

CATS, CROCODILES, CATTLE, AND MORE: INITIAL STEPS TOWARD ESTABLISHING A CHRONOLOGY OF ANCIENT EGYPTIAN ANIMAL MUMMIES

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ABSTRACT. The ancient Egyptians mummified animals as part of cultic activity from the Late Period into the Roman era (7th century BC to the 4th century AD). Necropolises have provided millions of animal mummies, reflecting the religious fervor of Egyptians with regard to sacred animal cults during this period. Despite the number of sites containing mummies, and the number of mummies themselves, surprisingly little is known with regard to the nuances in the dating of the cults’ popularity and activities. As part of a multidisciplinary project, we have conducted a series of radiocarbon dates based on a group of animal mummies from the collection of the Musée des Confluences in Lyon, France. Thus, 63 specimens of animal mummies and their wrappings were analyzed to provide a range of dates for this practice. Results show that some correlations can be made between the popularity of particular species and the time period in which they were mummified. Monkeys and goats appear to have been among the first mummified species (from 800 BC), while antelopes appear to be a later addition to the corpus (30 BC to 4th century AD), thereby reflecting changes in thought processes, religious beliefs, and economic imperatives over time.

KEYWORDS: AMS dating, animal mummies, Egypt, Confluences Museum.

INTRODUCTION

Egyptian necropolises have provided millions of animal mummies, reflecting the ancient Egyptian’s heartfelt belief in the efficacy of animal cults, and demonstrating the significant place that these cults occupied in Egyptian religious practice from the 7th century BC through the Roman period (~AD 300) (e.g. Kessler 1986; Charron 1996; Vernus and Yoyotte 2005; von den Driesch et al. 2005; Ikram 2015a). For the ancient Egyptians, each god had at least one totemic animal, and it was thought that part of the divine spirit of any particular god could enter the body of its totemic animal, which could be recognized by distinctive markings. During its lifetime, that animal would be worshipped as a god, and upon its death it would be mummified and buried with all that was due to a divinity—one might liken this to the way in which the Dalai Lama is conceived of and chosen (Kessler 1986; Ray 2001; Ikram and Iskander 2002; Ikram 2015a). In addition, many animal mummies exist in the form of votive offerings (Charron 1990; Ikram and Iskander 2002; Ikram 2015a, 2015b). These were creatures that were sacrificed and offered to a particular deity in the hopes that the dedicants’ prayers might be answered, and are akin to the practice of lighting a candle in a church, although more permanent and more bloody. This practice has created a significant group of animal mummies. Within the group of votive mummies lies a subgroup: ancient falsified mummies. These consist of fragments of animals (feathers, fur, bits of bone) or even mud, wrapped to look like a mummy of whichever animal was offered in that catacomb. These mummies have been variously interpreted as sacred relics from animals that were gathered up and wrapped and offered as an act of piety, the idea that a part of a creature can symbolize the whole, or they were the result of laziness on the part of the priests, or a deliberate defrauding of pilgrims (Kessler 1986, 1989; Ray 2001; Ikram and Iskander 2002; Ikram 2015a). The number of mummies that were generated due to this intense religious belief influenced Egypt’s economy, religious beliefs, and feelings of nationalism throughout the final phases of Egyptian civilization (Ikram 2015a,

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2015b). Despite the popularity of these cults and the massive numbers of animal mummies that have been found, the chronological range of the popularity of animal cults is still not fully understood, with vague dates being assigned to this practice.

The multidisciplinary research project MAHES (French acronym for Egyptian Mummies of Animals and Humans) has been established by the University of Montpellier and in particular, the CNRS Laboratory Archaeology of Mediterranean Societies (Charron et al. 2015; Porcier et al. 2015), which is working on holistically studying a large collection of animal mummies held in the Musée des Confluences at Lyon, in order to understand the history and culture of ancient Egypt, religious beliefs, the chronology of this practice, the geographic distribution of these cults, and their socioeconomic role in ancient Egyptian society.

Researchers have the opportunity to make use of the collection of animal mummies of the Confluences Museum in Lyon (France), the largest group in the world outside of Egypt. This exceptional collection, comprising 2500 specimens, includes a wide range of mummified animals dating to a broad time period, from the New Kingdom until the first centuries of our era (Porcier and Berthet 2014). The majority of these mummified remains was studied at the beginning of the 20th century by Dr. Louis Lortet, director of the Natural History Museum of Lyon, and the naturalist Claude Gaillard (Lortet and Gaillard 1903, 1907, 1909). These works remain essential references for research on the fauna of ancient Egypt (Nicolotti and Postel 1994). However, although fundamental, these publications are now outdated in many respects (only the external appearance of the wrapped mummies was investigated, outdated nomenclatures, appropriate research to that time, but not to current standards) and they mostly ignore any archaeological data: the places and contexts of excavations, as well as the religious character of the mummies.

Generally, scholars have ascribed the apogee of animal mummies to a long period of time spanning about 680 BC until AD 350 (Smelik and Hemelrijk 1984; Kessler 1986, 1989; Ray 2001; Ikram 2015a). However, increasingly there is an idea that the dating of activities related to these cults can be better defined and that these nuances will reveal more about the Late and Greco-Roman period (7th century BC to the 4th century AD) history, culture, and economy of ancient Egypt's history, culture, and economy during the Late and Greco-Roman periods (7th century BC to the 4th century AD) (Ikram 2015a, 2015b; Wasef et al. 2015).

Thus, 63 samples from mummies and their wrappings, from the Musée des Confluences' collection, were examined using ^{14}C , in order to establish a chronological framework for animal cult activities in Egypt. Specimens were taken from different species of mummies (cattle, rams, gazelles, cats, dogs, foxes, shrews, baboons, ibis, crocodiles, fish, etc.), in order to establish a basis of dates for such cultic activity (Figure 1).

MATERIALS AND METHODS

Sampling

A total of 63 samples were collected from selected mummies stored at the Musée des Confluences. Only mummies that were damaged in some way were sampled in order not to compromise the integrity of museum objects. A variety of species were chosen in order to see if there were chronological differences in the popularity of specific animals or cults. Between 10 and 30 mg of textile or 200 and 500 mg of bone were sampled with small pliers or very small scissors, taking care to sterilize the tools and to avoid contamination. It should be noted that using textiles to date mummies is slightly problematic in that mummy bandages often consist of reused



Figure 1 Photographs of six mummies of the Confluences Museum, showing the diversity of animal species and mummification techniques: (a) Nile perch mummy, Inv 90001178 (© Département du Rhône, Patrick Ageneau); (b) ram skeleton, Inv 90001215 (© Département du Rhône); (c) shrew mummies bundle, Inv 90001224, this wrapped bundle contains many mummified shrews (© Département du Rhône); (d) head of mummified calf, Inv 90001213 (© Département du Rhône, Patrick Ageneau); (e) Nile goose mummy, Inv 90001198 (© Département du Rhône); (f) gazelle mummy, Inv 90001623 (© Projet MAHES, Stéphanie Porcier).

textiles, and thus the fabric might be older—up to as much as 50 yr or possibly more—than the mummy (Letellier-Willemin et al. 2015a, 2015b; Wasef et al. 2015).

The mummies themselves had been collected in the 19th century by L Lortet and C Gaillard (1903, 1907, 1909) from a variety of sites, most of which were dated in a general way to the Late Period to Roman era, with more specific dates assigned based on ceramic evidence (Berthet 2016). Had it not been for these scholars, most of these mummies would have been looted, burned as fuel, or used as fertilizer (Ikram and Dodson 1998). Unfortunately, despite the fact that Lortet and Gaillard kept fairly good notes for the time, some of the samples do not have specific cemeteries associated with them, although educated guesses can be made as to their origin based on our knowledge of the collection process and history as outlined by Lortet and Gaillard (1903, 1907, 1909).

Sample Preparation

The varied nature of collected samples, which included biological tissues (hair, bones, cartilage, and horn) or vegetal materials (in the form of linen textiles) required the establishment of a special sample preparation protocols due to the presence of high quantities of exogenic organic compounds such as bodily fluids, mummification balms, grease, fats, and oils (Figure 2). These complex mixtures, if they are not correctly eliminated, could give false dates (older or younger) for the objects (Quiles et al. 2014; Wasef et al. 2015).

Cleaning and Solvent Extraction

In order to eliminate all sources of organic contaminations, samples were submitted with a protocol established for museum objects (Richardin and Gandolfo 2013a, 2013b; Richardin



Figure 2 Macrophotographs of three samples from animal mummies of the Confluences Museum: (a) textile sample from an ibis mummy (Inv 90002478); (b) hair sample from a shrew mummy (Inv 90001273A); (c) bone sample from a goat mummy (Inv 51000070) (©C2RMF, Gaëtan Louarn).

et al. 2013). Samples were first washed with ultrapure water (Direct-Q system from Millipore), then with a mixture of methanol/dichloromethane (v/v 1/1) (for analysis, VWR International), and finally with acetone (AnalaR Normapur, VWR International) in an ultrasonic bath for 10–15 min. After the last treatment, samples were thoroughly rinsed three times with ultrapure water.

Textiles, Hair, and Wool Samples Preparation

Textiles, hair, and wool samples were treated with the classic AAA method (Richardin et al. 2010a, 2010b). This consisted of a series of washes at 80°C for 1 hr with a 0.5N hydrochloric acid solution (HCl, VWR International), then with a 0.01N sodium hydroxide aqueous solution (NaOH, VWR International), and once again with the 0.5N HCl solution. Before each treatment, the supernatant was removed and the remaining fragments rinsed with water until neutrality of the washing waters was achieved. Finally, the cleaned samples were dried overnight under low vacuum (100 mbar) at 5°C.

Extraction of Collagen from Bones

Collagen from bones, when preserved, is the most reliable source for ^{14}C dating. The extraction of soluble collagen used was based on the method described by Longin (1971). A 2N hydrochloric acid (HCl, VWR International) treatment is used to solubilize the mineral fraction, in a cold ice bath for 30–60 min. The solution was diluted with water, and then allowed to stand

at 4°C for 4–5 hr. After centrifugation, acid was removed, the solid was washed with ultrapure water to pH 4–5, and left at 4°C overnight. Further washings are performed until the sample is neutral. The second step is a basic treatment with a 0.1N sodium hydroxide solution (NaOH, VWR International) in an ice bath for 1 hr, followed by further rinses until neutrality is achieved. A further acid treatment with the 2N HCl solution is performed in an ice bath for 1 hr, followed by rinsing to pH 3. Then, hydrolysis is carried out at 9°C overnight. The obtained solution is filtered on quartz-fiber filter. Finally, the filtrate is dried by lyophilization.

Combustion and Graphitization

The dried organic fraction is then combusted 5 hr at 850°C under high vacuum (10^{-6} Torr). Next, 2 to 2.5 mg of pretreated sample are combusted in a quartz tube with 500 mg CuO [Cu(II) oxide on Cu(I) oxide heart for analysis, VWR International] and Ag wire (99.95%, Aldrich). The combustion gas is separated by cryogenic purification and the CO₂ is collected in a sealed tube. The graphitization is achieved by direct catalytic reduction of the CO₂ with hydrogen, using Fe powder at 600°C and an excess of H₂. During the process, the carbon is deposited on the iron and the powder is pressed into a flat pellet.

Radiocarbon Measurements and Calibration

All measurements were performed at the Artemis AMS facility of Saclay, France (Moreau et al. 2013). ¹⁴C ages were calculated with correcting the isotope fractionation $\delta^{13}\text{C}$, calculated from accelerator mass spectrometry (AMS) measurements of the ¹³C/¹²C ratio. Calendar ages were determined using OxCal v 4.2 (Bronk Ramsey 2009) and the most recent calibration curve data for the Northern Hemisphere, IntCal13 (Reimer et al. 2013). Calibrated age ranges correspond to 95.4% probability (2σ).

RESULTS AND DISCUSSION

The ¹⁴C ages and calibrated age ranges of samples are given in Table 1, and almost all date to the Ptolemaic era (~323–30 BC), although some mummies are much earlier, and a few are later. The first point of discussion concerns the wide range of dates obtained for the mummies: between 3180 ± 30 BP [1506–1407 cal BC] for a single specimen, that of a Nile goose (Inv 90001198), and 1800 ± 30 BP [130–326 cal AD] for a gazelle mummy (Inv 90001291), a range of more than 2000 yr (Figure 3). These results correspond to dates starting in the New Kingdom (~1539–1077 BC) and continuing until the Roman period (~30 BC–AD 391). As noted above, on the basis of texts and ceramic evidence, animal cults are thought to have started flourishing in the Late Period (starting in ~664 BC), and continuing through the Roman period, ending with the establishment of Christianity as the state religion in Egypt.

Though the gazelle mummy fits into this timespan, as do all the other mummies studied, the goose is much earlier. It is possible that the mummy type is neither sacred nor votive, but that of a pet or, more likely, falling into the category of “other” (Ikram 2015a). A limited corpus of pet mummies are known from ancient Egypt (Ikram and Iskander 2002; Ikram 2015a). Although geese do not number among these examples, images and references to pet birds (including ducks and geese) are recorded (Houlihan 1996; Vernus and Yoyotte 2005), and it is possible that this goose is such a creature. However, as the bird was part of a foundation deposit of the Memorial Temple of Thutmose III (~1481–1425 BC) at Thebes (Lortet and Gaillard 1909: 155), it is more likely that it was a special kind of sacrifice, thus far unique in foundation deposits (Weinstein 1973). Of course, it is also possible, although unlikely for this well-provenanced object whose ¹⁴C dates fall within Thutmose III’s reign, that the linen was far older than the bird, and this is an

Table 1 ^{14}C age and calibrated age of all samples.

Animal types (number)	Inventory nr	Designation	Site of excavation	Sample type	Lab code	^{14}C age (BP)	Calibrated age 2σ
Smaller mammals (10)	90002397	Cat mummy	Mansourah	Hair + biological tissues	SacA41762	2335 ± 30	506 cal BC (0.6%) 500 cal BC 490 cal BC (94.8%) 362 cal BC
	90002360	Cat mummy	Egypt	Textile	SacA42786	2250 ± 30	395 cal BC (31.3%) 346 cal BC 320 cal BC (64.1%) 206 cal BC
	90002373	Cat mummy	Stabl Antar	Textile	SacA41071	2215 ± 30	373 cal BC (95.4%) 201 cal BC
	90001325	Dog mummy	Asyut	Textile	SacA42625	2175 ± 30	360 cal BC (94.7%) 163 cal BC 128 cal BC (0.7%) 121 cal BC
	90001273A	Shrew mummy	Asyut	Hair	SacA43414	2155 ± 30	357 cal BC (35.4%) 282 cal BC 258 cal BC (1.3%) 245 cal BC 236 cal BC (58.7%) 94 cal BC
	90002096	Shrews bundle	Akhmim	Textile	SacA42635	2145 ± 30	354 cal BC (24.6%) 290 cal BC 232 cal BC (68.7%) 88 cal BC 75 cal BC (2.0%) 58 cal BC
	90001279	Shrew mummy	Dra abou'l Naga	Hair	SacA44180	2140 ± 35	354 cal BC (21.0%) 290 cal BC 232 cal BC (74.4%) 54 cal BC
	90001224	Shrew bundle	Sheikh Abd el-Gourna	Textile	SacA42624	2120 ± 30	345 cal BC (4.2%) 322 cal BC 206 cal BC (91.2%) 50 cal BC
	90001327	Fox mummy	Asyut	Textile	SacA41066	2075 ± 30	180 cal BC (93.4%) 19 cal BC 12 cal BC (2.0%) 1 cal BC
	90002317	Dog mummy	Asyut	Hair Textile	SacA38733 SacA38732	2050 ± 30 1990 ± 30	166 cal BC (95.4%) 20 cal AD 49 cal BC (95.4%) 72 cal AD
Monkeys (3)	90001206	Monkey mummy	Egypt	Textile	SacA40592	2545 ± 35	<i>Comb</i> 2020 ± 22 57 cal BC (95.4%) 31 cal AD 803 cal BC (44.3%) 732 cal BC 690 cal BC (12.1%) 660 cal BC 650 cal BC (39.0%) 544 cal BC
	90002664	Monkey mummy	Egypt	Textile	SacA40598	2325 ± 30	480 cal BC (3.2%) 440 cal BC 434 cal BC (90.0%) 358 cal BC 276 cal BC (2.2%) 257 cal BC
	90002666	Monkey mummy	Egypt	Textile	SacA40599	2255 ± 35	398 cal BC (33.7%) 346 cal BC 321 cal BC (61.7%) 206 cal BC
Ovicaprines (7)	90002311	Goat mummy associated with crocodile bones	Saqqara	Textile	SacA40596	2420 ± 30	748 cal BC (15.5%) 685 cal BC 666 cal BC (4.7%) 642 cal BC 586 cal BC (0.4%) 581 cal BC 556 cal BC (74.8%) 402 cal BC
	51000073	Ram mummy (<i>Ovis aries</i>)	Esna	Bone	SacA41763	2215 ± 30	373 cal BC (95.4%) 201 cal BC
	90001215	Ram skeleton & skin (<i>Ovis aries</i>)	Elephantine Island	Hair	SacA41761	2190 ± 30	506 cal BC (0.6%) 500 cal BC 490 cal BC (94.8%) 362 cal BC
	51000168	Ram mummy (<i>Ovis aries</i>)	Abydos	Bone	SacA42341	2185 ± 40	377 cal BC (93.6%) 158 cal BC 133 cal BC (1.8%) 117 cal BC

	51000065	Barbary sheep mummy (<i>Ammotragus lervia</i>)	Giza	Bone	SacA43336	1965 ± 30	42 cal BC (94.5%) 85 cal AD 110 cal AD (0.9%) 115 cal AD
	51000069	Barbary sheep mummy (<i>Ammotragus lervia</i>)	Giza	Bone	SacA42618	1925 ± 30	4 cal AD (95.4%) 134 cal AD
	51000159	Barbary sheep mummy (<i>Ammotragus lervia</i>)	Giza	Bone	SacA42340	1920 ± 30	2 cal AD (95.1%) 138 cal AD
Gazelle (7)	90002281	Young gazelle mummy	Kom-Ombo	Textile	SacA40761	1920 ± 30	199 cal AD (0.3%) 204 cal AD 2 cal AD (95.1%) 138 cal AD
	90002282	Gazelle mummy	Kom-Mereh	Textile	SacA42781	1920 ± 30	199 cal AD (0.3%) 204 cal AD 2 cal AD (95.1%) 138 cal AD
	90001623	Gazelle mummy	Touna el-Gebel	Textile	SacA40604	1895 ± 30	52 cal AD (95.4%) 215 cal AD
	90002285	Gazelle mummy	Egypt	Textile	SacA44181	1890 ± 30	56 cal AD (95.4%) 217 cal AD
	51000043	Gazelle mummy (<i>Gazella dorcus</i>)	Kom-Ombo	Bone	SacA43335	1860 ± 30	80 cal AD (95.4%) 230 cal AD
	90001211	Gazelle mummy	Kom-Mereh	Textile	SacA40594	1845 ± 30	85 cal AD (95.4%) 238 cal AD
	90001291	Gazelle mummy	Kom-Mereh	Textile	SacA41065	1800 ± 30	130 cal AD (79.1%) 260 cal AD 279 cal AD (16.3%) 326 cal AD
Cattle (6)	51000200	Cattle mummy (<i>Bos taurus</i>)	Egypt	Horn	SacA42343	2340 ± 30	507 cal BC (1.0%) 500 cal BC 491 cal BC (94.4%) 366 cal BC
	90001214	Mummified head of ox	Asyut	Textile	SacA42623	2270 ± 30	400 cal BC (49.3%) 350 cal BC 304 cal BC (46.1%) 210 cal BC
	51000195	Cattle mummy (<i>Bos taurus</i>)	Saqqara	Textile	SacA42634	2265 ± 30	399 cal BC (44.4%) 350 cal BC 306 cal BC (51.0%) 209 cal BC
	51000193	Cattle mummy (<i>Bos taurus</i>)	Saqqara	Bone	SacA42342	2240 ± 30	390 cal BC (25.0%) 344 cal BC 322 cal BC (70.4%) 205 cal BC
	90001235	Anciently falsified mummified calf	Thebes	Textile	SacA42632	2235 ± 30	388 cal BC (22.7%) 342 cal BC 326 cal BC (72.7%) 204 cal BC
	90001213	Head of mummified calf	Asyut	Textile	SacA41070	2170 ± 30	360 cal BC (92.9%) 156 cal BC 134 cal BC (2.5%) 116 cal BC
Reptiles (10)	90001193	Mummified head of crocodile	Egypt	Textile	SacA40591	2255 ± 30	396 cal BC (35.1%) 348 cal BC 316 cal BC (60.3%) 208 cal BC
	90002669	Mummified snakes bundle	Egypt	Textile	SacA42797	2180 ± 30	361 cal BC (95.4%) 168 cal BC
	90002668	Mummified snakes bundle	Egypt	Textile	SacA40603	2040 ± 30	162 cal BC (6.9%) 131 cal BC 118 cal BC (88.1%) 26 cal AD 44 cal AD (0.4%) 46 cal AD
	90001372	Constructed crocodile mummy	Esna	Textile	SacA42628	1995 ± 30	52 cal BC (95.4%) 71 cal AD
	90001944	Crocodile mummies bundle	Egypt	Textile	SacA42630	1950 ± 30	21 cal BC (2.6%) 10 cal BC 2 cal BC (92.8%) 125 cal AD
	90001591	Crocodile mummy	Egypt	Textile	SacA40595	1935 ± 30	1 cal AD (95.4%) 130 cal AD
	90001390	Crocodile mummy	Egypt	Textile	SacA42629	1885 ± 30	60 cal AD (95.4%) 220 cal AD
	90001984	Mummified baby of crocodile	Egypt	Textile	SacA41067	1880 ± 30	66 cal AD (95.4%) 222 cal AD

Table 1: (Continued)

Animal types (number)	Inventory nr	Designation	Site of excavation	Sample type	Lab code	¹⁴ C age (BP)	Calibrated age 2σ
Fishes (2)	90001387	Crocodile mummy	Kom-Ombo	Textile	SacA42782	1845 ± 30	85 cal AD (95.4%) 238 cal AD
	90001192	Crocodile mummy	Kom-Ombo	Textile	SacA40590	1845 ± 30	85 cal AD (95.4%) 238 cal AD
	90002254	Nile perch mummy (<i>Lates niloticus</i>)	Egypt	Textile	SacA41068	2030 ± 30	156 cal BC (2.7%) 137 cal BC 114 cal BC (92.7%) 52 cal AD
Birds (17)	90001178	Nile perch mummy (<i>Lates niloticus</i>)	Esna	Textile	SacA42620	2010 ± 30	345 cal BC (4.2%) 322 cal BC 206 cal BC (91.2%) 50 cal BC
	90001198	Nile goose mummy	Sheikh Abd el-Gourna	Textile	SacA44179	3180 ± 30	1506 cal BC (95.4%) 1407 cal BC
	90002482	Ibis mummy	Egypt	Textile	SacA44182	2390 ± 30	728 cal BC (1.9%) 715 cal BC 708 cal BC (2.3%) 694 cal BC 542 cal BC (91.3%) 396 cal BC
	90001367	Ibis mummy	Egypt	Textile	SacA42627	2315 ± 30	414 cal BC (88.2%) 356 cal BC 285 cal BC (7.2%) 235 cal BC
	90002461	Ibis mummy	Egypt	Textile	SacA42787	2260 ± 30	397 cal BC (39.7%) 350 cal BC 308 cal BC (55.7%) 209 cal BC
	90002471	Ibis mummy	Egypt	Textile	SacA42788	2245 ± 30	392 cal BC (27.9%) 346 cal BC 321 cal BC (67.5%) 206 cal BC
	90002450	Ibis mummy	Saqqara	Textile	SacA41072	2235 ± 30	388 cal BC (22.7%) 342 cal BC 326 cal BC (72.7%) 204 cal BC
	90002451	Ibis mummy	Saqqara	Textile	SacA41073	2225 ± 30	380 cal BC (95.4%) 203 cal BC
	90001245	Ibis mummy	Kom-Ombo	Textile	SacA42633	2175 ± 30	360 cal BC (94.7%) 163 cal BC 128 cal BC (0.7%) 121 cal BC
	90010164	Bird mummy (without precision)	Luxor	Textile	SacA40600	2160 ± 50	363 cal BC (92.4%) 88 cal BC 76 cal BC (3.0%) 56 cal BC
	90002499	Ibis mummy	Sheikh Abd el-Gourna	Textile	SacA42796	2140 ± 30	353 cal BC (19.5%) 295 cal BC 230 cal BC (1.5%) 220 cal BC 212 cal BC (71.2%) 88 cal BC 77 cal BC (3.2%) 56 cal BC
	90002477	Ibis mummy	Egypt	Textile	SacA42790	2090 ± 30	195 cal BC (95.4%) 42 cal BC
	90002478	Ibis mummy	Egypt	Textile	SacA42791	2085 ± 30	192 cal BC (95.4%) 40 cal BC
	90010128.1	Eagle mummy	?	Textile	SacA40762	2070 ± 30	174 cal BC (92.6%) 19 cal BC 12 cal BC (2.8%) 1 cal BC
	90010128.2	Eagle mummy	?	Textile	SacA40605	2065 ± 30	171 cal BC (95.4%) 2 cal AD
	90002481	Ibis mummy	Egypt	Textile	SacA42792	2035 ± 30	160 cal BC (4.9%) 132 cal BC 116 cal BC (88.3%) 30 cal AD 38 cal AD (2.2%) 50 cal AD
	51000143	Ibis mummy	Thebes	Bone	SacA43334	2030 ± 30	156 cal BC (2.7%) 137 cal BC
90002491	Ibis mummy	Roda	Textile	SacA42795	2010 ± 30	92 cal BC (4.2%) 68 cal BC 61 cal BC (91.2%) 65 cal AD	

early example of recycling. As noted above, using textiles to date the mummies could potentially be an issue (Letellier-Willemin et al. 2015a, 2015b; Wasef et al. 2015). Nonetheless, it does seem that, on the whole, whether bones or textiles were sampled, the date range of the samples is similar, regardless of the site (e.g. specimens 51000043, 90002317, and 90001211), suggesting that for large-scale industrial-type burials of animals, there was a quick turnover in embalming materials, including mummy bandages.

The spectrum of dates gathered from the different animals may suggest changes in the popularity of different gods and their associated animals, or points during which particular cults in specific locations flourished. Sacred Ibis mummies (*Threskionis aethiopicus*; 13 samples) are dated to between 2390 ± 30 and 2010 ± 30 BP, from just before the “official” date assigned to the start of the Late Period, and continuing to the beginning of the Roman period. This range fits in very well with the whole span of time during which animal mummies were popular, and it should be noted that ibis burials were associated with Thot, the god of learning and divine justice, and the focus of one of the most widespread and enduring of Egyptian cults. Although this range is wider than that found by other studies on ibises, albeit ones that had far fewer specimens (Wasef et al. 2015), the majority of our ibises also fall within the Ptolemaic to Roman (~332 BC–AD 391) timeframe, the same period as for the other specimens (Wasef et al. 2015). Further analyses of ibis mummies from diverse locations should help to more precisely document the rise and fall of the cult of Thot.

Some trends have emerged from this study, such as the earlier presence of shrew and cattle mummies at Asyut compared to canine mummies. Canines were associated with the city gods: Anubis and, more significant, Wepwawet; one should bear in mind that for the Egyptians the phenotype was the basis of classifications for animals; thus, foxes would fall within canine types for the Egyptians (Houlihan 1996; Charron 2011). Shrews and cattle were both associated with the sun god Re, with the former being the nocturnal manifestation of that god (Brunner-Traut 1965; Ikram 2005) and bulls being associated with him from the earliest times (Dodson 2015). Canines are associated with Wepwawet/Anubis, god of travel and embalming, and long revered in Asyut (Charron 2011; Ikram 2013). Thus, it is somewhat surprising that animals associated with the sun cult should antedate those associated with the deity of the city. Either our findings indicate that the practice of animal mummification started with the sun god, the main god of Egypt, and then extended to other divinities, or indicate that our understanding of the importance of Wepwawet/Anubis at Asyut is flawed. If the former, this will mean a re-examination of scholarly understanding of the foundation and evolution of animal cults. This conundrum can only be clarified by further analyses of samples of different types of animal mummies from Asyut, but already, the dating has opened new avenues of inquiry.

Analyses of additional samples might clarify the situation in terms of tracking the geographical popularity of the cult: quite possibly the vogue for a particular cult rose and fell. According to our study, monkey and goat mummies fall into a range of dates similar to the ibises, dating from the Late Period and into the Ptolemaic period. The cattle sampled from three necropolises (Saqqara, Asyut, and Thebes), however, seem to be slightly later in date, while the small mammal mummies (shrews, dogs, foxes, and cats), fish, and reptiles seem to span the entire time period during which animal cults flourished.

However, the Barbary sheep (*Ammotragus lervia*) and gazelle (*Gazella* spp.) date exclusively to the Roman period (Inv 51000065 is 1965 ± 30 BP, which corresponds to around 40 cal BC–cal AD 85, and Inv 90001291, 1800 ± 30 BP, or cal AD 130–330), and are found in diverse sites, from Giza to Kom Ombo. These results suggests the rise of certain cults during this time or changes in

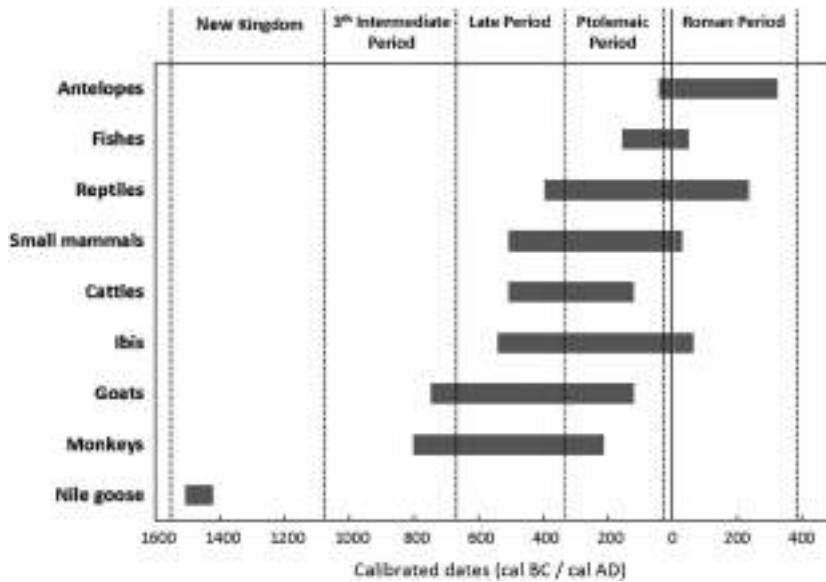


Figure 3 Range of calibrated ^{14}C dates for all animal species

how particular gods were revered. This might indicate the rise of a new cult or the renaissance of an old one, possibly associated with the goddess Anukis, daughter of Re, who was part of the Elephantine island triad of divinities (Wilkinson 2003: 138) and associated with gazelles. The discovery of gazelle mummies might provide evidence for her cult being celebrated in the Memphite region. Perhaps there was some association with the Roman goddess Diana, mistress of the hunt, as well. Alternatively, gazelles were associated with Reshep, a Near Eastern divinity who was incorporated into the Egyptian pantheon in the New Kingdom, and who might have enjoyed a renaissance in the Roman era, perhaps due to an increased international population (Wilkinson 2003: 126). In any case, the presence of these mummies provides an interesting insight into changing religious beliefs in terms of new cults, resurgence of old ones, or a change in how gods were revered, and which are possibly associated with the advent of the Romans.

It would thus seem that many animals that were readily available (notably ibis, cattle, ovicaprines, dogs, and shrews) were mummified throughout the timespan when animal cults were active. Monkeys are documented from the Late Period into the mid-Ptolemaic period, but not before, unless as pets (at present). However, the clustering of dates for all creatures, in the late 3rd to the 1st centuries BC, might indicate that this was the apogee of this form of worship, which started to decrease during the 1st century AD, dying out slowly, except in certain places and with certain animals (cattle and crocodiles, to name but two) by the late 3rd century AD. This is a change from the earlier idea that the phenomenon was most popular in the 5th and 6th centuries BC.

Also, it is possible that issues of economy and trade can be better understood by the dating of animal mummies. For instance, the (admittedly few) examples of baboon mummies date to the Late Period and the Ptolemaic era, perhaps indicative of a flourishing trade in exotic animals between Egypt and sub-Saharan Africa during this time. The possible absence of such animals being available for mummification in the Roman period might indicate Egypt's waning power and Rome's ascendancy, as animals that previously would have been

brought to Egypt and kept there were now being sent on to Rome as animals kept as pets, in zoos, or in circuses.

CONCLUSION

The dates reported here (Table 1) represent the first chronological results obtained from the Musée des Confluences in Lyon's collection of animal mummies. For the first time ever, a large-scale research project (MAHES) has launched an extensive program of ^{14}C dating of animal mummies of diverse species coming from all over Egypt. The ^{14}C dating has confirmed the textual and ceramic dates that indicate that animal mummification became popular from the 7th century BC and continued into the Roman era, and refined on these cult practices in terms of documenting the changing popularity of certain cults.

Although this work represents only a selection of the Museum's collection, we already have been able to identify broad trends in the history of animal cults. A considerable range of species, including shrews, cats, foxes, dogs, monkeys, cattle, ibises, crocodiles, and fish, were prepared as offerings for a variety of gods during the Late Period, with an apogee reached during the mid-Ptolemaic period, with a tapering off of some species during the Roman period, when an increased popularity in the cults associated with gazelle and Barbary sheep emerged. This raises questions about changes in religious beliefs and changing popularity of different divinities, as well as the economics associated with obtaining different species of animals for mummification, such as monkeys, which are the subject of a new and more detailed research project. Of course, further samples of any particular species might change the picture that has emerged thus far, but the current data serve as a starting point upon which we can build.

More ^{14}C work on the Musée de Confluences collection, as well as on other museum collections of animal mummies and mummies that are being excavated in Egypt, will further flesh out our understanding of the timespan of activity in different necropolises or even specific portions of a particular catacomb. This will enhance our comprehension of economic and sociocultural factors associated with ancient Egyptian animal cults.

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REFERENCES

- Berthet D. 2016. Les momies animales du musée des Confluences à Lyon: une collection unique au monde. *ISAAE 1 – First International Symposium on Animals in Ancient Egypt*. Lyon (France), 1–4. June 2016.
- Bronk Ramsey C. 2009. Bayesian analysis of radiocarbon dates. *Radiocarbon* 51(1):337–60.
- Brunner-Traut E. 1965. Spitzmaus und Ichneumon als Tiere des Sonnengottes. *Nachrichten der Akademie der Wissenschaften in Göttingen* 7:154.
- Charron A. 1990. Massacres d'animaux à la Basse Epoque. *Revue de l'Égypte* 41:209–13.
- Charron A. 1996. Les animaux et le sacré dans l'Égypte tardive: fonctions et signification [PhD thesis]. Paris: Ecole pratique des hautes études (EPHE).
- Charron A. 2011. Les momies d'animaux: une classification des espèces de l'Égypte ancienne. *Espèce* 1:58–65.
- Charron A, Porcier S, Ikram S, Pasquali S, Lichtenberg R, Mérigeaud S, Tafforeau P, Richardin P, Vieillescazes C, Piques G, Letellier-Willemin F, Bailleul-LeSuer R, Servajean F. 2015. Etude des momies animales du Musée des Confluences à Lyon (France) - premiers résultats.

- ICE XI International Congress of Egyptologists XI. Florence, Italy, 23–30 August 2015.
- Dodson AM. 2015. Bull cults. In: Ikram S, editor. *Divine Creatures: Animal Mummies in Ancient Egypt*. Cairo: American University in Cairo Press. p 72–105.
- Houlihan P. 1996. *The Animal World of the Pharaohs*. Cairo: American University in Cairo Press.
- Ikram S. 2005. A monument in miniature: the eternal resting place of a shrew. In: Janosi P, editor. *Structure and Significance*. Vienna: Österreichischen Akademie der Wissenschaften. p 335–40.
- Ikram S. 2013. Man's best friend for eternity: dog and human burials in ancient Egypt. *Anthropozoologica* 48(2):299–307.
- Ikram S. 2015a. *Divine Creatures: Animal Mummies in Ancient Egypt*. Cairo: American University in Cairo Press.
- Ikram S. 2015b. Speculations on the role of animal cults in the economy of ancient Egypt. In: Massiera M, Mathieu B, Rouffet F, editors. *Approivoiser le sauvage/Taming the Wild (CENiM 11)*. Montpellier: University Paul Valéry Montpellier 3. p 211–28.
- Ikram S, Dodson AM. 1998. *The Mummy in Ancient Egypt: Equipping the Dead for Eternity*. London: Thames and Hudson.
- Ikram S, Helmi A. 2002. The history of the collection of the animal mummies at the Egyptian Museum, Cairo. In: Eldamaty M, Trad M, editors. *Egyptian Museum Collections*. Cairo: Supreme Council of Antiquities. p 563–8.
- Ikram S, Iskander N. 2002. *Catalogue Général of the Egyptian Museum: Non-Human Remains*. Cairo: Supreme Council of Antiquities.
- Kessler D. 1986. Tierkult. In: Helck W, Westendorf W, editors. *Lexicon der Ägyptologie*. Band 6. Weisbaden: Otto Harrassowitz. p 571–87.
- Kessler D. 1989. *Die Heiligen Tiere und Der König*. I. Wiesbaden: Harrassowitz.
- Letellier-Willemin F. 2015a. Les textiles. In: Dunand F, Heim J-L, Lichtenberg R, directors. *El-Deir Nécropoles III: La nécropole Est et le Piton aux chiens*. Paris: Cybèle.
- Letellier-Willemin F. 2015b. The long-and-narrow-sleeved tunic of the mummy W 14 of el-Deir. 8th Conference of Textiles from the Nile Valley, Textiles, tools and techniques, 5–6 October 2013, Antwerp, Lannoo 2015.
- Longin R. 1971. New method of collagen extraction for radiocarbon dating. *Nature* 230(5291): 241–2.
- Lortet L, Gaillard C. 1903. La faune momifiée de l'ancienne Égypte I. *Archives du Muséum d'histoire naturelle de Lyon* 8.
- Lortet L, Gaillard C. 1907. La faune momifiée de l'ancienne Égypte II. *Archives du Muséum d'histoire naturelle de Lyon* 9.
- Lortet L, Gaillard C. 1909. La faune momifiée de l'ancienne Égypte et recherches anthropologiques III. *Archives du Muséum d'histoire naturelle de Lyon* 10.
- Moreau C, Caffy I, Comby C, Delqué-Količ E, Dumoulin J-P, Hain S, Quiles A, Setti V, Souprayen C, Thellier B, Vincent J. 2013. Research and development of the Artemis ¹⁴C AMS Facility: status report. *Radiocarbon* 55(2–3):331–7.
- Nicolotti M, Postel L. 1994. L'animal et le monde de l'au-delà: les momies du Muséum d'Histoire Naturelle de Lyon. *Bulletin du Cercle lyonnais d'égyptologie Victor Loret* 8:35–48.
- Porcier S, Berthet D. 2014. Quand momies animales et Muséum d'histoire naturelle font bon ménage: la prestigieuse collection du musée des Confluences à Lyon. *Archéothéma* 37:41–5.
- Porcier S, Charron A, Ikram S, Pasquali S, Lichtenberg R, Mérigeaud S, Tafforeau P, Richardin P, Vieillescazes C, Piques G, Letellier-Willemin F, Bailleur-LeSuer R, Servajean F. 2015. Projet MAHES - Momies Animales et Humaines ÉgyptienneS - Perception de la mort en Égypte ancienne à travers l'étude des animaux sacrés. ICE XI International Congress of Egyptologists XI. Florence, Italy, 23–30 August 2015.
- Quiles A, Delqué-Količ E, Bellot-Gurlet L, Comby-Zerbino C, Ménager M, Paris C, Souprayen C, Vieillescazes C, Andreu-Lanoë G, Madrigal K. 2014. L'embaumement comme une source de contamination pour la datation radiocarbone de momies égyptiennes: vers un nouveau protocole chimique pour extraire le bitume. *ArcheoSciences* 38:135–49.
- Ray JD. 2001. Animal cults. In: Redford DB, editor. *The Oxford Encyclopedia of Ancient Egypt*. Oxford: Oxford University Press. p 345–8.
- Reimer PJ, Bard E, Bayliss A, Beck JW, Blackwell PG, Bronk Ramsey C, Buck CE, Cheng H, Edwards RL, Friedrich M, Grootes PM, Guilderson TP, Haffidason H, Hajdas I, Hatté C, Heaton TJ, Hoffmann DL, Hogg AG, Hughen KA, Kaiser KF, Kromer B, Manning SW, Niu M, Reimer RW, Richards DA, Scott EM, Southon JR, Staff RA, Turney CSM, van der Plicht J. 2013. IntCal13 and Marine13 radiocarbon age calibration curves 0–50,000 years cal BP. *Radiocarbon* 55(4):1869–87.
- Richardin P, Gandolfo N. 2013a. Datation et authentification des œuvres de musée - Apports de la datation par le carbone 14. *Spectra Analyse* 292:55–60.
- Richardin P, Gandolfo N. 2013b. Radiocarbon dating and authentication of objects from ethnographic museums. *Radiocarbon* 55(3–4):1810–8.
- Richardin P, Gandolfo N, Moignard B, Lavier C, Moreau C, Cottéreau E. 2010a. Centre of Research and Restoration of the Museums of France: AMS radiocarbon datelist 1. *Radiocarbon* 52(4):1689–700.
- Richardin P, Cuisance F, Buisson N, Asensi-Amoros V, Lavier C. 2010b. AMS radiocarbon dating and scientific examination of high historical value manuscripts: application to two Chinese

- manuscripts from Dunhuang. *Journal of Cultural Heritage* 11(4):398–403.
- Smelik KAD, Hemelrijk EA. 1984. Who knows not what monsters demented Egypt worships? Opinions on Egyptian Animal Worship in Antiquity as Part of the Ancient Conception of Egypt. In: Haase W, editor. *Aufstieg und Niedergang der römischen Welt* 17(4):1853–2000.
- Vernus P, Yoyotte J. 2005. *Bestiaire des pharaons*. Paris: Librairie Académique Perrin.
- von den Driesch A, Kessler D, Steinmann F, Berteaux V, Peters J. 2005. Mummified, deified and buried at Hermopolis Magma – the sacred ibis from Tuna El-Gebel, Middle Egypt. *Ägypten und Levante* XV:204–44.
- Wasef S, Wood R, El Merghani S, Ikram S, Curtis C, Holland B, Willerslev E, Millar CD, Lambert DM. 2015. Radiocarbon dating of sacred ibis mummies from ancient Egypt. *Journal of Archaeological Science: Reports* 4:355–61.
- Weinstein JM. 1973. Foundation deposits in ancient Egypt [unpublished dissertation]. University of Pennsylvania. <http://repository.upenn.edu/dissertations/AAI7324237>.
- Wilkinson R. 2003. *The Complete Gods and Goddesses of Ancient Egypt*. London: Thames & Hudson.