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Backroom Treasures: CT Scanning of Two Ibis Mummies from the Peabody Museum Collection

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Backroom Treasures

Museum collections of Egyptian human and animal mummies have great potential for research and museums often curate larger collections than those on exhibit. Scheduling access for medical imaging projects is often complicated for mummies on display because of the important environmental controls under which they are kept. Consequently, collections in storage are often more numerous and more readily available, in terms of time and physical access, than those on exhibit.

Two such mummies from the Peabody Museum's collection, both identified as mummies of the Sacred Ibis, were radiographically examined and demonstrated:

- **variations in position**
- **similar manners of death (spinal fracture)**
- **similar mummifications, including**
  - **complete evisceration**
  - **replacement of the gizzard and its contents**

Application of computed tomography (CT) to the study of mummified remains allows for detailed three-dimensional evaluations, without the difficulties of superimposition that characterise plain film radiographs. Three-dimensional visualisation, multi-planar reformats (MPR), maximum intensity projections (MIP), and curve-linear reconstructions of these mummies were especially valuable for close examination of the complex curves of the spine and the contents of the gizzard. These manipulations are no less important in the study of animal mummies than they are in those of humans.

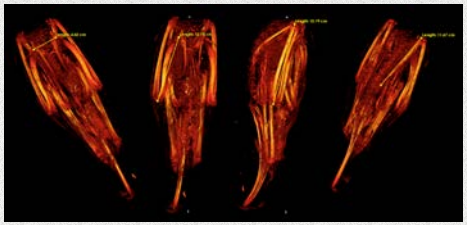

Figure 3. *3D reconstruction of ibis #1, showing wing measurements.*

Ibis #1

Figure 1. *Photo and 3D reconstruction of ibis #1, showing orientation and gizzard packet.*

Ibis #2

Figure 2. *Photo and 3D reconstruction of ibis #2, showing orientation and snail packet.*

The Ibises

Two ibis mummies (ANT.006924.002 – Fig.1 & ANT.006924.004 – Fig.2) from the site of Abydos, and not currently on display in the museum, were obtained from the Peabody Museum of Natural History. The Sacred Ibis, now extinct in Egypt, was commonly mummified for votive purposes [1,2]. Thousands have been excavated at Abydos [3] and more than a million were exhumed at Saqqara [4].

The CT Scans

The ibises were CT scanned at the beginning of November 2010, using the Toshiba Aquilion 64-slice scanner at Quinnipiac University's Diagnostic Imaging Program and Bioanthropology Research Institute. The ibises were scanned in environmentally controlled boxes, and could only be oriented by estimating their position in the box from scout scans.

The raw CT data, helically-acquired at 120 kV, were preprocessed using Standard Body (FC13 – no beam hardening correction), Sharp Lung (FC86), and High Resolution Bone (FC81) filters, mathematical manipulations that determine the appearance of the scans.

The scans were examined using the Toshiba Aquilion workstation, Vital Images' Vitrea reconstruction software, and Osirix reconstruction software.

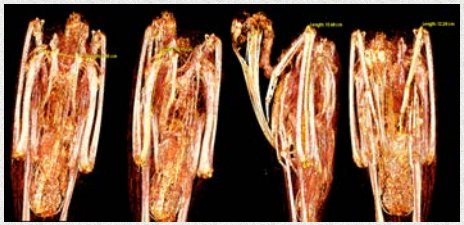

Figure 4. *3D reconstruction of ibis #2, showing wing measurements.*

Species Identification

The body size and long, curved beak indicate that the birds belong to Family Threskiornithidae (ibises and spoonbills). Current and historical geographic ranges of ibises [5] provided five possible species:

Sacred Ibis (*Threskiornis aethiopicus*)
Northern Bald Ibis (*Geronticus eremita*)
Glossy Ibis (*Plegadis falcinellus*)
Hadada Ibis (*Bostrychia hagedash*)
Wattled Ibis (*Bostrychia carunculata*)

Hadada and Wattled Ibises were eliminated owing to their relatively short bills. Body length and wingspan estimates from the CT scans (Fig.3,4) provide total lengths of 69cm and wingspans of 117.1cm and 122.5cm, indicating they were most likely *T. aethiopicus* (length 68-75cm, wingspan 112-124cm).

The scans were also compared to ibis cranial X-rays, and the ratios of zygomatic length to orbit height (2.06, 2.08) more closely resemble the Sacred Ibis (2.07) than the similarly-sized Northern Bald Ibis (1.86) [6].

Their Deaths

The spinal cord in ibis #1 is severed at the level of the 11th and 12th cervical vertebrae, which are rotated perpendicular to the spinal column and parallel to one another (Video 1).

The spinal cord in ibis #2 is severed at the level of the 14th and 15th cervical vertebrae, which demonstrate a large gap dorsally. This wide intervertebral joint was noted also by the Vitrea reconstruction software's flythrough algorithm. Despite following the complex curves of the spine caudally from the head, the flythrough departed the spinal column through this gap (Video 2).

In both cases, this discontinuity is found at the base of the neck, where it meets the body, and most likely represents traumatic over-rotation of the cervical spine as the cause of death.

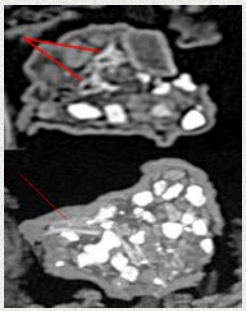

Figure 5. *CT scan and MIP showing rocks, vertebrae, and feather in gizzard packet.*

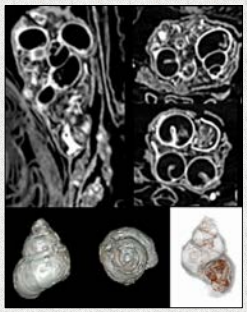

Figure 6. *CT scans and 3D reconstructions showing rocks and snails in gizzard packet.*

Embalming Features

The wings and legs of both birds are folded close against the body, with the digits of the pes extended cranially. The birds are wrapped in a few layers of resin-impregnated linen, surrounded by layers of plain linen.

In both birds, the entire body cavity has been emptied of its organs, via the cloaca. Within the body cavity of each, there is a packet filled with heterogeneous material. Objects range from high density, amorphous masses (rocks) to small, hollow, medium density masses (seeds).

The contents of ibis #1 include two small vertebrae and a feather (Fig.5), while ibis #2 includes eight snail shells, identified as *Bellamya unicolor* (Fig.6) [7]. The packet likely represents the contents of the gizzard. The contents are surrounded by a relatively thick, medium density material that may be the thick, muscled gizzard and/or a resin-impregnated linen wrapping.

Significance

CT examination of these two backroom mummies has elicited information about the species of birds being mummified at Abydos, the intentional selection and killing of Sacred Ibises (likely as votive offerings), and the intriguing manner of their embalming.

An 1805 account of the unwrapping of two ibises suggested that evisceration was not conducted in ibis mummies. While the study attributed "a soft spongy substance, lying quite loose, containing a great number of scarabaei" [8:270] to intact viscera, it is possible that this account and a similar account of reptile skin and scales in an ibis [9] represent intentional replacement of full gizzards following evisceration, as seen here.

This pattern of ibis evisceration and packing, suggesting the provision of an afterlife food source to the bird, is now the subject of CT studies of other backroom ibis mummies.

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