Fields of change

Progress in African archaeobotany

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Crop production on the Senegal River in the early First Millennium AD: preliminary archaeobotanical results from Cubalel

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This paper reports the archaeobotanical results from flotation samples collected at Cubalel on the Senegal River. These samples are dominated by the grains and chaff of domesticated pearl millet (*Pennisetum glaucum*), from the earliest levels onwards, as well as other economic taxa, such as fonio (*Digitaria* cf. *exilis*), *Zizyphus* and *Celtis* fruit stones and numerous wild/weed species. The large quantities of *Pennisetum* chaff, including involucres, involucre bases, peduncles and bristles, provides the basis for a consideration of pearl millet crop processing activities and the use of processing by-products as animal fodder and fuel.

1 Introduction

The Iron Age site of Cubalel is located on the Senegal River, which is the natural border with Mauritania in northern Senegal. Cubalel was excavated by Susan and Rod McIntosh of Rice University, Texas. The site comprises a series of eight tumuli (or tells) situated along the river, covering an area of over two hectares. Excavations of the tumuli have uncovered a six metre sequence of stratigraphy spanning 800-900 years, dating from AD 0-100 to AD 900. The area of Cubalel has some of the most productive agricultural land in the Middle Senegal Valley floodplain. This is the first archaeobotanical data reported for this region.

2 Sampling and sorting

In total, 289 archaeobotanical samples were recovered from six of the eight Cubalel tumuli by Mary Anne Murray in 1991. 23 samples were collected from C1, eight from C2, 128 from C3A (the most thoroughly excavated tumulus), 68 from C3B, 51 from C6, seven from C8 and four from a separate trench. Nearly every context was sampled and these included hearths, pit fills, occupation floors and ash deposits. The botanical remains were recovered by bucket flotation using 1 mm and 250 mμ mesh sieves. Due to the use of bucket flotation, sample sizes were generally smaller than those taken for machine flotation. They ranged from between about 4 and 12 litres each, yet multiple samples were often taken from the same contexts. The plant samples were analysed under a low power (10x to 64x) binocular Wild MC3 microscope. All items, such as the seeds and chaff of cereals and other food plants, wild/weed species, wood charcoal, other plant parts and animal dung were extracted from each sample. Identifications of plant taxa were made on the basis of morphological characteristics and the comparison of the ancient specimens with modern comparative reference material. Several specimens were photographed using a scanning electron microscope (SEM) (figures 1-6). The samples were quite rich in organic remains as the average volume of material to be sorted for each sample was about 50 ml. Of the 80 samples analysed thus far, many consisted primarily of wood charcoal, while fewer were rich in seeds, chaff and other items. Table 1 lists the taxa found at Cubalel to date.

3 Discussion

The crop assemblage from Cubalel provides evidence for the importance of modern West African savannah cultivars during the Iron Age. These include pearl millet (*Pennisetum glaucum*) (figures 1-4), which had a single domestication in the far western Sahel, perhaps in Mauritania (Tostain, 1992), by the second millennium BC, and fonio (*Digitaria* cf. *exilis*) (figure 5), which has several possible centres of origin across the West African savannah belt (Harlan, 1971). What is of interest, however, is that the likely ecological contexts of origin of these two cereals are different, and thus Cubalel attests to the bringing together of these cereals into a sin-

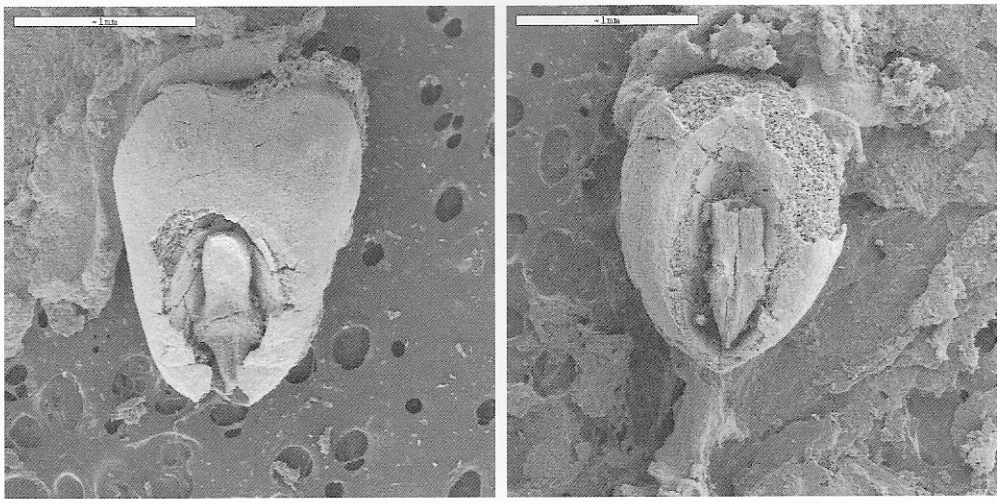

Figure 1: Examples of larger, plumper Pennisetum glaucum *grains from Cubalel.*

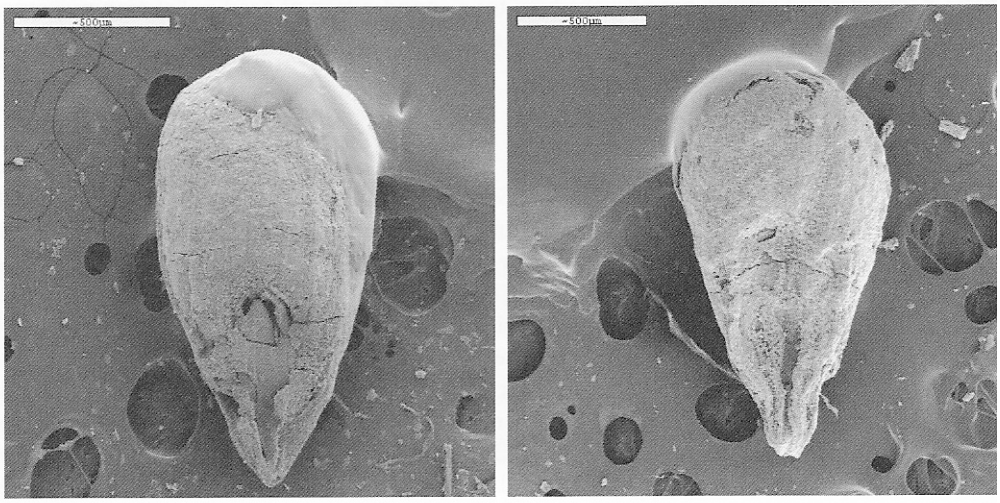

Figure 2: Examples of smaller, thinner Pennisetum glaucum *grains from Cubalel.*

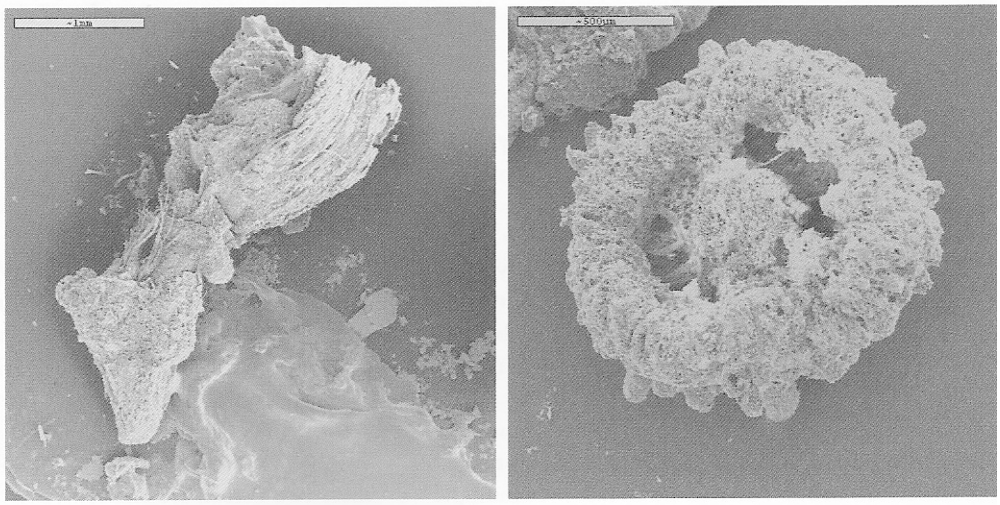

Figure 3: Examples of Pennisetum glaucum *chaff from Cubalel: left, domestic* P. glaucum *involucre, with preserved right spikelet; right, two-grained involucre apex, viewed from above.*

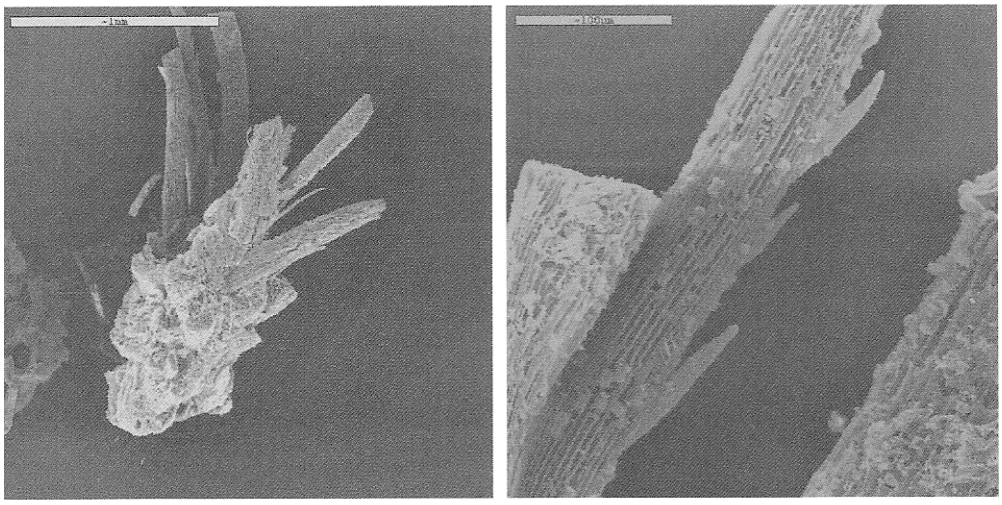

Figure 4: Pennisetum glaucum *involucre apex, with bristles, viewed from the side (left), with close-up of bristle showing unicellular, serrate hairs (right).*

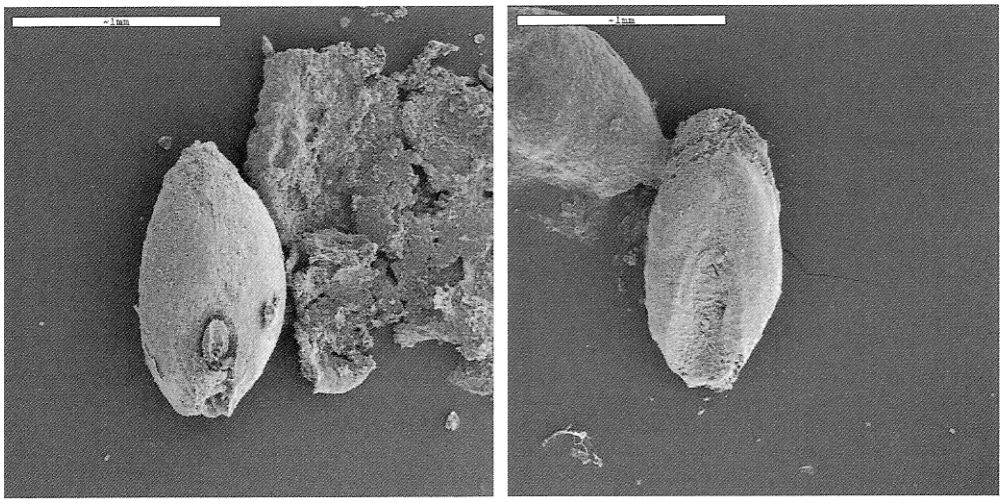

Figure 5: Examples of Panicum *sp. grains, cf.* P. laetum.

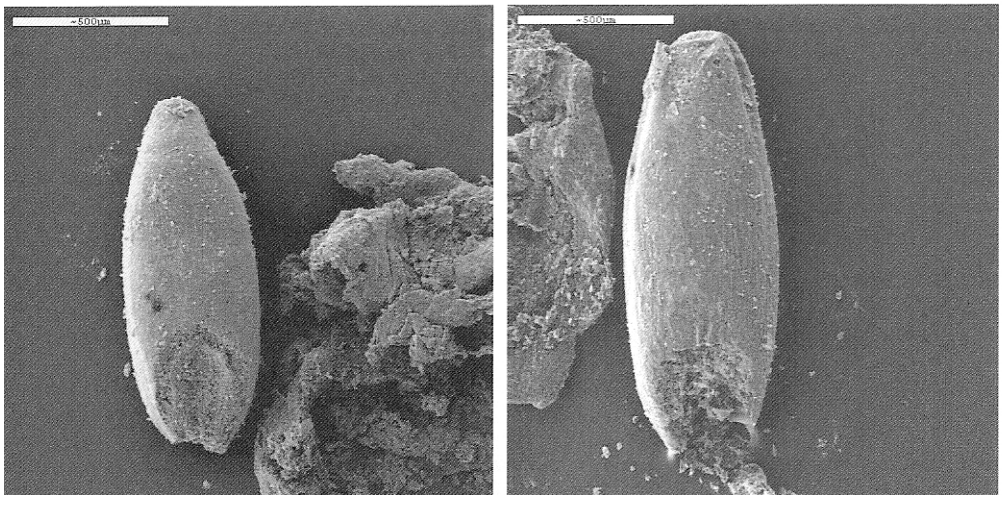

Figure 6: Examples of Digitaria *sp. grains, cf.* D. exilis.

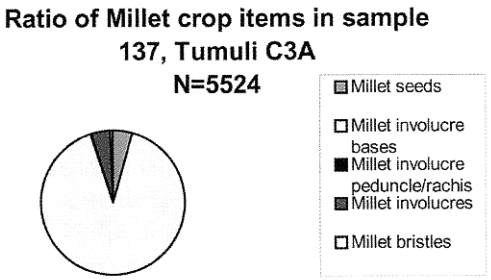

Figure 9. Chart of proportions of millet crop items in sample in samples 137, Tumulus C3A, which is rich in threshing by-products from involucres (total number of items: 5,524).

Cereals

The remains of *Pennisetum* are the most common components in the assemblage, including seeds, involucres, involucre bases, involucre stalks, and the bristles that surround the involucre bases (figures 1-4, 7). Much of the material appears to be cultivated pearl millet, *Pennisetum glaucum*. The *Pennisetum* seeds that fall outside the size range of cultivated pearl millet (Brunken, 1977) may be the result of shrinkage due to charring. Some of these seeds may also belong to the subspecies *stenostachyum*, which originated as a hybridisation between cultivated pearl millet and the wild subspecies *monodii*. The morphologically intermediate *Pennisetum stenostachyum* is a common mimetic weed in pearl millet crops (Brunken *et al.*, 1977). The smallest *Pennisetum* seeds may possibly be the wild subspecies *monodii*. Other remains of *Pennisetum*, too, indicate the presence of *Pennisetum glaucum*, as stalked involucres are a characteristic of the cultivated subspecies and these elements are ubiquitous throughout the assemblage.

More than 50% of the samples contain *Digitaria* spp., many of which most closely resemble fonio (*Digitaria exilis*), one of the two cultivated *Digitaria* species used as cereals in West Africa (figure 5). As yet none appear to be black fonio (*Digitaria iburua*), the other cultivated *Digitaria*. Others specimens are labelled as *Digitaria* type. In this region, the genus *Digitaria* contains generally good fodder plants (Dalziel, 1937) and some, as with other wild grasses in the Sahel, are collected for food (Boré, 1983).

The remains of other cereal include a possible fragment of rice (*Oryza* sp.) from the earliest phase of occupation in tumulus C3A. The fragment is small and seems too narrow to be domesticated rice. Rice had already been domesticated by the time of the first phase of occupation at Cubalel. As yet, there is no evidence that rice was a major crop (or weed) at the settlement as there no other rice anywhere in the Cubalel sequence, even in the later phases.

Table 1: Taxa present at Cubalel.

CEREALS and OTHER GRASSES
Pennisetum glaucum seeds
Pennisetum glaucum involucre bases
Pennisetum glaucum involucre base stems
Pennisetum glaucum involucres
cf. *Pennisetum glaucum* bristles, many in dung fragments
cf. *Oryza* sp.
Digitaria cf. *exilis*
cf. *Panicum* sp.
cf. *Setaria* sp.
cf. *Cenchrus* sp.
Dactyloctenium sp.
cf. *Bothriochloa* sp.
cf. *Echinochloa* sp.
cf. *Chloris* sp.
cf. *Brachiaria* sp.
cf. *Paspalum* sp.
Graminae indeterminate
FRUIT
Zizyphus sp. seeds (charred)
Zizyphus sp. seeds (mineralised)
Zizyphus sp. kernels (charred)
Zizyphus/Celtis (mineralised)
cf. *Zizyphus* thorns
cf. *Celtis* (charred)
cf. *Celtis* (mineralised)
OTHER TAXA
Leguminosae
Solanaceae
Cyperaceae
Caryphyllales
Fistymbristis sp. (*hispidula*?) (uncharred?)
Seeds indeterminate
OTHER ITEMS
cf. Root/tuber fragments
cf. Nut shell fragments
cf. Leaf fragments
Dung fragments

Other Graminae

Other Graminae are present in more than 80% of the samples studied to date although many of these remain challenges for further identification. The grasses may have arrived on site as collected foods, weeds of crops or as animal fodder preserved in charred animal dung.

Panicum spp. - *Panicum* is a genus with over forty species in West Africa, including those used as food, such as *P. laetum*, *P. subalbidum*, and *P. turgidum* (Boré, 1983; Cissé, 1991). The Cubalel specimens appear to be *P. laetum* (figure 6) and may have been used as a wild cereal.

Setaria spp. - There are eleven West African *Setaria* species (Hutchinson & Dalziel, 1936). The three more common to the area include *Setaria pallidefusca,* which is highly drought resistant and makes good animal pasture and fodder (Dalziel, 1937). The edible seeds are also collected for food in the Inland Niger Delta (Boré, 1983; Cissé, 1991). *Setaria verticillata* and *S. sphacelata* also provide animal fodder (Dalziel, 1937).

Echinochloa sp. - Of the five species present in West Africa (Hutchinson & Dalziel, 1927-1936), the most economically important is *E. stagnina,* which is a swamp grass whose grains are often prepared like rice (Boré, 1983; Cissé, 1991). It is also a rich fodder, either green or as hay, and the stems are used for thatch (Dalziel, 1937, p. 527). *E. colona* is also appreciated as a minor cereal and in some areas it is tended in a type of protocultivation (Boré, 1983, p. 30). Dalziel (1937, p. 527) claims that it had also been cultivated in Egypt as a cereal. *E pyramidalis* is another species used for food.

Brachiaria sp. - Several specimens are present in West Africa. *B. ramosa* has been recovered in abundance at Jenne-Jeno (McIntosh, 1995) and together with *B. lata* is listed by Bore (1983) as one of the wild grasses still used for food in the Inland Niger Delta.

cf. *Paspalum* sp. - These seeds were found in fourteen samples. Three species are listed by Dalziel (1937) as useful West African plants - *P.conjugatum, P. scrobiculatum* and *P. vaginatum.* We have only had access to comparative specimens the first two species, neither of which closely corresponds with the archaeological specimens. The third species is a grass of coastal areas. Boré (1983), however, mentions *Paspalum orbiculare,* a grass of damp areas that can be found in millet fallows and in rice fields as one of the plants collected for food in the Inland Niger Delta.

cf. *Bothriochloa* sp. - These seeds were found in seventeen samples. The genus *Bothriochloa* are grasses of no economic importance and may be present as a weed of crops.

Other grasses include cf. *Dactyloctenium* sp., cf. *Cenchrus* sp., and cf. *Chloris pilosa.*

Leguminosae

Remains from the Leguminosae family have been found in more than 40% of the samples. Most of them are seed fragments from the subfamilies Mimosoideae and Caesalpinoideae. Genera, such as *Acacia, Prosopis,* and many other trees typical of the Sahel and open dry savannah belong to these subfamilies. Many small legumes are also commonly found in the samples and have yet to be identified.

Fruits

Fruit remains are a common component in the samples. These primarily consist of the fragmented seeds and kernals of *Zizyphus.*

Zizyphus sp. - This is the most frequent taxon in this category (present in nearly 80% of samples), as indicated by the presence of both charred and mineralized seeds and kernels, as well as the charred thorns of the plant. Three species are present in West Africa: *mauritiana, mucronata* and *spina Christi.* All of which have edible fruits although *mucronata* is reported to have less value, both in terms of nutritional benefit and taste, compared to the other two species (Dalziel, 1937; Von Maydell, 1986). Although it is very difficult to distinguish between the seeds of Z. *mauritiana* and *Z. mucronata.* It may be more likely that the remains present at Cubalel are *Z. mauritiana,* the species most commonly used for food. The fruits of this species, a small tree, are edible fresh, dried or ground into a flour that makes a long lasting bread, cakes and beverages (Cissé, 1991; Dalziel, 1937; Von Maydell, 1986). *Celtis* sp. is also present in the assemblage.

A considerable variety of species of fruits and seeds of woody plants has been recognized in the plant remains at the site of Saouga in Burkina Faso, showing the importance of this type of resource at the end of the first millennium A.D. (Neumann *et al.*, 1998). A re-examination of the fruit and nut fragments from Cubalel may reveal several more useful taxa.

Other remains which are frequently present in the assemblage have been identified only to the family level, such as Solanaceae or Cyperaceae or to the order level, such as Caryophyllales (which includes families, such as Aizoaceae and Portulacaceae). These and other taxa will be identified in greater detail at a later date.

The presence of root/tuber remains is of interest as it may represent an important, though as yet unrecognised, food source. The analysis of this material with scanning electron microscopy (SEM) may help to identify it further.

7 Conclusions

The main cereal at Cubalel was pearl millet (*Pennisetum glaucum*). The large numbers of seeds and the various components of pearl millet chaff indicate the importance of the cereal, as well as the stages of its processing. The remains of millet chaff are also found in animal dung from the site, indicating the importance of the species as an animal fodder as well. The absence of crops typical of *decrue* (or flood recession) agriculture, such as sorghum or rice, as opposed to the normally rain fed millet needs to be explored further.

Several other grasses present may have been important foods, such as fonio (*Digitaria* cf. *exilis*) and further

analysis will provide a clearer picture of these taxa. It is also clear that various fruits, particularly *Zizyphus,* were another major component of the diet at Cubalel.

The use of animal dung as fuel is clearly shown throughout the sequence, as is the use of wood as fuel, as wood charcoal is also ubiquitous throughout. Indeed, many of the samples contain only wood charcoal.

After a full analysis of the plant remains from Cubalel, it will be possible to answer questions concerning the type of agriculture practiced at the settlement, the use of pearl millet by-products as fodder, fuel, etc., differences in fuel use (wood vs. animal dung), the role of wild foods, differences in the presence of taxa through time, such as the co-occurance of pearl millet and fonio in the sequence, but also those between the eight Iron Age tumuli located along the Senegal River at this important Middle Senegal Valley settlement.

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