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Traces of date palm in an early third-millennium BC tomb in Zukayt, al-Dākhiliyyah, Sultanate of Oman (poster)

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Summary
Tomb ZKT109 in the oasis of Zukayt (al-Dākhiliyyah, Sultanate of Oman) yielded a small biconical Mesopotamian jar made of fine, buff-coloured paste and dated to Jemdet Nasr/Early Dynastic I–II period (*c*.3100–2700 BC). The vessel is entire and well preserved aside from severe abrasion on its external surface. This find testifies to the penetration of southern Mesopotamian material culture (or to the contextual production of local imitations) into central Oman during the first half of the third millennium BC. Micro-botanical and elemental analyses were carried out on the sediment contained in the vessel: 1) to determine the overall feasibility of such analyses in this environmental context; 2) to elucidate possible uses of the vessel; and 3) to explore depositional and post-depositional processes. Results showed relatively good preservation of plant micro-remains, including pollen and phytoliths (mostly from palms and dry land grasses). Elemental analysis shows the presence of phosphates, suggesting the preservation of organic matter, which should be further tested through lipid analysis. These results open interesting scenarios for the study of residues from vessels in the Arabian Peninsula and a better understanding of date-palm exploitation during the early third millennium BC.

Keywords: date palm, micro-botanical remains, elemental analysis, Bronze Age, Oman

Introduction

Tomb ZKT109 was identified during a systematic survey of the oasis of Zukayt (Fig. 1/a) carried out under the auspices of the Wadi Halfayin Survey Project under the patronage of the Ministry of Heritage and Culture of the Sultanate of Oman between 2010 and 2013 (Bortolini 2014). The survey aimed to obtain a census of all the monumental funerary structures located in the area, recording elements of structural variability and their spatio-temporal distribution.

The tomb has entirely collapsed and a great part of the stone blocks from the walls has been removed and possibly reused in ancient and modern times, leaving a preserved height of *c*.50 cm. The structure is located on a plain about 1 km to the south of the modern oasis, next to another completely collapsed tomb and surrounded by similar structures (Fig. 1/b).

In light of the unworked or partially worked stone blocks of locally available materials and the relatively small diameter, Tomb ZKT109 was described as a Hafit-type cairn and tentatively dated to the first half of the third millennium BC. This chronological attribution is confirmed by the finding of a small, buff-coloured biconical carinated jar with everted rim (Fig. 1/c). The fallen stone blocks completely covered the vessel and preserved it in its entirety, aside from signs of severe abrasion on the external surface (Bortolini 2012). The same type of vessel has been found in other cairn concentrations in northern Oman such as those at Jabal Ḥafīt, ᶜIbrī, Bāt, and ᶜAmlah (Méry 1996; Cleuziou & Méry 2002). The pot is considered to be Mesopotamian dating to the Jemdet Nasr/Early Dynastic I–II period (*c*.3100–2700 BC). This type of pottery testifies to the penetration of southern Mesopotamian material culture or to the contextual production of local imitations into central Oman during the early Bronze Age. A detailed study of their morphology, fabric, and residual contents may offer further evidence on the use and reuse of imported materials in funerary practices of prehistoric southern Arabia.

The small jar found at Zukayt — now housed at The National Museum of the Sultanate of Oman — is of particular relevance since its good state of preservation may help to address questions on its use and content. With this purpose in mind, the aeolian sediment that filled the vessel was collected and preserved in a sterile container. Considering the small size of the pot and the partial isolation from the external environment offered by the collapsed tomb, it is plausible that this sediment relates to the period immediately following the deposition of the vessel within the tomb. Micro-botanical and elemental analyses were carried out on the sediment: 1) to determine the overall feasibility of such analyses in

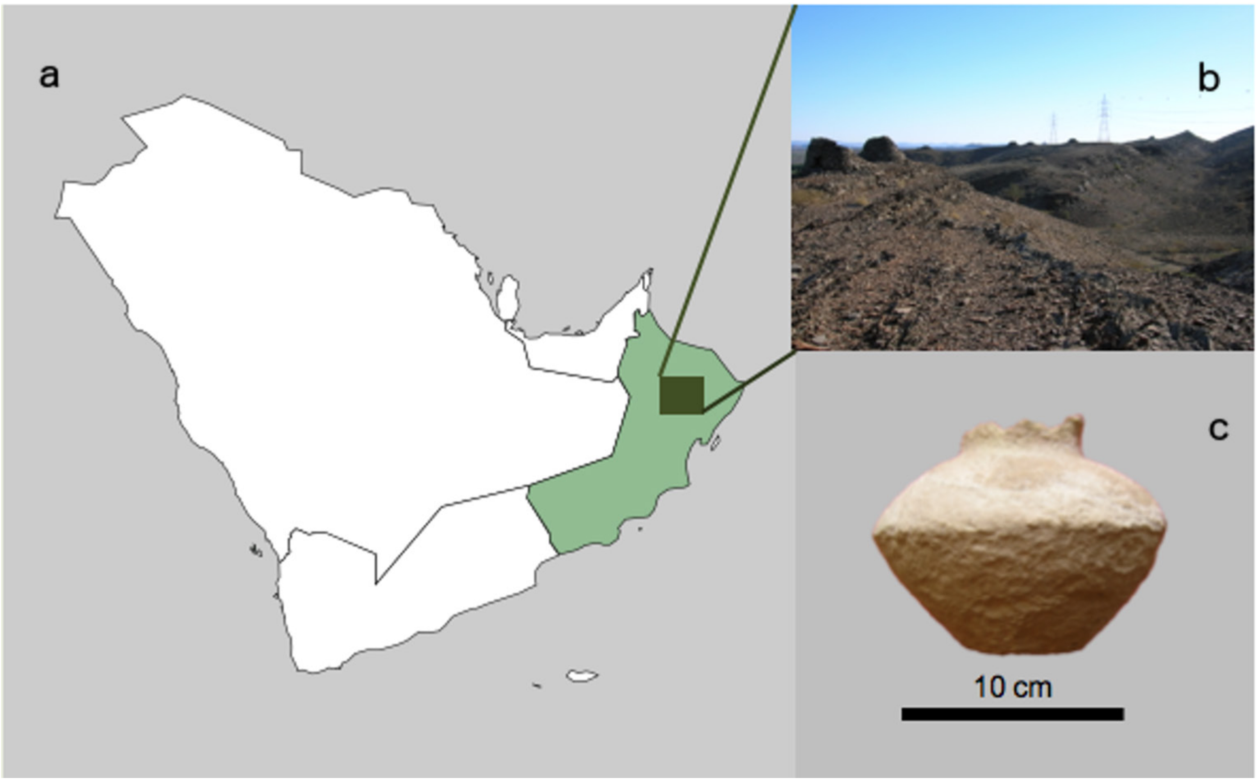

Figure 1. a. *The location of the oasis of Zukayt (al-Dākhiliyyah, Sultanate of Oman);* **b.** *a view of the Early Bronze Age Hafit-type tombs in Zukayt;* **c**. *the Jemdet Nasr/Early Dynastic I–II period vessel uncovered under the collapsed vault of Tomb ZKT109, from which sediment was extracted and analysed.*

this environmental context; 2) to elucidate possible uses of the vessel; and 3) to explore depositional and post-depositional processes.

Methods

The sediment contained in the vessel was processed for the extraction of micro-botanical remains at the BioGeoPal Laboratory (IMF-CSIC, Barcelona, Spain). The laboratory work followed the protocol established by García-Granero, Lancelotti and Madella (2016), which allows for the separation of light particles such as micro-charcoal, starch and pollen grains, and heavy particles (phytoliths). Micro-botanical remains were then analysed with a Leica DM2500 microscope with transmitted light (plain and cross-polarized) and a Leica DFC490 camera for microphotography. The light fraction was mounted on 50% glycerine and fully scanned at x200 and x630 magnifications, while the heavy fraction was mounted in Entellan (permanent mounting) and scanned at x630 magnifications until 10% of the slide was analysed. Phytolith nomenclature followed the recommendations of the International Code for Phytolith Nomenclature (ICPN; Madella, Alexandre & Ball 2005).

XRF (X-ray fluorescence spectroscopy) elemental analysis was carried out with an Olympus Innov-X DELTA handheld XRF with workstation test stand at Universitat Pompeu Fabra, Barcelona, Spain. This technique captures the spectrum of secondary emissions from materials that have been bombarded with X-rays, and identifies/quantifies the presence of different elements based on the intensity of the signal.

Results

A total of ninety-four identified phytoliths were observed in the heavy fraction scanned area (Fig. 2), with predominance of globular echinates characteristic

Morphotype	**Number of phytoliths**	**Percentage of identified phytoliths**
Elongate psilate	8	8.51
Elongate echinate	2	2.13
Elongate dendritic	1	1.06
Saddle	2	2.13
Bilobate	8	8.51
Rondel	4	4.26
Bulliform cuneiform	4	4.26
Globular echinate	50	53.19
Parallelepipedal	3	3.19
Trichome	10	10.64
Trichome base	2	2.13
Total identified	**94**	**100.00**
Weathered unidentified	27	
Total phytoliths	**121**	

Figure 2. *The phytolith assemblage from the Mesopotamian pot in Tomb ZKT109.*

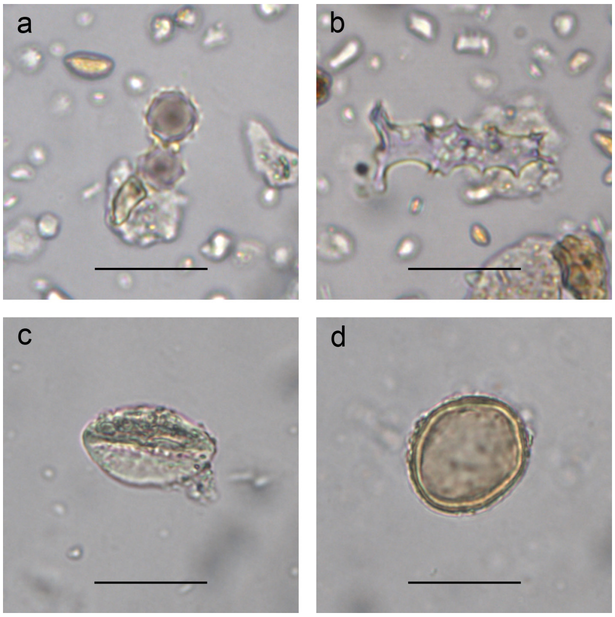

Figure 3. *Micro-botanical remains observed in the sample from the Mesopotamian pot in Tomb ZKT109:* **a.** *globular echinate phytoliths from palms (Arecaceae);* **b.** *elongate dendritic phytolith from a grass inflorescence (Poaceae);* **c–d.** *pollen grains. Scale bars: 20 µm.*

of palms (Arecaceae, 53.19% of the identified phytolith assemblage) (Fig. 3/a) and several morphotypes from grasses (Poaceae, 30.85%) (Fig. 3/b). The phytolith assemblage also included other non-taxonomically diagnostic morphotypes (15.96%) and twenty-seven phytoliths that were too weathered to be identified. The analysis of the light fraction yielded no starch grains but a variety of pollen grains (Fig. 3/c–d). Elemental analysis (Fig. 4) showed high concentrations of calcium (Ca) and metals, lead (Pb) in particular, as well as the presence of phosphates (P).

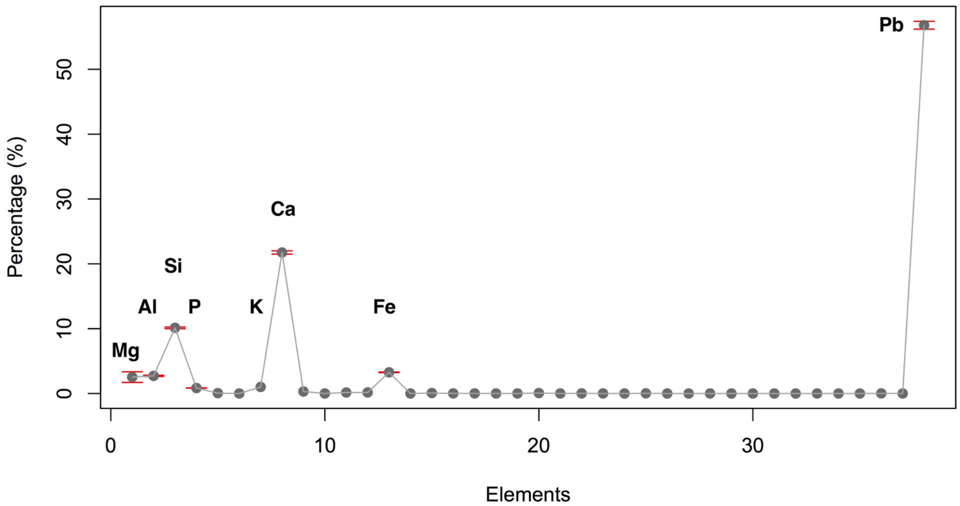

Figure 4. *Results of the XRF elemental analysis exhibiting the presence (in %) of magnesium (Mg), aluminium (Al), silicium (Si), phosphorus (P), potassium (K), calcium (Ca), iron (Fe), and a possible high concentration of lead (Pb).*

Discussion and conclusions

The results of phytolith analysis suggest the presence of palms (and more specifically palm leaves) at Zukayt at the time, or immediately after, the small pot was deposited in the grave. This may be due to the use of palm leaves in rituals or, more probably, to the presence of palm trees in the local environment at the time the pot was deposited. It is interesting to note that the phytolith assemblage has a high proportion of palm leaves and that grasses are less represented (Fig. 2), even though the grass family is the highest producer of phytoliths per gram of plant dry matter (Piperno 2006).

Phoenix dactylifera (L) — date palm — is the only palm native to the Gulf region (Western 1989) and can reach up to 100 years of fruit productivity, especially when grown in managed palm groves via offshoots. Dates have a high sugar content (>75%) and can be easily dried. There are more than 2000 date varieties, with appreciable phenotypic differences in colour, shape, taste, time of development, and profitability. These characteristics make dates an extremely valuable and easily portable source of energy in arid environments with changing and unpredictable conditions.

It is still difficult to determine wild ancestors of date palm (Tengberg 2003) and consequently to avoid possible confusion with the many feral varieties occupying the same habitat (Gros-Balthazard et al. 2016). As far as domestication of *P. dactylifera* is concerned, the most likely scenarios include: a) two independent domestication events in western Asia and northern Africa, followed by admixture in the Near East/Egypt due to interaction and exchange; and b) domestication in western Asia and spread into northern Africa followed by introgression with local feral/wild populations in both regions and drift due to isolation (Terral et al. 2012; Hazzouri et al. 2015; Mathew et al. 2015). Genetic and morphological data confirm the prominent role of western Asia and the Arabian Peninsula in the process of date-palm domestication. Archaeological evidence for its exploitation mostly consists of macro-botanical remains such as charred or mineralized seeds. The earliest presence is documented for the Neolithic settlement at Dalma (UAE), dated to the late sixth/early fifth millennium BC and to the early/mid-fifth millennium BC (Beech & Shepherd 2001; Beech & Glover 2005); and at al-Ṣabiyyah (Kuwait), dated to the second half of the sixth millennium BC (Beech 2003). Sporadic findings of date stones have also been reported from the Neolithic layers (period I and III) of Mehrgarh, Pakistan (Costantini 1985). A more intensive exploitation of this tree may be linked to the contextual development of efficient irrigation systems from the second half of the third millennium BC (Potts 2003; Tengberg 2012), although there is archaeological evidence suggesting that systematic exploitation and cultivation of palms may have begun at least by the beginning of the third millennium BC in sites that are geographically close to Zukayt (Cleuziou 1982; 2009; Desruelles et al. 2016). In this emerging scenario, palm phytoliths reported here may be interpreted as further evidence of an early presence of date palm in northern Oman, specifically in the high density of monumental funerary structures.

The presence of both calcium (which can be of geological or biological origin) and phosphate highlighted by elemental analysis, as well as the preservation of pollen grains, might point to the presence of organic matter in the vessel and hint at the possibility of obtaining information on the use of the pot when it was deposited — as well as on a variety of post-depositional processes. The high concentration of lead, also detected through elemental analysis, may be genuine or an artefact of XRF measurement, considering the low presence of lead in local geological deposits. Further analyses are needed better to assess the presence and role of this specific element.

The results of this study firmly support the possibility of conducting micro-botanical and elemental analyses on sediments of this particular environmental and cultural context. The current study, notwithstanding its limitations, opens many additional and interesting questions that could be addressed by directly examining the vessel uncovered in Tomb ZKT109. The origin of organic matter can be further assessed through chemical analysis (Copley et al. 2001), while the analysis of phytoliths can be expanded to different parts of the internal surface of the vessel. Finally, archaeometry and compositional analyses can help us understand whether the small jar found at Zukayt was actually imported from southern Mesopotamia or is a locally produced copy.

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