

Articoli/Articles

MODERN BEAMS FOR ANCIENT MUMMIES
COMPUTERIZED TOMOGRAPHY OF THE HOLOCENE
MUMMIFIED REMAINS FROM WADI TAKARKORI
(ACACUS, SOUTH-WESTERN LIBYA; MIDDLE PASTORAL)

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SUMMARY

The Middle Pastoral human remains from Wadi Takarkori in the Libyan Acacus mountains (Fezzan) are exceptionally preserved partial mummies ranging between 6100 and 5000 uncal years BP; this small sample represents the most ancient of its kind ever found. In this report, we present a survey of the skeletal anatomy of these mummified corpses, based on high resolution CT-scan data, including a preliminary phenetic interpretation of their cranial morphology.

Introduction

The modern radiological techniques for high-resolution 3D imaging applied to archaeological and human remains have become an essential tool to understand findings of extraordinary importance, especially when such techniques are paired with innovative morpho-

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logical and morphometric approaches. In this perspective, the analysis of mummified and skeletal remains can benefit of the application of virtual techniques finalized to recording, studying and preserving through a non-invasive and non-destructive approach. Furthermore, in the context of extended international policies of repatriation of archaeological and human remains, it becomes essential to create as much as virtual databases are possible, in order to guarantee the minimum loss of morphological and anatomical information implied by the original specimens. This becomes of paramount importance if the repatriation of ancient materials takes place in countries characterized by social and political instability, where accessibility and preservation of such important specimens is not guaranteed continually.

The case for an extraordinary sample of mummified human remains coming from central Sahara in the south-western Libyan territory appears of special interest. There are in fact remains of this kind discovered in the Tadrart Acacus (Fezzan), which include the infantile mummy found in the '50s at Uan Muhuggiag¹ and, among a number of skeletal remains spanning in time along the Holocene², the recent discoveries at Takarkori³. The latter mummies are the subject of the present report.

The Takarkori rock shelter is in correspondence of the homonymous mountain pass across the Acacus mountains, near the border between Libya and Algeria (Fig. 1). It represents a key site to understand Holocene human occupation in the central Sahara, while giving insights on the funerary practices of pastoral groups in the region. The aim of this report is to present a preliminary description on the naturally mummified human remains discovered at this site. The focus will be on the anatomical and some pathological aspects of the skeletal remains, examined through CT scans and 3D virtual reconstruction. The radiological techniques allowed to discriminate and isolate the different tissues preserved, by virtue of their different

Modern beams for ancient mummies

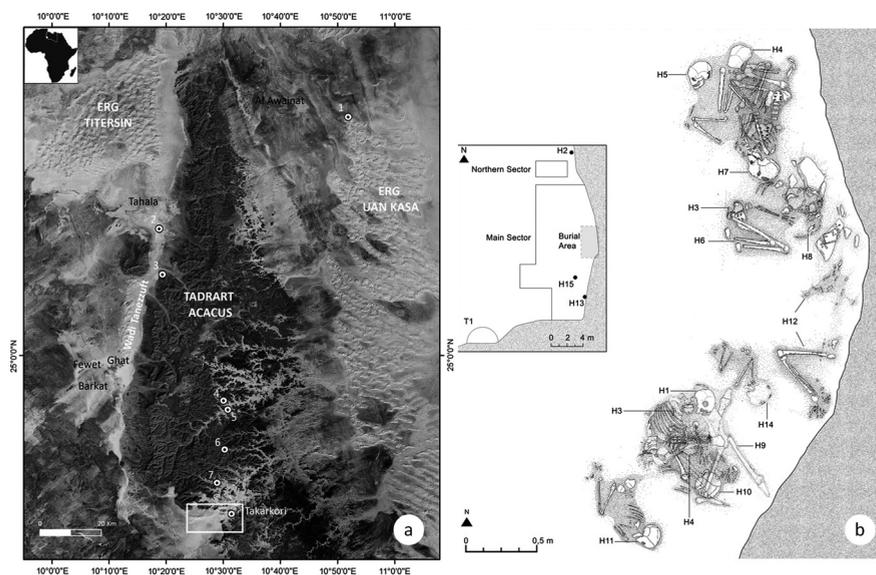


Fig. 1. a) Landsat satellite image of the Tadrart Acacus Mountains, in south-western Libya; b) The “burial area” of the Takarkori rock shelter.

electron density/physics: i.e., bone, teeth, tendons, connective tissue, epidermis, hair, nails; the outcome of this investigation allows inferences on morphological traits. In the present study, the virtual specimens obtained through computerized tomography were also used to take cranial measurements and to place, by multivariate statistical tools, the cranial morphology of the human sample from Takarkori within a range of African pre/proto-historic skeletal variability.

The big scenario and the local evidence

The Holocene pastoral populations that occupied the region between the Tassili and the Acacus mountains are characterized by complex demographic and cultural phenomena linked to phases of the so-called “Green Sahara”⁴. Such phenomena are ruled by water resources availability, when seen in a larger framework that includes the

whole Sahara. The study of the naturally mummified human remains from Takarkori becomes thus essential to the understanding of food-producing communities.

What truly marks the uniqueness of the Takarkori findings resides in the exceptional state of preservation of some of the mummified remains paired with their antiquity. Although burials in caves and rock shelters are common in the central Sahara, the majority of the findings from this region are in poor state of preservation, either for erosional or post-depositional phenomena. This results in the paucity of skeletal and archaeological information for these sites in comparison with those from sites in the south (Gobero) or toward west (Hassi al Abiod). The exception is represented precisely by the remains from Wadi Takarkori. At this site (Fig. 1b), 15 burials of women, juveniles and children were unearthed from a restricted part of the shelter, associated with different cultural phases, including the Late Acacus as well as the Early, Middle and Late Pastoral. No adult males were found inside the excavated area. Of particular interest is the finding of two naturally mummified corpses, both belonging to adult female individuals, respectively named RS-H1 and RS-H9, and associated with the Middle Pastoral, that is from ca. 6100 to 5000 uncal years BP⁵.

RS-H1 is a naturally mummified skeleton of a 30-35 years old female found interred in the organic sands. The body was not complete, the main elements missing were the right humerus, the right fibula, the right rotula and several elements of the thoracic/abdominal region (e.g., some thoracic vertebrae and ribs). The body appeared to be partially dried and was lying contracted on its left side (N-S oriented, looking at East) tightly bended. The cranium was complete and perfectly preserved, while the mandible was found a few cm above the layer of deposition of the body. The left arm was bent under the left hemithorax, while the right arm presumably bent above the right hemithorax. The left hand was near the left knee; the right hand under the left knee; the left leg was contracted and preserved the

anatomical position (femur articulated with the hip bones and tibia and fibula), while the right leg was dislocated under the left one, in no anatomical connection. Both feet were preserved in their original anatomical position. The dislocation of the right leg and the mandible, the absence of the right humerus, the right fibula and of some of the vertebrae is probably related to post-depositional processes presumably linked to both the deposition of RS-H9 and more recent disturbances. All of the right side of the corpse has been affected by this event while the left side lied in place on the sediment. A small zoomorphic figurine (cow?) made of local clay (Italo Muntoni, pers. comm.) was found in the heavily disturbed northern part of the grave (Fig.1b), likely associated with the burial. This skeleton was radiocarbon dated to 6090 ± 60 uncal BP (Middle Pastoral).

The specimen RS-H9 is a skeletally mature female, partially dried and represented only by some anatomical districts (complete and articulated pelvis lying on its ventral surface, portions of the lower limbs in anatomical connection) found beneath RS-H1. The legs were incomplete (complete femurs, a portion of the left tibia and the left patella): the right leg was extended while the left one was strongly twisted beneath the pelvis. This position is apparently the result of a post depositional disturbance. Radiocarbon dated to 5600 ± 70 uncal BP, it also belongs to the Middle Pastoral.

During the Middle Pastoral, which is the cultural phase of both the mummified corpses from Takarkori, burials in the region of the Acacus seem to be separated in relation to sex and age of the individuals, with adult males probably buried in open sites while females and children were placed within rock shelters. In view of the exceptional state of preservation of the findings from Takarkori, it is possible to gather a great deal of information about aspects not only anatomical and paleopathological but also with regard to dietary practices and inter- and intra-populational relationships of these pastoral communities based on various sources of data. Detailed

studies are currently underway to clarify these aspects. Researches have already led to the publication of an isotopic analysis carried out directly on human and domestic animals (sheep and cattle) remains, which constituted, together with plant food, the main source of subsistence for this human community⁶. At the same time, although the results of an extensive osteological investigation are forthcoming, the extreme fragility of these finds call for a non-invasive and non-destructive approach, whose preliminary results are presented here.

Methods and comparative material

Before the restitution to Libyan Authorities in 2013, the Takarkori mummified specimens were subjected to a full tomographic (CT) recording in order to preserve in digital and accessible format any details of their anatomy. All the specimens were scanned at the Department of Radiology of the Policlinico Umberto I in Rome, using a conventional CT machine Siemens/Somatom by contiguous 0.6-mm-thick scans at 120 kV and 200 mAs. Data were exported in DICOM files, with a pixel size of 0.748 mm and a matrix of 512 x 256 mm. 3D virtual rendering; segmentation was processed by the Amira software version 5.4.5. The application of an isosurface algorithm was used to represent regions of a particular density in a 3D CT scan of the Takarkori virtual remains.

Besides the tomographic investigation, morphological and morphometric comparative analyses were carried out on the cranial skeletal sample, in order to frame the small Takarkori sample within the human variability recorded from Pleistocene to historical times in the central Sahara region. Metrical data were taken on 2 adult individuals from Takarkori, namely RS-H1 (female, 30-35 years) and RS-H9 (female, 30-35 years). The comparative samples come from: the Garamantian site of Fewet, N=14⁷; the funerary area 96/129 near Tahala, N=12 (from the Late and Final Pastoral site 96/129 in the Wadi Tanezzuft⁸); the Wadi el-Ajal, N=24 (the Garamantian sam-

ple from the Wadi-el-Ajal and Ghat area⁹); the sub-Saharan site of Gobero (Ténéré desert of Niger) represented by two different phases of human occupation, namely the early Holocene (Kiffian) population of Gobero A, N=6, dated from 9700 to 8200 yrs BP (Level G3¹⁰) and the Mid-Holocene sample from Gobero B, N=12 dated from 7200 to 4500 yrs BP (Levels G1-3, G5¹¹). In addition, the adult male individual from Herto (BOU-VP-16/1), Middle-Awash valley in Ethiopia, was pooled as out-group on the basis of its archaic cranial morphology and its very ancient chronology: it is dated to between 160,000 and 154,000 years ago¹².

For the comparative analysis we have used 6 cranial measurements according to Martin and Saller¹³ that are reported in Table 1, whose selection was largely conditioned by data available in the literature. Given the small number of sufficiently complete adult crania from Takarkori (N=2) and their composition (both females), we have scaled metrical data to the maximum length of the skull (M1 glabella-opisthocranion) that represents a good proxy of the skull size, so as to minimize the effects on cranial morphology due to natural allometry (in relation to sex or, more in general, to individual variability). This allowed us to intercept the genetic and/or phylogeographic signal implied by the phenotypic expression.

Table 1. Cranial measurements used in this study.

Variables (according to Martin and Saller, see note 7)	Definition
M5	Base length (nasion – basion)
M17	Basion – Bregma height
M8	Maximum cranial breadth (euryon – euryon)
M45	Byzigomatic breadth
M48	Superior height of the face (nasion – prosthion)
M54	Nasal breadth

Results and comments

Although damaged and lacking the left portion of parts of the body, the mummy RS-H1 is undoubtedly the better preserved of the whole sample from the Takarkori rock shelter. All segments of the body preserve the anatomical connections, particularly with respect to the right arm and hand (Fig. 2a; Figs. 3a,b). The skull (Fig. 2b) appears to be gracile, with visible parietal bosses and a verticalized frontal bone, according to the female sex estimate. While the face only preserved the skeletal tissue, the superior and posterior areas corresponding with the parietal and occipital bones includes large portions of connective tissues referred to the galea aponeurotica and fragments of the overlying dermis and epidermis, with no traces of hair, mostly preserved on the resting side.

Teeth show a poor state of preservation, a pattern already documented at other sites in the area and probably due to the extreme climatic variations of the desert environment¹⁴. Dental crowns are severely worn, suggesting the consumption of hard foods (or food mixed with sand) and/or the use of the teeth in extra-masticatory activities¹⁵. Both maxillary and mandibular bones (Fig. 2c) show traces of reabsorption, mostly in the region of the first and second molars. The alveoli of the third molars are present on both upper and lower dentition.

In the endocranial surface traces of connective tissue are preserved; they can be related to the decay of the meningeal layers. Through the virtual filling of the endocranial cavity, we have reconstructed the tridimensional endocast (Fig. 2d); the endocranial capacity is rather small, only 1150 cm³. Inside the skull, by the occipital, we have registered the presence of a discontinuous layer of saline concretion (Fig. 2d).

The preserved portions of the postcranial bones of RS-H1 are in anatomical connections. The state of preservation of the limbs is extraordinary (Figs. 3a, b), with large portions of muscular tissues and tendons preserved. The bones of the right hand are perfectly con-

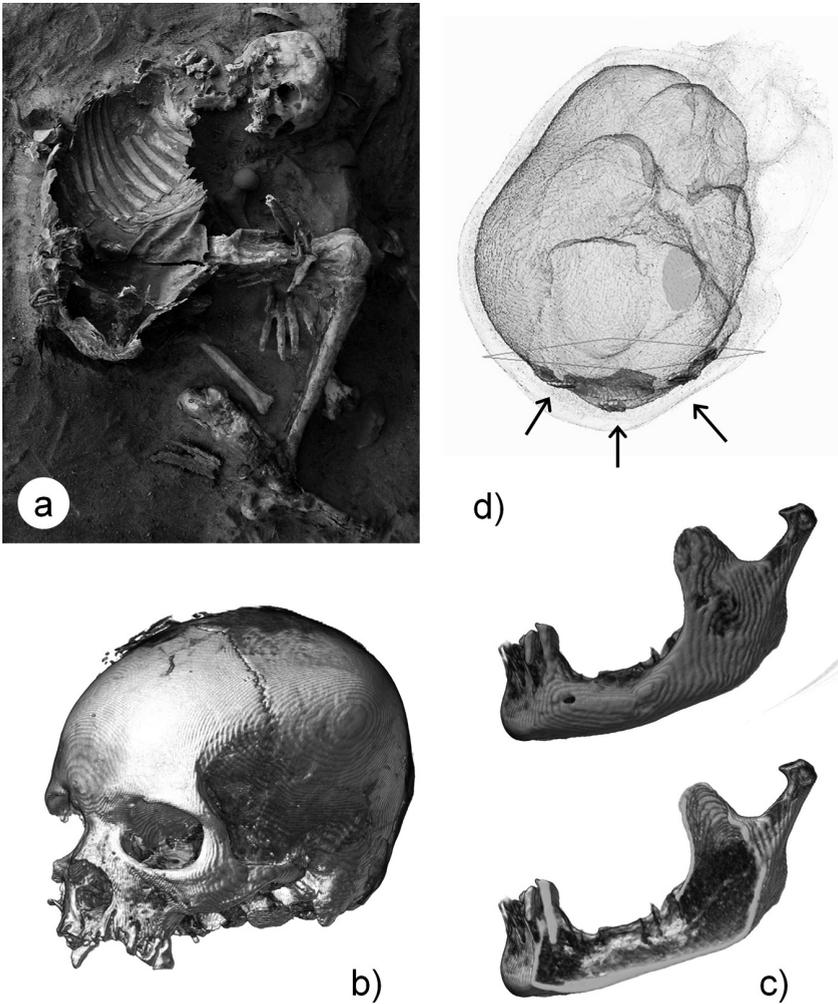


Fig. 2. a) Three-dimensional rendering of the mummy RS-H1; b) virtual rendering of its skull; c) mandible showing the area of bone reabsorption (cross section); d) saline concretion (pointed by arrows) and virtual endocast are showed inside the skull in transparency.

nected and kept together by muscles, tendons and skin (Fig. 3a). We did not observe signs of tattoos or scars on the skin.

Similarly, the postcranial elements of the partial skeleton RS-H9 are well preserved (Figs. 3c, d). In particular, the left knee includes most of its elements; the patella is surrounded by the ligaments of the knee. The pelvis (Fig. 3d) is also well preserved (particularly the right coxal bone, perfectly articulated with the sacrum). Its general morphology allowed the attribution of RS-H9 to a female¹⁶; this di-

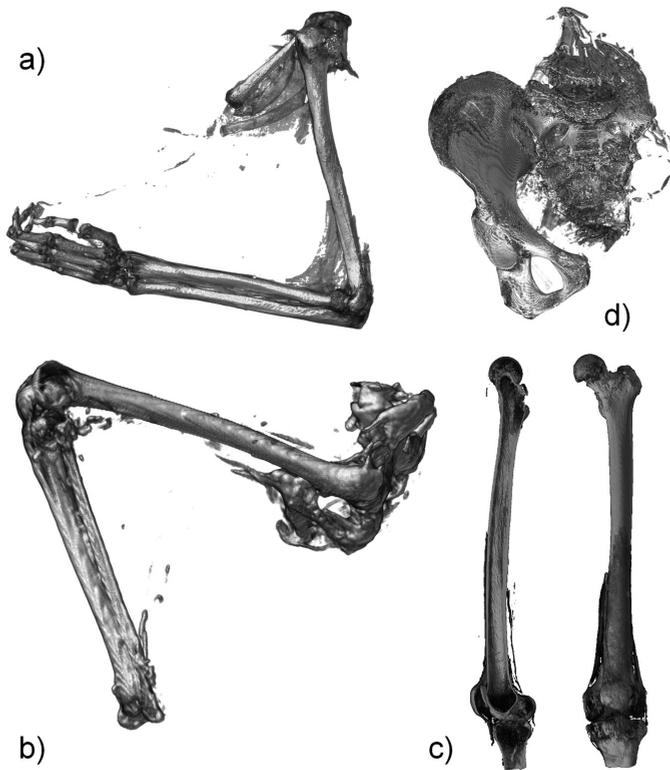


Fig. 3. Postcranial remains of RS-H1: a) upper limb with preserved large portions of muscular tissues and tendons and all the bones of the hands still in anatomical connection; b) right lower limb in articulation with the pelvis. Postcranial remains of RS-H9: c) left knee with patella; d) right coxal bone, perfectly articulated with the sacrum.

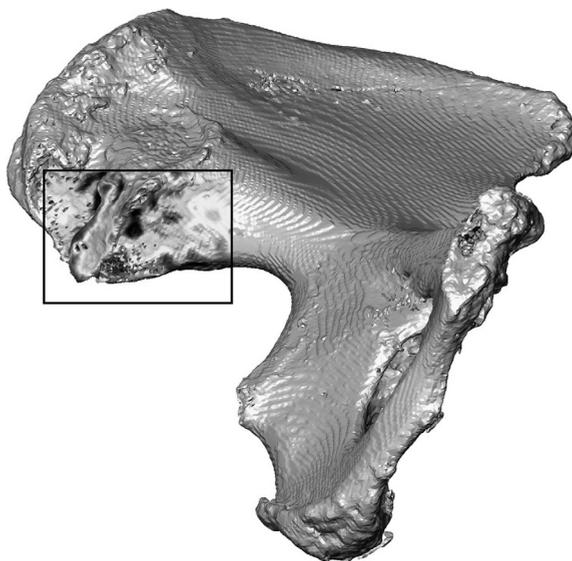


Fig. 4. The left coxal bone of RS-H9 with the preauricular sulcus identified as a dark depression in the preauricular area.

agnosis may be reinforced by the identification of a preauricular sulcus (Fig. 4), which is considered associated to pregnancy and birth¹⁷. The phenotypic relationships based on cranial metrical variables are expressed in Figure 5. The Neighbourhood Joining tree shows that the small sample from Takarkori takes relationships with the populations from Gobero in Niger, either coeval (Gobero B) or more ancient (Gobero A), thus with humans from sub-Saharan regions which are characterized by a wide morphological variation¹⁸. Populations from the Fezzan such as Fewet, Wadi-el-Ajal and Tahala, much younger chronologically than the Takarkori sample, are separated from it (according to the length of the branches that are proportional to the Euclidean distances between the metrical variables) and are, by contrast, more in relationship with one of the earliest representatives of our species such as the cranium from Herto (Ethiopia,

late Middle Pleistocene). Paradoxically, therefore, although more recent than the two women from Takarkori, samples from this time period appear more “archaic” and closer to the root of the tree.

We speculate that this occurrence is probably in relationship with the expression of recessive phenotypic features, which in turn suggests a certain degree of geographic and genetic isolation. It is likely, vice versa, that the great variability displayed by Middle Pastoral populations (represented in our preliminary analysis by Takarkori and Gobero B) have spread over a large territory thanks to favour-

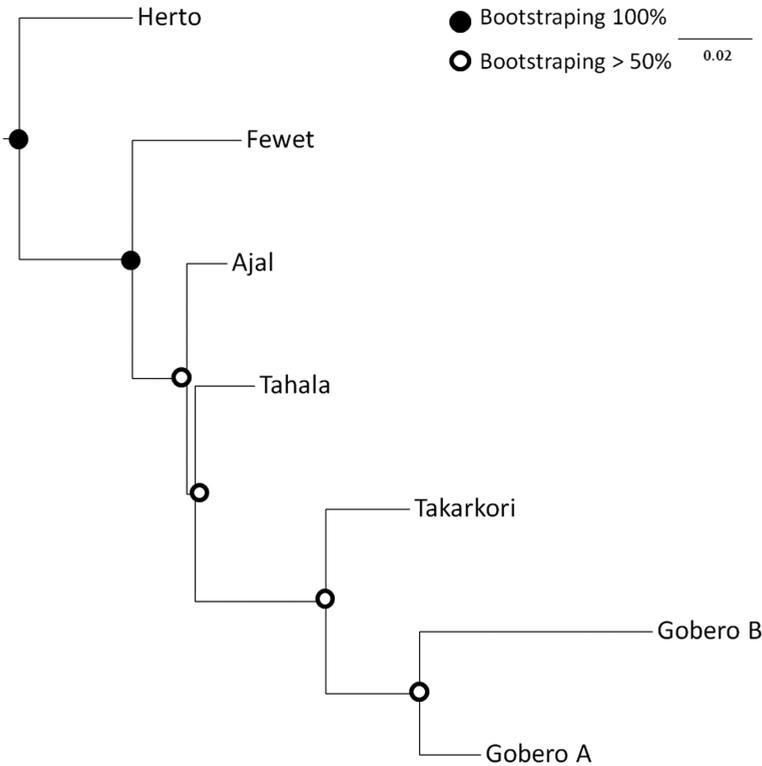


Fig. 5. Phenetic relationships of the early Holocene sample from Takarkori based on cranial metrical variables.

able climatic conditions. This could have increased levels of gene flow, producing a high phenotypic variability of the skeletal material associated with these human populations of the “Green Sahara”.

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