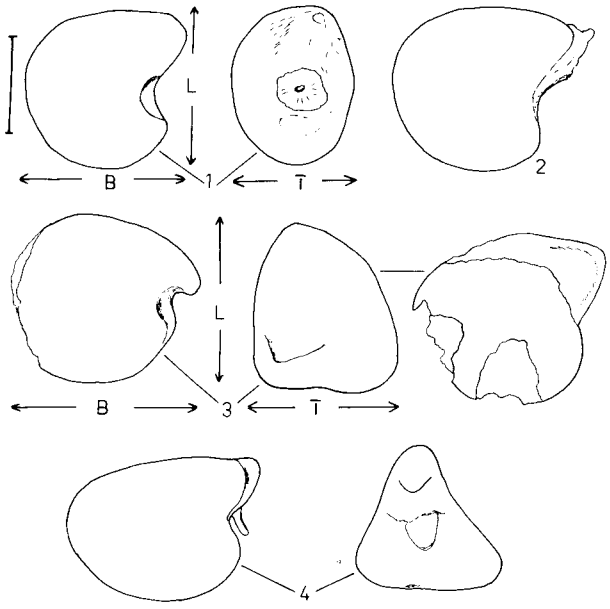

Fig. 28. 1 – *Abutilon* type, one fruitlet from the lateral and hilum side, hut F 75/1; **2** – fruitlet of extant *Abutilon longicuspe* Hochst from Nairobi in lateral view; **3** – *Sida* sp. one fruitlet from the lateral, hilum and bottom side, hut F 2/90; **4** – fruitlet of extant *Sida acuta* Burm. f. from Burkina Faso from the lateral and hilum side. L length, B breadth, T thickness. Scale equals 1 mm

Discussion. Out of six species which occur in Egypt at present only 2 were seen, *Abutilon longicuspe* Hochst. and *A. theofrasti* Medik. The ancient specimen resembles seeds of the former in shape and size (Fig. 28: 2) and is much smaller than seeds of the latter. Seeds of similar shape, but bigger, occur also in the genera *Hibiscus* and *Pavonia*.

Distribution and ecology. *Abutilon theofrasti* is an annual plant, all other species present in modern flora of Egypt are shrubs. They grow in the Nile valley, in the oases of the Western Desert and in the Eastern Desert, none is common (Täckholm 1974, Boulos 1995), two of them occur in the central and southern Sahara (Ozenda 1983).

Present-day use. According to Schulz and Adamou (1992) two species are used as medicines in the Sahara, *Abutilon* cf. *fruticosum* Guill. et Perr. and *A. pannosum* (G. Forst.) Schltdl.

Sida sp.

Number of specimens. Two seeds in hut F 2/90 and pit 75/P5.

Description. Seeds almost circular in lateral outline, with a protruding radicle tip, thickest at the end opposite to the radicle (Fig. 28: 3); inflated due to charring. Seed surface damaged. Size: length 1.85 mm, breadth (including radicle tip) 2.0 mm, thickness 1.7 mm, the same dimensions for the other specimen are 2.0 × 2.3 × 1.9 mm.

Discussion. At present, four species grow in Egypt (Täckholm 1974, Boulos 1995), three of them were seen: *Sida alba* L., *S. rhombifolia* L. and *S. acuta* Burm. f. Flora of Sudan lists 8 species, three of them widespread (Andrews 1952), Ozenda (1983) does not record the genus in the Saharan flora. On the basis of seed morphology species identification was not possible. The presence of *Sida alba*, the only common species in modern flora of Egypt, seems most likely.

Distribution and ecology. *Sida alba* is an annual or perennial herb occurring in tropical Africa, often as ruderal plant, on different substrata (Schulz & Adamou 1992). It is the only species of that genus mentioned in "The vegetation of Egypt" by Zahran and Willis (1992) as growing in the desert ecosystem of the Kharga and Dakhla oases, in a thin ground layer of the scrub community dominated by *Tamarix nilotica*. In Sudan it belongs to common weeds widespread in the Nile valley (Braun et al. 1991).

Present-day use. Leaves of *Sida alba* are used as medicine in Niger (Schulz & Adamou 1992).

NYCTAGINACEAE

Boerhavia sp.

(Previousely described as the NP-18 type)

Pl. 20, figs 3–9

Number of specimens. The very frequent and abundant type, 1695 seeds in 9 huts and 4 pits, in a few samples present in larger quantities.

Description. The subfossil specimens show the characters typical for the family Nyctaginaceae. A propagule (anthocarp) is composed of a fruit enclosed in persistant calyx with 5 (sometimes 4) distinct coarse longitudinal ribs

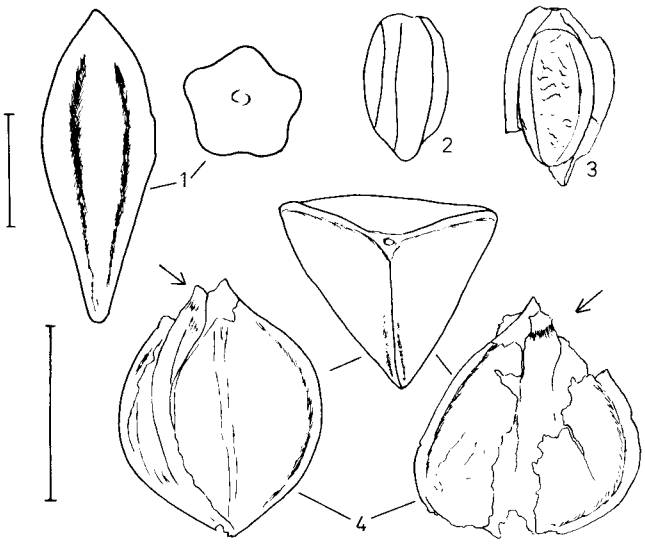

Fig. 29. 1–3 – *Boerhavia* sp. 1 – complete propagule and its cross section, 2 – conduplicate seed, 3 – fruit with calyx fragments, fruit surface shows transversal wrinkles; **4** – *Rumex* sp., one fruit in two lateral views and from the bottom; arrows point to the radicle tip. 1 and 3–4 hut F 1/90; 2 pit P 75/5. Scale equals 1 mm

(Fig. 29: 1, Pl. 20 figs 3–5). Several more or less complete propagules are found but most of the specimens represent fruits without calyx or naked seeds. The fruits are pentagonal (or tetragonal) in the cross section, 5 (or 4) walls are separated by delicate edges, the surface is transversally wrinkled (Fig. 29: 3, Pl. 20 figs 6–7). The seeds are conduplicate; radicle and cotyledons are visible (Fig. 29: 2, Pl. 20 fig. 8). Size of 10 complete propagules: length 2.54 (1.9–3.3) mm, breadth 1.05 (0.8–1.2) mm. Size of 10 seeds: length 1.29 (1.1–15) mm, breadth 0.65 (0.5–0.7) mm.

Discussion. Two genera from the family Nyctaginaceae occur in Egypt, *Boerhavia* (2 species) and *Commicarpus* (4 species) (Täckholm 1974, Boulos 1995). Very limited reference material included both Egyptian *Boerhavia* species, namely *B. diffusa* L. and *B. repens* L. *Commicarpus* was not seen. Identification of the genus seems fairly reliable.

Distribution and ecology. The subspecies of *Boerhavia repens* are perennial or annual plants growing in the deserts and the Nile valley, the subsp. *diandra* (L.) Maire & Weiller grows also as a weed of cultivated lands in the oases. The perennial *B. diffusa* occurs in the Nile valley (Boulos 1995, Zahran & Willis 1992).

Present-day use. Several species of *Boerhavia* have edible seeds and leaves (Knapp 1973, p. 17). Among plants collected in the Hoggar area for their seeds, Nicolaisen (1963) lists *B. agglutinans* and *B. repens*, Gast (1968) *B. coccinea* Mill. (*B. repens* L. subsp. *viscosa* (Choisy) Maire). Rich stands of these plants develop after rain. Acc. to Gast (1968) when the seeds are mature the whole plants are harvested, left in stacks to dry and then, they are threshed and seeds are winnowed. Flour made of seeds, with addition of dates to reduce unpleasant smell, is used to make cakes. Sometimes, a kind of gluey gruel is boiled from flour mixed with milk and cut into pieces when cooled. Seed gathering of several subspecies of *B. repens* is reported from Aïr Mountains where leaves are also used as a vegetable; the plant is grazed by sheep and goats (Schulz & Adamou 1992). The use of seeds mixed with cereals and other food is reported from the west Africa (Senegal and countries of the former French Sudan) by Dalziel (1955), who also mentions that, in North Nigeria, roots are added to cakes.

Boerhavia repens L. has medicinal properties (Boulos 1983).

POLYGONACEAE

Rumex sp.

Pl. 20 figs 10–11

Number of specimens. One fruit in hut F 1/90.

Description. The fruit is trigonous, broad-oval in outline, shortly narrowed at both ends; fruit edges sharp, distinctly separated from the rest of the fruit wall. The seed visible below broken pericarp has the radicle placed in the middle of one wall, its tip directed toward the fruit apex (Fig. 29: 4). This position of the embryo is typical for *Rumex* and differs the fruits of this genus from *Polygonum* and *Carex* (Martin & Barkley 1961). Pericarp surface damaged, more or less smooth or possibly with a very faint transversal wrinkles. Fruit length 1.5, breadth 1.35 mm.

Discussion. Eight species occur in the Egyptian flora, all are annuals (Boulos 1995). Only fruits of *Rumex vesicarius* L. were seen. It has much bigger fruits, about 3.6–3.8 mm long, gradually narrowed at the apex. This is a very common species in the whole Sahara (Ozenda 1983) but the fruit from Nabta Playa does not belong to it.

Present-day use. The information about

the gathering of *Rumex* for food in the Sahara area is scarce. Gast (1968) writes that in the Hoggar leaves of *R. vesicarius* are collected by the nomads only as a forage for camels but not for human consumption, while in the Tassili n'Ajjer the nomads sometimes eat them. Nicolaisen (1963), however, cites the information of Foley, from 1930, about eating of boiled leaves of *Rumex vesicarius* and *R. roseus* (*R. cyprius*) by people in the Hoggar.

RHAMNACEAE

Ziziphus sp.

Pl. 21

Number of specimens. *Ziziphus* is a frequent fossil at Nabta Playa, usually found in the form of fruit-stone pieces. The material includes 7 complete fruit-stones, over 670 pieces of various sizes and 24 seeds present in 8 huts and 4 pits. It was not possible to evaluate the number of complete fruit-stones and for the quantitative analyses numbers of fragments instead those of complete specimens were used. For this reason the number of *Ziziphus* fruits is overestimated and cannot be compared directly with the number of other plant remnants.

Description. The *Ziziphus* fruit is a fleshy drupe, 2-celled and 2-seeded. In the subfossil material 2 cells are visible in broken stones (Pl. 21 fig. 3). The stone surface has a coarse sculpture, typical for the genus (Pl. 21 fig. 1). Two narrow bands run from the stone base toward its top. A few specimens are preserved with the remnants of a fleshy epicarp, and its basal part with the attachement point surrounded by a collar-like rim is visible in one case (Pl. 21 figs 2, 4). The seeds are flattened, round or oval in outline (Pl. 21 figs 6–9). The size of one well preserved stone is 6.5 × 6.3 × 5.6 mm. The sizes of five seeds are 3.9 × 2.8, 3.8 × 3.2, 3.0 × 3.0, 2.9 × 2.8 and 2.2 × 1.8 mm.

Discussion. At present two *Ziziphus* species occur in Egypt, *Z. spina-christi* (L.) Desf., which grows in the whole country, and *Z. lotus* (L.) Lam., restricted to the Mediterranean coast (Boulos 1995). Flora of Sudan includes 5 species: *Z. mauritiana* Lam. in central and southern Sudan, *Z. abyssinica* Hochst. in central and southern Sudan, *Z. mucronata* Will. widespread, *Z. spina-christi* (L.) Willd. in northern and central Sudan and *Z. pubescens* Oliv. in Equatoria (Andrews 1952). Ozenda (1983) lists 3 species from the Sahara, two wild *Z. lotus* (L.) Desf. and *Z. mauritianus* Lam., and *Z. spina-christi* (L.) Desf. cultivated in the oases. In the available reference material no diagnostic features were found which would allow to distinguish species on the basis of fruit-stones alone. Taking into account the present day distribution and ecology, *Z. spina-christi* is the most likely species to have occurred at Nabta Playa. Archaeobotanical finds from other sites in Egypt and Sudan are usually included in this species.

Distribution and ecology. *Ziziphus spina-christi* is a common tree in Egypt, it grows in all deserts, in oases and wadis, as well as in the Nile valley (Boulos 1995, Täckholm 1974, Zahran & Willis 1992).

Present-day use. There are several ethnographic records concerning the use of *Ziziphus spina-christi* and *Z. mauritiana* in Africa. Fruits may be eaten in fresh or dried condition without any preparation. Dried fruit pulp may be pounded in a mortar to obtain flour used for making porridge or cakes. Stones are collected to get seeds which are added to the syrup made of sugar extracted from fruits and eaten as nougat (Tubiana & Tubiana 1977). Poor people in the Hoggar area collect *Ziziphus* fruits and store them for some time (Gast 1968). Fruits, leaves and ash from wood are used as medicines (Boulos 1983).

At Nabta Playa *Ziziphus* is preserved almost exclusively in the form of crushed stones. The same situation was observed by Magid (1989) in the Sudanese sites. This might suggest purposeful crushing of the fruit-stones in order to get the seeds out of them. However, spontaneous breaking of charred stones in the deposit is also possible; it has been observed that a few specimens found as complete stones distintegrated immediately after being picked up from the soil.

SOLANACEAE

Hyoscyamus cf. ***muticus*** L.

Pl. 20 figs 12–13

Number of specimens. 3 seeds in hut F 3/90.

Description. Seeds oval-triangular in outline, slightly flattened from lateral sides, elongated and compressed toward the hilum,

thicker and rounded on the opposite side. Very pronounced sculpture has the form of a coarse reticulum. Size: 1.3 × 1.0, 1.3 × 0.8 and 1.05 × 0.85 mm. The sculpture is coarser and seeds are larger than the specimens described here as *Solanum* cf. *nigrum*.

Discussion. Seven species occur in Egypt at present (Täckholm 1974), only *Hyoscyamus muticus* is common. The specimens from Nabta Playa are very similar to the seeds of this species but other species were not seen.

Distribution and ecology. *Hyoscyamus muticus* is a perennial plant which grows on salt and fresh sandy soils in the Western and Eastern Deserts, in oases and in the Nile valley (Zahran & Willis 1992, Boulos 1995). This is the only species of that genus mentioned in the flora of Sahara by Ozenda (1983) and described as common in the whole northern and central parts of the desert.

Present-day use. It is a poisonous plant, used for poisoning people, but has also medicinal properties (Boulos 1983, Schulz & Adamou 1992).

Solanum cf. ***nigrum*** L.

Pl. 20 figs 14–15

Number of specimens. 2 seeds in hut F 1/90 and pit P 2/90.

Description. Seeds laterally flattened, elongated near hilum. Surface sculpture in the form of a reticulum, distinct but less coarse than in the specimens determined as *Hyoscyamus*. Size: over 1.0 × 0.8 mm.

Discussion. Most of the ten *Solanum* species present in Egypt are rare or very rare, only *S. nigrum* is very common and *S. incanum* L. common (Täckholm 1974). The last mentioned species is excluded because of its much bigger and more rounded seeds; the size and shape of the subfossil specimen are very similar to *S. nigrum*, other species were not seen.

Distribution and ecology. *Solanum nigrum* is an annual plant which occurs in Egypt in all phytogeographical regions, including the deserts and the Nile valley (Boulos 1995). It grows in different natural habitats and as weed of cultivation (Zahran & Willis 1992). This is the only species of *Solanum* included in the flora of Sahara by Ozenda (1983) who writes that the plant occurs here and there in the north and central Sahara, near inhabited areas, probably as adventive species.

Present-day use. In Africa young leaves and fruits are collected for human food. Leaves and fruits are used as medicines, berries have narcotic properties and seeds act as aphrodisiac (Boulos 1983, Schulz & Adamou 1992).

TILIACEAE

cf. ***Grewia*** sp.

Pl. 22 figs 1–5

Number of specimens. Four fruit fragments in 3 samples from hut F 1/90 and in one additional sample, 4 seeds in four other samples from huts F 1/90, F 2/90 and F 74/104.

Description. Fruit fragments have a thin, smooth exocarp, longitudinally striated mesocarp built of more or less paralell anastomosing fibres and a thick, hard endocarp (Fig. 30: 1, Pl. 22 figs 1–4). The innermost layer which surrounds the seed cell, has a smooth surface with the delicate pattern resembling finger prints. The size of fruit half is 4.7 × 3.5 mm, breadth of the largest fragment 4.8 mm.

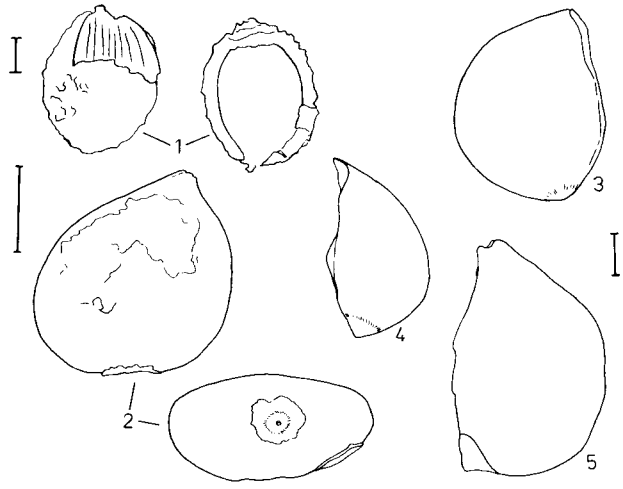

Fig. 30. 1–2 – cf. *Grewia* sp. from hut F 1/90. 1 – half of a fruit from two sides, 2 – one seed from the broad side and from the side of attachement scar, **3** – one broken seed of extant *Grewia asiatica* L., **4–5** – two broken seeds of extant *G. liliacina* K. Schum. Scale bars equal 1 mm

The seeds are laterally flattened, broad ovate in the lateral outline, gradually narrowed at the apex, narrow oval in cross section (Pl. 22 fig. 5, Fig. 30: 2). The attachement point and the seed apex are placed assymetrically. The outer testa layer is damaged. Size: 2.5 × 2.2, 2.8 × 2.4, 2.6 × 2.1 and 2.4 × 2.3 mm.

Discussion. The subfossil fruit fragments

resemble drupes of *Grewia* which have similar 3 layers of pericarp but the original shape of the whole fruit cannot be reconstructed from preserved pieces. The seeds are very similar to those of *Grewia*, though smaller than the modern material. Four African species were seen, *G. tenax* (Forssk.) Fiori, *G. mollis* A. Juss., *G. woodiana* K. Schum. and *G. liliacina* K. Schum., but the close match was not found. Shape of seeds is very characteristic for *Grewia* but the identification of fruit fragments seems uncertain.

Distribution and ecology. Three species of *Grewia* occur in the present-day flora of Egypt, all are shrubs recorded only from the area east of the Nile (Boulos 1995). The occurrence of *G. tenax* (Forssk.) Fiori, having the widest distribution, is most likely. In Egypt it grows on the north facing slopes of coastal hills, in mountain foothills, and in the mountains (Zahran & Willis 1992). Its general range covers tropical Africa, including i.a. south Sahel from Mauretania to Ethiopia. It is widespread in the northern and southern Sudan (Wickens 1976) where its fruits ripen in September-October, shortly before the millet harvest (Tubiana & Tubiana 1977).

Present-day use. Sweet fruits of a few *Grewia* species are collected in many parts of Africa as an important source of sugar. Zaghawa people consume three species, includning *G. tenax*. They eat sweet flesh of fresh fruits, while dried fruits are stored and sugar is extracted from them by soaking in water or boiling. The syrup is added to tea or porridge (Tubiana & Tubiana 1977). Dried fruits may be also ground in a mortar and added to the flour made of cereals (Gast 1968). People of North Niger consume *Grewia* fruits in fresh or dried condition, they add them also to sour milk; the fruits have medicinal properties (Schulz & Adamou 1992).

Wood charcoal of cf. *Grewia tenax* was found at the site Abu Ballas, southwestern Egypt, dated to 6 800 bp (Neumann 1989b).

Morphological types of seeds and fruits of unknown taxonomic alliance

NP-25 type

Number of specimens. 6 fruits in 5 samples from 2 huts and one pit.

Description. Fruits almost circular in outline when viewed from one side, broad oval from the other, with a thickening (rib) or more or less sharp edge at the circumference (Fig. 31: 1–2). The slight elongation at one end

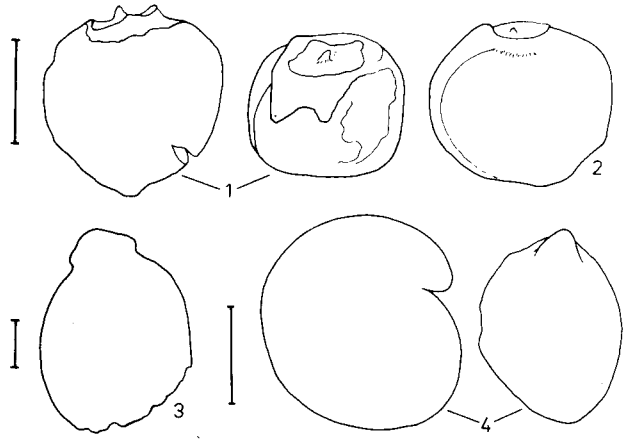

Fig. 31. Diaspores classified as morphological types. **1–2** – NP-25 type, two fruits; **3** – NP-26 type, fruit or seed; **4** – NP-40 type, one seed. 1 hut F 2/90; 2 pit P 75/5; 3 hut F 75/1; 4 hut F 1/90. Scale bars equal 1 mm

may represent the attachement point, the small stalk surrounded by a collar-like rim at the other end may be basal part of a style but the opposite orientation is also likely. Size: 1.8 × 1.7 × 1.4, 1.9 × 1.8 × 1.4, 1.9 × 1.6 × 1.2, 1.8 × 1.6 × 1.4, 1.6 × 1.55 × 1.3 mm.

NP-26 type

Number of specimens. One specimen in hut F 75/1.

Description. Fairly large fruit or seed, oval in one and almost circular in the other section (Fig. 31: 3). Partly damaged seed/fruit coat, elongated at one end, with no sculpture on the surface, surrounds one large ovoid seed or embryo. Size: 4.2 × 3.2 mm.

NP-28 type

Pl. 23 figs 1–8

Number of specimens. 61 seeds in 6 huts and 2 pits.

Description. The specimens found represent probably the seed embryos. The flat cotyledons, circular or oval in outline, stick to each other with broad surfaces and form two lobes on each side of a centrally placed radicle (Fig. 32: 2–4, Pl. 23 figs 3–6). One specimen is composed of two seeds, one smaller (aborted?) and one normally developed (Fig. 32: 5, Pl. 23 fig. 2) which might indicate that fruits were

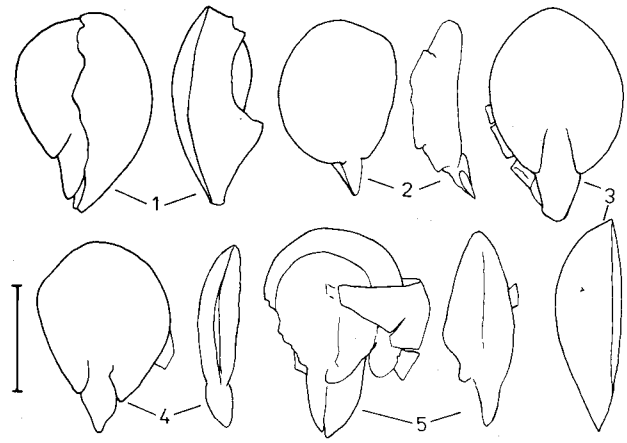

Fig. 32. Diaspores classified as morphological types. Five seed embryos of the NP-28 type from hut F 2/90. 1 – one embryo with best preserved outer layer (fruit or seed coat?), 2–5 – embryos in two views showing radicle between the two lobes of cotyledons, 5 – specimen with two radicles and remnants of outer coat, probably two seeds of unequal sizes stick to each other. Scale bar equals 1 mm

probably 2-seeded. The outer coat remains (pericarp ?), preserved in a few specimens, show that fruits must have been relatively flat, obovate, symmetrical or assymetrical in outline, with a sharp margin, with or without a wing (Pl. 23 figs 1, 7). Size of 12 embryos: 1.89 (1.50–2.25) × 1.23 (0.90–1.65) mm.

Discussion. Fairly variable seed shapes suggest that more than one species may be present.

NP-34 type
(Previousely described as *Cleome / Gynandropsis* type)
Pl. 22 figs 6–8

Number of specimens. 5 seeds in 4 samples from two huts.

Description. Seeds discoid, laterally compressed, more so towards the radicle (Fig. 33: 1–2); seed outline almost circular, with incision at the radicle tip which is slightly incurved. The surface is covered with an irregular reticuloid pattern. Size of four specimens: 0.6 × 0.65, 0.65 × 0.85, 0.7 × 0.75 and 0.8 × 0.8 mm.

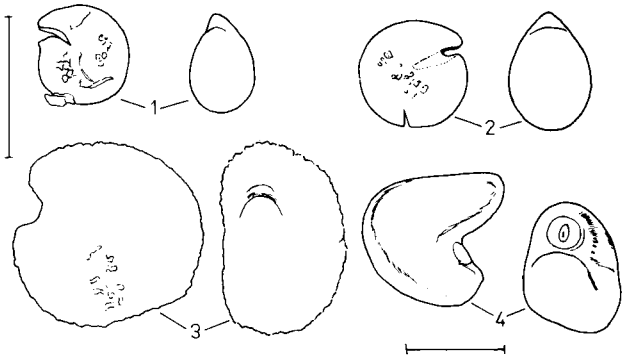

Fig. 33. Diaspores classified as morphological types. **1–2** – NP-34 type, two seeds from hut F 1/90, **3** – NP-36 type, one seed from hut F 77/2, **4** – NP-37 type, one seed or fruit from hut F 1/90. Scale bars equal 1 mm, lower bar for No. 4

Discussion. Seed shape slightly resembles that of *Cleome* but subfossil specimens have completely different surface sculpture and a smaller size.

NP-35 type
(Previousely described as *Cleome / Gynandropsis* type)
Pl. 22 figs 9–13

Number of specimens. 7 seeds in 6 samples from three huts.

Description. Seeds discoid, slightly compressed laterally, more so towards the radicle; seed outline circular to broad oval, incision at the radicle tip broad, radicle almost straight, surface covered with a distinct reticulum (Fig. 34). Size of 7 seeds: 0.93 (0.85–1.05) × 0.94 (0.8–1.05) mm.

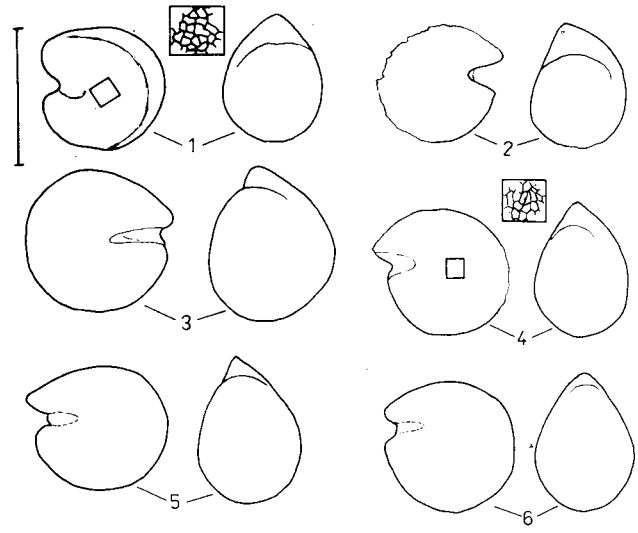

Fig. 34. Diaspores classified as morphological types. Six seeds of the NP-35 type; 1–3 hut F 1/90; 4 hut F 74/117; 5–6 hut F 3/90. Scale bar equals 1 mm

Discussion. Seeds similar to the NP-34 type but bigger, thicker in the cross section, with much more pronounced sculpture and different appearance of the area around radicle tip. Seed shape slightly resembles that of *Cleome* but subfossil specimens have a completely different surface scultpure and a smaller size.

NP-36 type
(Previousely described as *Cleome/Gynandropsis* type)
Pl. 22 fig. 14

Number of specimens. One seed in hut F 77/2.

Description. Seed discoid, laterally flattened, circular in outline with a slight incision at the radicle tip (Fig.33: 3). Surface covered with the very characteristic papillae, more or less irregularly distributed. Size: 1.4 × 1.45 mm.

Discussion. Slightly similar sculpture appears in the seeds of some *Mesembryanthemum* species which, however, have papillae arranged in lines paralell to the seed circumference.

NP-37 type
(Previousely described as Malvaceae type)
Pl. 22 fig. 15

Number of specimens. One seed in hut F 1/90.

Description. Seed characteristically incurved, round hilum on the concave side of the broader end (Fig. 33: 4), convex side thick; seedcaot with cracks, surface with a very fine reticuloid pattern (muri concave) but the outer testa layer may be missing. Size: length 1.45 mm, breadth 1.2 mm, thickness 1.05 mm.

NP-40 type
Pl. 22 fig. 18

Number of specimens. One complete and 2 fragments of seeds in one sample from hut F 1/90.

Description. Lense-like seed with almost circular outline, radicle slightly protruding (Fig. 31: 4). No sculpture preserved. Size: 2.3 × 2.0 mm.

NP-43 type
Pl. 23 figs 11–12

Number of specimens. One specimen found in additional sample outside hut F 1/90.

Description. The specimen represents probably a fruit, ovate or obovate in the outline. Broad, low rib runs along the circumference (Fig. 35: 1). Surface covered with shallow, broad depressions (rugose sculpture). Size: length 3.95, breadth 2.8, thickness 1.9 mm.

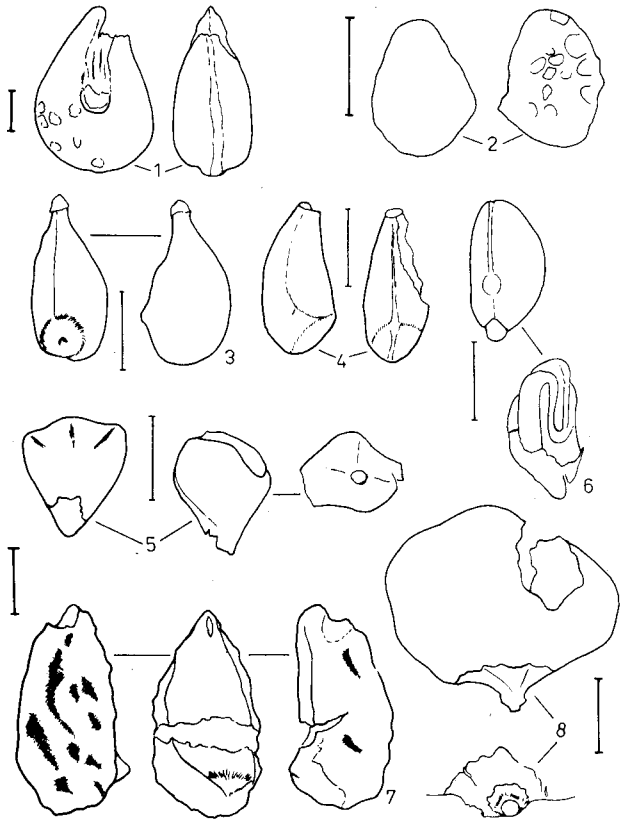

Fig. 35. Diaspores classified as morphological types. **1** – NP-43 type, one fruit/seed; **2** – NP-44 type, one fruit/seed; **3–4** – NP-51 type, two fruits; **5** – NP-52 type, one fruit/seed; **6** – NP-53 type, one fruit/seed from two sides showing rolled up cotyledons (lower row); **7** – NP-49 type, one fruit; **8** – NP-45 type, two-cell berry-like fruit, details of the attachement point show the remnants of damaged outer layer. 1 and 8 additional samples; 2 pit P75/5; 3 and 5 hut F 2/90; 4 and 6 hut F 1/90; 7 pit P 1/90. Scale bars equal 1 mm

NP-44 type

Number of specimens. 2 fruits in hut F 1/90 and pit P75/5.

Description. The shape of fruits is similar to that of *Potentilla* but surface sculpture is made of shallow irregular depressions and ridges (Fig. 35: 2). Size: 1.2 × 0.95 × 0.9 and 1.4 × 0.95 × 0.95 mm.

NP-45 type
Pl. 22 figs 16–17

Number of specimens. 7 fruits in 4 samples from huts F 1/90 and F 2/90 and 9 in 2 additional samples.

Description. Berry-like fruits of spherical shape with the attachement point in the form of a stalk (Fig. 35: 8). One immature fruit is complete, the other specimens are only smaller or bigger fruit pieces. Outer surface smooth or uneven (undulated), dull, pericarp filled with a

structureless, highly lustrous substance. The size of the best preserved specimen is 3.1 × 2.8 × 2.4 mm, of the immature one is 2.2 × 2.2 1.9 mm, and of the biggest fragment 4.2 × 3.2 × 3.3 mm.

NP-49 Type

Number of specimens. 4 specimens in hut F 2/90 and pit P 1/90.

Description. The specimens probably represent fruit-stones with a thick wall and a coarse sculpture on the surface (Fig. 35: 7).

NP-50 type

Pl. 24 figs 1–4

Number of specimens. 12 specimens in huts F 1/90 and F 77/5.

Description. Fruits or seeds broad oval, slightly flattened, one end narrowly rounded, the other one truncated with a depression in the centre. Surface covered with characteristic fine wrinkles (Pl. 24 fig. 4). A few specimens tend to split in two cotyledons (as e.g. in the family Leguminosae). Two specimens have small pieces of a thick outer layer covering the wrinkled surface (Pl. 24 figs 2–3). The presence of an external wall fragments shows that preserved specimens are seeds or the inner fruit portions. Size: 3.5 × 2.6, 2.7 × 2.2, 3.6 × 1.85 and 3.8 × 2.8 mm.

NP-51 type

Pl. 23 fig. 9

Number of specimens. 2 fruitlets in huts F 1/90 and F 2/90.

Description. The fruitlets slightly resemble mericarps of the Umbelliferae family, being narrowly elongated at one and broadly rounded at the other end. However, the inner (presumed commissural) face of fruitlets is roof-like convex with a distinct longitudinal ridge, while the commisural face in Umbelliferae fruits is plane or concave. Size 2.3 × 1.1 and 2.3 × 1.15 mm.

NP-52 type

Pl. 23 fig. 10

Number of specimens. 2 seeds or fruits in huts F 1/90 and F 2/90.

Description. The very characteristic seeds or fruits have the shape of the two low pyramids adhering to each other with the broadest faces (Fig. 35: 5). The scar at one end is probably an attachment point, the outer layer of the coat is missing. Size: 1.3 × 1.1 × 0.9 and 1.25 × 1.15 × 1.0 mm.

NP-53 type

Pl. 23 fig. 13–14

Number of specimens. 13 fruits/seeds in hut F 1/90.

Description. The shape slightly resembles fruits of the Labiatae family (*Salvia* or *Stachys* type), with curved cotyledons and radicle (Fig. 35: 6). Poor preservation makes the identification impossible. Size of 7 specimens: 1.55 × 1.1, 1.5 × 1.0, 1.7 × 0.9, 1.4 × 0.9, 1.6 × 1.0, 1.55 × 0.95 and 1.6 × 0.95 mm.

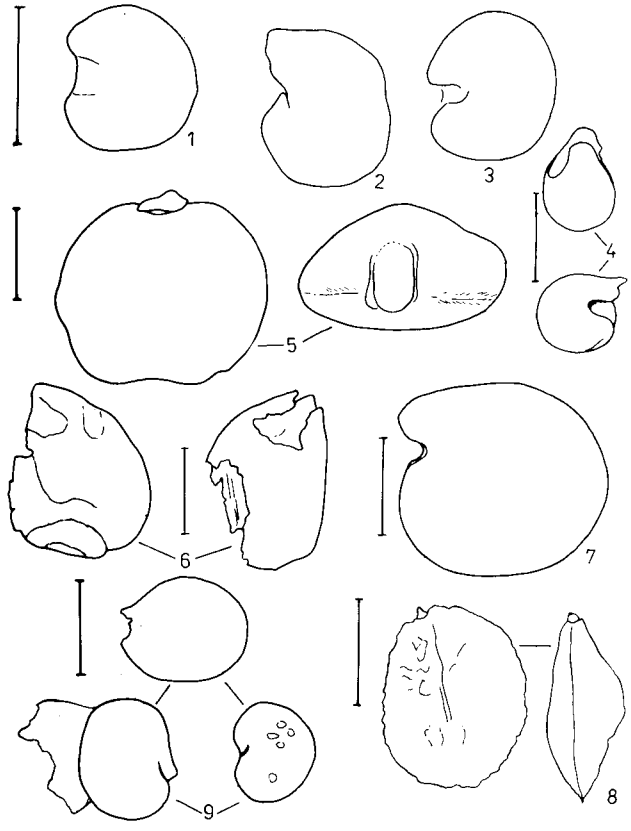

Fig. 36. Unknown seeds or fruits. **1** – seed from hut F 1/90; **2–3** – seeds from hut F 77/5; **4** – seed from pit P 2/90; **5** – fruit or seed from hut F 77/5 (see also Plate 24 figs 13–14); **6–8** – fruits or seeds from hut F 1/90; **9** – seeds from hut F 74/104 (see also Pl. 24 figs 11–12). Scale bars equal 1 mm

Undetermined seeds and fruits

Certain number of diaspores could not have been consistently recognized and counted in all samples due to their damage or not quite distinct characteristics. Some of those specimens preserved in poor condition may belong

to the taxa already described while the others represent approximately 20 other species. Selected specimens are illustrated in Plate 24 figs 5–18 and Figure 36.

Tubers and rhizomes

Tubers and rhizomes from site E-75-6 were studied by J. Hather who presented their detailed description (Hather 1995, in prep.). Here only a few specimens are illustrated.

The most frequent were tubers of *Cyperus rotundus* L. (Pl. 25 figs 3–6). A few complete and numerous tuber fragments were present in over 30 samples from different huts and pits. The large tuber fragment found by H. Barakat in a charcoal sample from hut F 1/90 is 8.3 mm long and 4.3 mm broad (Pl. 25 figs 4–6). Its outer side is covered with a paralell striation interrupted at 5 nodes, one lateral bud and scars of the two other buds are visible. Broad attachement scar is present at one end, the other end is broken. It resembles very much the extant specimen found on an island near Asswan by L. Kubiak-Martens (Pl. 25 figs 7–8). Smaller tuber pieces have characteristic outer layer consiting of parallel fibres.

The other subterranean plant organs identified by Hather were tubers of Gramineae (Pl. 26 fig. 3), fragments of *Typha* sp. and *Nymphaea* sp. rhizomes, isolated aerenchyma of an aquatic plant (possibly *Alisma*) and a fragment of tissue which could belong to a fern (Hather 1995). Two tuber fragments possibly belonged to *Scirpus* sp. (Pl. 26 figs 1–2; Hather pers. com.).

Coprolites ?

Quite frequent at site E-75-6 were charred specimens very much resembling specimens described by Hillman from the Palaeolithic site Wadi Kubbaniya as bird feces, probably belonging to waterfowl, e.g. from the families Anserinae or Anatinae (Hillman et al. 1989b, Fig. 7.3). Specimens from Nabta Playa have the shape of a half or a new moon, their surface is sculptureless or has transversal ribs on the convex side (Pl. 26 figs 5–10). In a few cases two specimens adhere together. No internal structure can be seen on the fructure. The size is variable, the diameter of 29 specimens equals 2.84 (1.3–5.3) mm. They were represented by 63 specimens in 39 samples from 7 huts and 3 pits.

The specimens from both sites could come from different avian species because the coprolites from Wadi Kubbaniya are bigger on the average (3–6 mm in diameter) and no signs of any sculpture are mentioned in Hillman's description. Modern specimens (coprolites?) similar in shape were found on an island near Asswan by L. Kubiak-Martens in 1992, together with tubers of *Cyperus rotundus* (Pl. 26 figs 11–12).

GENERAL CHARACTERISTICS OF THE FLORA

Plants identified from site E-75-6 (Table 2) belong to 19 families. The three with the largest number of taxa are Gramineae (over 24 taxa), Leguminosae (over 16 taxa) and Cyperaceae (over 10 taxa). The first two families belong to the richest in the present day Saharan flora (Ozenda 1983) and include several useful plants, collected from wild stands. It seems that their abundance at Nabta Playa reflects, in the first place, their economic significance and not the role played in the natural flora. The fairly rich representation of Cyperacae, on the other hand, may be due to the local ecological situation, many species of the sedge family growing in moist places, although some of them are also exploited by man.

On the basis of seeds and fruits 9 taxa were identified to the level of species and 17 to that of genus (in both cases including cf. and type), 23 to higher units (tribes, families), 16 as morphological types and the presence of about 20 other kinds of seeds or fruits was noted. Besides, some of the identified taxa (e.g. grains of Gramineae indet.) represented more than one species. By including results based on the analyses of wood charcoal (Barakat 1995a, b) and tubers and rhizomes (Hather 1995, in prep.) the number of taxa increases by 8 species and 4 genera. These numbers allow the minimum number of species present in the charred assemblage to be estimated at about 127. Assuming that this rough estimate approximately reflects the diversity of the subfossil flora, we must acknowledge that only about 30% of the taxa (13% of species, 16% of genera) were identified with an accuracy sufficient to allow paleoecological reconstructions to be made.

The number of diaspores representing indi-

Table 2. Flora of site E-75-6 at Nabta Playa. The list includes all plant remains: identification of seeds and fruits K. Wasylikowa, wood charcoals H. Barakat (1995a, b), tubers, rhizomes, parenchyma and aerenchyma J. Hather (1995 and unpubl.). The species most likely to have occurred and the suggested occurrence of more than one species are indicated. Kind of remains: ae – aerenchyma, ch – wood charcoal, f – fruit, p – parenchyma, rh – rhizome, s – seed, t – tuber, vb – tissue fragment with vascular bundle(?)

ALISMATACEAE

Alisma type?, ae

BORAGINACEAE

cf. *Arnebia hispidissima* (Lehm.) DC, f
cf. *Heliotropium* sp., f, 1 or 2 species

CAPPARACEAE

Capparis sp. (probably *C. decidua* (Forssk.) Edgew.), s
Capparis decidua (Forssk.) Edgew., ch

COMPOSITAE

Compositae A type, f
Compositae B type, f, 1 or a few species
Compositae C type, f

CRUCIFERAE

Schouwia purpurea (Forssk.) Schweinf., s

CUCURBITACEAE

Cucurbitaceae indet., s

CYPERACEAE

Cyperus cf. *rotundus* L., t, p
Fuirena type, f
Scirpus maritimus L., f
cf. *Scirpus* sp. ?, t
Cyperaceae A type, f
Cyperaceae B type, f
Cyperaceae C type, f
Cyperaceae D type, f
Cyperaceae E type, f
Cyperaceae F type, f
Cyperaceae NP-21 type, s, f, 1 or a few species

GRAMINEAE

Brachiaria sp., f
Digitaria type, f, 1 or a few species
Echinochloa colona (L.) Link., f
Panicum turgidum Forssk., f
Setaria type, f
Sorghum bicolor (L.) Moench. subsp. *arundinaceum* (Desv.) de Wet & Harlan, f
Urochloa sp., f
Paniceae A type, f
Paniceae B type, f
Paniceae indet., f
Gramineae indet., f, t, at least 14 species

LABIATAE

Salvia/Stachys type, f
Labiatae/Boraginaceae type, f, 3 species

LEGUMINOSAE

Acacia ehrenbergiana Hayne, ch
A. nilotica (L.) Delile, ch
A. tortilis (Forssk.) Hayne subsp. *raddiana* (Savi), Brenan, ch
Acacia sp., ch
cf. *Astragalus vogelii* (Webb) Bornm., s
Astragalus type, s, 2 species
Coronilla scorpioides (L.) Koch. type, s
Indigofera type, s, 2 species
Senna alexandrina Mill. (*Cassia senna* L.), ch
Trifolieae tribe, s
Leguminosae NP-9 type, s
Leguminosae NP-13 type, s, a few species
Leguminosae NP-19 type, s, 1 or a few species
Leguminosae NP-24 type, s, 1 or a few species
Leguminosae NP-30 type, s, 2 or 3 species
Leguminosae indet., s, a few species

MALVACEAE

Abutilon type, s
Sida sp. (probably *S. alba* L.), s

NYMPHAEACEAE

Nymphaea sp. (probably *N. coerulea* Savigny), rh

NYCTAGINACEAE

Boerhavia sp. (*B. repens* L. or *B. diffusa* L.), f

POLYGONACEAE

Rumex sp., f

PTERIDOPHYTA

Pteridophyta indet.?, vb

RHAMNACEAE

Ziziphus sp. (probably *Z. spina-christi* (L.) Desf.), f, s

SALVADORACEAE

Salvadora persica L., ch

SOLANACEAE

Hyoscyamus cf. *muticus* L., s
Solanum cf. *nigrum* L., s

TAMARICACEAE

Tamarix sp., ch

TILIACEAE

cf. *Grewia* sp. (probably *G. tenax* (Forssk.) Fiori), f, s

TYPHACEAE

Typha sp. (probably *T. domingensis* (Pers.) Poir.), rh

UNDETERMINED

About 36 taxa represented by seeds/fruits

Table 3. Quantitative occurrence of seeds and fruits in all features from site E-75-6 at Nabta Playa. Abundance – number of specimens in percentage of the total of specimens, frequency – number of samples containing a taxon in percentage of the total of samples

	Number of specimens	Abundance	Number of samples	Frequency
Abutilon type	1	0.00	1	0.27
cf. *Arnebia hispidissima*	630	3.08	152	40.97
cf. *Astragalus vogelii*	6	0.03	5	1.35
Astragalus type	7	0.03	4	1.08
Boerhavia sp.	1695	8.30	179	48.25
Brachiaria sp.	20	0.10	17	4.58
Capparis sp.	295	1.44	86	23.18
Compositae A type	1	0.00	1	0.27
Compositae B type	18	0.09	6	1.62
Compositae C type	9	0.04	9	2.43
Coronilla scorpioides type	1	0.00	1	0.27
Cucurbitaceae indet.	54	0.26	43	11.59
Cyperaceae A type	5	0.02	3	0.81
Cyperaceae B type	1	0.00	1	0.27
Cyperaceae C type	5	0.02	3	0.81
Cyperaceae D type	2	0.01	1	0.27
Cyperaceae E type	2	0.01	2	0.54
Cyperaceae F type	4	0.02	3	0.81
Cyperaceae NP-21 type	1963	9.61	140	37.74
Digitaria type	62	0.30	34	9.16
Echinochloa colona	2806	13.74	187	50.40
Fuirena type	69	0.34	18	4.85
Gramineae indet.	40	0.20	26	7.01
cf. *Grewia* sp.	6	0.03	6	1.62
cf. *Heliotropium* sp.	6	0.03	5	1.35
Hyoscyamus cf. *muticus*	3	0.01	3	0.81
Indigofera type	20	0.10	12	3.23
Labiatae/Boraginaceae type	4	0.02	3	0.81
Leguminosae indet.	104	0.51	46	12.40
Leguminosae NP-9 type	393	1.92	96	25.88
Leguminosae NP-13 type	62	0.30	31	8.36
Leguminosae NP-19 type	130	0.64	84	22.64
Leguminosae NP-24 type	430	2.10	118	31.81
Leguminosae NP-30 type	32	0.16	17	4.58
Paniceae A type	12	0.06	4	1.08
Paniceae B type	34	0.17	26	7.01
Paniceae indet.	50	0.24	24	6.47
Panicum turgidum	576	2.82	112	30.19
Rumex sp.	1	0.00	1	0.27
Salvia/Stachys type	8	0.04	6	1.62
Schouwia purpurea	7588	37.14	226	60.92
Scirpus maritimus	46	0.23	15	4.04
Setaria type	33	0.16	18	4.85
Sida sp.	2	0.01	2	0.54
Solanum cf. *nigrum*	2	0.01	2	0.54
Sorghum bicolor ssp. *arundinaceum*	821	4.02	186	50.13
Trifolieae	1560	7.64	194	52.29
Urochloa sp.	7	0.03	6	1.62
Ziziphus sp.	676	3.31	122	32.88
NP-25 type	6	0.03	6	1.62
NP-26 type	1	0.00	1	0.27

Table 3. Continued

	Number of specimens	Abundance	Number of samples	Frequency
NP-28 type	61	0.30	25	6.74
NP-34 type	5	0.02	4	1.08
NP-35 type	7	0.03	6	1.62
NP-36 type	3	0.01	3	0.81
NP-37 type	1	0.00	1	0.27
NP-40 type	2	0.01	1	0.27
NP-44 type	2	0.01	2	0.54
NP-45 type	7	0.03	4	1.08
NP-49 type	3	0.01	3	0.81
NP-50 type	12	0.06	9	2.43
NP-51 type	2	0.01	2	0.54
NP-52 type	2	0.01	2	0.54
NP-53 type	13	0.06	4	1.08
Total	20429		371	

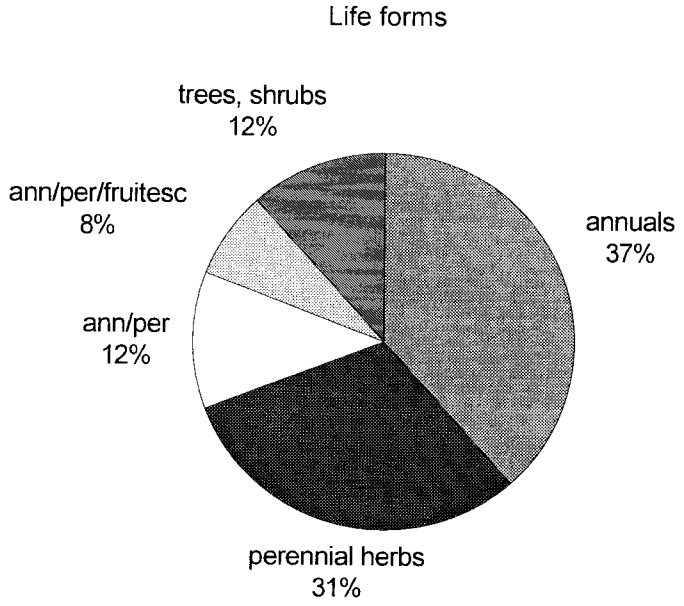

Fig. 37. Biological spectrum of the flora from site E-75-6, Nabta Playa

vidual taxa varied from 1 to over 7500, constituting 0.01 to 37.14% of the total specimen number present in all samples (Table 3). Four taxa were very frequent, occurring in over 50% of the samples, namely *Schouwia purpurea*, Trifolieae, *Echinochloa colona* and *Sorghum bicolor* subsp. *arundinaceum*. Another 11 taxa were frequent, present in 10–50% of the samples and 23 taxa occurred sporadically, in less that 1% of the samples.

The biological spectrum of the flora (Fig. 37) shows almost equal numbers of annual and perennial herbs. The group of annuals includes some abundant and frequent species, which were gathered as wild cereals, like *Echinochloa colona* and *Sorghum*, or were used for some other purpose like *Schouwia purpurea* and cf. *Arnebia hispidissima* (Table 4). Important economic plants are to be found also among the perennials. Here belong plants collected for their fruits, like *Panicum turgidum* and perhaps *Scirpus maritimus*, as well as those gathered for their tubers or rhizomes (*Cyperus rotundus*, *Nymphaea* sp., *Typha* sp.). Among perennial or annual species having edible fruits, there are some other grasses (*Digitaria* sp., *Urochloa* sp.) and *Boerhavia* sp. The high number of trees and shrubs results

Table 4. Possible ways of use of plants found at site E-75-6, Nabta Playa based on ethnographic and archaebotanical evidence (for details see the chapter "Systematic description of the flora")

Wild cereals:

Echinochloa colona
Sorghum bicolor ssp. *arundinaceum*
Panicum turgidum
Digitaria type
Setaria type
Brachiaria type
Urochloa sp.
Paniceae A type
Paniceae B type
Paniceae indet.

Other human foods:

Seeds
Boerhavia sp.
Scirpus maritimus
Trifolieae
Ziziphus sp.
Green parts
cf. *Astragalus vogelii*
Boerhavia sp.
Rumex sp.
Schouwia purpurea
Solanum cf. *nigrum*
Fresh or dried fruits
Capparis sp.
cf. *Grewia* sp.
Ziziphus sp.
Tubers, rhizomes
Cyperus cf. *rotundus*
Nymphaea sp.
cf. *Scirpus* sp.
Typha sp.
Gramineae indet.

Possible use for food

Compositae A type
Compositae B type
Compositae C type
Cucurbitaceae (other than *Citrullus*)
Cyperaceae NP-21 type

Possible medicinal use

Abutilon type
Boerhavia sp.
Capparis sp.
cf. *Grewia* sp.
cf. *Heliotropium* sp.
Hyoscyamus cf. *muticus*
Indigofera type
Panicum turgidum
Schouwia purpurea
Sida sp.
Solanum cf. *nigrum*
Trifolieae

Dye extraction from roots

cf. *Arnebia hispidissima*

Fuel

Acacia ehrenbergiana
A. nilotica
A. tortilis subsp. *raddiana*
Acacia sp.
Capparis decidua
Senna alexandrina
Tamarix sp.
Panicum turgidum stems (?)
other grass stems (?)
Schouwia purpurea stems (?)

mostly from the identification of wood. Only three arboreal taxa are represented by their fruits, which were collected and could be consumed without any preparation.

REGIONAL VEGETATION AND CLIMATE IN THE NABTA PLAYA AREA 8000 YEARS AGO

Nabta Playa is situated in a belt of the Sahara which, according to the results of various paleoenvironmental studies, had a less arid climate in the older Holocene than it has today. It is generally accepted that the pluvial episode, interrupted by drier phases of short duration, occurred between 10000 and 6000 years ago and caused the shift of the tropical climate and Sudanian and Sahelian vegetation zones to the north (Grove 1993, Petit-Maire 1989). The scale of vegetation zone displacement has been estimated to be about 4° or 400 km (Ritchie & Haynes 1987, Schulz 1987), with variations in different parts of north Africa. This displacement was characterized by a mosaic-like spread to the north of the present-day savanna and Sahel vegetation types and not by a simple movement of whole vegetation belts (Ballouche & Neumann 1995, Schulz 1991). Within the general framework of paleovegetational changes, individual areas differed in the degree of expansion of various floristic elements, which creates difficulties in the reconstruction of past vegetation for particular sites.

Plant material from Nabta Playa alone gives no grounds for discussing the position of climatic and vegetation zones during the Early Holocene. All the taxa identified occur at present in the desert. However, local vegetation in the basin itself, and probably also in the less immediate surroundings, was fairly rich, particularly after seasonal rains. The floristic diversity suggests rather good climatic conditions, as far as precipitation was concerned, and makes it quite likely that Nabta Playa was situated within semi-desert or at the transition from desert to semi-desert. This is confirmed by paleobotanical evidence including pollen analysis (Haynes et al. 1989, Ritchie et al. 1985, Ritchie & Haynes 1987, Ritchie 1994) and charcoal studies (Neumann 1989a, b) from the Early Holocene in northwest Africa, in the area nearest to Nabta Playa (for discussion see Boulos et al., in prep.).

LOCAL VEGETATION OF THE NABTA PLAYA AND ITS ECONOMIC SIGNIFICANCE

The recovered diaspore assemblages are made up mostly of plants consciously selected by man and do not properly reflect the vegetation of the area at the time of habitation. Many plants of no use to man must be missing and quantitative relations between species in the ancient flora were certainly different from those in the subfossil material. The presence of a plant in the material is, however, direct evidence of its occurrence in the area visited by people. Wood charcoals may give a better representation of the trees and shrubs which were growing in the area, because probably all wood available in the immediate neighbourhood was collected for fuel. The other shortcoming of the material is the relatively small proportion of taxa identified to species or genus level. It is conceivable that, with more plants determined to a higher degree of accuracy, a different picture of the ancient environmental and economic conditions would be obtained. Notwithstanding, the subfossil flora of site E-75-6 is one of the richer subfossil floras, and is probably the richest one so far described from the Saharan environment.

For reconstruction of the vegetation it is important to know how extended was the period of time represented by the subfossil plant assemblages. The large settlement at site E-75-6, inhabited during the dry season, was occupied repeatedly for several years (Wendorf & Schild 1995–1996). The consecutive seasonal habitation episodes probably occurred within a relatively short time, because all accelerator dates run on seeds from huts connected with the Middle Level clustered around 8000 BP. Three pits from the Upper Level, dated to c. 7500–7300 BP, did not differ in plant composition from material coming from the Middle Level. Thus, the subfossil flora gives a picture of vegetation developing in the area for a limited time, perhaps a few hundred years or less, corresponding to the habitation of the Middle and Upper Levels at the site.

There is no direct evidence showing what the vegetation was like in different years. The similar taxonomic composition of the diaspore assemblages from the various features indicates that the plant communities were composed of the same species. On the other hand, quantitative differences in the dominance of the diaspores of different plants, in different houses, indicate that some sort of differentiation of the plants available to man in various years could have occurred. It might have taken the form of a variable density of plant stands of the different species, depending probably on fluctuating local moisture conditions.

In the Nabta Playa basin, as in any desert environment, the vegetation depended first of all on water supply, which was regulated by precipitation as well as local topography, geology and soils. The presence of *Nymphaea* sp. (probably *coerulea*), represented by 3 fragments of rhizome tissue, found in one sample (Hather 1995), indicates that a body of open water must have existed in the area some time ago. The existence of moist or swampy areas is indicated by the presence of *Cyperus rotundus* tubers, rhizomes of *Typha* sp. (probably *domingensis*), fruits of *Scirpus maritimus* and *Fuirena* types, and one detached fragment of aerenchyma, a tissue characteristic for rhizomes of aquatic or damp soil plants which, in this case, might belong to *Alisma* (Hather 1995). They were probably growing on the lowest lying surfaces and their occurrence is good evidence for the presence of a swamp (or salt marsh?). Similar habitats were probably occupied by other plants from the sedge family, identified only as various Cyperaceae types.

After the rainy season, the sands, silts and

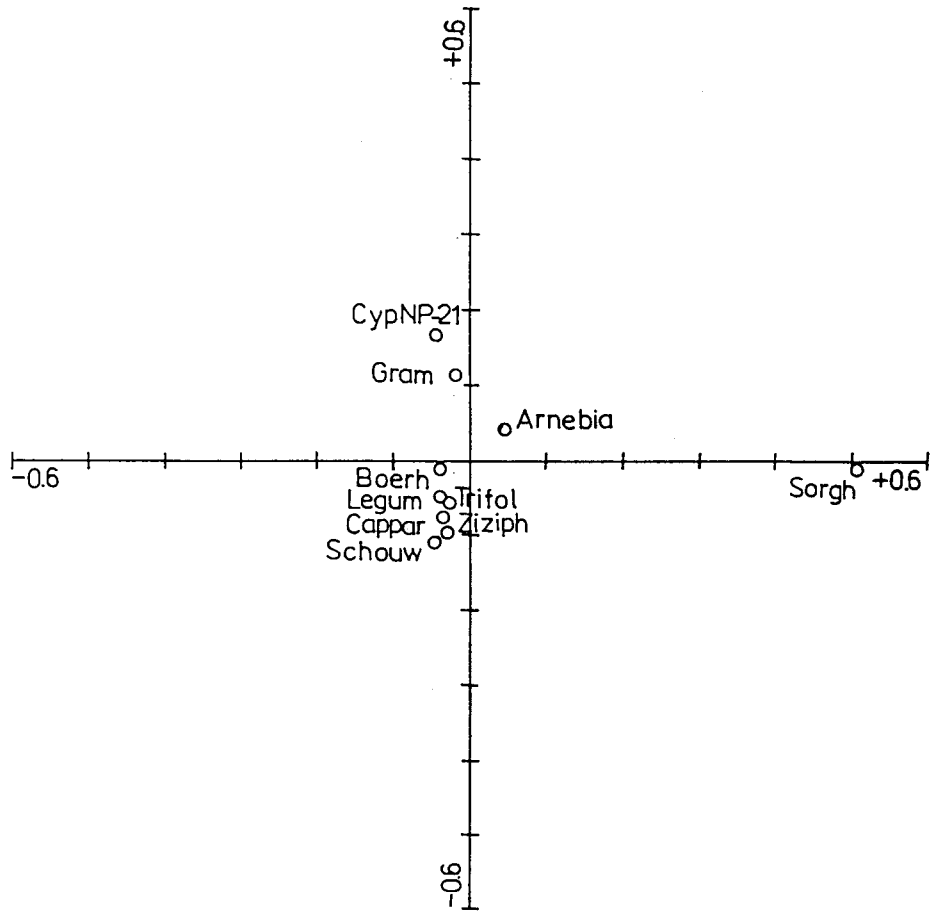

Fig. 38. Correspondence analysis of the most abundant taxa from Nabta Playa, site E-75-6. Plant names: Ziziph – *Ziziphus* sp., Schouw – *Schouwia purpurea*, Legum – Leguminosae other than Trifolieae, Boerh – *Boerhavia* sp., Trifol – Trifolieae, Cappar – *Capparis* sp., Gramin – Gramineae other than *Sorghum*, NP-21 – unknown type of Cyperaceae family, Arneb – cf. *Arnebia hispidissima*, Sorgh – *Sorghum bicolor* subsp. *arundinaceum*

clays of the Nabta Basin could have been covered with different plant communities or monotypic stands, partly in mosaic, and partly in zonal arrangement, depending on the ground water level. The herbaceous vegetation would have included several grasses like *Panicum turgidum*, *Echinochloa colona*, *Brachiaria*, *Urochloa* sp. and about 20 other undetermined grass types (but no *Stipagrostis* type). A race of wild *Sorghum bicolor* subsp. *arundinaceum* was probably present. *Schouwia purpurea*, *Arnebia* cf. *hispidissima*, *Boerhavia* sp. (probably *repens* or *diffusa*), cf. *Astragalus vogelii*, *Hyoscyamus* cf. *muticus*, *Solanum* cf. *nigrum*, *Sida* sp. (*alba*?) and *Rumex* sp. were the other constituents of the herbaceous vegetation.

Arboreal vegetation was made up of groves or individual trees of *Acacia ehrenbergiana*, *A. nilotica*, *A. tortilis* subsp. *raddiana*, *Cappris decidua*, *Maerua crassifolia*, *Salvadora persica*, *Senna italica (Cassia senna)*, *Tamarix* sp. and *Ziziphus* sp. (probably *spina-christi*). The trees represented by charred wood were probably growing in the area, but fruits could have been transported over considerable distances. The local occurrence of *Ziziphus* at E-75-6 was very likely because crushed fruit-stones were frequent and its charcoal has been found in a younger phase at Nabta Playa, site E-91-1C, dated to 7800–7400 BP (Barakat 1995a). Seeds of *Capparis decidua* were also fairly frequent. On the other hand fruits of *Grewia* sp. (possibly *tenax*) were rare and the genus was not present among wood charcoals, so its local growth is not certain. It seems possible, however, because wood of *Grewia* was found by Neumann (1989a, pp. 115–116) near Abu Ballas, site 85/80, northwest of Nabta, in a level dated to ca. 6800 bp.

This picture does not reflect the whole floristic diversity of the past vegetation of the Nabta Basin. It should be supplemented by many taxa of herbs or woody plants, not ident-

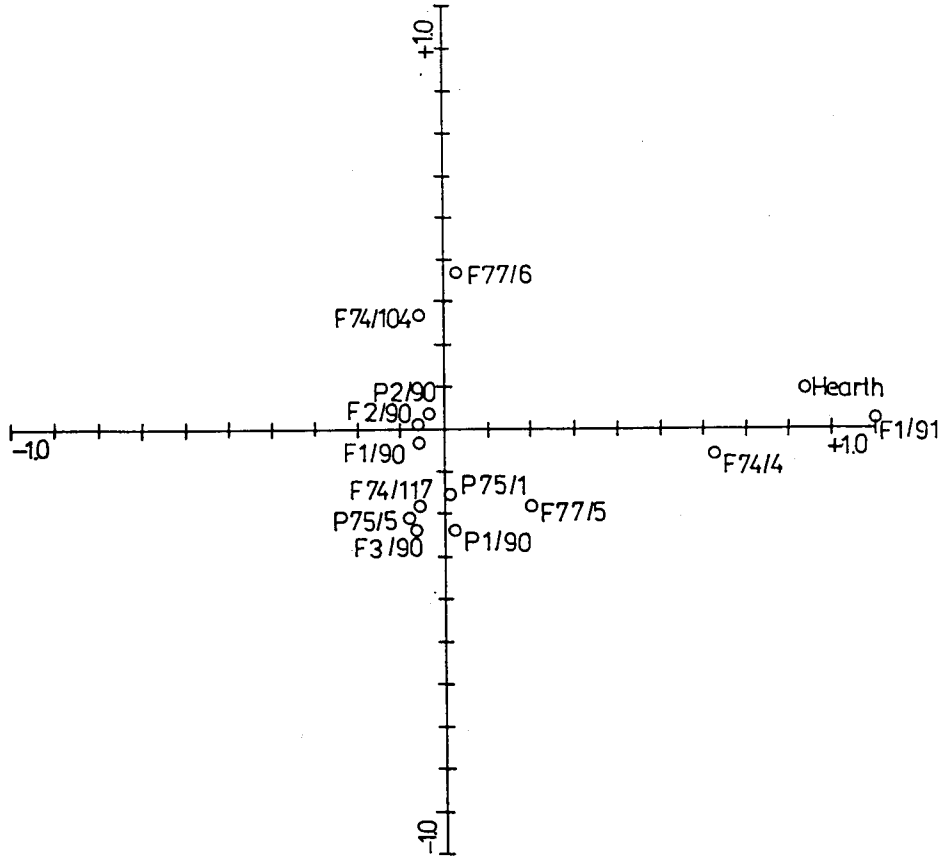

Fig. 39. Correspondence analysis of huts, pits and isolated hearth from Nabta Playa, site E-75-6.

ified with sufficient accuracy to allow palaeoecological conclusions to be drawn. Several unknown species of the Leguminosae family were present: Trifolieae tribe, *Astragalus*, *Coronilla*, *Indigofera* types, and over 6 other types. Other families represented in the flora were Compositae (at least 3 taxa), Cucurbitaceae, and Labiatae, while for over 36 different diaspore types no taxonomic affinity was found.

As it has been mentioned previousely, the diaspore assemblages from various huts and pits did not differ in the taxonomic composition. Correspondence analysis of the most abundant taxa has shown, however, the existence of groups of plants characteristic for certain groups of features (Figs 38, 39). Seed abundance of these taxa was calculated for 14 huts and pits and the diagrams were grouped according to the clustering of features.

The diagrams (Fig. 40) show four distinct seed assemblages attributed to particular features. These are 1/ a mixed assemblage, dominated by *Schouwia purpurea* and Gramineae, with almost equal numbers of Leguminosae, Trifolieae and NP-21 type, with *Boerhavia*, *Sorghum* and *Ziziphus* present in small numbers, 2/ a mixed assemblage dominated by *Schouwia purpurea,* accompanied by almost equal numbers of Leguminosae, Trifolieae, *Boerhavia* and *Ziziphus*, but low representation of *Sorghum* and NP-21, 3/ a Gramineae – NP-21 assemblage dominated by Gramineae, other than *Sorghum*, and the NP-21 type representing an unknown plant from the sedge family, and 4/ a *Sorghum* assemblage dominated by *Sorghum* kernels.

The presence of the oldest known *Sorghum* and its somewhat isolated position in the material, are of great interest in connection with the discussion on *Sorghum* domestication in Africa. This grass is considered here as a wild species, because of its morphological characteristics, but cultivation of a wild plant cannot be excluded solely on botanical criteria (Dahlberg & Wasylikowa 1996).

It is assumed that these four seed assemblages reflect the use of the same plants, but in various quantitative combinations, by the inhabitants of different houses. Preparation of food was probably the main purpose of the use of these plants. The predominance of certain

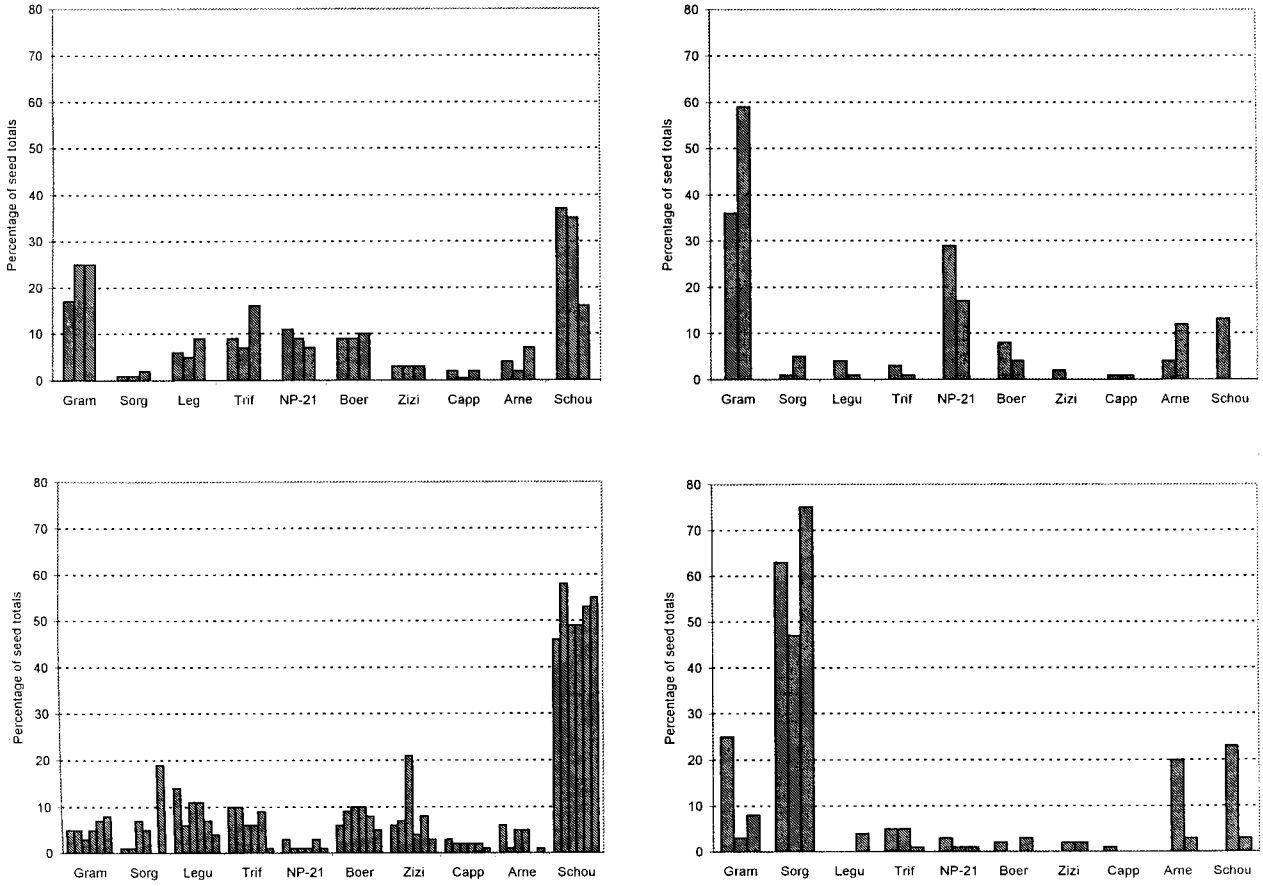

Fig. 40. Diaspore abundance in four groups of features from Nabta Playa, site E-75-6, illustrates four plant food types: two mixed types (on the left), grasses – NP-21 type (upper right), sorghum type (lower right). For plant names see Fig. 38

food types in particular features may be explained by the more luxuriant growth locally of some plants in different years, due to fluctuating climatic or other natural conditions. The possibility that cultural or social reasons played a role is also possible, such as gathering in special areas, food preferences or traditions among people living at Nabta Playa in various years.

It seems that rich local herbaceous vegetation was not only an important source of human food, but could also have been grazed by animals (Wasylikowa et al. 1997). Several species recorded in the material are known today as good pasture plants. Some of them, *Echinochloa colona, Panicum turgidum, Sorghum, Boerhavia* and *Schouwia purpurea*, are very frequent in subfossil samples, while some are rare, like *Brachiaria, Digitaria, Setaria, Urochloa*. The last four genera are listed by Le Houérou, in his study on Sahelian pastures (Le Houérou 1989), among the good fodder plants which are eliminated from vegetation due to overgrazing. According to Bernus (1992–93), *Schouwia purpurea*, in areas visited by Tuaregs, forms rich seasonal pastures where animals can graze freely for 1–2 months. Also clovers and medicks could have grown in pastures. Butler has reported increased seed production by these plants in heavily grazed meadows in Ethiopia (Butler 1995). Animals could also have fed on pods and seeds of *Acacia nilotica* and fruits of *Ziziphus spina-christi*.

POSTSCRIPT

The problem announced in chapter on taphonomy was solved by the new AMS date obtained after the paper was given to the printing-office. The age of sorghum grains from hut F 77/5 is 7680 ± 80 BP (CAMS-41691); thus, this hut is younger than the others and belongs to the Upper Level of the Neolithic at site E-75-6. The age difference seems too small to be the only reason for various degree of sorghum grain carbonization.

ACKNOWLEDGEMENTS

The author, taking full reponsibility for what is presented in the paper, feels indebted to several people who have helped during field work and in subsequent consultations and who will probably find some

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PLATES

Plate 1

1–7. cf. *Arnebia hispidissima* from hut F 1/90
   1. crushed fruits and seven charred seeds (in the centre)
   2. seeds
   3–4. two fruits, most common type of sculpture
   5–6. one fruit from two sides, rare type with less rugged surface
   7. fruit with charred seed inside

8–9. Compositae A type, one fruit from hut F 1/90

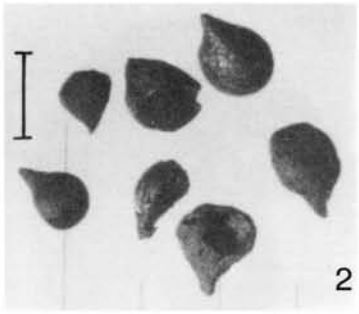
10. Compositae B type, a group of fruits from hut F 1/90

11. Compositae C type, fruit from hut F 2/90

Scale bars equal 1 mm

3–7 phot. A. Pachoński


1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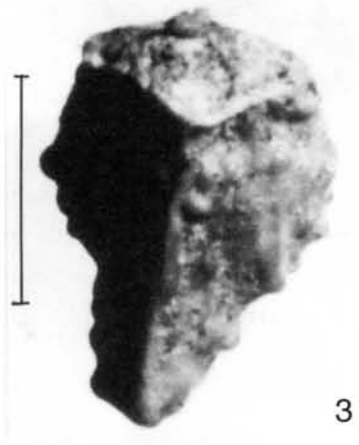
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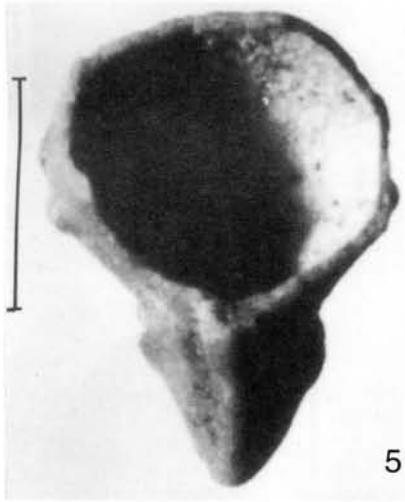
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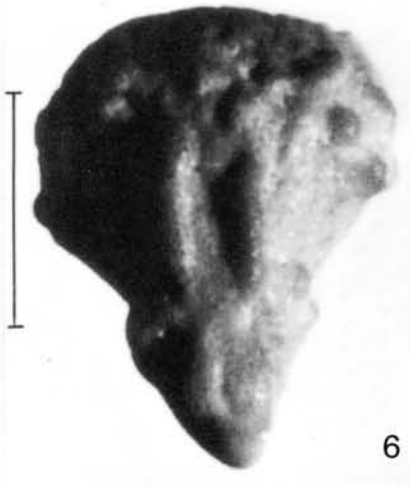
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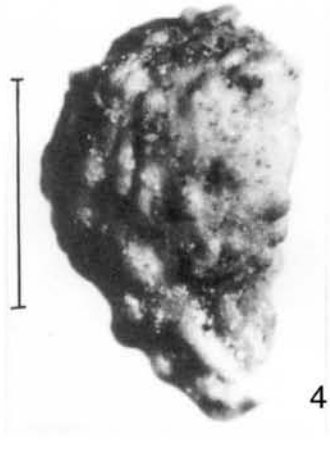
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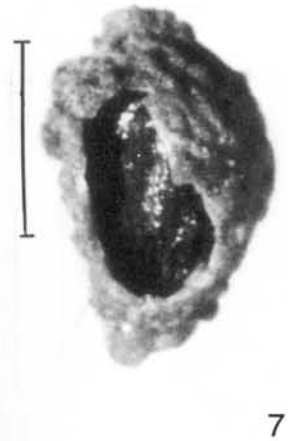
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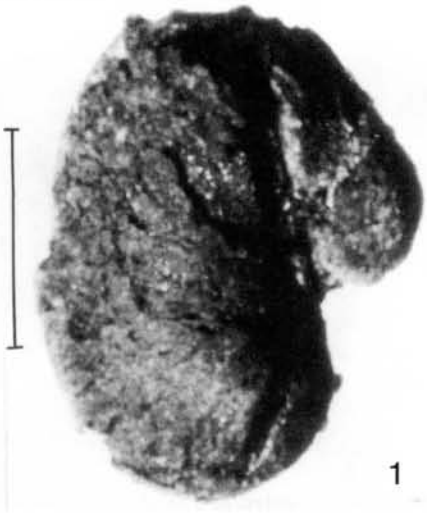
Plate 2

Capparis sp. from hut F 1/90

1–5. best preserved seeds showing different degree of damage of the outer layer
6–7. two cotyledons of one seed from the outer (6) and inner (7) side
8. seed without outer testa layer
9. artificially charred seed of extant *Capparis spinosa* without testa

Scale bars equal 1 mm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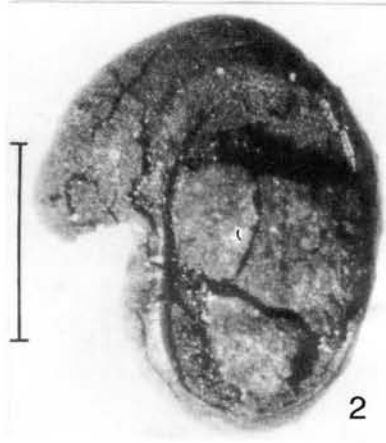
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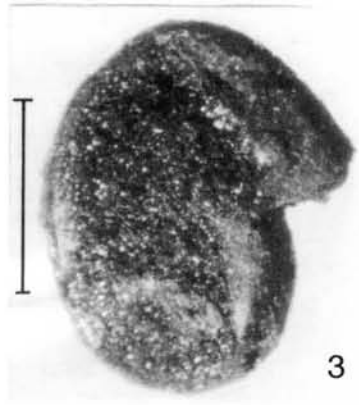
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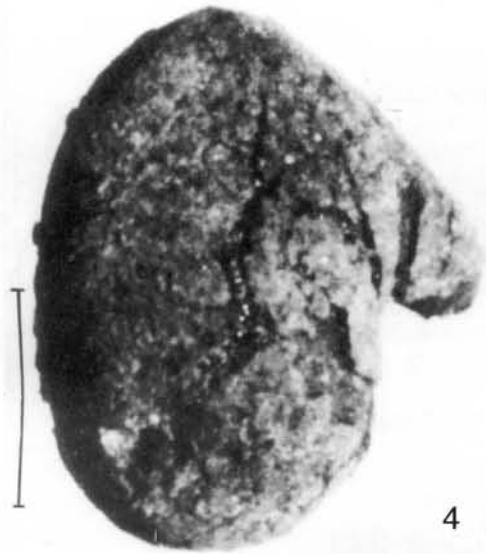
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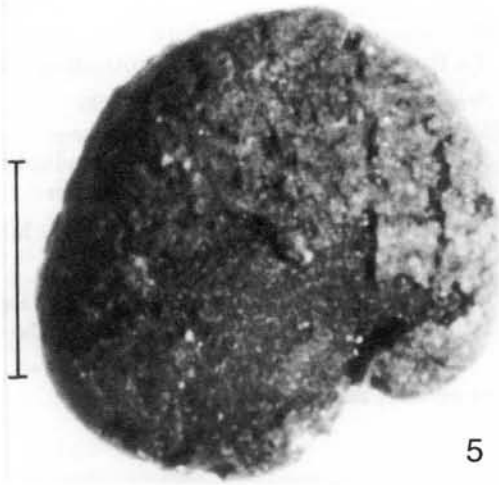
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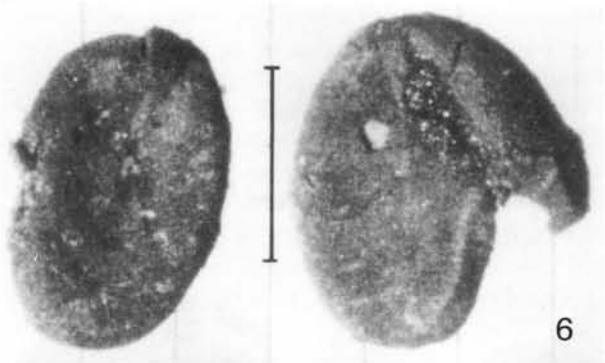
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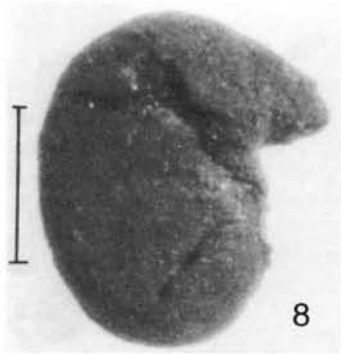
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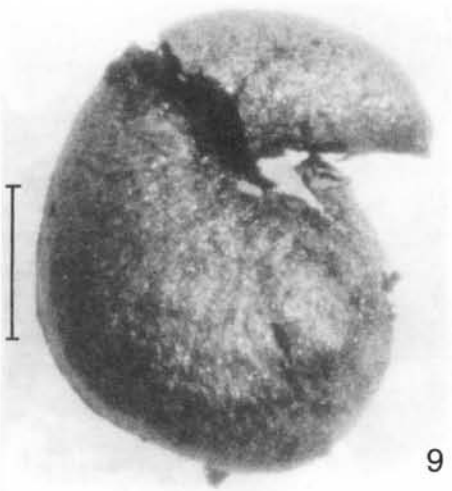
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Plate 3

1–3. cf. *Heliotropium* sp., one fruit from hut F 1/90, showing sculpture in the centre of the dorsal side (1), the fruit margin (2) and the protruding stalk on the ventral side (3)

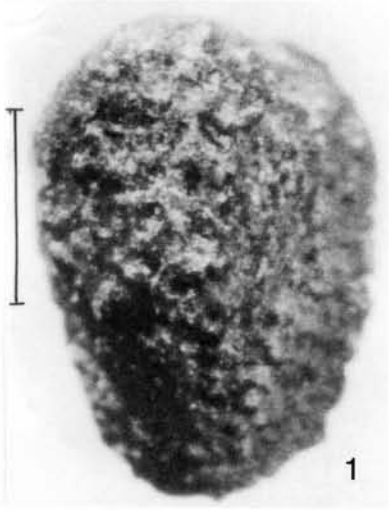
4–9. *Schouwia purpurea* from hut F 1/90
4–5. seeds with testa showing cracks
6–8. seeds without testa showing conduplicate arrangement of cotyledons and a radicle
9. fragment of seed testa with hilum

10. seed of extant *Schouwia purpurea* with hilum

11–14. Cucurbitaceae indet.
11–13. three seeds showing shape variation from pit 1/90 (11–12) and hut F 1/90 (13)
14. seed fragment with thickenings at the micropylar end, hut F 2/90

Scale bars equal 1 mm

11–13 phot. A. Pachoński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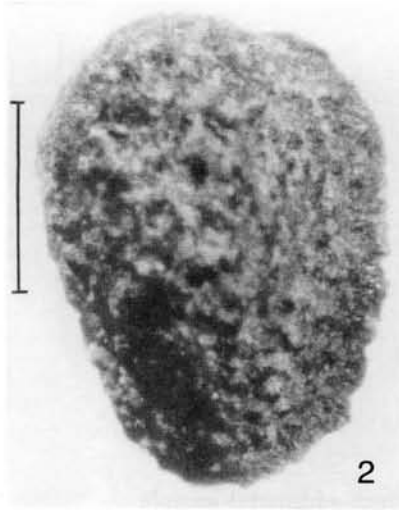
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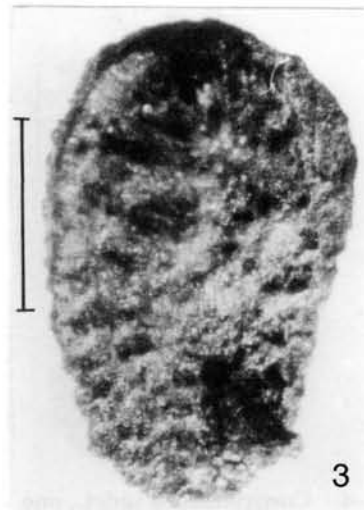
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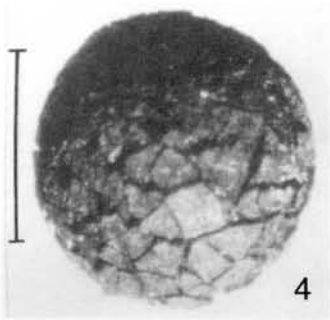
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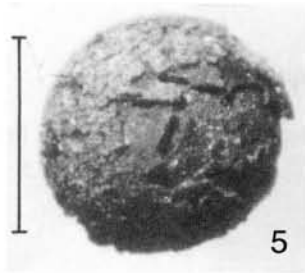
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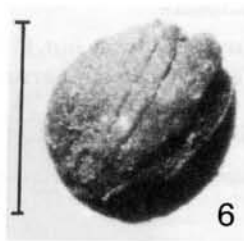
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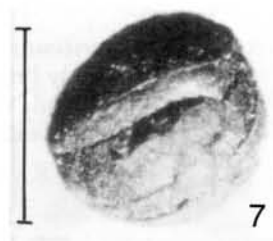
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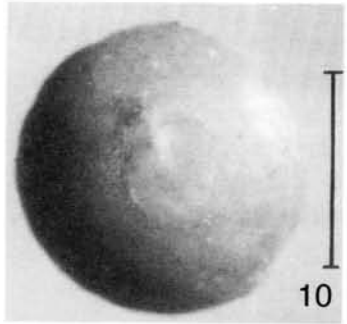
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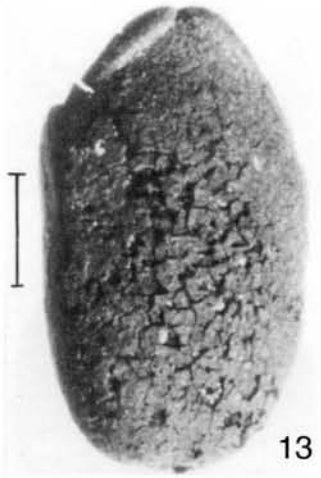
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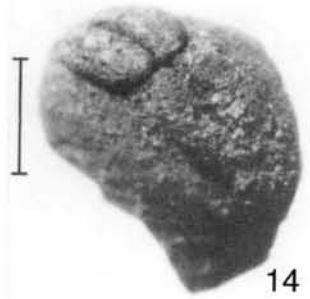
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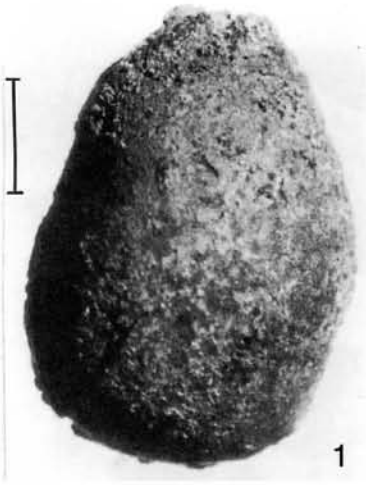
Plate 4

1–4. Cucurbitaceae indet., one seed from additional sample
2. a rim along the narrower side of seed separates from each other the thickenings at the micropylar end
3. thickenings at microplar end
4. details of surface sculpture

5–8. *Scirpus maritimus*, four fruits from hut F 2/90
5–6. extremely broad and extremely narrow fruits
7. broken fruit and its seed (right)
8. fruit with collar-like thickening made of basal portions of broken bristles

9. fruit of extant *S. maritimus* L. var. *macrostachys*

Scale bars equal 1 mm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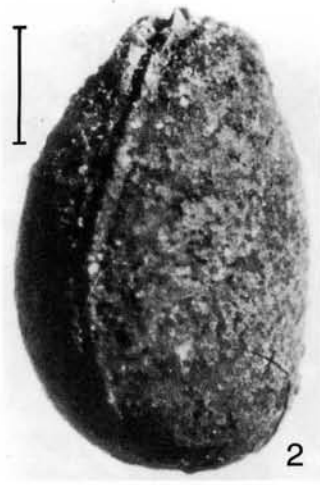
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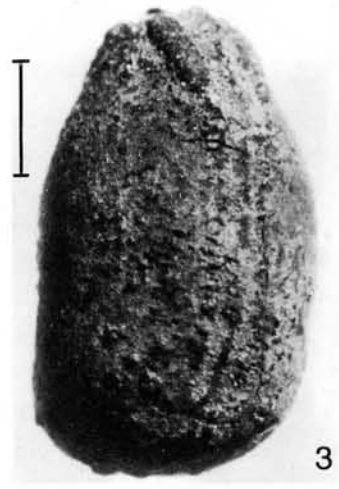
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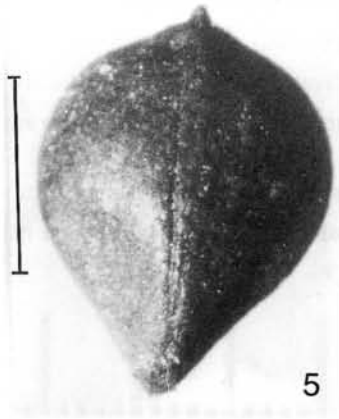
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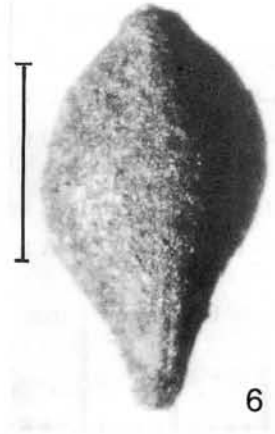
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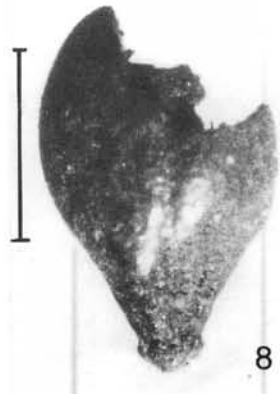
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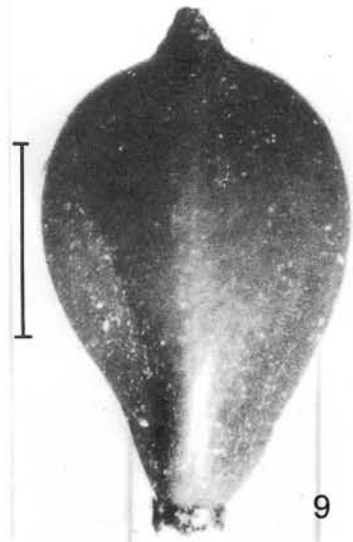
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Plate 5

1. *Scirpus maritimus*, fruits in one sample from hut F 2/90

2–3. *Fuirena* type
2. group of fruits in one sample from hut F 2/90 and three fruits of extant *Fuirena umbellata* (extreme right)
3. three fruits from hut F 1/90 (upper row) and three fruits of extant *Fuirena umbellata* (lower row)

4. Cyperaceae F type, fruit from isolated hearth

5. Cyperaceae B type, fruit from hut F 2/90

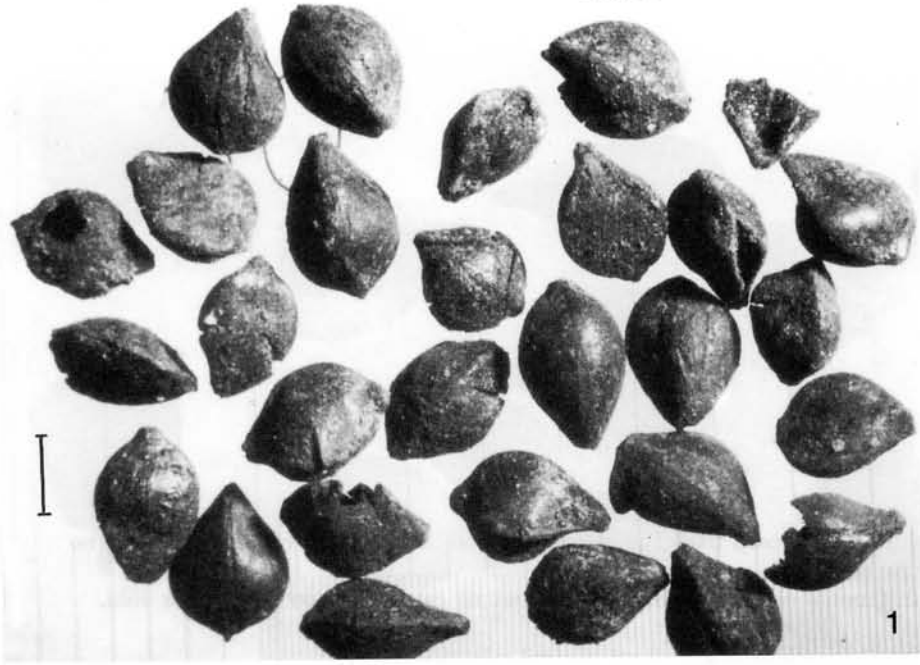
6–8. Cyperaceae C type, three fruits from huts F 74/104 (6–7) and F 1/90 (8)

9–10. Cyperaceae D type, one fruit from two sides, note the wall thickness and the seed with embryo tip inside fruit, hut F 1/90

11. Cyperaceae E type, fruit with remnants of pericarp having two ribs on convex side, hut F 1/90

12–13. Cyperaceae A type, two fruits from the flat (12) and convex (13) side, hut F 2/90

Scale bars equal 1 mm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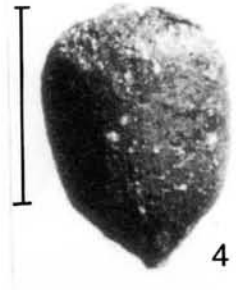
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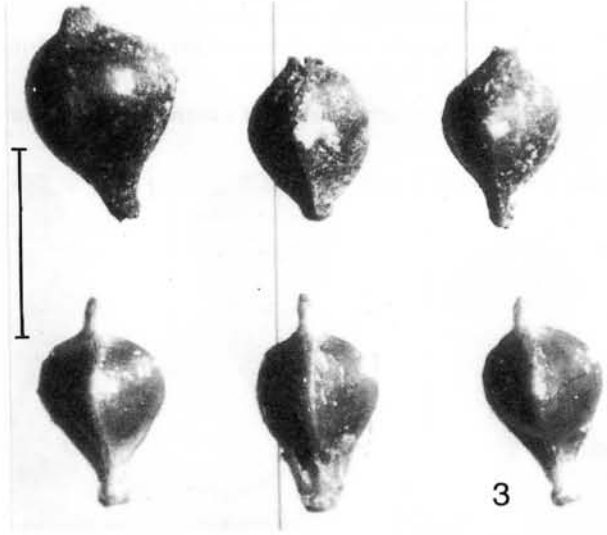
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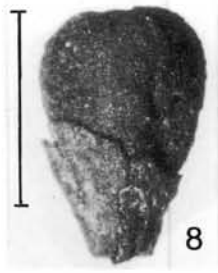
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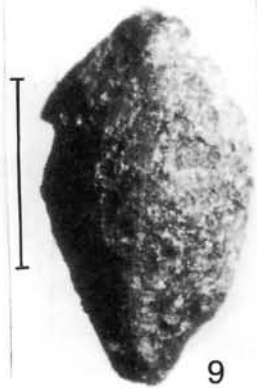
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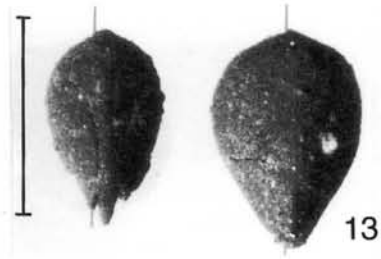
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Plate 6

1–10. Cyperaceae NP-21 type
- 1–2. one seed with remnants of pericarp from the convex (1) and flat (2) side; convex side with no central rib, hut F 77/5
- 3. seed with pericarp fragments showing sharp margin but no central rib on the convex side, hut F 2/90
- 4. seed with pericarp fragments showing distinct central rib, hut F 2/90
- 5–6. one fruit from convex (5) and flat (6) side, hut F 1/90
- 7. trigonous fruit with partly damaged pericarp, hut F 1/90
- 8–9. two seeds with pericarp fragments showing small papillae, hut F 74/104
- 10. seeds from hut F 1/90

11. artificially charred seeds of extant *Scirpus lacustris*

Scale bars equal 1 mm

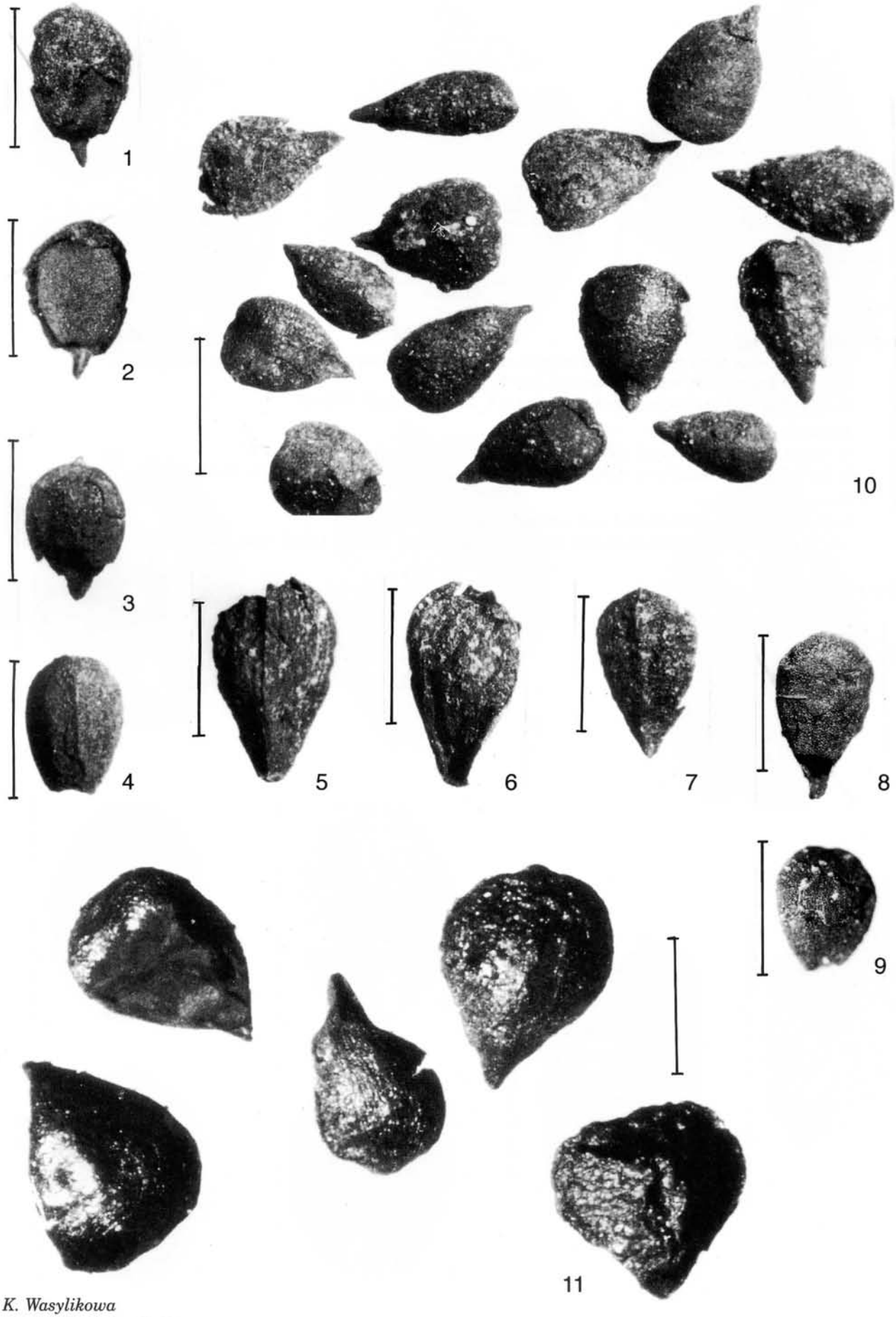
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Plate 7

1–5. *Brachiaria* sp.
1–2. one grain with fragments of lemma and palea in dorsal and ventral view, hut F 77/5
3. one grain with wrinkled lemma, hut F 1/90
4–5. two naked grains in dorsal view, huts F 1/90 (4) and F 77/5 (5)

6–7. *Digitaria* type
6. naked grain from dorsal side, hut F 1/90
7. hulled grain from dorsal side, lemma with parallel rows of narrow cells, hut F 74/104

8–12. *Echinochloa colona*
8–11. two grains from dorsal and ventral side, pit P 75/5
12. grain with lemma fragment showing longitudinal rows of broad cells, hut F 1/90

Scale bars equal 1 mm

2, 5, 7–8 phot. A. Pachoński

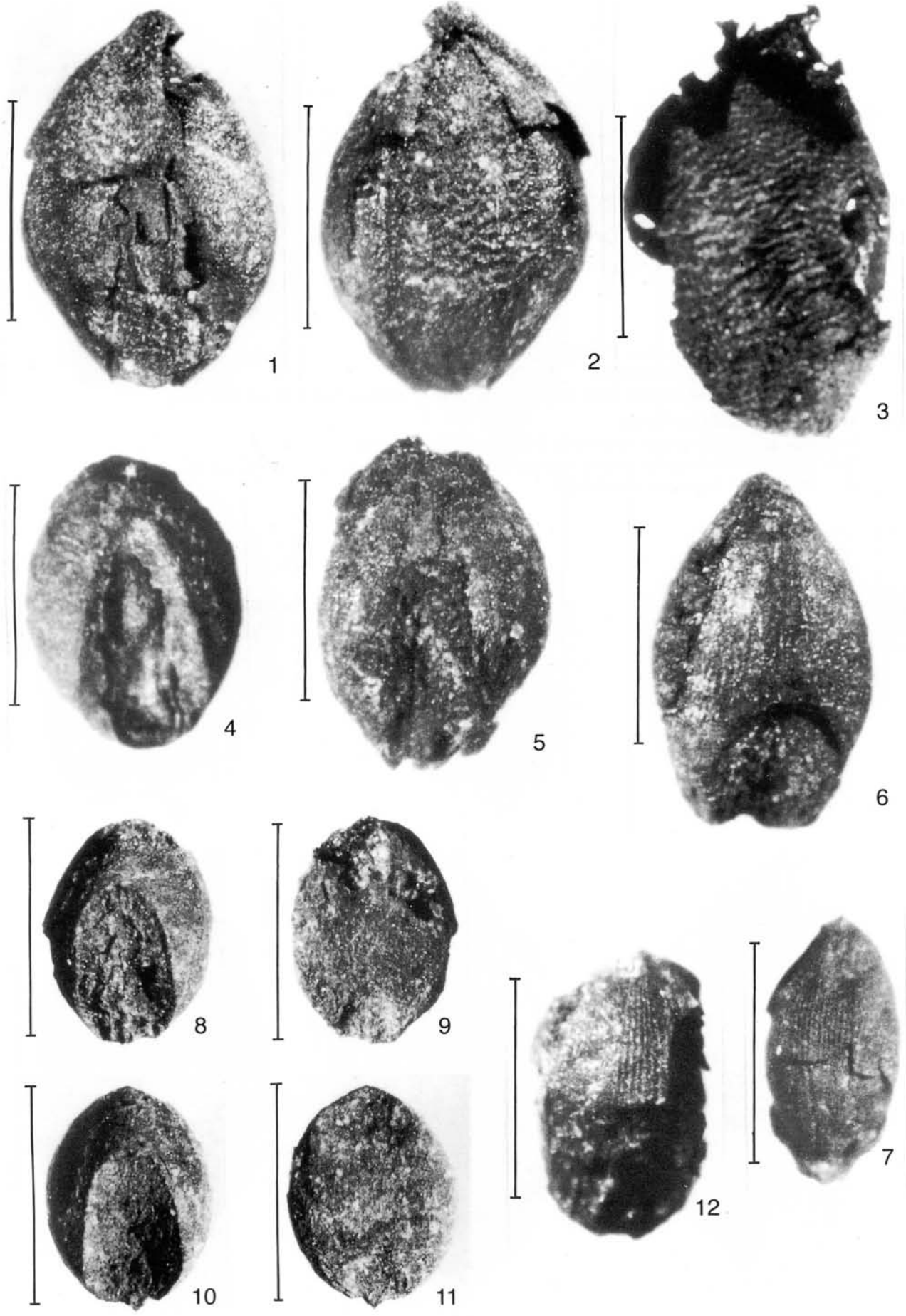
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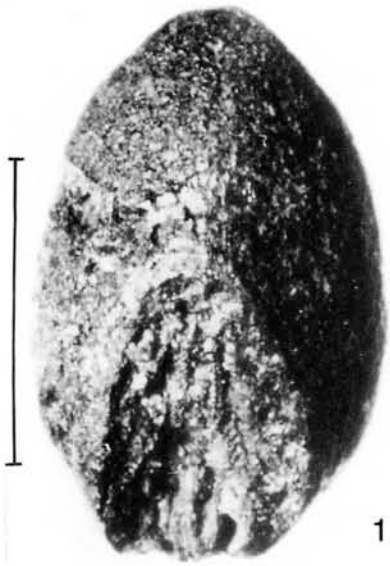
Plate 8

1–4. *Panicum turgidum* from hut F 1/90
1–2. two grains from dorsal side
3–4. one fragment of lemma from two sides; note very narrow longitudinal cell rows

5–9. *Setaria* type from hut F 1/90
5–6. one grain with glume remnants from dorsal and ventral side
7–8. one spikelet from the side of lemma and palea showing transversal wrinkles
9. palea with transversal wrinkles

Scale bars equal 1 mm

Phot. A. Pachoński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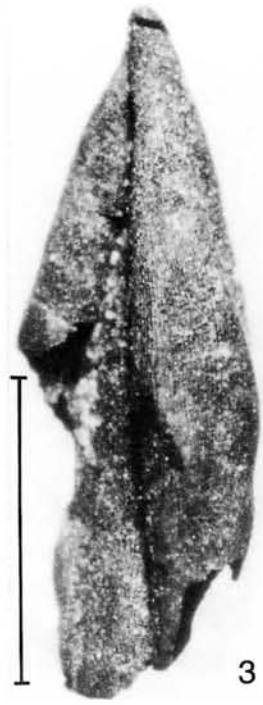
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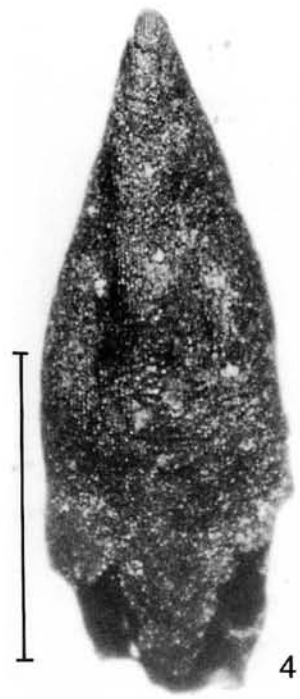
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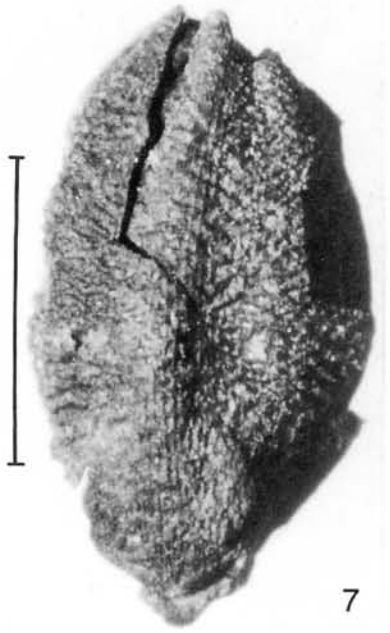
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Plate 9

Sorghum bicolor subsp. *arundinaceum*, nine grains from dorsal side

1–5, 7. from hut F 77/5
6. from hut F 1/90
8–9. from hut F 74/4

Scale bars equal 1 mm

Phot. A. Pachoński

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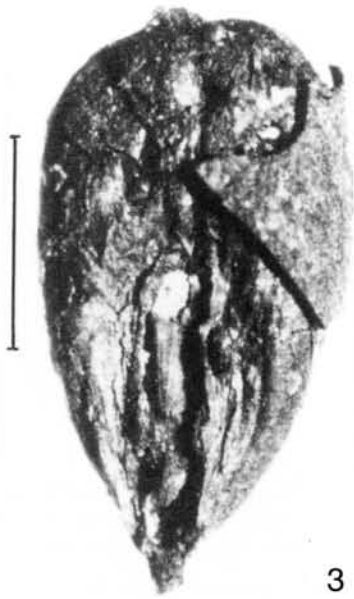

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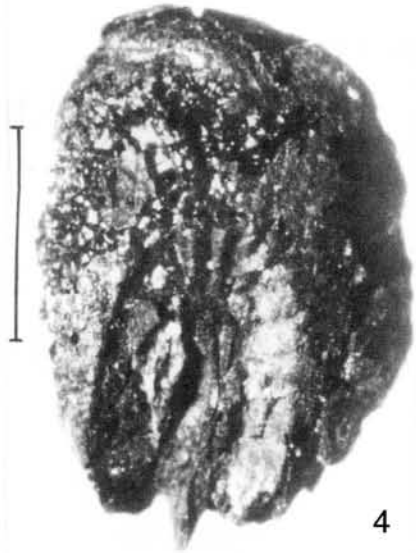

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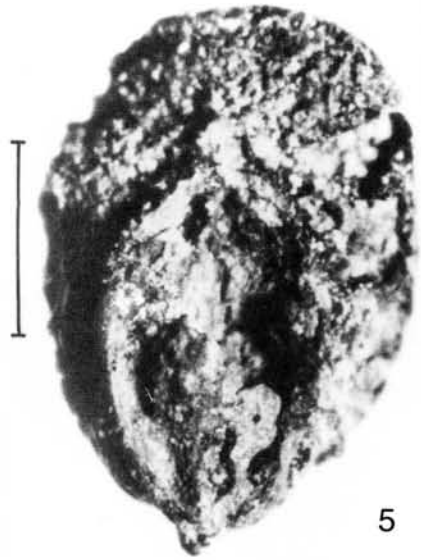

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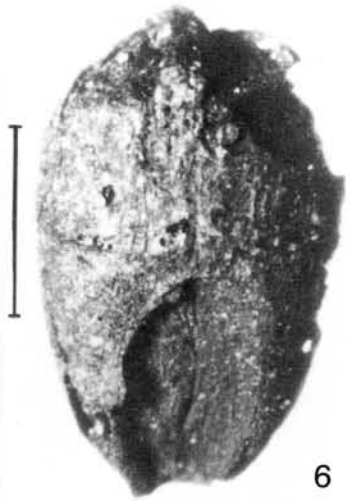

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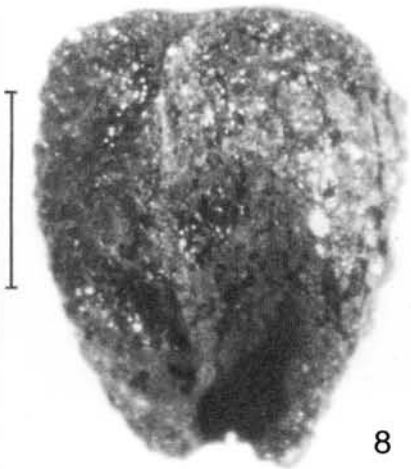

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Plate 10

1–6. *Sorghum bicolor* subsp. *arundinaceum*, two grains from hut F 2/90 from dorsal, ventral and lateral side; note the lateral groove in (3), deformation of the central portion of grain in (4–5) and strongly convex ventral side in (6); arrows point to embryo

7–10. Paniceae B type from hut F 1/90
7–8. one grain from dorsal and ventral side
9–10. two grains from dorsal side

Scale bars equal 1 mm

1–6. phot. A. Pachoński

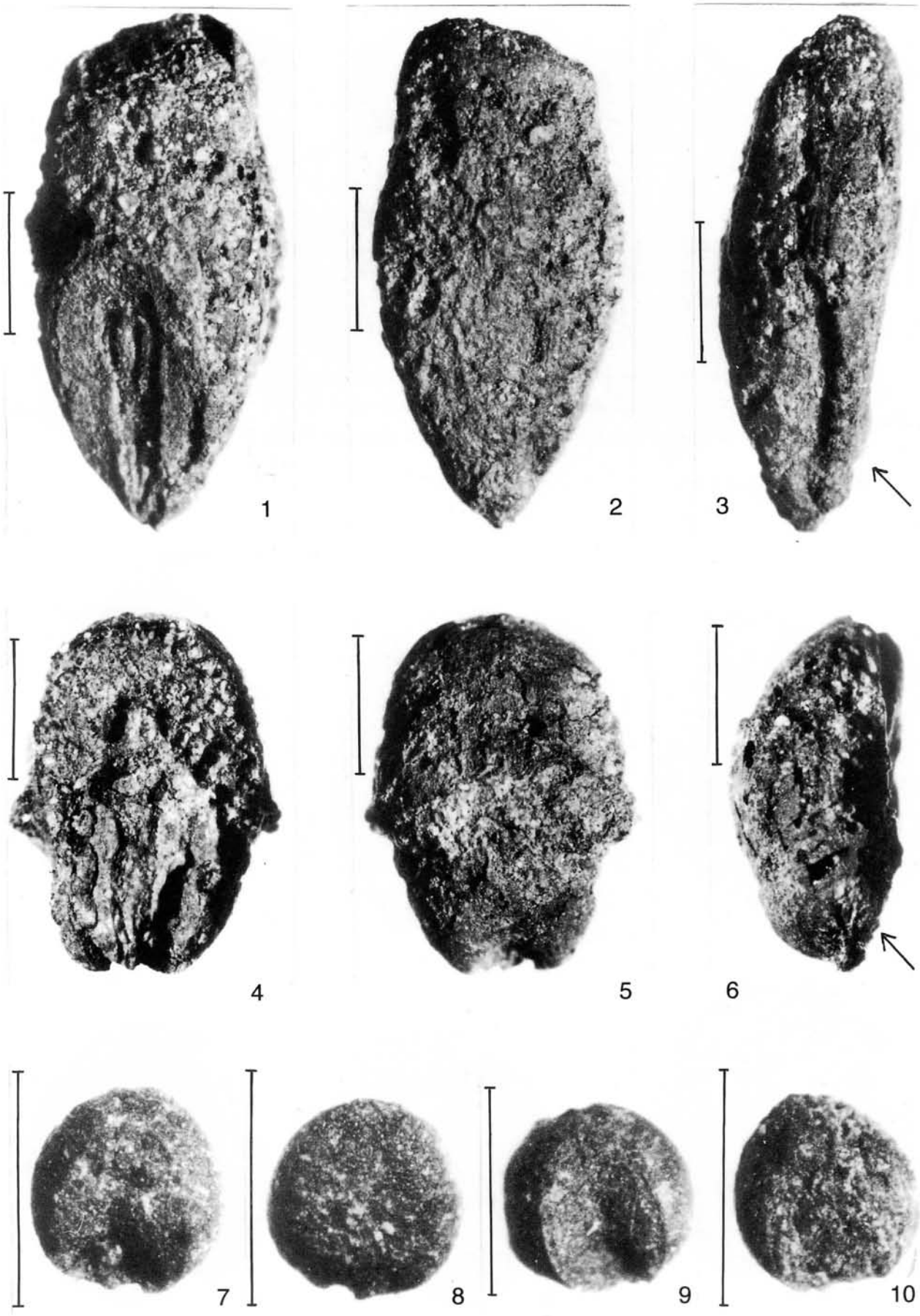
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Plate 11

1–2. *Sorghum bicolor* subsp. *arundinaceum*, one grain from dorsal and ventral side, hut F 1/90

3–4. Paniceae A type, two grains from dorsal side, hut F 1/90

5–8. *Urochloa* sp., two grains from dorsal and ventral side, hut F 1/90

Scale bars equal 1 mm

Phot. A. Pachoński


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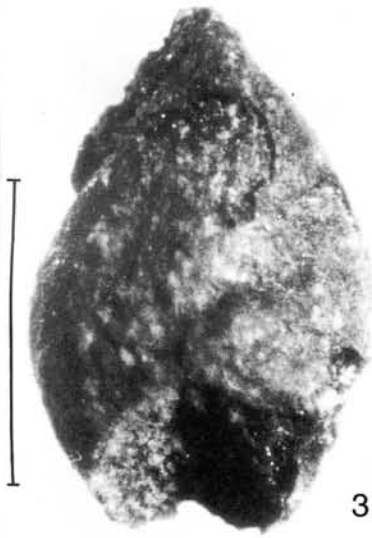
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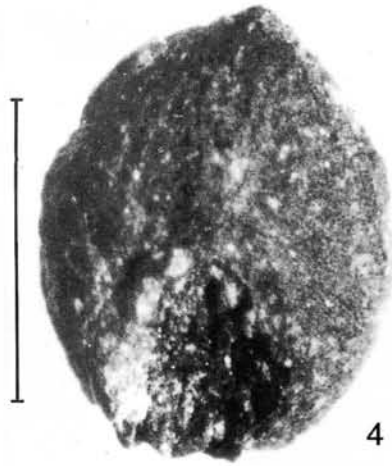
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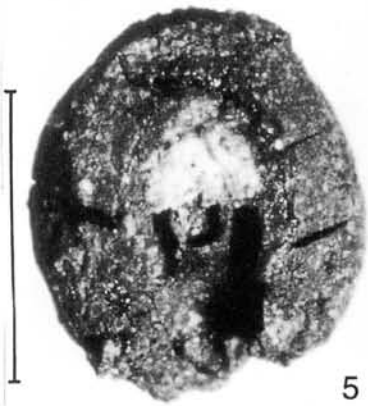
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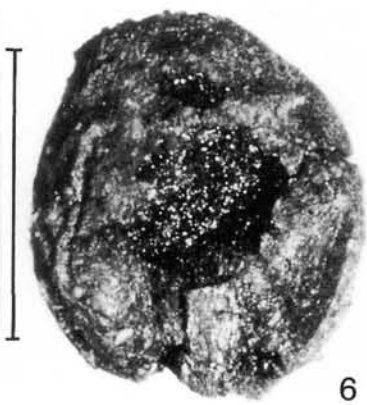
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Plate 12

Sorghum bicolor subsp. *arundinaceum*

Four immature spikelets shown from the side of outer (1, 3, 5, 7) and inner glume (2, 4, 6, 8); outer glume preserved only in (7); twisted awn visible inside the inner glume in (1); 1–4 hut F 75/1; 5–8 hut F 1/90

Scale bars equal 1 mm

Phot. A. Pachoński

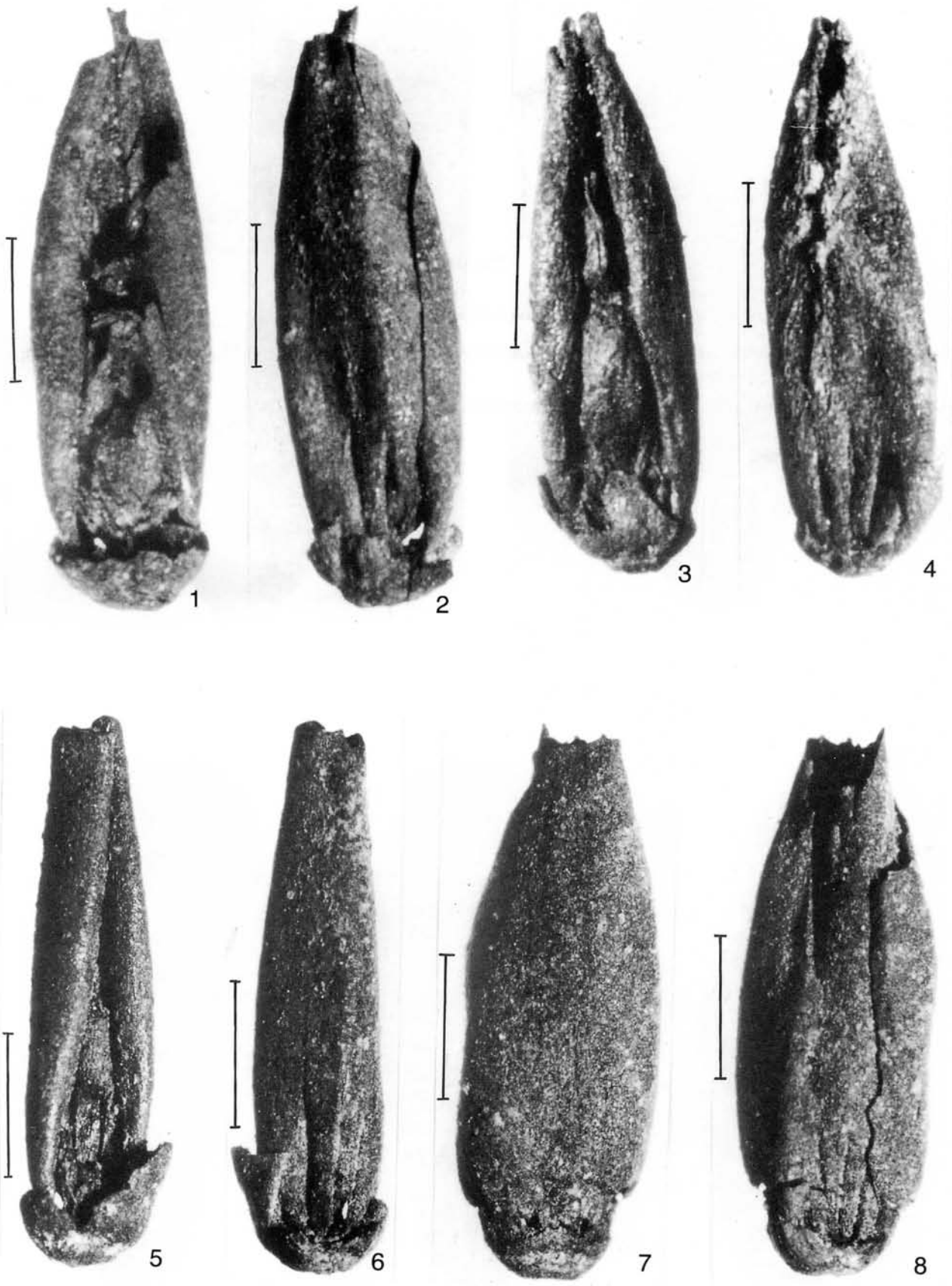
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Plate 13

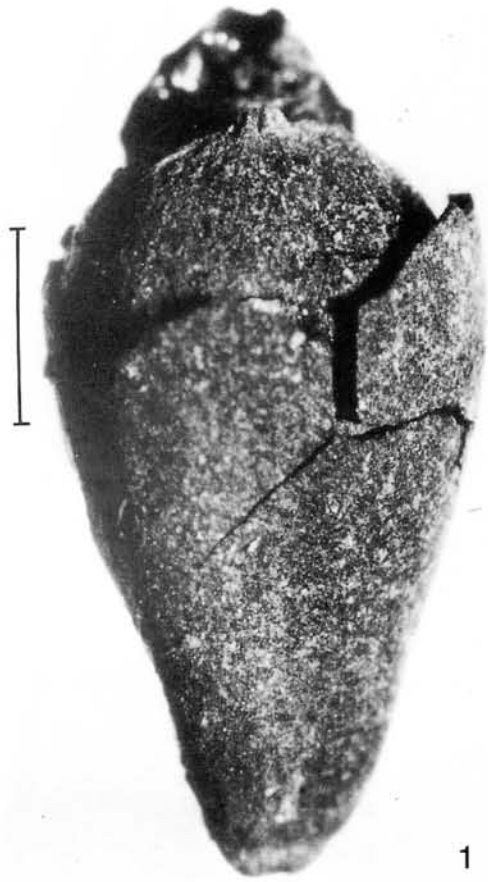
Sorghum bicolor subsp. *arundinaceum*

1–4. two sessile spikelets in different stage of maturity from the side of outer (1,3) and inner glume (2, 4); 1–2 hut F 77/5; 3–4 hut F 1/90

5. grain from dorsal side showing shape deformation at the apex, hut F 1/90

Scale bars equal 1 mm

Phot A. Pachoński



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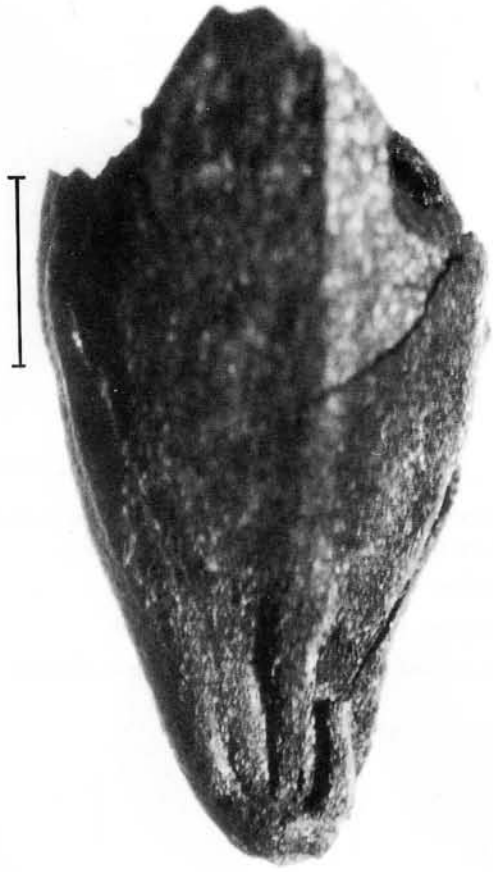

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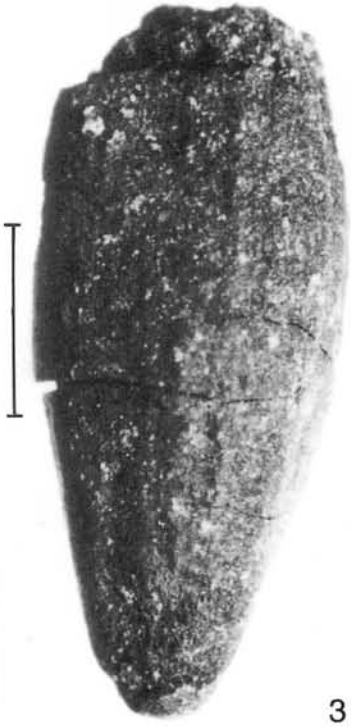

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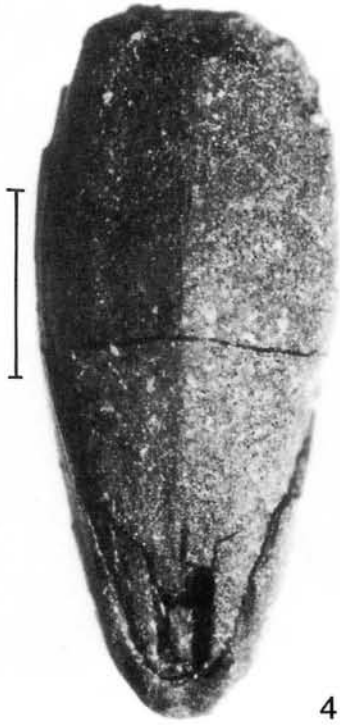

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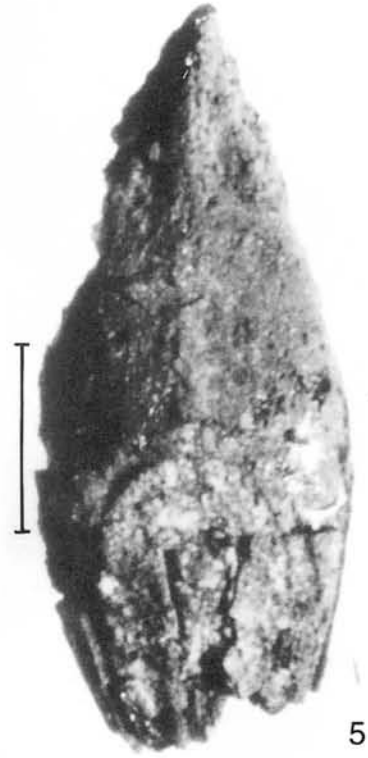

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Plate 14

Sorghum bicolor (L.) Moench subsp. *bicolor* race bicolor

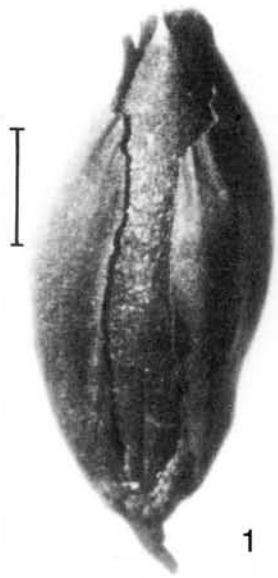
Cultivated sorghum from the site Jebel et Tomat, Sudan, 240 A.D.,
identified by A. Stemler (Clark, Stemler 1975)

1–3. spikelets with pedicels attached

4. immature spikelet without a pedicel

5–9. nine grains showing different degree of shape distortion

Scale bars equal 1 mm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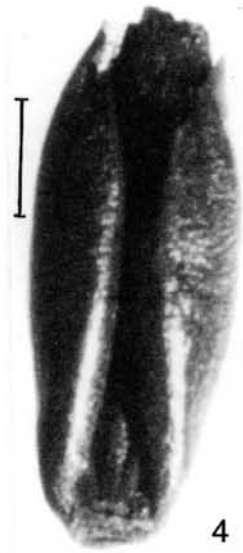
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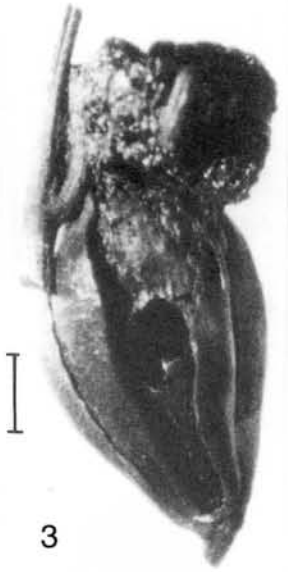
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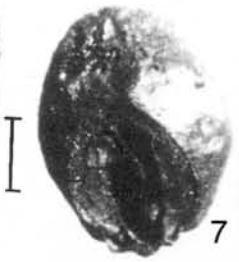
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Plate 15

Gramineae indet.

1–2. one grain from dorsal and ventral side, hut F 1/90
3–4. two grains from dorsal side, hut F 1/90
5–6. one grain from dorsal and ventral side, hut F 74/104
7. grain from dorsal side, hut F 74/104
8. grain from dorsal side, hut F 3/90
9–10. one grain from dorsal and ventral side, hut F 1/90
11–12. one grain from dorsal and ventral side, hut F 74/104

Scale bars equal 1 mm

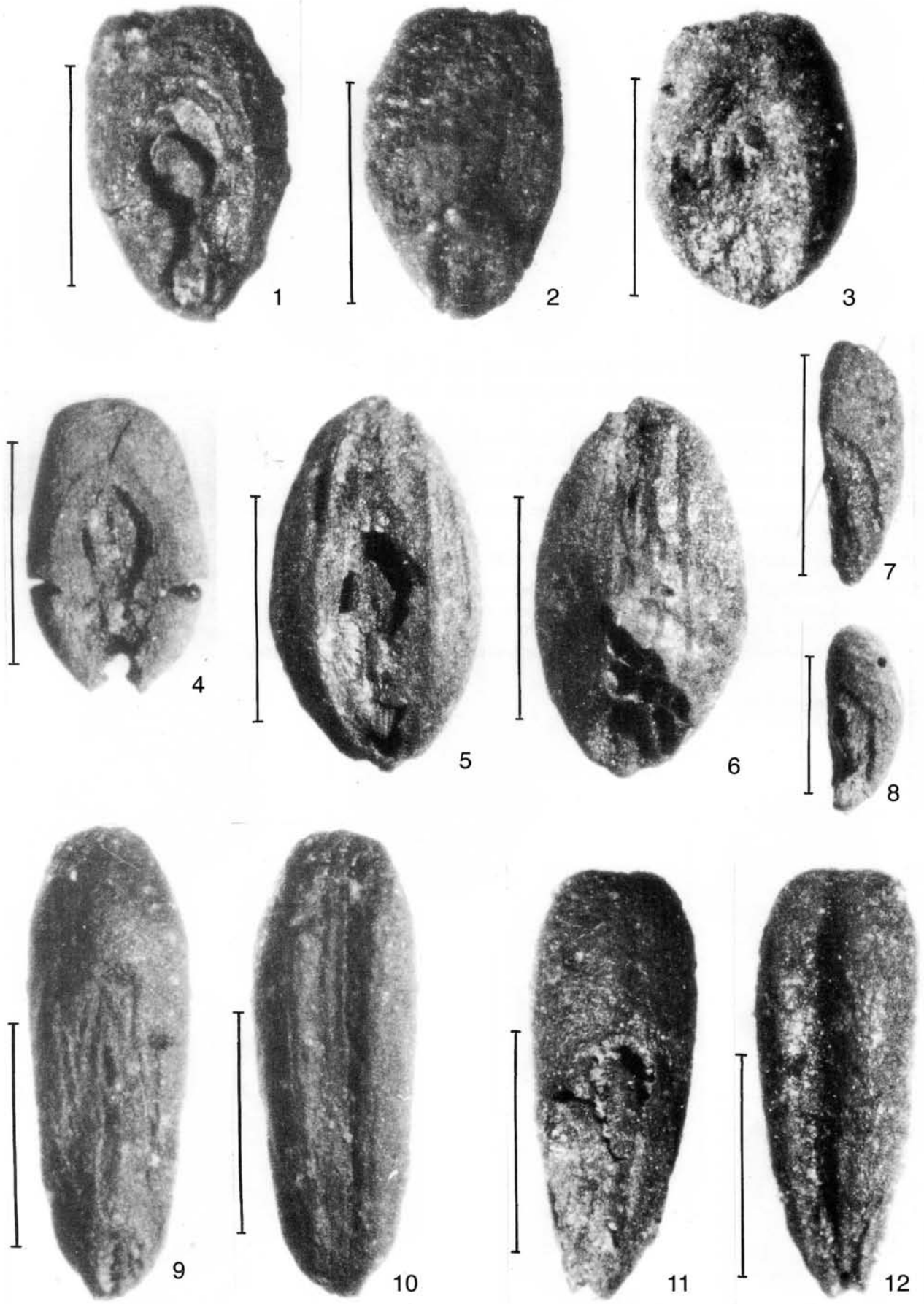
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Plate 16

1–3. Gramineae indet.
1–2. one grain from dorsal and ventral side, hut F 77/6
3. dorsally flattened spikelet from ventral side, hut F 1/90

4–9. fruits of Labiatae/Boraginaceae type
4–5. one schizocarpium from two sides, hut F 1/91
6–7. two fruitlets with wrinkled surface, hut F 2/90
8–9. one fruitlet from two sides, hut F 2/90

10–12. cf. *Astragalus vogelii*, three seeds from huts F 1/90 (10, 12) and F 74/104 (11); note coarsely pitted surface in (10)

13–14. *Astragalus* type, two seeds from hut F 1/90

15–17. *Indigofera* type, three seeds of a smaller type
15. seed with damaged hilum and smooth surface, hut F 1/90
16. seed with pitted surface, hut F 1/90
17. seed with large oval hilum, surface indistinctly pitted, hut F 74/104

Scale bars equal 1 mm

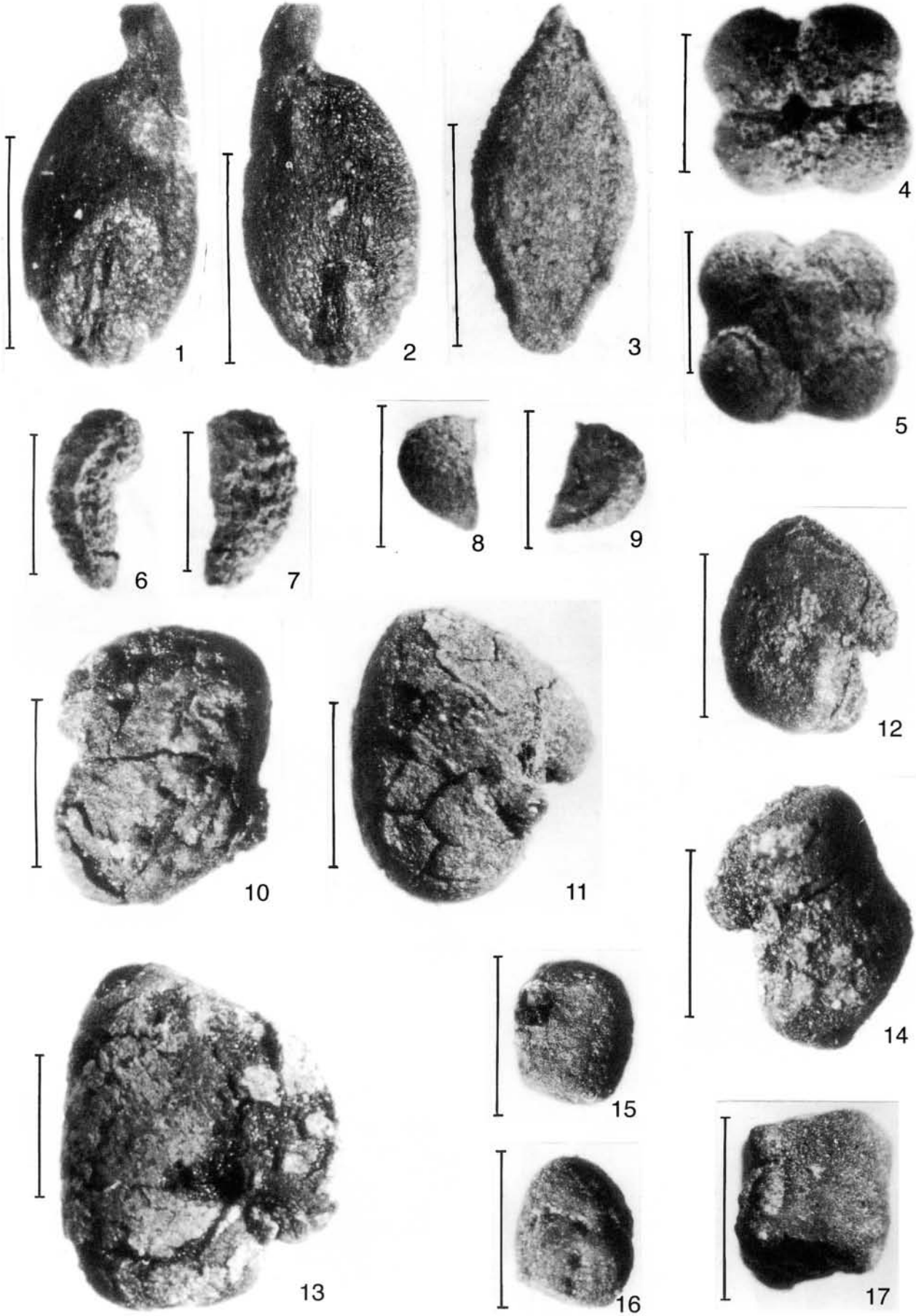
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Plate 17

1–3. Trifolieae tribe, seeds from hut F 1/90 (1) and pit P 75/5 (2, 3)

4. Leguminosae NP-9 type, seeds from hut F 74/104

5–7. Leguminosae NP-13 type, seeds from hut F 1/90

Scale bars equal 1 mm

3 phot. A. Pachoński

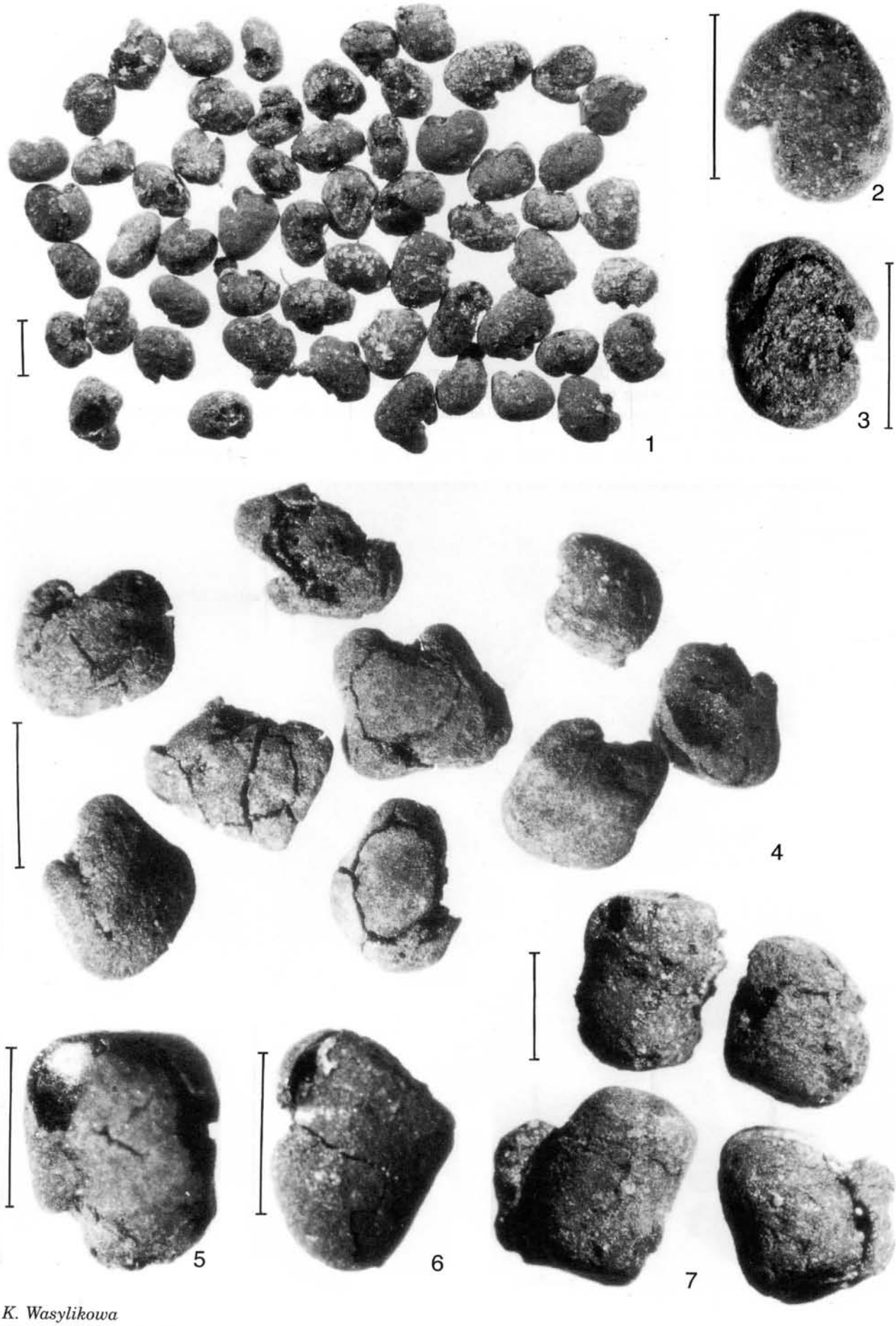
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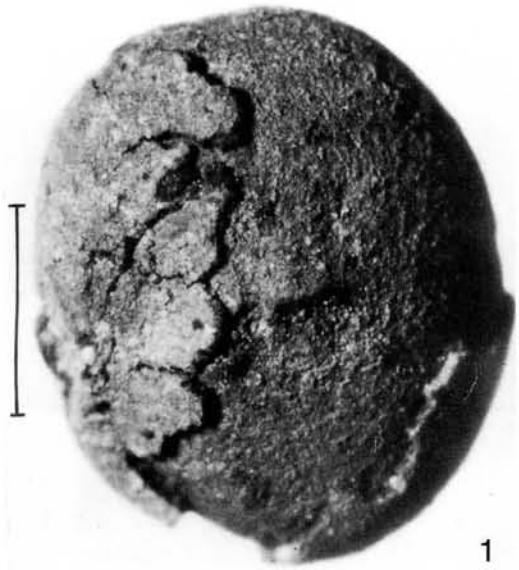
Plate 18

1–6. Leguminosae NP-19 type
   1–2. two seeds with testa partly preserved, hilum visible, pit P 75/5 (1) and hut F 1/91 (2)
   3. seed fragment showing round hilum, hut F 1/91
   4–5. two seeds without testa showing wrinkled cotyledon surface (4) and the shape of radicle (5), huts F 1/90 (4) and F 77/5 (5)
   6. seeds without testa from hut F 2/90, one cotyledon shows the trace of a plumule (lower right)

7. Leguminosae NP-24 type, seeds from hut F 1/90

Scale bars equal 1 mm

1 phot. A. Pachoński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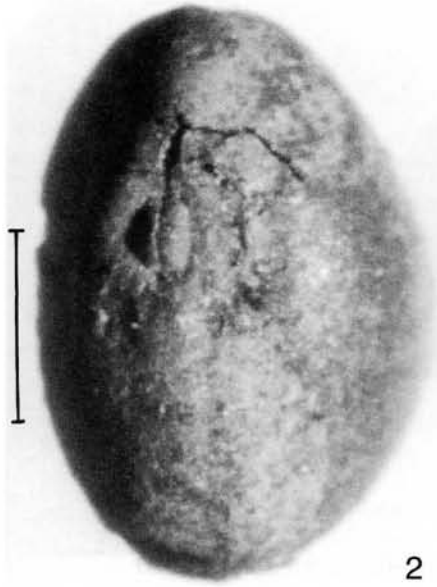
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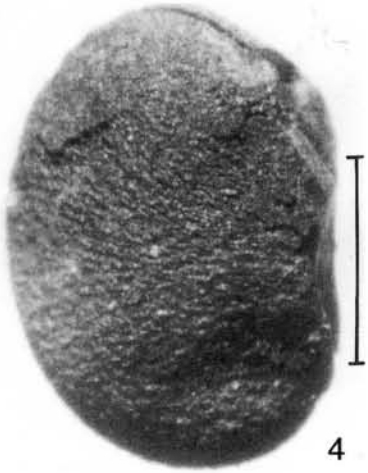
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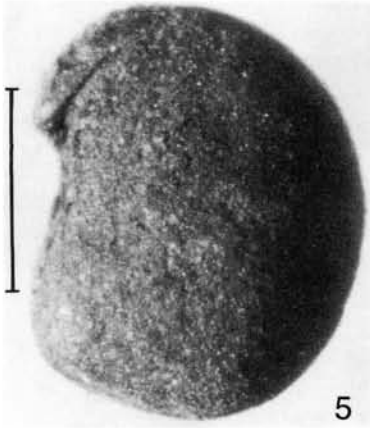
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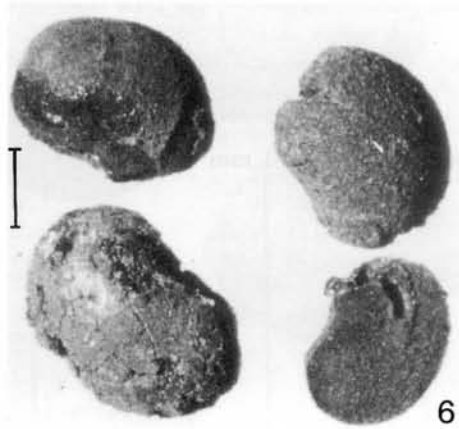
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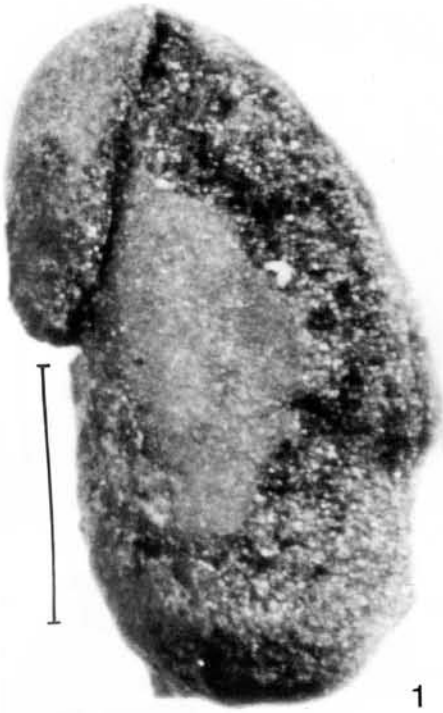
Plate 19

1–2. Leguminosae NP-24 type
1. seed from hut F 3/90
2. details of hilum in a seed from hut F 1/90

3. *Abutilon* type, seed from pit P 75/1

4–6. Leguminosae NP-30 type from hut F 1/90
4. seeds without testa
5. four seeds with transversally ribbed testa
6. seed with pitted testa surface

Scale bars equal 1 mm



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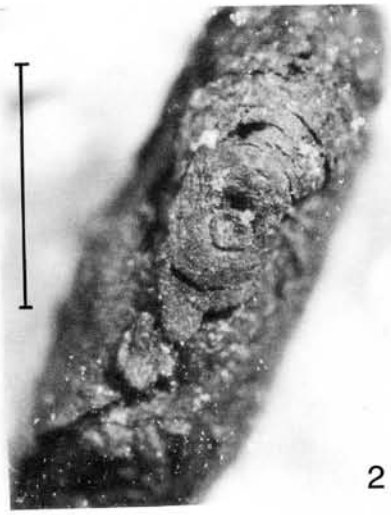

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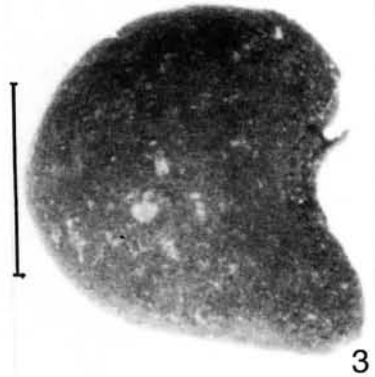

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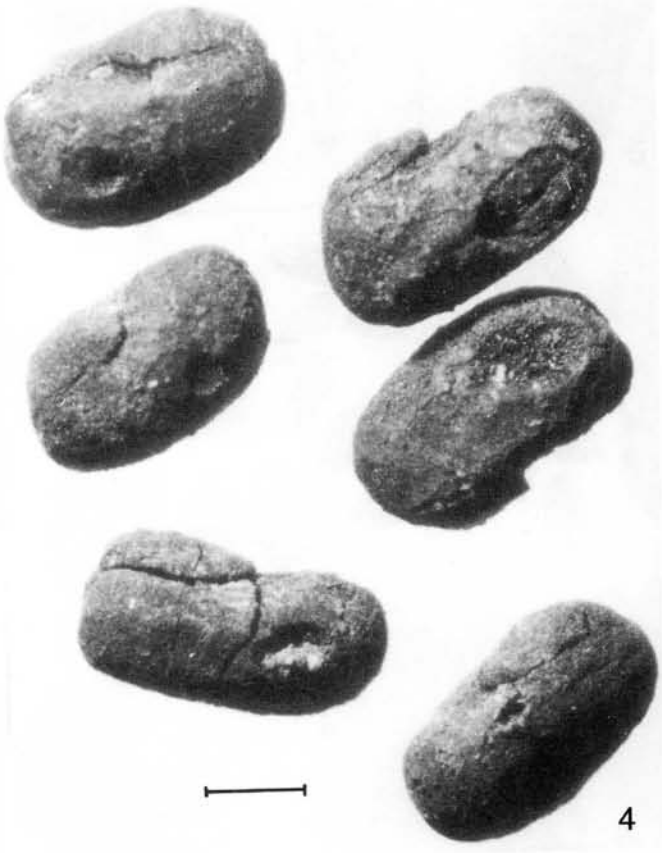

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Plate 20

1–2. Leguminosae indet., two seeds from pit P 75/1 (1) and hut F 1/90 (2)

3–9. *Boerhavia* sp.
- 3–5. complete propagules from huts F 2/90 (3), F 3/90 (4) and F 1/90 (5)
- 6. damaged propagule showing fruit inside, hut F 2/90
- 7. fruit with wrinkled surface, hut F 3/90
- 8. seed without testa showing radicle and cotyledons, hut F 3/90
- 9. seeds and fruits in one sample from hut F 2/90

10–11. *Rumex* sp., one fruit from hut F 1/90 in lateral (10) and apical view (11)

12–13. *Hyoscyamus* cf. *muticus*, one seed from hut F 3/90

14–15. *Solanum* cf. *nigrum*, one seed from hut F 1/90

Scale bars equal 1 mm

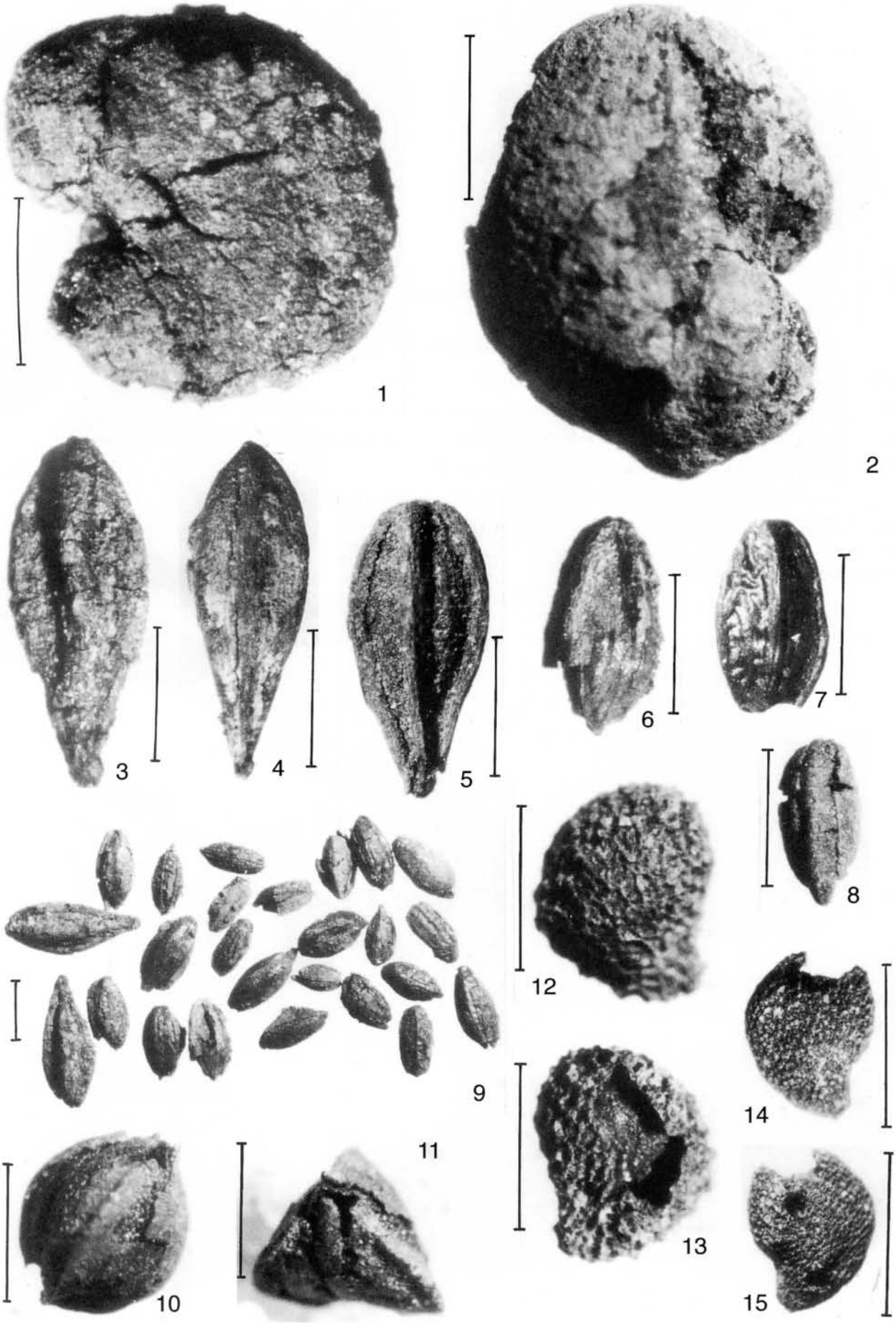
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Plate 21

Ziziphus sp.

1. complete fruit-stone from additional sample
2. fruit-stone fragment with fleshy mesocarp partly preserved, hut F 74/104
3. fruit-stone fragment with two cells which contained seeds shown in (8) and (9), isolated hearth
4. basal part of a drupe of the same specimen as (3)
5. broken fruit-stones, the most common preservation form, hut F 1/90

6–9. seeds, 8–9 from the fruit (3), 6–7 from hut F 74/104

Scale bars equal 1 mm

1–4 and 8–9 phot. A. Pachoński


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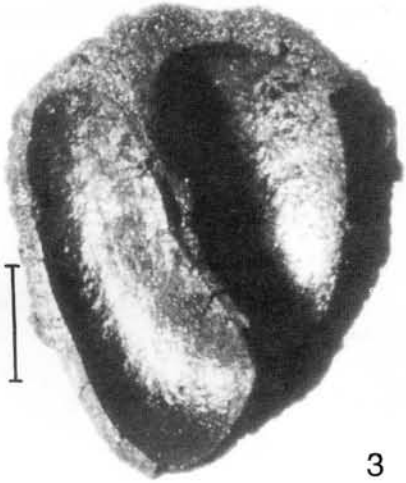
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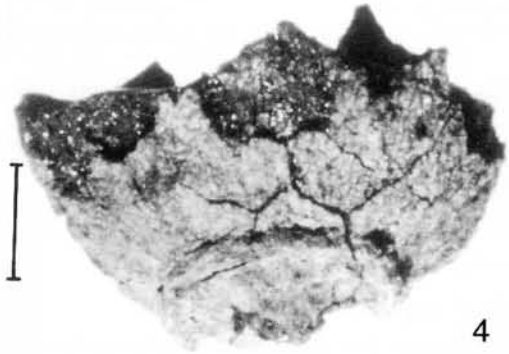
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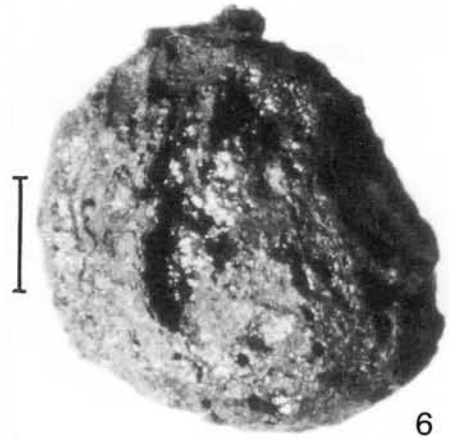
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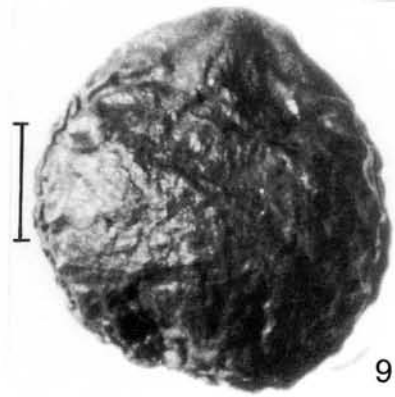
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Plate 22

1–5. cf. *Grewia* sp.
1–2. half of a fruit from the outer and inner side, note striated mesocarp ? (1) and thick endocarp (2), hut F 1/90
3–4. one fruit fragment showing smooth outer layer (4) and anastomosing fibres of the mesocarp ?, hut F 1/90
5. three seeds from huts F 1/90 (the marginal two) and F 2/90 (in the centre)

6–8. NP-34 type, three seeds from hut F 1/90

9–13. NP-35 type, five seeds from huts F 74/117 (9), F 3/90 (10–11), F 1/90 (12–13)

14. NP-36 type, seed from hut F 1/90

15. NP-37 type, seed from hut F 1/90

16–17. NP-45 type, two fragments of a berry-like fruit from additional sample

18. NP-40 type, seed from hut F 1/90

Scale bars equal 1 mm

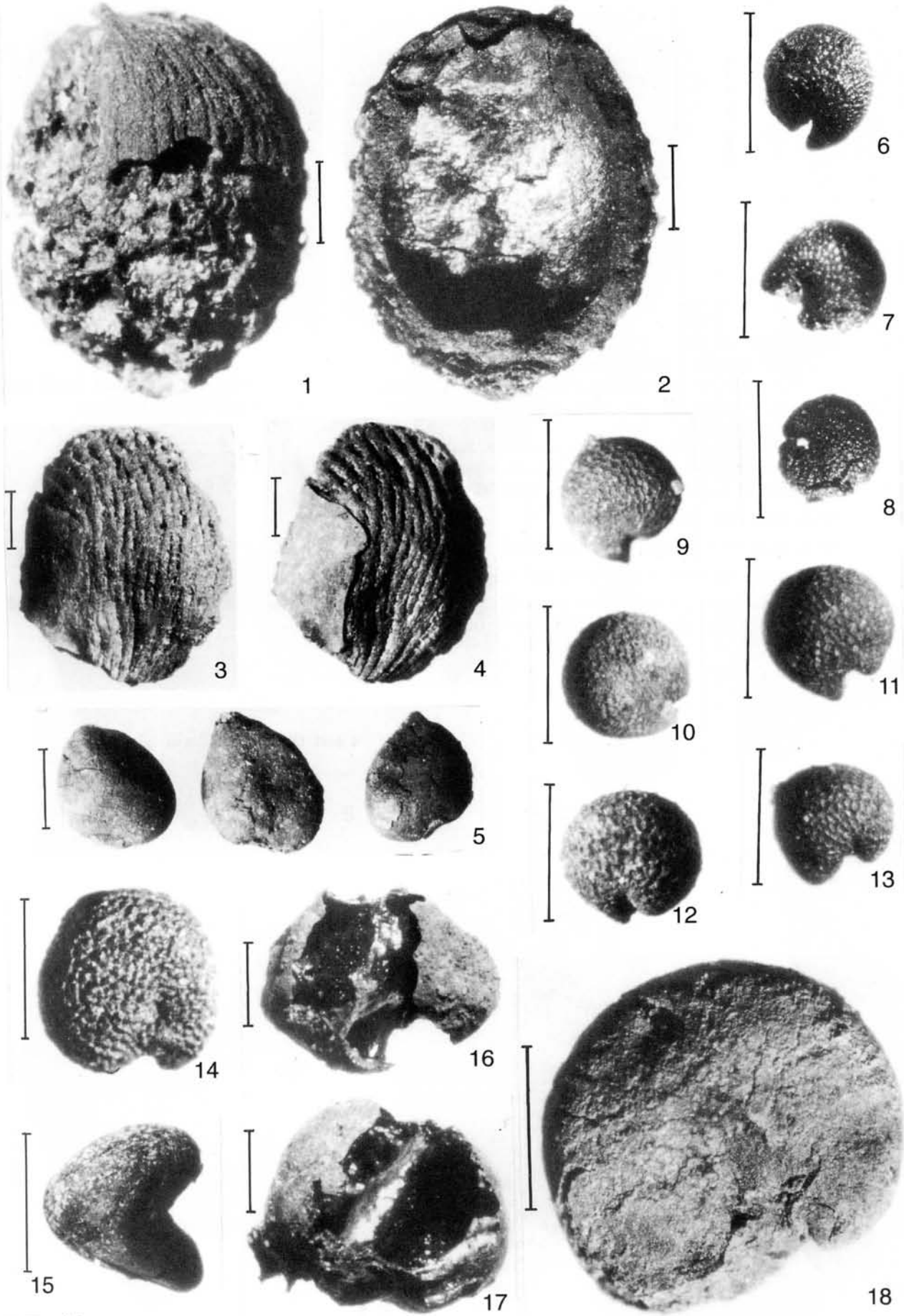
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Plate 23

1–8. NP-28 type
1. seed with fragments of outer coat, hut F 3/90
2. seed showing two radicles (two embryos sticking together ?) and remants of outer coat, hut F 2/90
3–4. one seed from the broad and narrow side, note the fissure between two cotyledons along the margin, hut F 1/90
5–6. two seeds with fragments of outer coat, hut F 2/90
7. seed with remnants of outer coat showing narrow wing, hut F 1/90
8. group of seeds from one sample from hut F 1/90

9. NP-51 type, fruit from hut F 2/90

10. NP-52 type, fruit or seed from hut F 2/90

11–12. NP-43 type, one fruit or seed from two sides, additional sample

13–14. NP-53 type, one fruit from two sides, note the remnants of pericarp on the roof-like side (13) and folded cotyledons on the opposite side (14); hut F 1/90

Scale bars equal 1 mm

4 and 10 phot. A. Pachoński


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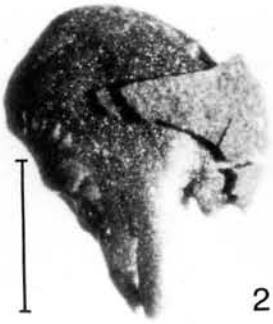
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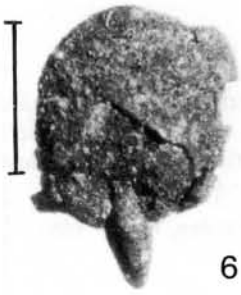
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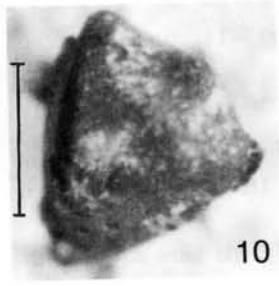
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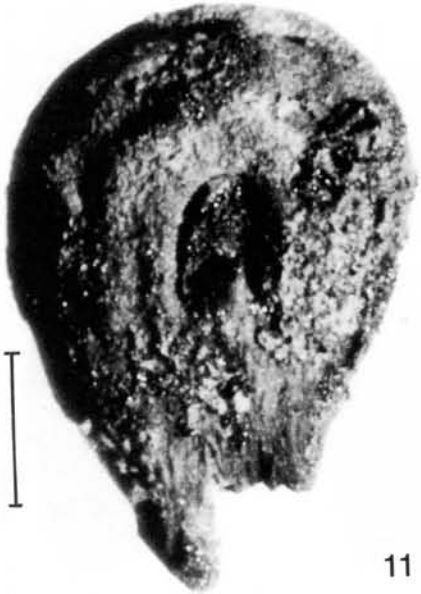
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Plate 24

1–4. NP-50 type, three fruits or seeds from hut F 1/90
1. exceptionally narrow specimen, a structure at one end may be an attachement point (?)
2–3. one specimen from two sides showing depression at one end (2) and broken outer coat (3)
4. another specimen showing wrinkled surface below the outer coat

5. unknown, calyx with a fruit inside (?), hut F 2/90

6–7. unknown, one fruit/seed from two sides, hut F 1/90

8. unknown seed, hut F 1/90

9. unknown fruit (?) with a pedicel, hut F 74/104

10. unknown seed, hut F 74/104

11–12. two groups of different unknown seeds, hut F 74/104 (see also Fig. 36:8)

13–14. unknown fruit or seed from flat (13) and convex (14) side, a kind of operculum at the top, hut F 77/5 (see also Fig. 36:5)

15. unknown fruit, thick and truncated at the top, hut F 1/90

16–17. two unknown fruits flattened at both ends, isolated hearth

18. unknown seed (?) with hilum on the straight margin and attachement point at one end, hut F 77/5

Scale bars equal 1 mm

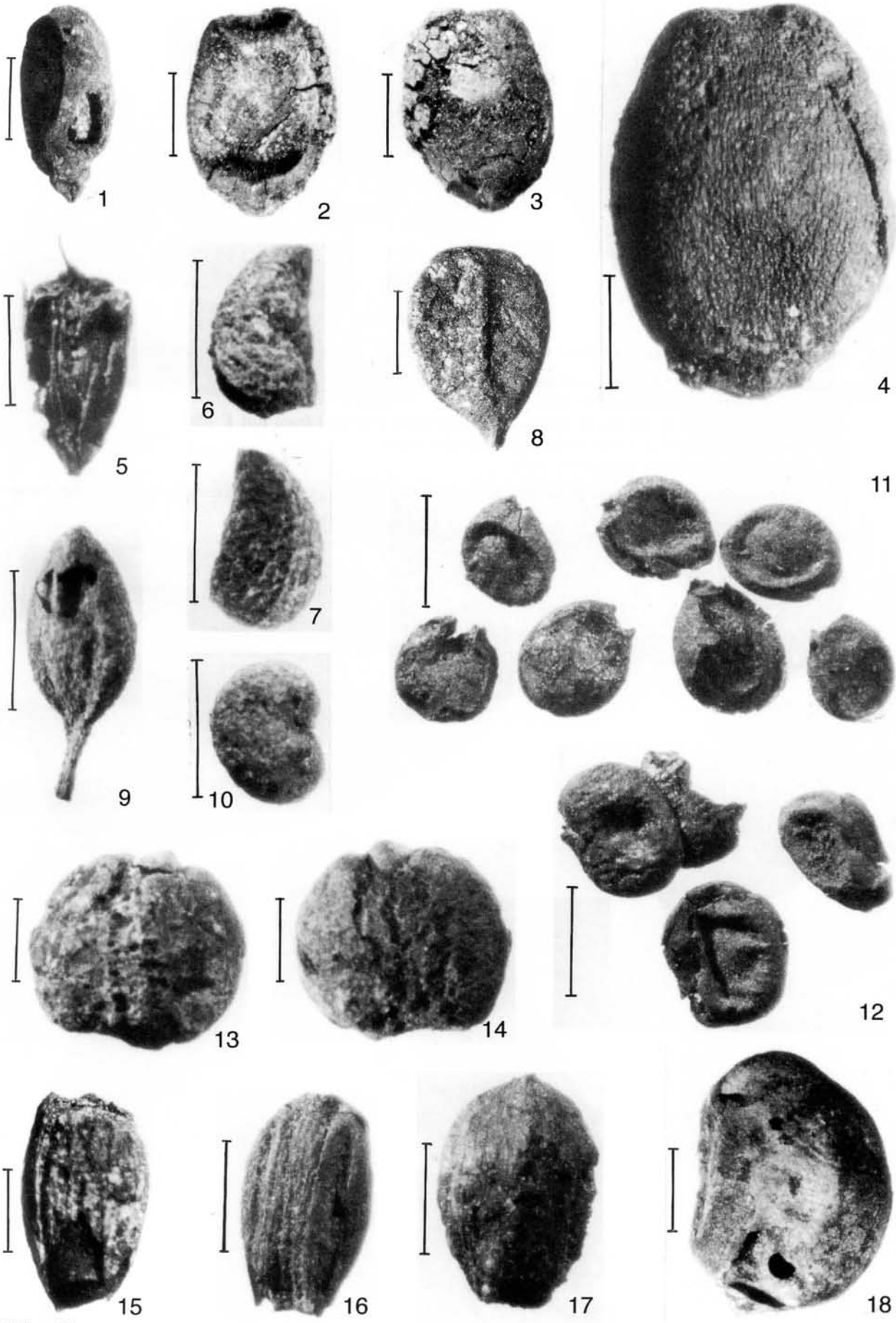
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Plate 25

1–2. undetermined tuber fragment from the outer side (1) and in the section (2); additional sample

3–6. *Cyperus* cf. *rotundus* tubers identified by J. Hather
3. tuber fragment from hut F 1/90
4–6. half of a tuber, found by H. Barakat among wood charcoal from hut F 1/90
4–5. outer view showing tuber nodes and rhizome scars
6. the same specimen from inner side

7–8. one tuber of extant *Cyperus rotundus* found by L. Kubiak-Martens on an island on the Nile near Asswan
7. outer view
8. longitudinal section

Scale bars equal 1 mm

1–3 phot. A. Pachoński

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Plate 26

1–2. possibly cf. *Scirpus* sp. tubers from hut F 2/90, identified by J. Hather

3. Gramineae indet., tuber from hut F 1/90, identified by J. Hather

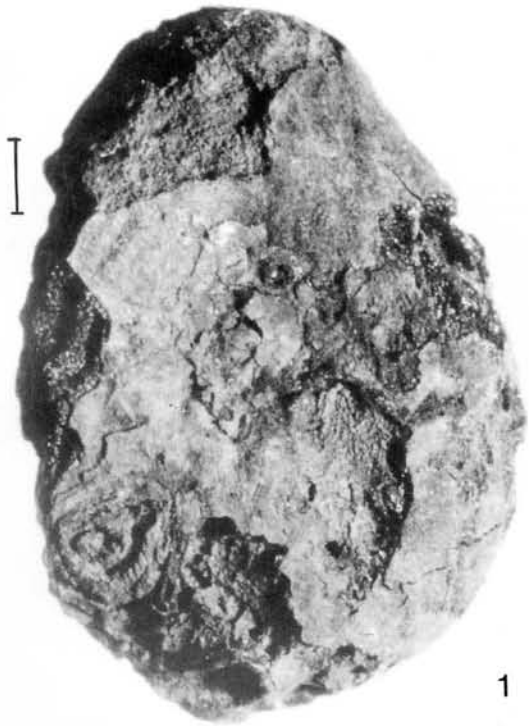
4. undetermined rhizome fragment, hut F 1/90

5–10. undetermined charred coprolites (avian feces ?)
- 5. the smallest specimen, hut F 77/2
- 6–7. one specimen from two sides showing ribs on convex side, hut F 77/2
- 8. specimen composed of two segments, no ribs on the surface, hut F 1/90
- 9–10. one specimen from two sides with ribs on outer surface, hut F 77/2

11–12. uncharred modern coprolites similar to the subfossil ones, collected on an island on the Nile near Aswan, by L. Kubiak-Martens

Scale bars equal 1 mm

1–3 phot. A. Pachoński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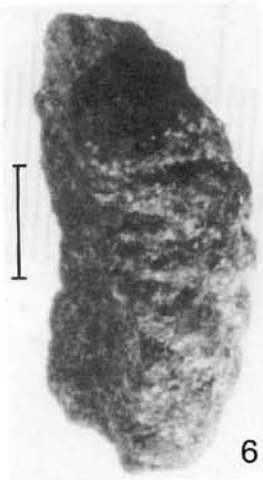
3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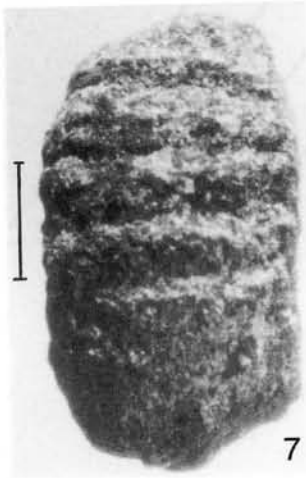
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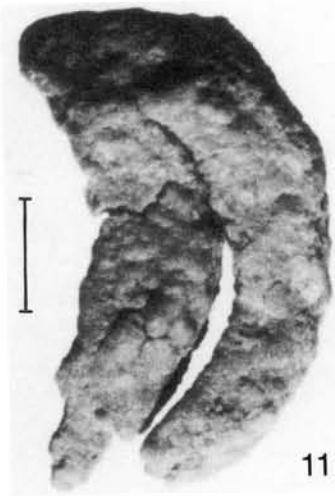
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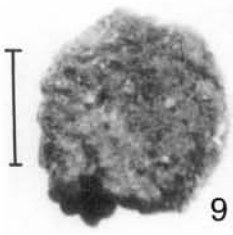
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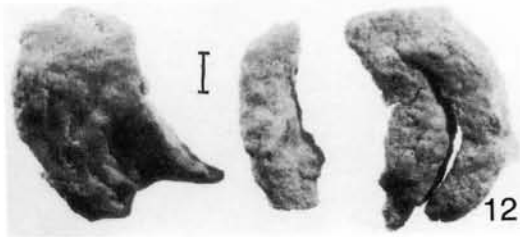
10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