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COMPARISON OF TWO FALCONID MUMMIES FROM THE LATE PERIOD OF ANCIENT EGYPT USING NONINVASIVE TECHNIQUES

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To the ancient Egyptians, life on Earth was merely a precursor to the afterlife, the immortal world following the transient present one. Burial ceremony and mummification procedures were essential components for achieving a happy afterlife. Animals, including falcons, were also mummified for various reasons. Animal mummies can be divided into four main categories: beloved household pets (often interred with their owners); victual mummies (food offerings for humans in the afterlife); sacred animals (worshiped during their lifetimes and often buried with great ceremony); and votive mummies (dedicated as offerings to the specific gods to whom these animals were sacred; Ikram 2005).

Pets were often mummified because the ancient Egyptians, like modern people, frequently developed close emotional attachments to them. One of the graves in a cemetery in Mostagedda, dated prior to 4000 BC, contained the bones of a man, a gazelle, and a cat. The bones of the gazelle may have been a victual offering for the dead man's voyage in the afterlife, whereas the cat, which was found at the man's feet, may have been his pet (Malek 1993). Tomb reliefs from burials during the Old Kingdom (ca. 2649-2150 BC) depict scenes of owners with their animal companions, including cats, dogs, monkeys, and birds.

Victual mummies consisted of joints of meat, wild game, or birds intended for human consumption. Meat was not usually placed in the tomb as a whole carcass, but was jointed and butchered as in preparation for cooking. Several species of birds were found in King Tutankhamun's tomb and were intended to serve as food for the Boy King's voyage to and sojourn in the afterlife (Houlihan and Goodman 1986).

Sacred animals were worshiped in many parts of Egypt. In early Egyptian eras, sacred animals were considered to be the living incarnations of gods on earth and were worshiped as such throughout their lifetimes. In later eras, the divinity of animals took on more metaphoric subtleties, but the animals were still enshrined and were considered to contain elements of divinity or to act as intermediaries between people and the gods. Sacred falcons, like ibises (*Threskiornis aethiopicus*), were raised by and cared for by temple priests. A number of Egyptian gods appeared in falcon form (Houlihan and Goodman 1986). Only the temple priests had the authority and sanctity to dispatch these sacred animals, usually by breaking their necks. Sacred animals were mummified and buried with great ceremony.

A complete industry surrounded these animal cults, with animal keepers, animal embalmers, priests tending to pilgrims, and laborers building the cemeteries and catacombs (Ikram 2005). Pilgrims to various temple sites could purchase animals that had been specially bred at these cult centers. Falcons' eggs may have been artificially incubated in ovens and the hatchlings raised by hand (Houlihan 1996). These creatures would then be killed, mummified, and placed in a catacomb as votive gifts to the resident god. Votive mummies were by far the most commonly mummified animals. At various sites, the species of animal sacred to that particular geographic region's local god were sacrificed. Although votive animal burials are found at all periods throughout Egyptian history, the systemic productions of animal mummies for sale and subsequent burial as votive objects began in earnest in the Late Period (ca. 664–332 BC). Birds were especially popular votive offerings because they were associated with many gods. Birds were frequently represented in Egyptian art. Egypt lies along a major migratory route for birds of the Palearctic region; thus, great numbers and diverse species passed through the country.

At least 54 different species of birds have been identified from mummified remains dating from the New Kingdom to the Greco-Roman Period (Houlihan and Goodman 1986). At Saqqara, complexes were built for falcons. These animals were bred for the purpose of dedication (Wilkinson 2000). Mummified by priests and paid for by pilgrims,

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these animals were formally offered to a god during visits to a temple. This was taken to be a sign of devotion or that the pilgrim was seeking divine blessings. The mummies were dedicated in the name of the pilgrim who bought them and placed in vast necropolises to provide eternal prayers to the gods.

Pettigrew described several species of falcon, known from art and hieroglyphs, that were used as votive mummies, including the Eurasian Hobby (*Falco subbuteo*), the Eurasian Sparrowhawk (*Accipiter nisus*), and the Osprey (*Pandion haliaetus*; Pettigrew 1834). The Eurasian Kestrel (*F. tinnunculus*) and Lesser Kestrel (*F. naumanni*) are also known from art and hieroglyphs. The Eurasian Kestrel is a common permanent breeding resident in the Nile Valley and the Nile Delta, as well as in the Faiyum and Siwa Oases (Houlihan and Goodman 1986). The Lesser Kestrel breeds in parts of Europe, Asia, the Middle East, and North Africa, and winters in Spain, parts of Asia, Turkey, and Africa. In Egypt, both ancient and modern, the Lesser Kestrel was a common migrant in the Nile Valley and Delta (Houlihan and Goodman 1986).

The enormous number of animal mummies produced could lead one to assume that their care and preparation were inferior to that of human mummies. In fact, although the exact method of animal mummification is not completely known, it appears that Egyptian animal mummies were mummified using many of the same methods as those used on their human counterparts (Ikram 1998). A gas-chromatography study involving two hawks, a domestic cat, and an ibis (dating from 818 to 343 BC) revealed the presence of various products commonly used in the human mummification process. Chromatography methods revealed the presence of highly complex organic mixtures, including fats, oils, beeswax, sugar gum, and petroleum bitumen, as well as coniferous and cedar resins (Buckley et al. 2004).

METHODS

Radiographic analysis of Egyptian mummies was first employed by Petrie in 1897 (Petrie 1898). Radiographic analysis became more common starting in the 1960s (Harris and Weeks 1973); however, flat-plate radiography is limited to a two-dimensional view of the mummy. Recently, computed tomography (CT) and magnetic resonance imaging (MRI) have been utilized as nondestructive means of investigating the interiors of mummies. CT scanning is especially useful for measuring very fine differences in bone structure; thus, it is an excellent noninvasive procedure for investigating mummies, especially birds, where the skeletal structure is often delicate.

We used plain radiology, flat-plate radiology, and digital radiology to investigate the interior contents of two kestrel mummies in a noninvasive way. Both mummies were lent to the authors from a private collection, and have undocumented pedigrees. Anteroposterior radiographs were taken of the two mummies using 39 kVp and 5 mAs and shooting from a table-top mode. We also used computed tomography (CT) scan to evaluate Mummy #1.

To elucidate the species of bird found within the linen casings, the authors compared the radiographs of both birds to type skeletal specimens held at the Smithsonian National Museum of Natural History in Washington, DC. Using bone length, width, articulation, density, and talon shape, comparisons were made to several species of Accipitridae and Falconidae.

RESULTS AND DISCUSSION

Both of the mummies studied were definitely Egyptian and dated from 1069-525 BC.

Mummy #1. Mummy #1 (Fig. 1a) was 17 cm long by 4 cm wide at its broadest part. It was nearly cylindrical in appearance, with a slight tapering at the level of the talons. The entire mummy was wrapped in coarse linen and encased in a tar-like substance. Unlike some votive and pet mummies, this mummy did not incorporate a head piece, nor have a death mask or other external markings as seen in some falcon mummies (Morgan and McGovern-Huffman 2008), and it appeared to be rather hastily wrapped.

Both talons were easily recognizable at the posterior of the animal on the radiograph. Bone density was remarkably well preserved, with even fine tarsal and metatarsal bones easily distinguishable. The radiographs showed a distinct fracture in one of the cervical vertebrae. Although this may have been a post-mortem artifact, temple birds of this sort were commonly dispatched by temple priests breaking their necks (Armitage and Brock 1980). A sunken relief fragment from an edifice of Akhenaten at El-Amarna shows the pharaoh wringing the neck of a pintailed duck in preparation for offering it to the god Aten (Houlihan and Goodman 1986).

The computed tomography (CT) scan (Fig. 1b) indicated that much of the plumage remained and was clearly visible. The skeleton was folded and appeared complete on the CT scan as well. It may be that the tail feathers were amputated prior to wrapping, or that they were folded up beneath the wings. It was obvious from visual assessment that the linens were wrapped very tightly around the bird. The scan showed the skull ventro-flexed to the sternum. The rear portion of the skull was missing, and there appeared to be knife marks on the skull in this region. This may indicate that the brain was removed prior to embalming the bird, which would be a departure of the normal mummification procedure of keeping the skull and brain intact in birds. The CT scan revealed a complete transverse fracture of the proximal humerus that was not detected by plain radiography. The entire skeleton was present and confirmed both on radiographic analysis and CT scan.

We identified the mummy by process of elimination of likely candidate species. We were able to eliminate the Accipitridae because of a lack of a pronounced calcaneal ridge on the tarsometarsus. The Lanner Falcon (*F. biarmicus*) and Peregrine Falcon (*F. peregrinus*) were excluded due to their large size relative to the mummy. The Lesser Kestrel (*F. naumanni*), Red-footed Falcon (*F. vespertinus*), and Eleonora's Falcon (*F. eleonorae*) were eliminated be-

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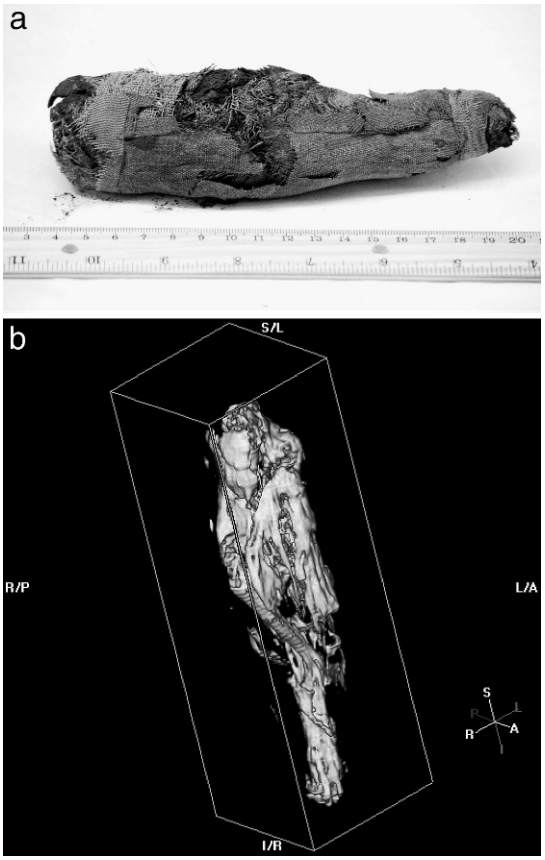


Figure 1. (a) Photograph of the exterior wrappings of kestrel Mummy #1, from the Late Period of Ancient Egypt. (b) CT scan showing entire skeleton of Mummy #1. Note fractured right proximal humerus and suspected cervical vertebrae disarticulation.

cause the length of the tarsus is short compared with the length of the ulna. Unlike the mummy, the Eurasian Hobby (*F. subbuteo*) has a distal tibiotarsus and proximal tarsometatarsus that widen markedly from the shaft, and the tibiotarsus has a pronounced external ligamental prominence. The Merlin (*F. columbarius*) has a tarsus length slightly shorter in proportion to the tibiotarsus; however, the limb proportions do not differ enough to exclude it as a possibility. After considering the possibilities, we concluded that the specimen most closely resembles the Eurasian Kestrel (*F. tinnunculus*). Interestingly, the mummy measured only 17 cm long, but an adult Eurasian Kestrel from Egypt is typically 30.5 to 35.6 cm (Houlihan and Goodman 1986). It is possible the bird preserved as Mummy #1 was a young individual: the proximal foramina of the tarsometatarsus were elongated, which is an indicator of immaturity (M. Spitzer and H. James pers. comm.).

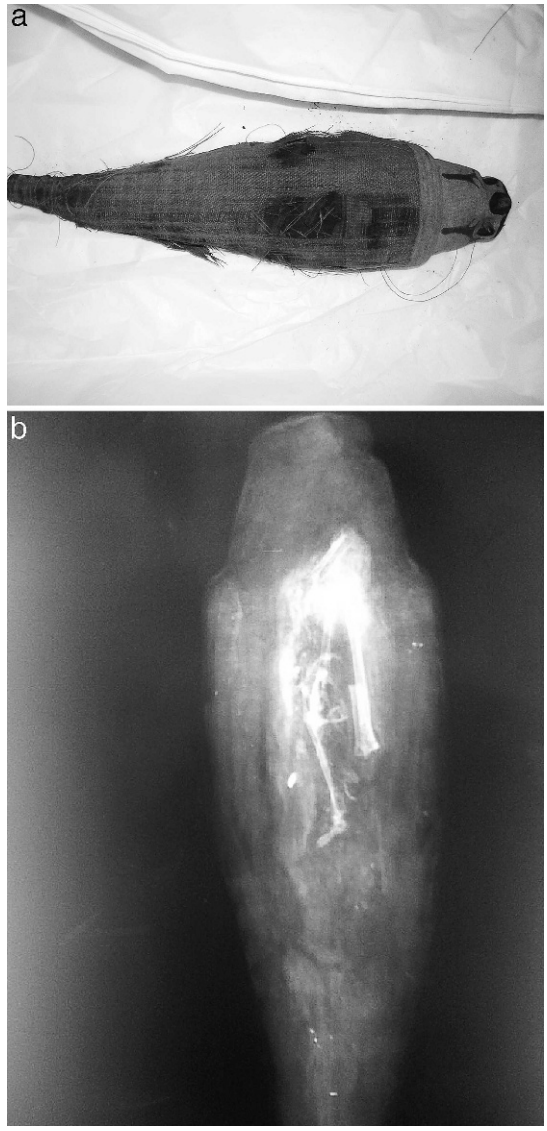


Figure 2. (a) Kestrel Mummy #2, from the Late Period of Ancient Egypt. Note elaborate markings on death mask. (b) Radiograph showing paucity of skeletal bones within Mummy #2.

Mummy #2. Using the same methods of bone comparison and elimination of possibilities, but notably with fewer complete bones to compare, we concluded that Mummy #2 was also that of a Eurasian Kestrel. Mummy #2 was 36 cm long by 9.0 cm wide at its broadest part, and 7 cm thick. The exterior of the mummy was quite extensively decorated and exquisite (Fig. 2a). In a theme similar to that of Mummy #1, but with a great deal more detail, the head piece was painted to resemble the falcon god, Horus,

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who was equated with the living king. The teardrop marking was clearly seen below each eye. The entire mummy was wrapped in linen and a black substance that resembles tar. The head piece showed a pronounced beak, characteristic of a falcon, and made up the upper fourth of the mummy.

Radiographic analysis indicated an incomplete skeleton in Mummy #2. Although few bones were present, the mummy wrapping was very elaborate. An ulna and a tarsometatarsal were intact and visible in their entirety. Portions of the major and minor carpometacarpus were identifiable in the cranial portion of the radiograph. Portions of the tibiotarsal and tarsometatarsal were also identified. One of the talons was intact. A small portion of the humerus was seen articulating with the intact ulna. Smaller bones, such as the vertebrae and phalanges, were also discernable. Diaphyseal fractures were seen in a humerus, a tibiotarsus and in the proximal portion of a major and minor metacarpal. There was no evidence of callous formation, suggesting that the fractures happened either immediately prior to death or postmortem, possibly during the mummification process.

Because falcons were difficult to capture in the wild and difficult to breed in captivity, there may not have been enough falcons available to meet demands (Ikram 2005). It is possible that the part represents the whole, and that fragments of the falcon, such as Mummy #2, were considered just as sacred as the whole bird, if the bird was associated with a sacred site (Ikram 2004).

There were vast differences in the levels of mummification of the two kestrels, perhaps reflecting the price paid. Ironically, Mummy #1 was more well-preserved than was Mummy #2, even given its apparently haphazard preparation. However, this may have been due more to environmental conditions in the catacomb (such as humidity) than to the variances between the mummification procedures.

Use of Falcon Mummies. Although the two kestrel mummies differed in appearance and content, it was likely that they both served the same function; namely, to allow pilgrims to worship and pay tribute to their gods. The less-ornate specimens, such as Mummy #1, may have been a less-expensive votive, which would allow less-affluent pilgrims the opportunity to worship as well. Falcon mummies were usually either sacred animals, which lived in dedicated temples, or votive animals that were purchased by pilgrims, dedicated to a god, dispatched, and mummified. Vast necropolises were established for votive animals. The two falcons we studied were votive offerings and represented two distinct approaches to bird mummification. The first kestrel mummy was wrapped in an ordinary linen-and-tar wrapping, with no external markings; however, it was a complete skeleton. Because of its plain appearance, it is possible that this mummy represented a more economical choice for the paying pilgrim. It was also possible that this mummy was originally wrapped elaborately, but that the outer wrappings have either fallen away or been removed (S. Ikram pers. comm.). The second votive kestrel mummy, in contrast, had very elaborate markings, including a highly ornate death mask that encompassed one-fourth of the mummy. However, unlike the first mummy, the second mummy had only a partial skeleton, perhaps because falcons were difficult to breed in captivity and hard to capture in the wild.

In summary, noninvasive techniques such as plain radiography, digital radiography, and CT scans can provide researchers with invaluable data about the mummification process without damaging the objects studied. Our research, which included one of the first CT scans of a mummified kestrel, highlighted the importance of falcons in ancient Egypt, and illustrated the need for additional studies to further our understanding of raptor-human interactions in ancient times.

COMPARACIÓN DE DOS MOMIAS DE FALCONIDAE DEL PERIODO TARDÍO DEL EGIPTO ANTIGUO USANDO TÉCNICAS NO INVASIVAS

RESUMEN.—Los halcones eran considerados animales sagrados en el Egipto antiguo y se momificaban frecuentemente después de su muerte. Las momias votivas eran compradas como ofrendas por los peregrinos, y los envoltorios utilizados en las momias a menudo reflejaban el precio que un peregrino estaba dispuesto a pagar, o lo sagrado que se consideraba un animal en particular. A menudo, sólo se encontraban esqueletos parciales dentro de las momias. Comparamos dos momias votivas de *Falco tinnunculus* de la época tardía del Egipto antiguo utilizando técnicas no invasivas, como la radiografía digital y tomografía computarizada. Una de las momias que fue analizada estaba envuelta en lino grueso y envuelta en una sustancia similar al alquitrán, pero no tenía una pieza de cabeza, ni una máscara de la muerte. La tomografía computarizada (TC) de esta momia indica que gran parte de su plumaje se mantuvo, y que el cráneo fue flexionado hacia el esternón. La parte posterior del cráneo había desaparecido, y parecía haber marcas de cuchillo en esa región del cráneo. El resto del esqueleto estaba presente, según lo confirmado por el análisis de radiografías y tomografía computarizada. El exterior de la segunda momia estaba muy decorado, con una pieza de cabeza pintada para parecerse al dios halcón, Horus. El análisis radiográfico indicó que el esqueleto de la momia # 2 estaba incompleto, que consiste de un cúbito y de un tarsometatarso y de las porciones del carpometacarpo mayor y menor, tibiotarsal, tarso y el húmero, así como huesos más pequeños, como las vértebras y falanges.

[Traducción del equipo editorial]

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