8th International Workshop for African Archaeobotany

IWAA

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Contents

International Workshop for African Archaeobotany

Modena and Reggio Emilia, Italy, 23 - 26 June 2015

The 8th International Workshop for African Archaeobotany has been addressed to scholars working in the field of relationships between plants and humans as well as colleagues from related disciplines joining science and humanities in Africa. IWAA meetings have been held regularly every three years. They are key events, where data and knowledge on African Archaeobotany are exchanged on a wide range of topics. The 1st IWAA meeting was organized by Krystyna Wasylikowa and was held in Krakow (1994). Following IWAA workshops were held in Leicester (1997), Frankfurt (2000), Groningen (2003), London (2006), Cairo (2009) and Vienna (2012).

The 2009 conference – IWAA6 – was held in Egypt, hosted by Helwan University and the chief organizer was Ahmed Gamal-El-Din Fahmy whose untimely death in December 2013 has left us deeply saddened. IWAA8 at Modena is dedicated to his memory and the first edition of the Award to "Prof. Ahmed G. Fahmy Memorial Speaker" is given to Young African researchers in Archaeobotany.

At IWAA meetings, the primary focus of research and discussion was on seeds/fruits and palaeoethnobotany, but topics have been extended progressively to other research fields dealing with the complex relationships between culture and environment in Africa. Studies on plant macroremains including charcoals and seeds/fruits, phytoliths and pollen are currently being analyzed following a multidisciplinary archaeo-ecological approach. Environmental reconstructions, methodologies, ethnological and linguistic studies are fruitfully integrated in thematic interdisciplinary sessions. Oral communications and posters presented at IWAA8 are presented in this book of abstracts.

IWAA8 has taken place in the evocative frame of the historical towns of Modena and Reggio Emilia (25th June), at the feet of the Northern Apennines and in the Po Plain in Italy. The LPP-Laboratory of Palynology and Palaeobotany of the Department of Life Sciences organized the meeting. A special exhibition on the Herbarium Chiovenda from the collection of the Botanical Garden of Modena was hosted at the Complesso San Paolo thanks to the Municipality of Modena. The University of Modena and Reggio Emilia welcomed the initiative having among its priorities an extension of the international contingent among its students, and development of its relationships with African universities and enterprises working together towards a common mission for cultural development.

The EEHAR Escuela Española de Historia y Arqueología en Roma-CSIC, the Fondazione Cassa di Risparmio di Reggio Emilia and the University of Modena and Reggio Emilia Pietro Manodori are acknowledged for their financial support.

Special thanks are also due to the Museo Civico Archeologico Etnologico di Modena and to the Parco Archeologico e Museo all'aperto della Terramare di Montale for welcoming us in their museum and archaeological park.

Anna Maria Mercuri

"Professor Ahmed G. Fahmy Memorial Speaker" Award Winners:

1. Mennat-Allah El Dorry
   Westfälische Wilhelms-Universität Münster Institut für Ägyptologie und Koptologie, Münster, Germany

2. Elshafaey Abdellatif Elshafaey Attia
   Helwan University Department of Botany and Microbiology, Faculty of Science, Cairo, Egypt

3. Emuobosa Akpo Orijemie
   University of Ibadan Department of Archaeology and Anthropology, Ibadan, Nigeria

In memory of Ahmed Gamal el-Din Fahmy
(March 5th 1962 - December 18th 2013)

(Photo courtesy of Katharina Neumann)

SESSION 1

PROF. AHMED G. FAHMY MEMORIAL SPEAKER

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Mennat-Allah El Dorry[1]

Grapes, raisins and wine: archaeobotanical finds from the Monastery of St John the Little in Wadi El Natrun (Egypt)

Abstract
The discovery of grape pressing remains at a monastic residence in Egypt's Western Desert has brought up questions about the uses and values of grape processing residues. The material, excavated by the Yale Monastic Archaeology Project at 10th century AD monastic residence of St John the Little in Wadi El Natrun, consists of charred pressed whole Vitis vinifera *L. fruits, skin fragments, pips, and stalks, recovered almost exclusively from heating (cooking) installations. As wine is a valuable product in Egyptian monasteries, these remains have also raised questions related to wine manufacture in Egyptian monasteries and churches. This paper presents the material and its context, and discusses some ideas about the original uses of grapes, and the value and uses of pressing residues. Ethnographic studies on the modern production of wine in Coptic monasteries and churches are also presented.*

Key words: *Grape-pressing remains, Coptic Egypt, wine.*

Introduction

The study of macrobotanical material excavated at a 10th century AD monastic residence in Wadi El Natrun in Egypt's Western Desert focused on helping to reconstruct food ways and agricultural practices in the excavated residence which is part of the monastic settlement of St. John the Little (Brooks Hedstrom *et al.*, 2010).

Materials and Methods

One residential structure of *ca.* 25x25 metres was excavated by the Yale Monastic Archaeology Project. The residence revealed 17 cooking installations in the form of ovens and open-top stoves known in Egypt as *kānūns*. The macrobotanical material is primarily charred and associated with the use of ovens and *kānūns*.

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Results and Discussion

The recovered remains include cereal grains and chaff, pulses and weeds, in addition to pressed whole *Vitis vinifera* L. fruits, skin fragments, pips, and stalks (Valamoti *et al*., 2007). Since wine is a valuable product in Egyptian monasteries, these remains have raised questions related to wine manufacturing in Egyptian monasteries and churches.

Conclusions

This paper presents some ideas about the original uses of grapes, and the value and uses of pressing residues. Its final remarks discuss the activities resulting in these assemblages.

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Elshafaey Abdellatif Elshafaey Attia[1], Elena Marinova[2,3], Beatrix Midant-Reynes[4]

Predynastic plant economy in the Nile Delta: archaeobotanical evidence from Tell el-Iswid

Abstract
This study presents a reconstruction of the plant economy of Tell el-Iswid, a site situated in the eastern Nile which was inhabited mainly during the Predynastic period from ca. 3800 to 3200 BC, covering several phases of two main Predynastic periods, namely Buto and Nagada III. Research is based on the analysis of plant macroremains from over 30 flotation samples collected from different areas of the site during the 2010-2013 excavation seasons. For both study periods the main cultivated crops are barley and emmer, but also pulses like pea. Some remains of fruits and vegetables were also found. Finds of the oli/fiber crop-flax have been registered until now only in samples from the Nagada III period. The greatest amount of plant macrofossils belong to field weeds. The wild-growing vegetation is represented mainly by plants of wetland or marshy vegetation, along with few representatives of desert vegetation. The final aim of this study is to situate the plant economy of Tell el-Iswid within the wider framework of archaeobotanical studies covering the region of the Nile Delta in the Predynastic period.

Key words: *Macrobotanical remains, Predynastic period, Lower Egypt*

Introduction

The establishment of Neolithic economy in Egypt, including farming and herding is a complex process, with great variations in the different regions of the area, which were related with the first introduction of herding and pottery. Among the important elements of the Neolithic cultural and technological innovations, agriculture was introduced in late 5th - early 4th millennium BC by different Predynastic cultures in the Nile valley (Upper and Lower Egypt). The Nile Delta, as part of the Lower Egypt, possessed rather specific environmental settings in which the near-eastern crop package had to adapt. Moreover, the geographic position of this region allows the cultural interactions between

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Lower and Upper Egypt, the Mediterranean area and the Near East to be traced.

For the Predynastic and Early Dynastic period several archaeobotanical studies have been conducted on material recovered during excavations at settlement sites in the north-eastern Nile Delta, Egypt (van den Brink *et al*., 1989; Thanheiser, 1991, 1992a, 1992b, 1997). The recovery of plant macroremains from these archaeological sites provides diverse information on agricultural production and economy, diet and the environment in this formative period of Egyptian civilization. At most of these sites the staple cereal crops, as during the subsequent Dynastic periods, are emmer (*Triticum dicoccum*) and barley (*Hordeum vulgare*). The most frequent weeds are *Lolium* and *Phalaris*, but also numerous *Rumex* and small *Vicia* seeds were present. In most of the sites crop processing by-products are recorded and the finds from Buto suggest that they were used as fodder (Thanheiser, 1991). Harvesting of tubers of tiger nut was attested in both sites of Tell el-Farkha (Kubiak-Martens, 2012), with larger archaeobotanical sets published about the Buto period (Thanheiser, 1992a, 1997) and at Tell el-Iswid (De Roller, 1989). Furthermore, a remarkable homogeneity of the archaeobotanical assemblage from all of the Predynastic layers was also observed, as well as continuity in the plant economy between Predynastic and Early Dynastic layers (De Roller, 1989; Thanheiser, 1997).

A large scale excavation at the site of Tell el-Iswid was carried out by IFAO, Cairo, starting in 2006; it allowed systematic archaeobotanical sampling of different structures from a large area of the site covering the Predynastic period (Lower Egyptian Cultures to Naqada Culture) to be undertaken. The current study aims to reconstruct the plant economy of Tell el-Iswid, based on archaeobotanical (marcobotanical) evidence, and to situate the plant economy of the site within the wider framework of the archaeobotanical studies of the Predynastic period covering generally the region of Lower Egypt.

Materials and Methods

30 samples from different levels at Tell el-Iswid were investigated (13 from Buto II period and 17 from Nagada III period). The volume of samples before flotation ranged between 1.5 litres and 12 litres including organic materials.

Results and Discussion

A total of 3326 fragments of plant macroremains were identified included 867 fragments from Buto II and 2459 from Nagada III periods.

i. ***Field crops:*** Cereals - The preservation is generally poor. *Hordeum* *vulgare* and *Triticum dicoccum* were the major cereal crops that were found regularly in both periods with considerable amounts and there is no significant change between two periods. Emmer is the usual wheat type at Egyptian sites in Predynastic and Dynastic times and it was mainly used for baking bread (Thanheiser, 1992a).

Pulses - Preservation of pulses is extremely bad; they were found in very few amounts represented mainly by *Pisum sativum* and *Vicia* sp.

ii. Weeds: Field weeds represent 35.7% of the recorded plant remains in the samples from Buto II and 56.8% of the samples from Nagada III. *Lolium* is found in large amounts in nearly all samples and it was represented in high percentage in Buto II and Nagada III: 12% and 29.2% respectively.

iii. Oil/Fibre crops: Flax is an annual herb that is cultivated in winter. At present, it is mainly cultivated in the Nile Delta and at Abu-Tig in the Assiut governorate (south of Cairo). It requires moderate climate conditions for the production of a good yield. It was not observed in all investigated samples from Buto II and was found in very small percentage (0.1%) from Nagada III.

iv. Garden/Imported plants: Garden plants are only represented by one grape-pip in Buto II and two in Nagada III. *Cucumis melo* was found only in Nagada III period with three charred and eight mineralized seeds. Fig seeds were identified in both periods. Both grape and fig were used by the Egyptians since the early times. To infer a minor importance of these plants would be misleading as they are usually eaten uncooked and therefore have only a small chance of being preserved by charring.

v. Rudreal/Segetal vegetation: *Polygonum lapathifolium* was the most collected species counted from the two periods. The following plants could have been collected: *Chenopodium murale*; *Rumex* sp.; *Malva* sp., remembering that all these plants are also frequent weeds in fields. They could have therefore reached the village together with the harvested crops.

vi. Riparian/Flood vegetation: Culm fragments of *Phragmites* were also identified. These species are characteristic of reed swamp plant cover in Egypt. Other water-loving taxa attested in the deposits were recovered from the site including: *Aeluropus, Juncus, Cyperus, Isolepis, Setaria*. The recovered seeds from samples related to Nagada III (88 seeds) are more aboundant than in Buto II (9 seeds).

vii. Xerophytes: 23 specimens of the plant macroremains were grouped under xerophytes. These remains were attributed to four species: *Capparis, Tamarix, Pulicaria* and *Arnebia*. *Pulicaria* was the only desert species that has been recovered from all samples referred to Buto II period with only 2 seeds.

The rate of preservation was generally poor in both periods but it is better in Nagada III than in Buto II. This sometimes made the identification difficult. From the chronological analysis of the samples and their preservation it seems that the samples from the Nagada III period (n=17) have higher concentration of plant remains (average concentration is 29 identifiable plant remains per litre), while the samples from the Buto II period (n=13) show nearly a 3 times lower concentration of identifiable plant remains per litre. The total number of plant macro remains separated from the samples from period Buto II is relatively small (n=867) compared with other period; Nagada III (n=2459).

The material available for anthracological analysis showed that the most numerous ones are the fragments of culms belonging to the grass family (Poaceae). In many cases it was possible to identify fragments of reed culms (*Phragmites*) among them. The wood charcoals represent *ca*. 10% of the anthracological remains and most of the preserved wood fragments belong to *Tamarix*. Also few fragments of *Acacia* were identified in both samples from Nagada III and Buto II period. In almost all samples also single fragments of rhizomes and tubers were found. Some of the rhizomes could belong to the local wetland vegetation. Comparison with reference material showed resemblance with rhizomes of *Imperata cylindrica*, but further analyses are needed to confirm this hypothesis. Few of the tuber fragments were well preserved and could be identified as *Cyperus rotundus/esculentus*. Most probably the reeds and wood originate from burning of fuel. This could also be the case for the rhizomes, although they, as well as the *Cyperus*-tubers, could also be roasted and used for human consumption.

Conclusions

The archaeobotanical analysis at Tell el-Iswid does not show considerable differences between the compositions of the samples in both periods. The botanical structure of the site in both periods consists mainly of four categories: cultivated crops and vegetables, field weeds, wild plants, wood and charcoal.

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Supplemento
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Emuobosa Akpo Orijemie[1]

Archaeobotanical study of Late Stone Age rock shelter AH1, Abeokuta, south-western Nigeria

Abstract
*An archaeobotanical study of a Late Stone Age rock shelter, AH1 in Abeokuta, Nigeria, was carried out with a view to reconstructing the vegetation history and ethnobotany of the inhabitants of the rock shelter. Twenty soil samples from excavated units inside and outside the rock shelter were studied. Three pollen zones (I, II and III) were recognised from each of the rock shelter and outside it. The vegetation from the earliest period (zone I) had northern Guinea savanna, mountain forest components and fungal spores. In zone II, southern Guinea savanna species (*Daniellia oliverii, Nauclea cf. latifolia, Stereospermum kunthianum *and* Vitex doniana*) and fungal spores were prevalent with a phenomenal rise in* Elaeis guineensis *pollen which suggested the use of the oil palm plant. The occurrence of fungal spores (*Glomus sp. *and* Diporotheca sp.*) known to inhabit herbivore dung revealed the presence of game around the site. In zone III, rainforest, freshwater and ferns became prevalent indicating the occurrence of favourable environmental conditions. The subsequent diversity in herbaceous plants associated with cultivation and the appearance of exotic species indicate less reliance on game and wild plants and the beginning or intensification of plant cultivation.*

Key words: *Ethnobotany, game-hunting, Late Stone Age, palynological study, south-western Nigeria, vegetation history*

Introduction

The Late Stone Age (LSA) (*ca*. 18,000-2,500 yr BP) in West Africa is characterised by the drastic decline and disappearance of heavy-duty tools, and the appearance and subsequent abundance of small-sized stone tools known as microliths (arrow points, blades, chips, chisels, flints, micro-blades and points). The change in tools has been linked to vegetation change (Shaw & Daniels, 1984), and interpreted as being an adaptation for hunting in a savanna environment (Soper, 1965). However, due to the paucity of archaeobotanical data of LSA sites in Nigeria, the vegetation changes referred to above

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have been inferred from palaeobotanical records from similar sites in Kintampo and Bosumpra (Ghana). Palynological analyses of Kariya Wuro (Sowunmi & Awosina, 1991) and Udi-Okigwe (Umeji *et al*., 2012) rock shelters revealed the use of *Bridelia scleroneura* and *Pavetta* sp. as medicine, and the fruits of *Elaeis guineensis* and *Sarcocephalus latifolius* (syn. *Nauclea latifolia*) as food in those rock shelters. The importance of these plant resources notwithstanding, LSA humans in Nigeria may have utilised plant resources other than those named above as was the case in Ghana (Flight, 1976; Stahl, 1986) and Cameroon (Kahlheber *et al*., 2014). What could these other plant resources be and under what environmental conditions did LSA humans survive? This paper attempts to answer these questions in the light of recent archaeobotanical investigations in rock shelter AH1, a LSA site in Olusegun Obasanjo Presidential Library (OOPL), Abeokuta, Nigeria.

Materials and Methods

Nine and eleven samples from inside and outside the rock shelter were obtained at intervals of 5 cm and subjected to standard palynological procedures without acetolysis (Faegri & Iversen, 1989). The final residues were studied under x40 and x100 objectives of a light microscope. Identification of palynomorphs was based on the 3600 reference slides collection and photomicrograph albums in the Palynology Laboratory, Department of Archaeology and Anthropology, University of Ibadan, Ibadan, Nigeria. Identified palynomorphs were classified into phyto-ecological groups based on the natural habitats of their presumed parent plants (Keay, 1959; Hutchinson & Dalziel, 1958–1972).

Results and Discussion

A total of 171 palynomorph types were recognised out of which 148 were identified. Six phyto-ecological zones were recognised namely: freshwater, dry rainforest, secondary forest, mountain forest, southern Guinea savanna and northern Guinea savanna. Others were classified into exotic plants, open vegetation, ferns and fungi. The vegetation at zone I had northern Guinea savanna, mountain forest components and fungal spores; the climate was predominantly dry and cool. Zone II was dominated by southern Guinea savanna species (*Daniellia oliverii, Nauclea* cf. *latifolia, Stereospermum kunthianum* and *Vitex doniana*) fungal spores and *Elaeis guineensis*. The phenomenal rise in the latter pollen is indicative of the importance of the oil palm plant at that time. Game may have been important and hunted on account of the occurrence of fungal spores (*Glomus* sp. and *Diporotheca* sp.) known to inhabit herbivore dung, as well as the abundance of arrow points and blades in the archaeological record. The abundance of rainforest species in zone III signalled a change to wet and warm climate. After the LSA, the diversity in herbaceous plants associated with cultivation and appearance of exotic species (*Azadiractha indica, Carica papaya, Delonix regia* and *Zea mays*) indicated less reliance on game and wild plants and the beginning or intensification of plant cultivation. In addition, the concomitant decrease and disappearance of stone tools reflect a shift in subsistence from a hitherto hunter-gatherer to agrarian society of the Neolithic. This change in subsistence depends partly on a favourable and more reliable wet and warm climate. Based on the recovery of the pollen of plants recovered exclusively from the rock shelter, the inhabitants deliberately brought at least 20 herbaceous plants into the rock shelter which they utilized for a variety of purposes including food, medicine, fishing and hunting. The majority of the plants, both flower and fruit, inferred to have been used in the rock shelter in November-January and is thought to have been the main occupation period of the rock shelter.

Conclusions

Archaeological and palynological data obtained from the LSA rock shelter AH1 have shown that during its early occupation, the environment of the rock shelter was dry and open being dominated by Guinea savanna plants. The occupants used microliths and were hunter-gatherers. They gathered a variety of plants which they utilised for food, medicine and hunting. With the subsequent amelioration of climate, microliths disappeared, rainforest became established while herbaceous plants increased. After the LSA, these phenomena signalled less reliance on game and wild plants and the beginning or intensification of plant cultivation.

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SESSION 2

THE MEDITERRANEAN AFRICA

Supplemento
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Rim S. Hamdy[1], **Ahmed G. Fahmy**[2]

The archaeobotanical remains of KV 63, Luxor, Egypt

Abstract
The archaeobotanical samples from site KV 63 have been analysed using morphological characteristics. Twenty species were identified; among them, 13 were used in the formation of floral collars.

Key words: *Floral collars, seeds, fruits, embalming cache*

Introduction

The excavation team from Memphis University, USA, has recovered plant macroremains (leaves, fruits, seeds and charcoal) at the archaeological site KV 63 in Luxor, Egypt. The archaeologists throughout previous seasons of excavations have gathered the botanical material under analysis. Dr. Otto Schaden and Dr. Roxie Walker have asked the authors to undertake an archaeobotanical study on this material.

Materials and Methods

The plant macroremains were visible; hence, there was no sampling strategy to retrieve them. However, natron samples underneath the discovered collars have been analysed looking for smaller seeds and fruits. Dry sieving has been used to separate plant macroremains from the archaeological natron. In this regard, a 0.5 mm mesh size sieve was used. The botanical material under study was desiccated. Each sample was investigated using a binocular microscope with 20x-50x magnifications. Identifications were based on the texts on the flora of Egypt, Africa, and the Middle East by Boulos (1999, 2000) and Zohary (1966, 1973). Digital images have been taken of almost all plant macroremains in order to check and confirm identification using as reference the collection of the Botany Department, University of Helwan.

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We must mention that treating the botanical material with chemicals such as paraloid should be avoided in any future studies. These chemicals, in fact, destroy morphological and anatomical characteristics of plant remains; hence their identification becomes difficult. The collars retrieved during the 2006 season were still intact when they were discovered *in situ* inside coffins (Fig. 1).

Results and Discussion

Morphological investigation of the samples results in classifying them into two major groups: “floral collars” and “seeds and fruits”.

The floral collars from KV63 have been attributed to 13 different plant species: 4 are represented by leaves (Pomegranate, Olive, Willow, and *Persea*), 3 are represented by flowers (Safflower, Cornflower, and Blue lotus), 3 are represented by fruits and seeds (*Withania* [Nightshade family], Argun palm, and *Hyoscyamus*) and 3 were used in binding the collar’s parts (Papyrus, Date palm and Linen). The seeds and fruits from KV 63 have been attributed to 7 species. These remains include chaff of barley and edible fruits of date palm, juniper, pine, olive, Christ’s thorn and *Persea*.

The presence of eight bags full of barley chaff is very interesting. The chaff in these samples consists of very fine glumes (lemmas and paleas) with complete absence of rachis internodes. Sacks made of linen and filled with chaff were recovered inside the tomb of Tut Ankh Amun (Winlock, 1941). Discovered fruits and seeds can be classified into two groups: native and non-Egyptian plants.

Conclusions

Morphological investigation reveals the presence of a diversity of botanical material from site KV 63, including wild and cultivated plants as well as native and non Egyptian taxa (Hamdy, 2015). Available archaeobotanical evidence suggests that this material was used during the actual process of embalming. There is a great similarity between the plant remains of KV 63 and those identified by Germer (1989) and Hepper (1990) from the tomb of Tut-Ankh-Amun.

Further archaeological and archaeobotanical analyses are necessary in order to understand the role of site KV 63. The area is very promising in terms of palaeo-ethnobotanical studies and we are looking forward to joining future research seasons.

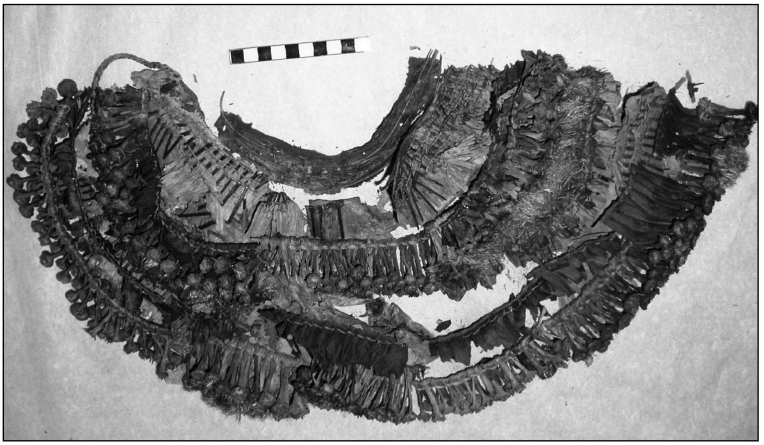

Fig. 1 – *Floral collars from site KV 63, Luxor*

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Alexa Höhn[1], Katharina Neumann[1]

From heyday to demise – tracing human impact of the Nok Culture in central Nigeria in the 1st millennium BC

Abstract
Archaeological charcoal is used to trace the development of a cultural landscape and accompanying environmental changes in the 1st millennium BC in central Nigeria under the influence of the Nok Culture.

Key words: *Cultural landscape, Nok Culture, archaeological charcoal*

Introduction

We have recently put forward a hypothesis on environmental change during the second half of the 1st millennium BC in central Nigeria as a possible agent in the demise of the Nok Culture (Höhn & Neumann, in press), which has been known for its impressive terracotta sculptures and the mastering of iron metallurgy since the middle of the last century. In the last years new insights into chronology, settlement patterns, economy and environment have been gained through the work of the Frankfurt based Nok Research Project (Breunig, 2014). Archaeobotanical and archaeological evidence point to a shift in site location and vegetation exploitation from the hills to the valleys after the end of the Nok Culture. We assume that a different seasonality pattern (recorded in several supra-regional proxies for the middle of the 1st millennium BC) accompanied by strong rainfall events triggered soil erosion on the hill slopes, where woodland previously had been opened up by cultivation and iron-smelting.

The prerequisite for this hypothesis, that human impact had indeed changed the woodland vegetation, is now tested with charcoal remains from Pangwari, a large site with abundant material from archaeologically described contexts mostly dating to the beginning of Middle Nok, the heyday of the Nok Culture (Fig. 1).

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Materials and Methods

About 20 charcoal samples from several pits within the site were analyzed under the transmitted light microscope and assigned to charcoal types. The types were grouped according to their habitat preferences.

Results and Discussion

ANOGEISSUS LEIOCARPUS (charcoal types in capitals to clearly distinguish them from biological taxa) dominates the samples concerning shares as well as ubiquity. Abundantly present are also several charcoal types assigned to Leguminosae and Phyllantaceae families.

Thus the assemblage of Pangwari differs from other Middle Nok sites, only spot checked however, in which charcoal types assigned to the Leguminosae, possibly representing *Isoberlinia* spp., are ubiquitous. ANOGEISSUS LEIOCARPUS is present in these samples as well, but not as prominent as in Pangwari.

Conclusions

It is feasible that the charcoal samples from Pangwari represent less disturbed woodland vegetation that had been present when the site came into use. It might thus stand for the first stage of the development of a cultural landscape at Pangwari and in the research region in general. The sites/samples with assemblages dominated by Leguminosae could then represent later stages with a higher proportion of fallow vegetation present and exploited. However, in order to postulate such a development we will need samples that are securely dated (radiocarbon or context) to later phases of Middle Nok and/or Late Nok and that are dominated by charcoal types relatable to fallow vegetation.

Radiocarbon dates from these phases exist, for Pangwari and other sites, but repeated use of sites, erosion and illicit diggings pose difficulties concerning find contexts. We still expect that, with the ongoing archaeological and archaeobotanical investigations providing a wider dataset from Pangwari and other large scale excavated sites (e.g. Ungwar Kura), it will be possible to trace the development of a cultural landscape during the Nok period and the environmental change towards its end.

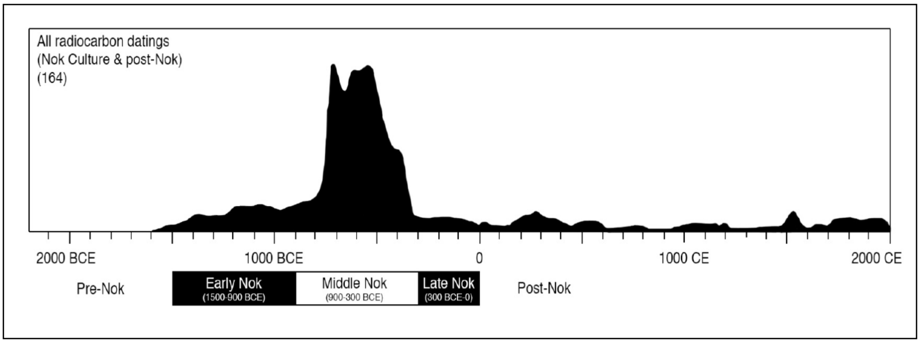

Fig. 1 – *Chart plot of the age of Nok Culture and its subdivisions (Breunig, 2014)*

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Adel M. Ahmed[1], Ahmed G. Fahmy[2], Rim S. Hamdy[3]

Archaeobotanical study of plant diversity at Early Dynastic Helwan (3100-2600 BC, Egypt)

Abstract
Analysis of plant macroremains from sealed pots discovered inside ten tombs at the Early Dynastic Cemetery in Helwan provided an excellent opportunity to study the economy and ecology of Ancient Egypt. The plant macroremains that were retrieved from Helwan Cemetery were classified into two major groups. The first group is "cultivated crops" including cereals representing (38.4%) and flax (0.02%). The second one is 'wild plants' containing wild edible fruit (0.01%), field weeds (52.0%), plants of moist habitats (2.2%), plants of dry habitats (0.04%) and other unknown taxa (2.9%).

Key words: *Egypt, Helwan, Early Dynastic Cemetery, archaeobotany, plant macroremains*

Introduction

The current study deals with the analysis of the plant macroremains that were retrieved from 10 tombs in the Early Dynastic Cemetery at Helwan/Ezbet El Walda archaeological site (Operation 4) about 30 km south of Cairo. This site is considered to be the largest necropolis of the Early Dynastic Period in Egypt (Köhler, 2008, 2014). This study aims at understanding the economic and ecological characteristics of the site as well as increasing our knowledge of the plant diversity that flourished during the Early Dynastic Period in the area of ancient Memphis.

Materials and Methods

Thirty soil samples were collected during the excavation seasons between 2003 and 2006 by the archaeological team of the University of Macquarie (Sydney, Australia). Their volumes range between 0.3 and 7 litres of ash as well as ash mixed with clay. Water flotation process was used for the separa-

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tion of plant macroremains from the archaeological sediments found inside the pots. Remains were sorted into categories using a Russian binocular microscope (magnification: 10x–20x).

Results and Discussion

Morphological analysis has yielded a total of 26,819 fragments of charred plant macroremains. The state of preservation of the plant remains was excellent and homogenous in all samples. Cereals, field weeds and plants of moist habitats have been recorded in all samples but with different ratios. The cereal remains from the studied tombs of Operation 4 at Helwan consist of 90.3% chaff and 9.7% grains. Remains of five crops have been identified: *Hordeum vulgare* L. convar. *vulgare* L. (Hulled, Six-row Barley), *Hordeum vulgare* L. convar. *distichion* (L.) Alef. (Hulled, Two-row Barley), *Hordeum vulgare* L. convar. *coeleste* (L.) Trofim (Naked, Six-row Barley), *Triticum turgidum* L. ssp. *dicoccon* (Schrank.) Thell. (Hulled, emmer wheat) and *Triticum aestivum/durum* (Free threshing wheat, durum wheat) which is represented only by one rachis segment. In this study, remains of wild taxa represent 57.3% of the total number of plant macroremains. This category includes wild edible fruits, field weeds, plants of moist habitats, plants of dry habitats and unknown taxa. A great number of field weeds has been recorded from the Early Dynastic Helwan cemetery with a percentage value of 52.0% of the total number of plant macroremains. Plants of moist habitats from the tombs were 2.2%. These plants grow on wet soil near irrigation canals and water sources, and were represented by the following taxa and types: *Carex divisa* Huds, *Cyperus articulatus* L., *Fimbristylis bisumbellata* (Forssk.) Buhani, *Eleocharis palustris* (L.) Roem & Schult., *Scirpus* type 1, *Scirpus* type 2, Cyperaceae type 1, Cyperaceae type 2, *Juncus rigidus* Desf. Remains of plants of dry habitats are the 0.04%, and include: *Zilla spinosa* (L.) Prantl in Engl. & Prantl, *Echium* sp., *Nauplius graveolens* (Forssk.) Wiklund and *Asphodelus fistulosus* L.

Conclusions

The assemblage of plant macroremains retrieved from the Early Dynastic Cemetery (Operation 4) at Helwan shed light on the past relationships between people and plant diversity during the Early Dynastic period. Remains of field weeds and cereal chaff dominated the plant assemblage, with 51% and 38%, respectively. Ten species of field weeds were recorded among field weed assemblages associated with wheat and clover cultivation in modern Egypt. Humid conditions which have prevailed during the Early Dynastic period are responsible for applying the simple methods of agriculture (Basin irrigation) depending on a single winter crop (Barley or Wheat) after which the farmland was submerged by the summer Nile floods. It is also suggested that the arable economy of Early Dynastic Memphis was largely based on the cultivation of cereals. The inhabitants of the area had cultivated barley (six-row barley) as a major crop associated with emmer wheat, as well as small amounts of free threshing wheat, naked barley and two-row barley. The study suggests the occurrence of different vegetation types and habitats of xerophytes and swampy stands in the vicinity of the site.

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Valentina Caracuta[1,2], Girolamo Fiorentino[2],
Paola Davoli[3], Roger Bagnall[4]

The archaeobotanical analysis at Amheida (Dakhleh Oasis – Egypt), preliminary results

Abstract
The present paper includes the results of the first archaeobotanical investigation carried out during the 2015 field season in the site of Amheida. The study aimed at analyzing plant material collected in Areas 2.1, 2.2, 4.1, 8.1 during 2006, 2007, 2010 and 2015 campaigns. Fourteen species: five annual-herbaceous and nine perennial-arboreal plants were identified. Phoenix dactylifera, Olea europaea, Vitis vinifera *dominated the archaeobotanical assemblage, followed by* Prunus persica, Ceratonia siliqua, Prunus avium, Ziziphus spina-christi. Hordeum *ssp. is the most attested annual species, followed by* Triticum monococcum/dicoccum. *Very few specimens of* Triticum aestivum/compactum *were found.*

Key words: *Seeds, charcoal, Egypt, Amheida, Late Roman, agriculture, diet*

Introduction

The archaeobotanical investigation at Amheida started in 2015 and it aimed at analyzing plant material collected during the 2006, 2007, 2010 and 2015 campaigns. The bulk of the material consists of seeds and fruits found in the garbage deposit that filled the foundation of the upper-class 4th century AD house with wall paintings and the adjoining school (Area 2.1, Building 1, rooms 9, 10, 14, 15) and the garbage accumulated in the streets (S2 and S3) that flanked the house. The rest of the plant material comes from the Temple area (Area 4.1), from a votive deposit that included offerings of animals and plants inside clay-coffins, and from a bread mould found in the oven F144. A few samples come from the secondary deposit that filled the abandoned thermal complex (Area 2.2, B6/R26; B6/R24). A single sample of sediment was

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collected from inside a jar found in a storage room in Area 8.1 (B10/R1). The new evidence joins a rich array of evidence from textual sources and archaeobotany for agriculture and diet in the Dakhla Oasis (Bagnall *et al.*, 1997, forthcoming). These sources show an economy in the Roman period that included both typical arable crops (wheat, barley) and higher-value tree crops: grapes for wine, olives largely for olive oil, dates, jujubes, figs, and other fruits. In addition, it is clear that cotton and pearl millet were cultivated in the summer. Olive oil, dates, and cotton were largely exported.

Materials and Methods

Five samples contained 10l of sediment each; ninety-two other samples included handpicked plant material. The handpicked material was sorted using the binocular microscope, while the sediment was first dry-sieved, using sieves of 0.3 and 0.5 mm mesh, and only then sorted. The perfect state of preservation of the remains, whether charred or desiccated, allowed an accurate study of morphological traits. The identification was carried out comparing the archaeological material to modern plants of the area (Ritchie, 1999) with the help of an anatomical atlas (Neef *et al*., 2012). As result 95% of the one-thousand and seven hundred remains were identified.

Results and Discussion

The study of the morphological features of the seeds and fruits led to the identification of fourteen species: five annual-herbaceous and nine perennial-arboreal plants. Date palm (*Phoenix dactylifera*), olive (*Olea europaea*) and grape (*Vitis vinifera*) dominated the archaeobotanical assemblage, followed by peach (*Prunus persica*), carob (*Ceratonia siliqua*), cherry (*Prunus avium*), Christ's thorn jujube (*Ziziphous spina-christi*). Barley (*Hordeum* ssp.) is the most attested annual species, followed by hulled wheat (*Triticum monococcum/dicoccum*). Very few specimens of naked wheat (*Triticum aestivum/compactum*) were also found.

Arboreal and non-arboreal species were not equally attested in all the contexts. The garbage deposit that filled the foundation of the upper-class 4^{th} century AD house and the adjoining school was mainly composed of remains of edible plants such as date pits and fruits, that represent 74% of the entire archaeobotanical assemblage, and olive pits (25%). The discovery of one seed and one pod of *Acacia nilotica* in the deposit might suggest that fodder was also dumped in the garbage. 64% of the deposit accumulated above the streets (S2-S3) was made up of dates; the rest of it was made by olive pits (14%), carob seeds (3%), and desiccated peach fruit and peach stones (19%). Date and olive pits were also found in the dump that filled the abandoned thermal complex (Area 2.2). The plant material recovered in the Temple area (Area 4.1) differs from that collected in the dumps of Areas 2.1 and 2.2 for the abundance of grape (pip and fruits) and for the presence of cereal grains. More than three hundred grapes were recovered from inside the clay coffins, and outside of them, in a layer that included burnt organic material (Stratigraphical Unit 120). Chaff remains of hulled wheat were also found in the coffins, but no grains of this kind have been discovered so far. The only grains recovered are caryopses of barley found in coffin F81. Residues of barley were collected also in the bread mould found in oven F144. Here barley spikelet and grains (40%) were mixed together with hulled wheat spikelet (9%) and naked wheat grains (8%). Less than 15% of the plant remains were papyrus-like seeds. The last context analyzed, a jar discovered in a storage room of Area 8.1 (B10/R1), was filled with sediment that included two tiny grape pips.

The data collected so far confirm that a broad spectrum of agricultural products was available to the inhabitants of Amheida in the 4th century AD. Native species, such as the date palm, were certainly cultivated, but we can assume that non-native crops, such us grape, olive, and plums, might also have been locally produced. Remains of non-native crops are plentiful at another site of the Dakhleh Oasis, Roman Kellis (Thanheiser, 1999), thus reinforcing the idea that the crops were an essential component of the diet of the local settlers.

Conclusions

This preliminary study proves the great potential of the archaeobotanical analysis in the site of Amheida. The abundance of findings, and their perfect state of preservation, suggests that more data could be collected. Further analyses will help to characterize the local agricultural system and to estimate its impact on the landscape. The study of seeds and fruits will certainly be coupled with the analysis of charred wood remains to improve our understanding of the environment exploitation, and the extent of trades and exchanges.

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Marie-Pierre Ruas[1], **Sarah Ivorra**[2]

Plant economy during the Islamic period: seed and wood remains from the sites of Rirha and Îgîlîz (Morocco)

Abstract
The archaeobotanical results (charcoal, seeds and fruits) from two Islamic Moroccan sites are presented. Differences in the plant spectra likely reflect the contrast in both the environment of the two sites and the social status of the inhabitants.

Key words: *Morocco, food plants, farming production, Middle Ages*

Introduction

The archaeobotanical data of the site of Rirha, located in the plain of Gharb, and the site of Îgîlîz, in the Anti-Atlas range in Morocco, highlight the exploitation of plants and the places of supply between the 11th and 13th century AD (Figs. 1-3). The results of charred and mineralized plant remains analyses were compared in relation to the contrast in the environment and the lifestyle of the inhabitants during the Islamic occupation.

Materials and Methods

Up to now a total number of 99 sediment samples from Îgîlîz and 21 from Rirha were processed by manual flotation through 2 and 0.5 or 0.3 mm meshes. For the mineralized remains, the sediment was sieved in water through the same meshes. The analyzed samples represent a total volume of 465.6 litres for Îgîlîz and 923.5 for Rirha.

Results and Discussion

At Rirha, 13 economic plants and 27 wild taxa are attested. At Îgîlîz, 19 cultivated/gathered plants and 85 wild taxa are identified.

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Differences in the spectra of crops and wild species likely reflect the contrasts both in the environment of the two sites and the social status of their inhabitants (Fig. 4).

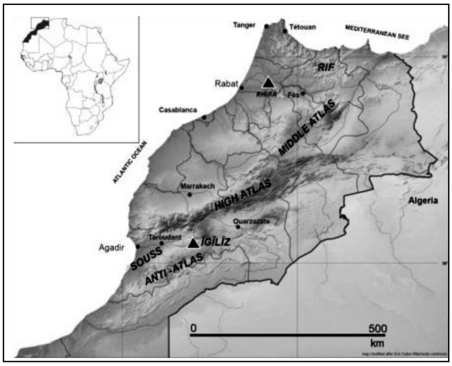

Fig. 1 – *Location map of the sites*

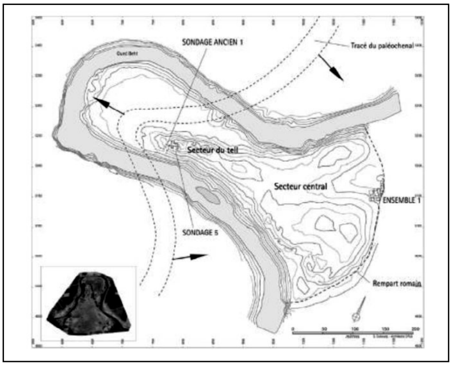

Fig. 2 – *Site plan of Rirha (©Archaeological Mission of Rirha)*

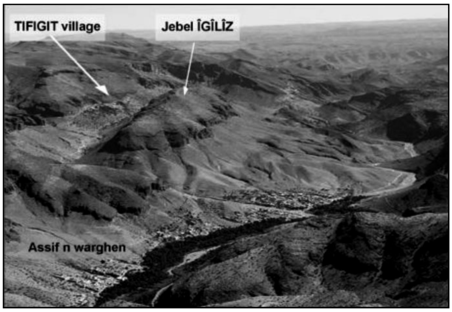

Fig. 3 – *View of the Îgîlîz Mountains (© Humbert)*

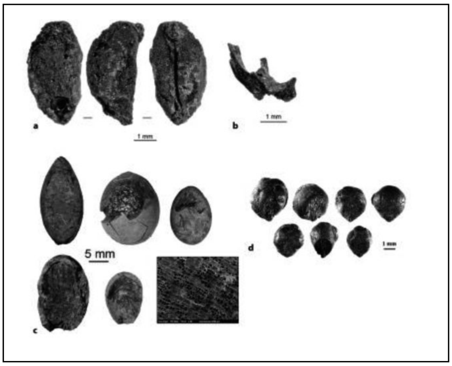

Fig. 4 – *Charred remains from Islamic levels. a, b -* Triticum dicoccum*, caryopsis and furca, Rirha; c -* Argania spinosa*, kernel and charcoal; d -* Sorghum bicolor*, caryopsis, Îgîlîz (© Ruas, CNRS-Muséum)*

Conclusions

The comparison of crop farming shows two food-producing savings based on the four common plants (barley, naked wheat, horse bean and grape) but with various, more specific products in diet which locally played a staple role in economy: argan tree, sorghum, broomcorn millet and emmer. Wild plants indicate different ecological local origins. At Îgîlîz, there is clear evidence of plant transport into the site from the bank wadi formations. The contrasted semi-arid landscapes and the different farming production potentialities bring about elements for assessing the two medieval plant exploitation systems.

Acknowledgments

The excavations at Îgîlîz and Rirha are part of two Moroccan-French-cooperation researches. Those at Îgîlîz are co-directed by A. S. Ettahiri (INSAP, Rabat), A. Fili (Al Jadida Univ.) and J.-P. Van Staëvel (Paris 4 Univ., Paris). The archaeobotanical works were supported by the interdisciplinary project HARGANA (COMUE Sorbonne Universités) co-directed by J.-P. Van Staëvel and M.-P. Ruas. The excavations at Rirha are co-directed by M. Kbiri Alaoui (INSAP, Rabat), L. Callegarin (Pau Univ., Casa de Velazquez, Marid) and C.-A. de Chazelles (CNRS, Lattes). The two four-year research field are mainly supported by the National Institute of Sciences of Archaeology and Heritage (INSAP, Rabat), The French Ministry of Foreign and European Affairs (Paris) and the Casa of Velazquez (Madrid).

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Plant resource exploitation at the Gueldaman GLD1 cave (Algeria): archaeobotanical data from the Late Glacial to the Middle Holocene

Abstract
This paper focuses on the study of plant remains (charcoal, fruits and seeds) recovered at Gueldaman GLD1 cave. The analysis allows a first approach to the evolution of vegetation and exploitation of plant resources between the Late Glacial and the Neolithic occupation.

Key words: *Archaeobotany, food plants, vegetation, northern Africa*

Introduction

Since the early excavations in the1920s, Gueldaman Cave 1 (Algeria) has been a reference site for research into the Early Neolithic in North Africa (Fig. 1). Archaeological excavations carried out in the cave during the past few years have brought to light a sequence beginning at the Late Glacial and covering in great detail the Pleistocene-Holocene transition, up to the Neolithic (Kherbouche *et al.*, 2014). From the palaeoenvironmental point of view, this is an extremely interesting period for discussing climate and landscape changes. Indeed, North Africa (as well as southern Europe) has been often considered a refugial area for warm species during the glacial periods which would, in fact, explain the rapid postglacial expansion of these species and the configuration of the Holocene Mediterranean landscapes. However, palaeoenvironmental studies from Algeria and North Africa, in general, are still scarce.

In this work, archaeobotanical data (charcoal and seeds) from Gueldaman are presented. Results show significant changes in local vegetation from the beginning of the Holocene to the Neolithic when the cavity seems to have been used for animal shelter.

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Materials and Methods

During fieldwork, systematic sampling was carried out and soil samples were floated using a flotation machine. The plant macros (seeds and fruits) have been already analyzed while the wood charcoal studied comes from column covering the whole sequence of the excavated levels. A series of radiocarbon dates are in progress, in order to clarify the sequence and confirm the antiquity of selected ecological markers such as *Olea europaea*, which can also help to detect taphonomic problems.

Results and Discussion

The sequence shows at least three distinct phases. During the Preboreal, vegetation is open and dry, dominated by juniper, *Ephedra* and Labiatae. Before 10,000 cal. yr BP, a reduction of juniper and an increase in *Pistacia* (two different species have been identified at least) is detected, showing a vegetation still open but with a gradual introduction of thermophilous taxa. Since the beginning of the sequence, the percentage of *Olea europaea* fluctuates and this taxon becomes dominant in the third phase, corresponding to the Neolithic; then, a drastic change in the presence of species is detected, as is shown by the presence of an *Olea* woodland (perhaps overrepresented because of its use as fodder), accompanied by evergreen *Quercus* and *Arbutus unedo*, while taxa that dominated previous phases disappeared almost completely.

As regards the plant macroremains, the base of the sequence is characterized by the presence of only wild fruits while from the Neolithic, legumes are also present (some of them possibly cultivated). Cereals are only identified in historical times.

Conclusions

The data obtained so far allow us to trace the evolution of the local vegetation since the Late Glacial to the establishment of Holocene climate conditions. Although it is not a continuous sequence, it shows the main changes caused by both climate and human activity, with particular emphasis on the introduction of farming practices. Radiocarbon dates might confirm the existence of a refugial area for thermophilous species such as *Olea europaea*.

The use of the cave as an animal shelter from the Neolithic has probably influenced the type of species present, among which those used as fodder appear to have an important role.

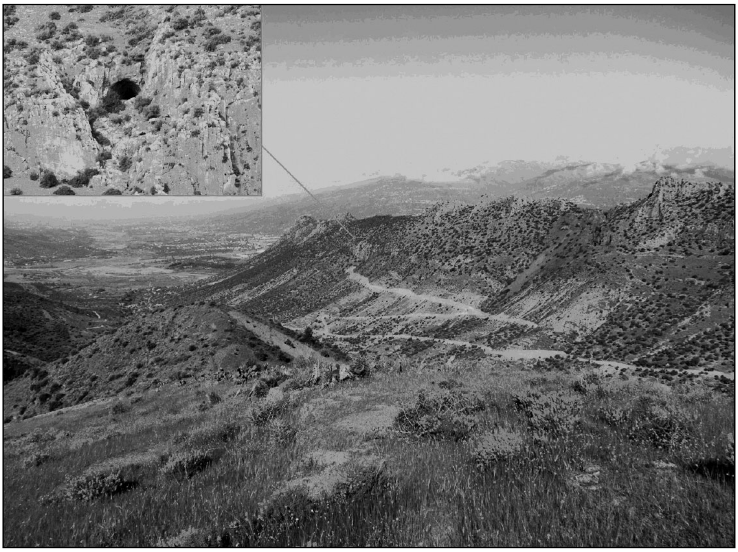

Fig. 1 – *Location of the Gueldaman Cave 1*

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SESSION 3

ARCHAEOLOGY AND PALAEOCOLOGY: INTEGRATED METHODS

Supplemento
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146 (2015)

May L. Murungi[1]**, Marion K. Bamford**[1]

Palaeoenvironments at Sibudu Cave, South Africa: preliminary results from phytoliths

Abstract
Sibudu cave is a well studied archaeological site with deposits that have yielded an assemblage of fauna and plant remains within a well-dated context. Numerous ash lenses and charcoal-rich units representing hearths have been identified together with thin sections that provide evidence of abundance of plant material at the site. This makes Sibudu Cave an ideal site to study in detail the potential of phytoliths to provide information on plants used for fuel by early humans, reconstruct vegetation and make inferences on the climate in which they lived. Phytoliths were found to be abundant in Sibudu deposits although they have not generally been indentified in detail. This study therefore presents a more detailed analysis of phytolith at Sibudu. Twenty nine samples were analysed to identify phytolith morphotypes. Phytolith preservation is mostly good and they are abundant. The major source of plant material deposited at the cave seems to be from wood and bark that were used for fuel. Grass phytoliths present in the samples are possible evidence of kindling. Phytoliths that may not be related to fuel use are also present. This study shows that phytolith analyses can contribute to our understanding of early human-plant interactions at Sibudu and can provide a more complete understanding of monocots such as grasses, a currently missing component of botanical studies at the site.

Key words: *Phytoliths, vegetation history, Middle Stone Age, Sibudu, South Africa*

Introduction

Archaeological interest has focused on South Africa's Middle Stone Age (MSA) for more than a decade particularly because of the early human cultural and occupation evidence preserved in several MSA sites. Sibudu cave, a rock shelter located in KwaZulu-Natal on the east coast, has the potential to become one of the most important MSA sites in South Africa because of its deep, well-dated MSA. It provides evidence of early human occupation spanning >77,000 years to ca 37,000 years with a long cultural sequence (Wadley & Whitelaw, 2006).

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Because the deposits at Sibudu are largely anthropogenic, environmental interpretations are problematic. However, this study not only documents early-human plant interactions at Sibudu, but tests the potential of phytoliths to reconstruct past vegetation and climate at the site and whether early human occupation and associated changes can be linked to environmental variations. In general charcoal and seeds represent the dicots whereas phytoliths also represent the monocots, and grasses in particular, so this study provides further details to a previous phytolith study and adds the missing floral element to the vegetation reconstruction of Sibudu's occupation (Schiegl *et al*., 2004; Sievers, 2006).

Materials and Methods

Sediment samples for phytolith analysis were collected in March 2011 by Angela Bruch. 29 exposed MSA sediments in square C4 were collected vertically from each stratigraphic layer, avoiding hearths. Fossil phytoliths were extracted from the sediment samples following standard procedures.

Enumeration of phytolith morphotypes was done on mounted slides and observed under x400 magnification using a Zeiss CP-achromat light microscope mounted with a camera. Phytoliths were identified and classified following standard classifications from the literature. A minimum of 200 phytoliths with consistent morphology were counted per slide.

Results and Discussion

The phytolith record at Sibudu is excellent in terms of abundance and preservation is generally good in the overall stratigraphy. Samples analysed are characterized by high numbers of phytoliths typical of wood and bark as well as of monocots including grasses and sedges.

Despite the high number of abraded phytoliths, most were still identifiable and phytoliths with a consistent morphology allow us to make useful interpretations of plant use by early humans, vegetation reconstructions and make possible climatic inferences.

Conclusions

Phytolith analyses of the Sibudu sequence support the conclusion that wood ash is a major component of the sediments that are not visibly part of hearths. It records an input of plants by humans for fuel as well as plants not directly associated with hearths such as sedges whose use has been well documented for this site.

This study seems to be promising to contribute to our understanding of palaeoenvironments, including climate, within which early humans lived during the Late Pleistocene and will be compared to other studies from the same site.

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Lucia Veronica Collura[1], Katharina Neumann[1]

Wood and bark phytoliths of West African woody plants

Abstract
In some archaeological contexts phytoliths from woody plants can be expected, but until recently, identification of these was hampered due to a lack of comparative modern data. We present here the results of a study on wood and bark phytoliths of West African woody plants. We examined 101 species out of 34 families of trees and shrubs from the modern wood reference collection of the Institute of Archaeological Science, African Archaeology and Archaeobotany section, of the Goethe University Frankfurt. Phytoliths of wood and bark can be clearly distinguished. Various globulars are typical for wood, while block-like and elongated shapes dominate among the bark phytoliths, probably representing silicified sclereids and fibres. 12 species have special taxon-specific morphotypes in the bark. However, some morphotypes, such as the blockies, are unspecific and can occur in other plant organs and in taxonomically non-related taxa.

Key words: *Phytoliths, West Africa, woody plants*

Introduction

Phytoliths are intercellular or extracellular silica accumulations in plants. After death and decay of the plant these silica bodies are deposited in soils. Since silica is an inorganic compound, phytoliths can be well preserved over long periods of time (Piperno, 2006: 5) and are useful for solving issues over vegetation history (Garnier *et al.*, 2012), tool use (Radomski & Neumann, 2011) and diet (Henry *et al.*, 2012). But the interpretation of phytolith assemblages can be challenging since the same phytolith morphotype can be produced by different plant species (redundancy) and one plant species can produce several different morphotypes (multiplicity).

The starting point of this study was a phytolith found in the tooth calculus of *Australopithecus sediba* – a hominine species discovered in the Malapa cave (South Africa), which is assumed to have been an almost exclu-

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sive C_3-feeder, with a diet from tree-leaves, fruits, wood and bark. In the calculus 38 phytoliths had been found, 10 of which had been assigned to the category "wood or bark" (Henry *et al*., 2012). These phytoliths are of rectangular shape with a strongly corroded surface.

The objective of our study was to check if the illustrated morphotype is really specific for wood or bark. In former studies, wood and bark were generally not distinguished. Researchers applied the rather unspecific terms "stem", "wood" or "wood-bark" interchangeably to refer to all silica bodies which are hypothesized to be formed in the stem. But wood and bark constitute two different components of the plant stem, fulfilling different biological functions (being responsible for the water and food transport system, respectively; Esau, 1964: 226). Differences in the cellular tissues are expected to become manifested in the production of diverse morphotypes. Therefore we studied wood and bark from selected African trees separately for their phytolith assemblages.

The observed phytoliths were also compared to similar morphotypes from other plant parts describe in the literature.

Materials and Methods

The focus of this study lies on the West African region, especially on Burkina Faso, an area characterized by savannah vegetation. 101 species out of 34 families of trees and shrubs from the modern wood reference collection of the Institute of Archaeological Science, African Archaeology and Archaeobotany section, of the Goethe University Frankfurt were selected for this study. A total of 95 bark and 29 wood samples were examined and processed with a modified dry- and wet-ashing method after Piperno (2006).

The extracted phytoliths were stored in ethanol. A small amount of the phytolith sample was mounted on a microscope slide. For the majority of the slides Caedex was used as an embedding agent. In few cases benzyl benzoate was used. The slides were studied with an optical light microscope (Leica DFC 320). In some cases SEM examination (Hitachi S4500) was needed to better identify the surface of the silica bodies.

We classified the morphotypes after two criteria: 1) anatomical origin (if clearly distinguishable) and 2) geometric shape. Presence/absence of the various morphotypes was noted in a semi-quantitative analysis, resulting in a percentage histogram of the different classes (Fig. 1).

Results and Discussion

The observed phytoliths can be attributed to eight classes: A. Fibre/Elongate, B. Blocky, C. Sclereid, D. Cork/Parenchyma, E. Cork aerenchyma, F. Globular s.l., SP. Silica particles and SA. Silica accumulations. The names fibre, sclereid, cork/parenchyma and cork aerenchyma refer to the anatomical origin in the plant if this is clearly recognisable. The names Elongate, Blocky und Globular s. l. are geometric terms referring to the shape of the phytolith. Elongate phytoliths and some blockies also reflect the anatomical shape of a cell, but often it is not possible to determine its function.

Wood and bark produce clearly different morphotypes (Fig. 1). All classes are represented in the bark, while only the classes F. Globular s. l., SP. Silica particles and SA. Silica accumulations are present in wood. SP. Silica particles and SA. Silica accumulations dominate in the bark, followed by B. Blocky, C. Cork/Parenchyma and A. Fibre/Elongate. While phytoliths in the bark predominantly reflect the anatomical form of the cell (fibres, some blockies, sclereids, cork/parenchyma and cork aerenchyma), the shape of the globulars s.l. is independent from the cell they are produced in. In 12 species morphotypes were observed that seem to be taxon-specific.

The phytolith found in the calculus of *A. sediba* (Fig. 2) shows similarities to class B. Blocky. Blocky phytoliths occur in the bark but their diagnostic value is insignificant. Blockies have been found in different plant parts, e.g. leaves (Fig. 3, leaves of *Marantochloa purpurea*), of several non-related taxonomic groups (Strömberg, 2003).

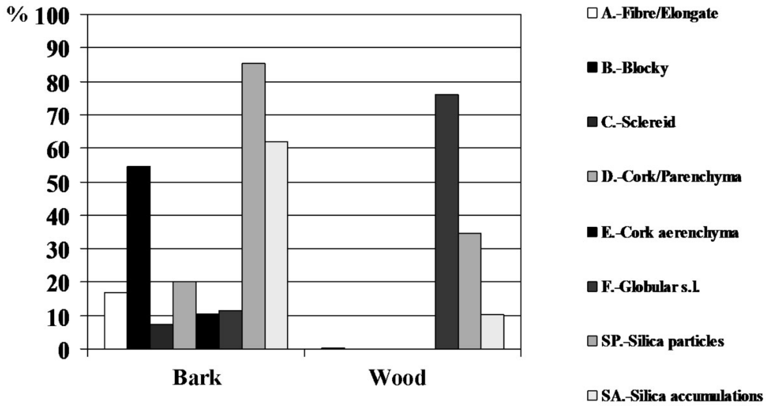

Fig. 1 – *Percentages of morphotype classes in wood and bark*

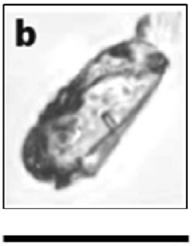

Fig. 2 – *"Wood or bark" phytolith* (*Henry* et al., *2012: 14, Fig. 5); scale: 50µm*

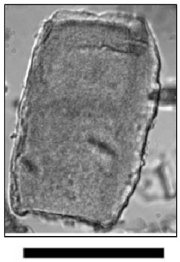

Fig. 3 – *Blocky phytolith from the leaf of* Marantochloa purpurea *(Maranthaceae); scale: 50 µm*

Conclusions

Wood and bark of West African trees produce clearly different pyhtolith morphotypes. Various globulars s.l. are typical for wood, while morphotypes reflecting the cell shape dominate the bark phytoliths, representing silicified sclereids, fibres, cork or parenchymatic tissue, cork aerenchyma and other unidentified blocky and elongate cells. The reason why silification of cells takes place in bark but not in wood is still unclear. A possible explanation is that silica accumulation supports the function of the bark in providing protection for the inner components of the stem. 12 of 93 examined species show taxon-specific morphotypes. The majority of the taxon-specific phytoliths were found in the bark. In the wood, only *Capparis tomentosa* has a taxon-specific morphotype. Because of multiplicity and redundancy it is not possible to identify the provenience of the phytolith found in the calculus of *A. sediba*. It cannot be excluded that it originates from bark, but other plant parts are also conceivable, for example leaves. In a broader perspective, the results of this study are significant for identifying wood and bark phytoliths in African archaeological and palaeoenvironmental deposits.

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Supplemento
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Welmoed Out[1], **Marco Madella**[2]

Towards the identification of millet crop by-products

Abstract
*Phytoliths remain preserved under a wide range of conditions, and are thus highly relevant for the detection and interpretation of plant remains at archaeological sites, including sites in Africa. Identification criteria exist for cereals by means of phytolith analysis, but only for major economic crops, and mainly for inflorescences, while identification criteria for other plant parts (crop by-products) that are also of economic value, have been mostly lacking up to now. To explore and improve the possibilities to identify cereal by-products by phytolith analysis, this study compares bilobates from leaves of the millets pearl millet (*Pennisetum glaucum *L. R. Br.) and sorghum (*Sorghum bicolor *ssp.* bicolor *L.) Moench) on the one hand and broomcorn millet (*Panicum miliaceum *L.) and foxtail millet (*Setaria italica *L.) P. Beauv.) on the other hand, it attempts to determine whether distinction between the taxa is possible. Although broomcorn millet and foxtail millet rarely occur in African archaeological sites, the study of these taxa is relevant for African archaeobotany since the outcomes show the potential to distinguish between leaves of various commonly exploited wild millet genera.*

Key words: *Crop by-products, millets, identification criteria, phytoliths, morphometry*

Introduction

In archaeological studies, phytolith analysis enables the detection of plant parts other than seeds or fruits, thus offering a method complementary to plant macroremains, under a wide range of preservation conditions. One field of research to which phytoliths can therefore contribute is the detection of non-dietary cereal crop products such as straw, hay and chaff, which have been of economic importance for supplying fuel, animal fodder and construction material in both the past and present. Better detection of these products at archaeological sites can lead to a better understanding of crop-processing, and thus indirectly about socio-economic aspects of former societies (Harvey & Fuller, 2005).

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While identification criteria for phytoliths are available for various Eurasian cereals, further development of classification tools remains necessary, particularly for plant parts other than chaff. Therefore, bilobates from leaves of pearl millet (*Pennisetum glaucum* (L.) R. Br.), sorghum (*Sorghum bicolor* ssp. *bicolor* (L.) Moench), broomcorn millet (*Panicum miliaceum* L.) and foxtail millet (*Setaria italica* (L.) P. Beauv.) were analysed to determine whether distinction between remains belonging to these taxa is possible. Bilobates were selected because of their routine and strong silicification. The analysis of broomcorn millet and foxtail millet also included a comparison of short cell frequencies.

Materials and Methods

Pearl millet and sorghum on the one hand and broomcorn millet and foxtail millet on the other hand were compared by measuring bilobate phytoliths from leaves. The analysis included 50 phytoliths per sample, and 2 samples from 2 leaves from 2 plants of 5 populations per species. While some of the populations were grown in Europe, others were collected from reference collections and come from different parts of the world. For the collection of the morphometric measurements, the samples were wet-oxidised by bleaching, and we developed a new open-source software tool for phytolith morphometry that measures 27 parameters of size and shape (Out *et al*., 2014). For the analysis of short cell frequencies of broomcorn millet and foxtail millet, additional samples were dry-ashed.

Results and Discussion

Morphometric comparison of 1600 pearl millet phytoliths and 1500 sorghum phytoliths shows that bilobate phytoliths from leaves do not allow for distinction between these taxa. Differences between populations of individual species raise questions about the influence of environmental factors on the size and shape of phytoliths.

Comparison of 2000 phytoliths of broomcorn millet and 2000 of foxtail millet shows that distinction between these taxa by morphometry is possible. The analysis of short cell frequencies supports the possibility of separating these two taxa. Comparison of the morphometric data of the four taxa shows that morphometric distinction between pearl millet/sorghum, broomcorn millet and foxtail millet is possible when a large sample size is available.

This study provides new tools for the identification of millet crop by-products. Although broomcorn millet and foxtail millet rarely occur in African archaeological sites, the outcomes are relevant for African archaeology since they show the potential to distinguish between leaves of wild *Panicum* and *Setaria* taxa that are found at archaeological sites in Africa.

Conclusions

While bilobates of pearl millet and sorghum do not allow for distinction between the taxa, the bilobates of broomcorn millet and foxtail millet do differ from each other, and also from pearl millet/sorghum leaf bilobates. In addition, broomcorn and foxtail millet show differential short cell frequencies. This study thus provides new tools for the identification of millet crop by-products. Lines for future research concern the comparison of the studied taxa with their wild relatives, the analysis of other morphotypes and plant parts of the studied taxa, and comparison with other taxa.

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Supplemento
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Barbara Eichhorn[1], **Katharina Neumann**[1]

The enigma of Iron Age plant subsistence in the Inner Congo Basin

Abstract
A combined approach of macroremain, wood charcoal and phytolith analysis is used to trace the initial spread of agriculture, Iron Age development of plant subsistence and vegetation changes during the past 2500 years in the Inner Congo Basin.

Key words: *Inner Congo Basin, rainforest crisis, pearl millet,* Musa *phytoliths*

Introduction

Food production in Central Africa did not develop independently and *in situ*, but was introduced from outside. The initial spread of agriculture was related to a major climate crisis in the second half of the 1st millennium BC, leading to partial rainforest breakdown and its replacement by pioneer formations. Enhanced seasonality allowed for the cultivation of the savanna crop pearl millet. We use a multidisciplinary approach to test how far these phenomena also affected the rainforest core area of the Inner Congo Basin (ICB) and investigate the still enigmatic further development to plant subsistence today mainly based on Asian and Neotropical crops. Vegetation changes due to climate change or human impact are traced by charcoal and phytolith analysis.

Materials and Methods

Pits and a settlement layer of two Iron Age sites in the ICB, Iyonda and Mbandaka (DR Congo) were sampled for fruits and seeds, wood charcoal and phytoliths. The site Iyonda belongs to the *Imbonga* pottery tradition which is attributed to the first sedentary settlers and dates from around 400 to 200 cal yr BC (Wotzka, 1995). The site Mbandaka comprises at least two phases: an

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excavated *Bokele* period pit dates from 100-400 cal yr AD and is overlaid by a *Bondongo* period settlement (1330-1550 cal yr AD).

After flotation, fruits and seeds were identified using a binocular loupe and the Frankfurt reference collection and literature sources. Wood charcoal fragments were analyzed with an incident light microscope and assigned to charcoal types using the wood slide reference collection and the Inside Wood Database. Soil samples were processed with a standard procedure using heavy liquids to isolate phytoliths. A minimum of 200 significant morphotypes was counted per sample and the Dicotyledon/Poaceae (D/P) index calculated.

Results and Discussion

Few small charred pearl millet grains at Iyonda confirm that in the initial phase of agriculture cereal cultivation played a role in the ICB. At Mbandaka, two *Pennisetum glaucum* grains were retrieved from a layer preliminarily attributed to the late Bondongo Period. They are currently AMS-dated in order to test if pearl millet cultivation was only a short interlude as expected or still occurred in later times. High numbers of oil palm and, at Iyonda, incense tree macroremains highlight the importance of gathering for Iron Age ICB subsistence. Finds of charred parenchyma fragments might point to tuber consumption but lack diagnostic features due to their small size. *Musa* leaf phytoliths attesting plantain cultivation were only detected in the uppermost Bondongo settlement layers. Wood charcoal analysis at both sites indicates forest vegetation but pioneer taxa show intermittent disturbance also attested by high numbers of palm phytoliths and, at Mbandaka, umbrella tree macroremains. Low D/P values at Iyonda point to relatively open vegetation at least in the vicinity of the site.

Conclusions

Cereal cultivation is confirmed at least for the initial phase of agriculture in the ICB. Other domesticated plants are so far only attested for the terminal occupation of the Bondongo settlement. Further archaeobotanical studies in the course of this ongoing project will elucidate the role of plant cultivation in the course of the Iron Age and highlight vegetation changes due to climate and/or human impact.

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Amy Styring[1], **Younes Hmimsa**[2], **Mohammed Ater**[3], **Amy Bogaard**[1]

The potential of crop isotopes to identify past manuring practices in arid regions

Abstract
Crop nitrogen isotope ($\delta^{15}N$) values of cereal grains offer a means of identifying the intensity of manuring practices in the past. In order to adjust manuring-level bands for use in (semi-)arid regions, a pilot study in Morocco determined $\delta^{15}N$ values of modern barley grains growing in a range of rainfall zones, demonstrating that the effect of aridity can be taken into account and does not mask additional increases due to manuring. Using this modern data as a framework, it was possible to infer the intensity of manuring practice at two archaeological sites in semi-arid regions from $\delta^{15}N$ values of preserved charred cereal grains.

Key words: *Nitrogen, manure, isotopes, cereal grains, Morocco*

Introduction

Primary macrobotanical analysis of plant remains can reveal much about past cultivation conditions and farming practice but alone cannot specifically link productive conditions indicated by, *e.g.*, weed seeds to manuring, or identify differences in the manuring intensity of different crops. Studies in temperate regions have demonstrated that cereal grain $\delta^{15}N$ values tend to increase with manuring intensity (amount and frequency of application), making it possible to directly identify intensive manuring practices using crop remains themselves (Fraser *et al*., 2011). The potential of using carbonised archaeological crop $\delta^{15}N$ values as a means of assessing manuring intensity has been demonstrated in a number of recent studies (Bogaard *et al*., 2013), but has not been explored in regions with lower rainfall, where increasing aridity also correlates with higher plant $\delta^{15}N$. This pilot study thus aims to disentangle the effect of manuring from aridity on cereal grain $\delta^{15}N$ values.

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Materials and Methods

This study determines the $\delta^{15}N$ values of barley grains growing in manured and unmanured fields (n = 34) under a range of rainfall conditions (190 to 800 mm/yr) in Morocco (Fig. 1). Ten ears were randomly selected from each field, half of the collected ears were then threshed, and a random selection of 50 grains were homogenised in a freezer mill to give an average $\delta^{15}N$ value for each field. In addition, between 5 and 10 carbonised grains from rich, well preserved archaeobotanical crop samples at Pre-Pottery Neolithic B Abu Hureyra (level 2), Syria (n = 7) and Ain Ghazal, Jordan (n = 11) were selected for isotopic analysis.

Results and Discussion

When $\delta^{15}N$ values of the modern barley grain from low rainfall regions (<400 mm/yr) were compared to the manuring levels established from studies on temperate regions, the level of manuring was overestimated (Fig. 1). This suggests that aridity increases the grain $\delta^{15}N$ values. Manuring-level bands were therefore adjusted for the effect of aridity using the correlation between annual rainfall and plant $\delta^{15}N$ (established by Hartman & Danin, 2010). The adjusted manuring bands more accurately estimate the manuring intensity of modern fields, and allow assessment of the intensity of manuring at the PPNB Abu Hureyra and Ain Ghazal sites (Fig. 2).

Conclusions

This modern pilot study in Morocco shows that it is possible to estimate the intensity of manuring in (semi-)arid regions using the $\delta^{15}N$ values of cereal grains from both modern and archaeological sites.

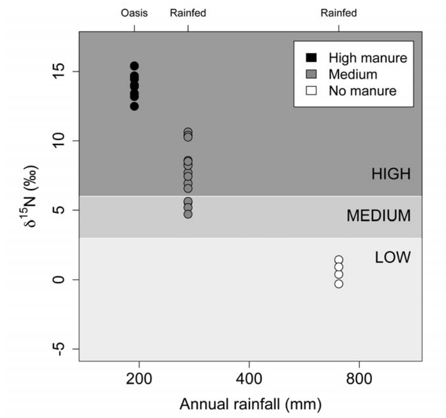

Fig. 1 – *δ15N values of modern barley grains plotted against annual rainfall, with manuring bands indicated by shading*

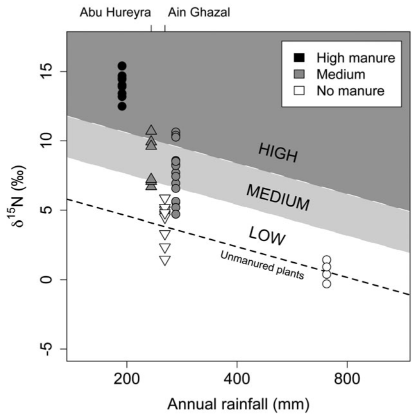

Fig. 2 – *δ15N values of modern and ancient cereal grains with adjusted manuring bands indicated by shading*

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Joseph Chikumbirike[1], Marion Bamford[1], Amanda Esterhuysen[2]

A study of archaeological charcoal from Chigaramboni archaeo-metallurgical site

Abstract
Most African prehistoric metallurgical industries were charcoal dependent. Therefore, the focus of this paper is on charcoal from Chigaramboni, an archaeo-metallurgical site, so as to understand the wood fuel choices made by the industrialist workers at the site. A wide range of species was burnt including, for example, Dichrostachys cinerea*,* Faurea saligna*, and* Acacia cf. polyacantha*. We conclude that various taxa were selected but not a single taxon. We also conclude that the Miombo palaeo-forest existed and has not changed since the time of occupation by the ancient iron workers.*

Key words: *Anthracology, Chigaramboni, archaeobotany, archaeo-metallurgy, charcoal studies, Holocene, woody plants*

Introduction

Chigaramboni is an archaeo-metallurgical site dating before 1800 AD. according to Marguerie & Hunot (2007), prehistoric societies established their economies based on firewood that resulted in the production of large amounts of charcoal after burning. This is true as most archaeological excavations yield volumes and volumes of charcoal. Most African prehistoric metallurgical industries were charcoal dependent. This paper focuses on charcoal from the Chigaramboni archaeo-metallurgical site to understanding the wood fuel choices made by the industrialist workers at the site. The metallurgical industries provided agricultural implements and tools, weapons for war, and culturally relevant objects. These offered their practitioners a potent stage for political, social and economic interactions with products ranging from mild carbon steel to wrought iron. Iron working required access to forests and hence this study. The identification of charcoal from Chigaramboni opens a window into the exploited ancient forests.

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Materials and Methods

To achieve the aims and objectives of this study a number of steps were employed that are in line with charcoal studies elsewhere. These included establishment of a comparative collection for identification of archaeological charcoal, a desktop study of literature on ethnographic study on uses of different trees, and sampling archaeological charcoal under the custody of National Museums and Monuments of Zimbabwe (NMMZ). The charcoal from Chigaramboni was excavated by Webber Ndoro around 1993-1994. The charcoal was prepared in the laboratory using the fracturing technique for preparing macrocharcoal. Specimens were fractured – by manually snapping or pulling apart the fragment of charcoal between the fingers – along the transverse (TS), tangential longitudinal (TLS) and radial longitudinal (RLS) sections (Chikumbirike, 2014). Specimens were observed with a compound microscope equipped with reflected light objectives (50x, 100x, 200x magnifications). An adequate comparative collection of identified modern woods was established according to the definition of anatomical features published by the International Association of Wood Anatomists (IAWA) committee (Wheeler *et al*., 1989), and descriptions in Bamford (2005).

Results and Discussion

Expertise in identification and the preservation condition enabled identification of charcoal assemblages, including small fragments, assemblages from Chigaramboni. In most cases adequate and sufficient diagnostic features were recorded. The results show that approximately 13 species were exploited. In this metallurgical site, the following woody plants were exploited: *Acacia mellifera, Acacia polyacantha, Acacia tortilis, Brachystegia boehmii, Dichrostachys cinerea, Faurea saligna, Faurea macnaughtii and Kigelia africana*. It is probable that some woods were collected whilst they were wet. Some of them were found still attached to the bark, and some wood showed ruptures probably due to high moisture content of the wood. The species composition in the archaeological record indicates a *miombo* kind of vegetation, which is the present type of vegetation at Chigaramboni.

Conclusions

Charcoal from the Chigaramboni archaeological site helps to answer questions on the nature of the wood exploited by its inhabitants, and the tree species collected. It also helped in answering questions on why some tree species were found in abundance whilst others were not. Valuable information about the culture and wood selection habits of the people can arise from this research.

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Supplemento
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Adéla Pokorná[1,2,3], **Kristýna Kuncová**[4]

Species responses to environmental gradients in a semi-desert zone of Sudan: calibrating recent vegetation data for further archaeobotanical reconstructions

Abstract
Recent vegetation of Jebel Sabaloka near the sixth Nile Cataract in Sudan was studied using phytosociological relevés in different habitats covering main environmental gradients in the area. Vegetation data of each plot were compared with corresponding seed-bank composition. Finally, recent data were used to interpret archaeobotanical assemblage from a post-Meroitic tumulus.

Key words: *Africa, archaeobotany, environmental reconstruction, multivariate analysis, seed-bank, Sudan, vegetation*

Introduction

The attempt to reconstruct past environments is an important part of archaeobotanical investigations. However, the interpretation of archaeobotanical data must be, among other things, based on detailed knowledge of species behaviour in recent vegetation. To meet this requirement, we studied vegetation in the area surrounding archaeological excavations in the western part of Jebel Sabaloka, near the sixth Nile Cataract in Sudan (Fig. 1). The botanical investigations are the part of multidisciplinary missions of the Czech Institute of Egyptology (Suková & Varadzin, 2012). A burial tumulus of an archer was uncovered in 2011, ^{14}C-dated to 245-397 cal. yr BP (95.4% probability), *i.e.* to the beginning of the post-Meroitic period in Sudan. More than 1,800 macroremains were acquired by flotation of the content of the burial niche. We aimed to compare these data with recent vegetation of the area, as well as with corresponding seed-bank of the selected vegetation types.

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Materials and Methods

Vegetation sampling was based on sample-plots (*relevés*) with a size of 100 m^2 (10 m x 10 m). 60 *relevés* were sampled in different habitats covering gradients from dry rocks to the irrigated alluvial plain of the River Nile. Six different habitat-types were selected for sampling: rocky hills, rocky crevices, wadis, fields, shrubby edges and banks of the River Nile. The phytosociological method of Braun-Blanquet was used to collect data from the *relevés*. The uppermost soil layer was sampled in each plot to analyze soil seed-bank. The soil samples were washed with the minimum mesh-size of 0.25 mm. The material was then examined under binocular microscope. For seed/fruit determination, a reference collection was used, based on field surveys from the surrounding area (collected in seasons: autumn 2009, spring 2010 and autumn 2014). Vegetation data were analyzed using multivariate analysis in CANOCO program (Ter Baraak & Šmilauer, 2002) to verify the relevance of arbitrary classification of the habitats. To test the applicability of recent data for archaeobotanical interpretations of past vegetation, the vegetation *relevés* as well as the seed-bank data were then compared with an archaeobotanical assemblage collected from the post-Meroitic tumulus.

Results and Discussion

According to Detrended Correspondence Analysis (DCA), the species composition variability clearly corresponds with the environmental gradient of water availability. In addition, the vegetation of the irrigated alluvial plain was divided along the second axis, showing the difference in management of the plots (fields versus shrubby edges). Plant species with a narrow niche were selected as potential diagnostic species for certain habitats, in contrast to species with a broad niche. The seed-bank data roughly correspond to the vegetation of sample-plots. However, marked differences were observed, especially in certain plant species. For comparison with the plant macro-remains from the post-Meroitic tumulus, eleven plant species were used, being documented in both recent and archaeobotanical data. The comparison showed great similarity of the archaeobotanical assemblage with recent vegetation types observed in close vicinity of the excavation site.

Conclusions

Investigation of recent vegetation is a good tool for further environmental interpretation of archaeobotanical data. However, we need to be cautious about generalizing this finding. Especially for reconstruction of the remote past, the knowledge of local environment would be insufficient. It is generally known that the Holocene climate differed distinctively from today (see *e.g.* Kuper & Kröpelin, 2006). For reconstruction of the older phases of the Holocene, it is necessary to investigate recent vegetation in areas situated much more to the south.

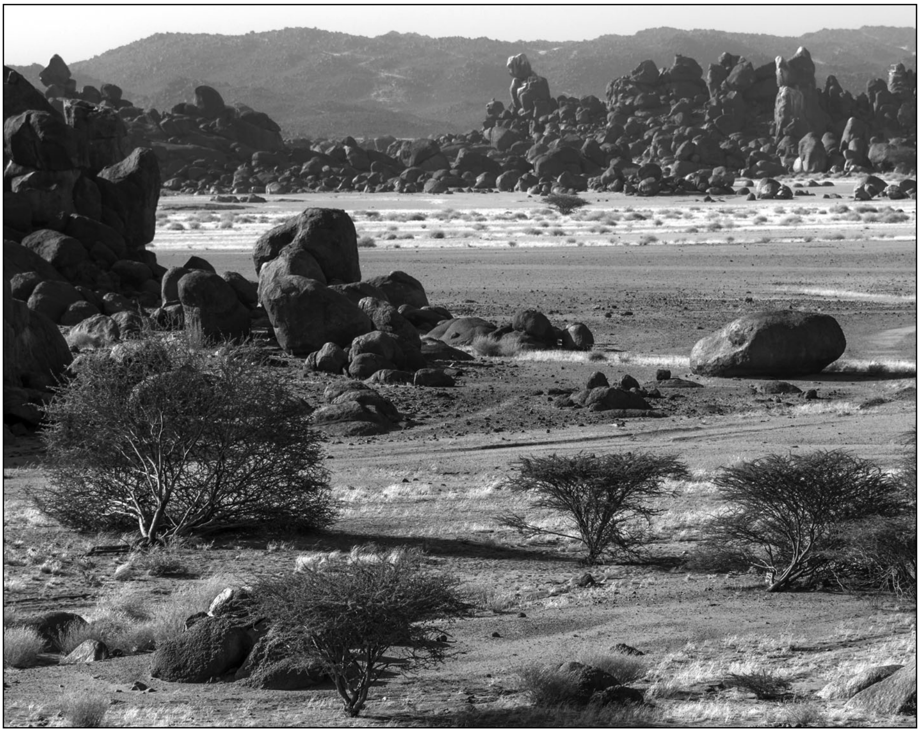

Fig. 1. *Scattered vegetation and wadis in the western part of the Sabaloka Mountains (photo P. Pokorný)*

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Roger Blench[1]

The translocation of useful trees in African prehistory

Abstract

Agriculture in Africa is usually conceptualised as having a distinct era when it begins and specific indicators of early plant domestication. However, as research on African vegetation evolves, it is increasingly clear that the identification, use and subsequent translocation of trees and other woody plants constituted a major process in the transformation of the African landscape far earlier than agriculture proper. The paper presents some examples of tree translocation, discusses the methodology of identifying such tree species, and suggests that the African rain forest is in many ways comparable to early domestication processes in the Amazon and the Pacific.

Key words: *Woody vegetation, trees, translocation, Africa*

Introduction

As cartography of African tree species becomes increasingly available, it is becoming clearer that many species extend far beyond their natural range (Morin-Rivat *et al*., 2014). A combination of field research and a trawl through the literature on useful trees, strongly suggests that many species were intentionally translocated, or facilitated by human migration as seeds of edible fruits were discarded (Vivien & Faure, 2011a,b). Well-known species of this type are the baobab and the silk-cotton, but there are many more, including the wild date-palm (*Phoenix reclinata*), the oil-palm (*Elaeis guineensis*), the shea (*Vitellaria paradoxa*) and the locust (*Parkia biglobosa*). Most of the evidence for this is biogeographical, with some information which can be gathered from palynology, ethnography and linguistics (Bostoen *et al*., 2013; Oslisly *et al*., 2013a,b).

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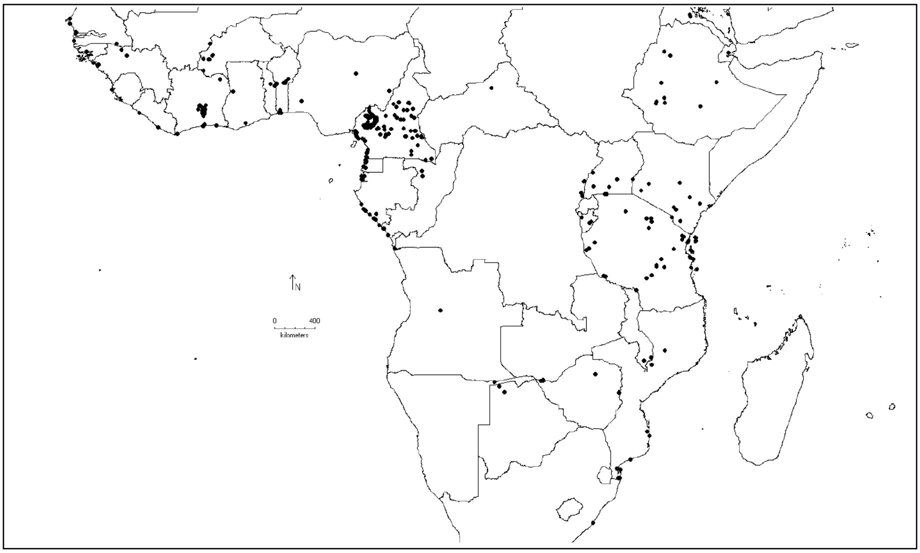

Fig. 1 – Phoenix reclinata *in Africa*

Results and Discussion

The paper will present a list of potential candidate species for translocation in African prehistory, and suggest possible eras when such translocations occurred, as well as discussing what types of evidence we should seek in extending and testing these hypotheses.

Fig. 1 shows the distribution of the wild date palm in Africa, and illustrates the hypothesis that part of its distribution at least must be anthropic. Although a tree of semi-arid savannas used principally for mats and hats, it has a long string of records down the west coast of Central Africa as well as is islands in the tropical moist forest. This suggests that it was translocated during the earliest phases of the Bantu migrations, as part of a postulated movement along the sea-coast of Gabon.

Conclusions

Tree translocation is a well-described process for the Amazon and the Pacific, but it hardly figures in accounts of the evolution of agriculture in Africa. However, there are many reasons to think the distributions of many tree spp. are anthropic. Dating these translocations is very difficult in the absence of pollen profiles, but in some cases, vernacular names can be tied to known migrations.

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Christine Sievers[1], **Justine Wintjes**[2]

"An Enchanted Garden": repeat photography and the flora of Great Zimbabwe

Abstract
In 1891, Mrs Theodore Bent described Great Zimbabwe as "an enchanted garden" (Brisch, 2012, p. 85). She and her husband, and many subsequent visitors, recorded their impressions of the site in words and photographs. Within these recordings of the impressive stone-walled site, aspects of the surrounding vegetation are included. Through a close visual analysis of these documents, we track the changing face of vegetation at Great Zimbabwe, from its lush overgrown late 19th century state to a more sparsely vegetated contemporary setting. We examine aerial and satellite imagery and photographs taken by various explorers, researchers and tourists, including the extensive legacy of the Frobenius expedition between 1928 and 1930. Through a method known as repeat photography, widely used in geography, but, to our knowledge, not yet applied to archaeology in southern Africa, we also recreate particular views to reveal how the vegetation has changed. Building on previous studies that established the importance of trees for ritual and other purposes and the effects of vegetation growth on the preservation of the walling at Great Zimbabwe, we examine the vegetation as an integral part of the landscape visually and culturally. For example, in the eyes of some, the interlinking of the boughs of two large Mimusops zeyheri *(Red Milkwood/*Muchechete*) trees on either side of the Conical Tower took on new meaning after Zimbabwean Independence in 1987; the peaceful entanglement of the branches above the iconic Conical Tower is said to symbolise the unity between the Zimbabwean political parties ZANU and ZAPU. Through our work we have also created a georeferenced digital archive of photographs of Great Zimbabwe.*

Key words: *Great Zimbabwe, flora, repeat photography, digital photographic archive*

Introduction

"An enchanted forest" (Brisch, 2012, p. 85), trilled an exhilarated Mrs J. Theodore Bent, when in 1891, she first ventured into the ruins of Great Zimbabwe. She figured among early European visitors to this large impressive stone-walled site, which had been the political and religious centre of the

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largest kingdom ever have existed in southern Africa (1300-1450 CE), and had fallen into a largely abandoned state, obscured behind a riot of tropical vegetation. The photograph she took of the Conical Tower inside the Great Enclosure (Fig. 1) is one of the earliest photographs taken at Great Zimbabwe. Since then, this World Heritage site has been recorded numerous times, inspiring our repeat photography project which examines changes in vegetation over the last 125 years. Mrs Bent's 1891 photograph now forms one half of a comparative photo pair (Figs. 1-2).

Repeat photography is widely used to monitor environmental processes (*e.g.*, Russell & Ward, 2014); in our research we study the vegetational changes at Great Zimbabwe, which includes a large part of deliberate management for reasons both practical and ideological. We use photographs by previous visitors and researchers, in particular the rich photographic record of the Frobenius expedition (1928-1930). We also adopt a citizen science approach, calling for wide participation to gather "tourist" images of the site. This assists with the second aim of our project, which is to create a comprehensive digital database of images of the site.

Materials and Methods

We use a Mamiya middle format film camera, as well as a digital DSLR camera, mounted on a tripod which we position according to distinctive features in previous photographs, in order to produce visual pairs of photographs for comparison of "then" and "now". The extensive stone walling of meticulously dressed different-sized blocks of granite allows the position from which previous photographs were taken to be identified precisely. We collect the previous photographs from whatever sources are available, such as published works and personal and institutional archives, in particular, the photographs of the 1928-1930 expedition to southern Africa by Leo Frobenius, which are housed at the Frobenius Institute at the Johann Wolfgang Goethe University, Frankfurt.

By noting presence and absence of vegetation in the photo pairs we are able to trace the changing face of vegetation at Great Zimbabwe. We also note differences in shadows or shade, which can indicate the presence of vegetation now absent.

Results and Discussion

Plants played an essential role at Great Zimbabwe in the past (firewood, building construction, wooden implements, plant foods, medicines, ritual use, livestock grazing etc.) (Garlake, 1973) and continue to act as an integral part of the place, its physical structure as well as its cultural significance. Recent plant studies range from vegetation management at the site (Ndoro, 2005) to vegetation of the surrounding area (Bannerman, 1982) and archaeological charcoal (Chikumbirike, 2014). Our work chronicles extensive initial clearing of the thick shrubbery at the site, and the ongoing maintenance (with some periods of neglect) of clear grassy areas, with certain trees left in place. In the late 19th century the site was heavily veiled by trees and vines, but it is much less vegetated today (Figs. 1-2). Substantial clearance took place alongside early excavations by Bent and others in the 1890s and continued into the 20th century (Ndoro, 1994, p. 619). Whereas this clearance was largely to facilitate excavations, mapping of the site and to pamper to tourism, recent efforts have been more specifically directed at issues of conservation and prevention of damage to walls due to vegetation, both in terms of its growth on and around the stone structures and the effects of bushfires (Ndoro, 2005, pp. 40-42).

However, certain vegetation has been deliberately preserved for aesthetic and symbolic reasons, in particular, the two large *muchechete* trees (*Mimusops zeyheri* Sond., Red milkwood) to either side of the Conical Tower. Local lore, according to some, is that the interweaving of the boughs of these milkwoods symbolises the peaceful union of the Zimbabwean political parties ZAPU and ZANU. The tower with its two trees has become iconic, and is frequently represented in contemporary items such as soapstone birds carved for tourist trade (Fig. 3), political items such as a ZANU PF shirt and on Zimbabwe bank notes. The importance of the *muchechete* tree to the right of the tower is reflected in attempts to preserve the tree by cement infilling of hollows in the trunk.

Conclusions

Although our project is still in its early stages (it began in August 2014), our analysis of the photographic record over the last 125 years provides a visual complement to other research at Great Zimbabwe. It documents the interplay between natural botanical exuberance and human intervention in the site’s vegetation, to enable access for excavation and tourism as well as for reasons of ideology and preservation of this unique World Heritage Site.

Fig. 1 – *Photograph by Mrs Theodore Bent, indicating the riotous vegetation of lianas and trees around the Conical Tower in 1898. National Archives of Zimbabwe, published in Garlake, 1973 (p. 100)*

Fig. 2 – *Photograph of the same scene as Fig. 1, taken during the Wits History of Art Expedition in 2014, by J. Wintjes*

Fig. 3 – *A soapstone bird purchased at a craft market adjacent to the site, photographed by J. Wintjes (2014)*

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Ryan M. Szymanski[1]

A multi-proxy microbotanical record from Mtwapa Creek, Kenya: critically approaching issues of data discord and equifinality

Abstract
Interpretation of palaeoecological records is often hampered by uncertainty relating to issues of equifinality. Ferreting out whether environmental change is the result of human activity, temperature/precipitation changes, or a combination factors, remains challenging, even when environmental records are interpreted in light of local archaeological data. I present multi-proxy palaeoecological data from a short sediment core obtained at Mtwapa Creek, and use discordant data gleaned from pollen, charcoal, and fungal records to illustrate means to deal with equifinal interpretations related to human landscape modification.

Key words: *Pollen, fungi, equifinality, palaeoecology, Kenya*

Introduction

In addition to being a region reasonably well surveyed archaeologically, the Swahili coast is one of only a few areas in East Africa which have produced primary botanical remains of agricultural activities (Fleisher & LaViolette, 1999; Kusimba, 1999; Helm *et al*., 2012). However, ecological information on immediate coastal ecologies has been lacking until recently (*e.g.*: Gelorini *et al*., 2011; van Geel *et al*., 2011). Several papers by Punwong & colleagues have addressed this issue via numerous sediment cores from the Rufiji Delta and Zanzibar (Punwong *et al*., 2013a, 2013b, 2013c). To build on this momentum, an analysis of a sediment core from Mtwapa Creek, Kenya is presented with the aims to further refine palaeoecological records from the East African Coast, and to demonstrate the usefulness of interpreting multi-proxy environmental records in light of available local archaeological evidence.

Materials and Methods

A five meter sediment core was extracted from Mtwapa Creek with a modified piston corer, sub-sampled, and chemically processed for microbot-

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anical content. The resulting pollen, charcoal, and fungal assemblages were analyzed under light microscopy at 200x-400x magnification. Minimally, slides were counted to 400 grains. The results are here graphically rendered and interpreted.

Results and Discussion

The youngest sediments seem to reflect lower sea levels in more recent years. This is suggested by elevated concentrations of *Bruguiera* and *Ceriops* mangrove types, as well as by *Heritiera* and *Lumnitzera* types, along with the generally freshwater associated Polygonaceae and Cyperaceae. A continue decrease in *Juniperus* percentage occurs through the history captured here, while large sized Poaceae (the grass family) pollen to which various cultivated crops, including wheat and many millets conform. This is also coincident with a slight increase in Asteraceae. Taken together, this may indicate increased land clearance for cultivation. Interpreting pollen remains in light of the fungal record provided additional means of cross checking interpretations. Fungal proxies for decaying and submerged vegetation, and/or wood, change considerably through the core. Fungal types associated with soil isolates and dung increase in frequency in the youngest third of these sediments, which may indicate increased emphasis on herd animals as part of Swahili cultural flowering. Fungi associated with cultigens are somewhat more anomalous. Concentrations of fusiform conidia, which dominate in assemblages derived from stored grains such as millets and sorghum, peak alongside pollen evidence for grain cultivation.

Conclusions

Overall, evidence for possible cultivation and animal husbandry is evident in the youngest sediments, likely reflecting the developing needs of an increasingly socially complex and densely populated geograhic area. Analysis of additional sediment cores from coastal contexts, as well as further study of the environmental associations of different fungal types will greatly improve archaeological and ecological knowledge of early human modification of coastal environments.

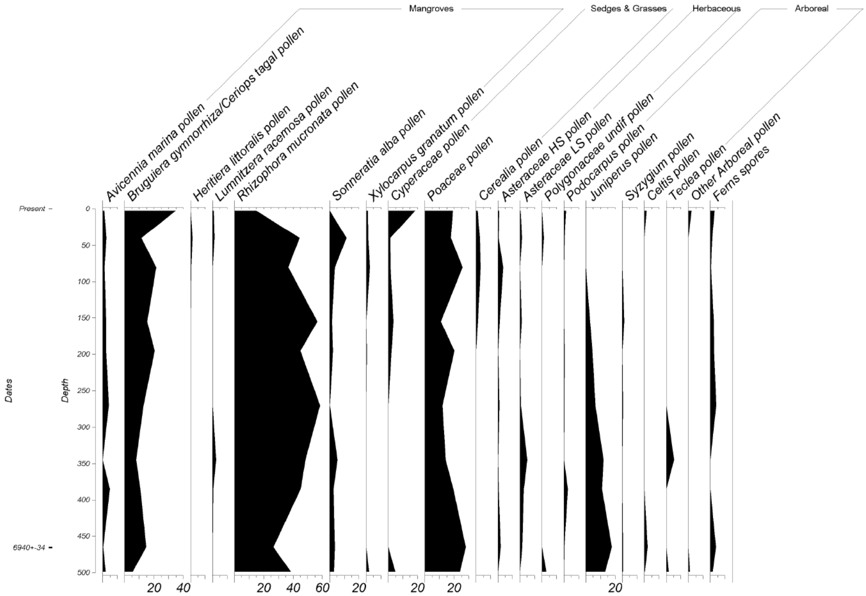

Fig. 1 – *Pollen diagram (drawn with Tilia programme)*

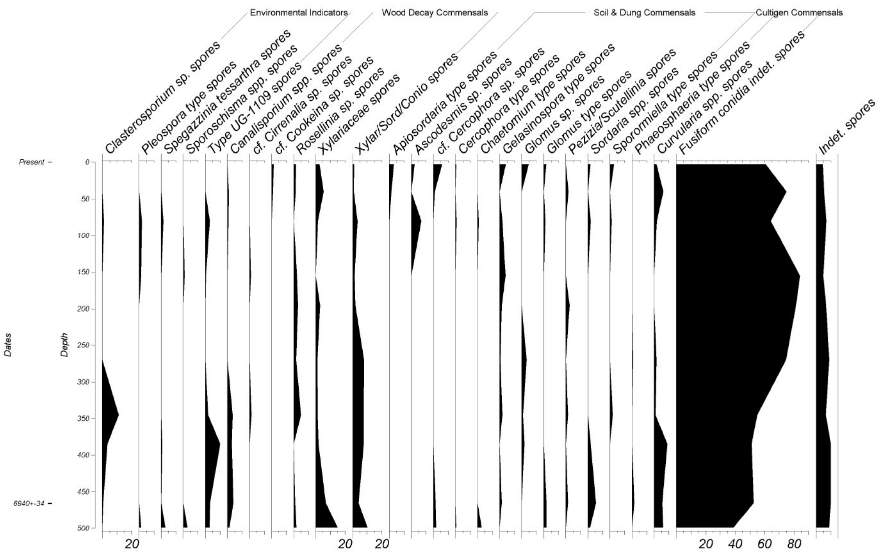

Fig. 2 – *Diagram showing fungal remains (drawn with Tilia programme)*

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SESSION 4

ARCHAEO AND ETHNOBOTANY: FOOD, FUEL AND FIELDS

Supplemento
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Daphne Gallagher[1]**, Susan McIntosh**[2]**, Shawn Murray**[2]

Agriculture & wild plant use in the Middle Senegal River Valley, ca. 800 BCE - 1000 CE

Abstract
The histories of the diverse agricultural strategies used in the Middle Senegal River Valley (MSV) (a productive inland floodplain located in the West African Sahel) are poorly understood. This paper presents a synthesis of the archaeobotanical seed and fruit record from seven sites excavated in association with the MSV Archaeological Project. These sites, spanning almost two millennia of occupation, have contributed to an important long-term record of food production and environmental interaction.

Key words: *Middle Senegal River Valley, archaeobotany, agriculture, pearl millet,* Ziziphus, *West Africa*

Introduction

The Middle Senegal River Valley (MSV) is an inland floodplain region extending 400 km along the border of Senegal and Mauritania. Due to seasonal inundation, which fills low-lying areas extending as much as 20 km from the main river channel, residents of the region are able to produce both a rain-fed and a flood recession crop each year. Today, the MSV is known as a reliable and productive place for agriculture within the context of the unpredictable Sahelian environment.

This paper presents a historical synthesis of plant use in the MSV with a focus on the charred seed and fruit record from the archaeological sites of Walaldé, Sincu Bara, Siwré, and Cubalel sites C-1, C-3, C-6, and C8. Collectively, the occupation at these sites is most intensive from 800 BCE - 1000 CE (occupation continues until after 1600 CE in mixed deposits). The analysis provides insight into the intensification of agriculture and continuities in wild plant use in the region.

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Materials and Methods

The archaeological sites included in this analysis were excavated as part of the Middle Senegal Valley Project (1990-1993), directed by R. McIntosh, S. McIntosh, and H. Bocoum (McIntosh & Bocoum, 2000; McIntosh *et al*., in press). Excavations at Waladé by A. Deme in 1998-1999 expanded the archaeological record on early occupation of the region (Deme & McIntosh, 2006).

Overall, 292 flotation samples from 12 excavation units at the seven sites have been analyzed. Samples ranged from 1-12 litres of initial sediment volume, and all were floated using a bucket method. Many scholars, including C. Capezza, D. Fuller, D. Gallagher, M.A. Murray and S. Murray, have been involved in the archaeobotanical analyses at the study sites resulting in numerous publications (Gallagher & Murray, in press; Murray *et al*. 2007; Murray, 2008; Murray & Deme, 2014). For this paper, the authors have compiled the archaeobotanical results (~25,000 identified specimens) from these sources, including previously uninterpreted data from C-1, C-3, C-6, C-8, and Siwré, to explore regional patterns.

Results and Discussion

Pearl millet (*Pennisetum glaucum*) is present from the beginning of the sequence, and the most commonly identified plant at all sites except C-8, which had a small sample. It generally occurs in conjunction with a range of mixed wild grasses. The second most frequently identified genus is jujube (*Ziziphus* sp.). While it is present in large numbers at Cubalel sites and at Waladé, it is virtually absent from Siwré and Sincu Bara. In addition to these plants, a range of other tree fruits and herbaceous wild plants consistent with a Sahelian riverine environment are found at all sites. Sorghum (*Sorghum bicolor*) was extremely rare, and two plants generally thought to have been significant in the past, rice (*Oryza glaberrima*) and cotton (*Gossypium* sp.), have not been conclusively identified at any of the excavated sites.

Conclusions

Pearl millet has been cultivated in the MSV for almost 3000 years. During that time, residents have continued to exploit a range of wild plants, with certain species appearing to have been more popular at particular sites. The rarity/absence of key plants in the archaeobotanical record may be the result of lesser significance than previously assumed or of preservation biases.

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Luíseach Nic Eoin[1]

Gatherers with grasses: why is grass seed consumption overlooked in southern African hunter-gatherer archaeology?

Abstract
Grass seed consumption has historically been overlooked by archaeologists in considering the diets of southern African hunter-gatherers, with geophytes receiving more favour. This paper reviews the southern African archaeobotanical record with reference to the Grassland Biome (Free State, Eastern Cape and KwaZulu-Natal provinces; Lesotho) and discusses the reasons for the historic marginalisation of this potentially important food source. Data from a doctoral project focusing on microbotanical residue analysis of grindstones from the site of Ha Makotoko, western Lesotho, are presented in support of the thesis that grasses may have contributed more to subsistence than has previously been indicated, and the ramifications of this to archaeological narratives of hunter-gathering and agriculture are discussed.

Key words: *Grass seed consumption, geophytes, southern Africa, phytoliths, starch grains, residue analysis, grindstones*

Introduction

Since Hilary Deacon's discussion of the importance of geophytes to southern African hunter-gatherer subsistence (Deacon, 1993), few have disputed the idea that they constituted a dietary staple, and the notion that their dietary importance explains the ubiquity of grindstones at archaeological sites has gone largely uncontested. There is, however, a wide body of ethno-historical evidence for consumption of grass seeds by hunter-gatherers and agro-pastoralists in the region (Dunn, 1931; Jacot Guillarmod, 1971), evidence for wild grass seed consumption further afield (Cane, 1989; Mercader, 2009; Radomski & Neumann, 2011), and now, a doctoral dissertation focussing on grindstone use at Ha Makotoko, a site in western Lesotho. The absence of discussion of seed-grinding in southern Africa is important, as archaeological narratives discussing the origins of agriculture tend to foreground its (pre-

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sumed) absence here, privileging instead the (presumed) role of geophytes in subsistence (Marshall & Hildebrand, 2002).

Materials and Methods

In this paper, results from phytolith and starch analysis of grindstones and sediments at Ha Makotoko are presented. They are contextualized with a review of literature pointing to a pervasive role for grass seeds in southern African hunter-gatherer subsistence as well as narratives that exclude them.

Results and Discussion

Data from Ha Makotoko point to the absence of geophyte starch in association with grindstones, and furthermore, the presence of grass inflorescence phytoliths suggests that the ubiquity of these neglected objects can be better explained (although perhaps not fully, as demonstrated by some intriguing exceptions) by the role of grass processing in hunter-gatherer subsistence.

Literature review suggests that in addition to clear cases of grass processing in the ethnohistorical record, archaeological deposits interpreted as grass bedding could in many cases suggest at the very least a dual role for such material (*i.e.* bedding and food).

Conclusions

At Ha Makotoko, grass-seed processing seems best able to explain the presence of most grindstones on site, with the exception of those used for pigment processing or some medicinal plants (while roles not visible from botanical or mineralogical analyses have yet to be interrogated).

Set against the ethnohistorical evidence and the plausibility of wide scale (although possibly non-intensive) grass-seed processing in southern Africa as compared with other regions (particularly Australia), I suggest that the presence of grindstones elsewhere may be largely due to this phenomenon also, although until further sites are examined, I caution against the simplistic use of grindstones as proxies for this behaviour. If grass-seed processing is attested on a wider scale (as I believe it may be), we must revisit assumptions and narratives about the complexity of hunter-gatherer subsistence.

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Senna Thornton-Barnett[1]

The archaeobotany of agricultural resilience at Engaruka, northern Tanzania

Abstract
*The abandoned terrace site of Engaruka in northern Tanzania has been featured as an example of poor agricultural sustainability in debates related to the motivation for and consequences of agricultural intensification. According to these narratives, the desertion of Engaruka in the 18th century after a 300-400 year occupation was the result of poor resource management. However, very little is known about the crops grown during the site's occupation other than that sorghum was identified in sediments from habitation terraces excavated in 1968. Resilience cannot be established with such limited information about the role of crop selection within the agronomy. Macrobotanical analysis of samples recovered during recent fieldwork at Engaruka has revealed the presence of several cereals (sorghum, pearl millet, and broomtail millet), weeds of cultivation, and possible thatching material (*Typha *sp.). This discovery challenges the idea that environmental mismanagement may be responsible for the systemic collapse of Engaruka and has the potential to recast perceptions of agricultural resilience.*

Key words: *Intensive agriculture, crop selection, resilience, collapse, macrobotanical, environmental mismanagement*

Introduction

The archaeobotanical component of the AAREA project (Archaeology of Agricultural Resilience in East Africa) (Stump, 2013) seeks to refine what is known about agricultural subsistence at two contrasting terrace agriculture sites, Engaruka, in northern Tanzania, and Konso, in Southeastern Ethiopia, through the identification of potential food crops. The sites in question have been featured in debates related to the basis for, and consequences of, agricultural intensification and the efficacy of "indigenous" agricultural techniques as models for sustainable rural development (FAO, 1990). Robust evidence for crop selection, beyond the identification of sorghum (Sassoon, 1967), has been notably absent. There is no ethnographic support for the practice of monoculture prior to the development of agricultural mechanization and it is

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unlikely that such an elaborate irrigation system would be engineered for a single crop. Furthermore, palaeoenvironmental data suggest that Engaruka was much drier at (dates) compared with the present and its inhabitants endured and adapted to agriculturally challenging conditions (Westerberg *et al*., 2010). This paper details the recent identification of three different charred cereals, several weeds of cultivation, and possible thatching material from Engaruka and places it in the context of historic accounts of agriculture in East Africa. Together these lines of evidence indicate that subsistence at Engaruka was more complex than previously recognized.

Materials and Methods

Fifteen bulk soil samples (10-20 litres each) were collected from stratigraphically distinctive agricultural terrace contexts. Eighty-nine samples were taken from sediments representing the occupation floors of the habitation terraces. To maximize the potential for finding charred seeds, 100% of the sediment from suspected hearth features was sampled (*n*=25). Samples were processed using tank or bucket flotation depending on the schedule of local irrigation allowances. I compiled a botanical reference collection of economically significant plants purchased from local markets as well as those harvested during ethnobotanical vegetation surveys. Finally, I have also conducted a review of pre-colonial and colonial agriculture in East Africa from travellers' expedition reports in order to better understand crop selection.

Results and Discussion

Whole and partial charred seeds from numerous weed taxa, and three different cereal grains (cf. *Sorghum bicolor*, *Panicum glaucum*, and *Eleusine coracana*) suggesting that Engaruka had a varied agronomy. A stem fragment of cattail (*Typha* sp.), a thatching material, was also identified and may be the first indication of the building materials employed in the construction of the habitation areas. Accounts of historic agriculture in East Africa do provide some, if limited, information about the use of irrigation to support multiple crops and evidence of trade between pastoralists and agriculturalists.

Conclusions

The macrobotanical and historic evidence for crop selection presented here are intended to lay the framework for a more robust assessment of agricultural resilience at Engaruka and also to contribute to the reconsideration of the markers of agricultural sustainability and resilience.

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Mats Widgren[1]

Mapping the history of African agricultural systems

Abstract
The contribution reports on a project in mapping the extent of different agricultural systems in Africa in AD 1000, AD 1500 and AD 1800. The project is motivated by the lack of known agricultural history in existing global historical cropland data.

Key words: *Mapping, historical cropland, agricultural systems*

Introduction

Recent global historical cropland data sets used in climate modelling greatly underestimate the pre-colonial development of agriculture in the Americas and many parts of sub-Saharan Africa (see *e.g.* Goldewijk *et al.*, 2011). Such data sets are usually based on back-casting and environmentally deterministic algorithms. Historical geographers have been slow in responding to this new demand for a global synthesis. No attempt has yet been made to express the present knowledge of global agrarian history in maps. Only for the Americas has such a synthesis been achieved (map by Mann, 2005, and references therein).

A small international project has been set up to respond to these challenges on a global scale. It aims at global reconstructions of agricultural systems for AD 1000, AD 1500 and AD 1800. For each of these cross-sections a map will be made, comparable in scale and detail to the often quoted map by Derwent Whittlesey on the major agricultural regions of the world in the first half of the 20th century (1936). In this presentation the preliminary results for Africa will be presented.

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Materials and Methods

The following work is based on existing historical and economic historical literature, some interdisciplinary environmental history projects and more specialised archaeological and archaeobotanical works. This has formed the basis for a GIS based on larger or smaller regions each characterised by their dominant agrarian system for three periods AD 1000, AD 1500 and AD 1800.

Results and Discussion

Owing to the lack of sources, the degree of certainty of types of agricultural systems differs between the periods. Nevertheless, mapping indicates both an expansion of agriculture and intensification over time in which more productive and labour intensive systems were introduced. The expansion of banana cultivation in the Great Lakes region exemplifies this. The establishment of "islands" of intensive agriculture in West Africa, the Sahel, East Africa (Widgren, 2010) and in the warm temperate regions of Southern Africa also bears witness to this change.

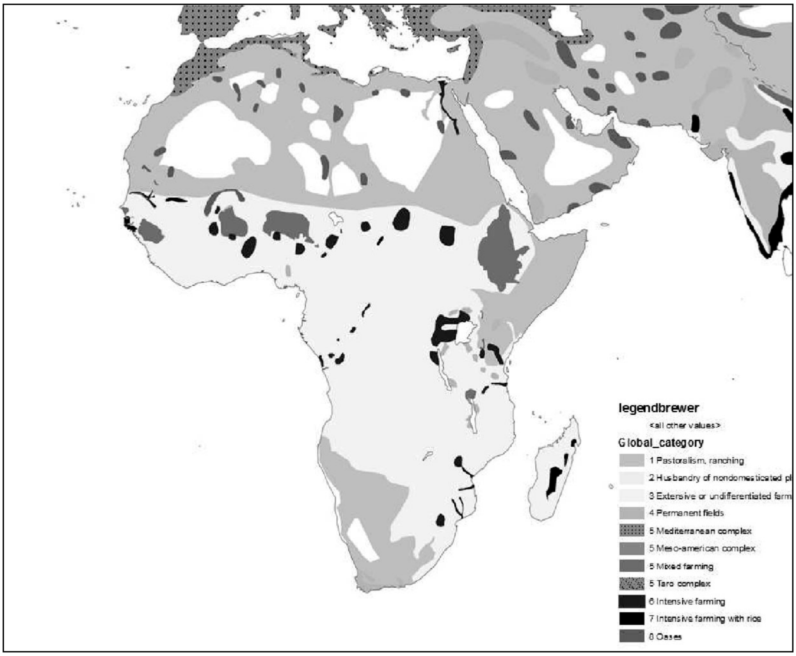

Fig. 1 – *Agricultural systems AD 1800 (preliminary map); even if details cannot be read from a black/white version of the map, it hopefully gives an impression of the level of detail at which we work*

Conclusions

The maps are only preliminary and will have to be continuously updated (hopefully the critical eyes of archaeobotanists will be able to question and improve these maps).

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Sarah Walshaw[1]

Cooking and crafting at Songo Mnara, Tanzania (14th-15th century AD): evidence from macrobotanical remains

Abstract
The Swahili coast is well known for its medieval Muslim trading towns, particularly the stone town of Kilwa, known through historical documents and impressive standing architecture. However, we have much less evidence to chart Swahili society during the 14th and 15th centuries, just prior to the Portuguese presence in the region and the severing of Swahili ties to trade and self-determination. The UNESCO World Heritage site of Songo Mnara is a famous yet understudied example of a stone town in the Kilwa region. Its compact 100-year occupation offers an unparalleled opportunity to examine spatial relationships among stone houses, earth-and-thatch structures, mosques, cemeteries, and open spaces. Macrobotanical remains from Songo Mnara have contributed to our understanding of local food culture and craft production, including differences between and within stone and earthen structures.

Key words: *Swahili Coast, macrobotanical remains, spatial analysis, households, agriculture*

Introduction

Current excavations at Songo Mnara, led by Stephanie Wynne-Jones and Jeff Fleisher, seek to illuminate how private space is organized within Swahili houses and how public places are delineated and used by residents and visitors (Fleisher & Sulas, 2015; Wynne-Jones, 2013). Archaebotanical sampling has included multiple lines of evidence for plant use, including charred macrobotanical remains, phytoliths, and stable isotope analysis. Here I present macrobotanical data concerning stone household spatial distribution of plant use and compare this with data from daub structures and ritual areas.

Materials and Methods

Macrobotanical samples were retrieved through bucket flotation using fresh and recycled water. Light fractions were caught in a 0.5 mm mesh, and

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water was recycled through a 0.3 mm mesh. Dried flots were transported to the Archaeobotany Laboratory at Simon Fraser University for analysis; further identification and analysis was conducted in Oxford.

Results and Discussion

Stone household plant use patterning – Sampling by room revealed several insights into plant use within stone houses, as well as discard patterns. The rear room of House 44 was comparatively rich in rice remains as well as cotton; taken together with evidence for spindle whorls and beads here, this was likely a cooking and crafting space dominated by women. One surprise was the presence of charred seeds and wood found in toilet deposits, suggesting that fire ash was put in the toilet, which could reduce odours.

Earthen house/workshop plant use – Two structures built of daub were found through remote sensing and subsequently excavated. Macrobotanical composition from these contexts appears different from those in stone houses, particularly in the fruit/nut and crop categories.

Regionalisms in Swahili Foodways – Compared with the relatively better-known pattern of rice dominance at the 11th-15th century AD site of Chwaka on Northern Pemba island (Walshaw, 2010), agriculture in this region seems to be limited by aridity due to later and lighter monsoon rains, and may more resemble archaeobotanical patterns among sites in the Mikindani region (Pawlowicz, 2011). While rice is present at the site, and dominates in certain contexts, the overall ubiquity of rice is low.

Conclusions

Songo Mnara macrobotanical remains show spatially differentiated food and craft patterning, suggesting gendered use of space and potential differences between stone houses and daub structures.

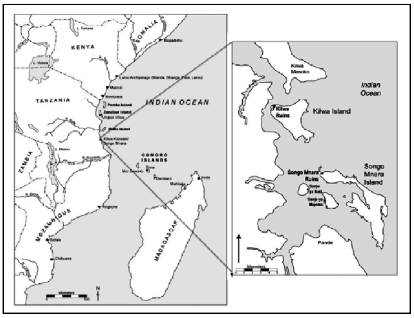

Fig. 1 – *Map of Swahili Coast*

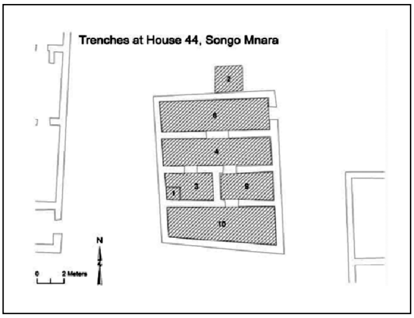

Fig. 2 – *House 44*

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Amanda Logan[1]

Toward an archaeobotany of food security in Africa

Abstract
In this presentation I describe a conceptual framework for tracing food security in the African continent, derived from the pillars of food security as outlined by the WHO. I argue that archaeobotanical data are critical to tracing shifts in food security over time. I illustrate this approach by presenting results from a case study in Banda, Ghana, over the last 1000 years.

Key words: *Archaeobotany, Ghana, food security, isotopes*

Introduction

Archaeobotanical analyses provide our best form of evidence for shifts in the use of staple grains over time. When compared with environmental, economic, and political data, we can use archaeobotanical data to address shifts in food security over time. I suggest that we use these data to track three pillars of food security: food availability, food access, and food preference. My approach can be best illustrated through a case study of changing crop plants in Banda, Ghana over the 1st millennium AD.

Materials and Methods

I analyzed 330 flotation samples from 10 sites in the Banda area of West Central Ghana. I compare these results to high resolution oxygen 18 isotope records from Lake Bosumtwi, Ghana, which document shifts in precipitation.

Results and Discussion

These data suggest a high level of food security during a two-century long drought from approximately 1450-1650 AD, with indicators of food insecurity appearing relatively late in time, in the 19th century.

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Conclusions

The results from Banda suggest that there have been major shifts in food security over the last 500 years. This time period has seen very little archaeobotanical attention, but more comparative data are needed to determine whether trends observed in Banda were widespread. Additional fine grained analyses of the impact of drought on agricultural production, as well as agricultural production techniques, would help inform on how people managed during the multi-century severe drought.

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Elisabeth Hildebrand[1], Steven Brandt[2], Endashaw Bekele[3]

New perspectives on the origins of *Coffea arabica* in south-west Ethiopia

Abstract
Coffea arabica *is one of the world's leading agricultural commodities today, but scientific data regarding the beginnings of coffee use are scarce. This paper considers ethnobotanical, ethnohistorical, and archaeological perspectives on modern, historic, and prehistoric use of coffee in its source area of south-west Ethiopia.*

Key words: *Ethiopia, coffee, food production, arboriculture, archaeology*

Introduction

Coffee is one of the world's leading agricultural commodities today, accounting for over $ 15 billion in annual trade. Coffee production in the global south not only supports local consumption, but supplies coffee habits in Europe (750 million cups drunk each day) and the United States (54% of American adults consume coffee daily, typically over 3 cups per day). Although anecdotal accounts of coffee origins bolster marketing efforts by major retailers and small coffee shops alike, scientific data regarding the beginnings of coffee use are scarce. This paper presents information on modern, historic, and prehistoric use of coffee in south-west Ethiopia, and considers the implications of these data for early use and cultivation of this crop.

Materials and Methods

Ethnobotanical data are drawn from Hildebrand's (1998-2000) fieldwork with the Sheko farmers of Bench-Maji Zone and Kafa farmers of Kafa Zone. Ethnohistorical data are drawn from published sources reviewed by Bekele

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and Hildebrand, and field data gathered by Brandt in diverse locations in the Horn. Archaeological data are drawn from excavations by Hildebrand and Brandt at Kumali Rockshelter (Kafa Zone, 2005-2006), and by Brandt at Mochena Borago (Wolaita Zone, ongoing).

Results and Discussion

The globally prevalent practice of roasting, grinding, and steeping beans is the result of a rapid spread of one particular preparation method. Ethnobotanical and ethnohistoric data suggest considerable diversity in practices of coffee preparation and use (*e.g.* steeping freshly roasted leaves as a drink, pounding and mixing with butter as food) across south-west Ethiopia, and show that coffee consumption was sometimes linked to rituals performed within indigenous non-Abrahamic belief systems. Archaeological finds show the presence of coffee at sites during late Holocene times, but raise many questions about the nature of its use.

Conclusions

Coffee use is of great antiquity and diversity in south-west Ethiopia. Its recent rise to prominence as an internationally traded commodity is still poorly understood, but may have been shaped by both cultural factors (*e.g.* acceptance by lay people and clergy practicing Abrahamic religions) and technological developments (*e.g.* preparation methods that could accommodate lengthy periods of storage and transport, postponing the roasting and brewing steps crucial to flavour to the final days and moments before consumption). This initial review lays the foundation for future investigations of these and other social and economic processes.

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Charlène Bouchaud[1], Alan Clapham[2], Claire Newton[3], Gaëlle Tallet[4], Ursula Thanheiser[5]

Cottoning on to cotton (*Gossypium* spp.) in Arabia and Africa during Antiquity

Abstract
*The examination of archaeobotanical, textile and textual evidences for cotton (*Gossypium *spp.) in the Middle East during Antiquity points to new hypotheses on the emergence of cotton production centres and their status in agrarian and textile economies.*

Key words: Gossypium herbaceum/arboreum*, Antiquity, Northeast Africa, Arabia*

Introduction

Cotton seeds and raw fibres appear on archaeological sites dated to the turn of the 1st century AD in Northern Africa and Western Arabia (Bouchaud *et al*., 2011; Brite & Marston, 2013; Clapham & Rowley-Conwy, 2009). This subtropical plant comprises two cultivated Old World species that cannot be distinguished from each other using morphological observations of seeds or fibres: *Gossypium arboreum* L., probably domesticated in the Northeast Indian subcontinent and commercialized since the 3rd millennium BC (Fuller, 2008) and *Gossypium herbaceum* L., an African species for which very little is known, except that it was present in Nubia during Antiquity (Palmer *et al*., 2012). By comparing archaeobotanical, textile and textual discoveries, the aim of the presentation is twofold. Firstly, new hypotheses on the two species' diachronic distribution in the past will be examined. Secondly, the potential role of cotton production in agrarian and textile economic dynamics on either side of the Red Sea during Antiquity (1st – 4th century AD) will be considered.

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[5] University of Vienna, Vienna Institute for Archaeological Science, Vienna, Austria.

Materials and Methods

The study is based on the examination of archaeobotanical, textile and textual discoveries relating to cotton in Middle East between the 1st and the 4th century AD. They comprise raw cotton remains in the form of seeds, bolls and unworked fibres, textiles, as well as textual evidences from classical Greek and Latin authors and ancient agricultural accounts. In parallel, the detailed archaeobotanical records of archaeological sites from Egypt, Sudan and Saudi Arabia are examined in order to understand the role of cotton in different agrarian production systems.

Results and Discussion

Keeping the ecological and economic contexts in mind, spatial and chronological distribution of the data allows us to suggest several avenues of investigation regarding the early history of cotton production and trade in the region considered.

1) Concentrations of cotton seeds and raw fibres clearly indicate the emergence of cotton production in Northeast Africa and Western Arabia from the 1st century AD. The earliest texts directly referring to cotton production date from the middle of the 2nd century AD (Bagnall, 2008; Tallet *et al.*, 2012). We suggest that the first cotton production represent small-scale experimentations led by local groups independently of authoritarian rulers' policies. Meanwhile, cotton textiles – for which the technical markers highlight an Indian or local origin (Wild, 1997) – gradually spread all over the Middle East, showing that cotton is not a massive but regular product of trade.

2) The development of cotton production centres in Nubia and Upper Nubia could likely be attributed to the diffusion of *Gossypium herbaceum*.

3) Semi-quantitative archaeobotanical data show that cotton production was established in distinct oasis systems on either side of the Red Sea. In Nubia and Upper Nubia, cotton arrival corresponds to profound agricultural and irrigation system changes whereas in Arabia, cotton seems to integrate oasis systems without any visible technical changes.

Conclusions

The integrative study of cotton evidence in the Middle East allows us to bring forward new hypotheses concerning the distribution of the two Old World species and the economic evolution of cotton production during the first centuries AD, just before its large-scale expansion during the Islamic period.

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Chris J. Stevens[1], **Dorian Q. Fuller**[1]

Sorghum domestication revisited

Abstract
This paper provides an update of the current state of knowledge, regarding the recording of morphometric traits related to domestication, recent genetic work, current archaeological records and comparison to domestication pathways for other crops and regions, such as wheat, barley in the Near East and rice in China.

Key words: *Sudan, Africa, domestication, pre-domestication cultivation, pearl millet,* Pennisetum glaucum*,* Sorghum bicolor

Introduction

Sorghum today is the fifth major crop in the world today, and the most important of African domesticates, yet its domestication is relatively poorly understood, in terms of the timing, evidence for the location(s) of domestication, ecological environment, and the nature and length of the process.

Almost 40 years have now passed since Jack Harland and Ann Stemler (1976) published "The races of Sorghum in Africa" in which the domestication selections for free-threshing varieties and dispersal of sorghum to other parts of Africa and India were discussed in detail.

Comparative Pathways towards Agriculture

As part of the ComPag (*Comparative Pathways towards Agriculture*) Project at UCL, a database of sites with archaeobotanical data for the Near East, China, Central Asia, South-East Asia, South Asia and Africa has been compiled. At present there are 173 sites recorded with archaeobotanical data for (sub-Saharan) Africa for which 103 have *Sorghum* recorded (Fig. 1). Out of these, 76 are recorded as probably domesticated.

The distribution of wild *Sorghum* (*arundinaceum*) was originally assigned to the sub-Sahara from Nigeria to Sudan (de Wet & Huckabay, 1967),

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although Ethiopia has also been added to this (Doggett & Prasada Rao, 1995). While genetic work has suggested three possible centres of origin for sorghum (Lin *et al*., 2012), as yet no sites with evidence for the domestication process are known although new discovers are beginning to shed light on this process (Beldados, this conference). As with cereals from the Near East and West Asia visible changes are noted between the lapse shattering panicles with small grains of wild forms and the non-shattering, dense panicles with large grains of domesticated *Sorghum* (Fig. 2). As with Near Eastern and West Asian cereals, a protracted period of cultivation of 2000-3000 years then seems probable (see Fuller *et al*., 2014).

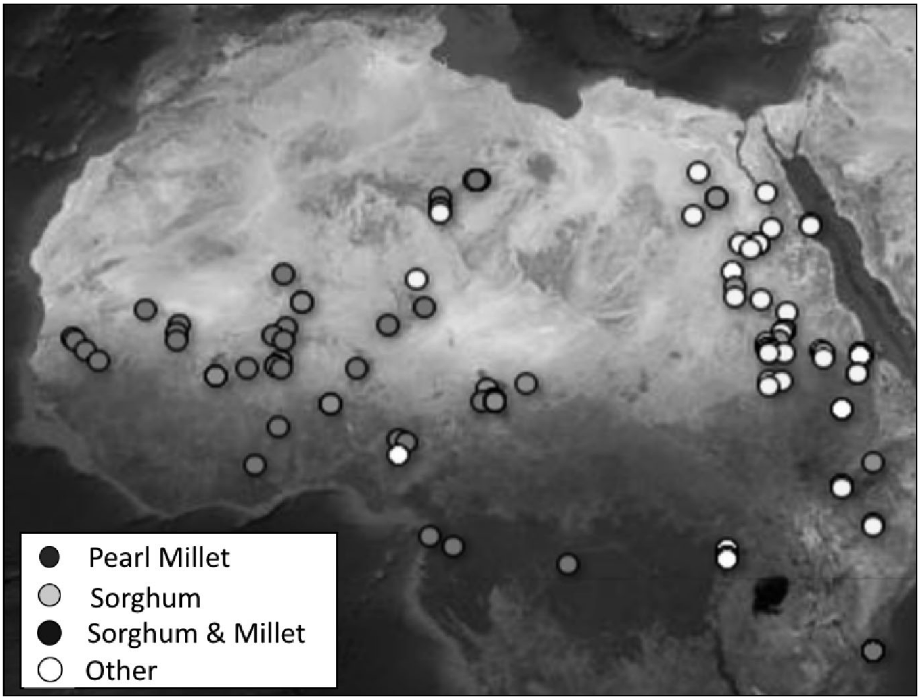

Fig.1 – *Sites with evidence* Pennisetum glaucum *and/or* Sorghum bicolor. *Records include wild, domesticated and undistinguished remains*

This paper examines panicle density from wild, archaeological and modern material with the aim of creating new morphological criteria for recording and understanding such material. Current archaeological evidence suggests that selection for colour begun probably by the 1st millennium BC with selection for denser panicles by at least the late 1st millennium AD (see Rowley-

Conwy, 1991; Clapham & Rowley-Conwy, 2007). In addition the process towards free-threshing varieties through both a reduction in the size of the glume bases and the twisting of the grain are also explored.

This process is understood alongside evidence for the domestication of other crops in Africa, such as pearl-millet, as well as the evidence for the movement of other cereal and millet crops, in particular between Africa and south Asia (see Fuller *et al.*, 2011).

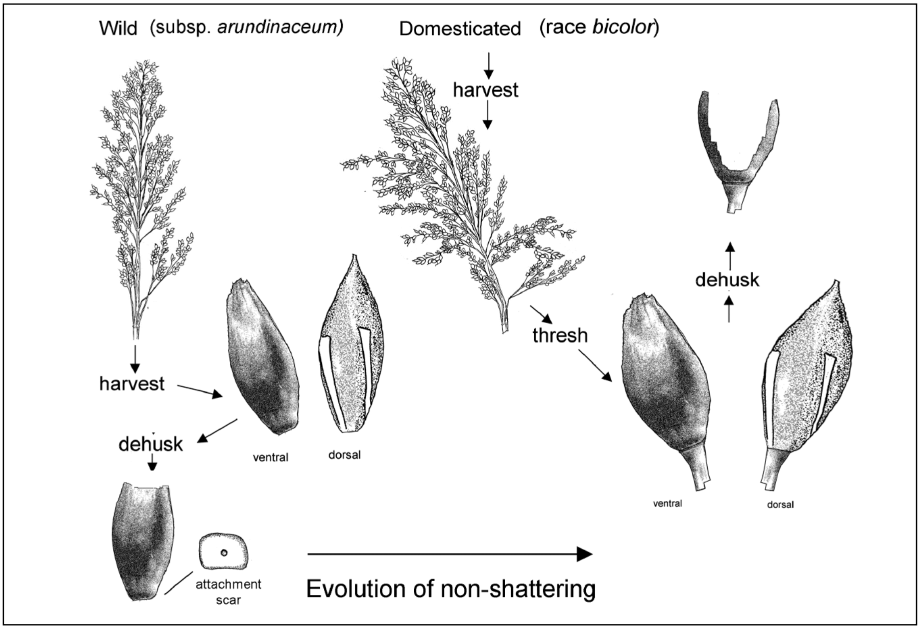

Fig. 2 – *The morphological transition from shattering* Sorghum bicolor *subsp.* arundinaceum *to non-shattering* Sorghum bicolor *subsp.* bicolor *and the prerequisite for threshing with domestication*

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Philippa Ryan[1], **Katherine Homewood**[2]

Cereals and agricultural practices in northern Sudan, past and present

Abstract
Nubian agricultural practices are rapidly altering due to infrastructure development, as well as technological and environmental changes. We will discuss changes in cereals grown and crop husbandry over the last century, and how this may help to consider agricultural strategies at archaeological sites.

Key words: *Ethnobotany, Nubia, macrobotanical remains, agriculture, Sudan*

Introduction

Nubian agricultural practices are rapidly altering due to technological and environmental changes. This research is part of a broader project "Sustainability and subsistence systems in a changing Sudan" (funded by the AHRC 2013-2016) which compares present-day and ancient crop choices to investigate agricultural risk management within Nile settlements. We are interviewing Nubian farmers about crops grown, their relative importance and crop-processing practices (cereals and pulses). We are visiting islands and riverbank villages throughout the north. Islands have always been important as there are large stretches of the middle Nile valley with little cultivatable land. We are also studying the archaeobotanical remains from Amara West (1300 – approx. 800 BC), which was originally located on a Nile island. The subsistence information from Amara West and farmer interviews is being contextualized within existing archaeobotanical and 20th century studies to create a long temporal view of crops used in the region. Here we outline changing cereal use over the last century and reasons behind these shifts. Also we discuss which categories of information from the farmer interviews may provide

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insights into agricultural strategies at archaeological sites, including Amara West.

Materials and Methods

Farmer interviews have focused on car- and electricity-free Ernetta Island, and we are interviewing farmers in other villages to understand variability. We ask them about cereals grown today and in the past, as well as about land-use and crop-processing by recording persisting practices and interviewing older farmers. We will compare the evidence for cereals used from the farmer interviews with what is known from early 20th century agricultural studies and the archaeobotanical record (including Amara West). Macroremains analyzed from the town at Amara West are preserved through charring whilst desiccated remains are also present in deposits from earlier 18th dynasty sites inland of Amara West. The main town (1300-1070 BC) was based on an island, but geomorphological data has shown subsidiary Nile channels dried by the end of the 2nd millennium BC. We discuss how studies of land-use from present-day Nile islands may provide useful analogies for agricultural land-use at Amara West.

Results and Discussion

The farmer interviews have revealed distinct phases of crop changes and complex reasons behind these shifts. For example, sorghum (*Sorghum bicolor* (L.) Moench) and hulled six-row barley (*Hordeum vulgare* subsp. *vulgare* L.) have become less common as food crops in recent decades. Their presence in the archaeological record suggests their long-term use in the region as well as their continued relevance to agriculture today [sorghum is recorded from ca. the mid-1st millennium BC and barley from *ca.* 5000 BC (Fuller, 2014; Madella *et al*., 2014)]. Wheat (*Triticum aestivum* L.) was not important during the early 20th century but became so from the late 1950s onwards. Interviews about agriculture during the time of the *sagia* (irrigation by waterwheel, replaced by petrol pumps between the 1950s-1970s) are especially relevant to periods using that technology (from the early 1st millennium AD onwards). However, some small farms only used the *shaduf* (lever and pole) and this provides a useful analogy to periods dating from the New Kingdom. Equally relevant to all periods of the archaeological past is how farmers exploit flooded areas. Seasonal islands and channels (that flow only in the summer) have provided particular insight into past and present agricultural land-use potential.

Charred botanical remains from Amara West are providing new evidence about agricultural practices for the 2nd millennium BC [little is published about agricultural practices before the 1st millennium BC]. Cereals exploited were winter crops, emmer wheat (*Triticum dicoccum* Schrank) and hulled barley (Ryan *et al*., in press). The ethnographic study is helping interpretations about cereal use at Amara West; especially about the possible processing of hulled barley for food, and cereal cultivation in a seasonal island environment.

Conclusions

Some 'traditional' agricultural practices still persist today but there have also been many changes in recent decades. The reduction today in summer cultivation, and of more arid tolerant cereals, is potentially risky as there have been significant problems in some villages recently with particular crops (notably wheat from bird attacks). Investigating which crops and practices are 'traditional' is helping to create modern reference points from which to make comparisons with the archaeological record.

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René T. J. Cappers[1]

The processing of hulled barley in Kerma (Sudan)

Abstract
Archaeobotanical research has been conducted on a number of mud bricks from Doukki Gel (Kerma, Sudan). The mud bricks are partly tempered with trash material, including the by-products of the processing of hulled 6-row barley. The whole grain kernels of barley, which were found in the trash, were well preserved and are indicative of high-grade processing.

Key words: *Kerm, Doukki Gel, mud bricks,* Hordeum vulgare*, temper*

Introduction

Archaeobotanical research has been conducted on a number of mud bricks from Doukki Gel (Kerma, Sudan).

Materials and Methods

A total of 23 mud bricks have been collected from the bottom, halfway and from the top of Doukki Gel. Plant remains have been extracted by flotation using a 0.5 mm sieve. After flotation, sieve residues have been dried and checked under a stereo-microscope.

Results and Discussion

Most of the mud bricks are tempered, though the quantity of temper differs among the bricks. Irrespective of the variation in its quantity, it shows a predominance of hulled 6-row barley (*Hordeum vulgare* ssp. *vulgare*). In addition, emmer (*Triticum turgidum* ssp. *durum*) is present, though always in low quantities. This assemblage mirrors the cereal composition in Egypt, where both founder crops were cultivated from the Early Neolithic until the New Kingdom. The absence of African domesticates such as Sorghum (*Sorghum bicolor*) can be explained by the flooding of the Nile, which forced farmers to

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cultivate winter crops. The winter crops were available from the Levant, being adapted to winter cycles.

The composition of the temper indicates that in each construction phase trash was used. This not only is clear from non-botanical components, such as bone fragments and stones, but also from the threshing remains of cereals. From both barley and emmer such remains are present, those of barley even in rather large numbers.

Of special interest are the chaff remains of barley in combination with germinated grain kernels that have been polished. Evidence of modern processing of hulled barley shows that the grains (in fact florets) are ground without dehulling. Removing the chaff and bran particles is done by sieving the flour. The subfossil material shows that dehulling has been done prior to grinding, and with such an accuracy that the fruit wall has been untouched. This is indicative of a high-grade processing that needs further study in which traces of processing might be linked with the implements that have been used.

SESSION 5

CLIMATE AND AGRARIAN-CULTURAL LANDSCAPES

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Jacob Morales[1], Lydia Zapata[1], Leonor Peña-Chocarro[2], Simone Mulazzani[3], Nick Barton[4], Louise Humphrey[5], Abdeljalil Bouzouggar[6], Jörg Linstädter[7], Lotfi Belhouchet[8]

Epi-Palaeolithic plant use in north-western Africa: macrobotanical evidence of food and basketry at Iberomaurusian and Capsian sites in Morocco and Tunisia

Abstract
This paper aims to explore the presence of macrobotanical remains and assess the role of food plants in sites from the Iberomaurusian and Capsian cultures (ca. 23,000-7,500 cal yr BP).

Key words: *Macrobotanical remains, food plants, basketry, Iberomaurusian, Capsian, Epipalaeolithic, Africa*

Introduction

This contribution presents the preliminary results of the Paleoplant Project (Palaeolithic plant exploitation in the Western Mediterranean) funded by the European Research Council. The project focuses on archaeobotanical analyses of Epi-Palaeolithic sites in north-western Africa. Previous research on the Epi-Palaeolithic diet in this region has emphasized the role of land snails and animal resources, but little attention has been paid to the consumption of plants.

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Materials and Methods

Preliminary results from systematic analyses of charred macro-botanical remains (other than wood charcoal) at several Epi-Palaeolithic (Iberomaurusian and Capsian) sites in Morocco and Tunisia are presented.

Results and Discussion

Abundant remains of several plants in all the sites examined were identified, with *Pinus halepensis*, *Quercus* sp., and *Stipa tenacissima* being the most frequent. Archaeobotanical and ethnographic evidence suggests that *P. halepensis* and *Quercus* sp. could have been used for human consumption while *S. tenacissima* may have been utilized as a source of fibre for basketry (Humphrey *et al*., 2014; Morales *et al*., 2013, 2015).

Conclusions

We propose that food plants, especially acorns and pine nuts, could have played an important role in the Epi-Palaeolithic diet of North Africa, providing a highly nutritious food source which could also be stored. Although plant remains are scarce and the conclusions we are obtaining are still preliminary, macrobotanical evidence is very promising and it encourages future research at new sites of this region.

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Sahbi Jaouadi[1], Vincent Lebreton[1], Nathalie Combourieu-Nebout[1], Beya Mannai-Tayech[2]

Landscape shaping of pre-Saharan Tunisia during the Holocene: climate change and anthropogenic impact during the last 7000 years

Abstract
Pollen data from the Sebkha Boujmel document the landscape history in the desert margins of southern Tunisia during the last 7000 years. Major vegetation changes have been triggered by climate forcing with an increasing aridity starting at the Mid-Late Holocene transition. The increasing percentages of cultivated taxa and anthropogenic pollen indicators document the progressive landscape shaping since historical period as a result of human pressure on local ecosystems.

Key words: *Palynology, Holocene, desert vegetation, southern Tunisia*

Introduction

Steppisation and desertification of North Africa is a central issue for the next decades with regards to global warming and increasing human impact. In that sense, southern Tunisia is a key area to investigate vegetation changes of a region characterized by semi-arid to arid and sub-desert bioclimates. Holocene sedimentary records suitable for pollen analyses are scarce in central and southern Tunisia under semi-arid and arid bioclimates (Horowitz, 1992). Therefore, the sedimentary record of Sebkha Boujmel, a coastal salt marsh, is a crucial area to provide essential information regarding vegetation and climate changes in southern Tunisia.

Materials and Methods

Pollen analyses have been carried out on a 140 cm deep sediment core retrieved from the paralic Sebkha Boujmel in southern Tunisia. The 71 samples provided the first high resolution pollen record from this area. According to the age-depth model of the sedimentary record based on 5 AMS ^{14}C dates, the pollen sequence spans over the last 7000 years.

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Results and Discussion

Pollen data from Sebkha Boujmel provided valuable palaeoecological information to reconstruct past environments and vegetation responses to both climate and human impacts. Overall, the Holocene pollen record pinpointed the lack of evidence towards a tropical Acacia steppe in southern pre-Saharan Tunisia.

From ca. 7000 to 4000 cal. yr BP major vegetation changes were triggered by climate forcing whereas human impact remained weak. At that time, a grass steppe was widespread in the coastal Jeffara plain, while the mountainous hinterland was covered by thermo-xerophilous Mediterranean shrubs (*Pistacia*, *Juniperus*). Such a vegetation cover is consistent with the humid Mid-Holocene period. Nevertheless, the drop of Mediterranean and aquatic taxa and the spread of desert vegetation (mainly Chenopodiaceae) show the occurrence of an intense aridity at ca. 6000 cal. yr BP.

Since the Mid-Late Holocene transition (ca. 4000 cal. yr BP), the decrease of Mediterranean vegetation and the progressive replacement of grass steppe by *Artemisia* steppe and/or desert highlights a trend of increasing aridity.

The first human impact on ecosystems is recorded only after 2500 cal. yr BP. Thus, at the top of the core, a sharp increase in *Olea* and *Artemisia* documents an abrupt environmental transformation assigned to human pressure on local ecosystems.

In the modern vegetation of southern Tunisia, degraded Mediterranean shrubby vegetation occupies the wettest biotopes in the mountainous hinterland, and is considered as evidence of relict vegetation due to intense human land-use since the historical period (Frankenberg, 1986; LeHouerou, 1959). According to the pollen data from Sebkha Boujmel, it appears that the modern degraded Mediterranean vegetation was set up in southern Tunisia before historical times. Therefore, it might be related to a climate aridity trend since the Mid-Holocene.

Conclusions

Pollen data from Sebkha Boujmel provided key paleaoecological information to decipher how climate change and human activities transformed the southern Tunisia landscapes since the Mid-Holocene.

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Alemseged Beldados[1], **A. Catherine D'Andrea**[2], **Andrea Manzo**[3]

Filling the gap: new archaeobotanical evidence for 3rd-1st millennium BC agricultural economy in Sudan and Ethiopia

Abstract
Archaeobotanical investigations of macrobotanical remains from the sites of Mezber in northern Ethiopia and Mahal Teglinos, Kassala in north-eastern Sudan were carried out with the goal of examining agricultural economy during the period of emerging social complexity in both areas. These studies demonstrate the early presence of both Near Eastern and indigenous African crop complexes in the region from the 3rd-1st millennium BC.

Key words: *Macrobotanical remains, early agriculture, Late Holocene, Ethiopia, Sudan*

Introduction

In order to reconstruct the late Holocene subsistence economy of highland Ethiopia and Eastern Sudan, archaeobotanical analyses of selected sites were undertaken. In Ethiopia, Pre-Aksumite contexts from the site of Mezber, excavated by the Eastern Tigray Archaeological Project (ETAP), were sampled for macrobotanical remains (D'Andrea *et al*., 2008). In Eastern Sudan, several excavations have been carried out by the Italian Archaeological Expedition of the University of Naples "L'Orientale", at Mahal Teglinos, a significant mid-late Holocene locality at Kassala that has provided data on various cultural groups of Eastern Sudan (Butana, Gash, Jebel Mokram, and Hagiz) (Fattovich, 1993; Manzo *et al*., 2011). The selected sites are settlement areas showing a complex culture.

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Materials and Methods

From the site of Mezber, soil samples, ranging in size between 1.8 and 7.5 litres, from 36 contexts were processed by flotation. The botanical remains from the floated light and heavy fractions were identified with the help of comparative collections at the laboratory at Addis Ababa University. From the site of Mahal Teglinos in North-Eastern Sudan, a total of 12 kg of soil samples collected from various levels was dry-sieved and the macrobotanical remains recovered were analyzed.

Results and Discussion

Preliminary results from the site of Mezber include the presence of *Hordeum vulgare*, *Triticum durum*/*aestivum*, *Lens culinaris* and *Linum usitatis-simum*. In addition, wild/weed seeds were observed including *Brassica*, *Lolium*, Poaceae and *Rumex*.

The identified species from the site of Mahal Teglinos include wild (*Sorghum* cf. *arundinaceum*) and domesticated sorghum (*S.* cf. *bicolor*), several millets (*Setaria*, *Eleusine*, *Paspalum*, *Echinochloa*, *Pennisetum*), *Triticum durum*/*aestivum*, *Hordeum vulgare*, and *Vigna unguiculata*. Additional identified species include *Grewia bicolor*, *Ziziphus* sp., *Celtis integrifolia*, *Adansonia digitata* and *Rottboellia cochinchinensis*.

Conclusions

The evidence for *Hordeum vulgare*, *Triticum durum/aestivum*, *Lens culinaris* and *Linum usitatissimum* from Mezber dated from the late 2nd to early 1st millennium BC represents one of the earliest records today for the presence of agriculture in the highlands of the Horn of Africa.

The study from Mahal Teglinos has demonstrated that both wild and domesticated sorghum were exploited simultaneously between 2500-1000 BC by Jebel Mokram Group populations in eastern Sudan (Beldados, 2011; Beldados & Costantini, 2011). These studies indicate the early presence of both Near Eastern and indigenous African crop complexes in this region from the 3rd-1st millennium BC. Although both complexes are clearly evident in Eastern Sudan, the situation based on macrobotanical remains is less clear in highland Ethiopia.

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A. Catherine D'Andrea[1], Ahmed G. Fahmy[2], Linda Perry[3], Michael P. Richards[4], Laurie Darcus[1], Michael Toffolo[5], El Shafaey A.E. Attia[2]

Ancient agricultural economy in the Horn of Africa: new evidence from grinding stones and stable isotopes

Abstract
The pre-Aksumite site of Mezber, northern Ethiopia, is providing an unprecedented view of agricultural economy in the Horn of Africa from the mid 2nd to 1st millennium BC. This paper reports the results of ethno-archaeological and microbotanical analyses (starch granules, phytoliths) carried out on Mezber grinding stones. In addition stable isotopes from post-occupational human burials at Mezber provide a glimpse into a changing economy in the region during the late 1st millennium AD.

Key words: *Ethiopia, pre-Aksumite period, agricultural economy, grinding stones, starch, phytoliths, stable isotopes*

Introduction

Mezber is one of a few pre-Aksumite sites undisturbed by later occupations (D'Andrea *et al.*, 2008). The site revealed continuous habitation from 1600 BC to 1 AD. Two burials of four individuals dating from 864-669 AD constitute the only post-occupational activity. Contexts throughout the occupational sequence are domestic, including a kitchen area and numerous grinding stones.

Materials and Methods

Ethno-archaeological studies employed direct observations of grinding stone production, use, and use-wear, in a rural area near Mezber where grinding stones remain part of a living tradition. Use-wear studies were also com-

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pleted on Mezber grinding stones. In the field, 7 archaeological grinding stones and associated soil were sampled for microbotanical remains using a modified technique of Pearsall *et al*. (2004). In the laboratory, a combined procedure was used to extract phytoliths and starches (Horrocks, 2005; Fig. 1). For stable isotopic studies, bone collagen was extracted from human remains using a modified Longin technique (Longin, 1971).

Results and Discussion

Use wear on Mezber grinding stones suggests large-grained (*e.g., Triticum dicoccon*, *T. durum/aestivum*, *Hordeum vulgare*, *Sorghum bicolor*) and small-grained (*e.g.*, *Eragrostis tef*, *Eleusine coracana*) cereals were milled. Phytoliths revealed large proportions of C_4 plants (*E. tef, E. coracana* or *S. bicolor*), while starch of Triticeae, Panicoideae and Fabaceae was identified. Damage relating to grinding and roasting is visible. Stable isotopes from 4 individuals post-dating Mezber occupations by more than 1000 years suggest C_4 plants constituted a major portion of their diet.

Conclusions

Ethnoarchaeological and microfossil studies indicate the significant presence of both indigenous African (C_4) and imported Near Eastern (C_3) crop complexes during the pre-Aksumite period at Mezber. This result differs from studies which suggest that Near Eastern cereals dominated pre-Aksumite subsistence (D'Andrea *et al*., 2011). Dominance of C_4 plants in diets of later inhabitants of the region supports existing macrobotanical evidence (D'Andrea, 2008).

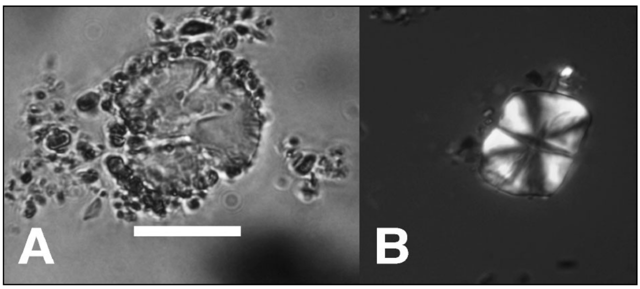

Fig. 1 – *Starch granules from Mezber grinding stones, showing grinding damage. A: starch characteristic of Triticeae; B: possible Panicoideae starch. Scale=20 µm*

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Shannon Hardwick[1]

Archaeobotany in the Limpopo Province: the siege of Historic Cave, AD 1854

Abstract
Historic Cave is the site of an investigation into the use of plants in the past, which focused on seed, nut and fruit remains. The plant remains are those of a society living under particular conditions: the remains of storage items and the preparation of the cave describe a society under siege. Species were brought into the cave by the Kekana Ndebele when they took refuge from the Boers. Historic Cave is unique because the deposits represent a single occupation event with abandoned material culture and written records. The identified species were analysed quantitatively using presence analysis and qualitatively through literature on indigenous plant use. I divided plant uses into four categories – food, muti *(medicine), water and utilitarian.* Muti *plants were applied in various ways to treat multiple spiritual and physical complaints. Examples of* muti *plants include* Aloe *and* Protea *species. Food plants include agricultural species such as* Sorghum bicolor *(sorghum) and* Vigna unguiculata *(cowpea) and wild fruits such as* Sclerocarya birrea *(marula) and* Englerophytum magalismontanum *(Transvaal milkplum).* Citrullus lanatus *(Tsamma melon) is known as a source of food and water for humans and animals. Utilitarian species include* Lagenaria siceraria *(calabash) and* Acacia *species. Plants were brought into the cave for particular reasons and may have had multiple uses. A species in the* Ganoderma *genus was identified from the cave. Fungi are a food-source that has been overlooked in southern African research. Historic Cave shows that plant remains are a significant source of information and define more than past diets.*

Key words: *Historical archaeology, plant utilisation, South Africa*

Introduction

Historic Cave is located approximately 20 km north-east of Mokopane in the Limpopo Province in northern South Africa and was host to a siege which lasted between October and November in AD 1854 (Esterhuysen, 2008a: 461, 2008b: 202; Esterhuysen *et al.*, 2009: 1038; Le Roux *et al.*, 2013: 98). The 1850s was a period of tension, raiding and skirmishes. Anticipating possible retaliation, the Kekana Ndebele prepared Historic Cave before they attacked a

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Boer (settlers of Dutch descent) commando (Esterhuysen, 2008a: 461, 2008b: 202; Esterhuysen *et al*., 2009: 1039). The preparation of the cave followed Kekana norms, following guidelines for the spatial layout and cattle selection strategies (Le Roux *et al*., 2011). It is likely that plant were selected and brought in to the cave according to typical plant selection strategies.

Materials and Methods

Historic Cave was excavated between 2001 and 2005 and again in 2007; plant remains were recovered through the use of fine sieves (Esterhuysen, 2008a: 463, 2008b: 204-205; Esterhuysen *et al*., 2009: 1040). I identified the plant species using the comparative collections housed in the herbarium in the National Botanical Gardens in Pretoria. Remains that I could not identify were assigned to Unidentified Types. I used presence analysis to highlight patterns of plant distribution among the areas of excavation.

Results and Discussion

I identified and counted over 12,500 macroremains from Historic Cave across eighty-one taxa. I described four categories of use for these species at Historic Cave: food, *muti*, water and utilitarian. *Muti* plants have either a medicinal component or ritual or spiritual significance. These two facets are usually entwined: an injury or sickness could not be remedied without them both (Ashforth, 2005:211-213).

Conclusions

The plant remains shed light on the day-to-day lives of the Kekana Ndebele and the plants they used during October and November 1854. Historic Cave provides a snapshot in time of a community utilizing various plant species to (physically and spiritually) survive a siege. The site suggests that plants (*i.e. muti*) were important in the ritual lives of this community.

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Kingsley C. Daraojimba[1], Philip A. Oyelaran[1], Cynthia F. Pinto Da Luz[2], Marcia A. De Barros[3], Jeanne Cordeiro[4]

A palynological study of an archaeological deposit in Motako, south-western Nigeria

Abstract
Botanical and archaeological evidence of human interaction with the environment in Motako (Nigeria) is presented. Twelve soil samples retrieved from the stratified northern wall of an excavated refuse mound were subjected to pollen analysis. 12 out of 28 pollen types identified belong to plants that may have been used for medicinal, food and ritualistic purposes. The high percentage of charcoal in the earliest level dating to the last 60 years and the subsequent increase of Elaeis guineensis indicates the occurrence of rudimentary burning techniques related to clearing land for farming, hence causing opening of the vegetation (Amaranthaceae). This forest clearance created conditions favourable for the oil palm to blossom.

Key words: *pollen analysis, refuse mound, medicinal herbs, Motako,* Elaeis guineensis

Introduction

Pollen analysis of sediment deposits from a refuse mound in Motako (lat. 7^{0}16´15´´N and 7^{0}18´15´´N, long. 4^{0} 17´20´´E and 4^{0} 18´20´´E), south-western Nigeria was carried out as an aspect of a multi-faceted study of the Motako area. The purpose of the study was to provide insights into the nature of the environment and the plants that the Motako people may have exploited, in the light of modern ethnobotanical data (Sowunmi & Awosina, 1991). This information will provide a clue to human-environment relationships in the area and an understanding of how the people of the area may have exploited their environment over time.

Materials and Methods

Twenty grams each of twelve soil samples collected from different layers of an excavated refuse mound, 120 cm deep, were subjected to modified

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Faegri and Iversen (1989) standard preparation treatment procedure (60% HF; 36% HCl, $ZnCl_2$/HCl [specific gravity 2.0], 0.5% HCl), with the exclusion of acetolysis.

Pollen and spores were counted alongside charcoal particles. Palynomorphs counted per subsample ranged between 215 (80-74 cm) and 3462 (23-17 cm), while charcoal particles ranged between 280/cm^3 (110-103 cm) and 17/cm3 (4-0 cm). The charcoal, fungal and fern spores were excluded from the pollen sum but expressed as a percentage of the pollen sum. TILIA and TILIAGRAPH software were used for illustration of the pollen and spore data calculations (Grimm, 1987). The zonation of the pollen record is based on marked changes in the pollen assemblages.

Results and Discussion

Twenty-eight pollen types were identified and categorized into the following phyto-ecological groups: Secondary Forest, Montane Forest, Guinea Lowland Rainforest, Fresh water swamp forest (monolete ferns and *Pteris* sp.), Open Vegetation, Sedge (Cyperaceae), Wide distribution, Exotic (*Chromolaena odorata*) and Fungal spores. Three pollen zones were delineated: Zone I (110-68 cm: 5 samples), Zone II (68-35 cm: 3 samples) and Zone III (35-0 cm: 4 samples). Data obtained showed high values of Amaranthaceae, Elaeis guineensis and fungal spores throughout the samples. Zone I (100-110 cm), from which a date of the last 60 years was obtained, marked a period of intense burning activity and a period of active life of the people. The high charcoal values are associated with a corresponding opening up of the vegetation (Amaranthaceae, *E. guineensis* and Poaceae) and emergence of secondary forest. *E. guineensis* plays an important role in the domestic economy of the people of Motako; palm oil is extracted and sold to buyers as a source of livelihoo:d, likewise palm wine. The oil is also used for making soap. It is common that native forest areas are devastated by fire creating conditions suitable for *E. guineensis* to thrive. The presence of a high percentage of charcoal in the lower part of Zone I and the subsequent increase of *E. guineensis* pollen indicates the occurrence of rudimentary burning techniques related to clearing land preparatory for plant cultivation but not necessarily the oil palm itself (Sowunmi, 1999). The reduction of charcoal percentages in the upper part in this zone, coupled with the increase of Amaranthaceae pollen type (plants that predominate in areas highly disturbed by human activities) confirms this hypothesis. Zone I records the pollen of *Borreria occymoides* and *Talinum triangulare*, plants used respectively, as medicinal herb and for ritualistic and food purposes in Nigeria (Verger, 1995). Also identified were

Alchornea cordifolia and *Oldenlandia corymbosa* with medicinal properties (Idu & Onvibe, 2007). The juice of the leaves of *Borreria occymoides* is applied for ring worm and eczema and the sap is squeezed on to the wound or lesion (Ebana *et al.,* 1991).

Zone II maintains the trend of prevalence of Amaranthaceae (Open Vegetation) associated with percentage reduction in *E. guineensis* in the diagram. Wetter conditions were observed, verified by the presence of pollen types of Cyperaceae family. The presence of *Podocarpus* pollen grains, whose dispersion is anemophilous and does not occur today in the region, indicates the existence of air transport to the archaeological site. Zone II is dominated by pollen of plants with ritualistic properties *Adenia cissampinoides*, *Allophylus africanus*, *Paullinia pinnata*, *Rauvolfia caffra* (Verger, 1995). In this zone is also observed the pollen of *Chromolaena odorata*, a species mainly used for the treatment of malaria (Idu & Onvibe, 2007). Being exotic, its occurrence suggests planting for medicinal use. Identified in zone III are pollen of *Alchornea cordifolia* and *Talinum triangulare* which also occurred in Zone I and *Alternanthera* sp., with medicinal properties (Idu & Onvibe, 2007). More so, *Luffa aegyptiaca* identified in this zone is primarily grown in Central Africa for its fiber production, to brush clothes, and also to treat water or palm wine (Achigan-Dako *et al.,* 2011). The predominance of Open Vegetation persists to Zone III, with an increase in the percentage of *E. guineensis* and decline of the Amaranthaceae pollen grains. The increase in the percentage of charcoal and fungi spores suggests new fire for land clearance.

Conclusions

The palynological study of the refuse mound at Motako revealed that from the early times of the site's occupation, humans contributed greatly to the opening of the vegetation and emergence of secondary forest in the area. This is evident from the relatively high percentage of pollen of *E. guineensis* from the earliest levels upwards dating to the last 60 years which reflects the exploitation of the oil palm and existence of methods of land use favourable for its spread (cf. Zeven, 1964). The presence of spheroids (90-100 cm) which may have been used in the breaking of the kernel shells to retrieve their nuts attest to this.

The exploitation of the vegetation of the area for various purposes by humans has also been indicated by the occurrence of 12 pollen types of plants which have medicinal, food and ritualistic properties out of the 28 pollen types identified in the study. Although only four (*E. guineensis, Talinum triangulare, Chromolaena odorata* and *Borreria occymoides*) of the twelve pollen types are currently in use by the people of Motako.

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Christopher A. Kiahtipes[1]

Combined culture-vegetation-climate dynamics in the African tropics: palaeoenvironmental assessment of late Iron Age vegetation change in the Ngotto Forest, Central African Republic

Abstract
One of the most serious limitations on our understanding of past human-environment interactions in tropical Central Africa is a lack of associated palaeoenvironmental and archaeological records. Riparian swamps immediately adjacent to archaeological sites occupied during the last millennium in the Central African Republic (CAR) yielded well preserved pollen and microscopic charcoal remains that document a range of human activities and their impacts on local vegetation. Because the core covers major cultural transitions from the Late Iron Age (LIA) through the post-colonial era, it sheds light on how intensive iron metallurgy, expanding trade networks, and, eventually, the collapse of local socioeconomic structures during French colonial rule shaped the modern composition and structure of Guineo-Congolian rain forests in CAR.

Key Words: *Palynology, Late Iron Age, palaeoecology*

Introduction

Modern ecological surveys and ethnographic research in tropical Central Africa indicate that human-modification of vegetation cover through manipulation of plant community succession, fire ecology, and nutrient cycling has produced extensive *anthropogenic* landscapes, yet there is little agreement among archaeologists, climatologists, and paleoecologists about how and when this pattern emerged. This issue remains unresolved, in part, because palaeoenvironmental and archaeological records are only rarely collected and analyzed together. Human impacts remain invisible in much of the palaeoenvironmental record because human modifications of the landscape take place outside of the sampled catchment (*i.e.* high-altitude lakes) or the catchment size is so large that local impacts are obscured by regional or global patterns (*i.e.* deep sea cores).

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Sedimentary sequences collected from riparian marsh sediments adjacent to dated archaeological remains in the Ngotto Forest Reserve, CAR, illustrate how different modes of production and landscape management impact vegetation cover. The Ngotto Forest is a roughly 12,000 km^2 block of Guineo-Congolian rain forest located in CAR along its shared border with the Republic of Congo. The region is of particular interest because while linguistic and genetic evidence have been used to speculate about the settlement history of the region, few systematic palaeoenvironmental and/or archaeological surveys have been executed in the region.

Materials and Methods

Paleoenvironmental samples, collected by coring riparian marshes, yielded organic-rich alluvium containing well-preserved pollen and microscopic charcoal fragments. A filled river channel less than 1 km from LIA quarry sites near the confluence of the Loamé and Lobaye rivers was cored to a depth of 2 m using a Russian peat corer and forty 1-cm long subsamples were collected at 5 cm intervals. AMS radiocarbon dating and assay of $^{210}Pb/^{137}Cs$ indicate that the channel fill accumulated starting in 1461-1640 AD and the upper 50 cm of the core was deposited after 1950 AD. Another core collected adjacent to the River Mbaéré reached two and a half meters below the surface and yielded forty-five 1-cm long samples collected at 5 cm intervals. AMS radiocarbon dates indicate that it accumulated starting at *ca*. 800 AD. Archaeological sites in the vicinity of the River Mbaéré are much more ephemeral, but radiocarbon dating of charcoal from ceramic and slag-bearing layers indicates human occupation of this part of the forest by 100 AD if not earlier.

Palynological samples were prepared according to standard methods with the addition of a heavy density separation using ethanol and a solution of zinc bromide and hydrochloric acid. Samples were then mounted on slides using glycerin, and both pollen and microscopic charcoal were identified using a microscope under 40x magnification. Identifications were made by comparison to images in the African Pollen Database and published pollen atlases for tropical Africa.

Results and Discussion

Pollen taxa from both cores represent major types of Guineo-Congolian rain forest including riparian forests, mixed rain forest, forest-woodland mosaics, secondary forests, and pioneer formations in addition to palms, herbs/grasses, and lianas. In the Loamé River core, forest taxa make up the majority of the pollen sum in the basal sample, but quickly decline in subsequent samples. Forest taxa do experience a moderate rebound in the uppermost samples from the core, largely driven by an increased representation of taxa from riparian forests, forest-woodland mosaics, and secondary forests. Pioneer forests are well-represented in all samples. Grasses and herbs make up relatively little of the pollen sum in the basal sample and quickly jump to more than 25% of the pollen sum as forest taxa decline. These events are roughly contemporaneous with radiocarbon dates from slag heaps and an iron ore quarry site located less than 5 km from the coring location. Charcoal concentrations vary widely in the basal samples, moving from a low influx to a high influx after which there is a steady decline in charcoal influx until it spikes along with pollen concentrations in the uppermost samples. The charcoal to pollen ratio indicates that charcoal fluctuations in the lower group of samples may reflect fire-related disturbances followed by an overall reduction in charcoal influx and muting of sample variability in the upper samples.

A similar pattern is visible in the River Mbaéré core, which shows regular fluctuations between light-demanding vegetation formations and closed forests from 800 to 1500 AD, after which there is a rather steep decline in the representation of forest taxa. Microscopic charcoal concentrations from these samples follow a similar pattern of fluctuating abundances between high-low concentrations followed by a general decline in the post-AD 1500 samples. While this core is located further from other archaeological sites than the River Loamé core, there appears to be some clear linkages with the general chronology of human activities in the Ngotto Forest.

Conclusions

These data show regular disturbances of forest cover starting in 800 AD followed by a shift to open savannah-woodland formations associated with a general reduction in microscopic charcoal influx after *ca*. 1700 AD. Ostensibly, the reduction in charcoal concentrations in these cores seems at odds with intensification of prehistoric iron production, but smelting activities produce a sink for forest biomass. By completely volatilizing and removing it from the catchment, smelts leave less biomass available for both natural and anthropogenic landscape fires to consume. Sustained forest disturbance through the end of the 19^{th} century followed by forest rebound during the late 20^{th} century argues for a radical disturbance of local economies and patterns of vegetation management under colonial French rule. These observations make a strong case for the merits of palynological assay of catchments associated with archaeological remains and offer additional insights into the ecological outcomes of *in situ* culture change and Colonial-era disruptions of socioeconomic organization in Central Africa.

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Cereal farming and early urbanism in northern Benin: archaeobotanical results from twelve sites

Abstract
Much of West African remains are terra incognita in terms of archaeobotany, despite that fact that modern botanical evidence indicates several crops were domesticated there, including pearl millet in the dry north, African rice in the riverine wetlands, and cowpea on the forest margins. The present research looks at flotation samples of several sites in northern Benin being investigated as part of Anne Haour's ERC-funded Crossroad of Empire project, investigating the early urban centre of Birni Lafiya and other broadly contemporary sites.

Key words: *Crossroad of Empire ERC project, northern Benin, African rice, pearl millet, Birni Lafiya*

Introduction

Flotation success has provided plant macro-remains from twelve sites dating from the mid-1st millennium AD to the early 2nd millennium AD. This provides evidence for the diverse agricultural base that supported urbanisation around the forest the savannah transition zone in West Africa. The most widespread crop on sites across the whole region and period is pearl millet (*Pennisetum glaucum*), the likely staple cereal of West Africa since the Neolithic.

Materials and Methods

The current research presents the result of 60 archaeobotanical samples comprising 1200 litres of sediment. All the samples were processed by bucket flotation.

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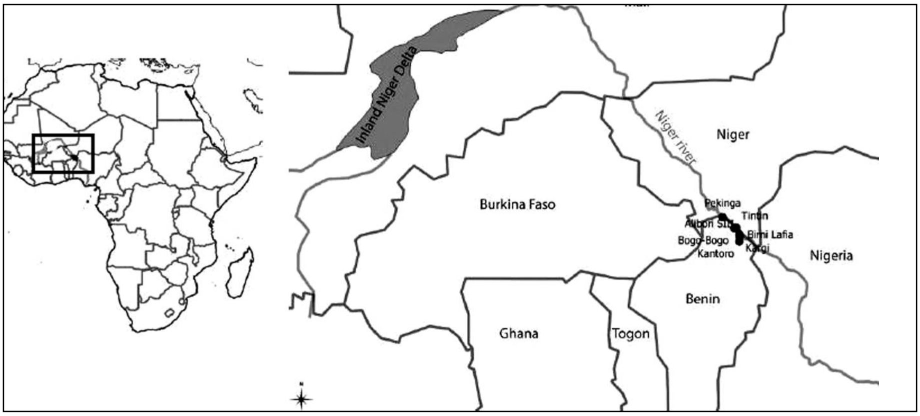

Fig. 1 – *Research area; location of the archaeological sites (© Champion Louis)*

Results and Discussion

Preliminary results provide evidence for a diverse agricultural base that supported urbanisation around the Sahel/Savannah transition zone in West Africa. The most widespread crop on the sites across the whole region, and over the periods covered, is pearl millet, the likely staple cereal of West Africa since the first domestication of cereals.

However, in Birni Lafia (Benin) and other later sites (dating to the 2nd millennium AD), rice is more dominant and sorghum is also present. This suggests that urbanisation in this region may have been based on diversified agriculture including highly productive African rice. Some sites also show evidence of consumption of baobab (*Adansonia digitata*), oil palm (*Elaeis guineensis*) and use of cotton (*Gossypium* sp.), suggesting that production of condiments and raw materials for crafts also contributed to the agriculture of urbanisation in West Africa, as in other parts of the world.

The first archaeological evidence of African rice is from the Inland Niger Delta in Jenné-Jeno, Dia and Sorotomo in Mali and are dated on the 1st millennium AD (Murray, 2004). Three sites in this research provide evidence of African rice around the same dates. Looking at all the plant remains assemblages from these research sites, African rice, with pearl millet, had an important place in the food system of the area.

During the second part of the 2nd millennium AD a shift appears in the composition of charred plant assemblages. These cereals, pearl millet, sorghum and African rice, are scarce and sometimes absent from archaeological contexts. On the other hand the oil palm and the baobab tree seem to make up the main part of plant remains. The reason for this shift is currently unknown, but several hypotheses such as climate change or labour depletion due to intensification of the slave trade, can be suggested.

In contrast, evidence for the presence of cowpea (*Vigna unguiculata*), one of the major pulse crops in West Africa, probably domesticated in the grassy woodlands of Ghana (D'Andrea *et al*., 2007), seems paradoxically weak.

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Claire Malleson[1]

The role of crop-weeds in ancient Egyptian agriculture: a study of 3rd century BC remains from Giza

Abstract
The exceptional preservation of an assemblage of charred plant macro-fossils from excavations in "Khentkawes town" (2472-2150 BC) on the Giza plateau (Egypt) has provided the potential to shed light on several aspects of agriculture and cereal crop-processing methods conducted in this town. The results of these analyses have much broader implications, specifically in relation to our understanding of arable agriculture in ancient Egypt.

Key words: *Egypt, Old Kingdom, cereal crop-processing, agriculture*

Introduction

Excavations by Ancient Egypt Research Associates in 2009 at the Khentkawes settlement dating to the 5th-6th Old Kingdom dynasties (2472 – 2150 BC) (for site report see Lehner *et al.*, 2011) yielded charred plant macro-fossils that were instantly recognized as being exceptional in many ways. This paper presents preliminary results of a study which took place over six months in 2013.

Materials and Methods

Samples were collected and processed via machine flotation during 2009 excavation season in "Khentkawes town". Following an assessment in 2010, a full study of the charred plant macrofossils was conducted in 2013. All items were sorted and identified using a standard Nikon Binocular Microscope 7-10x magnification. Statistical analyses were run using Microsoft Access and Excel applications.

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Results and Discussion

Ancient Egypt Research Associates excavations have generally focused on the major Old Kingdom 'workers' town of Heit el-Ghurob (see Fig. 1 for site map). The charred plant macrofossil assemblage at that site is generally sparse, making it difficult to draw any meaningful conclusions. The discovery of such well-preserved remains in the new excavation areas within the Khentkawes town area has enabled us to change that picture considerably. The preservation level of the archaeo-botanical assemblage from the town was exceptional; charred plant remains were extraordinarily abundant, and the condition of the specimens was remarkable – even the most delicate plant elements were still intact.

As a result, it has been possible to identify many items to a higher taxonomic level than is usually possible with charred plant remains. For example, many specimens had preserved pods and calyx as well as chaff elements which are not usually present. This has enabled a higher level of identification for several commonly found items – Trifolieae tribe / *Trifolium* sp. and *Medicago* sp., as well as *Phalaris* sp. An additional result of this level of preservation is that the range of taxa present in samples was considerably greater than usually expected. It has been possible to make a number of observations and put forward several hypotheses which have previously been impossible to approach in our settlement excavations at Giza.

Conclusions

The most significant outcome of this project is that whilst it has long been recognized that the by-products of cereal cleaning were a valuable commodity (Van der Veen, 1999), the results of this specific study have led me to reach a hypothesis that the "weeds" may have been considered an integral part of the crops, and that the value of the by-products was great enough to justify the crop yield losses, and increased labour costs.

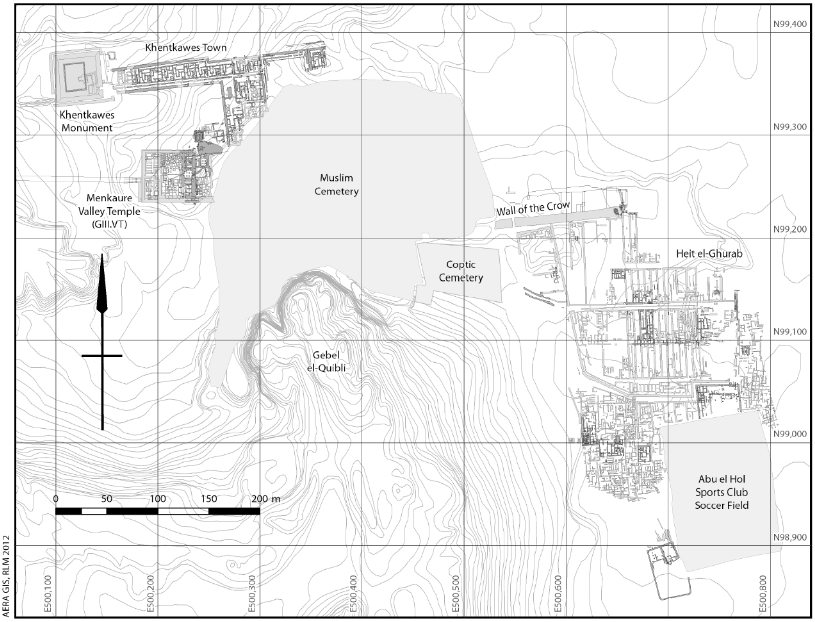

Fig. 1 – *Giza plateau SE of the pyramids – Khentkawes town and Heit el-Ghurob. Map by Rebekkah Miracle, Ancient Egypt Research Associates GIS manager*

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SESSION 6

POSTER SESSION

Supplemento
Atti Soc. Nat. Mat. Modena
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Welmoed Out[1], Philippa Ryan[2], Juan José García-Granero[3], Marco Madella[4], Judit Barastegui[5], Lara Maritan[6], Donatella Usai[7]

Plant exploitation in Neolithic Sudan

Abstract
Analyses of phytoliths from pillow-like grave deposits and phytoliths and starch from dental calculus from human skeletons from the Early and Middle Neolithic Sudanese cemeteries of Ghaba and R12 provide evidence of exploitation of wild and domesticated grasses. The evidence of wheat and barley from R12 indicates that these domesticated taxa were introduced into Africa earlier than known until now. The pillow-like grave deposits provide information about the role of plants in the burial ceremony.

Key words: *Neolithic, Sudan, wheat, barley, millets, phytoliths, starch grains*

Introduction

Little is known about the introduction of domesticated crops in Sudan. Apart from barley recovered from a grave at Kadruka 1 (ca. 4500-4000 cal BC) and the storage finds of grains of emmer wheat and barley from the Pre-Kerma site of Sai Island (2900-2600 cal BC) (Garcea & Hildebrand, 2009; Reinold, 2006), there is not much evidence of the Near Eastern domestic cereals *Triticum* spp. L. (wheat) and *Hordeum vulgare* L. (barley) until the Kerma period (2500-1500 cal BC). Early domestication of wild grasses has been pro-

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posed (Håland, 1999; Magid, 1989), but more recent results have led to the development of new hypotheses (Fuller, in press).

New evidence on the exploitation of wild and domesticated grasses comes from the Early Neolithic cemetery of Ghaba (4750-4350 and 4000-3650 cal BC) and the Middle Neolithic cemetery of R12 (5000-4000 cal BC) (Salvatori & Usai, 2008; Salvatori *et al.*, in press). Although the excavations did not provide any macrobotanical remains, both cemeteries yielded grave goods consisting of white powdery deposits. This material was recognised as phytoliths, *i.e.* plant material consisting of hydrated opal silica ($SiO_2 \cdot nH_2O$).

In order to obtain not only evidence about grave goods but also about plant consumption, dental calculus from buried humans was subjected to phytolith and starch analysis. Questions concern the composition of the grave goods (which plants were exploited?), the indications for plant consumption, and the implications for the understanding of the introduction of crop plants in the Nile valley.

Materials and Methods

An overview of the archaeobotanical record from mid-Holocene Sudanese sites was compiled based on literature study. Three grave deposits, one from R12 and two from Ghaba, were subjected to phytolith analysis and directly dated by ^{14}C dating. A.M. Mercuri excluded the possibility of pollen analysis for all three samples. Samples of dental calculus were obtained from 2 skeletons from R12 and 18 skeletons from Ghaba by J. Irish and D. Antoine following a standard protocol (Crowther, 2009). The samples were treated with sodium hexametaphosphate and with 5% hydrochloric acid (HCl) to dissolve the calculus fragments and release plant microfossils. Powder-free gloves were worn during all phases of the process.

Results and Discussion

An overview of the evidence of plants exploited at mid-Holocene Sudanese sites shows the evidence of plant exploitation collected over the years and in addition sheds light on the factors that shape the currently available archaeobotanical record.

The grave deposit from R12 consisted primarily of silica skeletons of chaff remains of C3 grasses. Morphological analysis allowed for the identification of *Hordeum* sp. and *Triticum* sp. The fact that wild relatives of these taxa did not occur in the relevant period and region indicates that this material represents domesticated wheat and barley. The sample was directly dated to c. 5300-5000 cal BC.

The two deposits from Ghaba were dominated by silica skeletons of chaff remains of wild C_4 grasses, which included primarily *Echinochloa* sp. and *Brachiaria* sp. and additionally small quantities of *Panicum*/*Setaria*, *Digitaria* sp., *Sorghum* sp. and *Hordeum/Triticum*. In contrast to the finds of R12, this material shows characteristics that point to plant processing.

The dental calculus revealed damaged and undamaged starch grains and some rare phytoliths of a variety of taxa, confirming the availability and exploitation of both C_3 and C_4 grasses and pointing to the exploitation of some further taxa.

Conclusions

The presence of *Hordeum* sp. and *Triticum* sp. in Sudan around 5000 cal BC (youngest range of the ^{14}C date and oldest known date of the site) indicates that domesticated cereals were introduced in Africa 500 years earlier than known until now (Fayum, 4650-4350 cal BC; Wendrich *et al*., 2010). Combined with the later evidence of wheat and barley from this region, this implies that Near Eastern crop cultivation had presumably been introduced in Upper Nubia already before the pre-Kerma period.

The finds of plant material as grave gifts in Neolithic cemeteries in Sudan suggests that plants played a role in the burial ritual and in the society, a hypothesis that is confirmed by other publications mentioning additional, often undefined finds of white material in other prehistoric graves in Sudan. Moreover, evidence from dental calculus suggests that grasses not only had a symbolic role but also formed part of the subsistence. The mid-Holocene Sudanese societies could thus best be described not as pastoral but instead as agro-pastoral societies.

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Supplemento
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Justin Bradfield[1], Lyn Wadley[2], Marlize Lombard[1], Vinesh Maharaj[3], Dwayne Coote[3], Madelien Wooding[3]

Chemical weapons of the San Bushmen: identifying plant-based toxins on arrows from southern Africa

Abstract
Biochemical analyses of residues preserved on ethno-historical and archaeological artefacts increase our understanding of past indigenous knowledge systems. The interpretation of biochemical traces is, however, difficult. Problems that can hamper credible interpretations of ethno-historical or archaeological residues include incomplete knowledge about local natural products, limited published data about product applications, and over-estimation of the abilities of the analytical techniques to make specific identifications. This poster outlines our approach to identifying plant-based poisons on ethnographic and archaeological arrows from southern Africa. Some preliminary results are presented.

Key words: *Bushmen arrows, plant-based poison, southern Africa*

Introduction

The aim of this study is to find out what plant poisons were used to tip hunter-gatherer arrows among Southern San of the Drakensberg. Margaret Shaw's seminal paper (Shaw *et al.*, 1963) on San poisons focused only on those specimens in the Iziko Museums attributable to /Xam and Ju/wasi groups from the Cape and Namibia. Indeed, what information exists on San poisons is confined to the western half of Southern Africa, where 18th and 19th century travelogues record eye-witness observations of the poison ingredients. Little to no literature exists on those groups that lived in the eastern half of the sub-continent. Furthermore, the methods Shaw and colleagues (1963) used are now 50 years old. New and better techniques now exist that allow for more accurate analysis using far less material.

The recent discovery of ricin at Border Cave in KwaZulu-Natal (d'Errico *et al.*, 2012), dating to the early Later Stone Age, means that there is a need to examine the range of poison ingredients used by hunter-gatherers in the eastern

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half of the country. We expect that different groups, in different ecological settings, would have used different plant ingredients from the limited range recorded in the literature of the 18th to 20th century Ju/wasi and /Xam. Different poison recipes present on the arrows may indicate that different arrows and poisons were used by different groups and/or to hunt different animals.

Materials and Methods

The poison samples were extracted with an appropriate volume of a mixture of organic solvents (typically dichloromethane: methanol, 1:1). Similarly, blank extractions following the same procedure were prepared to evaluate and subtract the background chemical noise. Specimen extracts are filtered/ centrifuged to remove any particulate matter. The extracts are then dried down under reduced pressure using a rotary evaporator below 40 °C. Thereafter, the extraction yield attained is gravimetrically determined. Dried extracts are reconstituted (re-extracted) in acetonitrile, H_2O (0.1% formic acid), pooled and centrifuged at 10,000 g for 10 min to remove particulates. A Waters UPLC hyphenated with a Waters Synapt G2 QTOF instrument centrally operated and controlled with Masslynx software is used to acquire the LC-MS data. Throughout all runs, leucine encephalin (as the internal control) is directly infused into the source through a secondary orthogonal ESI probe allowing intermittent sampling. Through use of this internal control, instrumental drift will be compensated for ensuring good mass accuracy throughout the duration of the runs. UPLC-MS chromatograms (fingerprints) are visually observed and overlayed (with various other fingerprints of plant extracts) to identify any obvious constituents in common. Raw (background subtracted) data is then analyzed using Markerylynx and Chromalynx software. The ion features (retention time-accurate mass pairs) are identified from the data matrix and compared for similarities and differences. Compounds of interest can potentially be chemically identified through accurate mass measurement and elemental composition assignment in conjunction with an in-house literature extracted arrow poison library and electronic database searches (Dictionary of Natural Products and ChemSpider). Identification of features common to a particular specimen extract and to a specific plant extract will strongly support the use of the plant material as a poison on the specimen.

Results and Discussion

The data presented in this poster are at a preliminary and exploratory stage. As yet no archaeological samples have been analyzed, although tests have been done on a 100-year-old museum specimen. Our method has so far proved efficacious in identifying unknown plant substances found on arrows. On very old samples, especially those that have been excavated from archaeological contexts, organic residues and compounds are not expected to be preserved in pristine condition. This may make the recognition of known toxins challenging as one must first reconstruct the parent compound based on the oxidative by-products. Fingerprinting fresh samples of known plant poisons can help in the identification of plant source.

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Alice Fietta[1,2], David Caramelli[2], Angela Schlumbaum[3], Cristiano Vernesi[1]

EvolvApple. Studying apple domestication through the genome scan of ancient seeds

Abstract
During the last decades genetic analyses applied to archaeobotany have had wide development and several applications. Analyses of ancient plant DNA became a useful tool for investigating relevant issues such as species identification, origin and spread of cultivated plants, state of domestication. The aim of this project is to shed light on the domestication history of the apple, discovering the details of its origin, worldwide spread and diversification. We are particularly interested in apple's divergence from wild and native populations in response to artificial selection by humans.

Key words: *Ancient DNA, crop domestication, plant remains*

Introduction

The domesticated apple, *Malus domestica*, is the most common and culturally relevant fruit crop of temperate areas and the elucidation of its origin, its following worldwide spread and diversification history is therefore of great interest (Juniper & Mabberley, 2006). Recently, genetic analyses shed new insight into the domesticated history of apple, particularly concerning the contribution of the current wild apple gene-pools into modern apple germplasm (Coart *et al*., 2006; Cornille *et al*., 2012, 2014; Schlumbaum *et al*., 2008). However, little is kown about the timing of this wild-to-crop gene flow and the contribution of the different wild apple species. The retrieval of DNA preserved in archaeological remains could be a valuable tool to understand the evolutionary divergence among apple species and to disentangle the complex history of *Malus domestica*.

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Materials and Methods

The collection of ancient seeds is the most challenging part of this project and implies a careful and detailed search of ancient material, available in the main Natural Science Museums, archaeobotanical collections and *herbaria* all over the world. Insofar we collected seeds from Austria, Switzerland, England, Netherland and Estonia (ranging from Neolithic until the Middle Ages) and we are still looking for other samples, especially from Central Asia. In brief, next steps will be: external cleaning if possible, powdering, DNA extraction, amplification (by PCR) and/or sequence capture approach of chosen target region within the plant's genome(s), putatively involved in domestication.

Results and Discussion

Our work is now focused on the genetic characterization of ancient material, trying to discern between wild and domestic species. We will set up a sequence capture procedure in order to detect the signature of the selection processes occurring during domestication.

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Supplemento
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Mohamed A. Ibrahim[1], **Nesrin M.N. El Hadidi**[2], **Rim S. Hamdy**[3]

Identification and decay assessment of a wig box at the Egyptian Museum in Cairo

Abstract
Investigations of a wig box (CG.4069) made of plant materials dating back to the New Kingdom, found in the cache of royal mummies TT320, that had been discovered in Deir El Bahari (1881) by Maspero, proved that the inner frame of the box was not made of reeds; the four corner posts were made of tree branches, while the frame was made of palm fronds stiffened by cross-rail and sloping ties. The outside panels were made of papyrus mats.

Key words: *Wig box, papyrus mats, palm fronds*

Introduction

Ancient Egyptians relied on furniture items made from reeds and papyrus. The inner frame of the boxes was usually constructed of thick reeds, while the outside panels were made of papyrus mats.

Materials and Methods

The box is fragile due to its poor condition (Fig. 1), and handling is considered to be a potential risk. The papyrus layer is very weak and the strips fall easily apart due to loss of structure cohesion. The frame of the box is broken in several parts, and one of the sides of the papyrus layer is partially missing, which may be a reason of the instability of the box structure. There is significant biological damage, which appears in the form of small holes, in addition to previous restoration using metal nails, which have rusted over the years, to join the papyrus layers in the inner frame of the box.

Due to the fragility of the wig box, the plant fragments that had been detached were studied for identification and decay assessment purposes (Fig. 2). Samples were studied under different microscopes. Additionally the wig box was studied using CAT Scan and documented with autocad (Figs. 3 and 4).

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Results and Discussion

Two halfa grasses, *Desmostachya bipinnata* and *Imperata cylindrica*, as well as three reeds *Phragmites australis*, *Arundo donax* and *Saccharum spontaneum*, and palm frond were widely used in ancient Egypt for making baskets, boxes and other objects. The wig box studied here was made of papyrus mats, *Cyperus papyrus*, palm fronds and wooden twigs from an angiosperm wood.

Fig. 1 – *The wig box CG.4069*

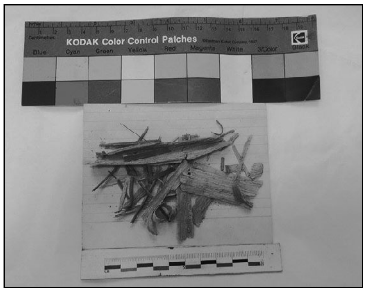

Fig. 2 – *Detached papyrus fragments*

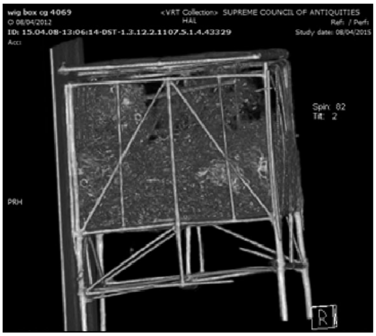

Fig. 3 - *CAT Scan of wig box*

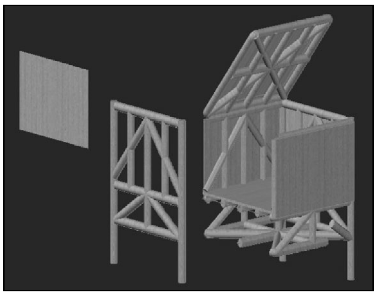

Fig. 4 - *Autocad drawing of wig box*

Conclusions

Reed furniture and different sized boxes dating back to the ancient Egyptian Dynasties had not been given a lot of attention in the past. These objects were rarely considered of much importance and only a few of the objects are exhibited in museums. Further investigations need to be carried out to document the plant materials used for making these extremely fragile objects before they disintegrate.

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Hayley McParland[1], Sarah Walshaw[2]

Swahili plant use and activity areas at Songo Mnara, Tanzania: a case study at macro and micro scales

Abstract
The UNESCO World Heritage site of Songo Mnara is a famously well-preserved example of Swahili stone architecture. The recent excavation of stone structures with intact lime plaster floor surfaces, and daub structures with intact interior packed earth floor surfaces, has permitted a unique insight into the life ways of the Swahili inhabitants or visitors undertaking day to day activities within these structures. Occupied for only a century, this site offers an unparalleled opportunity to examine spatial relationships between stone houses and wattle and daub structures from the 14th-15th centuries AD. This paper considers the role of plants within these spaces, through comparison with a Swahili stone house with a wattle and daub structure. The application of integrated phytolith and macrobotanical analyses from floor surfaces and discrete features provided an opportunity to consider plant use and distribution of plant remains, at the macro and micro levels. This paper considers the archaeobotanical signatures of contemporary structures, assessing the relative contributions of each method for the elucidation of spatial variation through archaeobotanical proxies.

Key words: *Swahili Coast, phytoliths, macrobotanical remains, spatial analysis, households*

Introduction

Archaeobotanical research at Songo Mnara is part of a larger project, based at the University of York and Rice University, which applies an innovative multi-layer approach to permit a high resolution interpretation of interior and exterior space (Fleisher & Sulas, 2015; Wynne-Jones, 2013). Phytolith analysis of open spaces within the settlement has provided an insight into activities undertaken outside (Fleisher & Sulas, 2015; Sulas & Madella, 2012). The present study identifies activity areas and explores the use of plant materials within the confines of wattle and daub and stone structures through high resolution systematic sampling for phytoliths and targeted sampling for charred plant remains.

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Materials and Methods

Systematic spot samples were taken for phytolith extraction, on a 1m grid across floor surfaces within wattle and daub and stone structures, enabling an assessment of spatial variation within structures and outside structures. Phytolith extraction was undertaken following a modified version of the protocol developed by Madella *et al*. (1998). Macrobotanical samples were retrieved through bucket flotation using fresh and recycled water. Light fractions were caught in a 0.5 mm mesh, and water was recycled through a 0.3 mm mesh.

Results and Discussion

The combined application of phytolith and macrobotanical analyses has enabled both a micro and a macro view of plant use and activity areas within the structures. In Trench 32, phytolith analysis revealed a homogenous background signature of herbaceous material across the floor surface. Applied to an ephemeral structure, lacking interior architecture, phytolith analysis proved effective for the identification of interior and exterior spaces. Activity areas were identified through concentrations of diagnostic charred plant remains and phytoliths. The presence of crop plants (Sorghum, Rice), identified through phytolith morphotypes and charred plant remains, attested to an area of food preparation or consumption. Phytolith analysis provided evidence for craft activities in the form of a concentration of Cyperaceae through to represent basketry or matting, further demonstrating the complementary nature of these proxies.

Macrobotanical remains from three contexts in House 18 revealed that residents were cooking with African grains (Sorghum, Pearl Millet) almost as frequently as they prepared Rice (evidenced by grains and chaff), and enjoyed Legumes (*Vigna* sp., *Vicia* sp.) as well as Baobab. Phytolith analysis within House 18 focused on floor surfaces within six rooms, providing an overall picture of the focus of plant use within the structure. One of these rooms was remodelled during the lifetime of the structure, providing an insight into the change in activity areas over time.

Conclusions

The combined application of phytolith analysis and macrobotanical analysis revealed evidence of plant use within these structures, at a micro scale and a macro scale, providing complementary datasets to inform an in-depth interpretation of plant use within domestic structures. In addition, systematic sampling of floor deposits proved particularly effective within the more ephemeral wattle and daub structure, enabling the identification of plant-based activity areas within these structures. The analysis of charred plant remains provided direct evidence for the processing of plant based foods, whereas phytolith analysis enabled the identification of otherwise invisible evidence for craft practices.

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Samira Amrani[1]

The Holocene vegetation of Tin Hanakaten cave (Tassili n'Ajjer, Algerian central Sahara)

Abstract
The contribution of archaeobotany study reveals some very interesting results and offers the possibility of a broader view on the vegetation cover and vegetation dynamic reconstruction of Tin Hanakaten cave.

Key words: *Neolithic, botanical remains, palynology, anthracology, vegetation cover, environment*

Introduction

During the excavations (1974, 1975, 1976, 1978, 1980 and 1981) of the Tin Hanakaten Cave (south-eastern Algeria, Fig. 1), several botanical remains were uncovered from the archaeological Holocene deposit (Fig. 2). In this poster, we exhibit the charcoals, seeds, wood, twigs, spores and pollen (Fig. 3) and provide an overview of the vegetation of Tin Hanakaten area from the archaeobotanical study (palynology and anthracology).

Materials and Methods

A total of 47 sediment samples were treated for pollen analysis. Considerable amounts of heaps of charcoal were taken from various squares, depths and sequences from the archaeological deposit.

For the recovery of spores and pollen sediment samples the method of extraction by zinc chloride (Court, 1974) was used. The mounting of blade thickness and, therefore, taxonomic identification was performed using Zeiss optical microscope observation (magnification: x160, and x1000 with immersion oil). In the absence of a reference collection for the Central Sahara, pollen was identified using reference literature (*e.g.* Reille, 1995).

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The identification of charcoal was made by using a reflected light microscope with bright and dark field (BF/DF). It was also based on some of the criteria observed in three sections obtained by breaking in the hand and / or scalpel under binoculars. Identification was made after microscopic observation criteria and identification keys compared different anatomy textbooks, digital programs (example Inside Wood), wood collections and charcoal wood and anatomical atlases (principally Neumann *et al*., 2001).

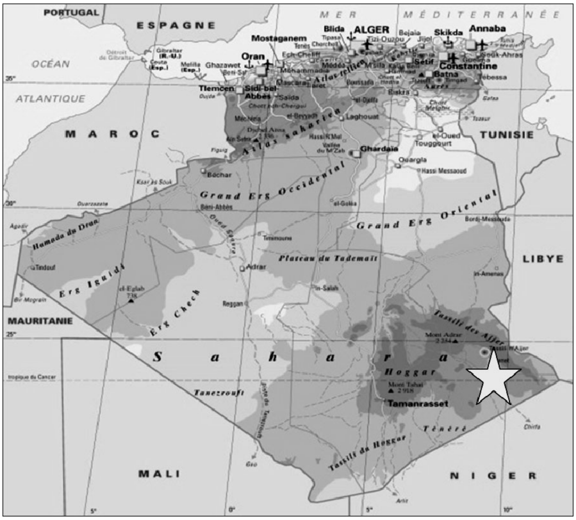

Fig. 1 – *Tin Hanakaten location map (star)*

Results and Discussion

The sum of 13,417 plant microorganisms was counted and analyzed and 5601 fragments of charcoal were studied. We infer the vegetation component of the Tin Hanakaten sequences (10, 8, 6, 4, 3 and 2) as varied and distinct. The conifers (pine, juniper and cypress) and hardwoods (oak, olive trees, acacias) are represented. Tamarix, olives and acacias are the important representatives of Tin Hanakaten vegetation. In addition, other various species mark an alternative presence with other essences marking a single appearance in only one of the sequences. Furthermore, determination reveals very rich herbaceous flora. Concerning the components of the cortege cover, we must remember that the modification of the floristic composition has sometimes undergone slight, and sometimes accentuated changes. It should be noted that the flora seems to be at its optimum growth in sequence 6 because it is rich, consisting of a large variety of species. From the perception of plant associations, we observed important dynamics: for example, Tamaricaceae are present in varied combinations along the deposit. The combination of Tamaricaceae with acacias is unstable; the presence of Tamaricaceae dominates the acacias in sequences 10 and 8. However, we find changes of dominance-presence, as the presence of acacias characterizes sequences 6, 4 and 3 and finally, we note the significant presence of Tamaricaceae compared to the presence of acacias in sequence 2.

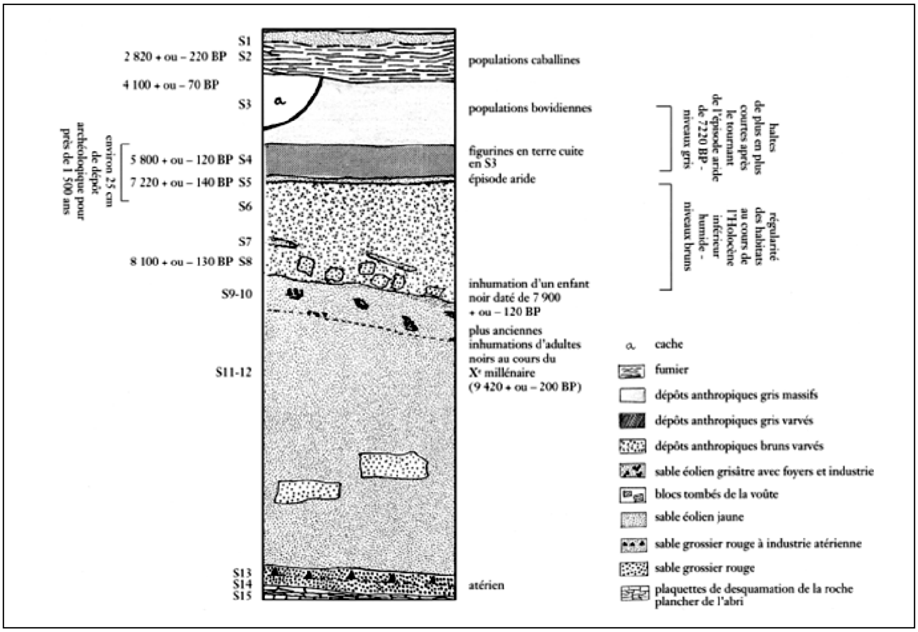

Fig. 2 – *Tin Hanakaten archaeological deposits (Aumassip, 1984)*

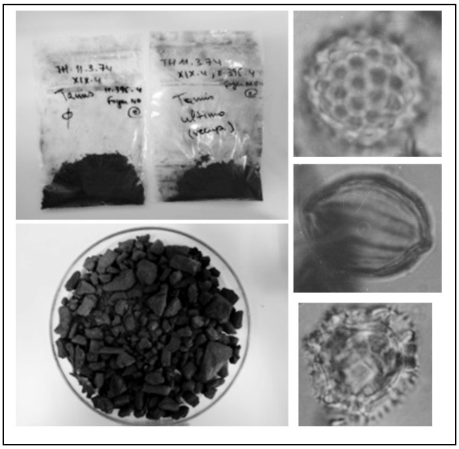

Fig. 3 – *Examples of Tin Hanakaten botanical remains (left: charcoals for identification; right: pollen, from the top:* Ambrosia, Ephedra*, Cichorieae)*

Conclusions

The component of the vegetation cover of the Tin Hanakaten cave area consists of plant mosaic and changing dynamics in the canopy. The identified species attest varied environments, consequently, vegetation strata moving across multiple territories. In addition the presence of Mediterranean vegetation at 1000 m a.s.l. (highest point in Tin Hanakaten region) is hypothesized, though this has now disappeared, and the transport of timber of some Mediterranean species from relict regions of the high mountains of Tassili n'Ajjer is suggested.

Finally, the anthracological taxonomic list certifies the exploration and exploitation of different plant environments by the occupants of Tin Hanakaten cave "gatherers, collectors and shepherds" and their relation to several activities (special planning, combustion etc.).

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Supplemento
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Integrated analyses of ancient wild cereals from Takarkori rock shelter (SW Libya)

Abstract
Both pollen and macroremains recovered from archaeological sites point to a long-time exploitation of wild cereals in SW Libya. Spikelets, florets and grains of Panicoideae are the most abundant plant remains found in the archaeological site of Takarkori (Tadrart Acacus Mts.), and were analysed by means of morphological and molecular (ancient DNA) approaches. By means of DNA barcoding, we aimed to elucidate detailed taxonomic identification, phylogenetic relationships of grasses with modern species and interactions between human groups and changing environments during the Holocene.

Key words: *aDNA, barcoding, archaeobotany, wild cereals, Takarkori rock shelter*

Introduction

The archaeological excavation of the Takarkori rock shelter in the Tadrart Acacus Mts., SW Libya, has been carried out by the mission of Sapienza University of Rome from 2003 to 2006. The excavations, directed by one of us (SDL), exposed a surface of *ca*. 140 m^2 in extent. Chronology ranged from *ca*. 10,200 to *ca*. 4,600 cal yr BP (Biagetti & di Lernia, 2013). The study of this site involves different research areas such as Archaeology, Geology, Archaeobotany, Molecular Biology and other archaeometric investigations (Dunne *et al*., 2012; Cremaschi *et al*., 2014; Olmi *et al*., 2011). This research focuses on the analysis of dried seeds/fruits belonging to the Poaceae family, whose members are key elements for investigating major aspects of landscape and food basis transformations. This project deals with the morphological and molecular analysis of *Panicum* and *Sorghum* spp. spikelets.

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Materials and Methods

Morphobiometric features of spikelets of *Panicum* and *Sorghum* spp. were studied by stereomicroscopy coupled with digital image analyses (ImageJ) at the Laboratory of Palynology and Palaeobotany of Modena University. The presence/absence of wild cereals (in particular of *Sorghum*) was recorded in samples chosen from different chronological contexts. aDNA extraction from spikelets was carried out by means of a method developed in the Plant Physiology Laboratory of Reggio Emilia (Italy). DNA barcoding was carried out using portions of the plastid regions rbcL, matK, trnH-psbA and trnL, as indicated by the Consortium for the Barcoding of Life (CBOL) Plant Working Group (Hollingsworth *et al*., 2011). We designed *ad hoc* primer sets for carrying out DNA barcoding analysis on the ancient spikelets. Bioinformatic analysis of the results is in progress, and will allow a better taxonomic identification of African wild cereals remains (Fornaciari *et al*., in preparation).

Results and Discussion

The records showed homogeneous typology and uniform size of records in each genus (Olmi *et al*., 2011). *Panicum* measures on 50 spikelets are: 1.26 ± 0.06 mm x 2.03 ± 0.06 mm; *Sorghum* measures on 50 spikelets are: 2.46 ± 0.14 mm x 6.43 ± 0.43 mm. The different distribution of those cereals is related to adaptive strategies and to the wild plants grown in the area, with different distribution during the early and middle Holocene climatic phases. Because of the ancient age of the samples, the significant difficulties involved in seed aDNA extraction and the lack of dedicated protocols of aDNA extraction and amplification, we developed an optimised method for DNA recovery from ancient dried spikelets (Fornaciari *et al*., in preparation).

Conclusions

First results demonstrate the presence of aDNA in the plant macroremains, and the effectiveness of our DNA extraction and amplification methods. Analysis of the barcode regions will confirm the taxonomic classification derived from morphological interpretation, and will unravel the phylogenetic relationships between archaeobotanical records and modern species. The study of the spatial distribution of *Sorghum* will allow better understanding of its exploitation by human groups that lived in the area during the Holocene.

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Supplemento
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When Archaeobotany meets Geoarchaeology: investigating fuel procurement in a historical Saharan oasis

Abstract
A combined archaeobotanical and geoarchaeological approach was applied to the study of the Garamantian archaeological features related to firing activities from the compound of Fewet (3^rd^ century BC – 1^st^ century AD) in central Sahara (Libya). The micromorphological investigation highlighted an exceptional concentration of gypsic pedofeatures in archaeological layers, in correspondence with high concentration of charcoal remains attributed to Tamarix. *We propose that tamarisk wood was the most exploited tree for fuel in the oasis of Fewet in Garamantian times; its combustion led to the dispersion of gypsum from the vegetal tissue and recrystallization in the archaeological layers.*

Key words: *Late Holocene Saharan oasis, domestic fireplaces, fuel,* Tamarix

Introduction

Fuel for domestic fireplaces is a strategic resource for traditional cultures and the identification of sources of wood or other kinds of fuels in archaeological and ethnographic contexts is essential to reconstruct the domestic economy of ancient sites (*e.g.*, Asouti, 2003). This is especially true in arid regions, where the paucity of natural resources implies responsible exploitation of resources, today as much as in the past.

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Fig. 1 – *(A) Location of the Garamantian village of Fewet (Libya); (B) overview of the compound*

In this paper a combined archaeobotanical and geoarchaeological approach is presented in order to decipher the formation of the archaeological record and to understand the use of fuel for domestic fireplaces in the oasis of Fewet (central Sahara) in Garamantian times (3rd century BC – 1st century AD; Mori, 2013).

Materials and Methods

Sample of sediments were collected from archaeological layers related to fire activities. Charcoal fragments were separated and identification was made following Neumann *et al.* (2001), on sections along fresh hand-made fractures of the records, almost always observing the transversal section. Thin sections of sediments were also prepared for micromorphological analyses.

Results and Discussion

Charcoal was frequent, abundant, and mostly well preserved in the samples. The floristic list consists of four taxa; *Tamarix* sp. is dominant (67% of identified records), followed by *Acacia* sp., *Nerium oleander* L., *Phoenix dactylifera* L. Further in-depth, our records were attributed to *T. aphylla* (L.) Karst. and *T. tetragyna* Ehrenb. The analysis of thin sections of archaeological deposits confirmed that layers were related to fire activity and highlighted an exceptional concentration of gypsum features (crystals and nodules) within sediments.

The high concentration of gypsic pedofeatures at Fewet is related to the high occurrence of *Tamarix* charcoal. In fact, according to Shahack-Gross & Finkelstein (2008), the diagenesis of by-products of tamarisk combustion led to the concentration in anthropogenic sediments of a huge quantity of gypsum and relatively minor quantity of micritic ash.

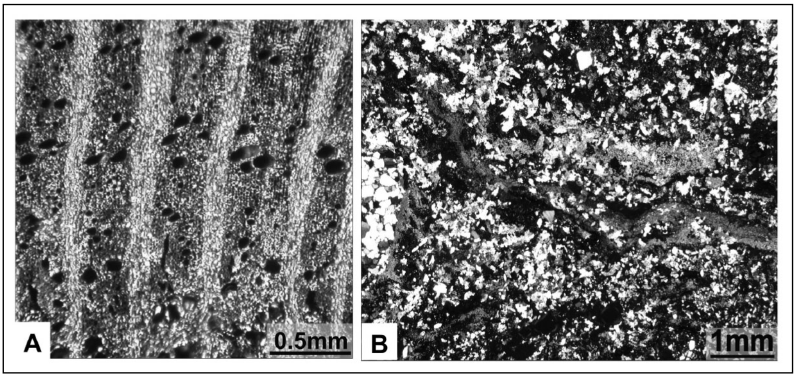

Fig. 2 – *(A) Transversal section of* Tamarix aphylla*; (B) Photomicrograph of an ashy layer rich in gypsum*

Conclusions

Our results suggest that *Tamarix* was the main source for fuel in the ancient oasis of Fewet. Also today, tamarisk wood is the most important traditional fuel employed in domestic fireplaces by the local people. Furthermore, in Garamantian times as much as today, the consumption of wood followed a responsible exploitation of natural resources, suggesting a high consciousness of the fragility of marginal environments.

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Supplemento
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Sonja Filatova[1], René T.J. Cappers[1]

The microscopy of crop-processing: investigating the anatomical, morphological and chemical traits of processed cereals

Abstract
Identifying which crop-processing techniques macroremains have undergone before deposition is of great interest for the interpretation of past food-economies, but unfortunately, it is often problematic to identify specific processes using solely a stereo-microscope. In order to gain more insight into the physical characteristics of processed cereals, processed and unprocessed modern crops were subjected to analysis by three different microscopic techniques: stereo light microscopy, transmission light microscopy and scanning electron microscopy.

Key words: *Crop-processing techniques, cereals, morphology, anatomy, nutrition, microscopy*

Introduction

Identifying past crop-processing techniques (e.g. dehulling, polishing and parboiling) is of great interest within archaeobotany, as getting an understanding of how and why crops were processed in specific ways is of importance for the interpretation of past food-economies. Despite the large variety of research conducted on this topic, it is often problematic to use macro-botanical analysis for the identification of the processes to which the crops were subjected before deposition.

The goal of this research is to gain a greater understanding of the morphological traits and nutrient composition of processed crops, and to compose a reference for the identification of processed cereals. In order to do so, modern material, which has been processed in several known ways, has been studied using three different microscopic techniques. The anatomy, morphology and chemical composition of the crops was analyzed thoroughly in order to reveal characteristics of the different crop-processing techniques.

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Materials and Methods

Twelve different taxa of cereals were selected for the analysis. All the species have a modern origin, and have undergone a known and documented series of crop-processing (unprocessed specimens are included as well). In order to get a better understanding of the nutritional and morphological traits of the processed cereals, three microscopic techniques have been applied. Firstly, each selected taxon has been photographed using a stereomicroscope. Three photographs were taken per cereal: one of the whole grains, one of the longitudinal cross-section, and one of the latitudinal cross-section (Fig. 1).

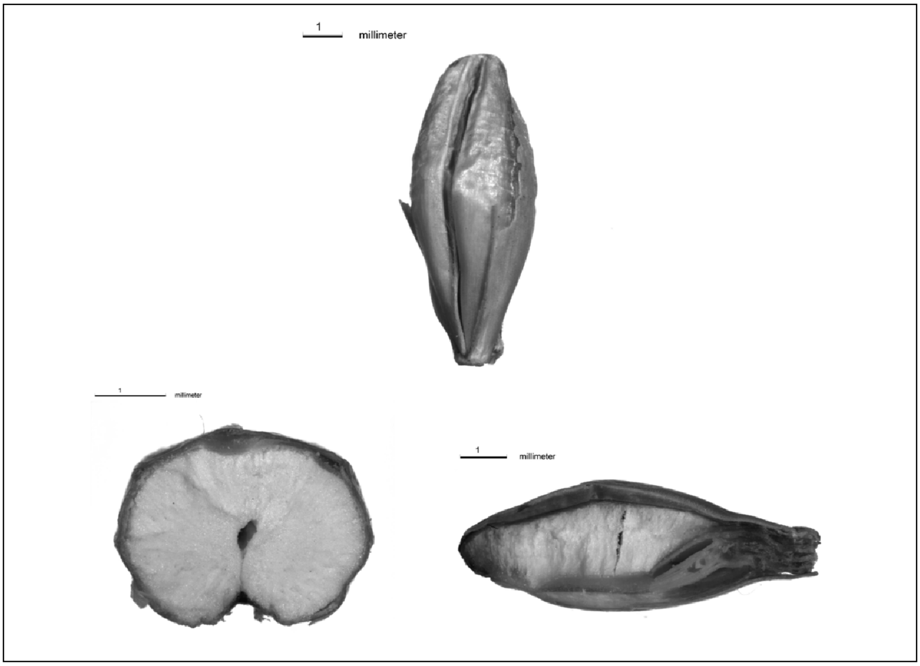

Fig. 1 – *Stereomicroscope photographs of a grain kernel of hulled barley (top) and its latitudinal (bottom left) and longitudinal (bottom right) cross-sections*

Secondly, a small number of cereals were selected for carbohydrate and protein analysis. In order to image which parts of the grain kernels contained the most proteins and/or carbohydrates, the kernels were stained using different chemicals, and subsequently diced into thin slices using a microtome. The results will be documented using a transmission light microscope. The aim is to gain insight into the consequences of food-processing techniques on the quantity of carbohydrates and/or proteins in the grains (*i.e.* when the germ is removed, which nutrient(s) is/are reduced?).

Lastly, each of the samples that were photographed with the stereo-microscope will be analyzed with a scanning electron microscope (SEM), using secondary electrons. As the SEM is able to image materials with greater precision and higher resolution than light-microscopes, it will be possible to conduct a more detailed study of the topography of the grains and especially the different layers of each (processed and unprocessed) grain kernel. The aim is to relate the morphology and anatomy of the grain kernels to specific crop-processing techniques.

All the data gathered during the different analyses will be used to interpret the morphological and nutritional traits of processed grain kernels. If successful, the data will be used as a reference for the interpretation of (processed) archaeobotanical remains.

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Elena A.A. Garcea[1], **Assunta Florenzano**[2], **Anna Maria Mercuri**[2]

Preliminary pollen analysis on Early and Middle Holocene archaeological sites in tropical Nubia (Northern Sudan)

Abstract
Ongoing archaeopalynological research at Sai Island in the River Nile and Amara West (ancient Nubia, present Northern Sudan) aims at obtaining information on the environmental changes during the Early and Middle Holocene and on the transition first to pastoralism and later to agro-pastoralism. Preliminary data delineate the main traits of the plant landscape and human plant selection in this part of North Africa.

Key words: *Pollen, River Nile, Sudan, Sai Island, Amara West*

Introduction

Nubia stretches across the six major rocky cataracts of the River Nile in its middle tract, in present Sudan. It is a crucial area for understanding the cultural, economic and environmental events related to the origin and spread of food production in north and east Africa and its relationships with the Mediterranean basin and the Near East.

Sai Island, an island in the River Nile (Fig. 1), is the location of several archaeological sites containing pre-pastoral Khartoum Variant and pastoral Abkan deposits (Garcea, 2006-2007; Garcea & Hildebrand, 2009). The Amara West district, on the present left bank of the Nile north of Sai Island, provided, among other sites, the earliest Holocene vestiges of hunting-gathering groups, locally called Arkinian (Schild *et al.*, 1968).

The archaeological work at Sai and Amara West aimed to carry out geoarchaeological investigations, to examine the relationship between archaeological evidence and the progressively changing environments during the Early and Middle Holocene in relation to the River Nile, and to explore the transi-

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tion to pastoralism and agro-pastoralism in this part of North Africa. Pollen analyses were conducted in order to obtain information on the plant landscape and human plant selection in these areas.

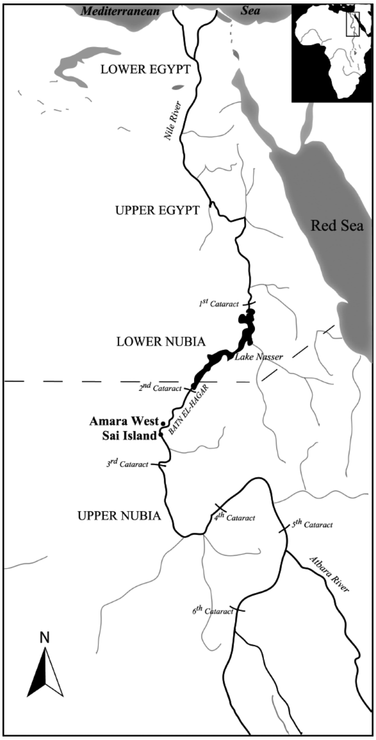

Fig. 1 – *Location map of Sai Island and Amara West sites*

Fig. 2 – *The archaeological excavation of site 8-B-10C (Sai Island)*

Materials and Methods

Fieldwork on Sai Island (N 20°42’30”, E 30°19’30”) included pollen sampling at the Khartoum Variant (9500-6800 cal BP) site 8-B-10C, the Khartoum Variant and Abkan (7400-5750 cal BP) site 8-B-76, the Abkan site 8-B-81, and the Pre-Kerma (5250-4450 cal BP) site 8-B-10A. In the Amara West district (N 20°50’01”, E 30°23’28”), pollen sampling was made at the Arkinian (11,600-10,400 cal BP) site 2-R-66.

Pollen samples were taken from these excavated sites according to archaeological stratigraphy. Pollen samples, of about 3 to 6 g each, were prepared using tetra-Na- pyrophosphate, HCl 10%, acetolysis, separation with Na-Metatungstate hydrate, HF 40%, and ethanol (see Florenzano *et al*., 2012).

Lycopodium tablets were added to calculate concentrations (pollen/gram). Pollen slides were mounted on glycerol jelly. Identification was made at x1000 magnification.

Results and Discussion

Pollen analyses are in progress at present; some samples showed that good preservation did not occur everywhere. Preliminary data were obtained from site 8-B-10C (Fig. 2). The main traits of these pollen spectra are the presence of tropical genera (*e.g.*, *Acacia, Barleria, Cadaba*) and the prevalence of Poaceae (ca. 40%) plus Cyperaceae (ca. 2%) among herbs. Poaceae pollen includes grains with different exines – scabrate or verrucate – and sizes, from small (20-22 μm, maximum diameter) to medium and large pollen grains (up to 50 μm), corresponding to different species. Cyperaceae include *Cyperus* pollen. Also, Fabaceae are well-represented (ca. 2%), while Asteraceae, Chenopodiaceae, Apiaceae and *Typha* are few. Therefore, pollen suggested a savannah landscape with wet environments.

In addition, traces of phytoliths (grass pollen of elongate class) and microcharcoals were observed in the slides. In a few cases, the latter records measured also more than 200 μm, which can be typically ascribed to human fires, as indicated in the archaeological excavation where three hearths were brought to light (Garcea & Hildebrand, 2009).

Conclusions

These preliminary results suggest that, although these sediments are not rich in organic matter, pollen analysis can be carried out and can contribute to the interpretation of palaeoenvironmental conditions, suggesting a fairly diversified flora in pollen spectra.

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First carpological data of the 9th century BC from the Phoenician city of Utica (Tunisia)

Abstract
This paper presents the first carpological data from the Phoenician city of Utica (Tunisia). Identified remains have provided ^{14}C chronology of the last quarter of the 9th century BC, which is contemporary with the earliest Phoenician settlements in the Iberian Peninsula. At the same time the information achieved confirms the oldest Phoenician presence in north-western Mediterranean.

Key words: *Early Phoenician colonization, carpology, food plants, North Africa*

Introduction

The ancient city of Utica is located in North Africa, in north-eastern modern Tunisia. According to classical sources, Utica is one of the oldest Tyrian foundation cities of the western Mediterranean (Alvar & Wagner, 1985). The sources said Utica was founded 285 years before Carthage but until now this had not been verified through archaeology. The latest excavations carried out by a Tunisian-Spanish team in Area II of the archaeological site (Lopez Castro *et al.*, 2010; 2014) demonstrated these chronological data by dating seeds. At the same time, the information provided by the carpological analysis showed the corpus of economic species the inhabitants of Utica interacted with.

Materials and Methods

The samples were taken during the excavation, still in progress, of a building complex which housed a well inside.

The dates of ^{14}C obtained from *Hordeum vulgare* seeds from the interior of the well, offer a chronology of the last quarter of the 9th century BC which is the oldest phase documented in Utica up to the present.

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[5] Universidad Autónoma de Madrid, Madrid, Spain.

Results and Discussion

Most of the species identified correspond to crop plants. Among cereals, hulled barley (*Hordeum vulgare*) is the main crop, followed by naked wheat (*Triticum aestivum/durum*). On the other hand, other cereals, such as emmer (*Triticum dicoccum*), show a low percentage. Pulses are represented by lentil (*Lens culinaris*).

Conclusions

These early data, although limited, provide us with a starting point for reconstructing agriculture in the city of Utica since its foundation. Hulled barley and naked wheat are the most commons species. In addition, other cereals such as emmer, although limited to a few specimens, appear recurrently. It should be noted that lentil is the only species of legume we found, contrary to others Mediterranean sites dated to the 1st millennium BC, where peas and broad beans are the main pulses (Montes, 2014).

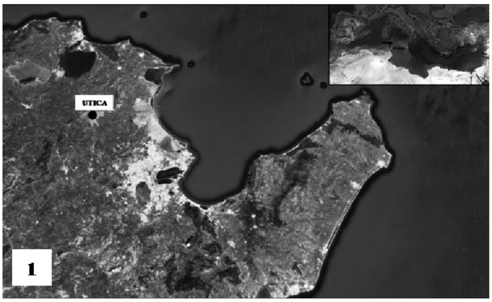

Fig. 1 – *Location map of the Phoenician city of Utica*
Fig. 2 – *Main crops found in the well*

In the excavation of this building complex, there are levels from the initial Phoenician city of Utica that are important because they offer the first data on the ancient agriculture practiced in this city. The later phases are documented in others sites of the city, and reveal significant changes in the evolution and distribution of certain crops. For example, the olive tree (*Olea europaea*), which was not found in any of the previous phases, entered the record from the Roman period onward.

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Supplemento
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Archaeobotanical studies from Hierakonpolis – evidence on food processing during the Nagada II period

Abstract
In the current paper we discuss the archaeobotanical evidence from the predynastic locality HK11C of Hierakonpolis and in particular the information on plant food resources and their processing. The studied plant remains come from installations established for large scale food production. Archeobotanical analysis included macrobotanical study of the plant remains found, as well as observation under reflected light microscope of special parts (like tissues, epidermal or pericarp fragments). Plant remains from samples from feature C4, together with refuse from cooking installations, indicate discarded waste and crop cleaning by products. Samples from residues found inside vats and their surroundings most probably represent emmer processed for beer production.

Key words: *Macrobotanical remains, ancient brewing, Predynastic, Upper Egypt.*

Introduction

Hierakonpolis was a major town in Predynastic Upper Egypt that included diverse zones related to activities of daily life (settlement areas and industrial quarters where, for example, beer brewing and pottery production took place). Moreover there are several cemeteries and a ceremonial centre. The activities that took place at the site left numerous plant remains related to food processing, production and consumption. The radiocarbon dates obtained on residues from large ceramic vats suggested that they contain the earliest evidence of beer production in the world.

Materials and Methods

The excavations at the locality HK11C, situated on the south bank of the Wadi Abu Suffian have revealed installations dedicated to industrial food pro-

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duction activities dating to the Naqada II period (Baba & Friedmann, in press). The plant macroremains dealt with here come from a locus of food production in Square C3-4 where a mud-brick structure of the late Naqada II period was found. The interior of the structure was filled with black burnt debris, and there were distinct features representing large hearths. From there both charred and desiccated plant remains were extracted with flotation. Further plant macroremains come from beer and pottery production complexes.

Results and Discussion

The mud-brick structure in which food of animal origin was processed yielded mainly crop cleaning by-products of emmer and barley, the principal cereal crops of the site (Fahmy *et al.*, 2011), as well as weeds and some representatives of wild growing vegetation. These remains probably reflect the use of crop cleaning by-products in the fuel (dung and wood) used for heating during meat processing. Archaeobotanical analysis of those remains also provided information on weeds and other wild flora. The field weed assemblages corroborate a mono-seasonal crop regime restricted to winter. Further reconstructed habitats include marshes with saline soils surrounded by desert, probably used also as pasture land for domestic stock. Locally available *Acacia* sp. and *Tamarix* sp. were the major sources of charcoal and wood. Further archaeobotanical evidence from the site HK11C comes from residues adhering to the inside of large vats, which were found in another food production installation. These burnt residues contain remnants of emmer (Fig. 1); the presence of whole grains has been attested, as well as fragmented grains. The presence of ground grains is proven by numerous cereal pericarp fragments and aleuron cell layers visible under higher magnification. The processing and subsequent heating must have resulted in a more or less homogenous mass suggesting that this matter was wet when charred. It most probably represents either dough for bread making or – most probably – mash for starting beer production (see Murray, 2000; Samuel, 2000). Beer production is also suggested by the malt grains found during the initial study of the material.

Conclusions

The botanical assemblages of studied samples correspond well previous findings from the Predynastic economy and environment from HK11C (Fahmy *et al.*, 2011). The palaeoethnobotanical results from this study show that the economy of Predynastic Hierakonpolis was based on the cultivation of cereals: emmer wheat and barley. Both crops were cultivated in winter in local fields along the Nile, as shown by the weed assemblages. The dung remains indicate that crop cleaning refuse and barley grains were mainly used as fodder. The archaeobotanical finds from vat contents provide the oldest direct evidence of cereal ingredients and procedures for beer production in ancient Egypt.

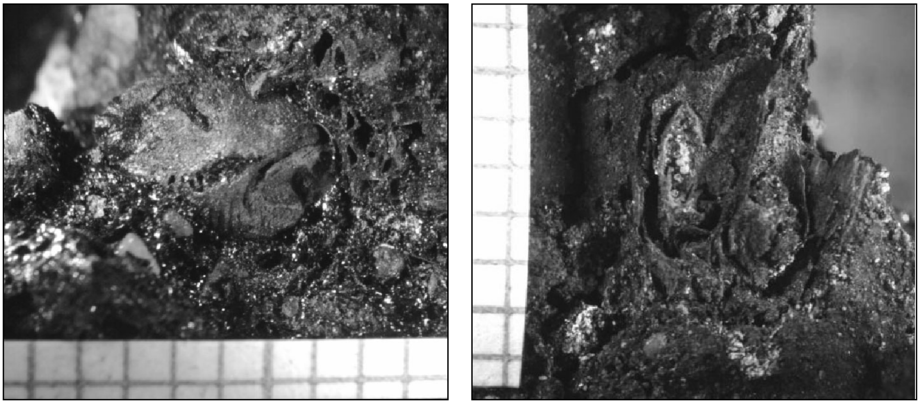

Fig. 1 – *Overview of parts of the sample from the inside of a vat, showing partly charred or desiccated plant remains. In the centre of the left picture cereal grain (cf.* Triticum dicoccum*) can be seen. In the centre of the right picture a desiccated spikelet of emmer is visible*

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Key words

Africa
macrobotanical
agriculture
remains
phytoliths
archaeobotany
vegetation
plants
millet
Sudan
Egypt
analysis
cereals
Ethiopia
Age
food
Late
Holocene
crop
starch
domestication
isotopes
environment
seeds
palynology
Middle
historical
grindstones
Neolithic
pollen
charcoal
spatial
grains
archaeology
culture
households
palaeoecology
ethnobotany
South
River
Morocco
criteria
study
stable
coast
wheat
Stone
metallurgy
mound
intensive
residue
barley
Cemetery
Valley
consumption
identification
selection
resilience
history
herbs
economy
morphometry
period
Helwan
Senegal
nitrogen
systems
early
Amheida
Zimbabwe
archaeo
Ziziphus
rainforest
Tunisia
Crossroad
Elaeis
Dynastic
Motako
translocation
arrows
basketry
Musa
fruits
utilisation
grass
refuse
poison
Bushmen
Congo
medicinal
collapse
manure
arboreum
desert
cache
trees
based
collars
cropland
coffee
Empire
Capsian
herbaceum
guineensis
Epipalaeolithic

A

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Africa
African rice
Agricultural economy
Agricultural systems
Agriculture
Amara West
Amheida
Anatomy
Ancient brewing
Anthracology
Antiquity
Arabia
Arboriculture
Archaeobotany
Archaeological charcoal
Archaeology
Archaeo-metallurgy

B

Barcoding
Barley
Basketry
Birni Lafiya
Botanical remains
Bushmen arrows

C

Capsian
Carpology
Cereal crop-processing
Cereal grains
Cereals
Charcoal
Charcoal studies
Chigaramboni
Coffee
Collapse
Coptic Egypt
Crop by-products
Crop domestication
Crop-processing techniques,
Crop selection
Crossroad of Empire ERC project
Cultural landscape

D

Desert vegetation
Diet
Digital photographic archive
Domestic fireplaces
Domestication
Doukki Gel

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Early agriculture
Early Dynastic Cemetery
Early Phoenician colonization
Egypt
Elaeis guineensis
Embalming cache
Environment
Environmental mismanagement
Environmental reconstruction
Epipalaeolithic
Equifinality
Ethiopia
Ethnobotany

F

Farming production

Flora
Floral collars
Food plants
Food production
Food security
Fruits
Fuel
Fungi

G

Game-hunting
Geophytes
Ghana
Gossypium herbaceum/arboreum
Grape-pressing remains
Grass seed consumption
Great Zimbabwe
Grindingstones
Grindstones

H

Helwan
Historical archaeology
Historical cropland
Holocene
Hordeum vulgare
Households

I

Iberomaurusian
Identification criteria
Inner Congo Basin
Intensive agriculture
Isotopes

K

Kenya
Kerm

L

Late Holocene
Late Holocene Saharan oasis
Late Iron Age
Late Roman
Late Stone Age

M

Macrobotanical
Macrobotanical remains
Manure
Mapping
Medicinal herbs
Microscopy
Middle Ages
Middle Senegal River Valley
Middle Stone Age
Millets
Morocco
Morphology
Morphometry
Motako
Mudbricks
Multivariate analysis
Musa phytoliths

N

Neolithic
Nile River
Nitrogen
Nok culture

Key study areas

Echinochloa colona (L.)
Herbarium Chiovenda from the Botanical Garden of Modena


ERBARIO DEL R. ORTO BOTANICO DI MODENA
Echinochloa colona (L.) Lk.
det. Prof. E. Chiovenda

Elenco Soci Soc. Nat. Mat. di Modena, anno 2015

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