Positive casts of wheat and barley on a fired-mud basin from the Christian site MRB-05-001 at El-Mirebiet oasis in El-Ga'ab Depression, Western Dongola, Sudan

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Introduction

Pottery often contains evidence of impressions of small plant materials such as seeds\grains, husks, leaves and twig which might have been originally in the clay or accidentally incorporated while shaping the vessels. The dry plant materials absorb a certain amount of water from their moist clay surroundings, and the passage of water from the clay deposits a layer of fine clay particle around them. This fine cast often preserves minute morphological details of the grain surface (Helbaek 1955, 653). During the firing of the pottery these plant materials are burnt away leaving depressions which retain more or less the same external morphological features as the plant remains themselves (Renfrew 1973, 8).

According to Magid and Krzywinski (1995) the development and application of the method of making positive casts of plant impressions in pottery is at least 100 years old. Some of the earliest publications we are aware of concerning impressions of plants are those of Mortimer (1905) and Cree (1908). The value of impressions of plants (e.g. seeds and grains) in pottery and baked clay as a source of evidence became fully recognized with the development of the study of plant remains in Scandinavia and Britain in the works of scholars such as G. F. L. Sarauw, K. Jessen and H. Helbaek (Renfrew 1973). However, we are not aware of any published or unpublished works, which explicitly deal with procedures for examining potsherds for plant impressions or for making positive casts of plant impressions in pottery and baked clay.

In Sudan, many plants impressions were reported from the surfaces of more than 300 pottery sherds recovered from the southern and northern settlement of the Neolithic site at Kadero, a little north of Khartoum. From here 170 impressions of plants were analysed and the plants identified were classified into three groups, sorghums, cereals and unidentified grasses (Klichowska 1978).

Impressions of plants were also reported on Mesolithic pottery sherds recovered from the sites of Sheikh Mustafa and Sheikh el-Amin in the Blue Nile region. The procedure for identification mainly was based on comparisons of the external morphological features (i.e. shape, size and surface pattern) of the positive casts with reference to a collection of extant plants, and with results of experimental plots showing changes in dimensions of grain impressions as seen in their positive casts. The specimens included: *Setaria* sp., Wild *sorghum* sp., *Cassia* sp., *Grewia* sp., *Celtis integrifolia*, *Solanum dubium, Cucurbitaceae*, (flattened)? *glume, Echinochloa* sp, *Carex* sp. and *Grewia tenax* and *Solanacea*e (Magid 2003).

From Mahal Teglinos ,which is located near Kassala, about 350km to the east of Khartoum, a total of 25 sherds was examined for plant impressions. These included *Sorghum bicolor, Setaria sp.* and *Vigna unguiculata,* and fruit stones of *Ziziphus spinachristi* and *Setaria sp.* (Beldados 2011).

Clapham and Rowley-Conwy (2007) identified three different species of the genus *triticum diococcum* dated to the Napatan, Meroitic and Post-Meroitic periods, and genus *triticum durum* and *tritucum aestuvum* dated to the Post-Meroitic.

A large part of the mud roof from two rooms in house E13.4 in the New Kingdom town at Amara West in northern Sudan was recovered. On it were impressions of grass and plants which indicate that the roof beams had been covered with branches and bundles of grass (Spencer 2014, 476).

Archaeobotanical remains from Gala Abu Ahmed (dated to 1250-400 BC) in Wadi Howar, included imprints of wild grasses on various fragments of pottery (Jesse 2014, 552).

From the 91 pottery sherds examined from KG23, in the locality of Khashm el-Girba in eastern Sudan, about 65 sherds produced a total of 279 identifiable plant impressions, of which 249 impressions of sorghum were recorded on 63 sherds (Winchell *et al.* 2017). The remaining sherds produced undiagnostic fragments of grass straw (leaf or culm).

El-Ga'ab location

El-Ga'ab depression is situated south west of the Third Cataract of the Nile on the western bank at the northern end of the Dongola Reach. It extends about 123km, crossing the desert in a north-east to south-west direction. It diverges from the Nile towards the south; the nearest point to the river is about 6km at the northern tip and the furthest point at 60km in the southern part. Its width varies from 2km to 8km. Based on geomorphological features, the el-Ga'ab area can be divided into three regions (Figure 1):

The northern channel which is a gravel-covered area begins in the vicinity of Soroog Village (19° 45.517' N/30° 23.120' E),

Wadi el-Hashsha which is an area of terraces and alluvial soils,

Ga'abs (oasis) to the south of the Wadi Hashsha where there is a series of Ga'abs.

Description of the excavation site

Site MRB-05-001 is located in Ga'ab el-Mirebiet to the south west of Ga'ab el-Thowani in a low-lying area. It consists of a building with an eastern corridor (partition), a room in the centre containing a ceramic basin, two rooms (halls) in the south west and the north west, two corridors and a doorway in the south. At a higher level in the central room a tank was

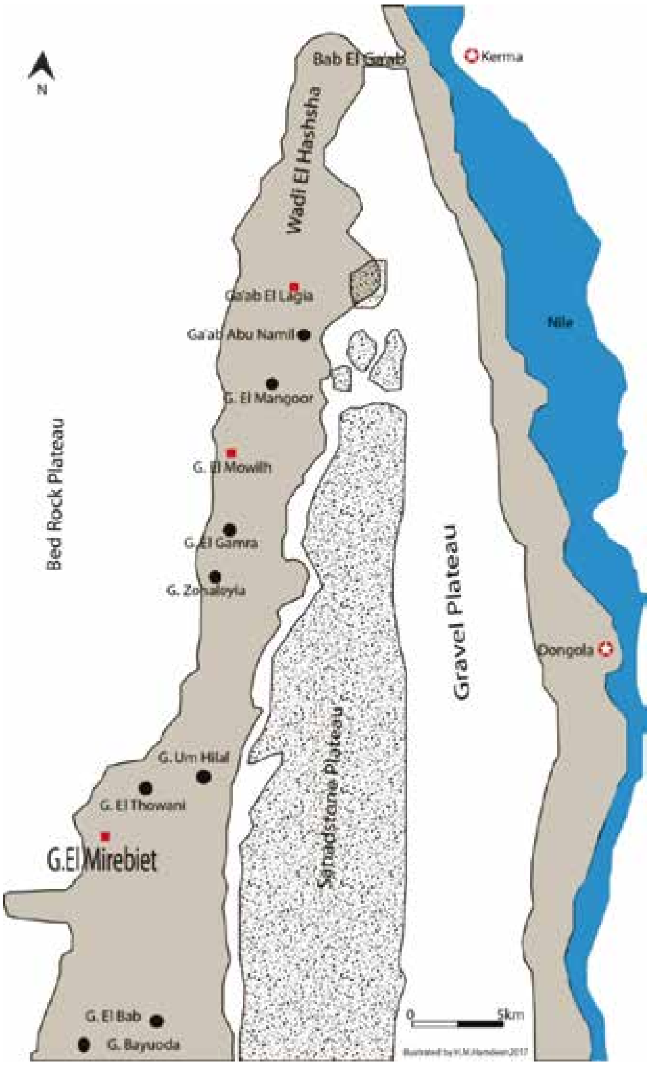

Figure 1. The location of el-Ga'ab Depression

constructed of stone. On the exterior surface, the stones are covered with plaster. On the surface of the site, there are coloured pottery sherds of different shapes, upper grinding stones, coal, and animal bone (Said and Tahir 2016) (Plate 1).

Description of the ceramic basin

In the southern part of the central room a large circular pottery basin was located, 850mm in diameter, 360mm in height and 2.55m circumference and with a wall 40mm thick. In the lower part of the basin, a 150mm opening was noted and it may have been used to extract liquid (such as wine) from the vessel (Plates 2 and 3). Under the basin, a gypsum layer mixed with sand appeared (Said and Tahir 2016).

Material and methods

Many plant impressions were observed on the surface of the ceramic basin. To make their casts, a small paint-brush was used for cleaning the basin and cast impressions. The casts of the impressions were made using plast air-drying latex which is a flexible mould compound, and left for one hour to dry. The latex mould compound was mixed with Indian

Plate 1. Site MRB-05-001: view from the south.

Plate 2. Ceramic basin.

Plate 3. Ceramic basin:.

ink to facilitate direct observation of the casts and to dilute the compound. The material was photographed and casts with clear impressions were selected for further examination using a stereo microscope (Krussoptronic, Germany) at x20 magnification and photographed using SMART 5MP PRO-DELTA/optical. The percentage of the surface area which included plant impressions was estimated.

The procedure for plant-cast identification was mainly based on the comparisons of the external morphological features (i.e. shape, size and surface pattern) with reference collections.

Results

General physical observations

It was observed that, more than 20% of the inner surface of the basin (estimated from the total surface area measurement) was covered with impressions of plants which may have been originally mixed with the clay to form the fabric or accidentally incorporated while shaping the ceramic basin (Plate 4). These included stem fragments: casts range between 1.5-30mm in length and 1-3mm in width, along with whole fruit casts being of different shapes and sizes (Plates 5 and 6).

Plant positive cast identification

Plate 4. Ceramic basin: 20% of the surface area was occupied by plant impressions on the inner surface.

Plant impressions were identified as wheat (*Triticum sp.*) and barley (*Hordeum sp.*). Identification was based on fresh samples obtained from cultivated material from northern Sudan. Comparative measurements such as fruit lengths and embryo scar angle on both fresh samples and the positive casts revealed that all the plant materials had been embedded while fresh (Plate 7). Wheat and barley were identified by their fruit casts.

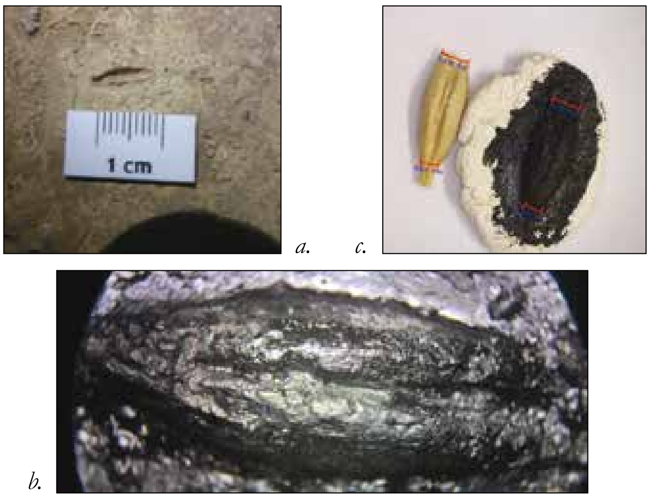

Plate 5. a) cereal impression; b) Positive cast of the cereal impression; c) Positive cast and the fresh reference sample.

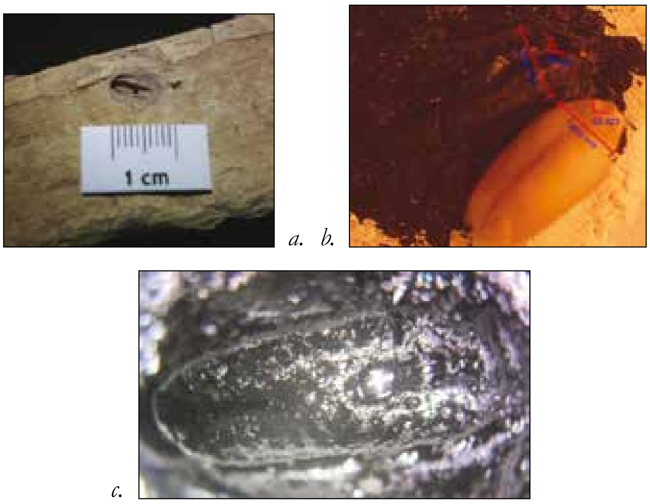

Plate 6. a) cereal impression; b) Positive cast of the cereal impression; c) Positive cast and the fresh reference sample.

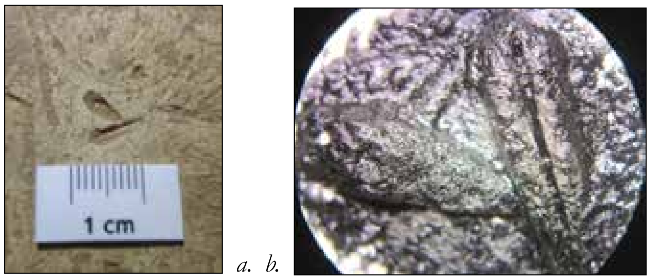

Plate 7. a) cereal impression; b) Positive cast of the cereal impression.

Discussion

It is evident that the positive-cast methodology has potential for the identification of plant impressions on pottery surfaces as was noted at the sites mentioned above.

Wheat and barley are Near Eastern crops and emmer wheat and hulled barley have been present in Sudan since the Neolithic, free-threshing wheats arriving later (Out *et al.* 2016). Their grains constitute the main source of calories for mankind. Cereals thrive in open ground and complete their life-cycle in less than a year. The nutritional value of their grains generally is high, and the seeds can be stored for long periods. In most cereals the kernels are packed with starch, and in some, such as in wheat and oats, they also contain an appreciable amount of protein. Food production in the Mediterranean basin, Europe, the non-tropical parts of Asia, and (to some extent) the highlands of Ethiopia, was based primarily on wheat and barley (Zohary and Hopf 1988, 13).

Three *matara* (*saqia*-wheel wells) were reported in the el-Hamra area (sites E H-3-001, EH-4-008 and EH-4-0012). *Qadus* (*saqia*-wheel pot) sherds are distributed in the vicinity of the abandoned wells. Such sites may have been greater in number than those discovered so far, as sand dunes hide many archaeological sites, among them are perhaps *mataras*.

The presence of three *saqias* in a small area is indicative of intensive agriculture practices in el-Hamra region. Another possibility for irrigation is the use of *shadouf*. In light of this evidence for agricultural activity it is assumed that the seeds recovered are from local production (Ikram Madani *et al.* 2015, 145-146).

Wheat and barley have been the traditional staples of Europe and west Asia, and they are also the principal 'founder crops' that started food production in this part of the world. The first definite signs of wheat and barley cultivation appeared in the Near East 'Fertile Crescent' towards the end of the eighth millennium BC. Later, grains of these cereals constituted the bulk of plant remains retrieved from Near Eastern Neolithic and Bronze Age contexts. Wheat and barley were also the main domesticates that made possible the explosive expansion of Neolithic agriculture from its 'core area' to the vast territories of west Asia, Europe, and North Africa - from the Atlantic coast to the Indian subcontinent and from Scandinavia to the Nile Valley (Zohary and Hopf 1988, 13).

The remains of these two cereal grains, *Triticum* sp. and *Hordeum* sp., as grain and spikelet have been reported at many archaeological sites in Sudan. At Napatan site HP736 in the Wadi Umm Rahau at the Fourth Nile Cataract, spikelet base fragments of emmer *Triticum cf. dicoccum* were recovered (Badura 2012). At Kawa, a grain and spikelet of *Hordeum vulgare* and *Triticum diococcum*, dating to the Napatan period 750-400 BC, were also recovered (Fuller 2004). Outside the Nile Valley, at Gala Abu Ahmad, located about 110km west of the river in Wadi Howar, *Triticum diococcum* was reported, again dated to the Napatan period (Kahlheber 2013). Wheat and barley were amongst the macro-plants remains at Meroe (Shinnie and Anderson 2004, 366). At Soba East located on the Blue Nile, van der Veen (1991) reported remains of the *Hordeum* sp. Fuller and Edwards (2001) reported the presence of wheat and barley at Nauri, a medieval/post-medieval site in the Third Cataract region. In the Christian complex at el-Hamra in the el-Ga'ab depression Ikram Madani *et al.* (2015) noted the remains of *Triticum aestivum* (L.) and *Hordeum vulgare* (L.).

In this study *Triticum* sp. and *Hordeum* sp. are identified for the first time from their positive cast from a Christian site in Sudan. *Hordeum vulgare* (barley) is grown for animal fodder today. The presence of this plant on this site indicates its importance as a food source for humans in the past. Barley possess a higher ecological adaptation to salinity and drier conditions than wheat, and this may be the reason for its consumption by humans during dry periods (Ikram Madani *et al.* 2015, 147).

A by-product of this crop cultivation is straw. Straw is strong if it is stretched but crumbles easily. Mixing mud and straw makes a material that is resistant to both squeezing and tearing. Many authors have studied the mechanic properties of old natural building materials. Yetgin *et al.* (2008) reported that the addition of plant fibres to the mud decreases the compressive and tensile strengths and shrinkage rates. Also Sharma *et al.* (2015) reported that several experimental investigations have established the positive effects on the physical and mechanical properties of mud-based building material when adding natural fibres, improving its mechanical strength, impermeability and durability.

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