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Archaeobotanical research in a pharaonic town in ancient Nubia

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Summary This contribution discusses ongoing collaborative archaeobotanical research at Amara West, an ancient settlement in Upper Nubia (Northern Sudan). The region of Upper Nubia was occupied by pharaonic Egypt between *c*.1500 and 1070 BC, and Amara West acted as the administrative centre of the region for the last two centuries of Egyptian rule, from *c*.1300 BC onwards. Since 2008, a British Museum research project has undertaken excavations at the site to investigate the lived experience of the inhabitants of the town, with a particular focus on seeking evidence of interaction between Egyptians and indigenous populations. This can be tracked through urban architecture, artefact assemblages, funerary preferences, skeletal remains and, perhaps, plant use patterns. The excellent preservation of both settlement and associated cemeteries, including evidence for use during the post-colonial period (1070–800 BC), has allowed recovery of reliable archaeobotanical evidence that is being used to study plants used for food, fuel and craft activities. The identification of wood and charcoal from the cemeteries and settlement is ongoing; ultimately this may not only reveal deliberate selection practices but shed some light on changes in local vegetation over time.

INTRODUCTION

Upper Nubia was annexed by Egypt around 1500 BC [1]; the town of Amara West was founded as a new administrative centre for the last two centuries of pharaonic rule (1250–1070 BC), Figure 1. There is also evidence for up to two centuries of post-colonial occupation. In the Nile Valley, agriculture is predominant on the narrow strips of land either side of the river, which are flanked by desert [2]. South of Aswan there are fewer areas suitable for traditional floodplain irrigation than further north; in Upper Nubia (Kush), the wide floodplain of the Dongola Reach has the most agricultural potential [3]. Amara West is situated between the Dal and Third cataracts, downstream of Sai Island, where a pharaonic town was founded in the mid-sixteenth century BC. The Nile turns east after Sai, with Amara West today located on the north bank. Amara West was founded on an island, and optically stimulated luminescence (OSL) dates from fluvial sands interleaved between the final silt- and clay-rich flood deposits in the palaeochannel north of the site have established that this channel failed towards the end of the second millennium BC [4]. When surrounded by water, Amara West would have been a pleasant place to live, with agricultural potential underpinned by the annual Nile flood and protection from windblown sand provided by both the river and riverbank vegetation. Once the channel failed, agriculture would have become increasingly difficult due to the strong northerly winds and subsequent accumulation of sand. Since

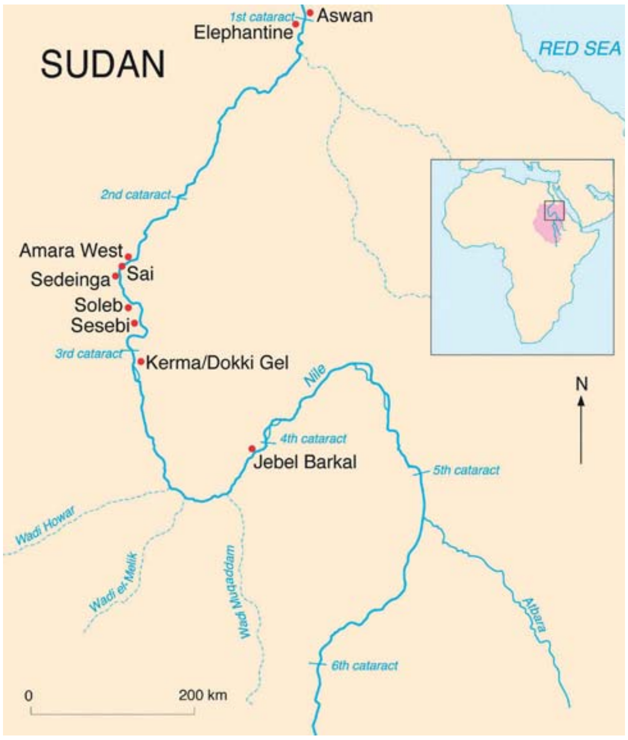

FIGURE 1. Map showing the location of Amara West. Map: Claire Thorne

FIGURE 2. Nubian style building E12.11 (foreground) and villa E12.10 (background).

the mid-first millennium BC, all significant settlement has been located on the opposite bank of the Nile.

Amara West was originally excavated by the Egyptian Exploration Society (EES) during 1938–1939 and 1947–1950 [5, 6]. A British Museum research project focused on reconstructing the lived experience of Egyptian, indigenous and mixed communities in Amara West has undertaken new excavations in the town and two associated cemeteries, revealing well-preserved architecture, artefact assemblages, faunal and botanical material.[1] The identification of wood and charcoal from the cemeteries and settlement is ongoing. A pilot study of charred macro-remains (seeds and fruits) and phytoliths is focusing on recovering plant remains from a villa located outside the west wall of the town and two contiguous small houses within the north west of the town. This study is being undertaken to assess archaeobotanical preservation, taxa present and to investigate whether the centralized Egyptian administration dictated plant use patterns or whether there are some aspects more similar to those found in Nubian settlements post-dating the New Kingdom.

Egyptian style architecture predominates in the town, including a temple with associated storage magazines (excavated by the EES), potentially suggesting a redistributive model of food supply. The issue of how much food was sourced locally and what was imported from other regions, particularly Egypt proper, is of key importance for a colonial settlement such as Amara West. Conversely, a building conforming to Nubian architectural traditions (Figure 2) suggests that alternative modes of urban experience, reflecting indigenous traditions, were present at the site [7]. Artefacts from the town are predominantly pharaonic in form, although Nubian style objects are found in the funerary assemblages, including funerary beds and distinctive jewellery [8]. The ceramic assemblages, from secure contexts within housing areas, indicate that some pottery vessels were supplied from Egypt, but most vessels were produced locally, in both Nubian and Egyptian style [9, 10].

Little is known about subsistence histories in Northern Sudan, particularly concerning how strategies were affected by climate and political change in the Late Holocene. There is evidence for wild grass exploitation by early to mid Holocene hunter gatherers; Near Eastern domestic crops (wheat and barley) appeared in pre-Kerma contexts (*c*.3500–2500 BC) in limited riverine settings but with some potential importance still attached to wild plant foods [11, 12]. Wheat and barley agriculture is reported from Kerma period sites [13], but little is known about agricultural practices or the relative importance of locally available plant resources in settlements occupied prior to, or during, pharaonic control. The presence of fatty acids in cooking pot residues from Askut, an Egyptian settlement of the mid-to-late second millennium BC, suggested some differences between Nubian and Egyptian food types and processing [1]. More is known, although from few sites, about later first millennium BC and AD Nubian subsistence practices [14–17]. Emmer wheat seems to have remained the predominant wheat species in Nubia until the later first millennium BC. Barley in Nubia has been generally identified as 'two-row', however identifications to species level are mainly from later post-New Kingdom sites. Within a few centuries of Amara West being abandoned, alongside winter cereals (wheat and barley), domesticated summer crops (sorghum and two domesticated millets) were also in use at Kawa, while other wild millet grasses hint at long-standing traditions of using African C4 grasses [18].[2]

METHODS

A combined approach

Charred seeds and fruits, as well as plant microfossils (phytoliths), are being analysed from targeted sediment samples taken across the settlement and cemetery, as well as selected off-site locations. There are well-preserved architectural features with associated archaeobotanical material, for instance ovens and hearths packed with *in situ* plant remains. Analyses of macro- and micro-remains provide complementary information since they survive through different taphonomic processes and also afford a means of cross-checking results and trends. As the analysis is ongoing, some of the comments presented here might require modification, particularly as more houses in the ancient settlement are investigated.

Desiccated wood and charcoal

Following standard procedures [19], anatomical examination of desiccated wood and charcoal from domestic and cemetery contexts has been carried out using optical microscopy and variable pressure scanning electron microscopy (VP-SEM). Charcoal fragments were retrieved through a combination of hand picking, sieving and flotation. These fragments have not been counted; such a practice simply gives an index of fragmentation rather than a quantitative or semi-quantitative indicator of (relative) ubiquity of different taxa. It is important to note that charcoal is present on an archaeological site as a result of many different factors – anthropogenic, taphonomic and incidental [19]. Selection of specific fuelwood by people must account for a high (and perhaps even the highest) proportion of charcoal excavated and retrieved. In consequence, different charcoal taxa should never be directly interpreted in proportional terms as exact reflections of the surrounding (local) environment [20]. It is also quite likely that different trees or shrubs could have been selected for firewood, building material or artefacts from considerable distances away from the archaeological site.

Macrobotanical remains (cereals, seeds and fruits)

Macrobotanical remains have survived at Amara West principally in charred form. These were recovered from sediments at the expedition house through a combination of sieving and flotation. Different methods were trialled during the 2011 field season: dry sieving, which involves passing sediments through a set of nested sieves; and flotation, which is a standard method for separating charred plant remains from sediments, based on the principle that charred items will float when sediments are immersed in water.

Simple bucket flotation was selected rather than creating a larger flotation system. This was due to the limited supply of water, which was only available for between two and three hours each day from a shared tap, and the fact that a flotation tank could not be set up close to the water's edge on account of crocodiles.

After various stages of experimentation it was found that the most effective way of processing the sediments to retrieve macrobotanical remains was to pass dry samples through a series of sieves (5.0, 1.0, 0.5 and 0.3 mm) and then to float the >0.3/<0.5 mm fraction (i.e. the contents of the 0.3 mm sieve). Overall, it was found that far higher proportions of charred macrobotanical finds survived from the non-floated samples, with some dry-sieved examples having up to 10 times more items. In contrast, flotation was still the best option for the smallest size fraction (>0.3/<0.5 mm). The grain size distribution of the sediments, which often contained a high proportion of silts, meant that large quantities of sediment collected in the 0.3 mm sieve during dry sieving and this rendered it difficult to retrieve seeds. It is also difficult to sort the >0.5/<1.0 mm dry fraction; however, at this site, many cereal fragments collect in the 0.5 mm sieve and they survive in higher quantities in the dry sieved versus floated samples. While flotation is usually the most common way to extract charred macro-remains, charred materials from sites where the soils have been consistently dry may 'explode' on contact with water; this has been observed elsewhere in Upper Egypt [21, 22]. Nevertheless, this study finds a combined approach to be most useful.

Various reference collections are being used for seed identification, including plants collected in the field, those bought in local markets in Sudan, the in-house British Museum botanical reference collection (which includes specimens from Africa and the Middle East) and specimens from Wakehurst Place, Royal Botanic Gardens, Kew. Various Sudanese and Egyptian floras are also being used [23–28].

Phytoliths

Phytoliths are formed in certain plants, especially grasses and wetland sedges but also in many woody taxa, when soluble silica taken up by plants in groundwater is deposited within and between certain epidermal plant cells [29]. Such plants often produce multiple forms of phytoliths, which provide varying levels of taxonomic information. Phytolith types sometimes offer anatomical information, enabling the distinction of plant parts such as seed bracts, leaves and stems. Such evidence can facilitate the study of crop processing procedures and spatial arrangements, in

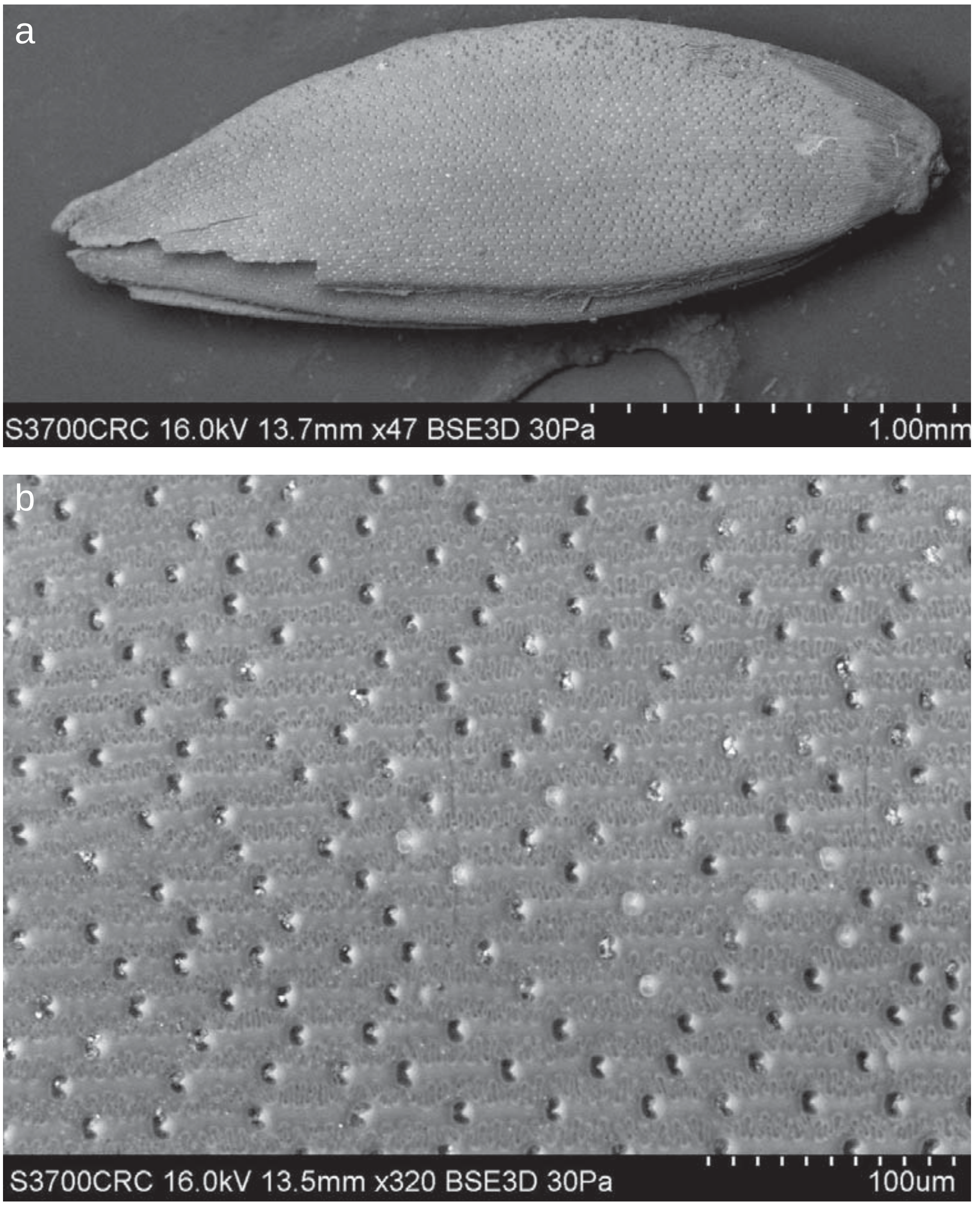

FIGURE 3. Backscattered electron images of: (a) a modern *Cynodon dactylon* grass seed; and (b) a detail of the epidermal cells and phytoliths. Image: Hitachi S-3700N VP-SEM

FIGURE 4. Backscattered electron image of modern *Digitaria exilis* grass seeds after charring. Image: Hitachi S-3700N VP-SEM

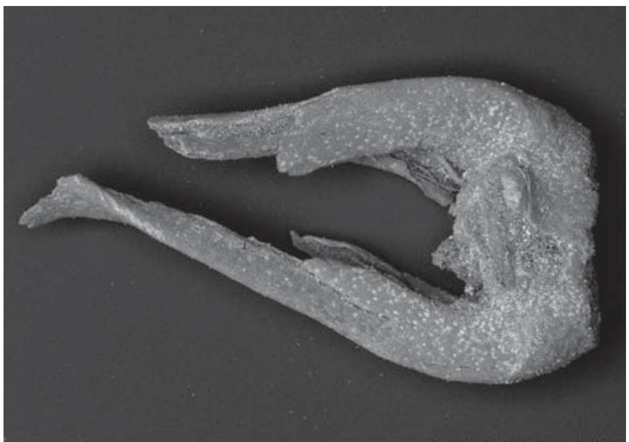

FIGURE 5. Backscattered electron image of an emmer wheat (*Triticum dicoccum*) spikelet fork from the oven fill (context 2130) in room 10 of villa E12.10. Image: Hitachi S-3700N VP-SEM

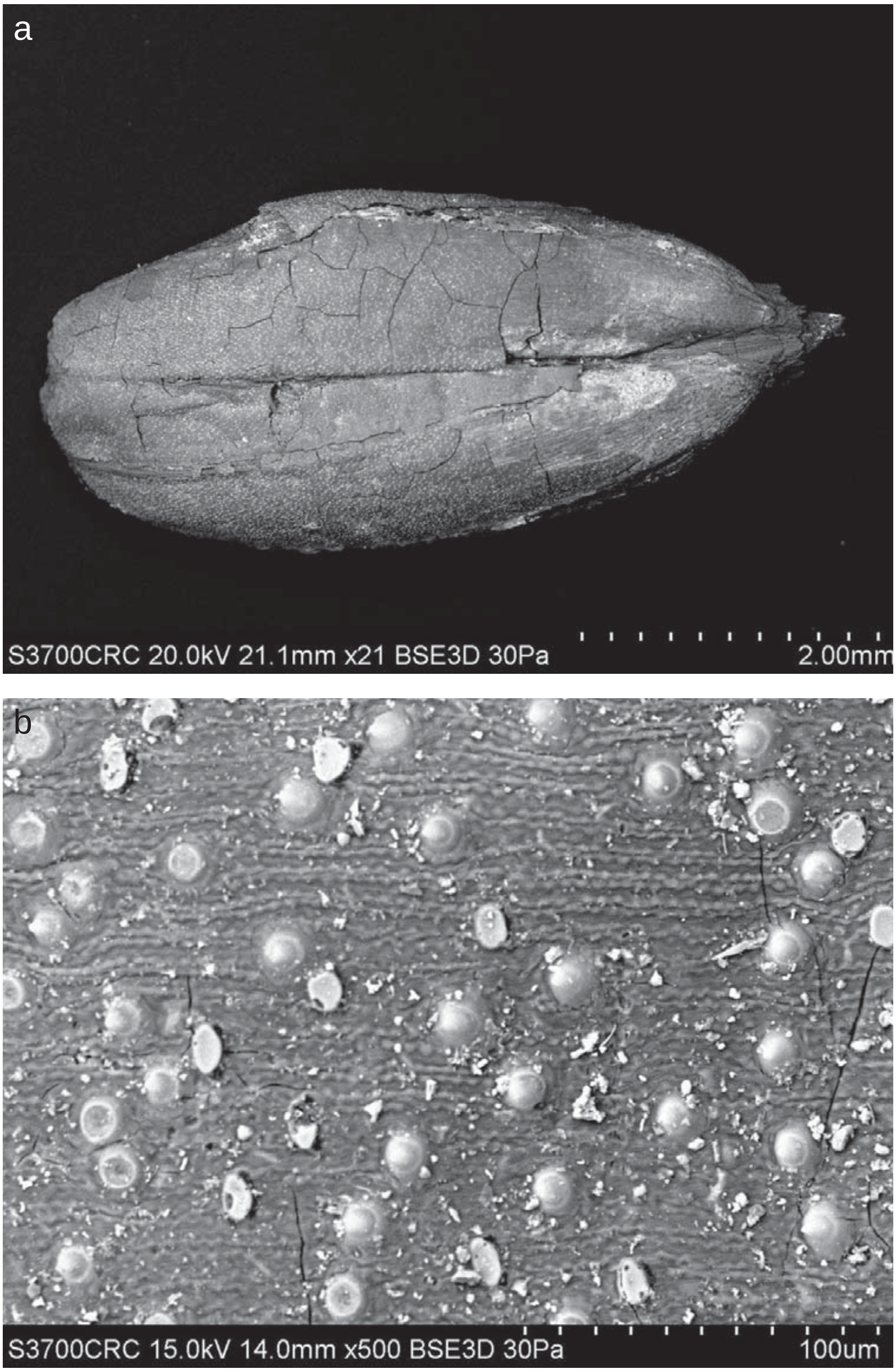

FIGURE 6. Backscattered electron images of: (a) a barley grain (*Hordeum vulgare*) from the charred layer (context 4106) in house E13.3–N; and (b) a detail of the epidermal cells and phytoliths. Image: Hitachi S-3700N VP-SEM

addition to distinguishing non-food plant uses such as for weaving, fuel and animal fodder.

Sometimes, depending upon environmental conditions that affect water uptake and levels of soluble silica, areas of epidermal tissue can become silicified, creating multi-cell forms commonly termed 'silica skeletons' [30]. The presence of silica skeletons enables a greater possibility of genus-level identification for many plant types, particularly grasses [30, 31]. Phytoliths can survive in non-charred and charred contexts and are released into sediments when plants die and decay, or through burning. The phytolith record can provide plant identification where charred material has been turned entirely to ash.

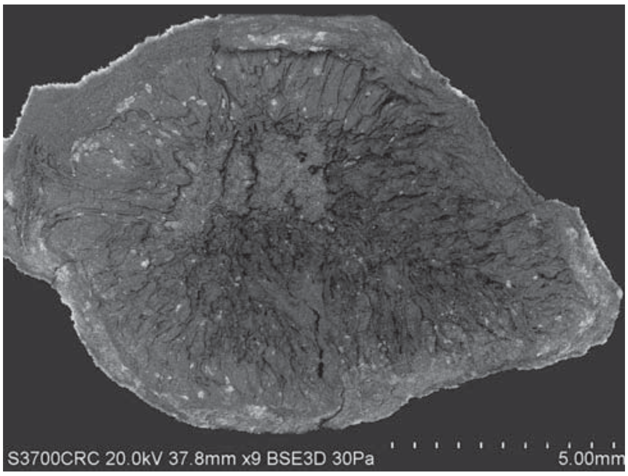

FIGURE 7. Backscattered electron image of a halved charred sycomore fig (*Ficus sycomorus*) fruit from the oven fill (context 4035) in house E13.3–N Image: Hitachi S-3700N VP-SEM

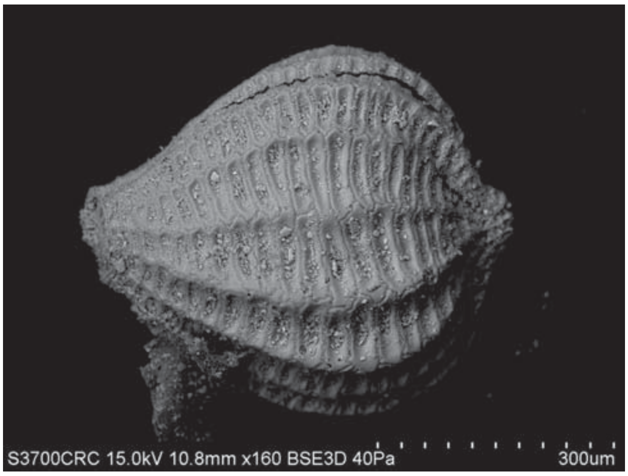

FIGURE 8. Backscattered electron image of a charred sedge nutlet (*Fimbristylis* sp.) from room 9 (context 2026) in villa E12.10. Image: Hitachi S-3700N VP-SEM

These durable micro-remains can be extracted from sediments through a series of laboratory techniques to remove clays, carbonates and organics; the procedures used in this study are based on those described by Rosen [32]. Extracted phytoliths are mounted onto slides and analysed under the microscope in transmitted light. Typically 300–400 morphologies will be counted per slide and the quantities and relative abundances (%) of morphologies can be compared between contexts.

To assist identification, phytoliths are extracted from modern plant materials so that reference slides can be made; modern plants collected during fieldwork are reduced to ash in a furnace and mounted on a slide for analysis by transmitted light microscopy. This phytolith reference material has also been studied using the VP-SEM.

A VP-SEM approach for simultaneous study of plant macro-remains and phytoliths

The VP-SEM has been used to study modern and archaeological plant remains to determine identifying features that can be used for macrobotanical analysis and, at higher magnifications, to examine seed coat patterning and epidermal cell arrangements. Studying cell arrangements is important for developing criteria to identify multi-cell phytoliths (silica skeletons) in the archaeological record. Highly silicified cells appear visibly white in the VP-SEM; it is possible to study elemental composition to ascertain whether the cells have a silicon content by using energy dispersive X-ray (EDX) analysis within the VP-SEM. The VP-SEM is particularly helpful for revealing undulating patterns of epidermal long cells, which can be useful for identifying conjoined phytoliths, Figures 3a and 3b. This approach shows potential for providing a new means to assess quantities of silica bodies and the extent of silica skeleton formation within plant parts.

Experimental charring of modern specimens

To inform the interpretation of archaeological assemblages, selected modern seeds were charred experimentally to

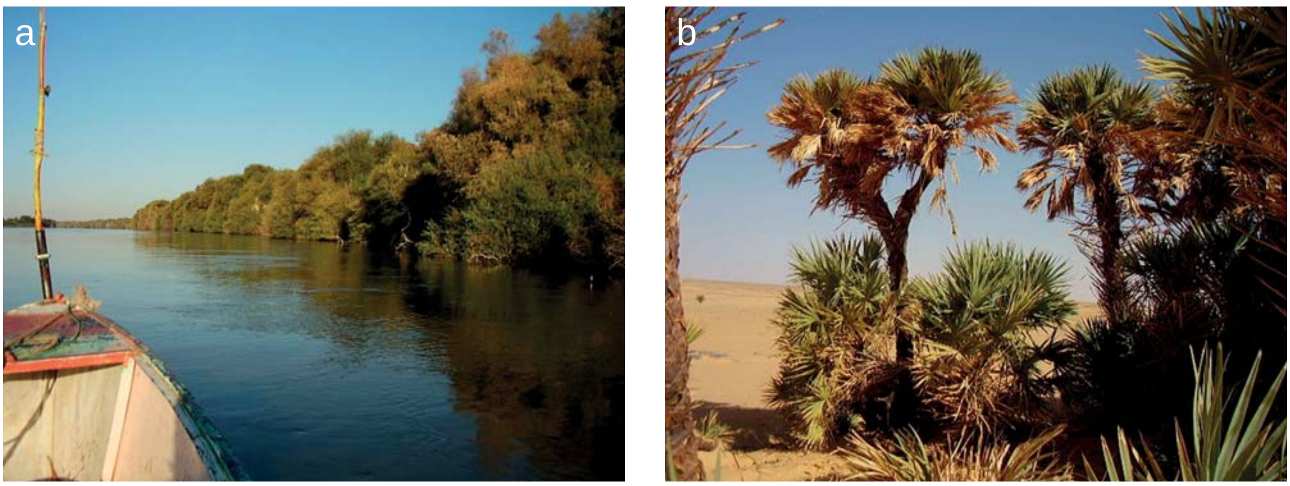

FIGURE 9. Local vegetation at Amara West: (a) tamarisks (*Tamarix* spp.) growing along the riverbanks close to the site; and (b) doum palms (*Hyphaene thebaica*) growing nearby

FIGURE 10. Backscattered electron image of a transverse section of tamarisk (*Tamarix* sp.) charcoal, showing large earlywood vessels almost entirely blocked by tyloses, wide rays, banded parenchyma and fibres. Image: Hitachi S-3700N VP-SEM

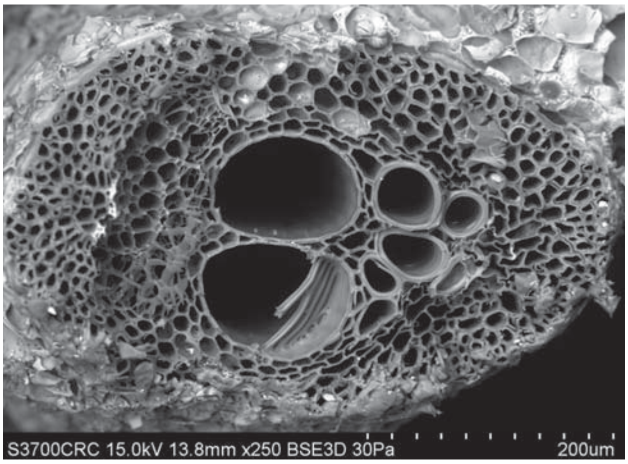

FIGURE 11. Backscattered electron image of a transverse section of doum palm (*Hyphaene thebaica*) charcoal, showing a vascular bundle embedded in parenchymatous ground tissue. Image: Hitachi S-3700N VP-SEM

investigate the varying impact of heat on different species. Seeds were placed in the furnace at 300°C for two hours and afterwards studied in the VP-SEM to record any changes to morphology or seed coat patterning. Interesting observations include the 'cream puff' appearance of some items after charring, including two taxa from the Amaranthaceae family and *Digitaria exilis* grass seeds, Figure 4. *Fimbristylis* sp. sedge nutlets did not appear particularly charred and had very distinctive outer layers, which appeared to consist of silicified cells (phytoliths). Such silicification may aid the preservation of these sedge seeds, which is particularly relevant as these are present within several of the archaeological samples.

When desert date (*Balanites aegyptiaca*) and Christ's thorn (*Ziziphus spina-christi*) fruits were heated at 360°C for two hours all the fruits remained whole after charring.

PRELIMINARY RESULTS AND DISCUSSION

An initial overview of the main taxa present and the types of contexts analysed is presented here. As part of the ongoing work at Amara West, full species counts and tabular quantifications will be presented in due course, once further sample analyses and taxon identifications have been conducted and comparisons made on a context-by-context basis (linked to site plans).

Site contexts

Within the rooms at Amara West, the deposits typically consist of occupation layers, rich in organic detritus and pottery along with other artefacts, above plain clay floors, interleaved with layers of brick rubble (from roofs and walls) and windblown sand. All of the deposits are dry, but textiles and wood are rarely preserved. Wind erosion is an important taphonomic factor at the site.

From the settlement, the oven and hearth deposits have the highest densities of plant remains; several with sediments containing up to 70–80% charred content indicating very well preserved *in situ* burnt deposits. Several contained greater quantities of ashy material with fewer charred items, while others had more sterile fills. In ashy fill deposits in which minimal charred material has survived, the phytolith evidence indicates key plant types. Large storage bins found in the extramural villa E12.10 appeared to contain only windblown sand and no charred remains were present. As these bins were not burnt in antiquity, any plant content within them would be unlikely to have survived in charred form; phytolith analysis of bin sediments (context 2044) confirmed that plant remains were absent, suggesting that these bins were empty at the time of abandonment. Floor sediments contained variable to low amounts of charred remains; these are most likely to represent charred and ashy materials derived and re-deposited from the ovens or hearths and, as such, are less strongly contextually related in comparison to the *in situ* remains from features such as ovens or hearths. Several pottery fills were dry sieved to test whether or not any plant macro-remains were present. These typically contained low densities of charred macro-remains that probably represent general fill rather than reflecting the purpose of the jars. In the two site cemeteries [8], the burials are cut into Nile alluvium or the schist bedrock. So far, the deposits extracted from vessels placed in tombs have been sterile. Remnants of wooden funerary objects have been recovered, as well as plant material used for basketry and wrapping of the deceased.

Charred cereals, seeds and fruits

The most common botanical elements recovered in the charred record are cereal grains and crop processing by-products. In the initial study, the cereals present are emmer wheat (*Triticum dicoccum*) and barley (*Hordeum vulgare*). On the basis of grain morphology as well as rachis segments, the barley has been identified as six-row (*H. vulgare* subsp. *vulgare*). Most examples of wheat and barley grains and chaff are excellently preserved.

During threshing, the cereal ears of hulled wheats break into individual spikelets that then require a second processing stage to free the grain from its seed bracts (lemma and palea enclosed within glumes). The crop processing by-products from hulled wheats that most typically survive the charring process are spikelet forks and glume bases, Figure 5. Hulled wheat spikelets differ in some respects from hulled barley spikelets, with the latter having residual glumes and more tightly enclosing lemmas and paleas. After threshing, the hulled barley ear breaks into both spikelets (barley grains encased within lemma and palea) and rachis segments and these grains will, like wheat, require a secondary processing stage if intended for human consumption, Figures 6a and b. Preliminary analyses indicate high proportions of cereal crop processing by-products in relation to grains in the majority of samples, high proportions of barley grains in comparison to wheat grains, but some variability in the relative proportions of barley to wheat chaff. Barley husk chaff is calculated by the number of rachis nodes while wheat husk chaff is quantified through the number of glume bases (spikelet forks comprise two glume bases). The percentage of husk chaff from wheat (in comparison to barley) in the grain processing area (room 9) of villa E12.10 was 89%. In the immediately adjacent oven room (room 10) the figure was 87% and, in contrast, in small houses E13.3–N and E13.3–S it was 45%.

Other crops present include domesticated lentils (*Lens culinaris*) and flax (*Linum usitatissimum*). A concentration of charred flax seeds was found in a burnt occupation deposit (context 4295) in building E13.3–S Small legumes were present in a number of samples, most frequently members of the Trifolieae tribe (which includes clover), possibly grown for fodder. The identification in several contexts of *Corchorus* spp. seeds (cf. *C. fascicularis*) is interesting, as species from this genus are widely cultivated in the Nile Valley today as a leafy green vegetable known as *mulukhiyah* [23].

Several fruits have been identified, including the sycomore fig (*Ficus sycomorus*), doum palm (*Hyphaene thebaica*), white cross berry (*Grewia tenax*), Christ's thorn (*Z. spina-christi*), *Cucumis* sp. (a genus that includes melons), colocynth (*Citrulllus colocynthus*) and watermelon (*Citrullus lanatus*). Watermelons have been cultivated in the Nile Valley since approximately the second millennium BC [33]. Sycomore fig trees may have been wild or cultivated through clonal propagation; wild examples grow near streams or ephemeral water sources and are still present in modern Sudan [33]. Doum palms may also have been wild or propagated, and today the doum is found growing naturally in Sudan and southern Egypt [2, 21]; its pounded kernel can be ground into flour [34]. No charred date stones from *Phoenix dactylifera* have been found and thus the status of the date palm is unclear, but it needs a reliable surface water supply or high ground water [33]. Other fruits such as Christ's thorn and the colocynth would have been gathered from the wild. The wild colocynth grows in desert and semi-desert sandy soils, while Christ's thorn has a wide distribution across savannah, thicket, desert oasis and Nile bank environments in Africa and across the Middle East [33]. Most commonly, the seeds of fruits are retrieved, but in several instances whole charred items are present, including sycomore figs (Figure 7), *G. tenax* berries and an example of a whole doum palm fruit (although the hard internal doum fruit endocarps are more usually retrieved).

Seeds from taxa that grow in wetter environments, such as along the Nile, include sedges (Cyperaceae), mainly *Fimbristylis* sp. (Figure 8) and *Cyperus* sp. and, more occasionally, rushes (Juncaceae). Some of these sedges and other wild seeds, including members of the Amaranthaceae family and *Portulaca oleracea* (Portulacaceae family), may have been cultivation weeds. Acacia seeds are also present and there are several acacia species in the region, with different growing habitats. Some of the seeds are from *Acacia nilotica*, which grows along the banks of the Nile. Wild grasses have been found infrequently as they are generally charred beyond recognition, but identifiable examples include C4 grasses from the chloridoid subfamily of the Poaceae. This wild grass subfamily is typically known to favour hot arid conditions [35].

Desiccated wood and charcoal

While the ultimate overall objective is to give careful consideration to each chronostratigraphic context from Amara West to evaluate economic and technological change alongside differences in the composition of vegetational communities, at this phase of the analysis the most significant results within the corpus of desiccated wood and charcoal are presented. There is a marked reliance on sycomore fig (*F. sycomorus*) for providing coffin wood and funerary artefacts and also for much of the fuel present in domestic contexts. Some use has also been made of the wood from several tamarisk species (*Tamarix* spp.) (Figures 9a and 10) for funerary objects, as well as for domestic fuel. Only present as charcoal in fuel debris are doum palm (*H. thebaica*) (Figures 9b and 11), Christ's thorn (*Z. spina-christi*) and Nile acacia (*A. nilotica*).

The phytoliths

Phytolith types extracted from sediments include silica skeletons (multi-cell phytoliths) from husks (seed bracts) and straw (stems) of wheat and barley. No multi-cell phytoliths from panicoid C4 grass husks (such as from domesticated and wild millet grasses or sorghum) have been identified thus far.

Specific single cells can also be used to distinguish between C3 and C4 grasses.[3] Habitually, C3 grasses (which include the cereal crops wheat and barley) favour temperate climates, while C4 grasses are more common in high temperatures [35]. Within the C4 grasses, the chloridoid subfamily is more often associated with aridity and the panicoid subfamily with moister conditions. In the Amara West phytolith record, there are low numbers of bilobe forms (associated with panicoid grasses); these suggest that some of the very charred grass seeds in the macro-record could be from panicoid grasses, but the small quantities imply that this group of grasses was not economically important. In contrast, saddle forms are present more frequently and in higher relative abundances, some possibly from the same wild chloridoid grass identified in the macro-record and are possibly associated with ashy fuel remains.

There are also phytoliths present from sedges (Cyperaceae), trees, shrubs and palms. Palm leaf phytoliths are commonly present in ashy deposits and include globular echinates as well as multi-cells. In several oven and hearth samples there are high quantities of multi-cell leaf phytoliths from dicotyledonous plants (trees and many herbaceous shrubs). These dicotyledonous forms may either be entering the record via leaves attached to the burnt charcoal or in dung burnt as fuel. Further analyses from dung pellet samples will help to clarify which phytolith forms may reflect part of the animal diet.

Dung

Charred dung was found in several ovens or hearths. The contents of dung pellets are being investigated through their dissection for macrobotanical remains, via VP-SEM analysis of the charred contents and through processing to extract their phytolith content. Preliminary analyses have found no whole charred seeds or plant parts, however highly fragmentary plant parts suggestive of leaf or stem material are present. VP-SEM analyses of selected fragments show some to be from barley lemma or palea material, suggesting that barley chaff was being fed to animals. Some plants may have been included within dung materials, for example, through being trodden into the floor areas of animal pens, or being added in the form of chaff temper to dung cakes to be used for fuel.

DIET AND AGRICULTURE DURING THE NEW KINGDOM COLONIAL OCCUPATION

The presence of wheat spikelets in the villa and houses indicates wheat de-husking in multipurpose spaces in smaller houses and in a dedicated room in the villa. This suggests wheat was stored in spikelet form, yet to undergo a final processing stage prior to grinding and consumption. Differential access to cereals is suggested by the large storage features in elite villas, such as the open courtyard (room 7) in villa E12.10, and their absence in smaller dwellings. The evidence for wheat de-husking, but no storage facilities, suggests the smaller houses had grain provided in ear or spikelet form from centralized storage facilities, possibly the magazines.

It is noteworthy that in the grain processing area of villa E13.10 (room 9), the barley grains displayed hull removal, suggesting the use of barley as a food in addition to wheat. Although barley is often considered inferior to wheat and grown as an animal fodder crop, it tolerates higher salinity and drier conditions and can be an important human food crop [33]. While some of the barley grains from hearth and oven contexts had their hulls removed, others were still in their hulls; it is possible (pending further analysis of dung pellets) that some of the barley may reflect animal diet and that the barley assemblages represent more than one taphonomic pathway.

Access to storage facilities within their large homes for members of the elite – whether priestly, military or administrative – is well attested at Tell el-Amarna [36]. In contrast, although there is evidence for cereal de-husking within houses at Amara West, there are no mortar emplacements resembling those found at sites such as the workmen's village at Amarna or Deir el-Medina in Egypt [37], which suggests some difference in the methods used for de-husking. However, there are similarities in other features connected with plant use. For instance, the circular structures of fired clay, coated in mud plaster, with walls tapering inwards and containing charred plant remains, are similar to those interpreted as bread ovens in New Kingdom sites throughout Egypt [37].

As yet, there is no suggestion of the C4 grass consumption noted from later Nubian sites [18]. Any indication of C4 grass consumption would be significant as a marker of diversification in cereals exploited, as well as the use of summer sown cereals. Furthermore, any such evidence for C4 grass use from specific buildings could hint at local plant use traditions. The apparent absence of free-threshing cereals matches the theory that emmer wheat was the predominant wheat species in Nubia until the later first millennium BC [18]. The presence of six-row hulled barley is interesting because two-row barley is identified from later Nubian sites, while six-row barley is more commonly grown in New Kingdom Egypt [38]. This suggests a similarity in barley use with contemporary Egypt, but does not necessarily indicate a deliberate cultural choice versus local two-row. Some of the later two-row barley identified in Nubia has been linked genetically to an earlier six-row form [39], while barley found from sites that are earlier than Amara West is not generally reported in the literature to species level.

Samples analysed from the villa and smaller houses thus far highlight the role of agriculture based on wheat, barley and pulses, which matches a typical New Kingdom agricultural pattern. The high proportions of barley may reflect multiple taphonomic pathways as well as aridity. It is interesting that many of the fruits present are taxa geographically associated with Northern Sudan and with wild populations still present today; it is possible that the use of local fruits was an expression of local habits and cultural decisions. The absence of taxa such as the date palm and grapes may reflect the lack of suitable horticultural conditions as well as other land use priorities enforced by the bounded nature of an island.

CONCLUSIONS

The archaeobotanical component of the Amara West project is providing new information about agricultural strategies in the occupied region of Upper Nubia in the late second millennium BC, together with insights into the degree of colonial control versus local traditions. The record is important for tracing food production trajectories in Sudan in the Late Holocene, where, at present, very little is known from urban settlements of the third and second millennium BC. Botanical data tables from the pilot study and comparisons between datasets on a context-by-context basis, in conjunction with site plans, will be presented in subsequent publications, together with statistical analyses of spatial variations in plant distributions. Future research aims include investigating whether patterns of plant use shifted alongside the collapse of Egyptian control (*c*.1070 BC) and increased regional aridification. Risk buffering might be attested through changing ratios between cereals with different water requirements or the use of supplementary wild plants. Studies of plant micro-remains (phytoliths and starch) from dental enamel in faunal remains recovered from the same deposits will help to clarify whether animals were foddered on wheat or barley (C3) or ate wild C4 grasses. The environmental evidence from the plant remains will be contextualized with landscape reconstructions by the geoarchaeological team from Manchester University (Jamie Woodward) and Aberystwyth University (Mark Macklin). To date the contexts analysed have been predominantly from within specific buildings, but this will be expanded in the future to include sun-dried mud bricks made from local alluvium, roofing impressions of plant material (some tied in bundles, or woven into mats) that was laid over a network of wooden poles and beams, and rubbish deposits; these will allow further characterization of the distribution of plant remains.

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NOTES

1. Further information on the Amara West project is available from the British Museum website, www.britishmuseum.org/AmaraWest (accessed 10 June 2012).
2. C3 and C4 grasses have different photosynthetic pathways. C3 grasses (which include wheat and barley) are generally associated with temperate climates, while C4 grasses are adapted to hotter climates. C4 grasses include the grass subfamilies panicoid and chloridoid. There is variation between individual genera, but as a rule panicoid grasses (which include wild and domesticated millets and sorghum) prefer moister conditions, while *most* chloridoid grasses are more arid adapted [35].
3. See note 2.