SUDAN & NUBIA

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ASWAN
1st cataract
Egypt
RED SEA
Wadi el- Allaqi
2nd cataract
Batn el-Hajar
Akasha
Wadi Gabgaba
Sedeinga
Jebel Dosha
Tinare
Jawgul
3rd cataract
ABU HAMED
Sudan
Nile
El-Ga'ab
Basin
Kawa
Sudan Military
Railway
KAREIMA
4th cataract
Fifth
Cataract
el-Kurru
Dangeil
Usli
Berber
ED-DEBBA
ATBARA
Wadi Howar
Gala
Abu Ahmed
es-Sour
el-Metemma
Atbara
Wadi el- Melik
Wadi Muqaddam
6th cataract
OMDURMAN
KHARTOUM
KASSALA
Eritrea
Blue Nile
MODERN TOWNS
Ancient sites
WAD MEDANI
Atbara/Setiet
GEDAREF
White Nile
Aba Island
KOSTI
SENNAR
N
Ethiopia
South
Sudan
0
250 km

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Front cover: The descendary of Tomb IV T 1 near Sedeinga under excavation (© V. Francigny / SEDAU).

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Archaeobotanical Investigations at the Gala Abu Ahmed Fortress in Lower Wadi Howar, Northern Sudan

The site and the findings

Friederike Jesse

The discovery of the massive stone walled fortress called Gala Abu Ahmed in the desert of lower Wadi Howar more than 25 years ago was a minor sensation as no such building was known so far from the Nile. First investigations already pointed to a Kushite date (see Jesse and Kuper 2006; Jesse 2006, 50-52) and this could largely be confirmed during recent years. Three seasons of excavation between 2008 and 2011 provided a large amount of new data concerning this intriguing massive structure which was in use between the later New Kingdom (> 1070 BC) and the Napatan period (*c.* 900-400 BC) (Jesse and Peters 2009; Eigner and Jesse 2009; Eger *et al.* 2010; Flache 2012; Eigner 2013; Jesse 2013). This is shown not only by the archaeological material, especially the numerous pottery sherds and the many small finds but also by 37 radiocarbon dates ranging between about 1250 BC and 400 BC (Jesse 2013, Tab. 1). Especially in light of the radiocarbon dates two phases become apparent at Gala Abu Ahmed: the first between *c.* 1200 and 900 BC and the second during the early Napatan Period (mid-8th to mid-6th century BC). The fortress seems to be abandoned by the beginning of the Meroitic period *c.* 400 BC (Figure 1).

During the time of the New Kingdom, Egypt conquered Nubia as far as the region of the Fourth Cataract. One of the main aims of this expansion was to control the foreign trade routes and access to the Nubian gold mines (e.g. Edwards 2004, 103-105). Political and social structures

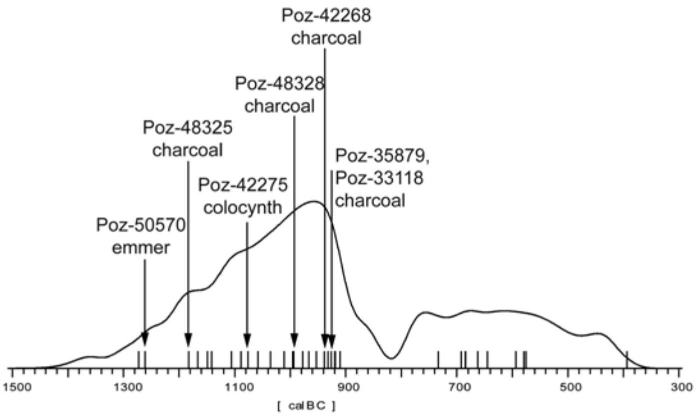

Figure 1. The radiocarbon dates for the Gala Abu Ahmed fortress (n = 37); marked are the dated archaeobotanical samples mentioned in the text.

able to organise the construction of such a fortress as Gala Abu Ahmed existed in the Nile Valley during late New Kingdom times and also later on. Whether the work was done by the Egyptians or by a local ruler remains to be seen. Gala Abu Ahmed fulfilled a multitude of purposes beyond its pure military function (see already Jesse and Kuper 2006, 145-147): it protected a source of water and trade and transport routes (e.g. for the transport of slaves, raw materials, skins, etc.), probably both north-south and east-west. It certainly served as a demonstration of power, a means of 'showing the flag' – if only to the pastoral groups living in this area.

Archaeobotanical investigations at Kushite sites in Nubia are rare: Some information is available from Kawa (Fuller 2004) and the region of the Fourth Cataract (Badura 2012). During the first investigations at Gala Abu Ahmed tiny fragments of charcoal were found as well as a small piece of clay with plant imprints which most probably might be glumes of a wild sorghum (Panicoideae) (Jesse and Kuper 2006, 140). Therefore it was a pleasant surprise that besides the abundant pottery sherds, lithic artefacts, small finds and large number of animal bones also more remains of charcoal were found in most trenches excavated between 2008 and 2011 at Gala Abu Ahmed and that sediment samples which were taken at different locations are of great interest from an archaeobotanical point of view. The results of the different approaches (analysis of the charcoal fragments by Barbara Eichhorn, of the phytoliths found on grinding material by Barbara Eichhorn and Kai Radomski, of the seed impressions on pottery sherds by Stefanie Nußbaum and of the charred seeds and fruits by Stefanie Kahlheber) will, therefore, be presented in more detail (Kahlheber this volume; Eichhorn this volume) as they allow deeper insights into the ecological situation at the turn of the 1st millennium BC but also on the plants used by the occupants of the fortress.

The area around Gala Abu Ahmed is an ecologically favoured one. A patch of tundub bushes (*Capparis decidua*) is still growing in the valley to the north east of the fortress. At the beginning of the second excavation season, in the autumn of 2009, summer rains had turned the entire *wadi* into a green area. The so-called gizzu-grass growing there is very good fodder for camels.[1]

All samples used for archaeobotanical analysis come from the excavated areas and are mostly associated with the structural remains found in the interior of the fortress, especially in trenches 6 and 10 (see Eigner and Jesse 2009, 142, 147-149; Jesse and Peters 2009). In trench 6 (Figure 2) a rectangular building, measuring about 10 x 9m, with three rooms was excavated: further walls in the trench could not yet be assigned to specific buildings. The solid walls, which were constructed on the natural sandy soil reached at a depth of *c.* 1.3m, still

[1] The following species were collected in 2009: *Stipagrostis acutiflora*, *Centropodia forskaolii*, *Tribulus mollis*, *Fagonia arabica*, *Boerhavia diffusa*, *Farsetia aegyptia*, *Indigofera argentea* (botanical determination by Frank Darius 2010). For gizzu vegetation in general see, for example, Wilson 1978.

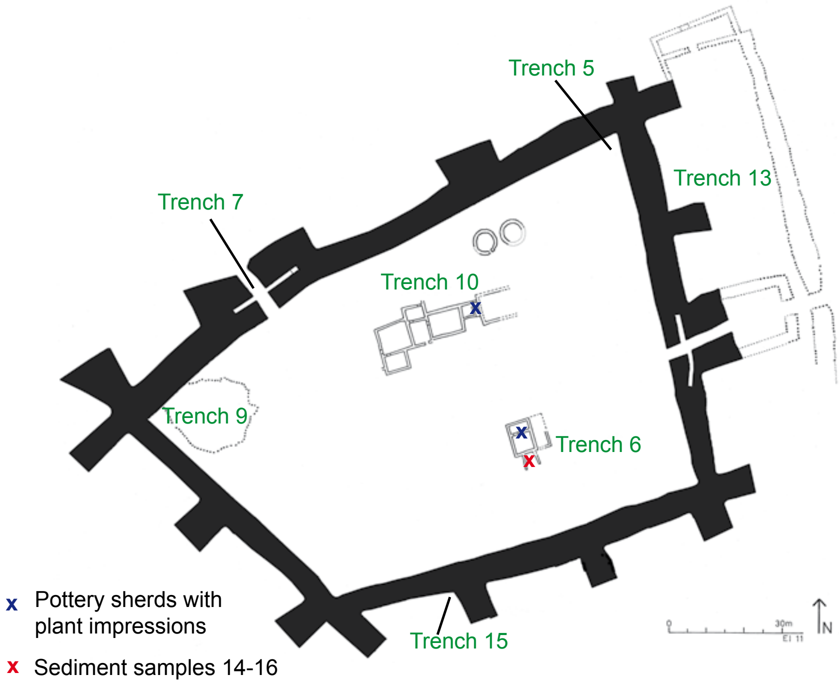

Figure 2. Ground plan of Gala Abu Ahmed fortress with sample locations (scale 1:2000). In green, the trenches where charcoal was taken for archaeobotanical analysis.

consist of seven courses of almost rectangular sandstone blocks bonded with clay mortar (Jesse and Peters 2009, 63-64). The building probably was an 'official residence' (Eigner 2013, 316). In the north-eastern part of the fortress (Figures 2 and 3) a complex building was found (trench 84/95-10).

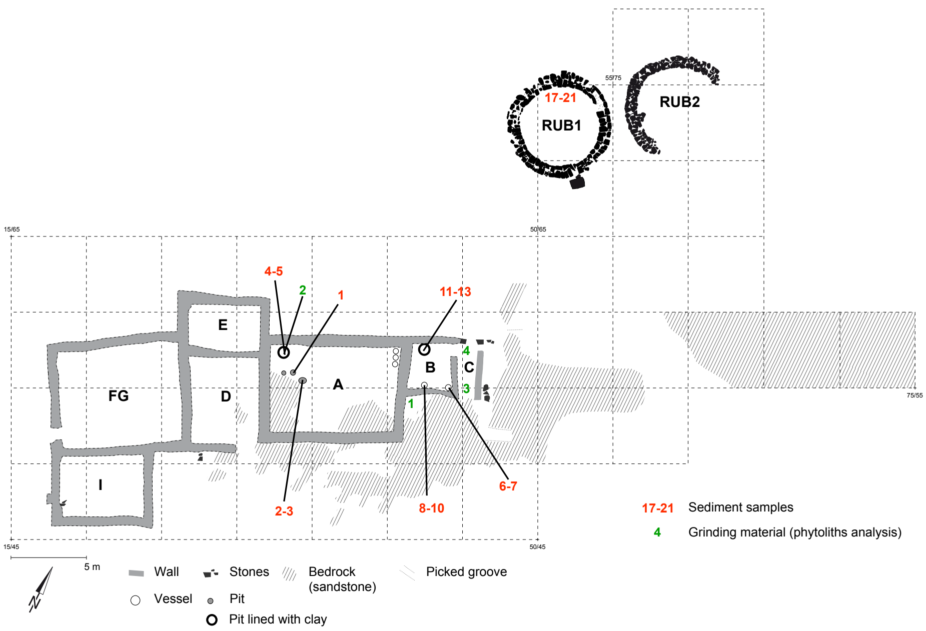

Figure 3. Detailed plan of trench 10 at Gala Abu Ahmed fortress with the archaeobotanical sample locations (scale 1:500).

The construction of the walls is solid and and carefully built and resembles that of the building found in trench 84/95-6. Sandstone blocks and clay mortar were used, but only up to three courses were preserved here. The natural sandstone was incorporated in the construction of this building and used as a foundation for the walls. Unevenness in the sandstone outcrop on which the building was erected had been smoothed out with a layer of sandstone gravel and sandy sediment (Jesse and Peters 2009, 64; Eigner and Jesse 2009, 147). The building in trench 10 is interpreted as a suite of rooms and courtyards (see Eigner 2013, 316). Two rotundas (RUB 1 and RUB 2) to the north of that building (Figure 3) are the remains of silos: several courses of sandstone blocks bonded with clay mortar are preserved (Flache 2012).

Various features were recorded in the different buildings, such as hearths of different sizes, layers of ash, vessels set into the floor (trench 6, location 1; trench 10, room B) and the remains of pits (trench 10, room A), sometimes lined with clay (Figures 2 and 3). Vessels set into the floor are a typical feature at sites of the Kushite period and have been recorded, for example, at Kawa (Macadam 1955, 211-212) and at Site 6-G-9 near Gezira Dabarosa (Adams 2004, 66-67 and figs 3-5). Pits lined with clay are known from Kawa, Site I, with diameters of about 800mm and were regarded as grain silos (Macadam 1955, 211 and pl. 18). At Jebel Moya the pits have diameters of about 700-800mm and are also lined with clay. They are interpreted as hearths or ovens and normally contain ash, animal bones, burnt stones, occasional sherds and the remains of grinding material or other debris. With one exception, the clay lining of the so-called ovens are not burned (Addison 1949, 102; see also pls 37-38).

Sediment samples at Gala Abu Ahmed were taken from the vessels set into the floor and the pits in trenches 6 and 10 and charcoal was found in most trenches excavated (Figures 2 and 3). Systematic sediment sampling was made in the sondage in the northern part of the western rotunda (RUB 1) by sieving 10 litres of sediment with sieves with a 3mm and 1mm grid respectively. Five sediment samples were taken at depths of about 100mm, 300mm, 350mm, 600mm and 700mm below the surface and submitted for archaeobotanical analysis (samples 17-21). One of the charred colocynth seeds found in sample 21 at a depth of about 700mm was radiocarbon dated to 2875 ± 30 bp / 1060 ± 50 calBC (Poz-42275).[2] Fragments of charcoal (among them also cf.

[2] All dates were calibrated using CalPal 2007 (Weninger *et al.* 2007).

Acacia nilotica) were dated to 2785 ± 35 bp / 940 ± 50 calBC (Poz-42268) and 2780 ± 35 bp / 930 ± 50 calBC (Poz-35879) (Flache 2012, 48, Tab. 1).

In trench 6, location 1 (Figure 2), an almost complete pottery vessel was found at a depth of about 250mm. The vessel was heavily eroded, a result of it being a coarse low-fired ware

Plate 1. The fixed vessel found at Gala Abu Ahmed fortress (84/95) trench 6, location 1.

(Plate 1). It was found upside down and had a diameter of about 320mm and a preserved height of 200mm. The base was not preserved. There was no decoration on the vessel (Jesse and Peters 2009, 64; Eigner and Jesse 2009, 150). The sediment fill of this vessel was separated into three layers: 1 (top layer) - greyish sand with some tiny particles of charcoal and roots; 2 (middle layer) - ashy greyish sediment, calciferous, with some charcoal and roots; 3 (bottom layer) – reddish-brown sediment, small gravel, roots, bones and charcoal. A sediment sample was taken in each layer (samples 14-16). Charcoal (*Acacia* cf. *nilotica*) found in the bottom layer was dated to 2830 ± 40 bp / 990 ± 60 calBC (Poz-48328; Jesse 2013, Tab. 1).

A similar vessel with a diameter of about 430mm was documented in the south-eastern corner of room B in trench 10 (Figure 3; Plate 2) where two sediment samples (samples 6 and 7) were taken. A large jar was deposited close to the southern wall of room B (Figure 3; Plate 3) and also probably used as a storage container. Sediment samples of the vessel fill were incorporated in the archaeobotanical analysis (samples 8-10).

In trench 10, room B another storage facility was found: a pit about 700mm in diameter lined with clay (Figure 3). A fragment of charcoal (identification not determinable) found at a depth of about 150mm below the surface was radiocarbon dated to 2955 ± 35 / 1180 ± 60 calBC (Poz-48325; Jesse 2013, Tab. 1). Sediment was taken and submitted for archaeobotanical analysis (samples 11-13). A comparable storage facility was excavated in the north-western part of room A of the complex building in trench 10 (Figures 3 and 4; Plate 4): a pit about 700mm in diameter, lined with un-

Plate 2. The fixed vessel found at Gala Abu Ahmed fortress (84/95) trench 10, room B.

Plate 3. The jar excavated close to the southern wall of room B in the complex building at Gala Abu Ahmed fortress (84/95), trench 10.

Plate 4. The pit lined with clay excavated in the north-western part of room A in the complex building at Gala Abu Ahmed fortress (84/95), trench 10.

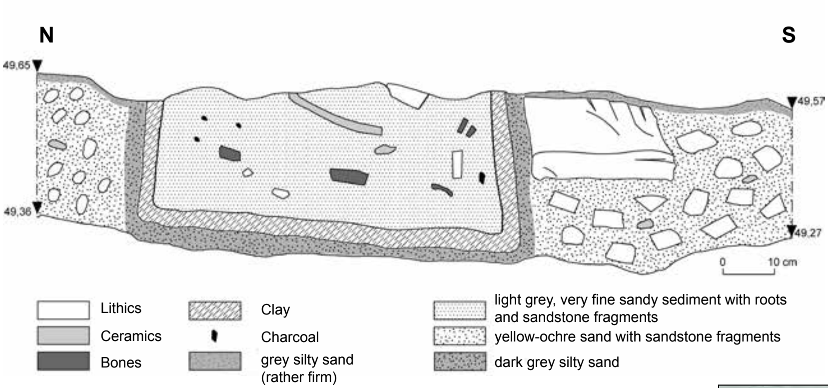

Figure 4. Eastern section of the pit lined with clay excavated in room A of trench 10 at Gala Abu Ahmed fortress.

burned clay (Eigner and Jesse 2009, 150). Sediment samples (samples 4 and 5) and an upper grinding stone (No. 2) found in the pit were submitted for archaeobotanical analysis which revealed seeds and fruits as well as phytoliths of different kinds of plants among them wild grasses and palm trees (Kahlheber this volume; Eichhorn this volume). A charred fragment of emmer (*Triticum dicoccon*) found in sample 4(1) gave a radiocarbon date of 3020 ± 70 bp / 1260 ± 110 calBC (Poz-50570). A fragment of charcoal (*Acacia* type) found in the vicinity of the pit was dated to 2780 ± 35 bp / 930 ± 50 calBC (Poz-33118) (Jesse 2013, Tab. 1).

Two shallow pits close to that feature furnished further sediment samples (Figure 2; samples 1-3). Sample 1 came from a pit about 100mm deep filled with a blackish-grey sandy sediment, charcoal and some pottery sherds. Samples 2 and 3 were taken in a round to oval structure which measured *c.* 350 x 450mm, probably the remains of a shallow pit lined with red loam. The function of these pits remains unkown.

Grinding material has been found at several places, an especially large number in room C of the complex building in trench 10 (Figure 3). An upper grinder (No. 3) and a fragment of grinding material (No. 4) excavated there were submitted for phytolith analysis as well as the fragment of a lower grinder (No. 1) found in the small annex to the south of room B (Eichhorn this volume).

Among the large amount of pottery sherds excavated in trenches 6 and 10 some clearly show seed imprints (Plate 5). Eight such sherds (seven excavated at trench 6 and one excavated at trench 10, room C; Figure 2) were examined by Stefanie Nußbaum and show that the imprints are the seeds of wild grasses (Gramineae, Poaceae family), including cf. *Pennisetum* sp., *Brachiaria* sp., *Panicum* sp., cf. *Echinochloa* sp.[3]

The charcoal fragments excavated in different hearths or ashy layers in most trenches at Gala Abu Ahmed (Eichhorn this volume) allow for the reconstruction of a denser and more diverse woody vegetation comparable to the situation in the upper Wadi Howar today (see Nußbaum *et al.* 2007), thus indicating much more favourable ecological conditions at the turn of the 1st millennium BC. The archaeobotanical investigations (Kahlheber this volume; Eichhorn this volume) indicate that the occupants of Gala Abu Ahmed used wild plants such as different grasses and fruits growing in the vicinity of the fortress but also imported grain (emmer wheat) from the Nile Valley.

Plate 5. Pottery sherds with plant impressions excavated at Gala Abu Ahmed fortress, trench 10, room C.

[3] Seed imprints of the Poaceae family (among them *Cenchrus* sp.) have also been identified on pottery sherds found on late 2nd millennium BC sites in the middle Wadi Howar (Vogelsang and Keding 2013, 48, 55).

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Phytoliths on Grinding Stones and Wood Charcoal Analysis

Barbara Eichhorn

Phytoliths on grinding stones

Introduction

Though often considered to be associated with the processing of plants, particularly grasses (e.g. Clark 1976), direct evidence for the use of grinding implements for this purpose is still rare (Radomski and Neumann 2011 and references therein). Large grinding implements are commonly found at Holocene sites in the Sahara and along its southern margins and ethnographic data from the African Sahel indicate the use of grinding stones for cereal processing (Schön and Holter 2000). However, multiple functions are known from archaeological as well as ethnographical sources (e.g. McBrearty and Brooks 2000; Dubreuil 2004). The presence of these artefacts at an archaeological site is thus not necessarily related to the preparation of plant food.

Botanical micro-remains (phytoliths, starch grains) traced on stone tools may be indicative of their utilization for plant processing. Both phytolith and starch analysis from stone tools are increasingly used to identify the function of tools and the plant taxa possibly treated (e.g. Fullagar and Field 1997; Kealhofer *et al.* 1999; Piperno *et al.* 2004; Pearsall *et al.* 2004; Harvey and Fuller 2005; Mercader 2009).

The archaeobotanical macro-remains found at the fortress of Gala Abu Ahmed in lower Wadi Howar, which was in use between the end of the New Kingdom (*c.* 1070 BC) and the Napatan period (*c.* 900-400 BC) indicate the palaeoeconomical importance of wild as well as imported domesticated grasses at this site (Jesse and Kuper 2006, 140; Kahlheber this volume; Jesse this volume and references therein). They comprise several Paniceae species, probably wild sorghum and emmer wheat. Grinding stones originating from different features at Gala Abu Ahmed were thus investigated for the presence of phytoliths, particularly typical Poaceae inflorescence phytoliths, which are a useful marker for cereal processing. These analyses were performed in order to assess if the implements were related to that special purpose, the processing of plants in general – which would be indicated by the presence of other morphotypes – or, in the case of the complete absence of phytoliths, were confined to the processing of non-plant material.

The taxonomical significance of the phytoliths found on a tool and subsequently classified is to a large extent dependent upon exhaustive modern reference material from the research area. Recently, Radomski and Neumann (2011) investigated inflorescence phytolith assemblages from 18 wild and domestic grass species from the African Sahel known to be used as food resources and thus provided a first reference for glume phytoliths of indigenous Poaceae likely to be found on grinding stones from the area. Several approaches to classify glume phytoliths from *Triticum* species, including emmer, and to distinguish them from other cereals have been presented (e.g. Rosen 1992; Ball *et al.* 1999; Portillo *et al.* 2009; Piperno 2006, and references therein).

Material and methods

One lower grinding stone fragment, two upper grinding stones and one grinding implement fragment from Gala Abu Ahmed were tested for the presence of phytoliths (Grinding material 1-4, Jesse this volume, Figure 3). Phytoliths found on the working surface of stones may principally be due to contamination from the soil. Therefore, Kealhofer *et al.* (1999) recommended the investigation of surrounding sediment samples. Two sediment samples (sediment sample 4 and 5, Jesse this volume, Figure 3) and one natural stone were analysed as a control at Gala Abu Ahmed (all artefacts and samples as well as their provenance are listed in Table 1).

Table 1. Grinding implements, control stone and control sediments from Gala Abu Ahmed (84/95) analysed for phytoliths.

Sample number	Origin	Sample/artefact description
Stone 1	84/95-10, room Bx, position 8	Lower grinding stone fragment, 200mm below surface
Stone 2	84/95/-10, RA-1, position 37	Upper grinding stone, from the sediment fill of clay-lined pit, depth 300mm
Stone 3	84/95-10, RC, position 18	Upper grinding stone (number 25) originating from an assemblage of grinding implement fragments in room C, 100mm below surface
Stone 4	84/95-10, RC, position 65	Grinding stone fragement from the northern part of room C, 50-100mm below surface
Control stone	84/95-10, RA-1, position 41	Natural stone, to the east of the clay-lined pit
Sediment sample 4	84/95-10, RA-1, position 32	Sediment fill from the western part of the clay-lined pit
Sediment sample 5	84/95-10, RA-1, position 39	Sediment sample from the excavation of the pit lining, eastern part of the pit

Sampling for phytoliths of the stone artefacts and the control stone followed a three-step method adapted from Pearsall *et al.* (2004) and described in Radomski and Neumann (2011):

Step 1: Dry-brushing of the stone with a toothbrush (the resulting sediment is assumed to represent the surrounding soil);

Step 2: Subsequent wet-brushing (the resulting sediment is assumed to represent the transition between surrounding soil and working surface);

Step 3: Subsequent wet-sampling with an ultrasonic toothbrush or in an ultrasonic bath provided that the artefacts are small enough (the resulting sediment is considered to represent the working surface).

In all cases, we further processed the sediment resulting from step 3 considered to contain the phytolith assemblage of the working surface. Extraction of the phytoliths from all sediments (those retrieved from the stones as well as the control soil samples) was conducted following a standard method using sodium polytungstate as heavy liquid after deflocculation with EDTA, carbonate destruction with HCl and organic matter removal with HNO_3 and $KClO_3$ (compare Piperno 2006, 90-93; Madella *et al.* 1998). The phytolith samples were mounted on micro slides in immersion oil allowing for the rotation and 3-dimensional investigation of the morphotypes.

Results

Only stone 2, an upper grinding stone found in the sediment fill of a clay-lined pit in room A (see Table 1; Jesse this volume, Figure 3) yielded identifiable phytoliths, with the exception of a single globular phytolith found in the sediment of stone 1. All other grinding implement sediment samples were devoid of phytoliths and contained only few uncharacteristic silica fragments. The detailed counting results for stone 2 and control sediment 4 from the sediment fill are displayed in Table 2. Sediment 5 from the pit lining and the natural control stone 2 did not yield identifiable phytoliths but only some heavily eroded fragments.

The majority of identified morphotypes can be attributed to the grass family (Poaceae; Table 2). In addition to the grass phytoliths, palm phytoliths (morphotype globular echinate) and a number of morphotypes which originate, according to the current state of knowledge, from woody dicots (shrubs and tress) could be identified (for the attribution of phytolith morphotypes to plant taxa see Piperno 2006, 23-44 and references therein).

The grass short cell phytoliths identified from the sediment of stone 2 are often fragmented and/or eroded. Many of the fragments could be attributed to the morphotype bilobate grass short cell phytolith (GSCP). Other identified GSCPs comprise rondel GSCPs, saddle GSCPs, complete bilobate GSCPs and cross GSCPs. In addition to the GSCPs, skeletons maintaining the united cell structure of the original tissue and different grass long cell phytoliths were identified, whereas parallelepipedal bulliform und cuneiform bulliform phytoliths are rare. Some of the GSCPs most probably belong to the subtype 'rondel/bilobate, variant saddle-like' described by Radomski and Neumann (2011), occurring in the investigated reference material only in wild and domesticated sorghum (*Sorghum* sp). However, the characteristic part of the phytoliths is heavily eroded and the identification less secure than in control sediment 4. A dendritic long cell phytolith pointing to grass inflorescences (glumes) was also found (see below: Discussion).

The variety of phytolith morphotypes identified in control sediment 4 is generally similar to that from stone 2. The

Table 2. Counting results for the morphotypes identified in the sediment from stone 2 and the control sediment 4 (nomenclature according to ICPN working group: Madella et al. *2005, modified).*

Taxonomical attribution/morpho-type category	Morphotype	Counting results for stone 2	Counting results for sediment 4
Grass short cell phytoliths (GSCP)	Bilobate GSCP	8 (+ 1 trilobate short cell)	28 (+ 1 polylobate short cell)
	Bilobate GSCP (fragment)	41	88
	Cross GSCP	6	10
	Saddle GSCP	10	84
	Rondel GSCP	9	24
Other grass phytoliths	Parallelepipedal bulliform cell	5	11
	Cuneiform bulliform cell	2	2
	Polylobate trapeziform	1	6
	Elongate psilate	3	20
	Elongate echinate	9	53
	Elongate dendritic	1	23
	Papillae	5	4
Palms	Globular echinate	6	3
Woody dicots	Globular psilate	1	5
	Subglobular dark core	1	1
	Cylindric sulcate tracheid and other sclereids	2	4
Others	Hair cell	4	15
	Unidentifiable fragments	92	149
	Skeleton (articulated phytoliths)	2	11

spectrum of GSCPs is diverse; saddle GSCPs are, however, more common in sediment 4. The variant 'rondel indented/ bilobate, variant saddle-like' considered by Radomski and Neumann (2011) to be characteristic for *Sorghum* sp. was attested several times. Dendritic phytoliths characteristic for glumes are a regular occurrence.

Discussion

As stated above, only one of the grinding implements (stone 2 found in the clay-lined pit in room A) yielded intact phytoliths originating mainly from grasses and in some rare cases from palms and woody dicotyledonous plants. The surrounding control sediment from the pit fill contained numerous phytoliths with a generally similar spectrum of morphotypes. The phytolith assemblage in the sediment samples from stone 2 may, therefore, be related to the processing of grasses with the grinding stone and possibly other plants but might, as well, represent a contamination from the adjacent sediment. Their presence in the samples originating from preparation step 3 (see Material and methods) indicates at least that they come from the working surface of the stone. Neither on the other grinding implements (stones 1, 3, 4) nor the natural stone from outside the pit nor in the control sediment from the pit lining (sediment 5) were phytoliths detected. These samples thus differ distinctly from the samples inside the pit (stone 2, sediment 4).The evidence of numerous grass phytoliths restricted to the pit fill and stone 2 points to the storage and/ or processing of grasses respectively their inflorescences or possibly the deposition of their waste within the spatial extent of the fill. At the site of Zilum in north-eastern Nigeria, the presence of a grass phytolith assemblage in a pit without preserved macro-remains has been convincingly connected with the storage of a Paniceae grass (Fahmy and Magnavita 2006). The assumption that grasses were used at Gala Abu Ahmed is consistent with the results of the macro-remain analyses by Stefanie Kahlheber and Stefanie Nussbaum (Jesse and Kuper 2006, 140; Kahlheber this volume).The dendritic long cell phytoliths detected on stone 2 and in sediment 4 as well as some of the silica skeletons are indeed characteristic for grass inflorescences pointing to the processing of grass grains for consumption by humans.

The spectrum of grass short cell phytoliths on stone 2 and in sediment 4 is diverse. Most of the identified morphotypes must, at least in the current state of phytolith research in the area, be considered as unspecific and do not allow for the classification at a low taxonomic level (e.g. Fahmy 2007; Radomski and Neumann 2011; Novello *et al.* 2012). Though not generally restricted to the grass subfamily Chloridoideae (Piperno 2006, 27-34 and references therein), saddle GSCPs have in the restricted inflorescence reference material from Sahelian useful grasses investigated by Radomski and Neumann (2011) only been identified in grasses from this subfamily.

In this reference study, short cell phytoliths of the morphotypes bilobate and rondel in the variant 'saddle-like' occurred only in the inflorescences of the genus *Sorghum* (subfamily Panicoideae). Among the long cell phytoliths, the elongate dendritic morphotype is common in *Sorghum* species and rare in the other taxa investigated by Radomski and Neumann (2011). This morphotype occurs also in the glumes of *Triticum* species, e.g. emmer wheat, which has been identified at Gala Abu Ahmed by macro-remains, but probably also in the glumes of other grass species not yet investigated. Articulated dendritic phytoliths considered highly diagnostic by Rosen (1992) have not been positively identified at Gala Abu Ahmed.

The presence of different Poaceae subfamilies in the phytolith assemblage of the pit in room A indicates the exploitation of a diverse spectrum of grasses.The high number of broken and eroded phytoliths may tentatively be interpreted in favour of *in situ* processing using the investigated grinding implement.

Wood charcoal analysis

Introduction

Wood charcoal from archaeological sites, often by far the most frequent archaeobotanical find category, is an important proxy for the reconstruction of past vegetation, its changes over time and the influence of climate and human impact on the landscape (e.g. Vernet 1997; Figueiral and Mosbrugger 2000; Scott and Damblon 2010). For the region of the present-day Sahara, wood charcoal analysis has contributed a lot to our understanding of Holocene environmental fluctuations, particularly the dramatic climatic changes as well as the related movements of human populations (e.g. Neumann 1989; Kuper and Kröpelin 2006).

A number of charcoal samples was retrieved during the archaeological excavations at Gala Abu Ahmed (Jesse this volume and references therein) and put at the author's disposal. In the following, qualitative results of their analyses (taxa representation) and an ecological interpretation will be presented. Wood anatomical descriptions of the finds and detailed quantitative data will be treated in a subsequent publication.

Material and methods

The analysed charcoal samples were retrieved during the excavation of different hearths and ashy layers at Gala Abu Ahmed. The samples are of very heterogeneous quality and size: while many of them consist of a few fragments only or the individual charcoal fragments are small and brittle, others contain numerous well-preserved charcoal fragments. In order to enhance identification security, the analyses concentrated on fragments with edge lengths $\geq$ 2.5mm displaying all relevant anatomical features. The charcoal fragments were split into the three diagnostic planes – transverse, tangential and radial – and studied with a Laborlux S incident light microscope (range of magnifications: 50x-500x). Identification was performed following the standards of the International Association of Wood Anatomists (Wheeler *et al.* 1989). The taxa were identified using the reference collection of micro slides from modern African woods in the Frankfurt archaeobotanical laboratory, the wood atlas of Saharan woods and anthracological catalogues (Neumann 1989; Neumann *et al.* 2001; Eichhorn 2002; Höhn 2005).

Results

The charcoal analyses at Gala Abu Ahmed revealed a diverse spectrum of woody taxa (Table 3), contrasting with the present day sparse Saharan desert flora and vegetation of the lower Wadi Howar (Nußbaum *et al.* 2007). Despite good preservation, most of the represented woody taxa cannot be identified to species level due to the high wood anatomical similarity and overlapping anatomical features in certain plant groups (e.g. the Capparaceae family). Among the identified taxa, only the tundub (*Capparis decidua*) has still today been recorded near the site (Jesse this volume). Several other shrubs and trees represented in the charcoal assemblage are absent from the area today, suggesting distinctly different climatic conditions.

Table 3. Woody taxa/wood anatomical types identified at Gala Abu Ahmed by charcoal analysis.

Family/subfamily	taxon/wood anatomical type
Fabaceae-Mimosoideae	*Acacia* type
Fabaceae-Mimosoideae	*Acacia* cf. *nilotica*
Rhamnaceae	*Ziziphus* sp.
Capparaceae	*Capparis decidua*
Capparaceae	*Maerua/Cadaba*
Tiliaceae	*Grewia* sp.
Boraginaceae	*Cordia sinensis*
Apocynaceae-Asclepiadoideae	*Leptadenia pyrotechnica*
Zygophyllaceae	*Balanites aegyptiaca*

Discussion

The wood charcoal assemblage from Gala Abu Ahmed in the lower Wadi Howar allows for the reconstruction of a distinctly more diverse and probably much denser woody vegetation in the vicinity of the site at the turn of the 1^{st} millennium BC. Whereas currently only a patch of tundub bushes (*Capparis decidua*) and gizzu vegetation have been noticed near the fortress (Jesse this volume), a number of other woody taxa could be determined in the archaeological charcoal samples.

For an ecological interpretation of these anthracological results, knowledge of the modern day vegation zonation of Wadi Howar is indispensable. Due to its length of almost 1,100km and its south west-north east orientation, Wadi Howar is characterised by a distinct environmental gradient from the Sahelian zone in the southwest to the extremely arid Saharan desert in the northeast. Vegetation changes gradually but distinctly along this gradient, from a Sudano-Sahelian savannah with gallery forest and thickets along the banks to semi-desert grassland with open *Acacia* woodland, and finally turns into a full desert system with isolated vegetation stands supported by groundwater (Nußbaum *et al.* 2007). In this light, the presence of *Cordia* sp. and *Grewia* sp. in the charcoal spectrum of Gala Abu Ahmed is of special interest. These taxa have been recorded by Nußbaum *et al.* (2007) in the uppermost section of WadiHowar ('Wadi Tina'), represented by the species *Cordia sinensis* and *Grewia tenax*. They are part of the dense gallery forest prevailing in this part, made up of Sahelian thicket and trees. *Ziziphus spina-christi*, *Balanites aegyptiaca* and *Acacia nilotica* are today constituents of a 'forest in the desert' (Nußbaum *et al.* 2007) prevailing in an episodically flooded river plain with braided channels at the eastern end of the upper Wadi Howar. The charcoal analytical results strongly suggest that the vegetation around Gala Abu Ahmed during the period of its occupation bore a high resemblance to that currently prevailing in the upper Wadi Howar. The occupation of Gala Abu Ahmed post-dates by a considerable period the Mid Holocene desiccation of vast areas of the Sahara which led to dramatic vegetation change, the retreat of human populations into ecological niches and finally to their 'marginalization' in the Late Holocene between 3500 and 1500 BC (Kuper and Kröpelin 2006). The charcoal spectrum of Gala Abu Ahmed indicates that the lower Wadi Howar still supported lush vegetation in the subsequent centuries indicating distinctly higher precipitation than today. We can, however, not clearly define the vegetation pattern from the charcoal spectrum.

During the Early Holocene climatic optimum, the Sahara has seen phases with vegetation types without modern analogue when tropical species penetrated far north along rivers and lakes, favoured by the high groundwater table, while desert species persisted nearby at zonal sites (Watrin *et al.* 2009). We cannot exclude that also during the long phase of gradual retreat of tropical species during the Mid- and Late Holocene vegetation types were present without a modern analogue. In the vicinity of Gala Abu Ahmed woody taxa like *Cordia*, *Grewia, Ziziphus* and *Acacia nilotica* and palms (evidenced by phytoliths) were probably restricted to sites with a high groundwater table whereas desert taxa settled less favourable sites. Sparse savannah vegetation with denser galleries is a likely scenario.

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The fruit and seed remains

Stefanie Kahlheber

Introduction

Sediment samples taken during excavations at Gala Abu Ahmed fortress yielded charred fruit and seed remains that allow for some insights into plant use and diet of the former occupants and the plant cover in the immediate surroundings of the site at the turn of the first millennium BC. The site, situated in lower Wadi Howar, about 110km from the Nile, was in use between the later New Kingdom (> 1070 BC) and the Napatan period (*c*. 900-400 BC). The archaeological features providing the archaeobotanical material, however, date pre-Napatan (for more details refer to Jesse, this volume).

Among the small number of Napatan sites that have been subject to archaeobotanical investigations is urban Kawa situated on the east bank of the Nile in the Dongola Reach (Fuller 2004). The large assemblage of charred plant material is dominated by crops of Near Eastern origin including emmer wheat (*Triticum dicoccum*), barley (*Hordeum vulgare*), water melon (*Citrullus* cf. *lanatus*) and pulses. With the discovery of sorghum (*Sorghum bicolor*), the site also provides evidence for crops of African origin. The excavations of the Napatan settlement HP736 in Wadi Umm-Rahau in the Fourth Cataract region revealed mainly mineralised and a few charred plant remains (Badura 2012). Crop evidence is restricted to emmer (*Triticum* cf. *dicoccum*), barley (cf. *Hordeum vulgare*) and water melon (*Citrullus lanatus*). So far no archaeobotanical information is available for Central Nubian sites directly predating the Napatan period.

Material and methods

Twenty-one sediment samples originating from eight features in the buildings in trench 6 and trench 10, and at rotunda 1 were processed for the extraction of fruit and seed remains.

The samples from the excavation seasons in 2008 and 2009 included between 15ml and 1000ml of sediment taken from various features in rooms A and B of the building in trench 10 and in one room of the building in trench 6 (for detailed location of sample origin see Table 1 and Jesse, this volume, Figures 2 and 3). Five samples originate from the contents of vessels set into the floor, three samples from a jar, three samples from pits and five samples from pits lined with clay. Five samples taken in 2011 from different depths at the western rotunda (RUB 1) comprised 10 litres of sediment each and were sieved through a 3mm and a 1mm grid.

All samples were dry sieved for uncharred botanical remains, then soaked in water and floated through sieves with mesh sizes of 3.15mm or 2mm, 1mm, 0.5mm and, in some cases, 0.25mm. The heavy fractions were checked for non-floating remains and then discarded. The light fractions were dried, studied under a microscope with a magnification of 5x to 20x and fruits and seeds were separated. The finds from

Table 1. Origin of archaeobotanical samples.

sample no. AB	trench/ building	room/ location	position/feature	feature type	feature type, addendum	displacement volume of flotation sample [ml]
1	10	RA-1	12	pit		430
2	10	RA-1	17	pit		800
3	10	RA-1	17	pit		50
4 (1)	10	RA-1	32	lined pit		900
4 (2)	10	RA-1	32	lined pit		500
5	10	RA-1	39	lined pit		1000
6	10	RB	45	fixed pottery vessel	near rim	30
7	10	RB	45	fixed pottery vessel	in centre	40
8	10	RB	200	jar		100
9	10	RB	205	jar	beneath ceramic sherd	15
10	10	RB	205	jar		300
11	10	RB	221	lined pit	layer A (upper layer)	250
12	10	RB	225	lined pit	near surface	200
13	10	RB	225	lined pit	bottom	200
14	6	loc. 1	17	fixed pottery vessel	layer 1, top	600
15	6	loc. 1	17	fixed pottery vessel	layer 2, centre	650
16	6	loc. 1	17	fixed pottery vessel	layer 3, bottom	550
17	RUB 1		96	rotunda	-100mm	570 *
18	RUB 1		99	rotunda	-300mm	1050 *
19	RUB 1		101	rotunda	-350mm	1270 *
20	RUB 1		102	rotunda	-600mm	1350 *
21	RUB 1		107	rotunda	-700mm	2020 *

* - after dry sieving

16 samples were completely sorted and quantified if possible; five samples were only screened. The fruit and seed remains were documented by photographs with a digital microscope camera MCA-310. Images of some remains were digitally combined by using the Image Stacking Software CombineZP.

Results and discussion

In the 16 completely sorted and quantified samples about 350 fruit and seed remains were counted. Most remains are preserved in a charred condition, but some mineralized vegetative plant remains like culm and leaf fragments, presumably from Poaceae, exist as well. Only four samples, sample 4 originating from a pit lined with clay in room A in trench 10, and samples 14, 15 and 16, taken from a vessel in trench 6, contained significant numbers of remains. Notably, these samples are among those with the largest sediment volumes. The samples with sediment volumes of 100ml or less all contained a very small number of fruits and seeds.

The remains were attributed to 12 plant families. Most frequent are Paniceae caryopses and other grass remains; *Citrullus colocynthis* occurs with the greatest ubiquity being present in all samples but one. Occasionally it was not possible to identify specimens to the species or genus level, and in some cases morphological types have been described. The identification results are summarized in Table 2. Selected fruits and seeds are depicted in Figure 1.

Sample processing for plant remains also yielded animal remains like eggshell, bone, snail shell, Ostracoda carapax and animal dung pellets. The latter comprise fragments of large pellets that are partly uncharred and resemble morphologically ovocaprid droppings, and small-grained dung sticking together, which may originate from insects.

The plant remains

Cultivated plants

Emmer wheat – *Triticum dicoccon* Schrank, Poaceae (grass family)

Figure 1.2, 1.3, 1.4

Record: spikelet fragments (spikelet forks, glume bases)

Comment: significant for identification are the broad bases of the glumes and their strongly veined lateral surface.

Biology and distribution. Emmer wheat has no great site demands and is well adapted to low quantities of rainfall. As a Near Eastern cereal it is a winter crop that is sown in autumn. It is the first wheat species domesticated around 8000 BC and prevails in Egypt until Greco-Roman times (Zohary and Hopf 2000).

Use: Emmer wheat is suitable for baking and brewing, and has been the main resource for beer in ancient Egypt (Samuel 2000). Its hulled grains are not easy to dehusk.

Table 2. Fruit and seed remains of Gala Abu Ahmed (84/95).

sample no. AB			1	2	3	4 (1)	4 (2)	5	6	7	8	9	10	11	12	13	14	15	16	17*	18*	19*	20*	21*	n	u
crops																										
Triticum dicoccon	Poaceae	forklet frag.			1 [b]	1	(1)											4+(2)	4						**13**	**4**
Triticum sp.	Poaceae	glume base	2																1						**3**	**2**
Triticum sp.	Poaceae	bract frag.				1												1	1						**3**	**3**
Cerealia, indet. sp.	Poaceae	caryopsis frag.				(1)	1+(4)											1	12						**19**	**3**
Cerealia, indet. sp.	Poaceae	forklet frag.															(4)								**4**	**1**
Cerealia, indet. sp.	Poaceae	bract frag.			(1)	2	(1)																		**4**	**2**
Cerealia, indet. sp.	Poaceae	rachis frag.	1			1	(1)				(1)														**4**	**3**
wild plants																										
cf. Trianthema sp.	Aizoaceae	seed/seed frag.															5	2	4						**11**	**3**
indet. sp.	Amarantha-ceae s.l.	seed				1	(1)										8	8	8						**26**	**4**
cf. Anastatica hiero-chuntica	Brassicaceae	fruit frag.															9	1	1						**11**	**3**
indet. sp.	Caryophyl-laceae	seed															2	1							**3**	**2**
Citrullus colocyn-this	Cucurbitaceae	testa frag.		x		x	x	x		x				x	x	x	x	x	x		x		x	x	**x**	**13**
cf. Citrullus colo-cynthis	Cucurbitaceae	testa/seed frag.	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x		x	**x**	**19**
indet. sp.	Cyperaceae	seed															1								**1**	**1**
indet. sp.	cf. Cyperaceae	rhizome															2								**2**	**1**
Gisekia pharnaceoides	Gisekiaceae	seed/seed frag.															1	2	1						**4**	**3**
indet. sp.	cf. Leg.-Mimo-saceae	testa frag.	x																						**x**	**1**
indet. sp., type 2	cf. Leg.-Mimo-saceae	seed															1	1							**2**	**2**
Boerhavia cf. repens	Nyctaginaceae	fruit				1																			**1**	**1**
Boerhavia sp.	Nyctaginaceae	seed				(3)	1+(1)				1						4+(3)	3+(2)	4						**22**	**5**
Eragrostis sp.	Poaceae	caryopsis				1																			**1**	**1**
Paniceae, indet. sp.	Poaceae	car./car. frag.	1			40	16										6	16	27						**106**	**5**
cf. Paniceae, indet.	Poaceae	car./car. frag.				13													3						**16**	**2**

x - present ( ) - uncertain, cf.-identification * - screened u - ubiquity relating to samples n - number of remains

Table 2. Fruit and seed remains of Gala Abu Ahmed (84/95) (cont.).

sample no. AB			1	2	3	4 (1)	4 (2)	5	6	7	8	9	10	11	12	13	14	15	16	17*	18*	19*	20*	21*	n	u
indet. sp.	Poaceae	car./car. frag.				(1)	1	1									1+(3)	2	1					(x)	10	6
indet. sp.	Poaceae	bract frag.				1		1									3	3	1						9	5
indet. sp.	Poaceae	culm frag.		1		5	3										6	4	40						59	5
Portulaca cf. foliosa	Portulacaceae	seed																	1						1	1
Ziziphus sp.	Rhamnaceae	endocarp frag.																x	x						x	2
cf. Ziziphus sp.	Rhamnaceae	seed																3							3	1
indet. sp., type 1		amorphous				x			x							x	x	x	x						x	6
indet. sp., type 3		seed																	1						1	1
indet. sp., type 5		seed															1		2						3	2
indet. sp.		seed/fruit	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	19
indet. sp.		parenchyma				x					x			x			x	x	x						x	6
indet. sp.		starchy remain	x	x		x	x	x	x	x	x	x	x	x			x	x	x						x	13
indet. sp.		veget. remain (thorns etc.)					1										2								x	2

Wheat – *Triticum* sp., Poaceae (grass family)
Figure 1.1
Record: glume fragments that lack the diagnostic identification criteria for emmer wheat.
Comment: presumably also emmer wheat.

Cerealia, indet. sp., Poaceae (grass family)
Record: caryopsis, bract and rachis fragments, which are poorly preserved and lack diagnostic criteria for species identification, but which are too large to originate from wild grasses.
Comment: presumably also emmer wheat.

<u>Wild plants</u>
Cf. *Trianthema* sp., Aizoaceae (ice plant family)
Figure 1.5
Record: compressed reniform seed with reticulate and circumferentially ribbed surface.
Comment: the surface of the seeds resembles that of *Trianthema pentandra*, but they differ in shape. Other species of the genus *Trianthema* or the family need to be considered.
Biology and distribution: *Trianthema* species are mostly succulent annuals of low stature. They occur in moist habitats in desert, semi-desert and savanna, on sandy soils with high salinity and nitrate contents, *e.g.* at the borders of salt marshes, in ruderal areas and along the edges of fields (African Plant Database; Bebawi and Neugebohrn 1991, 168; Boulos 1999-2005).
Use: Some species are exploited to obtain vegetable salt; others serve as astringents (Bebawi and Neugebohrn 1991, 168; Burkill 1985-2000).

Indet. sp., Amaranthaceae s.l. (amaranth family)
Figure 1.7
Record: lenticular seeds and seed fragments with circumferential ring-like embryo, testa smooth and shiny, but rarely preserved.
Comment: Amaranthaceae s.l. include former Chenopodiaceae.
Biology and distribution: Many Amaranthaceae species are drought-resistant and adapted to saline and nitrate-rich soils. Herbaceous species are common components of ruderal vegetation surrounding settlements and are frequent weeds of cultivation (Boulos 1999-2005).
Use: Many species are used in human nutrition with the leaves eaten as a pot herb or vegetable. They are also readily grazed by livestock (Burkill 1985-2000).

True Jericho rose – cf. *Anastatica hierochuntica* L., Brassicaceae (cabbage family)
Figure 1.13
Record: pericarp fragments with smooth surface, cochlear-shaped inside
Comment: identification is uncertain because of the presence only of small fragments and missing reference material for direct comparison.
Biology and distribution: Woody prostrate annual, distributed in coastal areas and in depressions of arid zones. According

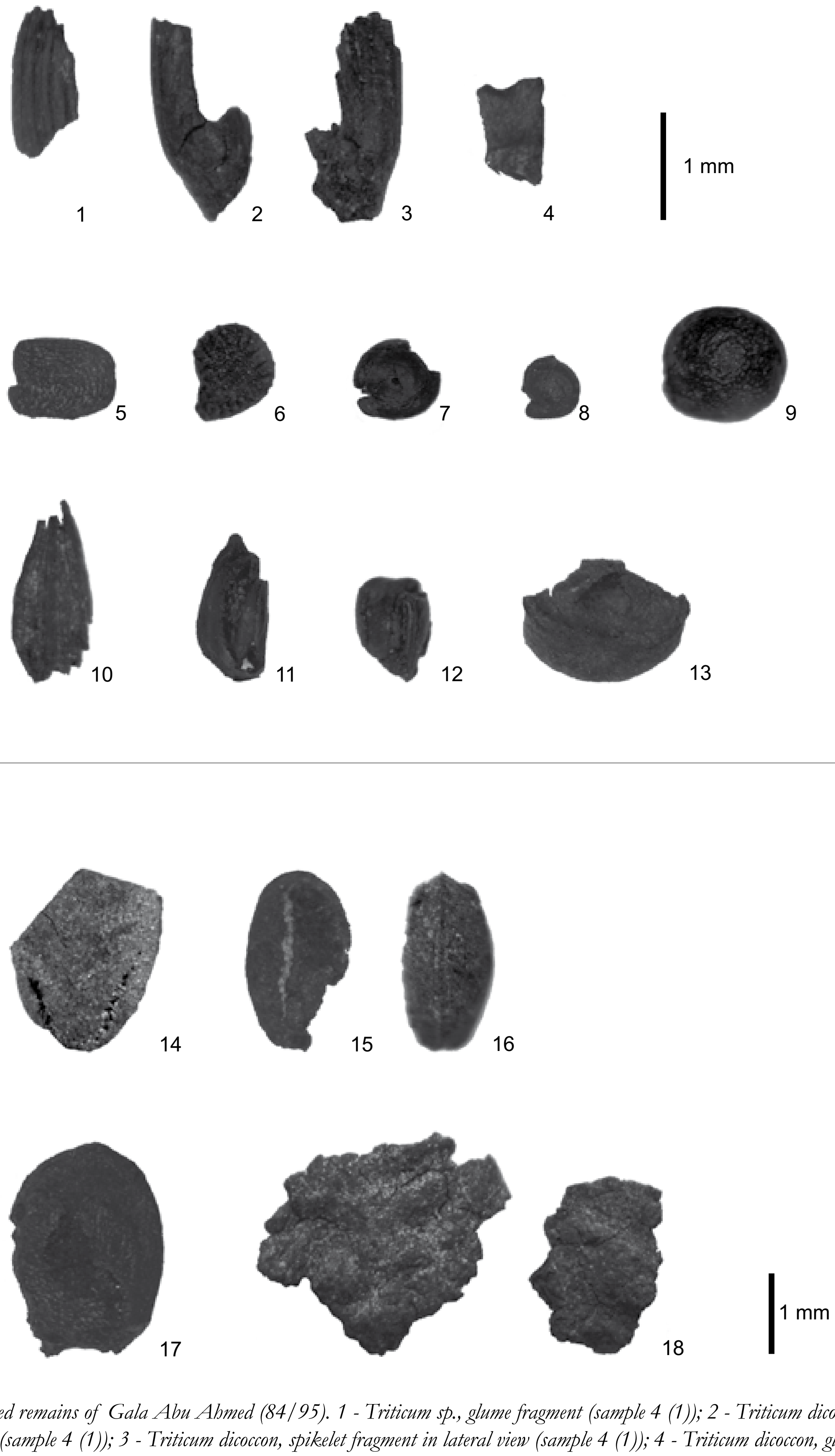

Figure 1. Fruit and seed remains of Gala Abu Ahmed (84/95). 1 - Triticum sp., glume fragment (sample 4 (1)); 2 - Triticum dicoccon, spikelet fragment in adaxial view (sample 4 (1)); 3 - Triticum dicoccon, spikelet fragment in lateral view (sample 4 (1)); 4 - Triticum dicoccon, glume base (sample 16); 5 - cf. Trianthema sp., seed (sample 16); 6 - Caryophyllaceae, indet sp., seed (sample 15); 7 - Amaranthaceae s.l., indet sp., seed (sample 16); 8 - Portulaca cf. foliosa, seed (sample 16); 9 - Gisekia pharnaceoides, seed (sample 14); 10 - Boerhavia cf. repens, fruit (sample 4 (1)); 11 - Boerhavia sp., seed (sample 15); 12 - indet. sp. type 3, seed (sample 16); 13 - cf. Anastatica hierochuntica, fruit fragment (sample 15); 14 - Citrullus colocynthis (L.) Schrad., testa fragment (sample 21); 15 - indet sp. type 2, seed in lateral view (sample 14); 16 - indet sp. type 2, seed in dorsal view (sample 14); 17 - cf. Ziziphus sp., seed (sample 15); 18 - Ziziphus sp., endocarp fragments (sample 15).

to Kindermann *et al.* (2006) the distribution of *Anastatica hierochuntica* is closely linked to the onset of winter rains. Hence, its presence in Late Holocene sites of the central Nile Valley seems unlikely. However, the species occurrence in arid zone depressions may also point to an azonal distribution pattern.
Use: medicinal, magical ('Mary's hand')

Indet. sp., Caryophyllaceae (pink family)
Figure 1.6
Record: reniform seeds with radial ribs.
Comment: the identification of these seeds with their very distinctive surface has been hampered by lacking reference material from Northern Africa. Besides Caryophyllaceae, species of Aizoaceae have to be considered.
Biology and distribution: Annual or perennial herbs, some species widely distributed as weeds in anthropogenically influenced ruderal and segetal vegetation.
Use: Most Caryophyllaceae species are not intensively used.

Colocynth – *Citrullus colocynthis* (L.) Schrad., Cucurbitaceae (gourd family)
Figure 1.14
Record: testa fragments, rarely seeds without testa.
Comment: basal grooves distinguish the seed from similar Cucurbitaceae species, *e.g.* watermelon; testa fragments without this diagnostic feature were classified as cf. *C. colocynthis.*
Biology and distribution: Perennial viney plant with woody rootstock, common on sandy soils in arid and semiarid areas, edges of cultivation (Boulos 1999-2005).
Use: Fruits are extremely bitter to taste, and are, therefore, not eaten. Although said to be poisonous for humans, some animals and livestock (donkey, camels) eat them together with the vegetative parts of the plant. Seeds are also bitter, but edible, possibly only after previous preparation and as an emergency food, and yield a valuable oil. Colocynths serve for medicinal purposes, *e.g.* as a purgative, antibiotic, anthelmintic and anti-inflammatory. The ripe fruit, charred and pulverized, is used to prepare gunpowder, tinder and fuses (Bebawi and Neugebohrn 1991, 154; Burkill 1985-2000).

Indet. sp., Cyperaceae (sedge family)
Record: seeds, rhizome fragments.
Biology and distribution: Most Cyperaceae species require humid to wet habitats.
Use: Cyperaceae fruits are rarely used, but some species, *e.g. Cyperus esculentus* and *C. rotundus*, have rhizomes that serve as food or for medicinal or magical purposes. The leafy parts of many species are exploited for basketry production or as construction material.

Gisekia pharnaceoides L., Gisekiaceae
Figure 1.9
Record: seeds and testa fragments with dull and pointed surface.
Biology and distribution: Annual or perennial, prostrate to creeping weedy plant with lightly succulent leaves, on sandy desert soils, in open woodland, savanna and on river banks, a common weed (African Plant Database; Boulos 1999-2005).
Use: Occasionally eaten as a vegetable and seasoning herb; information on fodder use and browsing values contradictory, possibly depending on growth stage; various medicinal applications known; *e.g.* against diarrhoea, oedema and worm infections, active medicinal contents are tannins; eaten by livestock (Bebawi and Neugebohrn 1991, 196; Burkill 1985-2000).

Boerhavia cf. *repens* L./*Boerhavia* sp., Nyctaginaceae (four o'clock family)
Figure 1.10, 1.11
Record: fruits with five prominent ribs, pentagonal seeds.
Biology and distribution: Annual or perennial herb, prostrate, up to 800mm; on sandy soils, in desert *wadis*, ruderal and segetal habitats (Boulos 1999-2005).
Use: At locale scale for human nutrition: leaves are prepared in a sauce as a vegetable, the root and seeds are added to cereals or other food; broad medicinal use of various plant parts, *e.g.* as emetic, diuretic, laxative, antbiotic; eaten by livestock and harvested as fodder (Muzila 2006).

Eragrostis sp., Poaceae (grass family)
Record: caryopsis.
Biology and distribution: Numerous species of the genus are distributed in the area.
Use: Because their caryopses are extremely small *Eragrostis* species are rarely gathered and used for human nutrition. An exception is domesticated teff (*E. tef*) that is native to the Ethiopian Highlands. The major use of wild *Eragrostis* species is in a technical way: they are made into brooms, basketry and serve as construction material. The species are grazed by all livestock (Bebawi and Neugebohrn 1991).

Paniceae, indet. spp., Poaceae (grass family)
Record: caryopses and caryopsis fragments of various species including *Echinochloa* sp., *Panicum* sp., *Paspalum* sp. and *Setaria* sp.
Biology and distribution: Species belonging to the taxonomic group Paniceae constitute the largest group amongst the grasses of arid and semiarid territories. They grow in nearly all habitats.
Use: Paniceae include many important fodder species that are readily grazed by all livestock. The fruits of many species, particularly those that form large stands, are intensively gathered for human nutrition, *e.g. Cenchrus biflorus*, *Echinochloa colona*, *Panicum laetum*. Many species are used in a technical way as well, *e.g.* for the production of mats and basketry and as construction material.

Portulaca cf. *foliosa* Ker Gawl., Portulacaceae (purslane family)
Figure 1.8
Record: reniform seeds with protruding radicula and the surface covered by irregular elevations arranged in rings parallel to the outline.
Comment: Identification needs to be verified because of discrepancies concerning distribution.
Biology and distribution: Succulent annual or perennial herbs,

common in dry to moist sandy sites, sub-Saharan distribution (African Plant Database).
Use: Medicinal, fodder, extraction of vegetable salt (Bebawi and Neugebohrn 1991, 240 f.; Burkill 1985-2000).

Ziziphus sp., Rhamnaceae (buckthorn family)
Figure 1.17, 1.18
Record: small endocarp fragments with reticulate surface, rarely seeds.
Comment: the fragments derive probably from *Z. spina-christi*; *Z. lotus* can be excluded because it differs from the finds in its finer reticulated endocarp surface.
Biology and distribution: *Z. spina-christi* is a small evergreen tree occurring in hydrologically-favoured locations in arid areas and savannas of North Africa and West Asia; also cultivated for its shade, timber and edible fruits (Boulos 1999-2005).
Use: The fruit mesocarp and the seeds are edible; timber is used for carpentry, construction and fuel; browsed by wild animals and livestock; various medicinal uses (Burkill 1985-2000).

The plant assemblage

The only domesticated crop species confirmed in Gala Abu Ahmed is emmer (*Triticum dicoccon*), a hulled wheat. Clear evidence is provided by chaff, *i.e.* spikelet forks with glumes of broad bases and veined surfaces. Small numbers of grain fragments exist as well, but their identification is less accurate, thus, having been classified as Cerealia. Poorly preserved chaff remains that lack diagnostic characteristics were classified as *Triticum* sp. However, it is probable that those grain fragments and poorly preserved chaff remains originate from emmer as well, since other wheat species were introduced to Nubia much later. In Lower Nubia, free threshing wheats like bread wheat and durum wheat (*Triticum aestivum*, *T. durum*) occur at Qasr Ibrim not earlier than the Roman period starting *c.* 25 BC (Clapham and Rowley-Conwy 2007). Further south in the Nile Valley their arrival is to be expected even later.

Evidence for emmer is also provided in the Early Kushite (Napatan) sites at Kawa and Wadi Umm-Rahau, located in the same region as Gala Abu Ahmed. At both sites the cereal is associated with barley (*Hordeum vulgare*) and watermelon, *Citrullus lanatus*; in Kawa additionally with pulses and indigenous *Sorghum bicolor* (Badura 2012, Fuller 2004). Whereas sorghum seems to arrive in Nubia not before the Napatan period, it appears more often in sites of the Meroitic period (*e.g.* in Gabati, Clapham and Edwards 1998) and reaches Lower Nubia in Roman times only (Clapham and Rowley-Conwy 2007). The lack of barley in Gala Abu Ahmed is remarkable. Like emmer, barley became established in the Egyptian Nile Valley around 5000 BC (Zohary and Hopf 2000), and cultivation presumably spread to the Middle Nile as early as the Late Neolithic (Fuller 2004, 70), where early evidence is provided on Sai Island and in the Kerma region (Hildebrand 2007, 175). Both these Near Eastern cereals are used for the same purposes, and their ecological needs and cultivation are similar. A reason for the absence of barley in Gala Abu Ahmed is hence not evident for the moment, but could result from moderate preservation conditions.

Being of Near Eastern origin emmer is grown in Nubia as a winter crop. In the Nile Valley, cultivation benefits from the floods that arrive in Northern Sudan in late spring and summer, but away from the Nile cultivation would have depended on irrigation. Although the lower Wadi Howar provides a hydrologically favoured situation and wells existed, it is questionable if the available water was sufficient for crop cultivation. More reasonably, the cereal was imported from the Nile Valley as suggested also for the provision of Gala Abu Ahmed with livestock (Eigner and Jesse 2009, 153).

Emmer is well suited for baking bread and brewing beer, and probably played a central role in the diet of the inhabitants of Gala Abu Ahmed. Chaff obtained as a by-product during cereal processing is a good fodder for livestock. From the archaeobotanical point of view there is little information for any processing line or food preparation method: cereal grains and chaff are scarce and not obviously linked to certain feature types. Clear processing waste including typical weeds of cereal fields is missing. Neither spent, *i.e.* germinated grain, nor typical beer condiments as an indicator for brewing have been proven. Some hints are given by archaeological artefacts. Grinding stones could have been employed for grinding emmer grain as well as wild grasses. Large vessels and pits are likely to have been used for storage, in particular of cereal grain. Apparently, emmer was imported in the form of hulled grains and locally processed into bread and/or beer. Activity areas where emmer processing took place have not been discovered. Besides areas in the fortress itself some work may have been done in a nearby settlement (site S01/7) that has been interpreted as having had a supply function (Eigner and Jesse 2009, 143).

From the wild plants in evidence at Gala Abu Ahmed presumably only some, in particular Paniceae, *Ziziphus* sp. and the colocynth (*Citrullus colocynthis*), were directly used by the inhabitants. Paniceae, including *Echinochloa* sp., *Panicum* sp., *Paspalum* sp. and *Setaria* sp., constitute the most frequent (counted) plant remains in the assemblage. The charred remains corroborate the results obtained by the examination of imprints in ceramic sherds by S. Nussbaum (see Jesse, this volume), which revealed a large number of grass taxa belonging mainly to the tribe Paniceae including the aforementioned. At the same time this complimentary evidence refutes the possibility that the wild grass grains had been imported from further south. Whereas many of the imprints originate from hulled caryopses, the charred remains occur almost exclusively in the form of naked caryopses. Since Paniceae are naturally dispersed as firmly hulled grains (florets), this indicates that the grains have been intentionally gathered and processed for human consumption.

Paniceae species are widely distributed in the arid and sub-arid areas of Africa, and the taxa discovered are found in Sahelian savanna vegetation at seasonally moist localities, where they often form dense stands. Such stands configure a regularly exploited and highly esteemed resource for carbohydrate needs up to today. The Paniceae taxa from Gala Abu Ahmed, thus, suggest a more humid climate than at present for pre-Napatan times. Currently, the region receives about 30-40mm of precipitation per year, and a denser grass and herb cover only develops in extraordinary years with higher rainfalls (compare Jesse this volume). A savanna environment is also indicated from the results of charcoal analyses carried out by B. Eichhorn (Eigner and Jesse 2009, 155).

The fruits of *Ziziphus* sp. (probably *Z. spina-christi*) have an edible mesocarp, and from the seeds a vegetable oil can be extracted. However, the plant including its fruits is also appreciated and browsed by livestock. The way the colocynth has been used is less clear. Highly abundant testa fragments, that occur in all samples but one (notably that with the smallest volume), and the lack of complete seeds indicate an intensive exploitation of the latter. It is conceivable that the seeds were eaten. Although bitter in taste, they are edible after boiling or steaming and also yield valuable oil (Burkill 1985-2000). Their use may have involved the utilisation of the entire fruits as well, which are extremely bitter and inedible, but commonly serve for medical purposes, *e.g.* as a purgative. In this case however, processing should have consisted of crushing the fruits including their seeds.

All other herbaceous plants identified to a lower taxonomic level (*Trianthema* sp., Amaranthaceae, cf. *Anastatica hierochuntica*, *Gisekia pharnaceoides*, *Boerhavia* sp., *Portulaca* cf. *foliosa*) are of minor nutritional or other use for man. They are distributed in ruderal and segetal vegetation, hence around the fortress and the settlements. Probably this surrounding vegetation was grazed by livestock, as is suggested by archaeozoological studies (Eigner and Jesse 2009, 151-152), and hence could have entered the archaeobotanical assemblage via animal excrement containing undigested seeds.

Taphonomical aspects

None of the pits and vessels interpreted as storage containers provided evidence for stored fruits or seeds *in situ*. Rather, the sampled features contained secondary fills that consist of general settlement debris being an admixture of residues from various processes, origins and plant groups that may not be linked to their original use or function. Nevertheless, the features are predominantly filled by the debris of activities and processes undertaken in the vicinity and should reflect the functional differences of the four areas sampled, the rotunda, trench 6 and rooms A and B in trench 10.

Notably, the samples originating from the rotunda (samples 17-21) and room B in trench 10 (samples 6-13) are poorer in species and specimen than those of room A in trench 10 (samples 1-5) and of trench 6 (samples 14-16). In particular the samples from the rotunda (interpreted as a silo), which had the largest sediment volumes, demonstrated a low concentration and diversity in plant remains. This suggests that the silo has been filled quite fast, possibly intentionally after it went out of use. The remains of *Citrullus colocynthis*, one of them radiocarbon dated to 1060 ± 50 BC, indicate, however, that the filling included settlement debris.

As in the rotunda the assemblage of the samples of room B in trench 10 is made up of little more than *Citrullus colocynthis* and indeterminates. In contrast to the rotunda samples, those of room B comprised very small volumes of 300ml or less, which might be a reason for the general paucity of remains. Another reason might be seen in the special function of the eastern and north-eastern part of the building (including room B) indicated by a number of small archaeological finds including precious items (Eigner and Jesse 2009, 156).

Samples of room A in trench 10, originating from three pits, provided very different and diverse results. The concentration and diversity of plant remains are apparently not linked to the sample volumes: samples 2 and 5, that comprised comparatively large sediment volumes, contained only small numbers of remains. Taken from the same feature as number 5, a large clay-lined pit, sample 4 has proved to be the richest sample in room A, also responsible for the majority of records in the whole of trench 10. The pit contained an amount of household debris including ceramic sherds, bones, a fragment of a grinder as well as charcoal and ash (Eigner and Jesse 2009, 150), and suggests, in agreement with the large number of emmer remains and Paniceae grains, that room A served as a living area where food was prepared.

A fixed pottery vessel in trench 6 from which three samples were obtained comprised the largest concentration and the highest diversity of botanical finds in Gala Abu Ahmed. Again, Paniceae and Cerealia/emmer are most abundant, and a number of wild plant taxa, cf. *Anastatica hierochuntica*, Caryophyllaceae, Cyperaceae, *Gisekia pharnaceoides*, *Portulaca* sp., cf. *Trianthema* sp. and *Ziziphus* sp. occur exclusively at this location. The presence of dung in trench 6 could be in part responsible for this accumulation of wild plants. The number of remains, especially those of grasses including Paniceae and cereals, increases with the depth of sample origin within the vessel. Possible interpretations are a better protection of charred remains from mechanical destruction at greater depth, or the original deposits are mixed with sterile sediment in higher levels. Archaeological finds in trench 6 include animal bones, ceramic and stone artefacts (Eigner and Jesse 2009, 153) pointing to a context similar to room A in trench 10. The presence of bones from young animals, however, is considered as a sign of luxury and implies a high social position of the inhabitants of the building in trench 6.

Summary and outlook

Analyses of charred fruit and seed remains from the fortress at Gala Abu Ahmed provide evidence for the use of domesticated emmer wheat and various wild plants, in particular wild grasses in pre-Napatan times. Out of 21 archaeobotanical samples more than 350 plant remains were identified and attributed to 12 plant families. Radiocarbon dates for these samples concentrate between 1200 BC and 900 BC and probably relate to the first settlement activities at Gala Abu Ahmed. Sampling was undertaken in a rotunda and three rooms of two buildings; the sampled features include a silo, a jar, fixed vessels and lined and unlined pits that are interpreted as storage containers. None of the samples came from stored food *in situ*, but for two of the rooms the plant remains and other household debris indicate food preparation activities within a living area.

The plant diet at pre-Napatan Gala Abu Ahmed seems to have been based on cultivated emmer wheat and wild Paniceae, supplemented by wild tree fruits (*Ziziphus* sp.) and eventually pot herbs and vegetables. It could not be established if emmer was locally grown. More likely, emmer was imported from the Nile Valley where cultivation conditions, in particular water supply, were more favourable. Wild plant food, in contrast, is thought to have been gathered in the surroundings of the fortress. As suggested by the fruit and seed remains, in particular the Paniceae taxa, environmental conditions in pre-Napatan times were more favourable than those pertaining today and allowed for the development of a savanna landscape. No clear evidence is available for imported plant food (besides emmer) or vegetal trading items, which is remarkable considering the role that Gala Abu Ahmed presumably played in controlling and protecting trade and transport routes between the Nile Valley and sub-Saharan Africa.

Although the preservation of plant material in Gala Abu Ahmed was revealed to be modest if compared with other Kushite sites, the analysed samples have demonstrated that there is potential and also a large need for future archaeobotanical studies. So far, the current archaeobotanical studies are the only ones available for Central Nubian sites directly predating the Napatan period. The results from Gala Abu Ahmed provide the first insights into the regional history of food provision, but urgently need further studies, either on material from other sites, or by further samples from the fortress itself. Promising targets for archaeobotanical analysis are in particular clearly identified areas related to plant processing and food preparation activities. The results have also shown that larger sample volumes are desirable. More information on later occupation phases of the fortress would offer the opportunity of chronological comparison and spatial comparison with other sites. Of major archaeobotanical interest is in particular the question if and how Gala Abu Ahmed participated in the variety of changes confirmed at later Kushite sites comprising agricultural innovations that increased productivity and the introduction of African crop species.

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Gabati

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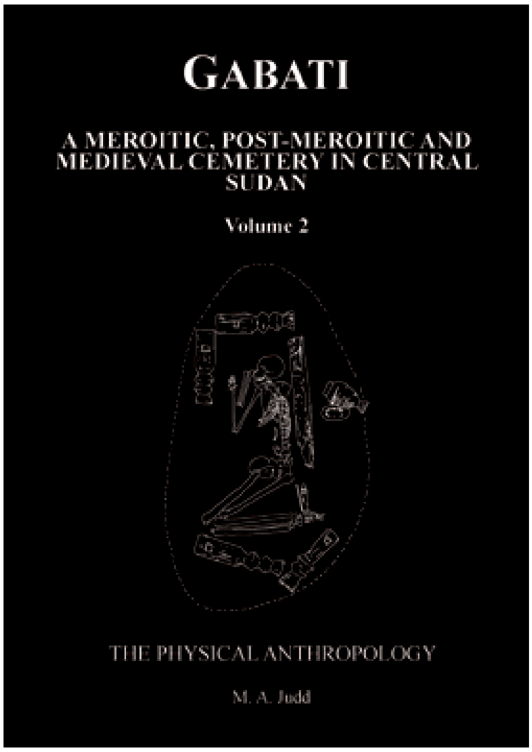

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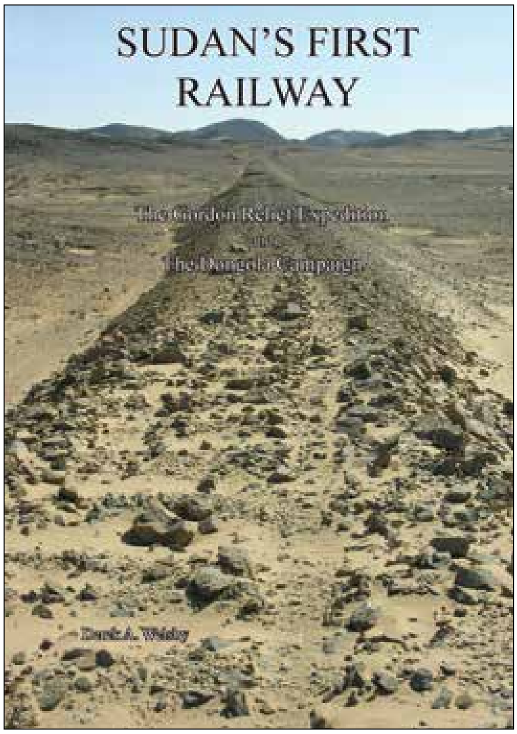

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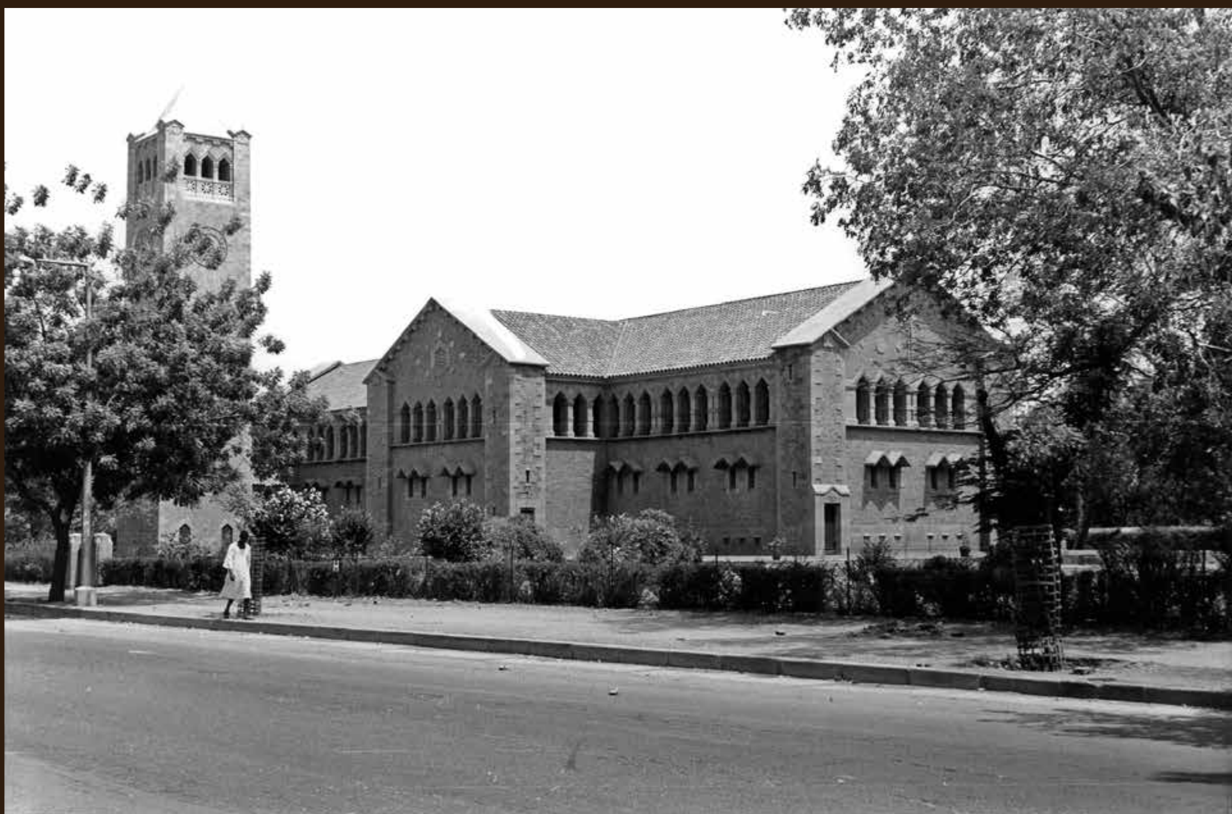

Khartoum. The Anglican cathedral in 1968. Now minus its bell tower it houses the Republican Palace Museum (photo SARS Hawkes Archive HAW P090.01).

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