A Taphonomic Analysis of Vertebrate Fossils Excavated from the Cemeteries and Rock-Cut Tombs of Qau el-Kebir, Egypt

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Declaration

This thesis is the result of my own work except where stated by reference or acknowledgement. My research was conducted under the guidance of Dr. Pip Brewer and Dr. Roula Pappa, Department of Earth Sciences, Natural History Museum, London.

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Abstract

A series of early 20th century excavations at grave sites near Qau el-Kebir, Egypt recovered hundreds of vertebrate fossils that represent the only surviving remains of an unknown Late Pleistocene fossil deposit. This study describes the taphonomic history and taxonomic composition of the mammalian remains excavated at Qau by recording and analysing taphonomic variables to determine the nature of the original deposit(s) and to understand the impact of biotic and abiotic factors on the death assemblage. The collection is unique in both its nature and context, as Pleistocene assemblages containing large mammals are rare in Egypt, and the presence of the fossils in graves dating to the 16th century BC implies cultural significance of these remains in antiquity. Mammalian specimens from Qau were identified to skeletal element and taxon, and taphonomic variables including weathering, abrasion, surface modifications, fracturing, and fragmentation were recorded. Distribution patterns of taxon, element, and taphonomic variables were compared among taxa and with similar studies using the literature as a guide. The Qau collection is dominated by Artiodactyla (primarily Ruminantia and *Hippopotamus*) specimens, and signs of both carnivore activity and human-mediated selection are present. Together, the representation of taxa and skeletal elements, abrasion, weathering, and surface modifications imply site formation in a riparian area within a desert environment. This ecologically and archaeologically unique collection is interpreted as a combination of remains derived from multiple autochthonous and allochthonous deposits.

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I Introduction

Historical Context

Between 1905 and 1925, a series of excavations near Qau el-Kebir, Egypt recovered hundreds of vertebrate fossils from cemeteries and rock-cut tombs (Welvaert, 2002; Steckeweh & Steindorff, 1936; Brunton, 1927). The last of these excavations, led by Sir Flinders Petrie and Guy Brunton from 1923 to 1925, produced two to three tons of fossil bones (Figure 1; Brunton, 1930) in addition to the archaeological artefacts and ancient human remains that were the primary focus of the excavation (Brunton, 1927). Many of the vertebrate fossils unearthed during these later excavations are now held at the Natural History Museum, London, and represent the only surviving remains of an unknown fossil deposit (or deposits) from central Egypt, possibly dating to the Late Pleistocene.

Figure 1. *Sir Flinders Petrie in 1924 at one of the excavation sites near Qau el-Kebir, Egypt. In the foreground is a mound of excavated fossil bones covered by cloth. Image courtesy of the Petrie Museum of Egyptian Archaeology, University College London.*

The city of Qau lies south of Asyut on the east bank of the River Nile and is situated within a wide-spreading fan of desert between the river and a shelf of rocky cliffs. The rock-cut tombs are found among these cliffs, while the cemetery burial shafts are located closer to the city (Figure 2). The grave sites (unoccupied in modern times) likely originated between the 16th to 13th century BC (Grajetzki, 2012; Brunton, 1927) and have experienced many periods of occupation and abandonment since their construction. Although other archaeological materials excavated at Qau have been closely studied (Brunton, 1930), the

cultural significance of the fossil bones is unclear.

Many of the specimens excavated at Qau are mineralised and thus pre-date the construction of the grave sites. Some are quite heavy and it is likely that most of the fossils present were collected in antiquity from one or more local deposits and brought to the various grave sites. Surveys of the surrounding desert in a 500 km radius (Brunton, 1927) could not determine an origination point for the fossils, as no additional fossils were uncovered. Some fossils were found wrapped in linen bundles within grave sites, while others were found loose and scattered about the tombs. The tombs were periodically filled with water as groundwater level rose during regular flooding of the River Nile. It is unlikely that organic material would survive such a moist environment, so it is possible that many more of the fossilised remains were wrapped in linen than have been discovered.

After the excavations by Petrie and Brunton, the vertebrate remains were separated from the archaeological finds (Figure 3), sorted, and selected specimens (Brunton, 1930) were sent to University College London, along with the ancient human remains, where they awaited further study (Petrie, 1930). This not forthcoming, the zoological material was shipped first to the museum at the University of Cambridge, then back to London in 1951, where most of the specimens found a home in the British Museum (Natural History) and were left undisturbed for many years in off-site storage.

The Qau Collection

The remains excavated by Petrie and Brunton at Qau are the focus of an ongoing set of multidisciplinary studies by researchers and curators at the Natural History Museum (London), Open University, Camborne School of Mines, University of Liverpool, Cardiff University, University of Manchester, and Bolton Museum and Art Gallery. These studies include archaeological and historical research, X-ray fluorescence testing, and radiocarbon dating, among others.

This project forms a preliminary part of this research and describes the taphonomic history and taxonomic composition of the death assemblage(s) represented at Qau. Although there is a wide range of vertebrate taxa represented in the collection—comprising crocodiles, turtles, fish, and mammals, including fossilised human bones—this study focuses on the mammalian taxa, which make up the majority of the fossil remains (over 800 specimens in the Fossil Mammal collection of the Natural History Museum, London). Using standard taphonomic variables and a comparative approach to similar megafaunal

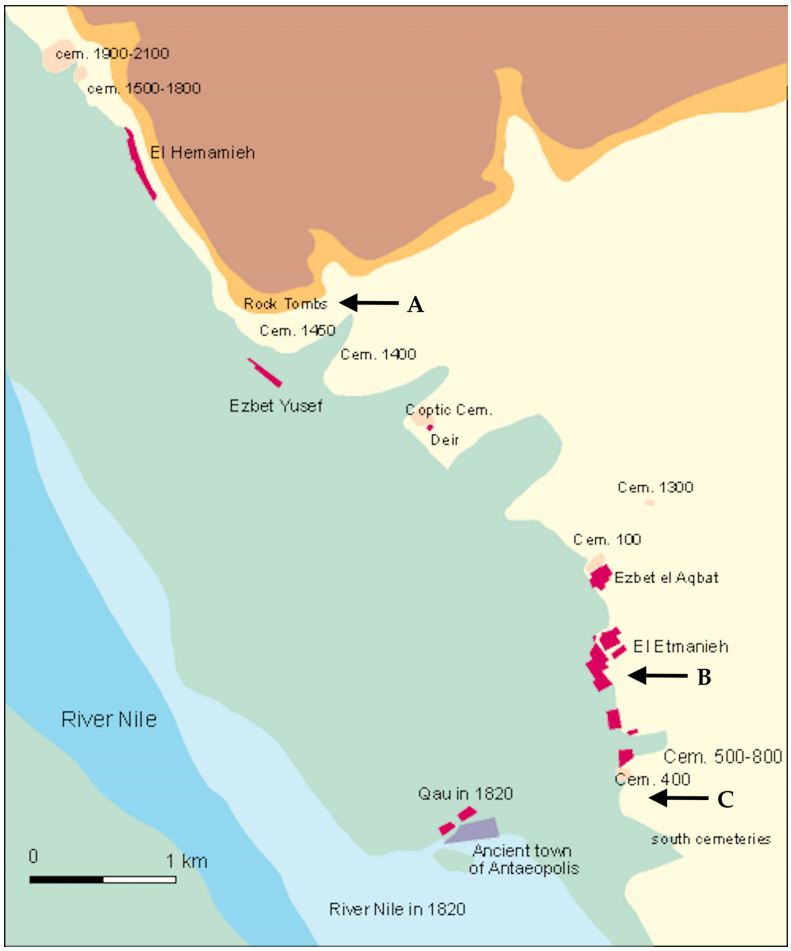

Figure 2. *Map showing Qau el-Kebir and the surrounding area. Known excavation sites are marked with arrows. A = rock-cut tombs; B and C = cemeteries. Image modified from Brunton (1927), courtesy of the Petrie Museum of Egyptian Archaeology, University College London.*

Figure 3. *Winifred Brunton in 1924, examining fossils from Qau el-Kebir on the lower terrace of one of the large tombs (Tomb of Uhaka II). Image courtesy of the Petrie Museum of Egyptian Archaeology, University College London.*

studies (e.g., Dortch et al., 2016)

The taphonomic and historical considerations of any study on the Qau collection are complex. A wide range of preservation types and colours is represented by the specimens (e.g., Figure 4), and much of the collection is highly eroded. Very few of the specimens are complete, all of the fossils are disarticulated, and no sedimentary or geological context is preserved. From the initial collection of the fossils in antiquity, to their excavation in the early 20th century, there are at least two layers of modern human-mediated selection biases in addition to any other biotic and abiotic processes that may have changed the composition or character of the assemblage at any point in its history.

Figure 4. *Two unidentified bone fragments highlighting the range of preservation in the Qau collection, from light brown (left, NHMUK Qau #1006) to shiny, polished black (right, NHMUK Qau #1024).*

Project Aims

Death assemblages containing large mammals are rare in Egypt, and the palaeoecology of this region is poorly represented in the Late Pleistocene fossil record. Although nearly a century has passed since the excavations at Qau el-Kebir, there has not yet been a comprehensive study of the zoological material. This project aims to establish, record, and analyse a series of taphonomic variables on the mammalian fossils excavated from Qau in order to describe the nature of the original deposit, to determine whether the fossils were gathered in antiquity from a single deposit or multiple, and to understand the impact of carnivore- and human-mediated factors on the original assemblage. The remains excavated at Qau el-Kebir are ecologically and archaeologically unique and the ultimate goal is for the results of this study to contribute to the understanding of the palaeoecological, zooarchaeological, and taphonomic processes affecting this collection and other Late Pleistocene assemblages in Egypt and similar environments.

II Materials & Methods

Taxonomic Representation

To assess the range of taxonomic representation in the collection, the number of identified specimens (NISP), minimum number of individuals (MNI), and minimal animal units (MAU) were calculated. To do this, all mammalian (non-human) remains recovered from Qau between 1923 and 1925 were identified to skeletal element and family-level taxon (Schmid, 1972; Pales & Lambert, 1971; Hillson, 2005; Walker, 1985; Constantinescu & Schaller, 2012; O'Leary, 2016). NISP values were calculated by counting the number of specimens identified for each taxon (Lyman, 1994). MNI values were calculated following White (1953) by counting the total number of left and right specimens for the most prevalent skeletal element per taxon and recording the highest of the two values. Although MNI values are commonly used to compare taphonomic analyses (Lyman, 1994; Marshall & Pilgram, 1993), the Qau collection had a number of specimens (particularly horn cores) that were difficult to assign to the left or right side of the body and thus were not included in the calculation of MNI values. To account for these ambiguous specimens, MAU values (Binford, 1981) were used as an alternative analytical unit for taxonomic representation (Lyman, 1994). The MAU value for each taxon was calculated by rounding up the total number of each skeletal element (left, right, and ambiguous), and dividing by the element's frequency in the taxon's body plan.

The Bovidae and Cervidae were grouped together into three ruminant weight categories (modified from Dortch et al., 2016): small = less than 10 kg; medium = between 10 and 100 kg; large = greater than 100 kg. Body size was estimated by matching skeletal elements with modern species of similar size and of known live weight. These categories were used as parataxonomic groups for Ruminantia and for specimens that were not identified to taxon.

Voorhies Groups

Specimens were sorted into three "Voorhies Groups" (Voorhies, 1969) based on their potential for fluvial transport to determine if the collection is autochthonous or allochthonous (de Araújo-Júnior, 2016). Because equivalent anatomical elements have different transport potentials in different taxa, the elements from each taxa were sorted into Groups (Table 1) using a modified combination of group definitions for medium to large taxa from Gunnell

(2001) and Behrensmeyer (1975).

Table 1. *Skeletal elements in Voorhies Group I and Group II, per taxon. Voorhies Group III contains all other elements for each taxon. "Phalanges (t)" refers to the terminal phalanges.*

Taxon	Group I	Group II
Hippopotamus	Phalanges (t) and sesamoids	Phalanges
Ruminantia (small)	Phalanges, sacrum, sternum, vertebrae (cervical, thoracic, lumbar, axis), patella, humerus, ribs, sesamoids	Podials, vertebrae (atlas), metatarsals, metacarpals
Ruminantia (medium)	Ulna, podials, sacrum, vertebrae (axis, atlas, cervical, thoracic), patella, sesamoids, phalanges	Calcaneum, vertebrae (lumbar), ribs
Ruminantia (large)	Phalanges (t), ribs, ulna	Astragalus, podials, phalanges
Suidae	Podial, phalanges, patella, sesamoids	Ribs, astragalus
Equus	Calcaneum, podials, phalanges, vertebrae (cervical and lumbar), patella, sesamoids	Vertebrae (thoracic), ribs, astragalus
Elephantidae	*Same as Hippopotamus*	*Same as Hippopotamus*
Carnivora	*Same as Ruminantia (small)*	*Same as Ruminantia (small)*
Unidentified (small)	*Same as Ruminantia (small)*	*Same as Ruminantia (small)*
Unidentified (medium)	*Same as Ruminantia (medium)*	*Same as Ruminantia (medium)*
Unidentified (large)	*Same as Ruminantia (large)*	*Same as Ruminantia (large)*

Group I includes elements that are most likely to be transported via fluvial transport, Group II contains intermediate elements, and Group III contains the elements most likely to remain behind in a lag deposit. Because the distribution of anatomical elements among these Groups is not uniform in most body plans (especially among the larger taxa), the distributions of observed elements in these Groups were compared within each taxon with the expected distribution of a complete (i.e., fluvially undisturbed) representative individual of that taxon (as in Bassarova, 2004). Skeletal elements that could not be identified to taxa were sorted into Voorhies Groups based on body size categories and compared with the expected distributions of skeletal elements from ruminants of the same size category (Table 1).

Abrasion, Polishing, and Embedded Particles

To test for evidence of tumbling and erosion of the bone surface due to fluvial transport and exposure to wind- or water-borne sediment, surface abrasion on each specimen was scored at the highest observed of three levels: low (level 1) = little to no edge-rounding;

moderate (level 2) = visible edge rounding; and high (level 3) = extensive edge-rounding and damage to landmarks (Dortch et al., 2016; Fernández-Jalvo & Andrews, 2003, 2016).

Some fossils from Qau are partially (and in some cases fully) covered in a smooth, shiny polish, which is often dark or notably darker than the surrounding surface and is consistent with polishing caused by fine-particle abrasion in high wind environments (i.e., sand-blasting; Denys et al., 2007). The presence of this type of abrasion was recorded and compared among taxa and weathering stages.

The presence of large clastic sediments embedded in alveoli, vertebral foramina, and other fossae may indicate exposure of specimens to seasonal heavy flow (Boaz, 1982). To test the Qau collection for this signal, the largest size of clastic particles embedded in or on the surface of each specimen was recorded in three categories (adapted from Wentworth, 1922): none = no clastic particles present; sediment = particles of small size (less than 1 mm in diameter); pebbles = particles of medium size (between 1 and 10 mm); and gravel = particles of large size (larger than 10 mm).

Weathering

Weathering can give an indication of the extent of pre-depositional, sub-aerial exposure a bone has undergone (Shipman1981). Each specimen was assigned one of four categories (modified from Behrensmeyer, 1978; Dortch et al., 2016) based on the maximum stage of bone surface deterioration observed on any patch larger than 1 cm^2 (Lyman, 1994). Smooth (stage 0) = no cracking or flaking; low (stage 1) = minor cracking parallel to the fibre surface; moderate (stage 2) = cracking and some exfoliation of the surface, mosaic cracks on articulating surfaces; and severe (stage 3) = extensive cracking, exfoliation, loss of cortex, and exposure of cancellous bone (Fernández-Jalvo & Andrews, 2003).

Limb Fracturing

Different fracture types can indicate breakage at different stages in a bone's history (Behrensmeyer, 1991; Shipman et al., 1981). Spiral fractures commonly occur on fresh bones, while transverse and oblique fractures most often occur on bones that have already mineralised (Behrensmeyer, 1991; Coombs & Coombs, 1997). To determine when the bones of different taxa were broken (i.e., while fresh, after prolonged sub-aerial weathering, or after mineralising), long bone specimens with fractures were grouped into the following five types (modified from Dortch et al., 2016; Shipman, 1981): splinter, longitudinal, transverse, spiral, and oblique. Specimens with signs of recent breakage (i.e., unabraded

breaks that may have occurred during or after excavation), were excluded from this analysis of fracturing, as the collection's recent history lies beyond the focus of this study.

Fragmentation

To analyse the patterns and types of bone fragmentation at Qau, specimens were sorted into eight categories based on the completeness of anatomical elements using a combination of groups defined in Dortch et al. (2016) and Coombs & Coombs (1997). Categories for limb bones were: complete; proximal epiphysis; diaphysis; distal epiphysis; proximal epiphysis and diaphysis; and distal epiphysis and diaphysis. For non-limb bones, the three categories were complete; partial (more than 50% of anatomical element present); and fragment (less than 50% of anatomical element present). Complete limb and non-limb bones were treated together as a single category. Additionally, where fragmented specimens could be recombined, the number of fragments (*nf*) making up each recombined specimen was recorded. Fragmentation data and the number of fragments for each specimen are included in Table 3 (Appendix).

Carnivore and Human Activity

Patterns of skeletal element proportions in death assemblages may indicate carnivore activity. The elements most often left behind after carnivore activity are: cranial bones, vertebrae, teeth, horn cores, ribs, and the ends of limb bones (Behrensmeyer, 1975). To test the Qau collection for this pattern, element proportions from the ungulate taxa (the most likely prey; Behrensmeyer, 1975) were calculated. Tooth punctures and gnaw marks were also recorded, as these bone surface modifications are often indicative of predator or scavenger activity (Binford, 1981).

III Results

Taxonomic Representation

Ruminants and *Hippopotamus* specimens dominate the Qau collection, respectively composing 53% and 40% of the identifiable mammal bones (n = 463, Table 2). The remaining taxa in decreasing abundance are *Equus*, Suidae, Elephantidae, and Carnivora and range from 3.9% to 0.6% (Table 2).

Table 2. *Taxonomic representation of mammalian species from Qau showing both the absolute values and proportions (in percent) of the number of identified specimens, minimum number of individuals, and minimal animal units per taxon.*

Taxon	NISP	MNI	MAU	%NISP	%MNI	%MAU
Hippopotamus	183	11	16	40	28	25
Ruminantia (small)	29	4	4	6	10	6
Ruminantia (medium)	165	11	30	36	28	47
Ruminantia (large)	51	5	6	11	13	9
Suidae	10	3	5	2	8	8
Equus	18	2	1	4	5	2
Elephantidae	4	1	1	0.9	3	2
Carnivora	3	2	1	0.6	5	2
Total	463	39	64	-	-	-

Taxonomic representation based on MNI values differs quantitatively between NISP values (Table 2), but is proportionately similar. The *Hippopotamus* MNI value is relatively low in comparison with its NISP value due the abundance of teeth. The total MNI value for all taxa (n = 39, Table 2) comprises more *Equus*, Suidae, Elephantidae, and Carnivora than expected because MNI values of taxa that are represented by a small number of specimens are consistently inflated (Grayson, 1978).

The difference between absolute MNI and MAU values is relatively low for the poorly represented taxa (Table 2, cf. *Equus*: MNI = 2 versus MAU = 1), but the proportional difference is much greater (cf. *Equus*: %MNI = 5% versus %MAU = 1.6%). The greatest difference between proportions of MNI and MAU is among the medium-sized ruminants, largely due to an abundance of ambiguously-sided horn cores (e.g., Figure 5). The majority of identifiable bones come from artiodactyls (about 95%), while about 4% of the collection is made up of perissodactyls (represented only by *Equus*). Carnivores make up 0.6% of the identified specimens in the Qau collection, but the %MNI for carnivores (5%) is proportionately higher due to the inflation of MNI values in taxa with low representation.

Figure 5. *Four horn cores in the Qau collection, showing a range of taxonomic representation, preservation types, weathering stages, and body size (specimens NHMUK PV M 102132, NHMUK PV M 102161, NHMUK PV M 102201, and NHMUK PV M 102160).*

Vertebrae are the most common element (21% of all specimens identified to element, Figure 6), followed by teeth, mandibles, and horn cores, ranging from 14% to 12%. The most common post-cranial elements are metapodials, tibiae, humeri, and podials (Figure 6), ranging from 6% to 4%.

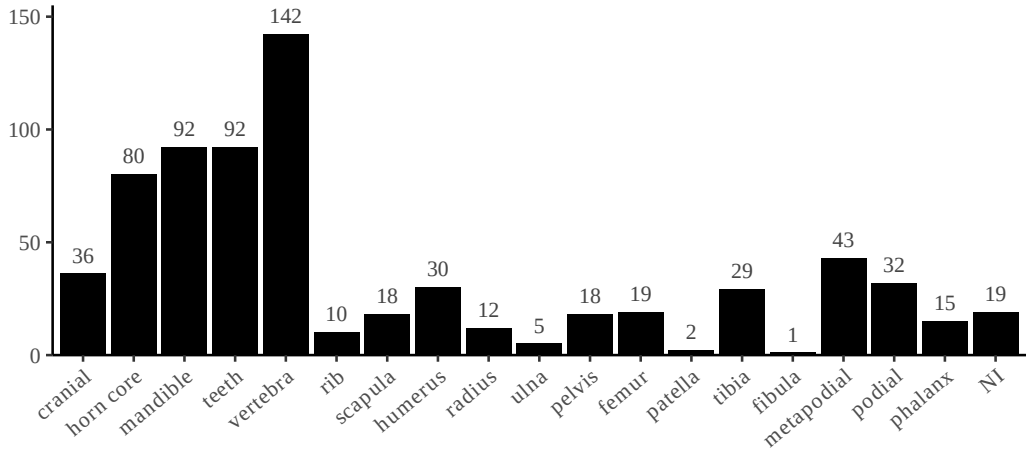

Figure 6. *Counts of skeletal element represented in the Qau collection (n = 695). NI are unidentified bones.*

Only 11% of all specimens had small body sizes (Figure 7), which may imply a selection bias against small taxa and specimens (see Section IV).

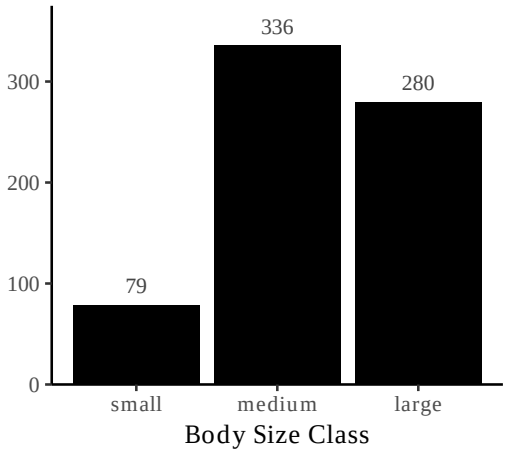

Figure 7. *Distribution of mammalian body size groups in the Qau collection (n = 695). Small: < 10 kg; medium: 10–100 kg; large: > 100 kg (modified from Dortch et al., 2016).*

Voorhies Groups

The observed distribution of elements into Voorhies Groups (Figure 8) differs significantly from the expected pattern (i.e., that of an undisturbed individual) in all taxa except the

Elephantidae and the Carnivora, which had very small small sample sizes (n = 4 and n = 3, respectively). *Hippopotamus* specimens (χ^2-test: χ^2 = 44.0, df = 2, p < 0.001) have only one representative element each in Group I and Group II (Figure 8), and the observed proportion of Group III elements (99%) is much higher than the expected proportion (86%). All other taxa except the Carnivora show the same pattern: a higher percentage of Group III elements and lower percentage of Group I elements. Thus, the majority of specimens across all taxa in the collection indicate a lag deposit due to fluvial transport.

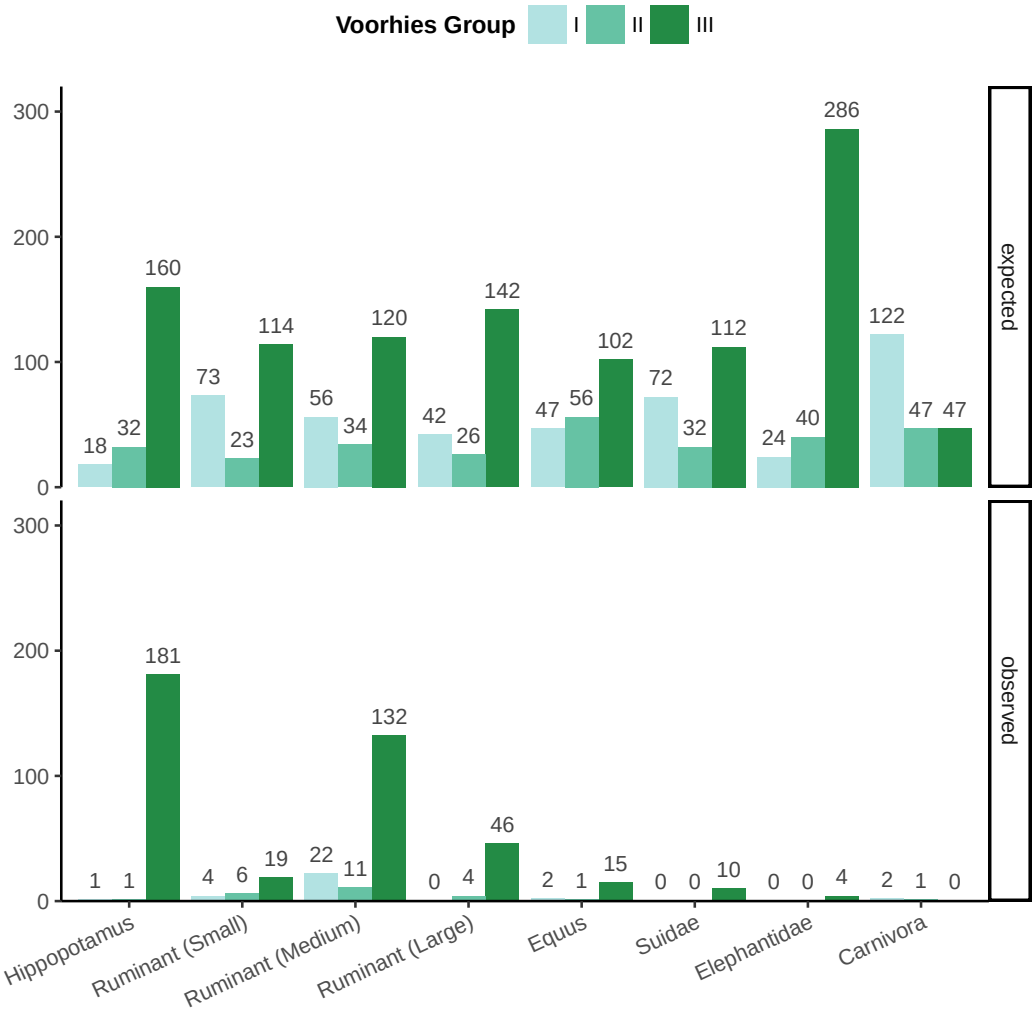

Figure 8. *The observed vs. expected distributions of skeletal elements into Voorhies Groups per taxon (n = 462).*

Abrasion, Polishing, and Embedded Particles

Most of the specimens in the collection have moderate to high levels of abrasion (Figure 9), which indicates that the majority of the collection has: (1) spent time exposed to water-

borne sediment or wind-borne particles; (2) has been fluvially or aerially transported; or (3) a has experienced a combination of these effects. Most specimens with moderate to high abrasion are abraded evenly, which suggests that they were transported and tumbled during or as a result of exposure to wind or water abrasion.

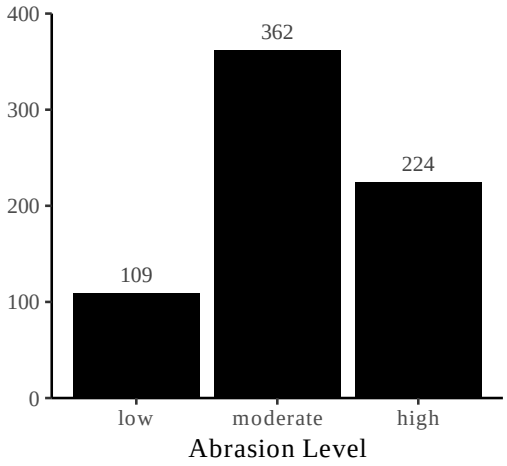

Figure 9. *The distribution of abrasion levels found on the specimens from Qau (n = 695). Low = little to no edge-rounding; moderate = visible edge-rounding; high = extensive edge-rounding and damage to landmarks (Dortch et al., 2016)*

All taxonomic groups share this pattern, and the distributions of terrestrial and semi-aquatic taxa do not differ significantly from each other. Most skeletal elements have a similar distribution pattern except teeth (χ^2 = 53.9, df = 2, p < 0.001), podials (χ^2 = 6.4, df = 2, p = 0.042), and phalanges (χ^2 = 11.7, df = 2, p = 0.003). The teeth (n = 92) show much less abrasion (low abrasion = 48%), most likely due to their robustness. None of the podials (n = 32) or phalanges (n = 15) have low abrasion, which may be due to the small sample sizes of these groups.

33% of specimens show signs of polishing (e.g., Figure 4, right). The proportion of specimens with polish increase with increasing weathering stages and abrasion levels (Figure 10). The majority of specimens with severe weathering show polish (53%, n = 184), as do the majority of specimens with high abrasion (52%, n = 224), indicating a correlation between these factors. All the skeletal elements are predominately unpolished except the vertebrae, podials, and phalanges, which have equal proportions of polished and unpolished specimens, and the ulnae (n = 5), which are mostly polished (80%).

41% of specimens have embedded clastic particles up to 1 mm in diameter. Specimens with larger pebbles and gravel embedded in them (e.g., Figure 11) make up a combined 30% of the collection, indicating that at least a third of the specimens have been exposed to a high-velocity fluvial system.

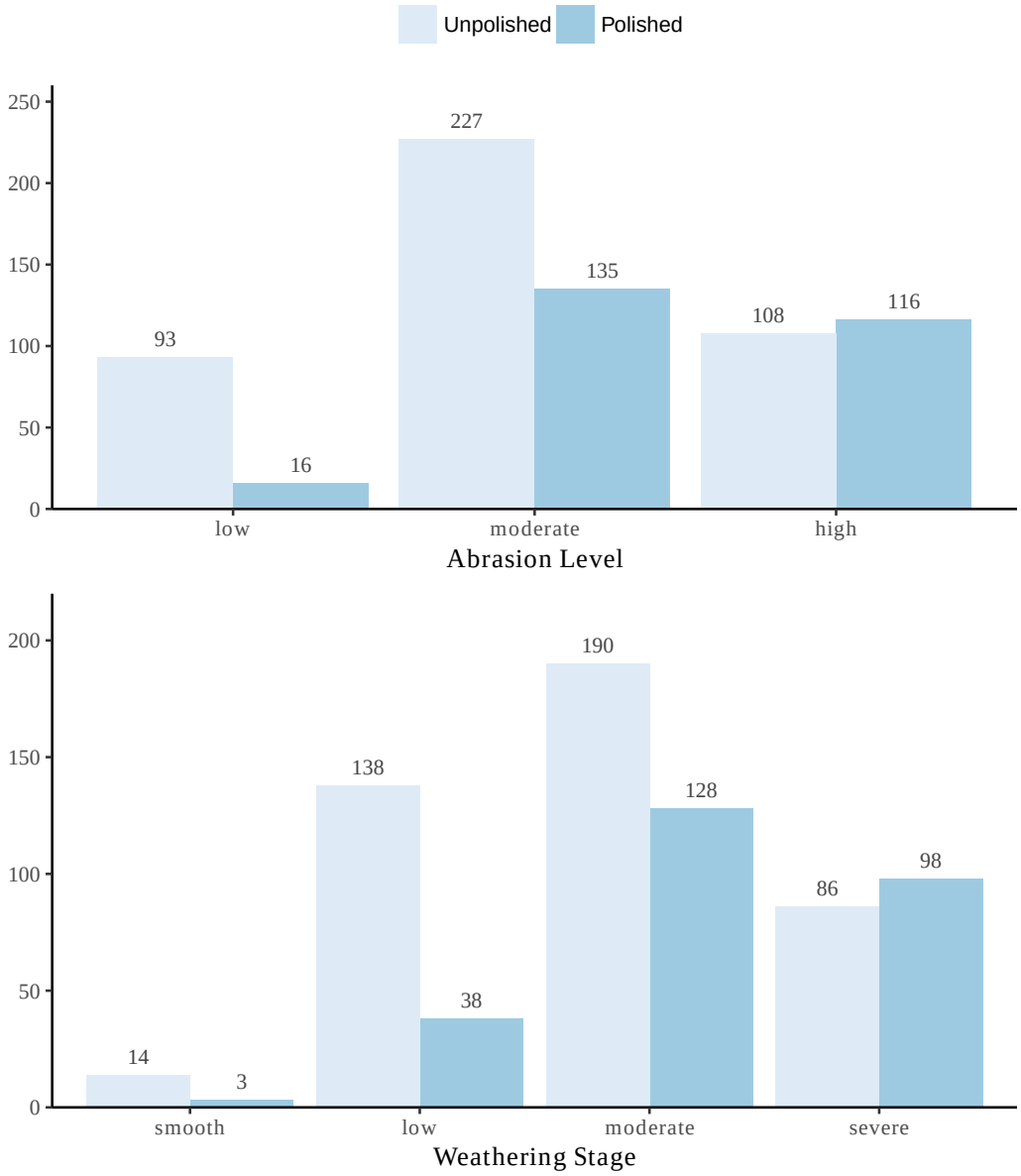

Figure 10. *The proportion of polished vs. unpolished specimens by weathering stage and abrasion level (n = 695).*

Figure 11. *Partial thoracic vertebra with embedded gravel in the vertebral foramen (NHMUK PV M 101898).*

Weathering

Examination of the distribution of weathering stages reveals a predominance of moderately weathered bones (Figure 12) and a low proportion of smooth bones (about 2%), indicating that most specimens experienced prolonged sub-aerial exposure prior to burial. The only taxonomic groups that do not share this pattern are the small ruminants (χ^2 = 9.0, df = 3, p = 0.029) and *Equus* (χ^2 = 7.7, df = 3, p = 0.053) specimens. The bones of the small ruminants (n = 29) show a low proportion of extensive weathering (7%), which may be due to the relative lack of robustness in smaller bones: highly weathered small bones may have been destroyed before they could fossilise. Similarly, all specimens with a small body size (less than 10 kg) have a larger proportion of low weathering than the overall distribution (χ^2 = 7.9, df = 3, p = 0.049). The *Equus* specimens (n = 18) have a higher proportion of extensive weathering than any other stage (56%).

Among the skeletal elements, cranial bones and podials are the only elements that deviate from the overall distribution (cranial bones: χ^2 = 8.7, df = 3, p = 0.034; podials: χ^2 = 12.3, df = 3, p = 0.007). Most of the cranial bones show low weathering (47%, n = 36), while the majority of the podials show extensive weathering (53%, n = 32).

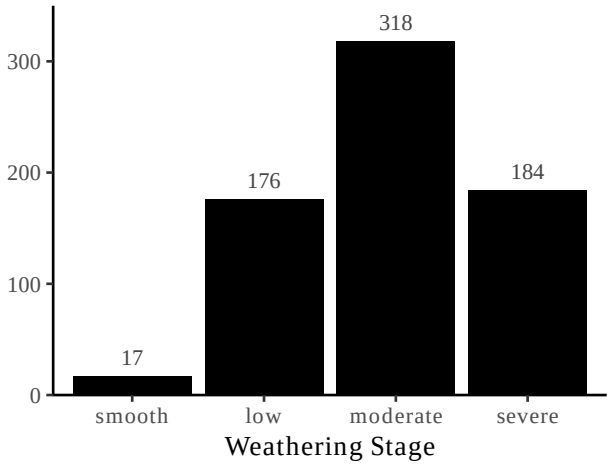

Figure 12. *The distribution of weathering stages among specimens in the Qau collection (n = 695). Smooth = no cracking or flaking; low = minor cracking parallel to the fibre surface; moderate = cracking and some exfoliation of the surface; severe = extensive cracking, exfoliation, loss of cortex, and exposure of cancellous bone (Behrensmeyer, 1978; Dortch et al., 2016).*

Limb Fracturing

Analysis of fracturing patterns (Figure 13) shows that the majority of broken limb bones without recent breaks (i.e., those caused during or after excavation) had oblique fractures (54%). Both the spiral and longitudinal fracturing categories were only represented by one specimen (4%). As oblique and transverse fractures are more likely to occur post-mineralisation, spiral fractures on fresh bones, and longitudinal fractures on weathered, but unmineralised bone, these distribution patterns suggest that most observable breaks occurred after fossilisation.

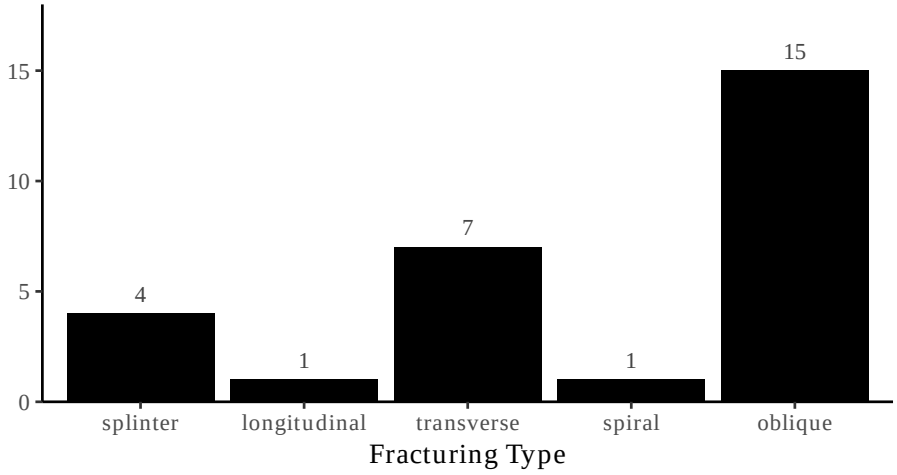

Figure 13. *The distribution of fracturing types (Shipman, 1981; Dortch et al., 2016) in Qau limb bone specimens without recent breaks (n = 28).*

Weathering stages among the three most common fracture types (oblique, transverse, and splinter) are similar to the overall pattern of weathering. Splinter fractures (n = 4) have only extensive and severe weathering. The only specimen showing longitudinal fracturing is moderately weathered, while the only spiral fracture specimen is extensively weathered.

The Ruminantia follow a similar pattern to the collection as a whole, with oblique and transverse fracturing types dominating the sample, but the proportion of splinter fractures is relatively low compared to the overall distribution of fracture types. The *Hippopotamus* specimens have a very small sample size (n = 3) but have mostly oblique and transverse fractures. The *Equus* specimens show a majority of oblique fractures, with an equal number of transverse and longitudinal fracturing.

Carnivore and Human Activity

The most common elements in the collection (Figure 6) are vertebrae (20%), followed by teeth (13%), mandibles (13%), and horn cores (12%). The remaining 15 element categories, decreasing in abundance from metapodials to patellae, range from 6.2% to 0.3%. These proportions are broadly consistent with the pattern expected as a result of carnivore activity, although the proportion of ribs (1.4%) is very low. One specimen (Figure 14) has a puncture consistent with a crocodilian tooth mark (cf. Vasileiadou et al., 2009; Hooker, 2018, unpub.), indicating that predation or scavenging likely occurred in a riparian environment. No specimens show signs of gnaw marks, although it is possible these signs have been erased, considering the large proportion of highly abraded specimens in the collection.

Although linear marks are found on 8% of specimens, none is clearly consistent with human-derived cut-marks. One vertebra specimen (NHMUK PV M 101891) has fragments of woven linen embedded on its surface. The implications and impacts of human-mediated factors affecting the Qau collection is discussed in more detail in Section IV.

Age of the Deposit

A combination of external studies of species time ranges and radiocarbon dating were collated to estimate an age range for the Qau collection. The three Elephantidae molars (NHMUK PV M 101692, NHMUK PV M 101690, and NHMUK PV M 101688) were measured and identified under the guidance of Dr. Adrian Lister. Two were identified as *Palaeoloxodon recki*, which was present in East Africa from approximately 2 million years

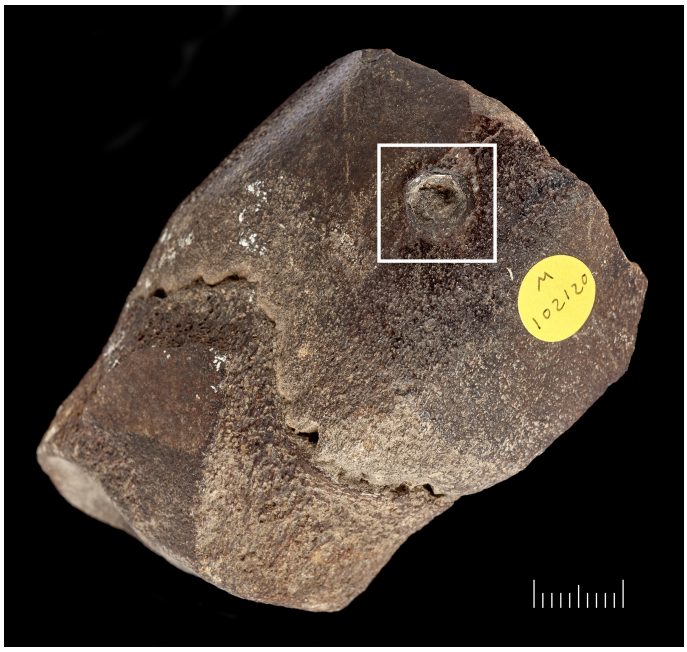

Figure 14. *Distal radius from a young* Equus *specimen showing a surface mark consistent with a crocodile tooth puncture (NHMUK PV M 102120).*

ago to 35,000 years ago (Beden, 1979; Lister, pers. comm.). One Crocodylia specimen (NHMUK PV R 36896) was identified by Dr. Lorna Steel as *Euthecodon sp.*, which is found throughout Africa including Egypt from the early Miocene to the early Pleistocene (Fourtau, 1920). Members of the Hippopotamidae family are known on the African continent from about 2.5 million years ago (Weston & Boisserie, 2010) and *Hippopotamus amphibius* was present along the River Nile in Egypt in modern times (Sidney, 1965). Together, these ranges indicate a Pleistocene origin of the collection, possibly as recent as the Late Pleistocene.

The extent of mineralisation in the collection varies widely, particularly among the Suidae, which range from heavily mineralised to nearly fresh. Radiocarbon dating analysis performed by researchers at the Natural History Museum, London (Brewer, pers. comm., 2018) on a suid mandible (NMHUK PV M M99995) places it around 400 AD. Radiocarbon dating of linen wrappings on specimens in the Bolton Museum collection dates them to about 1300 BC, which coincides with the age suggested by archaeological study of the grave sites carried out by Petrie and Brunton (Petrie, 1930; Brunton, 1927).

IV Discussion

Nature of the Deposit

The thanatocoenosis represented by the Qau collection is interpreted as a combination of remains derived from multiple autochthonous and allochthonous deposits. The post-depositional history of the collection is difficult to ascertain with clarity as heavy damage and abrasion may have eroded more subtle biotic signals, such as scavenger gnaw marks or linear marks caused by trampling or cutting. Many specimens have likely been exposed to a high velocity fluvial environment after mineralising, possibly in a river bed, wadi, or flood plain. Embedded gravel, high levels of abrasion, and cemented fresh-water oyster shells on a mineralised *Hippopotamus* atlas vertebra (Figure 15) support this hypothesis. The presence of polished surfaces on many specimens suggests post-mineralisation exposure to abrasion from sand particles carried by strong winds (as in a desert environment; Denys et al., 2007).

Taken together, analyses of Voorhies Group distributions, abrasion, weathering, and bone surface modifications imply that the much of the Qau death assemblage formed in a riparian area within an arid environment. The presence of semi-aquatic taxa—represented by the many *Hippopotamus* specimens (e.g., Figure 16)—as well as crocodile, fish, and turtle remains, suggests a river system, while the abundance of medium-sized ruminants suggests plains or grassland. It is possible that these terrestrial and aquatic taxa form parts of the same biocoenosis, where ruminants and other terrestrial species frequented the river's edge. It is likely that predation and scavenging occurred in these environments, as suggested by the crocodile tooth puncture (Figure 14), the representation of skeletal elements, and the relative abundance of large taxa (see Biases, below). Analysis of the distribution of Voorhies Group supports this environmental hypothesis in nearly all taxa and suggests that many of the remains in the Qau collection form a lag deposit, left behind after fluvial winnowing.

Biases

The taxonomic representation of mammalian fossils in the Qau collection (Table 2) is clearly biased in several ways. First, small mammals are almost entirely absent from the collection, which is unlikely in most biocoenoses. This is a common pattern in many assemblages and it usually reflects a combination of: scavenging and predation, fluvial

Figure 15. *A partial* Hippopotamus *atlas with oyster shells cemented in the vertebral foramen (NHMUK PV M 100054).*

Figure 16. *Anterior view of a partial* Hippopotamus *mandible and side view of 3rd lower molar (NHMUK PV M 101622 and NHMUK PV M 101713).*

dispersal, destruction of smaller and lighter bones, behavioural differences between small and large mammals, and differing patterns of diagenesis in bones of different sizes and compositions (Coombs & Coombs, 1997; Behrensmeyer, 1975, 1991). In this collection, it seems likely that behavioural differences (i.e., herding in ruminants, *Equus*, and Elephantidae; the semi-aquatic lifestyle of *Hippopotamus*), predation and scavenging of remains, fluvial winnowing, and strong abrasive forces have combined to reduce significantly the representation of smaller taxa. It is possible that human-mediated selection—either in antiquity or during excavation—has also contributed to this effect, as larger bones would be both easier to find in the desert around Qau el-Kebir and more likely to be chosen for collection and study.

Due to resource limitations at large excavation sites, specimens must often be selected—as the bones at Qau were—to be saved and studied later. Information potential of each specimen is often a deciding factor in this process, and elements such as teeth, which are taxonomically informative, are often collected, while elements like ribs and vertebrae may be left behind, especially in an (early 20th century) archaeological excavation site. The low representation of rib specimens in the collection follows this pattern, but the abundance of vertebrae is puzzling. It is possible that these were selected for preservation preferentially over ribs by the excavation team led by Petrie and Brunton or that fossilised vertebrae were collected in antiquity while ribs were overlooked. Perhaps the simplest explanation is that ribs are more fragile than vertebrae and were less likely to survive the weathering and heavy abrasion that many elements in the Qau collection experienced.

The traditional definition of Voorhies Groups (Voorhies, 1969) includes vertebrae in Group I—the easily transportable elements. Recalculated with this definition, Group I would make up a much larger proportion of the collection given the abundance of vertebrae and would provide evidence against the hypothesis that the assemblage has been fluvially sorted. Additionally, the sorting of specimens from unidentified taxa into size class groups allows them to be compared with other taxa in an analysis of Voorhies Group distribution. The assumption that these elements behave similarly to—and should be sorted into the same Voorhies Groups as—ruminant taxa is not insignificant: the expected distribution of skeletal elements in undisturbed individuals varies greatly among taxa. However, given the size of the elements and the estimated body size of the living organisms from which they came, the composition and hydraulic transport potential of these elements is likely similar enough to allow this sort of analysis.

Further Research

A finer-resolution study of the taxonomic representation among the remains from Qau may make clearer the relationships between biocoenosis and thanatocoenosis, as comparisons with similar studies may be more accurate with specimens identified to the species level. Although this may prove difficult for many specimens in the Qau collection due to their erosion and heavy abrasion, genus-level identification may be possible for more of the collection. Although the mammalian taxa make up the majority of the collection, remains of crocodile, turtle, and fish taxa, as well as fossil humans, have also been collected and may be incorporated into further taphonomic analyses to more completely represent the diversity of the death assemblage. Cluster analyses applied to preservation types—particularly the shiny, dark preservation polish—may provide data on depositional groups and taphonomic history that are otherwise obscured by erosion, destruction, and other selective biases. Finally, analyses of age class distribution based on tooth wear may provide population age profile information that could be compared with deposits of similar composition.

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Appendix

Taxonomic and Skeletal Element Data

Table 3 (pages 27–48) contains taxonomic and skeletal element information from all specimens used in this project. The following abbreviations are used:

- *nf* = number of fragments
- NI = Unidentified (element or taxon, respectively)
- Side: L = left, R = right, M = medial; LW = lower, UP = upper
- Element Portion = the portion and orientation (distal or proximal) of the element present (Dortch et al., 2016; Coombs & Coombs, 1997). Element portion value 1 applies to all bones, 2–6 apply only to limb bones, and 7 and 8 apply only to non-limb bones. See Section II: Fragmentation (page 9).

  1 = complete

  2 = proximal epiphysis

  3 = diaphysis

  4 = distal epiphysis

  5 = proximal epiphysis and diaphysis

  6 = distal epiphysis and diaphysis

  7 = partial (more than 50% of anatomical element present)

  8 = fragment (less than 50% of anatomical element present)

Taphonomic Data

An additional dataset containing the character states of all taphonomic variables for each specimen used in this analysis (n = 695) has been submitted digitally with this thesis.

Table 3. *Mammalian specimens from Qau el-Kebir that were used in analyses (n = 695; all specimens are located in the Fossil Mammal Collection, Department of Earth Sciences, Natural History Museum, London). See previous page for abbreviations.*

Accession Number	*nf*	Element	Element Portion	Side	Taxon	Body Size	Element Detail
NHMUK PV M 100438	1	mandible	8	L	*Hippopotamus*	large	
NHMUK PV M 100426	1	cranial	8	R	*Hippopotamus*	large	
NHMUK PV M 100445	1	NI	8		NI	medium	
NHMUK PV M 100423	1	mandible	8	L	*Hippopotamus*	large	
NHMUK PV M 100424	1	mandible	8	L	*Hippopotamus*	large	
NHMUK PV M 100425	1	mandible	8		*Hippopotamus*	large	
NHMUK PV M 100439	1	mandible	8	R	*Hippopotamus*	large	m1 p4 alveoli
NHMUK PV M 100432	1	mandible	8	R	*Hippopotamus*	large	
NHMUK PV M 100436	1	mandible	8	R	*Hippopotamus*	large	
NHMUK PV M 100420	1	mandible	8	L	*Hippopotamus*	large	
NHMUK PV M 100429	1	mandible	8	R	*Hippopotamus*	large	
NHMUK PV M 100428	1	cranial	8	L	*Hippopotamus*	large	
NHMUK PV M 100421	1	mandible	8	L	*Hippopotamus*	large	
NHMUK PV M 100422	1	cranial	8	L	*Hippopotamus*	large	
NHMUK PV M 100427	1	mandible	8		*Hippopotamus*	large	
NHMUK PV M 100433	1	mandible	8	L	*Hippopotamus*	large	
NHMUK PV M 100443	2	mandible	8	L	*Hippopotamus*	large	
NHMUK PV M 100430	1	mandible	8		Ruminantia	medium	
NHMUK PV M 100444	1	cranial	8		Ruminantia	large	
NHMUK PV M 100446	1	mandible	8		*Hippopotamus*	large	
NHMUK PV M 100442	1	mandible	8		Ruminantia	medium	p4 alveoli
NHMUK PV M 100447	1	mandible	8	L	Ruminantia	medium	alveoli of mx and px
NHMUK PV M 100431	1	mandible	8	R	*Hippopotamus*	large	
NHMUK PV M 100441	1	mandible	8	L	*Hippopotamus*	large	
NHMUK PV M 100437	1	mandible	8		NI	medium	
NHMUK PV M 100440	1	mandible	8	L	*Hippopotamus*	large	
NHMUK PV M 100434	1	mandible	8		NI	medium	
NHMUK PV M 100435	1	mandible	8		NI	small	
NHMUK PV M 101548	1	mandible	8	L	Ruminantia	medium	condylar & coronoid

Table 3. *Specimens from Qau el-Kebir (Continued from previous page)*

Accession Number	*nf*	Element	Element Portion	Side	Taxon	Body Size	Element Detail
NHMUK PV M 101577	1	mandible	8	R	Ruminantia	large	condylar & coronoid
NHMUK PV M 100019	2	mandible	8	R	Ruminantia	large	alveoli of m3, m2, 1, p4, p3, p2
NHMUK PV M 101557	1	mandible	8	L	Ruminantia	medium	condylar
NHMUK PV M 101566	1	mandible	8		Suidae	medium	
NHMUK PV M 101564	1	mandible	8	R	Ruminantia	medium	anterior
NHMUK PV M 101565	1	mandible	8	L	Ruminantia	medium	anterior
NHMUK PV M 101567	1	mandible	8	L	Ruminantia	medium	anterior
NHMUK PV M 101568	1	mandible	8		Ruminantia	large	coronoid
NHMUK PV M 101569	1	mandible	8	L	NI	medium	
NHMUK PV M 101556	1	mandible	8	R	NI	small	
NHMUK PV M 101535	1	mandible	8	L	NI	medium	
NHMUK PV M 101574	2	mandible	8		Suidae	medium	
NHMUK PV M 101536	1	mandible	8	L	Ruminantia	medium	alveoli m2, m1, p4, p3
NHMUK PV M 101576	1	mandible	8		Suidae	medium	
NHMUK PV M 101537	1	mandible	8		NI	small	
NHMUK PV M 101558	1	mandible	8	L	NI	medium	anterior
NHMUK PV M 101538	1	mandible	8		NI	small	
NHMUK PV M 101572	1	cranial	8		NI	small	horn core?
NHMUK PV M 101539	1	mandible	8		*Hippopotamus*	large	
NHMUK PV M 101575	1	mandible	8	R	Ruminantia	medium	anterior
NHMUK PV M 101540	1	mandible	8		NI	small	
NHMUK PV M 101547	1	mandible	8		NI	small	
NHMUK PV M 101541	1	mandible	8	L	*Hippopotamus*	large	
NHMUK PV M 101562	1	mandible	8	L	Ruminantia	medium	condylar & coronoid
NHMUK PV M 101542	1	mandible	8		*Hippopotamus*	large	
NHMUK PV M 101561	1	mandible	8	L	Suidae	small	anterior
NHMUK PV M 101543	1	mandible	8	L	NI	medium	
NHMUK PV M 101554	1	mandible	8	R	NI	medium	anterior
NHMUK PV M 101549	1	mandible	8		NI	small	
NHMUK PV M 101571	1	mandible	8	R	NI	medium	anterior
NHMUK PV M 101551	1	NI	8		NI	small	
NHMUK PV M 101559	1	mandible	8	R	Ruminantia	medium	

Table 3. *Specimens from Qau el-Kebir (Continued from previous page)*

Accession Number	*nf*	Element	Element Portion	Side	Taxon	Body Size	Element Detail
NHMUK PV M 101563	1	mandible	8		NI	medium	
NHMUK PV M 101552	1	mandible	8		NI	small	
NHMUK PV M 101573	1	mandible	8	L	NI	small	
NHMUK PV M 101570	1	mandible	8		NI	medium	
NHMUK PV M 101560	1	mandible	8		Suidae	medium	
NHMUK PV M 101550	1	mandible	8	L	Suidae	small	
NHMUK PV M 101553	1	mandible	8	L	Ruminantia	medium	anterior
NHMUK PV M 101555	1	mandible	8		Suidae	medium	juvenile
NHMUK PV M 101546	1	mandible	8		NI	small	
NHMUK PV M 101545	1	mandible	8		NI	medium	
NHMUK PV M 101544	1	horn core	8		Ruminantia	medium	
NHMUK PV M 101580	2	mandible	8	L	*Hippopotamus*	large	anterior
NHMUK PV M 100004	3	mandible	8	M	*Hippopotamus*	large	anterior
NHMUK PV M 101581	1	mandible	8	R	*Hippopotamus*	large	condylar
NHMUK PV M 101622	1	mandible	8	M	*Hippopotamus*	large	anterior
NHMUK PV M 101579	1	mandible	8	M	*Hippopotamus*	large	
NHMUK PV M 101578	1	mandible	8	L	*Hippopotamus*	large	condylar & coronoid
NHMUK PV M 101621	3	mandible	8	M	*Hippopotamus*	large	anterior
NHMUK PV M 101598	1	cranial	8	M	Ruminantia	small	
NHMUK PV M 101611	1	vertebra	8	M	*Hippopotamus*	large	
NHMUK PV M 101609	1	cranial	8	M	*Hippopotamus*	large	
NHMUK PV M 101585	1	cranial	8		NI	large	nasal
NHMUK PV M 101586	1	cranial	8	R	NI	large	
NHMUK PV M 101587	1	cranial	8		NI	medium	nasal
NHMUK PV M 101601	1	cranial	8		NI	medium	
NHMUK PV M 101584	1	pelvis	8		NI	medium	
NHMUK PV M 101595	1	cranial	8	M	*Hippopotamus*	medium	
NHMUK PV M 101602	1	cranial	8	L	Ruminantia	large	
NHMUK PV M 101583	1	vertebra	8	M	*Hippopotamus*	large	
NHMUK PV M 101596	1	mandible	8		*Hippopotamus*	large	
NHMUK PV M 101594	1	cranial	8	L	*Hippopotamus*	large	
NHMUK PV M 101606	1	mandible	8		*Hippopotamus*	large	

Table 3. *Specimens from Qau el-Kebir (Continued from previous page)*

Accession Number	*nf*	Element	Element Portion	Side	Taxon	Body Size	Element Detail
NHMUK PV M 101600	1	NI	8		NI	medium	
NHMUK PV M 101592	1	cranial	8	L	Ruminantia	medium	jugular
NHMUK PV M 101599	1	cranial	8		NI	medium	nasal
NHMUK PV M 101590	1	mandible	8	L	*Hippopotamus*	medium	
NHMUK PV M 101610	1	cranial	8		NI	large	jugular
NHMUK PV M 101603	1	cranial	8		NI	medium	
NHMUK PV M 101597	1	cranial	8		NI	large	nasal
NHMUK PV M 101582	1	mandible	8	L	*Hippopotamus*	large	
NHMUK PV M 101589	1	cranial	8		NI	small	
NHMUK PV M 101588	1	cranial	8		NI	medium	
NHMUK PV M 101591	1	cranial	8	R	NI	medium	interior
NHMUK PV M 101604	1	cranial	8	R	NI	medium	zygomatic arch?
NHMUK PV M 101607	1	cranial	8	R	NI	medium	nasal
NHMUK PV M 101593	1	cranial	8		NI	medium	
NHMUK PV M 101605	1	cranial	8	R	Ruminantia	medium	
NHMUK PV M 101619	1	cranial	8	M	*Hippopotamus*	large	
NHMUK PV M 101620	3	cranial	8	M	*Hippopotamus*	large	
NHMUK PV M 101613	1	mandible	8	L	*Hippopotamus*	large	
NHMUK PV M 101615	1	cranial	8	R	*Hippopotamus*	large	
NHMUK PV M 100023	1	vertebra	8	M	NI	large	
NHMUK PV M 101616	1	cranial	8	L	*Hippopotamus*	large	
NHMUK PV M 101608	1	cranial	8	L	*Hippopotamus*	large	p3
NHMUK PV M 101617	1	cranial	8	M	*Hippopotamus*	large	sagittal crest
NHMUK PV M 101618	1	cranial	8	L	*Hippopotamus*	large	
NHMUK PV M 101614	1	vertebra	8	M	NI	large	
NHMUK PV M 101612	1	cranial	8	L	*Hippopotamus*	large	
NHMUK PV M 101627	1	mandible	8	L	Ruminantia	large	m1? p4?
NHMUK PV M 101638	1	teeth	7		*Hippopotamus*	large	
NHMUK PV M 101636	1	teeth	8		Ruminantia	medium	
NHMUK PV M 101635	1	teeth	8		*Equus*	medium	
NHMUK PV M 101634	1	teeth	8		*Equus*	medium	
NHMUK PV M 101658	4	teeth	8		Ruminantia	medium	

Table 3. *Specimens from Qau el-Kebir (Continued from previous page)*

Accession Number	*nf*	Element	Element Portion	Side	Taxon	Body Size	Element Detail
NHMUK PV M 101656	1	teeth	8		Ruminantia	medium	
NHMUK PV M 101633	1	mandible	8	R	Suidae	medium	dp4
NHMUK PV M 101644	1	mandible	7	L	*Equus*	medium	m3 or p2
NHMUK PV M 101650	1	mandible	8	R	Ruminantia	medium	p4
NHMUK PV M 101642	1	mandible	7	R	Ruminantia	small	m3 m2 m1
NHMUK PV M 99995	4	mandible	8	R	Suidae	medium	
NHMUK PV M 101623	1	teeth	8		*Equus*	medium	
NHMUK PV M 101655	1	teeth	8		Ruminantia	medium	
NHMUK PV M 101641	1	mandible	8	R	Ruminantia	medium	m1?
NHMUK PV M 101647	1	teeth	7	LW R	Ruminantia	large	mx
NHMUK PV M 101652	1	teeth	7	LW	Ruminantia	large	
NHMUK PV M 101659	3	teeth	7		Ruminantia	medium	
NHMUK PV M 101629	1	mandible	8	R	Ruminantia	small	m3, alveoli of m2, m1, p4
NHMUK PV M 101660	3	teeth	7		Ruminantia	medium	
NHMUK PV M 101630	1	teeth	7	UP L	Ruminantia	large	M2/M1
NHMUK PV M 101649	1	mandible	8	LW L	Ruminantia	small	m3 m2 m1
NHMUK PV M 101657	1	teeth	7	LW	Ruminantia	medium	mx
NHMUK PV M 101663	1	teeth	8		Ruminantia	medium	fragment
NHMUK PV M 101653	1	mandible	8	L	Ruminantia	small	m3
NHMUK PV M 101654	1	teeth	8	LW	Ruminantia	medium	mx?
NHMUK PV M 101648	1	teeth	7		*Hippopotamus*	large	
NHMUK PV M 101632	1	mandible	8	L	Ruminantia	large	dp4? m3?
NHMUK PV M 101626	1	mandible	7	R	Ruminantia	small	dp2 dp3 dp4 m1
NHMUK PV M 101651	1	mandible	8	R	Ruminantia	small	p3 p2 alveoli of p1
NHMUK PV M 101645	1	mandible	8	R	Suidae	medium	dp4 m1
NHMUK PV M 101637	1	teeth	8		Ruminantia	medium	
NHMUK PV M 101639	1	teeth	8		*Equus*	medium	
NHMUK PV M 101624	1	teeth	7	UP	*Equus*	medium	
NHMUK PV M 101646	1	teeth	7	UP	*Equus*	medium	
NHMUK PV M 101643	1	teeth	7	LW	*Equus*	medium	
NHMUK PV M 101625	1	teeth	7	UP	*Equus*	medium	
NHMUK PV M 101628	1	teeth	8		*Equus*	medium	

Table 3. *Specimens from Qau el-Kebir (Continued from previous page)*

Accession Number	*nf*	Element	Element Portion	Side	Taxon	Body Size	Element Detail
NHMUK PV M 101631	1	teeth	8		Ruminantia	medium	
NHMUK PV M 101640	2	teeth	8		Ruminantia	medium	
NHMUK PV M 101691	1	teeth	8		*Hippopotamus*	large	cx
NHMUK PV M 101686	1	teeth	7	LW	*Hippopotamus*	large	
NHMUK PV M 101692	1	teeth	8	LW R?	Elephantidae	large	dp4/m1?
NHMUK PV M 101690	1	teeth	8	LW R?	Elephantidae	large	dp4/m1?
NHMUK PV M 101688	1	teeth	8	UP	Elephantidae	large	
NHMUK PV M 101689	4	teeth	8	UP R	*Hippopotamus*	large	cx
NHMUK PV M 101687	2	teeth	7		*Hippopotamus*	large	ix
NHMUK PV M 101673	3	teeth	8	UP	*Hippopotamus*	large	cx
NHMUK PV M 101662	1	teeth	8		*Hippopotamus*	large	
NHMUK PV M 102177	1	teeth	8		*Hippopotamus*	large	
NHMUK PV M 101665	1	teeth	8	UP	*Hippopotamus*	large	cx
NHMUK PV M 101666	1	teeth	8		*Hippopotamus*	large	
NHMUK PV M 101661	1	teeth	8	UP	*Hippopotamus*	large	cx
NHMUK PV M 101670	1	teeth	8		*Hippopotamus*	large	
NHMUK PV M 101664	1	teeth	8		*Hippopotamus*	large	
NHMUK PV M 101667	2	teeth	8	UP	*Hippopotamus*	large	cx
NHMUK PV M 101684	1	teeth	8		*Hippopotamus*	large	cx
NHMUK PV M 101674	2	teeth	8		*Hippopotamus*	large	cx
NHMUK PV M 101681	1	teeth	8		*Hippopotamus*	large	cx
NHMUK PV M 101675	2	teeth	8		*Hippopotamus*	large	cx
NHMUK PV M 101679	1	teeth	8	UP	*Hippopotamus*	large	cx
NHMUK PV M 101668	1	teeth	7	UP	*Hippopotamus*	large	ix
NHMUK PV M 101685	1	teeth	8		*Hippopotamus*	large	cx
NHMUK PV M 101682	1	teeth	8	UP	*Hippopotamus*	large	cx
NHMUK PV M 99994	1	teeth	8		*Hippopotamus*	large	cx
NHMUK PV M 101683	1	teeth	8	UP	*Hippopotamus*	large	cx
NHMUK PV M 101676	1	teeth	7	LW	*Hippopotamus*	large	ix
NHMUK PV M 101672	1	teeth	8	LW	*Hippopotamus*	large	ix
NHMUK PV M 101669	4	teeth	8		*Hippopotamus*	large	ix
NHMUK PV M 101678	1	teeth	8	LW	*Hippopotamus*	large	ix

Table 3. *Specimens from Qau el-Kebir (Continued from previous page)*

Accession Number	*nf*	Element	Element Portion	Side	Taxon	Body Size	Element Detail
NHMUK PV M 101671	1	teeth	8		*Hippopotamus*	large	
NHMUK PV M 101680	1	teeth	8	UP	*Hippopotamus*	large	cx
NHMUK PV M 101677	1	teeth	8	UP	*Hippopotamus*	large	IX
NHMUK PV M 101725	2	teeth	8		Elephantidae	large	
NHMUK PV M 100009	3	teeth	8	L	*Hippopotamus*	large	mx
NHMUK PV M 101721	1	teeth	8		*Hippopotamus*	large	mx
NHMUK PV M 101722	1	teeth	8		*Hippopotamus*	large	
NHMUK PV M 101724	1	teeth	8	L	*Hippopotamus*	large	
NHMUK PV M 101720	1	teeth	7	LW R	*Hippopotamus*	large	mx
NHMUK PV M 101719	1	teeth	7		*Hippopotamus*	large	mx
NHMUK PV M 101723	1	teeth	8	R	*Hippopotamus*	large	p4
NHMUK PV M 101713	1	teeth	7	LW R	*Hippopotamus*	large	m3
NHMUK PV M 101717	2	teeth	7		*Hippopotamus*	large	mx
NHMUK PV M 101718	1	teeth	7		*Hippopotamus*	large	
NHMUK PV M 101716	1	teeth	1	LW R	*Hippopotamus*	large	m3
NHMUK PV M 101712	1	teeth	7		*Hippopotamus*	large	mx
NHMUK PV M 101707	2	teeth	8		*Hippopotamus*	large	
NHMUK PV M 101708	1	teeth	8		*Hippopotamus*	large	
NHMUK PV M 101704	1	teeth	7	LW R	*Hippopotamus*	large	m3
NHMUK PV M 101715	1	teeth	7	LW L	*Hippopotamus*	large	m3?
NHMUK PV M 101705	1	teeth	7		*Hippopotamus*	large	mx
NHMUK PV M 101711	1	teeth	7	LW L	*Hippopotamus*	large	m3
NHMUK PV M 101714	2	teeth	7		*Hippopotamus*	large	mx
NHMUK PV M 101709	1	teeth	7	LW	*Hippopotamus*	large	px
NHMUK PV M 101706	1	teeth	8		*Hippopotamus*	large	mx
NHMUK PV M 101703	1	teeth	7		*Hippopotamus*	large	mx
NHMUK PV M 101693	1	teeth	8		*Hippopotamus*	large	px?
NHMUK PV M 101710	1	teeth	7		*Hippopotamus*	large	mx
NHMUK PV M 101701	1	teeth	8		*Hippopotamus*	large	px?
NHMUK PV M 101700	1	teeth	8		*Hippopotamus*	large	mx?
NHMUK PV M 101694	2	teeth	8		*Hippopotamus*	large	mx
NHMUK PV M 101695	1	teeth	8		*Hippopotamus*	large	mx?

Table 3. *Specimens from Qau el-Kebir (Continued from previous page)*

Accession Number	*nf*	Element	Element Portion	Side	Taxon	Body Size	Element Detail
NHMUK PV M 101696	1	teeth	8		*Hippopotamus*	large	mx
NHMUK PV M 101702	1	teeth	8		*Hippopotamus*	large	
NHMUK PV M 101698	1	teeth	7		*Hippopotamus*	large	px
NHMUK PV M 101699	1	teeth	7		*Hippopotamus*	large	
NHMUK PV M 101726	1	ulna	5	L	*Equus*	medium	
NHMUK PV M 101729	1	ulna	5	L	Ruminantia	medium	
NHMUK PV M 101730	1	NI	3		NI	medium	
NHMUK PV M 101731	1	ulna	5	R	Carnivora	medium	
NHMUK PV M 101727	1	radius	4	L	*Hippopotamus*	medium	
NHMUK PV M 101732	1	radius	5	L	*Hippopotamus*	large	
NHMUK PV M 101737	1	ulna	5	R	Carnivora	small	
NHMUK PV M 101736	1	radius	5	R	*Hippopotamus*	large	
NHMUK PV M 98480	1	radius	6	R	*Hippopotamus*	large	
NHMUK PV M 101734	1	radius	5	R	*Hippopotamus*	large	
NHMUK PV M 101738	3	radius	6	L	*Hippopotamus*	large	
NHMUK PV M 101733	1	radius	5	L	*Hippopotamus*	medium	
NHMUK PV M 101735	1	radius	5	L	*Hippopotamus*	medium	
NHMUK PV M 101728	1	scapula	8	R	Ruminantia	large	
NHMUK PV M 101748	4	humerus	6	L	Ruminantia	large	
NHMUK PV M 101745	1	humerus	6	R	NI	medium	
NHMUK PV M 101743	1	humerus	6	R	NI	small	
NHMUK PV M 101750	1	humerus	6	R	Ruminantia	large	
NHMUK PV M 101741	1	humerus	6	R	NI	small	
NHMUK PV M 101740	1	humerus	6	R	NI	medium	
NHMUK PV M 101755	1	humerus	6	R	*Hippopotamus*	large	
NHMUK PV M 101751	1	humerus	6	L	Ruminantia	medium	
NHMUK PV M 101749	1	humerus	6	R	Ruminantia	medium	
NHMUK PV M 100022	1	humerus	6	L	NI	medium	
NHMUK PV M 101746	1	humerus	6	R	NI	medium	
NHMUK PV M 101747	1	humerus	6	R	Ruminantia	large	
NHMUK PV M 101742	1	humerus	6	L	Ruminantia	medium	
NHMUK PV M 101739	1	humerus	3	R	Carnivora	small	

Table 3. *Specimens from Qau el-Kebir (Continued from previous page)*

Accession Number	*nf*	Element	Element Portion	Side	Taxon	Body Size	Element Detail
NHMUK PV M 101752	1	humerus	5	R	Ruminantia	medium	
NHMUK PV M 101753	1	humerus	6	L	*Hippopotamus*	large	
NHMUK PV M 101754	1	humerus	6	R	*Hippopotamus*	large	lateral epicondyle
NHMUK PV M 100021	1	humerus	5	L	*Hippopotamus*	large	
NHMUK PV M 100020	1	humerus	6	R	*Hippopotamus*	large	
NHMUK PV M 101760	1	humerus	4	L	Ruminantia	large	
NHMUK PV M 101761	1	humerus	6	R	Ruminantia	large	
NHMUK PV M 101759	1	humerus	6	L	*Hippopotamus*	large	
NHMUK PV M 101757	1	humerus	6	L	*Hippopotamus*	large	
NHMUK PV M 101758	1	humerus	6	R	*Hippopotamus*	large	
NHMUK PV M 101756	4	humerus	6	R	*Hippopotamus*	large	
NHMUK PV M 101779	2	humerus	6	L	*Hippopotamus*	large	
NHMUK PV M 101933	1	radius	4		Ruminantia	large	
NHMUK PV M 101771	1	tibia	6	L	Ruminantia	large	
NHMUK PV M 101778	1	tibia	6	L	Ruminantia	medium	
NHMUK PV M 101764	1	tibia	6	R	Ruminantia	medium	
NHMUK PV M 101768	1	tibia	6	L	Ruminantia	medium	
NHMUK PV M 101773	1	tibia	6	L	Ruminantia	large	
NHMUK PV M 101780	3	tibia	6	R	*Equus*	large	
NHMUK PV M 101772	1	tibia	6	L	*Hippopotamus*	large	
NHMUK PV M 101762	1	tibia	6	L	Ruminantia	small	
NHMUK PV M 101766	1	tibia	6	R	*Equus*	medium	
NHMUK PV M 101770	1	tibia	4	R	Ruminantia	medium	
NHMUK PV M 101765	2	tibia	6	R	Ruminantia	medium	
NHMUK PV M 101769	1	tibia	6	L	Ruminantia	medium	
NHMUK PV M 101767	1	tibia	4	L	Ruminantia	medium	
NHMUK PV M 101775	1	tibia	5	L	Ruminantia	medium	
NHMUK PV M 101763	1	tibia	4	R	Ruminantia	medium	
NHMUK PV M 101777	1	tibia	5	R	NI	medium	
NHMUK PV M 101776	1	tibia	6	R	Ruminantia	medium	
NHMUK PV M 101774	1	tibia	5	L	Ruminantia	large	
NHMUK PV M 100052	1	tibia	5	R	*Hippopotamus*	large	

Table 3. *Specimens from Qau el-Kebir (Continued from previous page)*

Accession Number	*nf*	Element	Element Portion	Side	Taxon	Body Size	Element Detail
NHMUK PV M 100007	1	radius	5	R	Ruminantia	small	
NHMUK PV M 100006	1	tibia	6	L	Ruminantia	small	
NHMUK PV M 100008	1	tibia	3	L	NI	small	
NHMUK PV M 101790	1	femur	3	R	*Hippopotamus*	large	
NHMUK PV M 101784	5	femur	3	R	Ruminantia	medium	
NHMUK PV M 101792	1	femur	4	L	*Hippopotamus*	large	
NHMUK PV M 101791	1	humerus	3	R	Ruminantia	large	
NHMUK PV M 101785	1	femur	6	R	Ruminantia	medium	
NHMUK PV M 101789	1	femur	6	R	Ruminantia	medium	
NHMUK PV M 101786	1	femur	5	R	NI	medium	
NHMUK PV M 101783	1	femur	5	L	NI	medium	
NHMUK PV M 101787	1	femur	2		NI	medium	
NHMUK PV M 101782	1	femur	5	R	Ruminantia	medium	
NHMUK PV M 101781	1	femur	5	L	Ruminantia	medium	
NHMUK PV M 101788	1	femur	5	R	Ruminantia	medium	
NHMUK PV M 98479	1	femur	6	R	*Hippopotamus*	large	
NHMUK PV M 98478	4	femur	5	R	*Hippopotamus*	large	
NHMUK PV M 101815	1	femur	2		NI	medium	
NHMUK PV M 101816	1	femur	5		NI	medium	
NHMUK PV M 101814	1	femur	5	R	NI	medium	
NHMUK PV M 101811	1	femur	2		NI	medium	
NHMUK PV M 101813	1	femur	5	L	NI	medium	
NHMUK PV M 101812	1	femur	5	R	NI	medium	
NHMUK PV M 101804	1	rib	8		NI	large	
NHMUK PV M 101810	1	rib	8		NI	small	
NHMUK PV M 101806	1	rib	8		NI	large	
NHMUK PV M 101807	1	rib	8		NI	large	
NHMUK PV M 101809	1	rib	8		NI	large	
NHMUK PV M 101802	1	rib	8		NI	medium	
NHMUK PV M 101808	1	rib	8		NI	small	
NHMUK PV M 101805	3	rib	8		NI	large	
NHMUK PV M 101803	1	rib	8		NI	large	

Table 3. *Specimens from Qau el-Kebir (Continued from previous page)*

Accession Number	*nf*	Element	Element Portion	Side	Taxon	Body Size	Element Detail
NHMUK PV M 101794	1	vertebra	7	M	NI	medium	atlas
NHMUK PV M 101797	1	vertebra	8	M	NI	medium	atlas
NHMUK PV M 101795	1	vertebra	7	M	NI	medium	atlas
NHMUK PV M 100054	1	vertebra	7	M	*Hippopotamus*	large	atlas
NHMUK PV M 101800	1	vertebra	8	M	Ruminantia	large	atlas
NHMUK PV M 101801	1	vertebra	7	M	*Hippopotamus*	large	atlas
NHMUK PV M 101799	1	vertebra	7	M	Ruminantia	large	atlas
NHMUK PV M 101798	1	vertebra	7	M	NI	medium	atlas
NHMUK PV M 101796	1	vertebra	7	M	NI	small	atlas
NHMUK PV M 101793	1	vertebra	8	M	*Hippopotamus*	large	atlas
NHMUK PV M 101837	1	vertebra	7	M	*Hippopotamus*	large	axis
NHMUK PV M 101836	1	vertebra	7	M	*Hippopotamus*	large	axis
NHMUK PV M 101833	1	vertebra	8	M	*Hippopotamus*	large	axis
NHMUK PV M 101835	1	vertebra	7	M	Ruminantia	large	axis
NHMUK PV M 101825	1	vertebra	8	M	*Hippopotamus*	large	atlas
NHMUK PV M 101828	1	vertebra	7	M	Ruminantia	large	axis
NHMUK PV M 101817	1	vertebra	7	M	Ruminantia	medium	axis
NHMUK PV M 101830	1	vertebra	8	M	*Hippopotamus*	large	axis
NHMUK PV M 101820	1	vertebra	8	M	NI	medium	axis
NHMUK PV M 101832	1	vertebra	7	M	*Hippopotamus*	large	axis
NHMUK PV M 101831	1	vertebra	8	M	Ruminantia	medium	axis
NHMUK PV M 101827	1	vertebra	7	M	Ruminantia	medium	axis
NHMUK PV M 101819	1	vertebra	7	M	Ruminantia	medium	axis
NHMUK PV M 101824	1	vertebra	8	M	Ruminantia	medium	axis
NHMUK PV M 101823	1	vertebra	8	M	NI	medium	axis
NHMUK PV M 101829	1	vertebra	8	M	Ruminantia	large	axis
NHMUK PV M 101826	1	vertebra	8	M	NI	large	axis
NHMUK PV M 101821	1	vertebra	8	M	NI	medium	axis
NHMUK PV M 101818	1	vertebra	7	M	Ruminantia	medium	axis
NHMUK PV M 101822	1	vertebra	8	M	Ruminantia	medium	axis
NHMUK PV M 101834	1	vertebra	7	M	Ruminantia	large	axis
NHMUK PV M 101855	1	vertebra	8	M	Ruminantia	large	axis

Table 3. *Specimens from Qau el-Kebir (Continued from previous page)*

Accession Number	*nf*	Element	Element Portion	Side	Taxon	Body Size	Element Detail
NHMUK PV M 101856	1	vertebra	8	M	NI	large	cervical
NHMUK PV M 101841	1	vertebra	8	M	Ruminantia	small	axis
NHMUK PV M 101843	1	vertebra	8	M	Ruminantia	medium	axis
NHMUK PV M 101842	1	vertebra	7	M	Ruminantia	medium	axis
NHMUK PV M 101852	1	vertebra	7	M	NI	medium	axis
NHMUK PV M 101840	1	vertebra	8	M	Ruminantia	medium	axis
NHMUK PV M 101848	1	vertebra	8	M	NI	medium	
NHMUK PV M 101839	2	vertebra	8	M	NI	small	axis
NHMUK PV M 101847	1	vertebra	8	M	*Hippopotamus*	medium	axis
NHMUK PV M 101845	2	vertebra	7	M	Ruminantia	medium	axis
NHMUK PV M 101846	1	vertebra	8	M	NI	small	
NHMUK PV M 101844	1	vertebra	7	M	NI	medium	axis
NHMUK PV M 101849	1	vertebra	7	M	NI	medium	axis
NHMUK PV M 101838	1	vertebra	8	M	NI	medium	
NHMUK PV M 101853	1	vertebra	8	M	NI	medium	axis
NHMUK PV M 101851	1	vertebra	8	M	*Hippopotamus*	large	axis
NHMUK PV M 101854	1	vertebra	8	M	NI	medium	cervical
NHMUK PV M 101850	1	vertebra	8	M	*Hippopotamus*	large	axis
NHMUK PV M 101857	1	vertebra	8	M	NI	large	
NHMUK PV M 101859	1	vertebra	7	M	*Hippopotamus*	large	cervical
NHMUK PV M 101858	1	vertebra	8	M	NI	large	cervical
NHMUK PV M 101876	1	vertebra	7	M	NI	large	cervical
NHMUK PV M 101877	1	vertebra	7	M	NI	medium	cervical
NHMUK PV M 101878	1	vertebra	7	M	NI	large	cervical
NHMUK PV M 101881	1	vertebra	7	M	NI	medium	cervical
NHMUK PV M 101880	1	vertebra	8	M	NI	medium	cervical
NHMUK PV M 101872	1	vertebra	8	M	NI	medium	cervical
NHMUK PV M 101875	1	vertebra	7	M	NI	medium	cervical
NHMUK PV M 101873	2	vertebra	8	M	NI	large	cervical
NHMUK PV M 101879	1	vertebra	7	M	NI	medium	cervical
NHMUK PV M 101874	1	vertebra	7	M	NI	medium	cervical
NHMUK PV M 101869	1	vertebra	7	M	NI	medium	cervical

Table 3. *Specimens from Qau el-Kebir (Continued from previous page)*

Accession Number	*nf*	Element	Element Portion	Side	Taxon	Body Size	Element Detail
NHMUK PV M 101861	1	vertebra	7	M	NI	medium	cervical
NHMUK PV M 101862	1	vertebra	7	M	NI	small	cervical
NHMUK PV M 101868	1	vertebra	8	M	NI	medium	atlas
NHMUK PV M 101860	1	vertebra	7	M	NI	medium	cervical
NHMUK PV M 101863	1	vertebra	7	M	NI	small	cervical
NHMUK PV M 101867	1	vertebra	7	M	NI	small	cervical
NHMUK PV M 101864	1	vertebra	8	M	NI	medium	cervical
NHMUK PV M 101871	1	vertebra	7	M	NI	medium	cervical
NHMUK PV M 101870	1	vertebra	8	M	NI	medium	cervical
NHMUK PV M 101865	1	vertebra	8	M	NI	medium	cervical
NHMUK PV M 101866	1	vertebra	8	M	NI	medium	cervical
NHMUK PV M 101899	1	vertebra	7	M	NI	large	thoracic
NHMUK PV M 101896	1	vertebra	7	M	NI	large	cervical
NHMUK PV M 101898	1	vertebra	7	M	NI	medium	thoracic
NHMUK PV M 101900	1	vertebra	8	M	NI	large	lumbar
NHMUK PV M 101883	1	vertebra	8	M	NI	medium	thoracic
NHMUK PV M 101894	1	vertebra	7	M	NI	large	thoracic
NHMUK PV M 101892	1	vertebra	7	M	NI	medium	thoracic
NHMUK PV M 101901	1	vertebra	7	M	NI	large	thoracic
NHMUK PV M 101882	1	vertebra	7	M	NI	medium	thoracic
NHMUK PV M 101897	1	vertebra	7	M	NI	large	cervical
NHMUK PV M 101888	1	vertebra	7	M	NI	small	thoracic
NHMUK PV M 100024	1	vertebra	7	M	NI	medium	thoracic
NHMUK PV M 101884	1	vertebra	7	M	NI	medium	thoracic
NHMUK PV M 101889	1	vertebra	7	M	NI	small	thoracic
NHMUK PV M 101885	1	vertebra	8	M	NI	medium	thoracic
NHMUK PV M 101887	1	vertebra	7	M	NI	medium	thoracic
NHMUK PV M 101893	1	vertebra	8	M	NI	medium	thoracic
NHMUK PV M 101886	1	vertebra	8	M	NI	small	thoracic
NHMUK PV M 101891	1	vertebra	8	M	NI	medium	thoracic
NHMUK PV M 101895	1	vertebra	8	M	NI	medium	thoracic
NHMUK PV M 101890	1	vertebra	7	M	NI	small	thoracic

Table 3. *Specimens from Qau el-Kebir (Continued from previous page)*

Accession Number	*nf*	Element	Element Portion	Side	Taxon	Body Size	Element Detail
NHMUK PV M 101921	1	vertebra	8	M	NI	large	
NHMUK PV M 101908	1	vertebra	8	M	NI	small	
NHMUK PV M 101917	1	vertebra	7	M	NI	small	lumbar
NHMUK PV M 101919	1	vertebra	7	M	NI	medium	lumbar
NHMUK PV M 101920	1	vertebra	7	M	NI	medium	lumbar
NHMUK PV M 101906	1	vertebra	7	M	NI	small	
NHMUK PV M 101916	1	vertebra	7	M	NI	small	lumbar
NHMUK PV M 101904	1	vertebra	7	M	NI	small	lumbar
NHMUK PV M 101907	1	vertebra	8	M	NI	small	thoracic
NHMUK PV M 101909	1	vertebra	7	M	NI	small	thoracic
NHMUK PV M 101913	1	vertebra	7	M	NI	medium	thoracic
NHMUK PV M 101910	1	vertebra	7	M	NI	small	thoracic
NHMUK PV M 101914	1	vertebra	8	M	NI	large	thoracic
NHMUK PV M 101902	1	vertebra	8	M	NI	large	thoracic
NHMUK PV M 101905	1	vertebra	8	M	NI	medium	thoracic
NHMUK PV M 101903	1	vertebra	8	M	NI	large	thoracic
NHMUK PV M 101915	1	vertebra	8	M	NI	large	axis
NHMUK PV M 101918	1	vertebra	7	M	NI	large	thoracic
NHMUK PV M 101912	1	vertebra	8	M	NI	medium	lumbar
NHMUK PV M 101911	1	vertebra	8	M	NI	medium	thoracic
NHMUK PV M 101922	2	vertebra	8	M	NI	large	lumbar
NHMUK PV M 101954	13	vertebra	8	M	NI	medium	
NHMUK PV M 101937	1	vertebra	7	M	NI	medium	lumbar
NHMUK PV M 101934	1	vertebra	8	M	NI	large	lumbar
NHMUK PV M 101932	1	vertebra	8	M	NI	medium	
NHMUK PV M 101936	1	vertebra	8	M	NI	large	lumbar
NHMUK PV M 101926	1	vertebra	7	M	NI	medium	lumbar
NHMUK PV M 101923	1	vertebra	7	M	NI	medium	lumbar
NHMUK PV M 101925	3	vertebra	7	M	NI	medium	lumbar
NHMUK PV M 101938	2	vertebra	7	M	NI	large	atlas
NHMUK PV M 101928	1	vertebra	7	M	NI	medium	lumbar
NHMUK PV M 101931	1	vertebra	7	M	NI	medium	lumbar

Table 3. *Specimens from Qau el-Kebir (Continued from previous page)*

Accession Number	*nf*	Element	Element Portion	Side	Taxon	Body Size	Element Detail
NHMUK PV M 101927	1	vertebra	7	M	NI	medium	
NHMUK PV M 101930	1	vertebra	7	M	NI	medium	lumbar
NHMUK PV M 101929	1	vertebra	7	M	NI	medium	lumbar
NHMUK PV M 101924	1	vertebra	8	M	NI	medium	lumbar
NHMUK PV M 101935	1	vertebra	7	M	NI	large	lumbar
NHMUK PV M 101939	1	vertebra	7	M	NI	medium	
NHMUK PV M 101958	1	scapula	8	L	NI	large	
NHMUK PV M 101960	1	scapula	8	L	NI	small	
NHMUK PV M 101959	1	scapula	8	L	NI	small	
NHMUK PV M 101965	2	scapula	8	R	NI	medium	glenoid
NHMUK PV M 101961	1	scapula	8	R	NI	medium	
NHMUK PV M 101957	2	scapula	8	L	NI	medium	
NHMUK PV M 101964	1	scapula	8	L	NI	medium	
NHMUK PV M 98482	1	scapula	8	R	*Hippopotamus*	large	
NHMUK PV M 98481	1	scapula	8	L	*Hippopotamus*	large	
NHMUK PV M 101962	1	scapula	8	R	*Hippopotamus*	large	glenoid
NHMUK PV M 101963	1	scapula	8	L	NI	medium	
NHMUK PV M 101953	1	pelvis	8	L	*Hippopotamus*	large	acetabulum
NHMUK PV M 101955	6	pelvis	8	L	NI	large	ilium
NHMUK PV M 101952	1	pelvis	7	L	*Hippopotamus*	large	acetabulum
NHMUK PV M 101944	1	vertebra	8	M	NI	medium	
NHMUK PV M 101946	1	pelvis	8	L	NI	medium	acetabulum
NHMUK PV M 101945	1	scapula	8	R	NI	medium	ventral
NHMUK PV M 101940	1	pelvis	8		NI	medium	
NHMUK PV M 101948	1	pelvis	8	L	NI	small	ischium
NHMUK PV M 101942	2	pelvis	8	L	NI	medium	pubis
NHMUK PV M 101950	1	pelvis	8	R	NI	small	acetabulum
NHMUK PV M 101943	2	pelvis	8	R	NI	medium	ilium
NHMUK PV M 101947	1	pelvis	8	R	NI	medium	ilium
NHMUK PV M 101949	1	scapula	8	L	NI	small	glenoid
NHMUK PV M 101941	1	pelvis	8	L	NI	medium	ischium
NHMUK PV M 101956	1	pelvis	8	R	NI	large	ilium

Table 3. *Specimens from Qau el-Kebir (Continued from previous page)*

Accession Number	*nf*	Element	Element Portion	Side	Taxon	Body Size	Element Detail
NHMUK PV M 101951	2	pelvis	8	L	NI	medium	pubis
NHMUK PV M 101966	1	metapodial	6		Ruminantia	large	
NHMUK PV M 101969	1	metapodial	7		*Hippopotamus*	large	
NHMUK PV M 101972	1	metapodial	1		*Hippopotamus*	large	
NHMUK PV M 101971	1	metapodial	6		Ruminantia	medium	
NHMUK PV M 101970	1	metapodial	7		*Hippopotamus*	large	
NHMUK PV M 100053	1	metapodial	5	R	Ruminantia	medium	
NHMUK PV M 101973	1	metapodial	5	L	Ruminantia	medium	
NHMUK PV M 101968	1	metapodial	1	R	Ruminantia	small	
NHMUK PV M 101967	1	tibia	6	L	Ruminantia	small	
NHMUK PV M 101976	1	metapodial	7		*Hippopotamus*	medium	
NHMUK PV M 101974	1	metapodial	3		Ruminantia	medium	
NHMUK PV M 101975	1	metapodial	1	L	Ruminantia	small	
NHMUK PV M 101982	1	podial	1	R	*Hippopotamus*	large	
NHMUK PV M 101980	1	metapodial	3		Ruminantia	large	
NHMUK PV M 101979	2	podial	7	R	*Hippopotamus*	large	
NHMUK PV M 101978	1	metapodial	5	R	Ruminantia	large	
NHMUK PV M 101981	1	podial	7	R	*Hippopotamus*	large	
NHMUK PV M 101977	3	metapodial	7	L	Ruminantia	large	
NHMUK PV M 102004	1	podial	7	L	*Hippopotamus*	large	
NHMUK PV M 101991	1	podial	1	L	Ruminantia	large	
NHMUK PV M 101986	1	metapodial	8		*Hippopotamus*	large	
NHMUK PV M 101989	1	podial	1	L	Ruminantia	large	
NHMUK PV M 102000	1	podial	7	L	*Hippopotamus*	large	
NHMUK PV M 101988	1	podial	7	L	Ruminantia	medium	
NHMUK PV M 101992	1	metapodial	6	L	*Equus*	medium	
NHMUK PV M 101993	2	metapodial	6		Ruminantia	large	
NHMUK PV M 101990	1	metapodial	6		Ruminantia	medium	
NHMUK PV M 101985	1	podial	7	R	Ruminantia	medium	
NHMUK PV M 101983	4	metapodial	5	L	Ruminantia	medium	
NHMUK PV M 101994	1	metapodial	1		*Hippopotamus*	large	
NHMUK PV M 101996	1	phalanx	7		*Hippopotamus*	large	

Table 3. *Specimens from Qau el-Kebir (Continued from previous page)*

Accession Number	*nf*	Element	Element Portion	Side	Taxon	Body Size	Element Detail
NHMUK PV M 101995	2	metapodial	7		Ruminantia	large	
NHMUK PV M 101987	1	metapodial	1		*Hippopotamus*	medium	
NHMUK PV M 102003	1	metapodial	1	L	*Hippopotamus*	large	
NHMUK PV M 102001	1	podial	1	R	Ruminantia	large	
NHMUK PV M 101984	1	podial	7	R	Ruminantia	medium	
NHMUK PV M 101997	1	podial	7	L	*Hippopotamus*	large	
NHMUK PV M 100026	1	metapodial	6		Ruminantia	medium	
NHMUK PV M 101999	1	podial	1	L	*Hippopotamus*	large	
NHMUK PV M 102002	1	podial	1	L	*Hippopotamus*	large	
NHMUK PV M 101998	1	podial	7	R	*Hippopotamus*	large	
NHMUK PV M 99993	1	podial	1	R	Ruminantia	medium	
NHMUK PV M 102016	1	phalanx	1		Ruminantia	small	
NHMUK PV M 102024	1	phalanx	1		Ruminantia	medium	
NHMUK PV M 102011	1	phalanx	1	L	Ruminantia	medium	
NHMUK PV M 102008	1	phalanx	1	L	Ruminantia	large	
NHMUK PV M 102012	1	podial	1	R	Ruminantia	medium	
NHMUK PV M 102023	1	phalanx	1	R	Ruminantia	small	
NHMUK PV M 102010	1	phalanx	1	R	Ruminantia	small	
NHMUK PV M 102013	1	phalanx	7		Ruminantia	medium	
NHMUK PV M 102025	1	scapula	8	L	NI	medium	glenoid
NHMUK PV M 102014	1	phalanx	8		NI	medium	
NHMUK PV M 102007	1	phalanx	1	R	Ruminantia	medium	
NHMUK PV M 102006	1	podial	7	L	Ruminantia	medium	
NHMUK PV M 102108	1	podial	7	L	Ruminantia	medium	
NHMUK PV M 102109	1	podial	7	R	Ruminantia	medium	
NHMUK PV M 102110	1	podial	1	R	Ruminantia	medium	
NHMUK PV M 102132	1	podial	1	L	Ruminantia	medium	
NHMUK PV M 102111	1	podial	7	L	Ruminantia	medium	
NHMUK PV M 102034	1	ulna	5	R	NI	small	olecranon
NHMUK PV M 102123	1	metapodial	3		Ruminantia	medium	
NHMUK PV M 102113	1	metapodial	3		NI	small	
NHMUK PV M 102020	1	phalanx	8		Ruminantia	medium	

Table 3. *Specimens from Qau el-Kebir (Continued from previous page)*

Accession Number	*nf*	Element	Element Portion	Side	Taxon	Body Size	Element Detail
NHMUK PV M 102127	1	metapodial	5	L	Ruminantia	small	
NHMUK PV M 102125	1	metapodial	6		Ruminantia	medium	
NHMUK PV M 102115	1	metapodial	5	R	Ruminantia	medium	
NHMUK PV M 102114	1	tibia	6	L	Ruminantia	medium	
NHMUK PV M 102030	1	phalanx	1		Ruminantia	medium	
NHMUK PV M 102112	1	tibia	3		NI	small	
NHMUK PV M 102026	1	podial	8	L	NI	medium	
NHMUK PV M 102130	1	metapodial	6		Ruminantia	medium	
NHMUK PV M 102133	1	podial	7	L	NI	medium	
NHMUK PV M 102121	1	metapodial	6		Ruminantia	medium	
NHMUK PV M 102029	1	podial	8	L	NI	large	
NHMUK PV M 102005	1	podial	1	R	Ruminantia	medium	
NHMUK PV M 102131	1	phalanx	1		*Equus*	large	
NHMUK PV M 102031	2	metapodial	6		Ruminantia	medium	
NHMUK PV M 102021	1	metapodial	5		Ruminantia	medium	
NHMUK PV M 102019	1	metapodial	2		*Hippopotamus*	large	
NHMUK PV M 102017	1	humerus	6	L	NI	small	
NHMUK PV M 102033	1	phalanx	7	L	Ruminantia	medium	
NHMUK PV M 102135	1	phalanx	1		*Hippopotamus*	large	
NHMUK PV M 102124	1	podial	7	L	Ruminantia	medium	
NHMUK PV M 102028	1	podial	7	L	NI	medium	
NHMUK PV M 102116	1	podial	7	L	*Equus*	medium	
NHMUK PV M 102107	1	metapodial	3		Ruminantia	small	
NHMUK PV M 102106	1	tibia	6	R	Ruminantia	small	
NHMUK PV M 102022	1	metapodial	6		Ruminantia	medium	
NHMUK PV M 102018	1	humerus	4	L	NI	medium	
NHMUK PV M 102128	1	tibia	6	R	Ruminantia	medium	
NHMUK PV M 102027	1	metapodial	3		Ruminantia	small	
NHMUK PV M 102119	1	metapodial	6		Ruminantia	small	
NHMUK PV M 102134	1	NI	8		NI	medium	
NHMUK PV M 102129	1	metapodial	6		Ruminantia	large	
NHMUK PV M 102117	1	metapodial	6		Ruminantia	medium	

Table 3. *Specimens from Qau el-Kebir (Continued from previous page)*

Accession Number	*nf*	Element	Element Portion	Side	Taxon	Body Size	Element Detail
NHMUK PV M 102118	1	podial	1	R	NI	medium	
NHMUK PV M 102032	1	metapodial	6		Ruminantia	medium	
NHMUK PV M 102120	1	radius	6	L	*Equus*	large	
NHMUK PV M 102126	1	podial	7	R	Ruminantia	medium	
NHMUK PV M 102122	1	metapodial	8		*Hippopotamus*	large	
NHMUK PV M 102009	1	tibia	6	R	Ruminantia	medium	
NHMUK PV M 102015	1	scapula	8		NI	medium	glenoid
NHMUK PV M 102241	1	fibula	5	L	*Hippopotamus*	large	
NHMUK PV M 102238	1	pelvis	8		*Hippopotamus*	large	
NHMUK PV M 102239	1	pelvis	8		NI	medium	
NHMUK PV M 102244	1	NI	3		NI	medium	
NHMUK PV M 102242	1	patella	1	L	*Hippopotamus*	large	
NHMUK PV M 102237	1	vertebra	8	M	NI	large	lumbar
NHMUK PV M 102236	1	tibia	3		NI	medium	
NHMUK PV M 102245	1	metapodial	3		Ruminantia	medium	
NHMUK PV M 102246	1	rib	8		NI	large	
NHMUK PV M 102243	1	patella	1	R	*Equus*	medium	
NHMUK PV M 102247	1	pelvis	8		*Hippopotamus*	large	
NHMUK PV M 102248	1	NI	8		NI	large	
NHMUK PV M 102240	1	cranial	8	R	NI	large	
NHMUK PV M 100025	1	NI	3		NI	medium	
NHMUK PV M 100005	1	NI	3		NI	medium	
NHMUK PV M 102140	1	NI	8		NI	medium	
NHMUK PV M 102149	1	NI	8		NI	large	
NHMUK PV M 102154	1	humerus	7	L	NI	medium	
NHMUK PV M 102150	1	tibia	8		NI	large	
NHMUK PV M 102151	1	mandible	8		*Hippopotamus*	large	
NHMUK PV M 102152	1	NI	8		NI	large	
NHMUK PV M 102153	1	scapula	8		NI	large	glenoid
NHMUK PV M 102148	1	scapula	8		NI	large	
NHMUK PV M 102142	1	NI	3		NI	medium	
NHMUK PV M 102145	1	NI	8		NI	medium	

Table 3. *Specimens from Qau el-Kebir (Continued from previous page)*

Accession Number	*nf*	Element	Element Portion	Side	Taxon	Body Size	Element Detail
NHMUK PV M 102146	1	NI	3		NI	medium	
NHMUK PV M 102144	1	NI	8		NI	medium	
NHMUK PV M 102143	1	NI	3		NI	medium	
NHMUK PV M 102141	1	vertebra	8	M	*Hippopotamus*	large	
NHMUK PV M 102136	1	pelvis	8		NI	medium	
NHMUK PV M 102137	2	NI	8		NI	medium	
NHMUK PV M 102139	1	radius	8		NI	medium	
NHMUK PV M 102138	1	NI	3		NI	medium	
NHMUK PV M 102147	20	mandible	8	R	Ruminantia	medium	
NHMUK PV M 102155	1	vertebra	8	M	NI	small	
NHMUK PV M 102156	1	cranial	8		NI	medium	
NHMUK PV M 102162	1	horn core	7	L	Ruminantia	large	
NHMUK PV M 102157	1	horn core	7	L	Ruminantia	medium	
NHMUK PV M 102159	5	horn core	7		Ruminantia	large	
NHMUK PV M 102158	1	horn core	8		Ruminantia	large	
NHMUK PV M 102160	1	horn core	8	L	Ruminantia	medium	
NHMUK PV M 102161	1	horn core	7	L	Ruminantia	medium	
NHMUK PV M 102163	3	horn core	8		Ruminantia	medium	
NHMUK PV M 102212	1	horn core	7		Ruminantia	medium	
NHMUK PV M 102210	1	horn core	8		Ruminantia	large	
NHMUK PV M 102213	1	horn core	8		Ruminantia	medium	
NHMUK PV M 102207	1	horn core	7	R	Ruminantia	medium	
NHMUK PV M 102205	2	horn core	8		Ruminantia	medium	
NHMUK PV M 102201	1	horn core	7	L	Ruminantia	medium	
NHMUK PV M 102211	3	horn core	8		Ruminantia	medium	
NHMUK PV M 102208	1	horn core	7	R	Ruminantia	medium	
NHMUK PV M 102209	1	horn core	7		Ruminantia	medium	
NHMUK PV M 102199	1	horn core	7	R	Ruminantia	medium	
NHMUK PV M 102204	1	horn core	7	R	Ruminantia	medium	
NHMUK PV M 102206	1	horn core	7	L	Ruminantia	medium	
NHMUK PV M 102200	1	horn core	7	L	Ruminantia	medium	
NHMUK PV M 102203	1	horn core	7	L	Ruminantia	medium	

Table 3. *Specimens from Qau el-Kebir (Continued from previous page)*

Accession Number	*nf*	Element	Element Portion	Side	Taxon	Body Size	Element Detail
NHMUK PV M 102202	1	horn core	7		Ruminantia	medium	
NHMUK PV M 102182	1	horn core	7		Ruminantia	medium	
NHMUK PV M 102180	1	horn core	7		Ruminantia	medium	
NHMUK PV M 102198	1	horn core	8		Ruminantia	medium	
NHMUK PV M 102181	1	horn core	7		Ruminantia	medium	
NHMUK PV M 102191	1	horn core	7		Ruminantia	medium	
NHMUK PV M 102197	1	horn core	7		Ruminantia	medium	
NHMUK PV M 102196	1	horn core	7		Ruminantia	medium	
NHMUK PV M 102179	1	horn core	7		Ruminantia	medium	
NHMUK PV M 102194	1	horn core	7		Ruminantia	medium	
NHMUK PV M 102193	1	horn core	7	L	Ruminantia	medium	
NHMUK PV M 102192	1	horn core	8		Ruminantia	large	
NHMUK PV M 102185	1	horn core	7		Ruminantia	medium	
NHMUK PV M 102190	1	horn core	7	R	Ruminantia	small	
NHMUK PV M 102187	1	horn core	8		Ruminantia	medium	
NHMUK PV M 102186	1	horn core	7		Ruminantia	medium	
NHMUK PV M 102188	1	horn core	8		Ruminantia	medium	
NHMUK PV M 102175	1	horn core	8		Ruminantia	small	
NHMUK PV M 102164	1	horn core	7		Ruminantia	medium	
NHMUK PV M 102189	1	horn core	8		Ruminantia	medium	
NHMUK PV M 102176	1	horn core	8		Ruminantia	medium	
NHMUK PV M 102170	1	horn core	1		Ruminantia	small	
NHMUK PV M 102178	1	horn core	7		Ruminantia	small	
NHMUK PV M 102183	1	horn core	8		Ruminantia	large	
NHMUK PV M 102195	1	horn core	8		Ruminantia	medium	
NHMUK PV M 102168	1	horn core	8		Ruminantia	medium	
NHMUK PV M 102167	1	horn core	7		Ruminantia	medium	
NHMUK PV M 102166	1	horn core	7		Ruminantia	medium	
NHMUK PV M 102173	1	horn core	7		Ruminantia	small	
NHMUK PV M 102172	1	horn core	7		Ruminantia	small	
NHMUK PV M 102165	1	horn core	7		Ruminantia	medium	
NHMUK PV M 102184	1	horn core	7		Ruminantia	medium	

Table 3. *Specimens from Qau el-Kebir (Continued from previous page)*

Accession Number	*nf*	Element	Element Portion	Side	Taxon	Body Size	Element Detail
NHMUK PV M 102171	1	horn core	8		Ruminantia	medium	
NHMUK PV M 102169	1	horn core	8		Ruminantia	medium	
NHMUK PV M 102174	1	horn core	7		Ruminantia	small	
NHMUK PV M 102235	1	horn core	7		Ruminantia	medium	
NHMUK PV M 102229	1	horn core	7		Ruminantia	medium	
NHMUK PV M 102234	1	horn core	7	R	Ruminantia	medium	
NHMUK PV M 102216	1	horn core	7		Ruminantia	medium	
NHMUK PV M 102227	1	horn core	7		Ruminantia	large	
NHMUK PV M 102231	1	horn core	7		Ruminantia	large	
NHMUK PV M 102222	1	horn core	8		Ruminantia	medium	
NHMUK PV M 102220	1	horn core	8		Ruminantia	large	
NHMUK PV M 102219	1	horn core	7		Ruminantia	medium	
NHMUK PV M 102232	1	horn core	7		Ruminantia	large	
NHMUK PV M 102214	1	horn core	7		Ruminantia	medium	
NHMUK PV M 102215	1	horn core	7		Ruminantia	medium	
NHMUK PV M 102249	2	horn core	7		Ruminantia	large	
NHMUK PV M 102233	1	horn core	7		Ruminantia	medium	
NHMUK PV M 102221	1	horn core	7		Ruminantia	medium	
NHMUK PV M 102218	1	horn core	7		Ruminantia	medium	
NHMUK PV M 102224	1	horn core	7		Ruminantia	medium	
NHMUK PV M 102225	1	horn core	7		Ruminantia	medium	
NHMUK PV M 102228	1	horn core	7		Ruminantia	large	
NHMUK PV M 102223	1	horn core	7		Ruminantia	medium	
NHMUK PV M 102226	2	horn core	8		Ruminantia	medium	
NHMUK PV M 102217	1	horn core	7		Ruminantia	medium	
NHMUK PV M 102230	1	horn core	8		Ruminantia	medium	